BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

Original Application No. 270/2025

IN THE MATTER OF:

NEWS ITEM TITLED "CONTAINERS FROM SUNKEN SHIP LIKELY TO DRIFT TOWARDS ALAPPUZHA KOLLAM COASTS IN 48 HOURS: INCOIS" APPEARING IN THE HINDU DATED 25.05.2025.

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Respondent No. 5

Filed by

Through

New Delhi
Dated 09-04-2026

GIGI.C. GEORGE
Advocate
Standing Counsel (UOI)
NATIONAL GREEN TRIBUNAL
Email: gigicgeorge.adv42@yahoo.in
M-9810625315

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION NO. 270/2025

APPLICANT: SUO MOTU

VERSUS

RESPONDENTS:

1. Member Secretary, Kerala Pollution Control Board
2. Member Secretary, Lakshadweep Pollution Control Committee
3. Member Secretary, Central Pollution Control Board (CPCB)
4. Secretary, Ministry of Environment, Forest and Climate Change (MoEF&CC)
5. Secretary, Ministry of Ports, Shipping and Waterways
6. Director General, Indian Coast Guard
7. Director-National Centre for Ocean Information Services (INCOIS) under Ministry of Earth Sciences

REPLY AFFIDAVIT BY RESPONDENT NO. 5

SECRETARY, MINISTRY OF PORTS, SHIPPING AND WATERWAYS

IN RESPONSE TO THE ORDER DATED 27.05.2025 PASSED IN OA 270/2025 (PB), CASE FILING NUMBER 070110201025/2025 BY THE HON'BLE TRIBUNAL

UNDER THE ENVIRONMENT (PROTECTION) ACT, 1986 AND HEAR & DECIDE THE OA FINALLY ON MERIT ON THE NEWS ITEM TITLED "CONTAINERS FROM SUNKEN SHIP LIKELY TO DRIFT TOWARDS ALAPPUZHA KOLLAM COASTS IN 48 HOURS: INCOIS" APPEARING IN THE HINDU DATED 25.05.2025

New Delhi, 24 March, 2026

Reply filed by

Respondent No. 5 - Secretary, Ministry of Ports, Shipping and Waterways: Parivahan Bhavan, 1, Parliament Street, New Delhi.

SUPPLEMENTARY AFFIDAVIT IN REPLY ON BEHALF OF RESPONDENT NO. 5

I, Rajendra Poswal, Age: 58, Occupation: Central Government Officer, having my office address at 3rd Floor, IWAI Building, A-13, Sector-1, Noida - 201301, do hereby state on solemn affirmation as under:-

1. I am filing this Affidavit in Reply in compliance with the Order dated 09.01.2026 passed by the Hon'ble National Green Tribunal (hereinafter also referred to as 'NGT'), Principal Bench (PB), New Delhi, on behalf of Respondent No. 5, i.e. the Secretary, Ministry of Ports, Shipping and Waterways (hereinafter referred to as 'MoPSW').

2. I say and submit that the Hon'ble National Green Tribunal, Principal Bench at New Delhi has taken *suo motu* cognisance in Original Application No. 270/2025 (PB) regarding the News item titled "Containers from sunken ship likely to drift towards Alappuzha, Kollam Coasts in 48 hours: INCOIS[1]" appearing in The Hindu dated 25.05.2025. The Hon'ble NGT (PB) vide order dated 09.01.2026 directed the Respondent - MoPSW to file a reply affidavit in the said matter. In respect of the marine incident involving 'MSC-ELSA 3' (IMO No. 9123221), I say and submit the following:

3. The present affidavit is being filed in compliance with the directions issued by this Hon'ble Tribunal vide order dated 09.01.2026, a true copy of which is annexed hereto and marked as **Exhibit A.**

4. In paragraphs 10, 11, 12 and 13 of the said order, this Hon'ble Tribunal directed Respondent No. 5, inter alia, to (i) disclose the names of States and Union Territories which may have suffered environmental damage on account of the ship sinking incident (other than the State of Kerala), and (ii) ascertain the extent of pollution and environmental damage likely to be caused by containers which have not been removed and are not feasible to be removed, including identification of the affected and likely-to-be-affected States/UTs.

[1] Indian National Centre for Ocean Information Services (hereinafter referred to as

NOTARY M.V. SINGH Advocate Notary G.B. Nagar up Regn. No. 195 GOVT. OF INDIA

Marine Department, New Delhi

5. With Reference to Paragraph 10 of the Order dated 09.01.2026, it is respectfully submitted that, apart from the State of Kerala, the State of Tamil Nadu has reported environmental impact arising from the incident involving the sinking of the cargo vessel MSC Elsa 3.

6. The Government of Tamil Nadu, through its Department of Environment and Climate Change, has submitted a claim assessment quantifying environmental damage and associated losses. As per the claim assessment received, the total estimated claim amounts to ₹1,041.805 crores, inter alia, towards environmental damage; and loss of livelihood, rehabilitation of critical habitats, and restoration of the natural ecosystem, arising due to the accumulation of plastic nurdles along the Tamil Nadu coast following the sinking of the cargo ship MSC Elsa 3. A true copy of the said claim assessment submitted by the Government of Tamil Nadu is annexed hereto and marked as **Exhibit B**.

7. It is respectfully submitted that, as on date, no other State or Union Territory, apart from the State of Kerala and the State of Tamil Nadu, has formally communicated any quantified environmental damage claims to Respondent No. 5. In so far as the Union Territory of Lakshadweep is concerned, Respondent No. 5 has not been formally apprised of any concluded assessment or quantified claim.

8. With Reference to Paragraphs 11 and 12 of the Order dated 09.01.2026, it is respectfully submitted that the issue relating to containers lying on the seabed and their removal is presently under technical evaluation by the Respondent No. 9 and their salvor, and no formal communication in this respect of the outcome has been provided by Respondent No.9. Furthermore, it is respectfully submitted that Respondent No. 5 is not the nodal agency for undertaking or certifying feasibility studies relating to environmental assessment or ecological impact determination. The assessment of environmental impact, including scientific feasibility evaluations concerning pollution and ecological consequences, falls within the domain of the Ministry of Environment, Forest and Climate Change, and its expert bodies.

9. It is therefore humbly submitted that any updated status in this regard may appropriately be sought from the Pollution Control Boards of the respective States and Union Territories or the Central Pollution Control Board under the Ministry of Environment, Forest and Climate

NOTARY M.V. SINGH Advocate Notary G. B. Nagar (U.P.) Regn. No. 185 GOVT. OF INDIA

GOVERNMENT OF INDIA Ministry of Marine Department, New Delhi

Change, which is the competent authority dealing with environmental assessment and related matters.

10. It is further submitted that Respondent No. 5 has already placed detailed factual updates regarding salvage operations, oil removal, shoreline cleanup, and coordination measures before the Hon'ble High Court of Kerala in WP (PIL) Nos. 50, 60 and 70 of 2025. The true copies of the reply affidavits filed in the said proceedings are annexed hereto and collectively marked as **Exhibit C**.

11. A consolidated true copy of all the situation reports ('SITREP'), including SITREP 42 dated 21.07.2025 to SITREP 46 dated 08.08.2025 in respect of 'MSC ELSA 3' is produced herewith and marked as **Exhibit D**.

12. In view of the facts and circumstances of the case furnished herein above, it is humbly requested that the Hon'ble Tribunal may kindly pass appropriate orders as deemed necessary.

PRAYER

In view of the above, it is respectfully prayed that this Hon'ble Tribunal may be pleased to take the present status report on record and pass such further orders as deemed fit and proper in the facts and circumstances of the case.

For & on behalf of the Secretary, Ministry of Ports, Shipping and Waterways,

Rajendra Poswal

Date: 24.03.2026

Place: Noida

NOTARY M.V. SINGH Advocate Notary G.B. Nagar up Regn. No. 1195 GOVT. OF INDIA

ATTESTED
Noida G.B. Nagar U.P.
24 MAR 2026

Solemn Affirmation

I, Rajendra Poswal, aged about 58 years, (Central Government Officer) do hereby take an oath and state on solemn affirmation that the contents as stated above from para. nos. 1 to 12 are true and correct to the best of my knowledge and information received from the official records, and hence I have signed on this day of 24 March 2026 at Noida.

NOTARY
M.V. SINGH
Advocate Notary
G. B. Nagar up
Regn. No. 1195
GOVT. OF INDIA

24 MAR 2026

Item No. 21 Court No. 1

BEFORE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 270/2025

News Item Titled "Containers From Sunken Ship Likely To Drift Towards Alappuzha Kollam Coasts in 48 Hours: Incois" Appearing in The Hindu Dated 25.05.2025.

Date of hearing: 09.01.2026

CORAM: HON'BLE MR. JUSTICE PRAKASH SHRIVASTAVA, CHAIRPERSON
HON'BLE DR. A. SENTHIL VEL, EXPERT MEMBER

Respondents: Mr. Sanjay Upadhyay, Senior Advocate with Mr. Amitava Majumder, Mr. Arvind Kumar Gupta, Mr. Vaibhav Agnihotri, Mr. Ruchir Goenka, Mr. Ashutosh Tiwari, Mr. Dushyant K Kaur, Ms. Mansi Bachani, Ms. Fizza Zaidi & Ms. Gitanjali Sanyal, Advs. for R - 9
Mr. Gigi. C. George, Adv. for R - 2, 5 & 6
Ms. Srishti Govil, Adv. for MoEF & CC (Through VC)
Mr. Anuj Bhandari, Adv. for CPCB (Through VC)
Mr. Nishi Rajen Shonker & Ms. Devika A.L, Advs. for the State of Kerala
Mr. Jogy Scaria & Mr. Ashwani Kumar Soni, Advs. for KSPCB
Mr. Samarvir Singh, Mr. Parveen Kumar Bansal, Mr. Naman Tandon & Mrs. Anshul, Advs. for R - 7

ORDER

1. This original application registered suo motu on the basis of the news item disclosing the incident of a container ship MSC ELSA 3 sink on the Kochi coast which was carrying 640 containers, including 13 with hazardous cargo and 12 containing calcium carbide.

2. The Tribunal vide orders dated 27.05.2025 and 30.07.2025 had impleaded the concerned respondents and had issued notices to them.

3. Learned Counsel appearing for the Respondent No. 9 has submitted that in respect of environmental damage which is caused on account of the sinking of the cargo, the proceedings have already been initiated before the Kerala High Court and the Admiralty Suit has been filed by the State of Kerala. Learned Counsel has pointed out that the WP (PIL) 50/2025 has been filed before the High Court of Kerala at

Ernakulam by T.N. Prathapan wherein following reliefs have been claimed:

> *"I. Declare that the 7th Respondent is having statutory duty to prepare a proper oil spill Disaster Contingency Plan and implement the same in accordance with Exhibit P2, P2(a) and P3 plans and finalise the proceedings in Exhibit P6 without any further delay.*
> *II. Issue a writ of mandamus or any other appropriate writ directing Respondents No. 1 and 6 to constitute a high-level expert committee to assess environmental damage and recommend measures for restoration;*
> *III. Issue a writ of mandamus or any other appropriate writ directing the Respondent Nos. 1 to 4 and 6 to prepare and implement a comprehensive compensation and rehabilitation package for all affected fishermen and stakeholders;*
> *IV. Issue a writ of mandamus or any other appropriate writ directing the Respondents No. 4, 6 and 7 to immediately remove all the pollutant/contaminants from the ship wreck site and affected areas;*
> *V. Issue a writ of mandamus or any other appropriate writ directing the Respondent Nos. 1 to 3, 6, 7 and 10 to initiate legal proceedings against the shipowner and insurer of the vessels viz. MSC ELSA-3 and MV Wan Hai 503 under all applicable international conventions and national laws.*
> *VI. Petitioner may be permitted to dispense with the filing of the translations of the documents in the vernacular language in the interest of justice;*
> *VII. Pass such other orders as this Hon'ble Court may deem fit in the interest of justice and equity."*

4. He has further submitted that WP (PIL) 60 of 2025 has also been filed before High Court of Kerala by one Ummer Ottummal, praying for the following relief:

> *"i. To declare that the 'MSC ELSA 3 Incident' and 'MV Wan Hai 503 Incident' had caused the ongoing environmental degradation in the Kerala Coast and the State inaction on the side of the 1st and 4th respondents and their Governmental Instrumentalities constituting a continuing violation of the Fundamental Right to Life, Liberty and Way of Living of the People living in the coastal area, under Article 21, 19(1)g and 29, r/w the Directive Principles of State Policy under Article 48A and the Fundamental Duties under Article 51A(g); and hence the matter be placed under the continuing monitoring process of the Hon'ble High Court of Kerala, by invoking the Jurisdictional Principles of 'Parens Patriae' and 'Sentinel on Qui Vive'.*
> *ii. Issue a Writ of Mandamus or any other appropriate Writ, Order or direction, directing the 1st respondent to constitute the High Court monitored Multi Agency Special Investigation Team comprising of representatives from the 3rd respondent MoEFCC, 7th respondent. Directorate General of Shipping, 10th respondent Indian Coast Guard, 8th respondent NDMA and other involved institutions to conduct a comprehensive time-bound investigation into the incidents involving MSC ELSA 3 & MV Wan Hai 503, in order to unearth :-*
> *A) cause of the accidents*
> *B) violation of Environmental, Safety and Maritime regulations*
> *C) The roles, responsibilities and failure, if any of the Classification Agencies (respondents 16 and 20, respectively),*

Insurer (15th respondent) and the 'Flag State' -Liberia & Singapore, respectively through the 21st respondent MEA.

iii. To constitute a Court-Monitored Environmental Restoration Task Force, composed of Independent Ecological Experts, Scientists, Maritime Safety Specialist and Representatives from the Statutory Bodies of the 1st and 4th respondents under the aegis of the 3rd respondent, MoEFCC.

iv. Issue a Writ of Mandamus or any other appropriate Writ, Order or direction, directing Respondent No. 4 to take immediate steps to enforce the 'Absolute Liability' based on 'Strict Liability Principles' to 13th and 19th respondent-owners, respectively and the 15th respondent Insurer of both the Vessels.

V. Issue a Writ of Mandamus or any other appropriate Writ, Order or direction, directing the Respondent No. 1 - Union of India (through the Ministry of Port and Shipping), to establish immediately a dedicated Coastal Victims Compensation, Rehabilitation and Environment Restoration Fund (CVCRERF) with the initial contribution of INR 1000 CR (Rupees One Thousand Crores) by the 1st respondent in order to restore the ongoing environmental degradation and the continued sufferings of the Coastal community - to be jointly administered by the 4th respondent and the Neutral High Level Committee comprised of members from the 1st respondent Union of India, 3rd respondent MoEFCC and the 23rd respondent, Ministry of Defense, as approved by the Hon'ble High Court of Kerala under the Chairmanship of a Chief Justice of a High Court (rtd), under the 'Public Law Remedy', for the benefit of the affected Coastal Community and for the restoration of the biodiversity and environment.

vi. Issue a Writ of Mandamus or any other appropriate Writ, Order or direction, directing the 1st despondent Union of India to take appropriate Legal action for prosecution and/or for compensation from the respondents 13 & 19 and 16 & 20 for violations of the Merchant Shipping Act and the applicable Laws in EEZ of India (Kerala Coast), including the International Conventions ratified in India, on 'Strict Liability Principles' and 'Polluter Pays Rule' in 'Environmental Jurisprudence'

vii. Issue a Writ of Mandamus or any other appropriate Writ, Order or direction, directing the Union of India 1st respondent to frame and place before this Hon'ble Court a National Coastal Hybrid Threat Prevention Framework and Constitute a High-Level Inter-Ministerial Task Force, with inclusion of the Defense and Environment Ministries, to address strategic maritime security breaches, beginning with the circumstances surrounding MSC ELSA 3 and MV Wan Hai 503 immediately,

viii. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the State of Kerala, 4th respondent, to form an effective comprehensive mechanism, immediately, for casting liabilities onto the owners/operators of the Vessels of the 13th and 19th respondents and it's Insurance Agency, 15th respondent, and their Classification Agents (respondents 16 and 20 under the laws in existence in India for a) Environmental degradation, b)Threat to biodiversity and marine life, c) Loss of livelihood and health risks to people, d) Violations of statutory and international nonns, prevalent in India.

ix. Issue a Writ of mandamus or any other appropriate writ, Order or Direction directing the Ist respondent to consider the proposal of the Petitioner, as contained in paragraph No. 16.11.i of the Writ Petition for avoiding/reducing the future incidents of Vessel mishaps with theHazardous and Noxious Substances and for the Safety, Security of the people, environment and the Nation.

x. Issue a Writ of mandamus or any other appropriate writ, Order or Direction directing the 4th respondent to handover the investigation of the Ext P 7 FIR registered, to the 24th respondent for a comprehensive investigation, forthwith.
xi To grant such other reliefs sought from time to time, including the cost of these proceedings.

INTERIM RELIEFS

For the reasons stated in the accompanying affidavit and the Memorandum of Writ Petition, it is most humbly prayed that this Hon'ble Court may be pleased to direct

a) the 1st respondent Union of India, to immediately coordinate the fire extinguishing and the rescue work with the DG of Shipping. Indian Coast Guard, the Disaster Management Authority (7th, 10th, 8th and 9th Respondents respectively) and the Indian Navy, and to control the inferno in 'MV Wan Hai 503 as the vessel is dangerously getting closer to the coast of Kerala, near Kodungallore, Kerala and place the 19th Respondent with absolute and strict liability,
b) the 4th respondent, State of Kerala, to constitute an immediate relief fund of a minimum of INR 100 crores (Rupees hundred crores) under 'Public Law Remedy Jurisdiction of this Hon'ble Court for mitigation of the suffering of the people in the Coast of Kerala and for the prevention of the damage caused/continuing to cause in the Coastal area due to the 'MSC ELSA 3 Incident' and 'MV Wan Hai 503 Incident'; and disburse the same through a High Level Committee appointed for the purpose, as approved by this Hon'ble Court."

5. He further submitted that the third writ petition, being WP(PIL) 70 of 2025 has been filed by one Charles George in Kerala High Court with the following prayers:

"I. Issue a writ of mandamus or any other appropriate writ, order or direction, commanding the 3rd Respondent to initiate and complete the urgent wreck removal operations of the sunken vessel MSC ELSA 3 in strict time bound manner forthwith, considering the grave environmental and navigational hazards posed by its continued presence in Kerala Coast & the exclusive economic zone of India;
II. Issue a writ of mandamus or any other appropriate writ, order, or direction, directing the 2nd Respondent or any other competent Respondent Authority to forthwith initiate proceedings under Section 4(1) (u) & Section 5 of the Admiralty (Jurisdiction and Settlement of Maritime Claims) Act, 2017, before this Hon'ble Court in its Admiralty jurisdiction, for the arrest of any vessel operated, owned, managed, or chartered by the 3rd Respondent, is presently within the territorial or Admiralty jurisdiction of this Hon'ble Court, in order to secure the maritime claim amounting to USD 134,000,000, being the estimated cost of complete wreck removal, bunker oil extraction, environmental remediation, and compensation to affected stakeholders arising out of the MSC ELSA 3 incident.
III. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 3rd Respondent to ensure that all components of the said wreck, including hazardous cargo and vessel debris, once recovered, are safely transported back to the flag State or the country of origin, in compliance with international maritime

environmental obligations and at no cost to the Indian Government or the public exchequer;

IV. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 8th Respondent in coordination with the 9th Respondent, to conduct a free, fair, independent and comprehensive investigation into the operational and technical failure of the vessel, MSC ELSA 3, and to prosecute any violations under applicable laws, both domestic and international;

V. Issue a writ of mandamus or any other appropriate writ, order or direction, commanding the 4th Respondent and 5th Respondent to take all necessary steps to enforce port-level safety protocols and to ensure that all major and minor ports in India are equipped with advanced scanning, detection and verification machinery to identify and intercept the movement of hazardous and noxious cargo in all vessels entering Kerala Coast & the exclusive economic zone of India;

VI. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 8th Respondent to immediately make public the complete Import General Manifest (IGM) filed by the 3rd Respondent in relation to MSC ELSA 3, in the interest of transparency and public safety;

VII. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 8th Respondent to publicly disclose the complete inventory of all containers recovered or salvaged from the wreck of MSC ELSA 3, and further directing that any inspection of such salvaged containers by the 1st, 2nd, 6th, 7th, and 8th Respondents shall be conducted only in the presence of an Amicus Curiae appointed by this Hon'ble Court to ensure transparency, credibility, and independent oversight,

VIII. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 1st, 2nd, 8th and 9th Respondents to publicly disclose all investigative steps, reports and findings undertaken thus far with respect to the sinking of MSC ELSA 3, and to make available such records for public scrutiny to uphold principles of transparency and accountability;

Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 3rd, 4th and 5th Respondents to produce and make public the official Stowage Plan of the vessel MSC ELSA 3, showing the exact configuration, type and placement of cargo onboard the vessel at the time of its departure, IX.

X. Issue a writ of mandamus or any other appropriate writ, order or direction, directing the 3rd Respondent to deposit an amount of minimum USD 134,000,000, adequate amount with the Registry of this Hon'ble Court, as security for future compensation to be awarded to the affected stakeholders, including but not limited to, the local fishing community, environmental agencies and the State Government of Kerala, in proportion to the environmental and economic damage caused by the incident;

XI. Pass such further or other orders as this Hon'ble Court may deem fit and proper in the facts and circumstances of the case, to prevent irreparable harm and hardship to the general public, to uphold the rule of law, and to secure the ends of environmental justice.

INTERIM RELIEF SOUGHT FOR:

For the reasons stated in the memorandum of writ petition (PIL) and its accompanying affidavit it is most humbly requested and prayed that this Hon'ble Court may be pleased to:

A. Direct the 3rd Respondent to initiate and complete the urgent wreck removal operations of the sunken vessel MSC ELSA 3 forthwith, considering the grave environmental and navigational hazards posed by its continued presence in Kerala Coast & the exclusive economic zone of India and to ensure that all components of the said wreck, including the hazardous cargo and vessel debris, once recovered, are safely transported back to the flag state or the country of origin, in compliance with International Maritime Environmental obligations and at no cost to the Indian Government or to the public exchequer.

B. Direct the 3rd Respondent to deposit an adequate amount with the Registry of this Hon'ble Court, as security for future compensation to be awarded to the affected stakeholders, including but not limited to, the local fishing community, environmental agencies and the State Government of Kerala, in proportion to the environmental and economic damage caused by the incident pending final disposal of this writ petition."

6. He has submitted that the High Court has put the proceeding in these PIL in abeyance and has directed the State of Kerala to file the Admiralty Suit and in compliance thereof, the State of Kerala has filed the Admiralty Suit No. 12 of 2025, wherein the security on account of the environmental damage suffered by the State under the following heads have been claimed:

"

Sl. No.	*Nature of Claim*		*Amount Claimed (in Crores)*	*Security to be demanded (in Crores)*
1.	*Compensation for oil pollution*	*:*	*Rs.8,554.39*	*Rs.500.00*
2.	Compensation for cargo pollution	*:*	Rs.71.73	Rs.41.31
3.	Cost incurred by the Kerala State Pollution Control Board	*:*	Rs.1.38	Rs.1.38
4.	Estimate for future cost for preventive measures by the Kerala State Pollution Control Board	*:*	Rs.18.00	Rs.3.00
5.	Cost incurred by the Department of Fisheries for studies	*:*	Rs.0.45	Rs.0.45
6.	Remediation cost for hazardous chemical pollution	*:*	Rs.152.10	Nil
7.	Remediation cost for plastic pollution	*:*	Rs.150.45	Rs.150.45

8.	Remediation cost for other pollutants.	:	Rs.56.10	Rs.56.10
9.	Economic loss to the fishermen due to market scare on fish quality	:	Rs.349.00	Rs.349.00
10.	Landing loss due to the fishing ban in 20 NM	:	Rs.71.00	Rs.71.00
11.	Economic loss to the fishermen due to the fishing ban	:	Rs.106.51	Rs.54.93
Total			Rs.9,531.11	Rs.1,227.62

"

7. He has further submitted that the Admiralty Court vide dated 25.09.2025 has directed to secure the amount of Rupees 1227.62 Cr and in terms of the said direction, the Respondent No. 9 has secured the State of Kerala claim by view of a bank guarantee.

8. Since the claim of compensation for the environmental damage suffered by the State of Kerala is already pending before the Kerala High Court as also in the Admiralty Suit filed by the State of Kerala, therefore, it may not be proper by this Tribunal to go into the issue of environmental damage suffered by the State of Kerala in the incident.

9. It is required to be ascertain if the other States or Union Territories have also suffered the environmental damage on account of the incident of the cargo sinking as the Kerala High Court in PIL or in admiralty suit will be exercising the jurisdiction confined to the environmental damage suffered by the State of Kerala only. It has been pointed by the learned counsel for the Respondent No. 5 that the WP (MD) 16258/2025 has been filed by S.M. Anthony Muthu and ors. before Madurai Bench of the Madras High Court. But it is not clear if in that writ petition the petitioners have also claimed the environmental damage compensation on account of the environmental damage suffered by the State of Tamil Nadu.

10. Learned Counsel for Respondent No. 5 has also submitted that the UT of Lakshadweep is also in the process of assessing the environmental damage, if any, suffered by it. The Respondent No. 5 is required to disclose if any other States or Union Territories have suffered environmental damage on account of the pollution caused in the incident of cargo sinking, under consideration in this OA. Therefore, the Respondent No. 5 is directed to file a fresh status report disclosing the names of the States and the Union Territories which may have suffered environmental damage on account of the ship sink incident in question except the State of Kerala

11. It has been disclosed to us that the shipwreck and containers have not been removed, and they are lying on the seabed.

12. The stand of the Respondent No. 9 is that it is in the process of retrieving the containers which are feasibly and possible. Hence, the Respondent No. 5 is required to be ascertain the extent of pollution and environmental damage which will be caused by the containers not removed and no possible to be removed and the extent of the area and the States and Union Territories which are affected and likely to be affected on account of such environmental pollution.

13. Let the report in this regard covering the above aspects be filed by the Respondent No. 5 within six weeks.

14. List on 21.04.2026.

Prakash Shrivastava, CP

Dr. A. Senthil Vel, EM

January 09, 2026
O.A No. 270/2025
HB

2874

Gmail

Yukta Matlapurkar <ymatlapurkar@gmail.com>

Fwd: Tamil Nadu Coast-Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill

1 message

Anish Joseph <anish-dgs@gov.in> Fri, Dec 12, 2025 at 10:10 AM
To: ymatlapurkar <ymatlapurkar@gmail.com>

सादर | Regards
कप्तान अनिश जोसफ़ | Capt. Anish Joseph
उप नॉटिकल सलाहकार-सह-वरिष्ठ उप नौवहन महानिदेशक (तकनीकी / समुद्री सुरक्षा)
Deputy Nautical Adviser -cum-Senior Deputy Director General of Shipping (Technical / IT & E-Governance / Maritime Security)
नौवहन महानिदेशालय, मुंबई | Directorate General of Shipping, Mumbai
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय | Ministry of Ports, Shipping & Waterways
Website : www.dgshipping.gov.in
Mobile : 91 98472 29295
Email : anish-dgs@gov.in

========== Forwarded message ==========
From: Anish Joseph <anish-dgs@gov.in>
To: "Yukta Matlapurkar Legal Assistant"<nautic.lglassit4-dgs@gov.in>
Cc: "Abul Kalam Azad"<abulkalam.azad@gov.in>
Date: Tue, 09 Dec 2025 16:44:28 +0530
Subject: Fwd: Tamil Nadu Coast-Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill
========== Forwarded message ==========

Dear Yukta,

On priority on file.

सादर | Regards
कप्तान अनिश जोसफ़ | Capt. Anish Joseph
उप नॉटिकल सलाहकार-सह-वरिष्ठ उप नौवहन महानिदेशक (तकनीकी / समुद्री सुरक्षा)
Deputy Nautical Adviser -cum-Senior Deputy Director General of Shipping (Technical / IT & E-Governance / Maritime Security)
नौवहन महानिदेशालय, मुंबई | Directorate General of Shipping, Mumbai
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय | Ministry of Ports, Shipping & Waterways
Website : www.dgshipping.gov.in
Mobile : 91 98472 29295
Email : anish-dgs@gov.in

2875

========== Forwarded message ==========
From : tamilnadudoe@gmail.com<tamilnadudoe@gmail.com>
To : <anish-dgs@gov.in>
Date : Tue, 09 Dec 2025 07:48:04 +0000
Subject : Fwd: Tamil Nadu Coast-Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill
========== Forwarded message ==========

Sub: Comprehensive Environmental Compensation claims due to wreckage of Cargo ship MSC ELSA-3 resulting nurdle spill off the Tamil Nadu coast.

Dear Mr.Anish, DG shipping

As discussed during our telephonic conversation today regarding the subject cited above, we are again submitting the following documents related to the environmental compensation claim due to the wreckage of the cargo ship *MSC ELSA-3* and the subsequent nurdle spill off the Tamil Nadu coast. These documents were previously submitted to the DG Shipping official email ID on 28.11.2025:

1. Request Letter for compensation claim
2. Detailed Report on Environment damages
3. Detailed Report on fisherman livelihood loss
4. Minutes of Meeting chaired by Chief secretary Government of Tamilnadu,
5. Govt approval Letter for comprehensive compensation claim

In this regard, it is requested that an acknowledgement of receipt along with the detailed procedure for applying the compensation claim, to enable us to provide the action taken report to the Government.

This may kindly be given Top Priority

Regards
For Director
Department of Environment
Government of Tamilnadu
044-24336421

---------- Forwarded message ---------
From: **Tamil Nadu Environment Department** <tamilnadudoe@gmail.com>
Date: Mon, Dec 8, 2025 at 2:18 PM
Subject: Fwd: Tamil Nadu Coast-Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill

2876

To: <dg-dgs@gov.in>
Cc: <ravi.sikarwar@gov.in>, <pcmeena-dgs@gov.in>

Dear Sir

In continuation of the trailing mail regarding the submission of the compensation claim for the MSC ELSA-3 nurdle spill along the coastal stretch of Tamil Nadu, it is requested to kindly send the acknowledgement of receipt of the letter and inform us about the processing time, to enable us to submit the details to the Government.

This may kindly be given Top Priority

For Director
Department of Environment and Climate change
Chennai - 600035
Tamilnadu

---------- Forwarded message ---------
From: **Tamil Nadu Environment Department** <tamilnadudoe@gmail.com>
Date: Fri, Nov 28, 2025 at 12:15 PM
Subject: Tamil Nadu Coast-Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill
To: <dg-dgs@gov.in>, <chennai-mmd@gov.in>
Cc: <ravi.sikarwar@gov.in>, <pcmeena-dgs@gov.in>, <chennai-mmd@gov.in>

Sir/Madam,

Please find the attached letter and report on Comprehensive Environmental Compensation claims for the MSC ELSA-3 Nurdle spill: Tamil Nadu Coast.
This may kindly be given Top Priority

And request you to kindly acknowledge the receipt of the same

3. Detailed Report TNPCB EC cost.pdf

For Director
Department of Environment and Climate change
Chennai - 600035
Tamilnadu

2877

5 attachments

- **1.CS Minutes of Meeting.pdf**
  770K
- **2.Letter (D) No.274 (2).pdf**
  508K
- **4.Fisheries compensation cost.pdf**
  1785K
- **5. Detailed Report Livelihood loss.pdf**
  927K
- **Letter for Compensation Claim.pdf**
  7897K

DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE

From
Thiru. A.R. Rahul Nadh, I.A.S.,
Director,
Department of Environment &
Climate Change,
No.327, 9th floor, CMRL building,
Anna salai, Nandanam,
Chennai -35
Ph.No :044-24336421
Email.tamilnadudoe@gmail.com

To
The Director General of Shipping
Directorate General of Shipping
"Beta Building", 9th Floor,
i-Think Techno Campus,
Kanjur Village Road, Kanjurmarg
(East),
Mumbai – 400042

Lr.No.efile.1012/JDO/AE/2025, Dated:27.11.2025

Sir

Sub: Department of Environment & Climate change, Govt of Tamilnadu Submission of Compensation Claims for (i) environmental damage and (ii) Loss of livelihood, rehabilitation of critical habitats/restoration of natural eco system, due to the accumulation of plastic nurdles along the Tamil Nadu coast following the sinkage of the cargo ship MSC ELSA III (IMO no - 9123221. Flag Liberia) off the Kerala coast – filing and processing of the Compensation Caim – Requested -Regarding

Ref.:

1. Incident of MSC ELSA III (IMO no - 9123221. Flag Liberia) cargo ship wreck along Kerala Coast near Kochi on 24.05.2025
2. Minutes of the Meeting chaired by the Chief Secretary to Government on 08.07.2025. (Copy Enclosed)
3. TNPCB letter No. T1/TNPCB/PWM/F.011515/Nurdle Spill/2025 Dated: 07/10/2025
4. Department of Fisheries and Fisherman Welfare Letter R.C No. 15020/P3/2025, dt:23.10.2025
5. Environment, Climate change & Forest Department, GoTN Letter (D) No.274, Dated 24.11.2025 (copy Enclosed)

****

With reference to the *MSC ELSA III* (IMO No. 9123221, Flag: Liberia) cargo ship wreck occurred in the Arabian Sea on 24.05.2025, at approx. 38 NM off the Kerala coast, it is submitted that aftermath

the incident, significant quantity of plastic nurdles (84 Ton reported so far) were accumulated into Tamil Nadu coastal stretch. The first confirmed landings along the Tamil Nadu coast were reported on 28.05.2025 in Kanyakumari District, subsequently impacting the other coastal stretch of Tirunelveli, Thoothukudi Districts of Tamil Nadu. Subsequently multiple rapid and repeated were found along the Gulf of Mannar and Palk Bay coasts, including Ramanathapuram, Pudukkottai, Thanjavur, Thiruvarur and Nagapattinam districts.

This plastic contamination has resulted in widespread accumulation of nurdles along the shoreline of Tamilnadu, which resulted in substantial environmental degradation, coastal pollution, and socio-economic losses to the local fisherman also caused severe adverse impacts on the coastal ecosystem, fisheries, livelihoods of coastal inhabitants, and ongoing beach management efforts. The affected stretch in Tamil Nadu is estimated at 843.7 Km across 8 coastal districts.

The nurdle pollution persists despite continuous cleanup operations undertaken by Government of Tamilnadu. The removal and safe disposal of these plastic pellets require considerable manpower, logistics, and financial resources. In addition to the direct environmental damages, as the incident occurred right during the onset of the peak fishing season, it obviously affected the fishing activities caused substantial socio-economic losses to the local communities who dependent on marine and coastal resources.

As per the environment and livelihood impact assessment study carried out by Tamil Nadu Pollution Control Board and Fisheries and Fisherman welfare department of Tamil Nadu, the following environment damages have been identified:

1. Marine Ecological damage to coral reef, Sea grass, Mangrove
2. Impact on fishing activities and livelihood losses
3. Beach and coastal habitat disturbance requiring remediation / restoration

4. Costs incurred by the GoTN for debris removal and emergency response

In this context, the above said authorities have assessed the losses as detailed below, and

S. No	Description	Amount in Crore
1	Environmental damage assessment and restoration measures for affected marine and coastal habitats. Including cleanup cost incurred for cleanup, collection, and scientific disposal of plastic nurdles.	Rs.182.415
2	Socio-economic rehabilitation support for impacted fishermen and coastal communities.	Rs.859.390
	Total Compensation Amount	Rs. 1041.805 crore

As per decision and direction issued in the Meeting chaired by the Chief Secretary to Government on 08.07.2025 vide the ref 2nd cited, a comprehensive compensation claim has been prepared based on the inputs from TNPCB and Fisheries and Fisherman welfare department and the government has accepted the comprehensive environmental compensation claim amount Rs. 1,041.805 crore (Rupees One Thousand Forty-One Crore Eighty Lakhs and Five Thousand only) vide reference 3rd cited.

The detailed compensation claim proposal towards environmental damage and livelihood loss to fishermen, supported with photographic evidence and survey findings, is submitted herewith for your kind perusal and it is requested to initiate necessary action for filing and processing the total compensation claim amount of **Rs. 1,041.805 crore** (Rupees One Thousand Forty-One Crore Eighty Lakhs and Five Thousand only) from the shipowner/ insurer. The above claim is directly linked to the pollution and environmental

damage resulting from the wreck of MSC ELSA III and is being sought in accordance with the "Polluter Pays Principle".

Further, it is also requested to provide the contact details of the concerned official/section for further coordination.

Enclosure

1. Comprehensive Compensation Abstract
2. Incident summary Report
3. Detailed Report on Environmental Compensation claim submitted by TNPCB, GoTN
4. Detailed Report on Compensation of Livelihood loss to the fisherman submitted by Fisheries Department, GoTN

Yours faithfully,
Sd./A.R. Rahul Nadh,
Director, Department of Environment
and Climate Change

Copy submitted to

1. The Principal Officer
   Mercantile Marine Department
   Anchorgate Building, 2nd Floor,
   P.B.No.5004, RajajiSalai,
   Chennai - 600 001 (For kind information and necessary action)

Copy to

2. The Additional chief Secretary to Government,
   Environment, climate change, & Forest Dept Secretariate,
   Chennai – 600 009 (For kind information)
3. The Chairperson,
   Tamilnadu Pollution Control Board (For kind information)
4. The Commissioner,
   Fisheries and Fishermen Welfare Department (For kind information)
5. The Commissioner (Disaster Management)
   Tamil Nadu Disaster Risk Reduction Agency,
   Chepauk, Chennai -5

//forwarded by Order//

22.11.19

For Director, Department of Environment
and Climate Change

ENCLOSURE-1

COMPREHENSIVE COMPENSATION ABSTRACT

S. No	Description	Amount in Crore
A.	ENVIRONMENTAL COMPENSATION claims due to MSC Elsa-III Plastic Nurdles Spill in Tamilnadu Coast.	Rs. 182.415
B.	COMPENSATION FOR LIVELIHOOD LOSS TO THE FISHERMEN, study the long-term impact and remedial measures due to MSC Elsa-III Plastic Nurdles Spill in Tamilnadu Coast	Rs. 859.390
	TOTAL COMPENSATION (A) + (B)	**Rs. 1041.805**

A. ENVIRONMENTAL COMPENSATION ASSESSED BY TNPCB

As Guided by the polluter-pays and precautionary principles, and consistent with the CPCB's Environmental Compensation framework (Clause 1.4.2), TNPCB constituted Technical Expert Committee consisting of Dr. Ramesh, Advisor, TNGCC, Dr. Patterson, Director, SDMRI; Dr. Rajamanickam, Retd ACEE, TNPCB; Dr. Vasudevan, Retd JCEE, TNPCB and inputs from CSIR-NIO report for assessment to base claims on actual as follows

S. No	Description	Amount in Crore
A	**Environmental Compensation Claim**	
I	**Ecological Restoration & Hotspot Remediation**	
1	Coral restoration	27.9808
2	Seagrass restoration	52.4640
3	Mangrove restoration	0.8744
4	Coastal Hotspot remediation (beach/estuary/rocky/mudflat)	15.00
	Sub Total (I)	**96.3192**
II	**Programs & Operational Receptor**	
	Public-health surveillance (12 months)	9.00
	Tourism amenity remediation	10.00
	Long-term monitoring & research (24 months)	6.00
	Government manpower & analytics	7.00
	Operational receptors (salt pans, aquaculture, intakes)	12.00
	Sub Total (II)	**44.00 Crore**
III	**Programme Management & Contingency**	
	Programme management (5% of Base)	7.016
	Contigency & transaction (25% of Base)	35.0798
	Sub Total (III)	**42.0958**
	(A) Grand Total (I) + (II) + (III)	**Rs.182.415 Crore**

B.

B. COMPENSATION OF LIVELIHOOD LOSS TO THE FISHERMEN

Department of Fisheries and Fishermen Welfare has submitted the compensation proposal in the following head

S. No	Description	Amount in Crore
B	Compensation loss of livelihood, rehabilitation of critical habitats', and restoration of natural eco system due to sinking of ship MSC ELSA 3	
1	Study – Long term impact of the deposition of pollutants and their remedial measures – Dr. J. Jayalalithaa Fisheries University	0.50
2	Compensative wage loss to the Fishermen and revenue loss to the Fishing boats of Kanniyakumari and Ramanathapuram districts	110.95
3	Compensation against the reduction in fish catch and reduction in consumption due to apprehension of plastic and other pollutants	600.00
4	Promotion off.shore fishing to compensate fishery stock reduction in inshore area providing subsidy (80%) for constructing deep sea fishing vessels	96.00
5	Sea ranching has to be undertaken as direct fish stock enhancement measures	5.47
6	Supporting natural breeding process, installation of artificial reefs at 40 villages	38.13
7	Long-term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi & Ramanathapuram coast	8.34
	B. Total	**Rs.859.39 Crore**
	TOTAL COMPENSATION (A) + (B)	**Rs. 1041.805 Crore**

****

Yours faithfully,
Sd./A.R. Rahul Nadh,
Director, Department of Environment
and Climate Change

//forwarded by Order//

For Director, Department of Environment
and Climate Change

ENCLOSURE -2

INCIDENT SUMMARY REPORT

1.Claimant Details

Name of Organization	-	Department of Environment and climate change, Govt of Tamilnadu (On behalf of Government of Tamilnadu)
Head of the Department	-	Thiru. A.R. Rahul Nadh, I.A.S., Director, Department of Environment & Climate Change
Address	-	No.327, 9th floor, CMRL building, Anna salai, Nandanam, Chennai -35 Contact No: 044-24336421 E-mail: tamilnadudoe@gmail.com

2. Incident Details

Name of Ship	-	MSC ELSA III – Cargo ship
IMO Number	-	9123221
Flag	-	Liberia
Date of Incident/ Wreck	-	25 May 2025
Location	-	In the Arabian Sea, 14.6 NM of the Kerala Coast

3.Nature of Incident:

- A Liberian cargo ship MSC ELSA-3 sank with 640 containers in the Arabian Sea on 24.05.2025 at about 38 Nautical Miles off Vizhingam coast of Kochi, Kerala.
- Out of 640 containers, 13 containers were reported to contain dangerous material. As per the Kerala State Disaster Management Authority (KSDMA) report, the following materials were present in the containers. Plastic Pellets (Nurdles), Calcium Carbide, Marine Gas Oil (MGO), Very Low Sulphur Fuel Oil (VLSFO)
- Impact of Southwest Monsoon: Due to Southwest Monsoon, some containers and spilt materials were moved towards the coast of Tamilnadu and got deposited in the shorelines of Tamil Nadu.

4. Incident Chronology:

4.1 **25 May 2025-** MSC ELSA-III sinks ~38 NM off Kochi, Kerala, with ~640 containers on board, including hazardous consignments and large volumes of diesel/furnace oil. Plastic resin pellets ("nurdles") are among the cargo.

4.2 **27 May 2025**- First confirmed landings in Kerala: Loose nurdles and sealed 25-kg Thiruvananthapuram beaches sacks reported on

4.3 **28 May- 02 June 2025**- Cross-state transport: Monsoon-driven currents carry plastic pellets around Cape Comorin; first confirmed landings in District Kanyakurnari, followed by Tirunelveli and Thoothukudi districts, Tamilnadu Coastal

4.4 **June-July 2025** - Recurrent beach falls observed along the Gulf of Mannar and Palk Bay coasts, including Ramanathapuram, Pudukkottai, Thanjavur, Thiruvarur and Nagapattinam. Pellets recorded both as surface deposits and buried layers in the high-tide zone; Intact bags recovered at several sites. Widening footprint in Tamil Nadu

4.5 **Ongoing (July-August 2025)** - Continuing arrivals. Intermittent fresh landings consistent with seasonal wind/wave patterns; re-mobilisation of previously buried pellets noted after high-energy events.

Implication: The event is dynamic rather than static; the footprint and load evolve with seasonality, necessitating a claim that includes continuing deposition and removal inefficiencies.

5. Actions Taken by Tamilnadu Government

The district administration took up the clean-up drive on the deposited pollutants and other measures in coordination with the following Departments/ agencies.

1. Tamil Nadu Pollution Control Board (TNPCB)
2. Tamilnadu Fisheries and Fishermen Welfare Department
3. Tamilnadu Revenue Administration and Disaster Management
4. Local Body, Tamilnadu
5. Department of Environment & Climate change, Tamilnadu

The Clean-up drive was initiated on 28.05.2025 and undertaken till 14.06.2025 by the district administration in coordination with the district level officials of various departments. Over 300 workers including Aapda Mitras, Sagar Mitras, Sanitary Workers and Government Officials were involved in these works on a daily basis.

The nurdles bags were stored in the respective fishing harbour sites under the jurisdiction of the Assistant Directors (Fisheries). Due to the monsoon, cleanup activities were temporarily stopped from 15.06.2025 to 21.06.2025. During this period, the bags stored in the respective harbour sites were sieved and repacked into bags of 25 kg and shifted to Jeppiar Fishing Harbour Warehouse at Muttom, which is the common storage site. The washed ashore container was transported to Tuticorin port. The barrel is in the Jeppiar Fishing Harbour, Muttom.

6. Environmental Comprehensive Compensation proposal

6.1 Environment Compensation assessed by TNPCB, GoTN

The affected stretch in Tamil Nadu is estimated at 843.7 Km across 8 coastal districts, encompassing ecologically sensitive and socio economically critical shoreline.

As Guided by the polluter-pays and precautionary principles, and consistent with the CPCB's Environmental Compensation framework (Clause 1.4.2), Tamilnadu Pollution control Board (TNPCB) has constituted Technical Expert Committee consisting of

Dr. Ramesh, Advisor, TN Green Climate Company;

Dr. Patterson, Director, SDMRI;

Dr. Rajamanickam, Retd ACEE, TNPCB;

Dr. Vasudevan, Retd JCEE, TNPCB and

Inputs from CSIR-NIO report

The environmental assessment to base claims on actual is summarized in the **Table-1** below

6.2 Livelihood loss assessed by Fisheries Department, GoTN

Tamilnadu, Department of Fisheries and Fishermen Welfare has undertaken several measures to address environmental issues caused by plastic nurdles washed ashore along the Tamil Nadu coast.

6.2.a Awareness and Warnings

Instructions were issued to coastal fishing villages advising people not to touch or handle the washed-ashore materials. Awareness was spread through public announcements and WhatsApp groups.

6.2.b Monitoring by Sagar Mitras

Sagar Mitras and fishermen volunteers were engaged to continuously monitor coastal areas and report nurdle deposition sites to the District Administration.

6.2.c Cleaning Coordination

The department coordinated with the Local Administration and Revenue Department for the safe removal of plastic pellets.

6.2.d Kanniyakumari District Situation

Plastic pellets, wooden boards, iron, and aluminum materials were found along 37 fishermen villages from Manakkudi to Neerodi due to the southwest monsoon and sea currents. A container was washed ashore near Vaniyakudi.

6.2.e Scientific Studies:

- The TNJFU, CMFRI, and SDMRI were engaged to conduct study the impact of the pollution on fisheries.
- Dr. J.Jayalalitha, Fisheries University, (TNJFU) collected fish samples and studied impact on Marine life and submitted a Report with key recommendations
- Central Marine Fisheries Research Centre (CMFRI) collected water, sediment, and plastic samples from Melakurumpanai and Enayam,
- SDMRI has conducted environment impact assessment study

Plastic nurdles pose severe environmental and health risks. They mix with sediments due to ocean currents, are ingested by marine animals, and cause

physical and ecological damage. Weathered nurdles break into micro- and nanoplastics, entering the food chain through filter-feeding organisms like bivalves and threatening benthic habitats. They can also adsorb toxic chemicals—up to a million times more concentrated than in seawater—and harbor harmful pathogens such as E. coli and Vibrio species.

The widespread dispersion, now reaching as far as Tamilnadu coast, has alarmed fishermen, environmentalists, and authorities due to the potential impacts on marine biodiversity, fisheries, and seafood safety, posing both ecological and public health concerns.

Table -1 Environmental Comprehensive compensation

Type of Damage	Description	Estimated Cost in crore	Remarks
6.1- Environmental Compensation Claim			
6.1.1-Ecological Restoration & Hotspot Remediation	Coral restoration	27.9808	Ecological injury to coral. Replacement and restoration cost - 8 ha x Rs.3.4976 crore/Ha
	Seagrass restoration	52.46	Ecological injury to Sea grass. Replacement and restoration cost- 40 ha x Rs.1.3116 crore/Ha
	Mangrove restoration	0.8744	Ecological injury to Mangrove. Replacement and restoration cost- 20 ha x Rs.0.04372 crore/Ha
	Coastal Hotspot remediation (beach/estuary/rocky/mudflat)	15.00	60 Km x Rs.0.25 crore
6.1.2- Programs & Operational Receptor	Public-health surveillance (12 months)	9.00	20 sites (2 test per site per month) @ 0.20 Lakhs per test And Lab upgrades QA/QC
	Tourism amenity remediation	10.00	Disruption along the polluted beaches and sanctuaries in Dhanuskodi/ greater Flamingo Sancturary
	Long-term monitoring & research (24 months)	6.00	To track microplastic burdens, hrdrocarbons and ecological recovery and to harden SOPs for future incidents.
	Government manpower & analytics	7.00	The cost incurred till date for the cleanup activity and for analysis of samples collected in the affected area is included under this head. Future cleanup required for next 12 months
	Operational receptors (salt pans, aquaculture, intakes)	12.00	The exact area of salt pans/industries which draws sea water arrived based on the expected effects on these receptors a lumpsum is taken.

Type of Damage	Description	Estimated Cost in crore	Remarks
6.1.3-Programme Management & Contingency	Programme management (5% of Base)	7.016	
	Contingency & transaction (25% of Base)	35.0798	
	Sub total (A)	Rs. 182.415	
6.2 Compensation of livelihood loss to Fisherman			
6.2.1 Study – Long term impact	Study – Long term impact of the deposition of pollutants and their remedial measures (The study aims to assess, analysis and map pollution hot spot the extent of plastic nurdle contamination in the coastal waters, sediments, and benthic communities along the contaminated coast.)	0.50	The outcomes will reveal how plastic nurdles transport harmful pollutants and aid in formulating effective mitigation strategies.
6.2.2-Compensative wage loss to the Fishermen	Compensative wage loss to the Fishermen and revenue loss to the Fishing boats of Kanyakumari and Ramanathapuram districts (There are 1,386 mechanized, 8,105 motorized and 125 non-motorized registered fishing crafts in the affected areas. Similarly, 51,557 active fishermen 55,602 fisherwomen reside in the affected areas.) A total amount of Rs 110.95 crore may be claimed to compensate the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Dt	110.95	The motorized and non-motorized country crafts were not ventured for fishing for a period of 5 days from 28.05.2025 to 01.06.2025. The revenue loss to the fishermen and fishing boats during these 5 days has been worked out.
6.2.3 Compensation against the reduction in fish catch	Compensation against the reduction in fish catch and reduction in consumption due to apprehension of plastic and other pollutants	600.00	Total value of the prominent fish species is around Rs 12,000 Crores. 5 % value loss of

Type of Damage	Description	Estimated Cost in crore	Remarks
			the total fish catch of 24 listed species due to restricted fishing and also apprehension among the local public regarding the consumption of fish is being calculated and the amount arrived is Rs 600 crores. It is proposed to create a corpus using the above compensation
6.2.4 Promotion off. shore fishing to compensate	Promotion off. shore fishing to compensate fishery stock reduction in inshore area providing subsidy (80%) for constructing deep sea fishing vessels	96.00	100 boats @ total cost 1.20 crores each. 80 % subsidy amount – 96 lakhs (To mitigate the long-term effects on the fisheries resources and also to enhance the livelihood of the fishermen of the district,)
6.2.5 Sea ranching	Sea ranching has to be undertaken as direct Fish stock enhancement measures Sea ranching involves releasing hatchery-breed aquatic organisms into natural habitats to restore depleted stocks and promote sustainable fisheries.	5.47	The proposal aims to replenish fish and shellfish populations affected by pollution and overfishing, restore ecosystems, conserve marine resources, and enhance fisherfolk livelihoods
6.2.6 Supporting natural breeding process	Supporting natural breeding process, installation of artificial reefs at 40 villages. Hence, as a measure to improve the coastal marine fisheries by stock enhancement, it has	38.13	Installation of artificial reefs would be helpful for the artisanal fishermen to exploit the fish stocks. It is proposed to install 120 artificial reef sets at 40 villages in the

Type of Damage	Description	Estimated Cost in crore	Remarks
	been proposed to deploy artificial reefs in 37 locations in Kanniyakumari District and 03 location in Ramanathapuram District.		inshore area of Kanniyakumari and Ramanathapuram Districts of Tamil Nadu. Total amount required for the project is Rs.38.13 crore.
6.2.7 Long-term monitoring	Long-term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thaothukudi & Ramanathapuram coast The Plastic nurdle pollution along the Tamil Nadu coast, threatening marine ecosystems, seafood safety, and public health.	8.34	The proposed study aims to assess contamination levels, establish a pollution testing lab, analyze ecological and human health impacts, and map high-risk zones for effective mitigation.
	Sub Total (B)	Rs. 859.39	
	Grand Total (A) + (B)	Rs. 1041.805 Crore	

Total Estimated Compensation Claim Amount: Rs. 1041.805 Crore

7. Supporting Evidence for comprehensive compensation

1. Pollution monitoring reports / laboratory Test results
   Test report for 42 points Page No. 203 to 213
2. Photographs, videos, maps showing extent of damage
   Page No.43 to 49
3. Expenditure statements, invoices, vouchers
   Page No 165 to 202
4. Assessment report from Pollution Control Board
   Booklet enclosed
5. Any other relevant record
   Chief secretary, Tamilnadu Government – Meeting minutes 08.07.2025enclosed

****

Yours faithfully,
Sd./A.R. Rahul Nadh,
Director, Department of Environment
and Climate Change

//forwarded by Order//

For Director, Department of Environment
and Climate Change

Ref-3

TNPCB-PWM-Environmental Compensation Claims for the impact of plastic nurdle epill from MSC Elsa-3 along TamilNadu coast-Submitted-Reg.

PWM Sec TNPCB < pwmsec@tnpcb.gov.in >
Tue, 07 Oct 2025 7:21:32 PM +0530

To "tndoe"<tndoe@nic.in>,"tndoe"<tndoe@tn.nic.in>

Cc "eccfd"<eccfd@tn.gov.in>,"revsec"<revsec@tn.gov.in>,"tnstateeoc1" <tnstateeoc1@gmail.com>

Sir/Madam,

Please find the attached report on Environmental Compensation claims for the MSC ELSA-3 Nurdle spill: Tamil Nadu Coast.

For Chairperson
TNPCB.

2 Attachment(s)

Environmental Compensation ...	20251007195901708.pdf
16.8 MB	348.2 KB

File No.10(1)/Corporate Affairs/Complaint No.xxxxx/xxxx
Downloaded from eOffice by MUNIYAMMAL JUNIOR ASSISTANT GR6, JUNIOR ASSISTANT GR6, DIRECTORATE OF ENVIRONMENT AND CLIMATE CHANGE on xx-xx-xxxx xx:xx:xx

TAMIL NADU POLLUTION CONTROL BOARD

LiFE Lifestyle for Environment

From
Dr. Jayanthi. M, I.F.S.,
Chairperson,
Tamil Nadu Pollution Control Board,
76 Mount Salai,
Guindy, Chennai 600 032.

To
The Director,
Department of Environment and Climate Change
No.327 Metros, 9th Floor, Anna Salai,
Nandanam, Chennai- 600 035

Letter No. T1/TNPCB/PWM/ F.011515/ Nurdle Spill/ 2025, Dated: 07-10-2025

Sir/Madam,

Sub: TNPCB - PWM - MSC Elsa-3 nurdle spill incident- Compensation Claims for the Impact of plastic nurdles in Tamil Nadu Coast-Submitted - Reg.

Ref: 1. Minutes of the meeting held under the Chairmanship of Chief Secretary to Government on 08.07.2025.
2. Govt letter (D) No. 1452/EC.2/2025-7 dated 22.09.2025.

****

I am to inform that as instructed in the Review meeting conducted by the Chief Secretary on 08.07.2025, TNPCB had taken up the assessment of environmental compensation claims for the impact of plastic nurdles on various ecosystems along the Tamil Nadu coast. In this regard, the compensation claims were prepared by the technical committee formed by TNPCB and the final report is submitted herewith for submitting the same to the Director General of Shipping as part of the Environmental Compensation assessment.

JAYANTHI M
CHAIRPERSON

Copy submitted to:

1. The Additional Chief Secretary to the Government,
Environment, Climate Change & Forest department,
Secretariat, Chennai – 600 009

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Tel : 044-22353134 - 139 Fax : 044-22353068
Email : tnpcb-chn@go2in Web : tnpcb.gov.in

2. The Additional Chief Secretary to Government
Revenue and Disaster Management Department
Secretariat, Chennai – 600 009
revsec@tn.gov.in

Copy To
The Commissioner of Disaster Management,
Tamil Nadu Disaster Risk Reduction Agency,
O/o Commissionerate of Revenue
Administration and Disaster Management,
Ezhilgam, Chepauk,
Chennai - 5

7/12/25
For Chairperson

Ref - 4

Speed Post

DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE

From
Thiru.K.V.Muralidharan, IAS.,
Director,
Fisheries and Fishermen Welfare,
Nandanam, Chennai – 600 035.

To
The Director,
Department of Environment & Climate Change,
Anna Salai, Nandanam,
Chennai-35

R.C.No. 15020/P3/2025. Date:23.10.2025

Sir,

Sub : Fisheries and Fishermen Welfare – Disaster Management- Accumulated nurdles washed ashore due to MSC Elsa 3 ship wreckage held on 08.07.2025- Proposal sent- Regarding

Ref : 1. Compensation proposal for ship wreckage sent by this office on 04.09.2025

2. Tamil Nadu Environment Department e-mail dated:16.10.2025.

With regard to the reference 1st cited, a communication has been received vide reference 2nd cited from the Tamil Nadu Environment Department stating that the total compensation figure mentioned in the proposal does not correspond with the cost abstract breakup provided and further it has been requested to inform the basis of budget estimate.

It is informed that based on the meeting Chaired by the Chief Secretary to Government, the proposal was subsequently revised. However, the revised total amount was not reflected in the abstract. The abstract seeking compensation amount of **Rs. 859.39 crore is enclosed herewith for perusal.**

Further, it is informed that the budget estimated is based on the inputs received from the concerned Assistant Director of Fisheries and the budget cost were calculated and consolidated accordingly.

Encl: as above

Sd/-K.V.Muralidharan
Director
Fisheries and Fishermen Welfare

for Director
Fisheries and Fishermen Welfare

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Fisheries and Fishermen Welfare Department

WRECKAGE OF CARGO SHIP MSC ELSA 3

Abstract

A total of **Rs 859.39 crore** is assessed for claim towards the compensation of livelihood loss to the fishermen, study the long term impact and remedial measures and environment and biodiversity restoration measures as follows.

i. A detailed study has to be undertaken at a total project cost of Rs 50 lakh by the Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU) to learn the long term impact of the deposition of pollutants and remedial measures.

ii. A total amount of Rs 110.95 crore is claimed to compensate the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.

iii. Compensation for an amount Rs 600 crore proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants

iv. Promotion of off shore fishing to compensate the fishery stock reduction in inshore area by providing subsidy (80%) for constructing deep sea fishing vessels at cost of Rs 96 crore.

v. Sea ranching has to be undertaken as direct Fish stock enhancement measure at a total cost of Rs 5.47 crore.

vi. To conserve the fishery resources and enhance the fish stock by supporting the natural breeding process, 120 units of artificial reefs are proposed to be installed in 40 villages at a total cost of Rs 38.13 crore.

vii. Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts at a cost of Rs 8.34 crore.

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Overall Cost Abstract

S No	Particulars	Amount (Rs in crore)
1	A detailed study by the Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU) to learn the long term impact of the deposition of pollutants and remedial measures.	0.50
2	Compensate claim to the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.	110.95
3	Compensation proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants	600.00
4	Promotion of off shore fishing to compensate the fishery stock reduction in inshore area by providing subsidy (80%) for constructing deep sea fishing vessels	96.00
5	Sea ranching has to be undertaken as direct Fish stock enhancement measure	5.47
6	To conserve the fishery resources and enhance the fish stock by supporting the natural breeding process, 120 units of artificial reefs are proposed to be installed in 40 villages	38.13
7	Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts	8.34
	Total	**859.39**

Sd/-K.V.Muralidharan
Director
Fisheries and Fishermen Welfare

23/10/2025

for Director
Fisheries and Fishermen Welfare

23/10/25

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2899

TNPCB-PWM-Environmental Compensation Claims for the impact of plastic nurdle spill from MSC Elsa-3 along TamilNadu coast-Submitted-Reg.

PWM Sec TNPCB < pwmsec@tnpcb.gov.in >

Tue, 07 Oct 2025 7:21:32 PM +0530

To "tndoe"<tndoe@nic.in>,"tndoe"<tndoe@tn.nic.in>

Cc "eccfd"<eccfd@tn.gov.in>,"revsec"<revsec@tn.gov.in>,"tnstateeoc1" <tnstateeoc1@gmail.com>

Sir/Madam,

Please find the attached report on Environmental Compensation claims for the MSC ELSA-3 Nurdle spill: Tamil Nadu Coast.

For Chairperson
TNPCB.

2 Attachment(s)

Environmental Compensation …
16.8 MB

20251007195901708.pdf
348.2 KB

2900

T1/TNPCB/PWM/F.011515/Plastic Nurdle/2025 I/23395/2025

LiFE Lifestyle for Environment

TAMIL NADU POLLUTION CONTROL BOARD

From
Dr. Jayanthi. M, I.F.S.,
Chairperson,
Tamil Nadu Pollution Control Board,
76 Mount Salai,
Guindy, Chennai 600 032.

To
The Director,
Department of Environment and Climate Change
No.327 Metros, 9th Floor, Anna Salai,
Nandanam, Chennai- 600 035

Letter No. T1/TNPCB/PWM/ F.011515/ Nurdle Spill/ 2025, Dated: 07-10-2025

Sir/Madam,

Sub: TNPCB - PWM - MSC Elsa-3 nurdle spill incident- Compensation Claims for the impact of plastic nurdles in Tamil Nadu Coast-Submitted - Reg.

Ref: 1. Minutes of the meeting held under the Chairmanship of Chief Secretary to Government on 08.07.2025.
2. Govt letter (D) No. 1452/EC.2/2025-7 dated 22.09.2025.

****

I am to inform that as instructed in the Review meeting conducted by the Chief Secretary on 08.07.2025, TNPCB had taken up the assessment of environmental compensation claims for the impact of plastic nurdles on various ecosystems along the Tamil Nadu coast. In this regard, the compensation claims were prepared by the technical committee formed by TNPCB and the final report is submitted herewith for submitting the same to the Director General of Shipping as part of the Environmental Compensation assessment.

JAYANTHI M
CHAIRPERSON

Copy submitted to:

1. The Additional Chief Secretary to the Government,
Environment, Climate Change & Forest department,
Secretariat, Chennai – 600 009

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Tel : 044-22353134 - 139 Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : tnpcb.gov.in

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2. The Additional Chief Secretary to Government
Revenue and Disaster Management Department
Secretariat, Chennai – 600 009
revsec@tn.gov.in

Copy To
The Commissioner of Disaster Management,
Tamil Nadu Disaster Risk Reduction Agency,
O/o Commissionerate of Revenue
Administration and Disaster Management,
Ezhilgam, Chepauk,
Chennai - 5

7/10/25
For Chairperson

2902

Environmental Compensation claims for the MSC ELSA-3 Nurdle spill: Tamil Nadu Coast

Submitted by

Tamil Nadu Pollution Control Board

October 2025

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Environmental Compensation Claim for the MSC ELSA-3 Nurdle Spill: Tamil Nadu Coast

Abstract

On 25 May 2025, the Liberian-flagged cargo vessel *MSC ELSA 3* sank approximately 38 nautical miles off the coast of Kochi, Kerala, releasing an estimated 640 cargo containers into the Arabian Sea. Among these were several containers filled with plastic resin pellets (commonly known as nurdles), along with 13 containers reportedly carrying hazardous materials. Nurdles are small, lentil-sized polymer pellets that serve as the raw material for plastic manufacturing. Due to their buoyant and durable nature, they are easily dispersed by ocean currents and can persist in marine environments for extended periods.

Within days, loose nurdles and even 25-kg factory sacks containing nurdles began washing ashore in Kerala; by late May and early June pellet landings were documented across Tamil Nadu's southern beaches as monsoon-driven currents wrapped the plume around Cape Comorin into the Gulf of Mannar and Palk Bay. The District Administration and Tamil Nadu Pollution Control Board (TNPCB) subsequently reported rapid and repeated landings at multiple coastal hotspots.

The meeting chaired by the Chief Secretary to Government of Tamil Nadu discussed the issue on 29.05.2025. It was decided to conduct an immediate rapid environmental assessment of the coast by TNPCB through SDMRI (Suganthi Devadason Marine Research Institute, Thoothukudi) to record

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the nurdle spill and to estimate the damage to environment. SDMRI's baseline data for Tamil Nadu makes the scale and sensitivity of the issue clear. In addition, the field documentation by CSIR-NIO (National Institute of Oceanography) was also assigned by TNPCB to collect relevant data from the affected coastal areas.

Of the State's 1,069-km coastline, about 843.7 km—spanning eight coastal districts from Kanyakumari to Nagapattinam—registered impacts. These shores host coral reefs, seagrass meadows, mangroves, rocky shores, mussel beds, estuaries, mudflats and sandy beaches that together underpin coastal protection, fisheries productivity, carbon sequestration, and livelihoods. SDMRI highlighted the persistence of nurdles: after a spill, pellets linger for months to years, fragmenting into micro- and nano-plastics that spread across habitats, degrade water and sediment quality, and act as vectors for toxic chemicals and pathogens.

A team of Scientists from CSIR-NIO consisting of Dr. Mandar Nanajkar, Dr. Suneel Vasimalla, Dr. Kalyan De, Dr. Krushna Vudamala, Mr. Chris Mano inspected on 12.07.2025 and 13.07.2025 and recorded the widespread nurdle deposition from Rameswaram to Kanyakumari, with pellets concentrated at the high-tide line and stockpiled in sacks, and confirmed them as Polypropylene (PP) / Polyethylene (PE) / Low Density Polyethylene (LDPE) / High Density Polyethylene (HDPE)—

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materials that can become bio fouled and break down further into microplastics.

The team from CSIR-NIO warned that the drifting and re-suspending pellets can smother or abrade corals and seagrasses, impair feeding and settlement in corals, get trapped within mangrove pneumatophores, and bioaccumulate in filter-feeding organisms like sponges and bivalves, with cascading risks to reef resilience, aquaculture, and human seafood safety. They further noted that coastal communities—dependent on reef fisheries, shellfish gathering, and seaweed farming—are directly exposed to ecological and occupational health risks and so the issue needs a system-wide response that goes beyond ad-hoc beach cleaning.

The amount of material already recovered underscores the magnitude of the spill. By early July 2025, official situation reports from the Directorate General of Shipping recorded ~450–500 tons of nurdles removed from Kerala–TN shorelines, with further verification pending and continued arrivals expected under seasonal winds and currents.

Guided by the polluter-pays and precautionary principles, and consistent with the CPCB's Environmental Compensation framework (Clause 1.4.2), TNPCB constituted Technical Expert Committee consisting of Dr. Ramesh, Advisor, TNGCC; Dr. Patterson, Director, SDMRI; Dr. Rajamanickam, Retd ACEE, TNPCB; Dr. Vasudevan, Retd JCEE, TNPCB and inputs from CSIR-NIO report for assessment to base claims on actual

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environmental damage and the costs of remediation, restoration and long-term monitoring, rather than on notional penalties.

Scope of this claim: This report rationalizes a defensible compensation claim for environmental damage and health loss, compensatory restoration and long-term environmental monitoring (for a minimum 24 months) along the affected coast of Tamil Nadu. It excludes fishery income losses (addressed separately by the Fisheries Department) and focuses on:

i. **Cleanup and shoreline interception** to address ongoing landings and the burial/re-mobilization cycle;

ii. **Ecological injury and compensatory restoration** for **coral reefs, seagrass meadows, mangroves, beaches, estuaries, rocky/mussel habitats** documented by SDMRI and CSIR-NIO;

iii. **Public health risk management** (seafood testing, risk communication, syndromic surveillance);

iv. **Tourism and recreation disruption** along polluted beaches and sanctuaries (e.g., Dhanushkodi/Greater Flamingo Sanctuary);

v. **Long-term monitoring and research** to track microplastic burdens, hydrocarbons, and ecological recovery, and to harden SOPs for future incidents.

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Component-wise Claim

Total compensation claim for environmental damage, health loss, compensatory restoration and long-term environmental monitoring **- Rs. 182.415 Crore**

Component -- A: Ecological Restoration & Hotspot Remediation

Sub-component	Amount (Rs. crores)
Coral restoration	27.9808
Seagrass restoration	52.4640
Mangrove restoration	0.8744
Coastal Hotspot remediation (beach/estuary/rocky/mudflat)	15.00

Subtotal A = Rs. 96.3192 crores

Components - B - F: Programme & Operational Receptors

Component	Amount (Rs. crores)
B. Public-health surveillance (12 months)	9.00
C. Tourism amenity remediation	10.00
D. Long-term monitoring & research (24 months)	6.00
E. Government manpower & analytics	7.00
F. Operational receptors (salt pans, aquaculture, intakes)	12.00

Subtotal (B - F) = Rs. 44.0 crores

Component - G: Programme Management & Contingency

Item	Amount (Rs. crores)
Programme management (5% of Base)	7.016
Contingency & transactions (25% of Base)	35.0798

Subtotal (G) = Rs. 42.0958 crores

TOTAL (A-G): (96.3192 + 44.0 + 42.0958) = Rs.182.415 crores

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Environmental Compensation Claim for the MSC ELSA-3 Nurdle Spill: Tamil Nadu Coast

Description & Justification

On 25 May 2025, the Liberian-flagged container ship MSC ELSA-3 capsized roughly 38 nautical miles off Kochi, Kerala, while carrying ~640 containers, including consignments with hazardous materials alongside diesel and furnace oil. India's rescue agencies evacuated all 24 crew members, but the wreck began shedding cargo—among it, multiple loads of plastic resin pellets ("nurdles") that disperse widely, float for months, and are exceptionally difficult to recover.

Within days, loose nurdles and even 25-kg factory sacks began washing ashore in Kerala; by late May and early June pellet landings were documented across Tamil Nadu's southern beaches as monsoon-driven currents wrapped the plume around Cape Comorin into the Gulf of Mannar and Palk Bay. Field teams and local TNPCB and other administrations subsequently reported rapid and repeated landings at multiple hotspots.

The meeting chaired by the Chief Secretary to Government of Tamil Nadu discussed the issue on 29.05.2025, recommending immediate rapid environmental assessment of the coast by TNPCB through SDMRI (Suganthi Devadason Marine Research Institute) to record the nurdle spill and damage to environment. SDMRI's baseline for Tamil Nadu makes clear the scale and sensitivity of the spill. In addition, the field documentation by CSIR-NIO (National Institute of

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Oceanography) was also assigned by TNPCB to collect relevant data from the affected coastal areas.

Of the State's 1,069-km coastline, about 843.7 km—spanning eight coastal districts from Kanyakumari to Nagapattinam—registered impacts. These shores host coral reefs, seagrass meadows, mangroves, rocky shores, mussel beds, estuaries, mudflats and sandy beaches that together underpin coastal protection, fisheries productivity, carbon sequestration, and livelihoods. **ANNEXURE-1** contains the photographs of nurdle spill and fish ingested with nurdle along the coast of Tamil Nadu including Island in Gulf of Mannar. **ANNEXURE - 2** explains in detail the importance of coastal habitats and associated biodiversity and the dependent coastal community.

SDMRI also highlights the persistence of nurdles: after a spill, pellets linger for months to years, fragmenting into micro- and nano-plastics that spread across habitats, degrade water and sediment quality, and act as vectors for toxic chemicals and pathogens. **ANNEXURE-3** explains in detail the environmental damage and impacts due to nurdle spill on various ecosystems and human health. **ANNEXURE-4** includes selected research publications explaining the impact of nurdle spill on various coastal ecosystems and human health.

Field documentation by CSIR-NIO engaged by TNPCB corroborates this picture. Teams recorded widespread deposition from Rameswaram to Kanyakumari, with pellets

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concentrated at the high-tide line and stockpiled in sacks, and confirmed as them Polypropylene (PP) / Polyethylene (PE) / Low Density Polyethylene (LDPE) / High Density Polyethylene (HDPE)—materials that can become biofouled and break down further into microplastics. CSIR-NIO warns that drifting and re-suspending pellets can smother or abrade corals and seagrasses, impair feeding and settlement in corals, get trapped within mangrove pneumatophores, and bioaccumulate in filter-feeding organisms like sponges and bivalves, with cascading risks to reef resilience, aquaculture, and human seafood safety. The institute further notes that coastal communities—dependent on reef fisheries, shellfish gathering, and seaweed farming—are directly exposed to ecological and occupational health risks and that the issue needs a system-wide response that goes beyond ad-hoc beach cleaning.

The scale of material already recovered underscores the magnitude of the spill. By early July 2025, official situation reports from the Directorate General of Shipping recorded ~450–500 tons of nurdles removed from Kerala–TN shorelines, with further verification pending and continued arrivals expected under seasonal winds and currents.

Guided by the polluter-pays and precautionary principles, and consistent with the CPCB's Environmental Compensation framework (Clause 1.4.2), TNPCB constituted Technical Expert Committee (including Dr. Ramesh, Advisor, TNGCC; Dr. Patterson, Director, SDMRI; Dr. Rajamanickam, Retd ACEE, TNPCB; Dr. Vasudevan, Retd JCEE, TNPCB and CSIR-NIO

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inputs) for assessment to base claims on actual environmental damage and the costs of remediation, restoration and long-term monitoring, rather than on notional penalties.

Scope of this claim: This report rationalizes a high yet defensible compensation claim for environmental damage and health loss, compensatory restoration and long-term environmental monitoring (for a minimum of 24 months) along the affected coast of Tamil Nadu. It excludes fishery income losses (addressed separately by the Fisheries Department) and focuses on:

i. **Cleanup and shoreline interception** to address ongoing landings and the burial/re-mobilization cycle;
ii. **Ecological injury and compensatory restoration** for **coral reefs, seagrass meadows, mangroves, beaches, estuaries, rocky/mussel habitats** documented by SDMRI and CSIR-NIO;
iii. **Public health risk management** (seafood testing, risk communication, syndromic surveillance);
iv. **Tourism and recreation disruption** along polluted beaches and sanctuaries (e.g., Dhanushkodi/Greater Flamingo Sanctuary);
v. **Long-term monitoring and research** to track microplastic burdens, hydrocarbons, and ecological recovery, and to harden SOPs for future incidents.

Methodological stance: The quantification employs Habitat-Equivalency Analysis (HEA), replacement/restoration cost, and benefit-transfer consistent with international practice, while

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making explicit all assumptions and uncertainties (e.g., evolving shoreline load, subsurface burial, seasonal re-deposition, and chronic exposure pathways). This stance—rooted in SDMRI's coastal ecology baseline and CSIR-NIO's field evidence, and cross-checked against official situation reports—provides the scientific, legal, and procedural footing the National Green Tribunal expects for a robust environmental compensation claim.

1. Factual Chronology & Geographic Scope

1.1. Incident chronology (verified timeline)

i. **25 May 2025** — *Loss of vessel*: MSC ELSA-3 sinks ~38 NM off Kochi, Kerala, with ~640 containers on board, including hazardous consignments and large volumes of diesel/furnace oil. Plastic resin pellets ("nurdles") are among the cargo.

ii. **27 May 2025** — *First confirmed landings in Kerala*: Loose nurdles and sealed 25-kg sacks reported on Thiruvananthapuram beaches.

iii. **28 May–02 June 2025** — *Cross-state transport*: Monsoon-driven currents carry pellets around Cape Comorin; first confirmed landings in Kanyakumari, followed by Tirunelveli and Thoothukudi.

iv. **June–July 2025** — *Widening footprint in Tamil Nadu*: Recurrent beachfalls observed along the Gulf of Mannar and Palk Bay coasts, including Ramanathapuram, Pudukkottai, Thanjavur, Thiruvarur and Nagapattinam. Pellets recorded both as surface deposits and buried layers in the high-tide zone; intact bags recovered at several sites.

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v. **Ongoing (July–August 2025)** — *Continuing arrivals*: Intermittent fresh landings consistent with seasonal wind/wave patterns; re-mobilisation of previously buried pellets noted after high-energy events.

Implication: The event is dynamic rather than static; the footprint and load evolve with seasonality, necessitating a claim that includes continuing deposition and removal inefficiencies.

1.2. Cargo and pollutant profile (relevant to exposure pathways)

i. **Plastics:** Polyolefin nurdles (PP/PE, incl. LDPE/HDPE); buoyant, persistent, prone to fragmentation into micro- and nano-plastics; high sorption capacity for POPs/PAHs/metals.

ii. **Petroleum products:** Diesel and furnace oil; acute toxicity to reef/seagrass biota; chronic sediment contamination risk.

iii. **Hazardous consignments:** E.g., calcium carbide and other listed dangerous goods—relevant to risk communication and public health surveillance (even where primary fisheries loss is addressed separately).

1.3. Transport, fate and deposition (statewide context)

i. **Hydrodynamics**: South-west monsoon winds and coastal current fields wrap floating material from Kerala around Cape Comorin into the Gulf of Mannar; eddying and weaker flow regimes favour Palk Bay retention.

ii. **Deposition behaviour:** Pellets strand at the wrack line, are pushed into supratidal berms, and buried within days; wave action intermittently re-exposes them. Entrapment occurs in

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seagrass blades, mangrove *pneumatophores*, coral rubble, rocky interstices, and mussel beds.

iii. **Persistence:** Residence times range from months to years; fragmentation creates secondary pollution that is effectively unrecoverable.

1.4. Geographic scope in Tamil Nadu

The affected stretch in Tamil Nadu is estimated at **843.7 km** across **8 coastal districts** (south–north), encompassing ecologically sensitive and socio-economically critical shorelines.

District	Coastline (km)	Key receptors (short)
Kanyakumari	71.5	Beaches, rocky shores/ mussel beds
Tirunelveli	48.9	Seagrass, rocky shores
Thoothukudi	163.5	Coral reefs (GoM), seagrass beds, mangroves, salt pans
Ramanathapuram	236.8	Coral reefs (GoM), seagrass beds, mangroves, saltpans, coastal aquaculture
Pudukkottai	42.8	Mangroves, seagrass beds, mudflats, beaches, coastal aquaculture
Thanjavur	45.1	Mangroves, seagrass beds, estuaries, coastal aquaculture
Thiruvarur	47.2	Mangroves, estuaries, seagrass beds, coastal aquaculture
Nagapattinam	187.9	Mangroves, beaches, seagrass beds, coastal aquaculture

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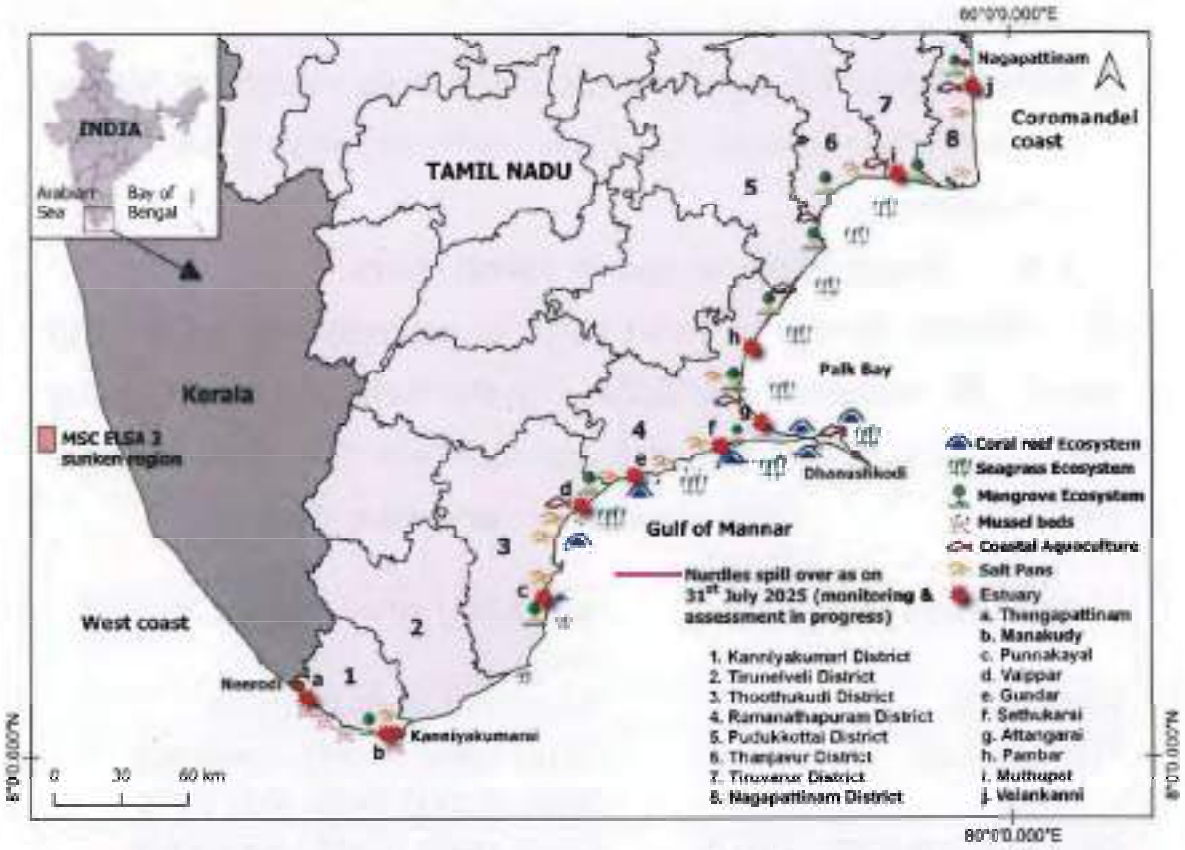

Figure 1 Affected coastline (843.7 km) with district boundaries and mapped receptors (coral, seagrass, mangroves, rocky/ estuarine/mudflat/mussel habitats/salt pans/aquaculture).

1.5. Evidence pack (Tamil Nadu)

i. **Field observations**: Loose nurdles and sealed 25-kg bags collected at multiple TN beaches; repeated stranding after high-tide events; pellets recovered from wrack lines and buried layers; polymer types consistent with PP/PE.

ii. **Habitat interfaces**: Visual and sample evidence of pellet entrapment in seagrass meadows, mangrove

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pneumatophores, and coral rubble/near-reef zones; beach amenity impairment noted at tourist sites.

iii. **Institutional logs**: TNPCB/DCZMA/Forest & Fisheries field notes; SDMRI & CSIR-NIO inspection memos; district-level clean-up registers and photo-logs.

1.6. Receptors and significance (why TN matters)

i. **Ecological value**: Gulf of Mannar is India's richest coral–seagrass–mangrove mosaic; Palk Bay supports extensive seagrass meadows and mudflat/estuarine systems; the Cauvery delta sustains priority mangrove habitats.

ii. **Service flows**: Coastal protection, fisheries nursery functions, carbon sequestration, water quality regulation, recreation/tourism.

iii. **Human dimension**: High dependency of coastal communities on reef and nearshore fisheries, shellfish gathering, and nature-based tourism.

1.7. Assumptions for quantification (declared up-front)

i. **Continuing arrivals:** Claim calculations include a load factor for fresh and re-mobilised pellets over the near-term monsoon cycle.

ii. **Burial inefficiency:** Recovery efficiency discounts applied to account for subsurface burial and microplastic generation.

iii. **Impact extents:** Receptor-wise "at-risk" areas (coral / seagrass / mangrove / beach–estuary–mudflat/rocky–

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mussel) defined from SDMRI baselines and verified spot observations; sensitivity bands (Low/Central/High) will be carried through valuation.

iv. **Carve-out:** Fisheries income loss excluded here (filed by Fisheries Dept.), while habitat injury to fish nurseries is included to avoid under-counting ecological loss.

1.8. What this section enables

This chronology and spatial frame underpin:

i. **Causation and nexus** (source-to-shoreline linkage),

ii. **Eligibility of heads of damage** (cleanup, ecological injury/restoration, health risk, tourism, long-term monitoring), and

iii. **Transparent, reproducible quantification** in Section 5–6 with explicit sensitivity analysis.

2. Legal & Policy Basis for the Environmental Compensation (EC) Claim

2.1. Guiding legal doctrines (India)

i. **Polluter-Pays & Precautionary Principles** — Recognized by the Supreme Court (e.g., *Vellore Citizens Welfare Forum v. Union of India*, 1996; *Indian Council for Enviro-Legal Action v. Union of India*, 1996) and applied consistently by the National Green Tribunal (NGT). These place the burden of preventing, abating, and remedying harm squarely on the polluter and allow ex-ante protective action where scientific uncertainty exists.

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ii. **Absolute Liability for hazardous activities** — For inherently dangerous operations, liability is strict and non-delegable; the shipowner/insurer and other culpable parties can be directed to fund full restoration.

iii. **Public Trust Doctrine & Right to Life (Art. 21)** — Coastal and marine ecosystems are a public trust; degradation implicates fundamental rights (health, livelihood, environment).

iv. **Constitutional & statutory scaffolding:** Arts. 48-A & 51-A(g); Environment (Protection) Act, 1986; Water Act, 1974; Air Act, 1981; Biological Diversity Act, 2002; Coastal Regulation Zone (CRZ) Notification, 2011/2019 (safeguarding ecologically sensitive areas like the Gulf of Mannar/Palk Bay); Wildlife (Protection) Act, 1972 (Marine National Park/Protected Areas).

Why this matters here: Nurdles are primary microplastics that persist for months to years, sorb toxic chemicals and metals, disperse widely with currents/winds, and are extremely difficult to recover—which justifies the precautionary, restoration-to-baseline stance and damages grounded in actual ecological injury and long-term monitoring.

2.2. NGT Act & CPCB Environmental Compensation framework

i. **NGT Act, 2010 –** Sections 14 & 15: empower the Tribunal to award relief/compensation for loss of ecology,

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environmental degradation, and to order restoration and preventive measures.

ii. **CPCB EC Guidelines (incl. Clause 1.4.2):** where predefined formulae are inadequate, EC may be computed on the basis of "actual damage to the environment assessed by expert organisations," and must include restoration/rehabilitation costs, monitoring, and ancillary costs.

Applicability: TNPCB has constituted a Technical Expert Committee precisely to anchor the claim in science and to align with the Plastic Waste Management Rules (PWM), 2016 and relevant CPCB protocols.

2.3. Maritime & international context (supporting duties/standards)

- **MARPOL (Annex V)** prohibits discharge of plastics; cargo-related losses that create persistent plastic pollution engage international expectations of due care/safe stowage.
- **OPRC 1990 / IMO guidance** on preparedness and response to pollution incidents supports polluter-funded clean-up, damage assessment, and restoration.
- **Comparative** precedents (e.g., X-Press Pearl, 2021, Sri Lanka) demonstrate tribunals/governments treating nurdle spills as complex, long-tail events requiring multi-year monitoring and ecosystem restoration, not merely beach-cleaning.

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2.4. Eligible heads of loss under this EC

The following heads are squarely supported by the doctrines/statutes above and by the science on nurdle fate/impacts:

i. **Ecological injury & compensatory restoration**: Coral reefs, seagrass meadows, mangroves, estuaries/mudflats, rocky/mussel habitats, and beaches are all impacted receptors identified by SDMRI and CSIR-NIO. Restoration and offsets are recoverable EC heads (habitat-equivalency approach; replacement cost).

ii. **Public health risk management**: Seafood safety testing, risk communication, and syndromic surveillance are justified given ingestion/bioaccumulation pathways and sorbed contaminants on pellets and microplastics.

iii. **Tourism & recreation disruption (amenity loss)**: Plastic-fouled beaches/reefs undermine the state's tourism assets; amenity impairment and recovery measures (beyond routine cleaning) are compensable.

iv. **Long-term environmental monitoring & research**: Nurdles fragment to micro/nanoplastics and bury/remobilise with storms; multi-year monitoring is essential for trend detection and adaptive management.

v. **Salt pan activities**

a) **Basis:** Salt pans depend on seawater intake and evaporation ponds. Pellet ingress/clogging and contaminated wrack can increase pre-treatment/clean-out

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costs, delay crystallisation cycles, and contaminate product (quality downgrades, batch rejections).

b) **Recoverable under EC:** Incremental operating cost, capital for temporary screening/booming, disposal of contaminated residues, product loss/downgrade, and business interruption due to environmental impairment (distinct from fisheries income claims).

vi. **Seawater-based aquaculture**

a) **Basis:** Hatcheries/ponds drawing seawater face risks of intake fouling, stock exposure to microplastics/adsorbed toxins, and biofouling in filters.

b) Recoverable: Intake protection/retrofits, enhanced filtration media and change-out, diagnostic testing, stock loss/morbidity attributable to contamination, and precautionary harvest holds mandated by authorities.

vii. **Seawater-intake industries**: (e.g., thermal/nuclear power plants using once-through cooling & auxiliary systems, desalination plants, and other industries drawing sea water)

a) **Basis:** Pellet loads and oil-associated residues can increase screen/blinding frequency, raise chemical dosing, elevate sludge disposal, and force load reductions or outages to protect equipment/water quality.

b) **Recoverable:** Incremental intake screening costs, pretreatment chemical/energy surcharges, extra backwash cycles and sludge handling, protective booming/screens, equipment wear/replacement, and

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documented outage-related loss/mitigation attributable to environmental contamination.

viii. **Government manpower & operational analytics (past + forward)**

a) **Basis:** Under Polluter-Pays/NGT Sec. 15, the State is entitled to recover reasonably incurred response and assessment costs: multi-agency field deployments, laboratory analyses, logistics, data management, coordination.

b) **Recoverable:** Actual manpower cost incurred so far (TNPCB, District Administration, Forests, Health, Fisheries for sampling, etc.) plus a justified forward-year budget (e.g., one-year horizon) including laboratory analytical charges and QA/QC systems.

Note on Fisheries income: As discussed, fishers' livelihood/market losses are being pursued by the Fisheries Department under separate heads; the present EC claims ecological nursery injury and public-health surveillance to avoid double counting.

2.5. Treatment of "clean-up operations" vs "environmental compensation"

To honour the committee's direction and maintain completeness for the Tribunal:

Scope statement to insert up front:

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"All cost heads in this EC claim exclude routine shoreline clean-up operations already undertaken or planned by Government agencies (collection, transport, routine disposal of pellets and debris). Those costs are being accounted and pursued separately against the shipowner/insurers under maritime liability channels. Included here are restoration-linked removals and hotspot remediation that are integral to ecological recovery (e.g., targeted removals in coral/seagrass/mangrove interfaces), long-term monitoring, public health risk management, and the new heads described in 2.4."

This bifurcation avoids double recovery, aligns with Clause 1.4.2 (actual damage & restoration), and still lets the Tribunal direct a consolidated deposit with later apportionment if it prefers.

2.6. Evidentiary foundation (science that supports inclusion)

i. **Persistence & transport:** Nurdles (PP/PE/LDPE/HDPE) are primary microplastics, buoyant, and widely dispersed by wind/waves/currents; they strand, bury in beaches, and remobilise during storms—making full recovery improbable.

ii. **Vector for contaminants & health pathways**: Due to high surface-area and hydrophobicity, nurdles adsorb/release POPs and trace metals; ingestion by marine biota facilitates bioaccumulation and human exposure via seafood, justifying public-health surveillance in EC.

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iii. **Operational Interference:** The same buoyancy/size that drives ecological harm also fouls intakes, screens, and filters, supporting recoverability for salt-pan/aquaculture/industrial intake costs as environmental-impact-caused losses rather than ordinary business risk.

3. Exposure Pathways and Evidence

3.1. Overview (how pellets move, settle, persist)

Field teams from CSIR-NIO documented widespread nurdle contamination from Rameswaram to Kanyakumari, with pellets concentrated at the high-tide line and stockpiled in municipal storage; labels and site checks confirm PP/PE/LDPE/HDPE composition. Pellets continue to arrive, strand, bury and re-mobilise under wind and wave events, creating a persistent source of microplastics to adjacent reefal and lagoonal waters.

By 11 June 2025, authorities had already collected 1,274 bags of nurdles across 42 fishing villages, underscoring the magnitude and spatial spread of the release. SDMRI's mapping shows about 843.7 km of Tamil Nadu's coast—eight districts from Kanyakumari to Nagapattinam—registering impacts, and identifies the full suite of sensitive ecosystems at risk (coral, seagrass, mangroves, rocky/mussel, estuaries/mudflats, sandy beaches).

Mechanistically, nurdles are buoyant to neutrally buoyant and are transported across reef flats into lagoons, trapped in seagrass/seaweeds, and lodged within coral structures; weathering and biofouling roughen surfaces, accelerating

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fragmentation into micro- and nano-plastics. These particles sorb POPs/PAHs/metals and can transfer sorbed contaminants when ingested.

Beach dynamics matter for persistence: Pellets are rapidly incorporated into beach sediments and later re-exposed, prolonging shoreline sources even after surface collections.

3.2. District observations (selected, evidentiary)

i. **Ramanathapuram & Rameswaram (Gulf of Mannar):** Dense high-tide line deposits at Dhanushkodi/Arichal Munai; municipal yards storing large, labelled sacks of pellets (PP/PE/LDPE/HDPE).

ii. **Kanyakumari coast:** Multiple beaches (e.g., Kadiyapattanam, Chinnavilai) with visible stranding; burial noted under wind activity; handling/processing sites and stockpiles recorded.

3.3. Receptor-wise narratives

A. Coral reefs (Gulf of Mannar & Palk Bay)

i. **Pathway:** Pellets and microplastics cross reef flats, entangle in coral architecture, and shade/smother surfaces, suppressing zooxanthellae photosynthesis. Microplastics abrade tissues, impair larval settlement, and carry opportunistic pathogens, compounding climate and eutrophication stressors common to nearshore Palk Bay/GoM.

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ii. **Significance baseline:** SDMRI emphasises the national conservation status of GoM/Palk Bay reefs (Marine National Park, Biosphere Reserve) and their exceptional biodiversity and livelihoods value.

B. Seagrass meadows

i. **Pathway:** Meadows physically trap pellets, reducing light availability, altering sediments, and degrading nursery functions; microplastics integrate into benthic food webs.

ii. **Seaweed farms interface:** Floating nurdles entangle culture lines (e.g., *Kappaphycus*, *Gracilaria*), lowering quality and market value; chemical leachates can degrade water quality.

iii. **Regional importance:** SDMRI notes 75% of India's luxuriant seagrass occurs in GoM/Palk Bay, central to blue-carbon and fisheries.

C. Mangroves

i. **Pathway:** Pellets accumulate around *pneumatophores* and other roots, altering sediment microhabitats; microplastic loading changes redox and microbial processes, with knock-on effects for nursery fauna. (Mechanistic link supported by NIO's transport/fragmentation and contaminant-sorption evidence.)

ii. **Significance baseline:** SDMRI profiles the Cauvery delta and other mangrove stands among the key receptors within the impacted 843.7-km stretch.

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D. Beaches, estuaries, mudflats, rocky shores, and mussel/oyster beds

i. **Pathway (beaches/estuaries/mudflats):** Rapid stranding → burial → re-exposure, creating chronic near-shore sources; pellets concentrate in wrack lines and berms.

ii. **Filter feeders (mussels/oysters):** Evidence of ingestion, reduced filtration, histopathology, oxidative stress, and contaminant bioaccumulation; direct implications for seafood safety and local aquaculture.

iii. **Amenity & access:** Repeated beach falls at tourism sites (e.g., Dhanushkodi) degrade amenity and increase removal effort, relevant to tourism disruption claims.

E. Water & sediment quality

i. **Pathway:** Pellets and fragments sorb/concentrate POPs/PAHs/metals, then release them within the water column and sediments; colonised plastics raft microbes, including pathogens.

ii. **Chronicity:** Prior regional studies cited by NIO report substantial microplastic burdens in Palk Bay/GoM sediments, biota, and coral settings, indicating an already stressed baseline.

F. Human health exposure pathways (risk basis for surveillance)

i. **Seafood pathway:** Ingestion by bivalves and reef-associated fish → trophic transfer of particles and sorbed toxins to people.

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ii. **Microbial vectors:**Plastics carry microbial assemblages, including opportunistic pathogens, to stressed coral and nearshore environments; risk communication and testing are warranted.

iii. **Public-health framing:**SDMRI summarises human-health risks from nurdles and microplastics, reinforcing the need for seafood testing and syndromic surveillance in the claim.

3.4. What the evidence means for valuation

i. **Persistence & remobilisation** justify multi-phase interception and long-term monitoring funding.

ii. **Receptor-specific injury** (coral, seagrass, mangroves, beaches/estuaries/mudflats, rocky/mussel) supports restoration and compensatory offsets under Clause 1.4.2.

iii. **Seafood and microbial risks** support public-health surveillance heads.

3.5 Data gaps & immediate actions

i. **Buried load quantification:** Implement stratified trenching & sieving on priority beaches to estimate subsurface stocks and recovery efficiency.

ii. **Receptor-proximal sampling:** Joint SDMRI–NIO transects from beach → nearshore → reefs/seagrass/mangroves for particle counts, polymer ID, and POPs/PAHs/metals.

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iii. **Filter-feeder health & seafood safety:** Targeted mussel/oyster biomonitoring at rocky/mudflat sites; lab QA/QC and public advisories integrated with Health Dept.

iv. **Tourism amenity baselines:** Photo-logs and visitor-day data for affected beaches to underpin tourism disruption estimates.

4. Impact Assessment by Receptor

4.1. Water & Sediment Quality

Mechanism & persistence: CSIR-NIO documents widespread pellet deposition from Rameswaram to Kanyakumari, with nurdles concentrated at the high-tide line—a persistent source that cycles between stranding, burial, and re-mobilisation under wind and waves. Pellets are buoyant to neutrally buoyant, move with nearshore currents, and fragment into micro- and nano-plastics through weathering and biofouling. These particles sorb and concentrate POPs/PAHs/metals at levels sufficient to transfer both particles and chemicals into food webs.

Baseline stressors. Prior regional studies cited by CSIR-NIO report substantial microplastic burdens (PE-dominated) in Palk Bay/Gulf of Mannar sediments, biota and reef environments—indicating that the spill compounds an already stressed baseline.

On-the-ground evidence. By 11 June 2025, authorities had collected 1,274 bags of nurdles across 42 fishing villages, confirming both magnitude and spread.

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Implications for valuation. Long residence times and burial/re-exposure cycles justify multi-year monitoring and restoration-linked removals near sensitive habitats. (See section 5–6 for costed monitoring design)

4.2. Coral Reefs (Gulf of Mannar & Palk Bay)

Pathways & effects: Pellets and fragments cross reef flats, become lodged in coral structures, and smother/shade surfaces—suppressing photosynthesis and impairing larval settlement. Microplastics abrade tissues, while sorbed contaminants and microbial colonisation can amplify disease risks.

Context & sensitivity: Reefs in GoM/Palk Bay are nationally significant and already under cumulative pressure; the spill elevates the risk of reduced coral cover, recruitment failure, and community shifts toward stress-tolerant taxa.

Indicators for assessment: Percent live coral cover, recent recruitment (settlement tiles), tissue condition/lesion frequency, and reef-associated microplastic counts (water/sediment).

4.3. Seagrass Meadows (and Seaweed Farms Interface)

Pathways & effects: Seagrass meadows physically trap pellets, which reduce light and alter sediments, degrading nursery functions. Fragments enter benthic food webs; seaweed culture lines can be entangled, lowering product quality and market value.

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Implications: Expect shoot density and leaf area suppression, higher epiphyte load, and sediment microplastic accumulation near meadow edges and farms.

Indicators: Shoot density/biomass, light attenuation, sediment microplastic counts and culture-line fouling rates.

4.4. Mangroves

Pathways & effects: Nurdles accumulate around pneumatophores and roots, modifying sediment structure/redox and microbial processes that underpin mangrove nursery function; fragments and sorbed contaminants pose additional stress to juveniles and benthic fauna.

Indicators: Pellet and microplastic load in surface/interstitial sediments, pneumatophore fouling indices, seedling recruitment and survival, benthic community composition.

4.5.Beaches, Estuaries, Mudflats, Rocky Shores & Mussel/Oyster Beds

Burial–remobilisation dynamic: CSIR-NIO field teams recorded beachfalls at multiple TN sites (e.g., Dhanushkodi, Kadiyapattanam, Chinnavilai), with rapid burial under wind activity and later re-exposure—creating chronic near-shore sources even after surface clean-ups.

Filter feeders (mussels/oysters): Literature collated by SDMRI notes bioaccumulation, reduced filtration, histopathological damage, oxidative stress, and contaminant

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uptake—all relevant to seafood safety and local aquaculture risk.

Indicators: Pellet density per m² (surface and trench-sieved profiles), estuary/mudflat sediment loads, bivalve microplastic burdens (particles/g), histology, and condition indices.

4.6. Human Health Risk (basis for surveillance in EC claim)

Seafood pathway: SDMRI summarises human exposure via seafood as fish and shellfish transfer ingested plastics up the food chain; nurdles adsorb POPs, heavy metals, PAHs at very high surface concentrations, and pathogenic bacteria have been isolated from beach-collected nurdles. Together these support risk communication and syndromic surveillance.

Operationalisation: Include targeted seafood testing (bivalves/reef fish), advisories in hotspots, and community health surveillance integrated with district hospitals (costed in section 6).

4.7. "Operational Receptors" (non-ecological but environment-linked)

Salt pans. Pellet ingress through seawater intake can clog pre-treatment, contaminate evaporation ponds, and lead to product downgrades/rejections; cleanup and disposal of contaminated wrack raise operating costs. (Mechanistic basis aligns with pellet buoyancy/size and contaminant carriage described by CSIR-NIO/SDMRI.)

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Sea-water based aquaculture: Elevated intake fouling, filter replacement, potential stock morbidity from microplastics/sorbed toxins, and precautionary harvest holds. (See also filter-feeder effects above.)

Seawater-intake industries (thermal/Nuclear power plants and other industries drawing sea water): Expect screen blinding, pretreatment chemical surges, extra backwash/sludge handling, and protective boom/screen costs; outages/load curtailments may occur to protect equipment and water quality. (Exposure mechanics consistent with CSIR-NIO transport/fouling observations.)

These heads are **separate from routine clean-up** and will be explicitly scoped and costed under EC (see 2.5 and 6), avoiding double counting.

4.8. Cumulative & Indirect Effects

Cumulative load: The spill adds to chronic regional microplastic burdens (Palk Bay/GoM), heightening ecological risk across receptors and extending recovery timelines.

Spatial–temporal footprint: Dynamic monsoon-season transport and burial/remobilisation imply continuing arrivals and secondary sources, justifying long-term monitoring and contingency allowances in the claim.

4.9. Measurement Plan (bridging to valuation)

To support **Habitat-Equivalency Analysis** and **restoration costing** in 5–6, implement:

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- **Beach trench**-sieving at priority sites to estimate subsurface pellet stocks and recovery efficiency; repeat post-storm.
- **Receptor-proximal transects** (beach → nearshore → reef/seagrass/mangrove) for particle counts, polymer ID, and POPs/PAHs/metals on pellets/sediments/biota.
- **Filter-feeder biomonitoring** (mussels/oysters) and **seafood testing** in harvesting areas.
- **Operational receptor logs** (salt pans, aquaculture, intakes): intake screen fouling, chemical/energy surcharges, sludge volumes, outage diaries.
-

5. Valuation & Quantification Methodology

(All values in Indian Rupees; USD→INR at Rs. 87.44/USD as of 13 Aug 2025.)

5.1. Scope & Exclusions (to prevent double counting)

Included (EC heads):

i. Ecological injury & compensatory restoration: coral, seagrass, mangroves.

ii. Receptor-linked hotspot remediation along beach/estuary/rocky/mudflat/mussel stretches (non-routine, restoration-oriented).

iii. Public-health surveillance (seafood/water microplastics & contaminants, risk communication).

iv. Tourism amenity remediation (site works/info near receptor-linked interventions).

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v. Long-term monitoring & research (24-month package).

vi. Government manpower & analytics (actuals to date + 12-month forward).

vii. Operational receptors (provisional): salt pans, sea-water aquaculture (if present), seawater-intake industries (thermal/Nuclear power plants, desalination, other industries drawing seawater).

Excluded:

i. Routine shoreline clean-ups already done/planned by departments (collection/transport/disposal): not claimed here.

ii. Fisheries income loss: handled separately by Fisheries Dept. (habitat injury is not monetized here).

5.2. Methods We Use (and how they combine)

i. **Replacement / Restoration Cost** – prices ₹ per hectare (or per km) to restore damaged habitats or perform receptor-linked remediation.

ii. **Habitat Equivalency Analysis (HEA)** – ensures the present value of services lost equals the present value of services gained by restoration (determines hectares required).

iii. **Benefit-Transfer (BT)** – selects unit restoration costs from peer-reviewed/global syntheses when local unit costs are unavailable (we only BT unit costs, not welfare benefits).

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5.3. Symbols (quick reference)

Symbol	Meaning
t	Year index (0...T)
r	Social discount rate (illustrative 4% for HEA examples)
A_{imp}	Impacted area (ha)
$S_{loss}(t)$	% service loss at year t (0–1)
$S_{rest}(t)$	% service gain from restoration at year t (0–1)
DSAY	Discounted Service-Acre (Hectare) Years

5.4. HEA — How to Compute Compensatory Area

Goal: Choose a compensatory restoration area (A_{comp}) so that discounted services gained equal discounted services lost.

Loss side (impact to natural recovery):

$$\mathrm{DSAY}_{\mathrm{lost}} = \sum_{t=0}^{T} \left(A_{\mathrm{imp}} \cdot S_{\mathrm{loss}}(t) \cdot (1+r)^{-t}\right)$$

Gain side (restoration performance over time):

$$\mathrm{DSAY}_{\mathrm{gain}} = \sum_{t=0}^{T'} \left(A_{\mathrm{comp}} \cdot S_{\mathrm{rest}}(t) \cdot (1+r)^{-t}\right)$$

Solve for area (A_comp):

$$A_{\mathrm{comp}} = \frac{\mathrm{DSAY}_{\mathrm{lost}}}{\sum_{t=0}^{T'} S_{\mathrm{rest}}(t) \cdot (1+r)^{-t}}$$

Then price it:

$$\mathrm{Cost\ (INR)} = A_{\mathrm{comp}} \times (\mathrm{INR\ per\ ha})$$

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5.5. Assumptions Used Here (central, conservative)

Variable	Value	Unit
Coral "at-risk" area	8	ha
Seagrass "at-risk" area	40	ha
Mangrove "at-risk" area	20	ha
Hotspot remediation length	60	km
Public-health sites	20	sites
Tests per site per month	2	tests
Surveillance duration	12	months

5.6. Unit Costs (converted at Rs.87.44/USD)

Head	Unit cost Rs.)	Unit	Note
Coral restoration	3.4976 crore/ha	ha	US$ 400,000/ha × 87.44 ÷ 1e7
Seagrass restoration	1.3116 crore/ha	ha	US$ 150,000/ha × 87.44 ÷ 1e7
Mangrove restoration	0.04372 crore/ha (4.372 lakh/ha)	ha	US$ 5,000/ha × 87.44 ÷ 1e7
Hotspot remediation	0.25 crore/km	km	Receptor-linked, non-routine
Public-health	see 5.8B	—	Program costing
Long-term monitoring	6.00 crore	—	Program costing

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(24 mo)			
Tourism amenity remediation	10.00 crore	—	Program costing
Govt. manpower & analytics	7.00 crore	—	Actuals + 12-mo forward
Operational receptors (prov.)	12.00 crore	—	Salt pans + aquaculture + intakes

5.7. Replacement / Restoration Cost — Current Application

A)

Coral: 8 ha × 3.4976 = Rs. 27.9808 crores

Seagrass: 40 ha × 1.3116 = Rs. 52.4640 crores

Mangroves: 20 ha × 0.04372 = Rs. 0.8744 crores

Coastal Hotspot remediation: 60 km × 0.25 = Rs. 15 crores

Subtotal A = Rs. 96.3192 crores

5.8. Program-Costing — Non-habitat Heads

B) Public-Health Surveillance (12 months) = Tests + Lab upgrades + Field staff + Risk comms

Tests: 20 sites × 2 tests/site/month × 12 = 480 tests; ₹0.20 lakh/test = Rs.96.00 lakh = Rs. 0.96 crores

Lab upgrades & QA/QC: Rs. 5.0 crores

Field staff: Rs. 2.0 crores

Risk communication: Rs.1.0 crores

Subtotal B = Rs. 8.9600 → Rs. 9.00 crore (rounded)

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C) Tourism amenity remediation: Rs.10.0 crore

D) Long-term monitoring & research (24 months): Rs. 6.0 crore

E) Government manpower & analytics: Rs. 7.0 crore

The cost incurred till date for the cleanup activity and for analysis of samples collected in the affected areas is included under this head. Further, the future cleanup activity required for the next 12 months.

F) Operational receptors (provisional): Rs.12.0 crore

The exact area of salt pans/ industries which withdraw sea water for process/cooling was not arrived and based on the expected effects on these receptors a lumpsum is taken.

5.9. Aggregation & Allowances (transparent math)

Base = A (Rs.96.3192) + B (Rs.9.00) + C (Rs.10.00) + D (Rs.6.00) + E (Rs.7.00) + F (Rs.12.00) = Rs.140.3192 crore

Programme Management (5% of Base) = 0.05 × 140.3192 = Rs.7.0160 crore

Contingency & Transactions (25% of Base) = 0.25 × 140.3192 = Rs.35.0798 crore

Total Environmental & Health Loss — Central Case = Rs.**140.3192 + Rs.7.0160 + Rs.35.0798 = Rs.182.415 crore**

Note: All heads exclude routine clean-up to avoid double counting.

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6. Component-wise Claim Tables

6.1. Component – A: Ecological Restoration & Hotspot Remediation (Rs. crore)

Sub-component	Amount (Rs. cr)
Coral restoration	27.9808
Seagrass restoration	52.4640
Mangrove restoration	0.8744
Coastal Hotspot remediation (beach/estuary/rocky/mudflat)	15.00

Subtotal A = Rs.96.3192 crore

6.2. Components – B –F: Programs & Operational Receptors (Rs. crore)

Component	Amount (Rs. cr)
B. Public-health surveillance (12 months)	9.00
C. Tourism amenity remediation	10.00
D. Long-term monitoring & research (24 months)	6.00
E. Government manpower & analytics	7.00
F. Operational receptors (salt pans, aquaculture, intakes)	12.00

Subtotal (B - F) = Rs.44.0 crore

6.3. Component – G: Programme Management & Contingency (Rs. crore)

Item	Amount (Rs. cr)
Programme management (5%	7.016

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of Base)	
Contingency & transactions (25% of Base)	35.0798

Subtotal (G) = Rs. 42.0958 crore

TOTAL (A-G): (Rs.96.3192 + Rs. 44.0 + Rs.42.0958) = Rs. 182.415 crores

7. Limitations & Uncertainties

This quantification rests on conservative, best-available approximations while the incident footprint continues to evolve. Nurdle arrivals are ongoing and seasonally modulated by winds and currents; burial–re-mobilization cycles in beach profiles mean inventories vary after storms, with episodic re-stranding (see Chronology, 1.1).

As a result, present estimates of affected areas/lengths (habitats and hotspots) may shift as trench-sieving and post-event surveys refine subsurface loads and nearshore transport pathways. Detection probabilities differ by method and effort, and polymer weathering/biofouling can alter buoyancy and fate, introducing variance in exposure assessments and contaminant loading. Facility-level impacts for operational receptors (intakes, salt pans, aquaculture) will be strengthened with logs and invoices prior to filing; similarly, public-health tariffs and laboratory panels may be updated as procurement is finalized.

To manage these uncertainties transparently, the claim

a) applies replacement/restoration cost with clearly stated assumptions,

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b) discloses sensitivity bounds (Low–High),

c) includes a contingency allowance pending integration of measured areas, lab results, and operator records; and

d) Totals will be adjusted on a reconciliation basis without double counting and continue to exclude routine clean-up.

Dr. D. Vasudevan, Retired Joint Chief Environmental Engineer, TNPCB

Dr. R. Rajamanickam, Retired Additional Chief Environmental Engineer, TNPCB

Prof. Dr. Ramesh Ramachandran Former Director, National Centre for Sustainable Coastal Management (NCSCM)

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ANNEXURE 1

Nurdles spill survey in Kanyakumari coast

a. Nurdles spill on Vaniyakudi shore, b. Nurdles spill on Chinnavillai shore, c. Nurdles near fiddler crab borrow on Neerodi shore, d. Nurdles scatterd on Melmidalam shore, e. Nurdles on Vallavalai shore, f. Accumulation of nurdles on Kurumbanai shore

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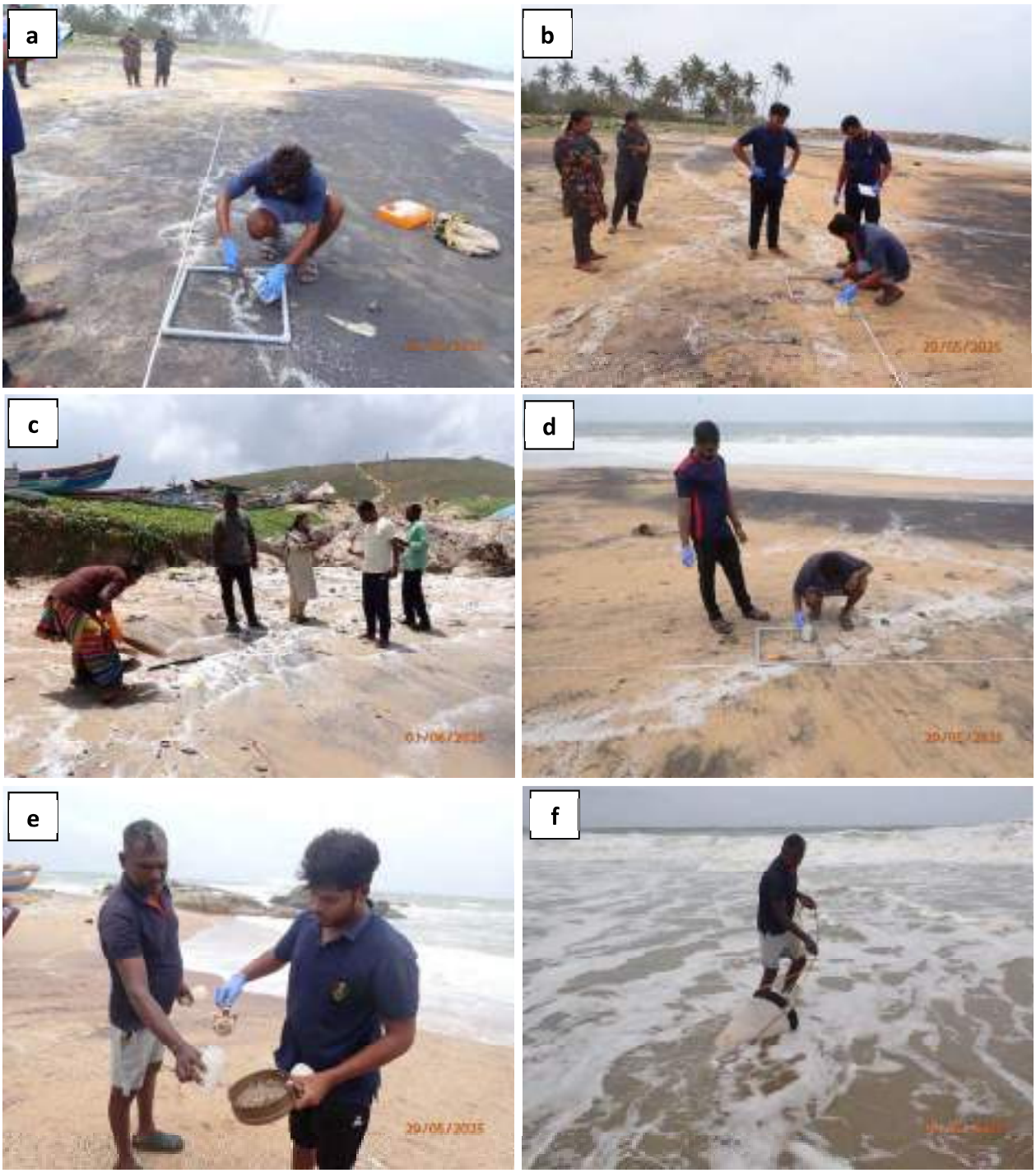
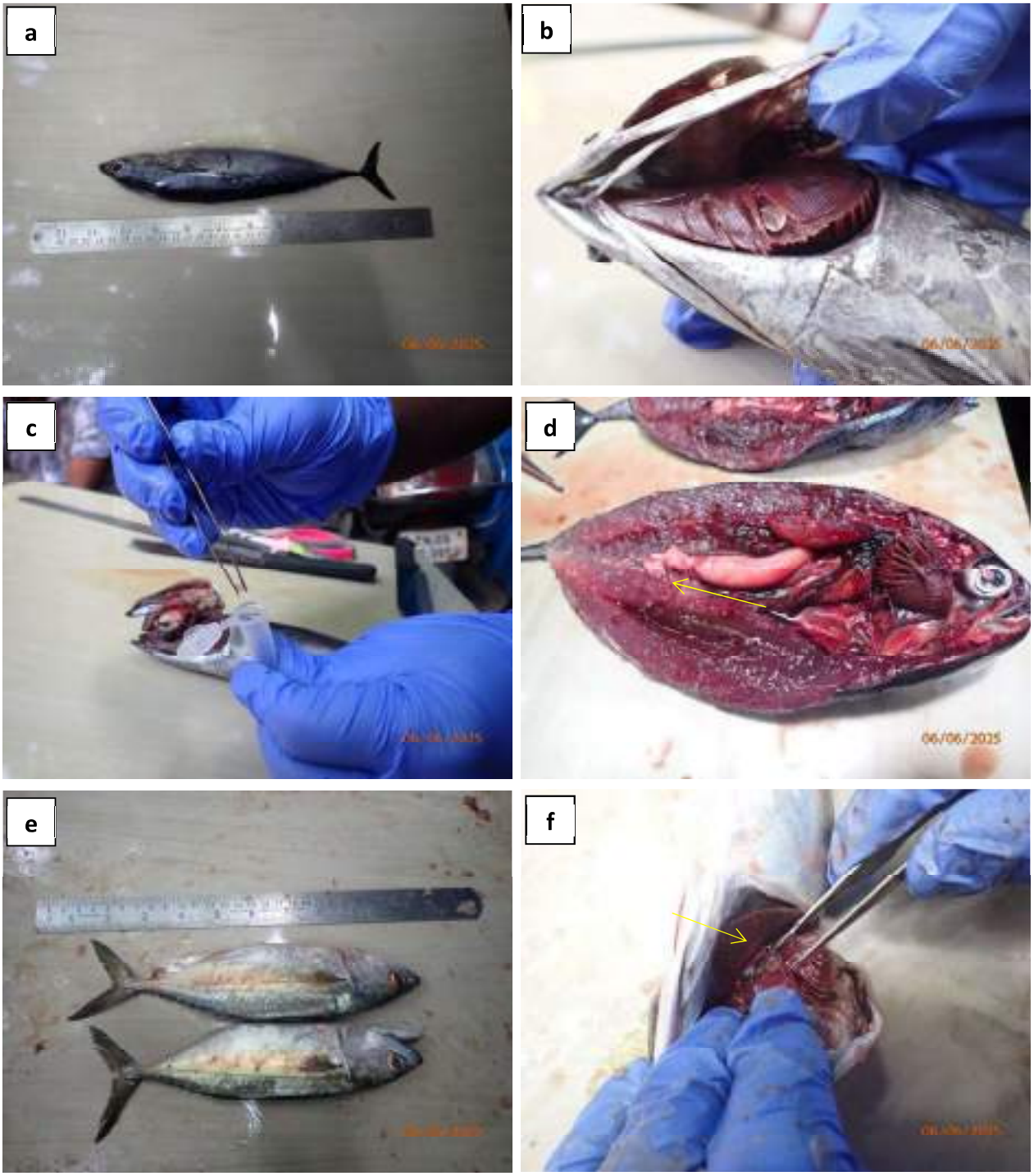


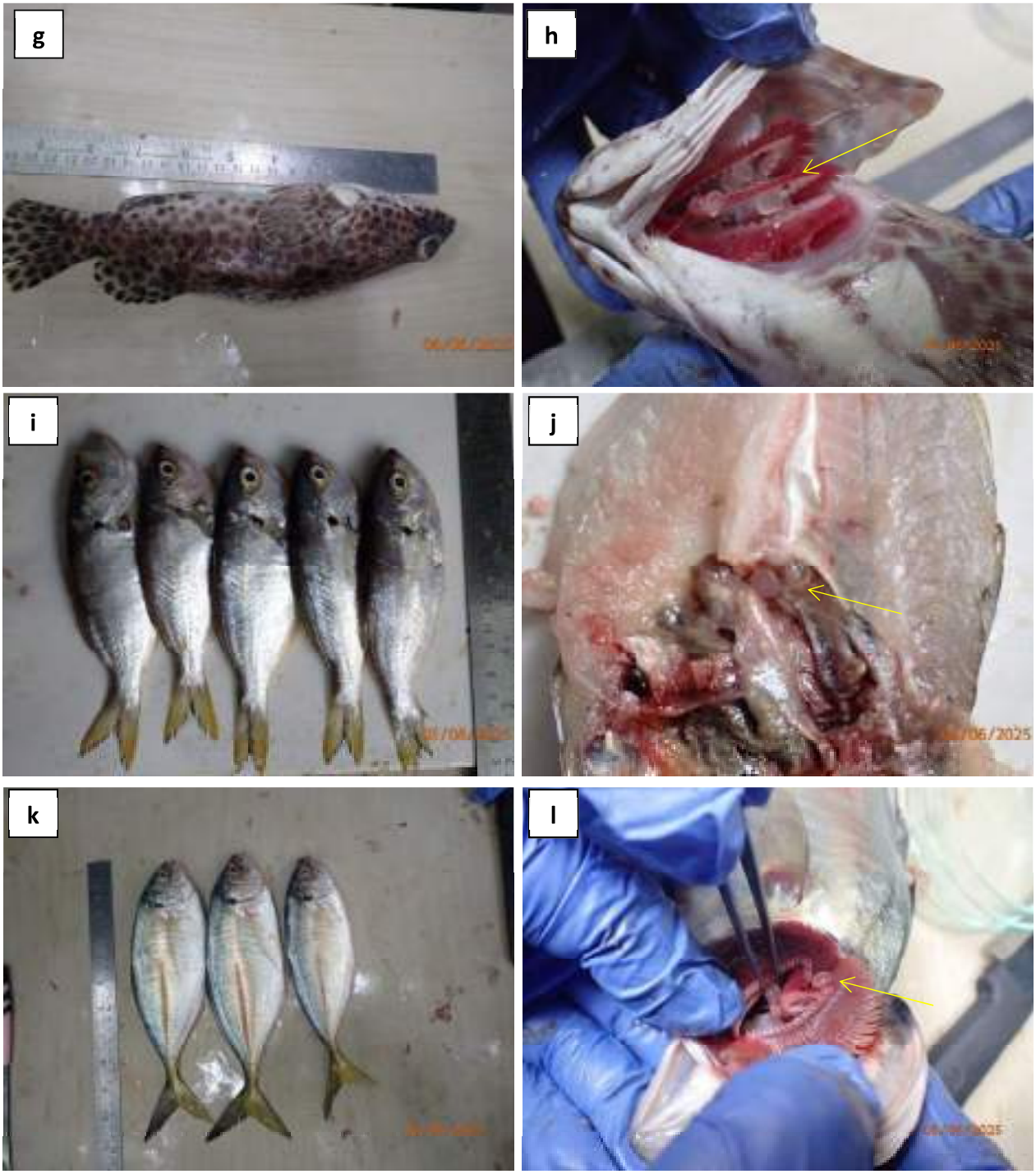
a. Collecting nurdles from a quadrat at Melmidalam shore, b. Shore line assessment at Melmidalam shore, c. Removal of nurdles by Sanitary workers at Chinnavilai shore, d. Sediment collection from Vaniyakudi shore, e. Nurdles sampling by using sieve, f. Water collection for microplastics analysis from Inayamchinnathurai shore

a. Nurdles removed from shore and collected in sacks, b. Collecting fish samples from local fishermen for nurdles ingestion assessment c. Accumulation of nurdles with other plastic debris, d. Pack of nurdles washed ashore at Inayamchinnathurai, e.Scattered nurdles on Kadiyapattinam shore, f. Nurdle collection from sediment through sieve at Kadiyapattinam shore

Photos of Fish ingested with nurdles

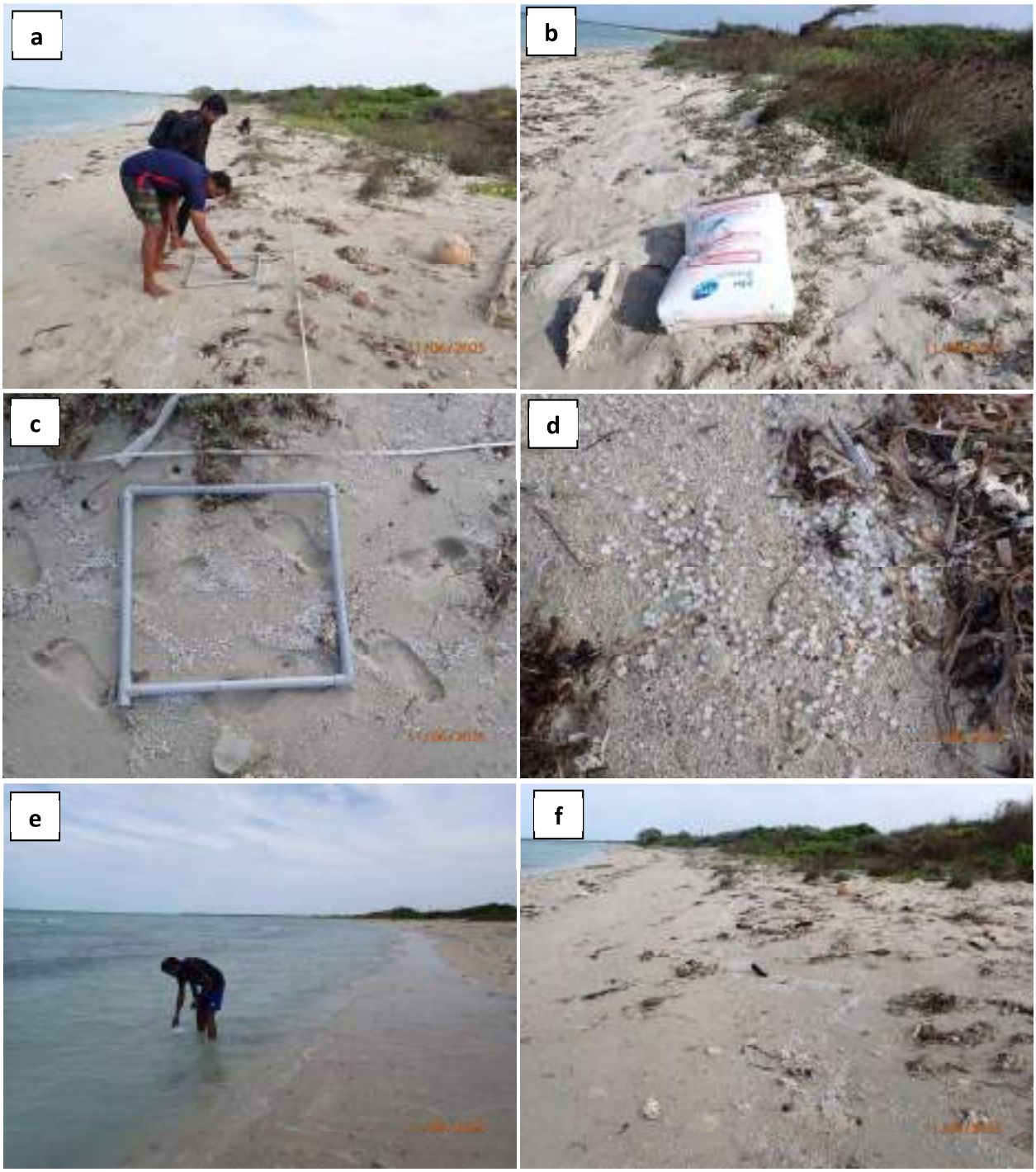


*a. Auxisthazard*fish from Neeordi, b. Nurdle trapped in the gill of the *Auxisthazard,* c. Nurdle collection for polymer identification, d. Nurdle found in the gut region, e. *Rasrelligerkanagurta*fish from Vaniyakudi, f. Nurdle trapped inside the gill



g. Epinephelusmerra fish from Kovalam, h. Nurdles trapped in the gill of the *E. merra,* i.*Lactarius lactariu s*fish from Kovalam, j. Nurdle found in the gut region, k. *Atule mate* fish from Eramanthurai, l. Nurdle trapped inside the gill

Nurdles spill survey at Hare Island (Coral reef ecosystem) of Gulf of Mannar



a. Shoreline assessment for nurdles spill at Hare Island, b. Pack of nurdles washed ashore at Hare Island, c. Assessing nurdles in a quadrat at Hare Island, d. Nurdles washed ashore at Hare Island, e. Water sampling for laboratory analysis, f. Scattered nurdles along the shore of Hare Island

Nurdles spill survey at Dhanushkodi coast

Nurdle bags collected by fishermen in Nagapattinam coast

கப்பலில் இருந்த 2 மூட்டைகள்
நாகை மீனவர் வலையில் சிக்கின

ANNEXURE - 2

Coastal habitats, associated biodiversity, dependent coastal community and other coastal based activities along the coast of Tamil Nadu.

1.1. Background

The Tamil Nadu state has a coastal length of 1,076 km encompassing 14 coastal districts bounded by the Bay of Bengal in the East, the Arabian Sea in the west and the Indian Ocean in the south. These coastal districts are highly productive areas contributing to the nation's economic growth and providing livelihood opportunities to the dependent populations.

A coastal length of about 843.7 km from Kanniyakumari to Nagapattinam covering eight coastal districts witnessed the impact of nurdle spill.The districts are Kanniyakumari (71.5 km), Tirunelveli (48.9 km), Thoothukudi (163.5 km), Ramanathapuram (236.8 km), Pudukkottai (42.8 km), Thanjavur (45.1 km), Thiruvarur (47.2), and Nagapattinam (187.9 km) (Fig.1).

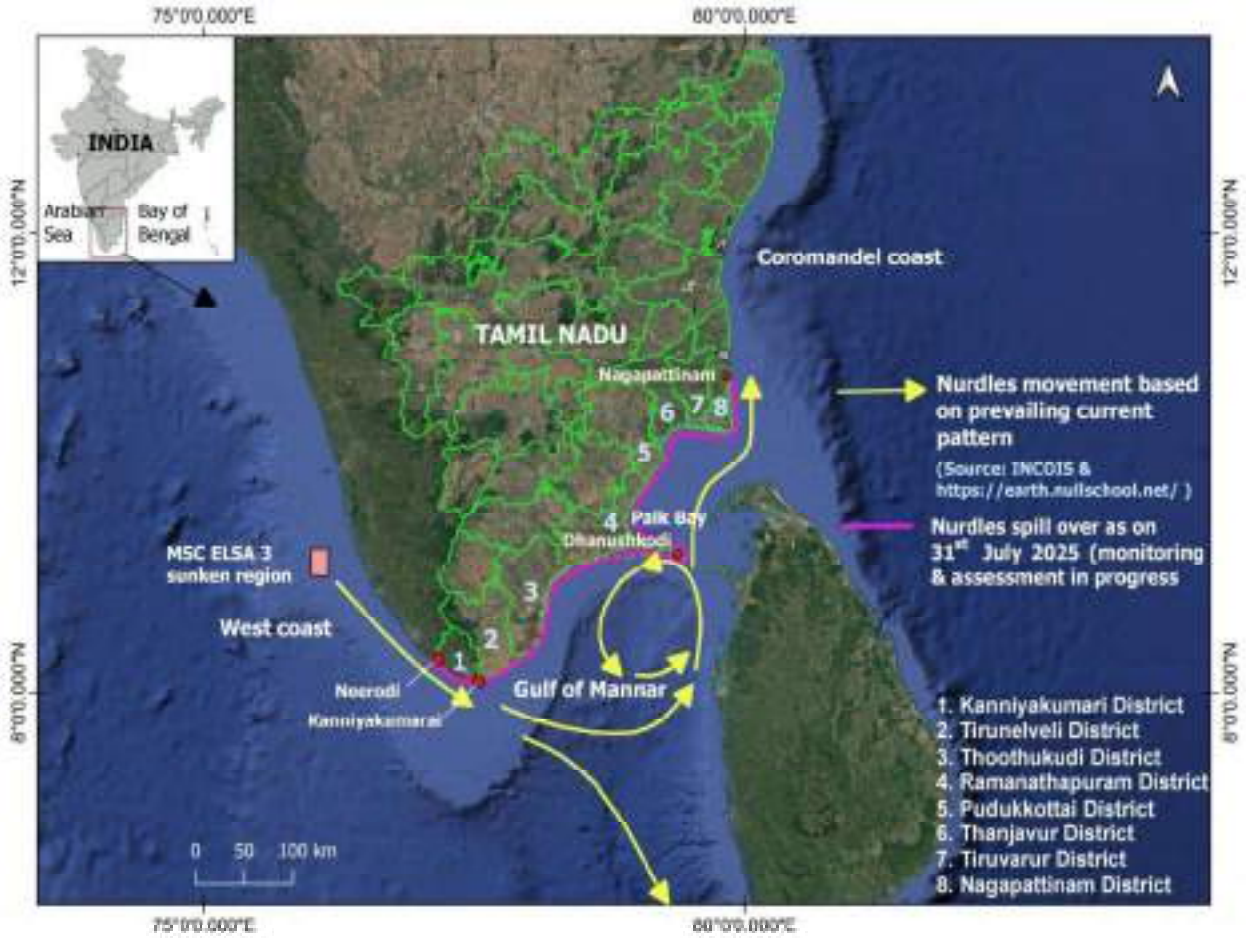


Fig.1: Map showing the coastal areas of Tamil Nadu affected by the nurdle spill

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The coasts of these eight districts have several important marine ecosystems such as coral reefs, seagrass stretches, mangrove stands, rocky areas, mussel beds, estuaries, mudflats and sandy beaches (Fig.2). These coastal ecosystems are vital for the dependent livelihood and generally for the human well-being, health,and survival. The important services of these ecosystems include the provision of food, climate moderation, coastal protection, carbon sequestration, nutrient cycling, recreation and more. It is only due to the availability of these key habitats that the biodiversity along the coasts of these districts is significantly high. This rich and varied biodiversity supportedby these habitats provides livelihood through fishery resources to thousands of fishermen who live along the coast. Any damage to these habitats will affect the dependent biodiversity and ultimately the fishery resources that are important for the livelihood of coastal communities.

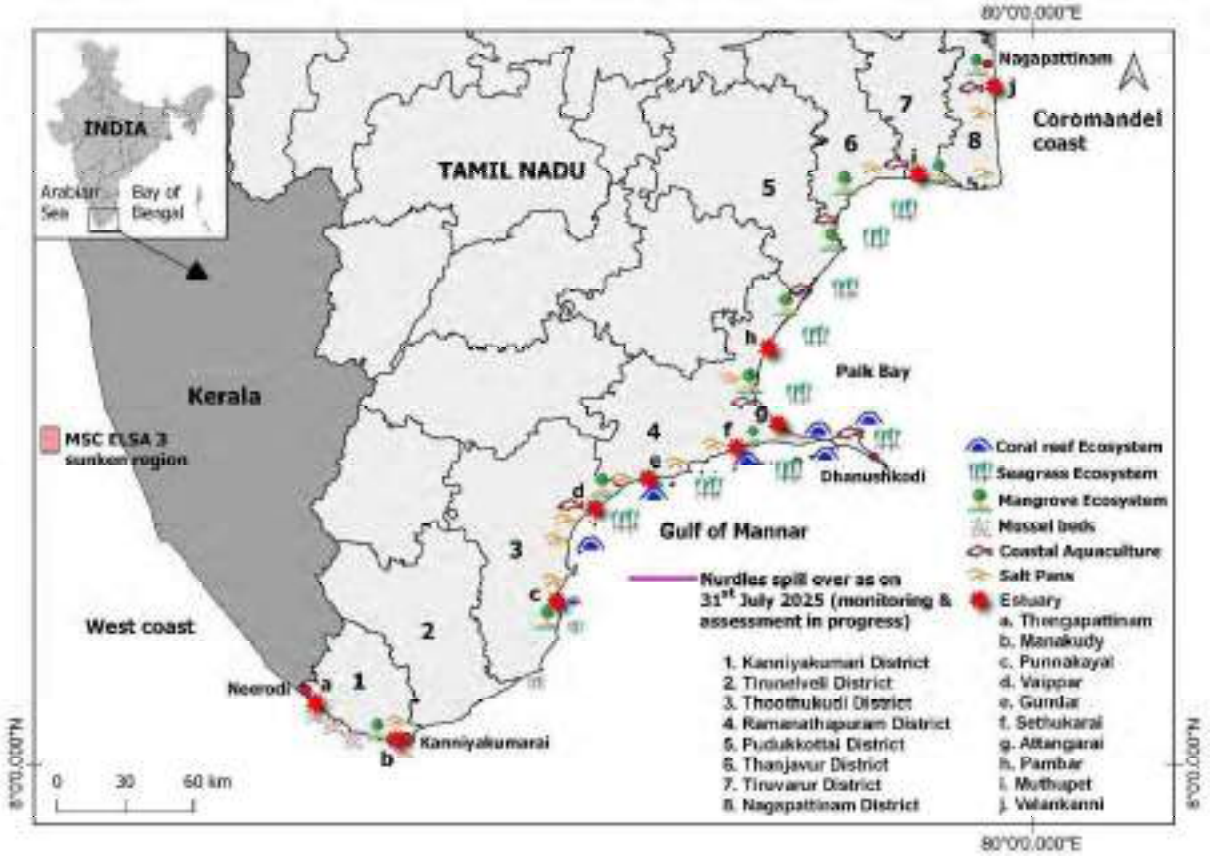

Fig.2: Map showing the key ecosystems affected by the nurdle spill

Details of the coastal and marine ecosystems occurring along the coasts of the eight districts are provided below.

1.2. Ecosystems and associated biodiversity in the affected coastal areas

1.2.1 Coral reef ecosystem of the Gulf of Mannar and Palk Bay

Coral reefs, termed as 'the rain forests of the sea', are underwater marine ecosystems that provide various ecological and economic benefits such as fishery production, coastal protection, and more. The Gulf of Mannar and Palk Bay are one of the major four coral reef regions of India that benefit thousands of coastal communities. From the south of Palk Bay through the

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south of the Gulf of Mannar coral reef areas cover the coastline of four districts, namely Ramanathapuram, Thoothukudi, Tirunelveli, and Kanniyakumari. The biodiversity of the Gulf of Mannar is comparatively high with a total of 4,223 species reported from here so far (Balaji et al. 2012). Considering the importance of the coastal habitats in the Gulf of Mannar, the Government of India in 1989 declared as the creation of the first Marine Biosphere Reserve in India called Gulf of Mananr Biosphere Reserve (GOMBR) covering 10,500 sq. km. There are 21 uninhabited low-lying islands occurring in a stretch from Rameswaram to Tuticorin. The major coral reefs and coral-associated ecosystems have developed around these 21 islands with rich biodiversity. The Government of Tamil Nadu in 1986 declared the 21 islands and the surrounding waters covering 560 sq.km as the Gulf of Mannar Marine National Park (GOMMNP) to protect this biodiversity hotspot. A total of 132 coral species have been reported from the Gulf of Mannar with a total reef area cover of 66.28 km^2 (Edward et al. 2023). Coral reefs in Palk Bay occurVedhalai and Rameswaram in the Ramanathapuram district. There are 63 species of corals under 22 genera in Palk Bay (Pillai 1969) and the overall floral and faunal species reported in Palk Bay is 3,289 (Kumaraguru et al., 2008).The total reef area in Palk Bay is about 20.5 km^2 (Naganathan et al. 2024). Coral reefs and associated biodiversity in the Gulf of Mannar and Palk Bay provide direct and indirect livelihood to thousands small-scale poor fisher folk.

Economic value of coral reefs

The economic value of coral reefs is approximately 70 times higher than tropical forests (Fezzi et al. 2023). The total economic value of healthy coral reefs ranges from US$ 100,000 to 600,000 per km^2 area per year through fisheries, tourism, and coastal protection (UNEP-WCMC 2006).The climate-related loss of reef ecosystem services will total around US$ 500 billion per year or more by the year 2100 (Hoegh-Guldberg 2015). Global coral reef fisheries valued at $6.8 billion per year support several local economies (Spalding et al. 2016). In the Indian context, the estimated value of 1.0 sq km coral reef area in the Gulf of Kachchh (Gujarat) is around Rs. 7.95 million per year (Dixit et al. 2010).

1.2.2. Seagrass ecosystem of the Gulf of Mannar and Palk Bay

Seagrasses are marine flowering plants and are dynamic ecosystems that play important ecological roles such as fishery production, carbon sequestration, nutrient cycling and coastal protection. India's most luxuriant seagrass beds (over 75%) occur along the Gulf of Mannar and Palk Bay providing livelihood to coastal fishermen. In the Gulf of Mannar, significant extent of seagrass beds occur predominantly between the mainland and the 21 uninhabited islands, as well as on the seaward sides of the islands (Mathews et al. 2010) in Ramanathapuram and Thoothukudi districts. The seagrass cover of the Gulf of Mannar and Pak Bay is around 400 sq.km. Seagrasses in the Gulf of Mannar and Palk Bay harbor several species of ecologically and economically important marine organisms including but not limited to dugongs, sea horses, sea turtles, sea cucumbers, sea urchins, starfishes, gastropods, bivalves, ascidians, sponges and crustaceans. Seagrass dependent fishery is significant along the coasts of the Gulf of Mannar and Palk Bay as several commercially important fishes, crabs and prawns are available in plenty in seagrass beds to provide income to thousands of fishermen every day. In 2022, the Government of Tamil Nadu notifiedthe creation of 'Dugong Conservation Reserve' in Palk Bay covering the coastal waters of Thanjavur and Pudukkottai districts with an area of 448 $km^2$to protect and conserve dugongs and their habitats (seagrasses).

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Economic value of seagrasses

Seagrasses offer significantly huge economic benefits valued at more than US$ 19,000 per hectare per year (www.oceanhealthindex.org). The economic contribution of seagrass habitats to secondary production in the gulf waters of South Australia has been estimated to be AU$ 114 million per year (McArthur and Boland, 2006). In Derawan Island, Indonesia, estimates of the economic value of fish and marine biota inhabiting the seagrass ecosystem area are US$ 13,488.80 and US$ 35,744.69 per hectare per year respectively (Kurniawan et al., 2019). The total economic value of the seagrass ecosystem in Nain Island, Indonesia has been estimated as US$ 1,997,848 yr-1 (Pandelaki et al., 2020). Further, it has been estimated that the economic value of seagrass beds amounts to US$ 481.77 CO_2/acre in the form of blue carbon (Nurdianto and Resosudarmo, 2016).An estimate states that the commercial fisheries in seagrass beds in Australia account for AU$ 31.5 million per year (Jänes et al., 2020). About 99% of the economic value of vegetated coastal habitats in Australia has been reported to be associated with seagrass beds with an average value of AUD 21,276 ha^{-1} y^{-1} (Jänes et al., 2020). As nurseries seagrass beds are worth AUD 31,650 ha^{-1} y^{-1} in Southern Australia (Blandon and zuErmgassen, 2014). According to another estimate from Gran Canaria Island, the value of seagrasses to inshore fisheries is EUR 606,239 y^{-1}.

1.2.3. Mangrove ecosystem of the Gulf of Mannar and Palk Bay

Mangrove ecosystems are one of the most productive ecosystems of the coastline of tropic and sub-tropic regions which are vital to our socioeconomic development. The Gulf of Mannar harbours mangroves with a considerable diversity, which supports a variety of biological organisms. The islands of Gulf of Mannar also possess unique mangrove vegetation. Krusadai, Manoli and Poomarichan islands have comparatively denser mangrove vegetation than the other islands in the Gulf of Mannar. Some of the important mangrove areas in the Gulf of Mannar include Manakudy Estuary in Kanniyakumari district and Punnakayal estuary in Thoothukudi district. Apart from these, there are several patches of mangroves along the mainland in Thoothukudi and Ramanathapuram districts. Mangroves are seen all along the coast of Palk Bay in distinct patches as there are several inlets for freshwater mixing with the sea throughout the coast. However, major mangrove forests are observed in Muthupettai and Karangadu. They are highly productive zones and also play a significant role in preserving the ecology of the area. s. There are thousands of fishermen who use mangrove areas, lagoons and estuaries for their livelihood needs.

Economic value of mangroves

The value of mangroves has been estimated to be 3.5 million dollars per sq.km per year in Thailand (Source: Mangroves for the Future). In Kenya, the total value of mangroves has been estimated as US$ 1,092 per hectare per year (Hoberg 2011). In the Indian context, the total economic value of mangroves ranges between Rs. 92,662/ha/yr and Rs. 33,61,144/ha/yrwith an average total economic benefit of Rs. 9,58,766/ha-/yr. The mangrove ecosystems of India are contributing equivalent economic benefit of Rs. 53,604 crore to the welfare of coastal communities (Ramesh et al. 2022).

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1.2.4. Rocky shore areas in the Gulf of Mannar

Rocky coastlines support a rich diversity of wildlife, including barnacles, crabs, snails, sea squirts and anemones, and help in primary production and nutrient cycling. Acting as a hard sea-defence, a rocky shore defends the coast by protecting it from erosion, flooding, and wave damage by absorbing and dissipating wave energy. In the Gulf of Mannar, discontinuous rocky areas are observed along the coastal stretch between Tiruchendur and Neerodi from the shore to deeper waters and have a significant amount of biodiversity. The submerged rocks provide surface to various epibenthic organisms and also shelter various commercially and economically important fish species. Thus these rocky areas act as active fishing grounds for the fishermen traditionally for several years.

1.2.5. Estuaries of the Gulf of Mannar and Palk Bay

Estuarine ecosystems are important coastal habitats that provide ecological, economic, and social benefits. Occurring between the land and the sea, they act as natural filters, protecting coastal waters, offering habitats for multitude of organisms, and supporting fisheries and tourism.Some of the important rivers such as Cauvery, Vaigai and Tamiraparanijoin the sea forming estuariesin the coastal areas of the eight affected districts. Distributaries of these major rivers cause several smaller and larger estuaries along the coast of the Gulf and Palk Bay. Major estuaries are seen in Manakudi(Kanniyakumari district), Karankadu(Ramanathapuram district), Punnakayal(Thoothukudi district), and Muthupettai(Thiruvarur and Nagapattinam districts). There are several smaller estuaries found throughout the coastal areas of these eight districts. Comparatively, more estuaries are seen along Palk Bay coast due to the many distributaries of the river Cauvery. Thousands of poor small-scale fishermen are dependent on estuarine ecosystem for their livelihood. Apart from fin fishes, plenty of crustaceans are available in the estuarine ecosystems. Moreover, estuaries act as feeding ground to many birds including the migratory ones.

1.2.6. Mudflats of the Gulf of Mannar and Palk Bay

Mudflats are intertidal areas and they are vital for their important ecological functions. They provide shelter to hundreds of intertidal organisms, act as nurseries for several commercially important fish species, offer feeding grounds for birds, and give protection against coastal erosion. Mudflats are often observed near the estuarine and mangrove ecosystems along the coast. Hence, Manakudi in Kanniyakumari district, Punnakayal in Thoothukudi district, Karankadu in Ramanathapuram district, Muthupettai in Thiruvarur and Nagapattinam districts are having major mudflat areas. Apart from that, there are several mudflats along the Gulf of Mannar and Palk Bay coasts offering livelihood to dependent small-scale fishermen.

1.2.7. Sandy beaches of the Gulf of Mannar and Palk Bay

Sandy beaches are important coastal ecosystems that offer a multitude of benefits of ecological, recreational and economic value. They act as natural barriers against erosion, support diverse marine and terrestrial life, and provide spaces for recreation and tourism. Sandy beaches are also crucial for nutrient cycling and groundwater recharge. Sandy beaches prevalently occur in all the eight districts in Gulf of Mannar and Palk Bay. Beach ecosystems in the Gulf of Mannar support a variety of biodiversity and protect the coast from erosion and coastal disasters. Sandy beaches are also present in the islands of the Gulf of Mannarwhich protect the islands from submerging. Importantly, sandy beaches, especially in Ramanathapuram and Thoothukudi districts provide nesting ground for endangered sea turtles.

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1.2.8. Mussel beds along Kanniyakumari coast

Kanniyakumari district located in the southern tip of the Indian Peninsula is known for its rich culture and tradition. The district's coastal population on the 71.5 km long rocky coast thrives by fishing. Fishing mussels particularly the delicious marine mussels *Perna perna* and *Perna viridis* (locally called "thodu" and "kallika") is a seasonal source of income and livelihood. Over 2,000 fishermen from 10 coastal villages (Kanyakumari, Muttom, Kadiapatinam, Colachel, Kodimunai, Vaniyakudi, Kurumpanai, Midalam, EnayamPuthenthurai and Enayam) are engaged in mussel fishing. A total of about 14,000 m^2 of rocky area is available for the rich mussel beds near the coast of the above said 10 villages. Active harvesting is done for 4-5 months in a year from November to March. The fishers in this villages practice community-based, sustainable, conservation-oriented mussel fishing without affecting the young ones and the breeding season (June to August). There is very high demand for the mussels in the neighboring Kerala state (75%) and also in the local markets (25%). Currently, mussels with the size ranging 8-12 cm fetch Rs 500-1,500 per 100 mussels depending on size. The average price is Rs 600-750 per kg. According to reports, a total quantity of about 400 tons of mussels valued at Rs 25 crore is harvested in a season. In addition to the direct livelihood to the fisher community, mussel fishing also provides livelihood to traders, who buy and supply the mussels to local fish-vendors and also to neighboring states. Thus mussel fishery enables a total livelihood worth of Rs 25 crore to about 2,000 coastal fishers and to traders and fish-vendors, who depend on mussel fishery for their living.

Fig.3: Map showing the mussel bed locations along Kaniyakumari coast of Tamil Nadu

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1.2.9. Salt pans

In certain coastal districts of Tamil Nadu, salt is extracted from seawater through natural solar evaporation, which is a traditional method practiced for hundreds of years. Tamil Nadu is one of the major salt producers in the country, where major salt production happens in Tuticorin and Vedaranyam regions. In the year 2016 alone, Tamil Nadu has produced 2,18,450 tonnes of Industrial Grade Salt (Tamil Nadu Salt Corporation). Thoothukudi district contributes more than 60% of the total salt production of the state, followed by Nagapattinam district with over 20% and Ramanathapuram district with over 10% (Amutha 2024). Thousands of coastal people are involved in salt production for their livelihood. About 5,500 acres of Government land have been given for salt production on long-term lease basis by the Tamil Nadu Salt Corporation Limited. Any pollution in the seawater will affect the salt production and the livelihood of the dependent people.

1.2.10. Coastal aquaculture

There are several aquaculture units operating along the coast of Tamil Nadu. Out of the total of 56,000 ha of brackish water area in the state, a total area of 6,236 ha is under coastal aquaculture production, mainly shrimp aquaculture (Department of Fisheries and Fishermen Welfare, Government of Tamil Nadu). Tamil Nadu is the third largest producer of the commercially important shrimp *Penaeus vannamei* in India (Angela and Sharma 2023). A large number of shrimp farms are functioning along the coastlines of Ramanathapuram and Nagapattinam districts, where hundreds of people are working for their livelihood. About 30,000 ha of brackish water area in Nagapattinam, Thanjavur, Thiruvarur, and Ramanathapuram districts is used for shrimp farming. Water quality changes in shrimp farms can cause mass mortalities and consequent economic loss. Apart from shrimp farming, seaweed cultivation and cage culture activities also take place along the coasts of the Gulf of Mannar and Palk Bay. These activities can also be affected by the pollutants in the seawater.

2. Dependent Fishermen and fishing details

A total of 6,09,674 fisherfolk live on the coast between Kanniyakumari and Nagapattinam districts, which include 395 fishing villages and 1,50,241 fishermen families. Among the total number of fishermen families, 1,39,114 families live below poverty line (CMFRI-DoF 2020). Among the eight districts, a total of 28,070 crafts are being operated, of which 4,682 are mechanized 22,364 are motorized and 1,024 are non-motorized. The estimated marine fish production among these eight districts for 2022-23 was 3,69,208.04 tonnes, which is 61.88% of the total catch of Tamil Nadu (Tamil Nadu Statistical Hand Book 2022-23) (Table 1-3).

Table 1: Population details of fisherfolk living between Kanniyakumari and Nagapattinam districts (Source: CMFRI-DoF 2020)

Name of the District	No. of fishing villages	No. of fishermen	No. of fishermen families	No. of BPL families
Nagapattinam	52	87,013	22,763	18,970
Thiruvarur	13	12,361	3,096	3,081
Thanjavur	31	30,797	7,070	7,066
Pudukkottai	34	28,485	6,645	6,456

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Name of the District	No. of fishing villages	No. of fishermen	No. of fishermen families	No. of BPL families
Ramanathapuram	178	1,88,915	42,672	36,605
Thoothukudi	32	84,987	22,039	21,732
Tirunelveli	9	24,669	6,554	6,463
Kanniyakumari	46	1,52,447	39,402	38,741

Table 2: Number of fishing crafts operated between Kanniyakumari and Nagapattinam districts

Name of the District	No. mechanized boats	No. of motorized boats	No. of non-motorized boats
Nagapattinam	811	4,225	0
Thiruvarur	0	137	0
Thanjavur	256	1,289	0
Pudukkottai	412	1,253	0
Ramanathapuram	1,948	4,673	420
Thoothukudi	386	4,576	1
Tirunelveli	0	1,022	6
Kanniyakumari	869	5,189	597

Table 3: Estimated marine fish production for 2022-23 from the coast between Kanniyakumari and Nagapattinam districts
(Source: Tamil Nadu Statistical Hand Book 2022-23)

Name of the District	Quantity in tonnes	% in Tamil Nadu's total catch
Nagapattinam	46.609.63	7.81
Thiruvarur	2.010.33	0.34
Thanjavur	51.867.95	8.69
Pudukkottai	48.081.60	8.06
Ramanathapuram	86.417.47	14.48
Thoothukudi	55.550.02	9.31
Tirunelveli	10.546.93	1.77
Kanniyakumari	68.124.11	11.42

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ANNEXURE - 3

Nurdle impact on coastal ecosystems, associated biodiversity and human health

1. Background

On 24 May 2025, the Liberian-flagged cargo vessel *MSC ELSA 3* sank approximately 38 nautical miles off the coast of Kochi, Kerala, releasing an estimated 640 cargo containers into the Arabian Sea. Among these were several containers filled with plastic resin pellets (commonly known as nurdles), along with 13 containers reportedly carrying hazardous materials. Nurdles are small, lentil-sized polymer pellets that serve as the raw material for plastic manufacturing. Due to their buoyant and durable nature, they are easily dispersed by ocean currents and can persist in marine environments for extended periods.

2. Overview of Environmental Impacts of Nurdle Pollution

After the occurrence of a nurdle spill, the pellets can persist in the marine environment for months to years due to their buoyancy, durability, and resistance to degradation. Over time, they fragment into micro- and nanoplastics and spread across diverse habitats. These persistent pollutants can affect water and sediment quality, damage critical ecosystems like coral reefs, seagrass beds, and mangroves, and act as carriers of toxic chemicals and pathogens.

Table 1 given below provides a consolidated summary of the major ecological impacts associated with nurdle pollution, particularly in marine ecosystems. Based on existing scientific literature, it outlines the key pathways through which nurdles and their derived microplastics (MPs) affect environmental quality, biodiversity, and ecosystem functioning. Each impact category is concisely described, with supporting references to facilitate further understanding and investigation.

Table 1: Summary of the ecological impacts of nurdle pollution

Environment & Biodiversity	Impacts	Supporting References
Nurdle fragmentation and sinking	Fragmentation increases surface area for contaminant adsorption; sinking changes transport fate	Kaiser et al., 2017; Sewwandi et al., 2022
Nurdles as vectors	Nurdles carry pollutants and microorganisms over long distances	Rodrigues et al., 2019; Jiang et al. 2021
Environmental impacts on water and sediment quality	Leachates and adsorbed toxins alter pH, conductivity, and organic load, potentially disrupting microbial communities and sediment chemistry.	Thacharodi et al., 2024; Cocozza et al., 2024
Impacts on coral reef ecosystem	Smothering, reduced light penetration, and chemical leachates impair coral health	Reichert et al., 2018; Chen et al., 2022; Nama et al., 2023

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Environment & Biodiversity	Impacts	Supporting References
Impacts on seagrass ecosystem	Microplastics modify sediment texture and reduce light availability, impairing photosynthesis and root function, which leads to seagrass decline.	Sanchez-Vidal et al., 2021; Gerstenbacher et al., 2022
Impacts on Mangrove Ecosystem	Plastics entrapment in pneumatophores and sediment alteration affect mangrove growth, affecting benthic invertebrates dependent on mangrove habitats.	van Bijsterveldt et al., 2021; Adyel&Macreadie, 2021
Impacts on productivity: (phytoplankton and zooplankton)	Reduced chlorophyll and zooplankton abundance due to toxicity and light limitation	Rist et al., 2023
Nurdle Ingestion by fish and Invertebrates	Widespread ingestion leads to false satiation, gut blockage, and reduced feeding	Day et al., 2024; Jimenez-Guri et al., 2024
Impacts on benthic organisms	Ingestion and smothering by nurdles disrupt benthic community structure and reduce species diversity.	Hiki& Nakajima, 2022; Izar et al., 2024
Iimpacts on mussel bed ecosystems	MPs cause bioaccumulation, disrupt byssal thread formation, induce histopathological damage, and trigger oxidative stress responses in mussels.	Khan, & Prezant, 2018; Shang et al., 2021
Impacts on oyster beds	*Exposure to MPs causes physical abrasion, reduced filtration rates, and chemical stress through contaminant uptake in oysters.*	Hammadi et al., 2022; Guruge et al., 2024
Impacts on marine mammals and wildlife	Ingestion leads to blockages, malnutrition, mortality in birds, turtles, marine mammals	Charlton-Howard et al., 2023; Ramasamy et al., 2024
Potential for pathogen transfer via nurdles	Fecal and pathogenic bacteria on nurdles may spread diseases to marine biota	Rodrigues et al., 2019; Meng et al., 2021
Risks of Nurdles to Human Health	Human exposure through seafood, pathogen risk, and contaminant transfer	Thacharodi et al., 2024; Marfella et al., 2024
Salt Pan	Nurdles and nurdle-derived microplastics can enter salt pans through seawater, accumulate in crystallizing salt, persist in sediments, and potentially contaminate the final product, posing human health risks.	Nithin et al., 2021; Rakib et al., 2021
Shrimp Farms / Aquaculture	Nurdles and nurdle-derived microplastics can enter shrimp ponds via seawater, accumulate in shrimp tissues, impair immunity, and increase pathogen susceptibility, with potential for bioaccumulation of associated contaminants.	Valencia-Castañeda et al., 2022; Timilsina et al., 2023

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3. Nurdles and their ecological impacts

Nurdles are small polyethylene (PE) or polypropylene (PP) pellets (1–5 mm) used in plastic manufacturing and classed as “primary microplastics” (< 5 mm) (Day et al., 2024). Spills during transport are a major source of marine pollution, with their buoyancy enabling long-range dispersal and making cleanup difficult (Ferreira et al., 2021).They degrade into smaller plastics, accumulate in diverse habitats, and adsorb persistent organic pollutants (POPs) such as PCBs, DDT, HCHs, and PAHs (Jiang et al. 2021), transferring toxins through food webs and posing ecological and human health risks (Marfella et al., 2024). Extremely persistent, they can remain for years (Galgani& Rangel-Buitrago, 2024).Globally, ~230,000 tonnes enter oceans annually (Sherrington, 2016) from chronic losses and major spills, e.g., Hong Kong (2012), South Africa (2017), MSC Zoe (2019), X-Press Pearl (2021), Toconao (2023) (Jiménez-Guri et al., 2024). The MSC ELSA 3 spill (India, May 2025) released PE and PP nurdles off Kochi, dispersing from Neerodi to Nagapattinam, threatening habitats, biodiversity, and fisheries.

3.1. Nurdle fragmentation and sinking

Polyethylene (PE, 0.91–0.96 g/cm³) and polypropylene (PP, 0.90–0.92 g/cm³) are buoyant in seawater (~1.025 g/cm³) and initially float (Matavos-Aramyan, 2024). Over weeks to months, biofouling, sediment adhesion, and photodegradation reduce buoyancy, causing sinking often within 6–13 weeks (Kaiser et al., 2017), with PE pellets observed sinking after 66 days (Fazey& Ryan, 2016). Fragmentation, driven by UV photooxidation, abrasion, and microbial activity, can take months to decades. PE is highly stable, while PP is more susceptible to oxidative degradation due to tertiary carbons in its backbone (García-López et al., 2024). Breakdown releases microplastics (<5 mm) and nanoplastics (<1 µm), which can disperse via wave action and embed in sediments (Sewwandi et al., 2022).

3.2. Nurdles as vectors

Nurdles absorb and transport pollutants and pathogens, introducing them into food webs when ingested by marine life. Weathering increases pollutant sorption by creating functional groups and expanding surface area (Liu et al., 2019). Heavily weathered pellets often contain higher PAH and PCB concentrations (Jiang et al., 2021) and provide surfaces for biofilm formation, harboring microorganisms such as *E. coli* and *Vibrio* spp. (Rodrigues et al., 2019). The aging (weathering) status of nurdles is therefore critical in assessing environmental risk.

4. Environmental impacts

Nurdles and their fragmented microplastics can degrade water and sediment quality, leach additives, contaminate substrates, and stress habitats such as coral reefs, seagrass meadows, and mangroves, disrupting ecological balance.

4.1. Water and sediment quality

Buoyant nurdles disperse widely by wind and currents, sorb hydrophobic contaminants, and provide surfaces for biofilm formation, including faecal-indicator and potentially pathogenic bacteria (Pozo et al., 2020). In the water column they can be ingested by plankton and other biota, concentrate adsorbed toxins, and foster biofilms that may alter local nutrient dynamics (Thacharodi et al., 2024). Upon settling, pellets embed in sediments, disrupting nutrient cycling and benthic fauna (worms, bivalves, crustaceans), while contaminated sediments can act as secondary sources of pollutants and microplastics when disturbed. Their persistence and slow degradation make these effects long-term and difficult to reverse (Cocozza et al., 2024).

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4.2. Impacts on coral reefs

Direct evidence of nurdle-specific impacts on corals is scarce, but their degradation into microplastics (<5 mm) poses documented risks to reef ecosystems. Microplastics can adhere to coral surfaces, smother polyps, and reduce light penetration, impairing photosynthesis and growth (Reichert et al., 2018). Laboratory studies show that various polymers (PE, PET, PA66) accumulate on or within coral skeletons, reducing endosymbiont density, chlorophyll content, and metabolic enzyme activity, while inducing oxidative stress, immune suppression, and histopathological damage (Chen et al., 2022; Isa Valerio, 2022). They can also transport pathogens, disrupt coral-associated microbiomes, and introduce plastic-derived toxins such as phthalates (Lear et al., 2021). These stressors can impair coral health, reproduction, and resilience, with broader consequences for reef biodiversity, ecosystem services, and coastal economies (Nama et al., 2023).

4.3. Impacts on seagrass ecosystems

Seagrass meadows, vital for coastal biodiversity and ecosystem services, are threatened by microplastics from nurdle fragmentation. These particles settle on blades and sediments, smothering plants, blocking light, and impairing photosynthesis (Gerstenbacher et al., 2022). They transport toxins such as heavy metals, PAHs, and bisphenol A, disrupting metabolism, nitrogen fixation, and nutrient cycling (Daniel Tang Kuok Ho, 2024). Ingestion by grazers like sea cucumbers and herbivorous fish promotes trophic transfer and biomagnification (Idris et al., 2021). Seagrass can trap and aggregate plastics up to 1,470 items/kg in beach-cast fiber balls (Sanchez-Vidal et al., 2021) this also increases in-habitat exposure. Experimental studies indicate that polyethylene microplastics reduce nutrient content, inhibit root function, and alter nitrogen cycling in submerged plants, suggesting similar functional risks in seagrass systems (Yu et al., 2022).

4.4. Impacts on Mangrove Ecosystems

Mangrove root systems and calm waters trap nurdles and microplastics, which accumulate in sediments and roots, disrupting oxygenation, seedling growth, and overall plant health (van Bijsterveldt et al., 2021). Ingestion occurs in mangrove fauna such as crabs and bivalves, with high particle loads indicating bioaccumulation and potential biomagnification (Sivan et al., 2025). Rhizophora propagules can absorb microplastics, causing oxidative stress and growth inhibition (Nacario et al., 2025). In the Sundarbans, dense roots trap much of the ~3 billion microplastic particles entering the Bay of Bengal daily, threatening biodiversity, fisheries, and community livelihoods (Adyel&Macreadie, 2021). Persistent nurdle deposition may weaken mangrove resilience against existing pressures like climate change and habitat loss.

4.4. Nurdle impacts on salt pans

Nurdles and the microplastics derived from them, transported via seawater, can enter salt pans during the salt production process. These particles may accumulate in crystallizing salt, potentially contaminating the final product and posing human health risks. Salt pan sediments can act as a sink for microplastics, leading to long-term persistence (Nithin et al., 2021). The extent of accumulation depends on water flow, salt pan design, and particle size. Continuous input from polluted coastal waters can lead to long-term accumulation of contaminants in salt pan sediments (Rakib et al., 2021).

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4.5. Nurdle impacts on shrimp farms

Nurdles and the microplastics derived from them can enter shrimp farms through seawater intake, particularly in semi-intensive and extensive aquaculture systems. These particles accumulate in shrimp tissues, potentially impairing immunity and increasing vulnerability to viral and bacterial infections (Valencia-Castañeda et al., 2022). Bioaccumulation of microplastics may also facilitate the transfer of adsorbed chemical contaminants, affecting shrimp health and aquaculture productivity. Monitoring of microplastic presence in farmed shrimp is crucial to assess potential ecological and food safety risks (Timilsina et al., 2023).

5. Impacts on biological productivity

Nurdle pollution can reduce biological productivity by disrupting the base of the marine food web. Leachates and microplastics from nurdles may alter nutrient cycling, reduce primary production, and impair energy transfer to higher trophic levels.

5.1. Phytoplankton and zooplankton

Nurdle spills can impair marine productivity by affecting phytoplankton and zooplankton. After the *X-Press Pearl* spill in Sri Lanka, experiments showed nurdle leachates slightly inhibited phytoplankton growth (*Rhodomonassalina*) but severely harmed zooplankton. *Paracentrotuslividus* larvae and *Acartiatonsa* exhibited malformations, reduced growth, high nauplii mortality (up to 46%), and adult mortality (up to 51%) at higher concentrations (Rist et al., 2023). Such disruptions to plankton communities can destabilize coastal food webs and diminish ecosystem productivity.

6. Impacts on marine fauna

Nurdles and their microplastic by-products harm marine fauna through ingestion, habitat alteration, and contaminant transfer, affecting fish, invertebrates, shellfish beds, and larger wildlife, with consequences for survival, reproduction, and food web stability.

6.1. Nurdle ingestion by fish and invertebrates

Nurdles, often mistaken for prey such as fish eggs or zooplankton, are ingested by a wide range of marine organisms, including fish and invertebrates (Sewwandi et al., 2023). Ingestion can cause gastrointestinal blockages, false satiation, reduced nutrient absorption, gut abrasion, and energy depletion (Day et al., 2024). Nurdles also adsorb toxicants such as PAHs, PCBs, and heavy metals, leading to hepatic stress, oxidative damage, and reproductive impairments (Jiang et al., 2021). Weathered nurdles fragment into micro- and nanoparticles, increasing bioavailability and potential trophic transfer, while leachates can induce cellular damage even without ingestion (Jimenez-Guri et al., 2024).

6.2. Impacts of nurdles on benthic organisms

Nurdles accumulate in sediments, exposing infaunal and epifaunal benthic species to ingestion risks, either directly during foraging or indirectly via contaminated prey such as prawns and burrowing crabs (Hiki& Nakajima, 2022). Deposit feeders and detritivores, including polychaetes, amphipods, and bivalves, are especially vulnerable, with impacts such as reduced feeding efficiency, depleted energy reserves, and impaired reproduction (Leslie et al., 2017). Toxicity can be heightened in weathered nurdles due to higher contaminant loads and in organic-rich sediments, as shown in benthic isopods where exposure increased mortality and abnormal behaviors (Izar et al., 2024).

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6.3. Impacts on mussel bed ecosystems

Mussel beds enhance nutrient cycling, habitat complexity, and biodiversity but are highly vulnerable to microplastic pollution due to suspension-feeding and low particle selectivity (Khan & Prezant, 2018). Ingested MPs and nanoplastics can persist in tissues for weeks, reducing filtration, digestion, growth, reproduction, immune function, and byssal strength, compromising colony stability and aquaculture yields (Shang et al., 2021). Chemical leachates from virgin and polluted pellets further impair development and byssus production, with stronger effects from polluted sources (Zardi et al., 2023). These impacts threaten both individual mussels and the collective resilience of mussel bed ecosystems.

6.4. Impacts on oyster beds

Oyster beds provide critical ecological and economic services but are vulnerable to microplastic and nurdle pollution due to their filter-feeding nature (Hammadi et al., 2022). MPs in oysters pose seafood safety risks, with concentrations up to 2.20 particles g^{-1} wet weight reported in *Saccostrea cucullata* beds in Sri Lanka (Guruge et al., 2024). Nurdles can smother benthic surfaces, hinder larval settlement, fragment into ingestible MPs, and accumulate in tissues causing inflammation, reduced filtration, impaired reproduction, and toxicant transfer from adsorbed PAHs, PCBs, and heavy metals (Rochman et al., 2016).

6.5. Impacts on marine mammals and wildlife

Marine mammals can ingest nurdles directly or indirectly through prey, leading to gastrointestinal blockages, internal abrasions, false satiation, impaired nutrient absorption, and, in severe cases, mortality (Charlton-Howard et al., 2023). Juvenile sea turtles are particularly vulnerable due to their surface-feeding behavior and tendency to mistake floating plastics for prey (Bjorndal et al., 1994). Seals and cetaceans have been found with plastics in their digestive tracts, acquired either directly or via prey transfer (Beck & Barros, 1991). Plastic ingestion is also documented in piscivorous birds, such as polyethylene and polypropylene microfibres detected in regurgitated pellets of the Common Kingfisher, indicating trophic transfer within aquatic food webs (Ramasamy et al., 2024). The persistence of nurdles in both coastal and pelagic zones represents a significant threat to biodiversity and ecosystem health.

7. Emerging biological risks

Beyond ecological degradation, nurdle can act as vectors for pathogenic microorganisms and leach toxic additives, posing risks to marine biodiversity, public health, and food safety. Ingestion by seafood species may lead to human exposure to harmful chemicals through diet.

7.1. Potential for pathogen transfer via nurdles

Plastic resin nurdles provide an ideal surface for microbial colonization in marine environments. Once introduced into coastal waters, they can travel long distances and accumulate along shorelines and sensitive habitats. Studies show that plastic debris, including nurdles, can harbor faecal indicator organisms such as *Escherichia coli* and pathogenic bacteria like *Vibrio* spp. (Rodrigues et al., 2019). They may also facilitate disease spread and antibiotic resistance gene transfer in aquatic systems (Meng et al., 2021), posing significant public health and ecological risks. Their persistence and mobility enable pathogens to reach remote habitats, potentially impacting vulnerable wildlife. In densely populated coastal regions, this risk extends to human communities through seafood consumption and recreational water use.

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7.2. Risks of nurdles to human health

Human exposure to nurdles and associated microplastics occurs mainly through seafood consumption, as fish and shellfish can transfer ingested plastics up the food chain (Neves et al., 2015). Nurdles readily adsorb toxic chemicals such as POPs, heavy metals, and PAHs, with surface concentrations up to a million times higher than surrounding seawater (Thacharodi et al., 2024; Pozo et al., 2020), posing risks via contaminated seafood. Pathogenic bacteria have been isolated from beach-collected nurdles (Rodrigues et al., 2019), adding potential risks from seafood exposure. Emerging evidence of microplastic accumulation in human tissues underscores the need for further research on long-term health effects (Marfella et al., 2024).

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26

Plastic Nurdles in Marine Environments Due to Accidental Spillage

Madushika Sewwandi[1], *Santhirasekaram Keerthanan*[1], *Kalani Imalka Perera*[2], *and Meththika Vithanage*[1]

[1] *Ecosphere Resilience Research Centre, Faculty of Applied Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*
[2] *International Program in Hazardous Substances and Environmental Management, Chulalongkorn University, Bangkok, Thailand*

26.1 Introduction

26.1.1 Microplastics

Microplastics (MPs) are defined as water-insoluble solid polymer particles <5 mm in size (Kooi and Koelmans 2019). Based on their source, they can be categorized as primary or and secondary MPs. Primary MPs are particles that are directly released into the environment. They are manufactured purposely for industrial or domestic applications, such as microbeads in pharmaceuticals and personal care products (PCCPs), including facial scrubs and toothpaste; scrubbing agents in toiletries and cosmetics, and resin pellets used in the plastic industry (Atugoda et al. 2021). Secondary MPs are generated from the degradation of larger plastic items into smaller plastic fragments. Degradation can occur under the effect of several environmental processes, such as biodegradation, photodegradation, thermal degradation, thermo-oxidative degradation, hydrolysis, sunlight, and sea waves. For instance, secondary MPs can be fibers or fragments generated from consumer products, industrial raw materials, or fishing nets (Chatterjee and Sharma 2019; Eerkes-Medrano et al. 2015). MPs can be further categorized based on their physical characteristics (size, color, shape, and density) and chemical characteristics (polymer type, chemical bond, and additives). They exist in different shapes, such as fibers, beads, fragments, foams, and pellets and also can be various colors, such as green, blue, white, red, black, and transparent (Bradney et al. 2019).

MPs can be found in all ecosystems, including marine environments, freshwater, estuaries, and terrestrial ecosystems and are highly persistent (Chatterjee and Sharma 2019; Huang et al. 2020; Liu et al. 2019; Priya et al. 2022). With rising global plastic production and waste generation, the amount of MPs in the environment has gradually increased in recent decades and is expected to continue to increase in the future (Bradney et al. 2019; Isobe et al. 2019). Compared with normal plastics, MPs are very abundant and can be transmitted long distances (Zhou et al. 2019). They also tend to adsorb and release organic pollutants, toxic substances, and trace metals in the environment more easily than ordinary plastics due to their high surface-area-to-volume ratio and hydrophobicity (Fu et al. 2021; Xi et al. 2022). These pollutants can accumulate and be transported along the food chain (Bradney et al. 2019).

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26.1.2 Plastic Nurdles

Nurdles have been extensively manufactured since the beginning of plastic production in 1940. They are called *pre-production plastic pellets*, as almost all plastic products originate from them. They are the building blocks of plastics. Petrochemical companies manufacture these pellets, which are about the size of lentils, from either crude oil or natural gases. After extraction, crude oil and gases are shipped to factories to undergo a refinement process (Scobel 2021). Natural gases are then separated into methane and ethane; crude oil is separated into different groups of chemicals. Naphtha is one of those groups that contain ethane and propane. Ethane and propane are used to create plastics, but before that, they undergo a cracking process in a cracker plant (Freudenrich 2022). High pressure and heat are used to break down their original state, creating smaller monomers. After that, long repeating chains of polymers are created from these individual monomers using the polymerization process. Finally, these polymers are mixed with antioxidants and stabilizers in a chamber, and with the use of an extruder machine, long strings of plastic are created and chopped into smaller pellet pieces or nurdles (Scobel 2021). The nurdles are shipped to plastic manufacturing facilities worldwide to be melted down and molded into final plastic products such as plastic bottles, cups, grocery bags, etc.

Nurdles can be made of various polymer types, including polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC), and a variety of additives can be mixed in to create pellets of different densities (Tunnell et al. 2020). It is estimated that every year, about 270 million metric tons of plastic are produced worldwide, much of which begins its life as a plastic pellet (As You Sow 2022). By definition, nurdles are MPs that are less than 5 mm in size and, specifically, primary MPs, as they enter the environment directly in MP form (Cole and Sherrington 2016). Plastic nurdles are a major source of plastic pollution in marine environments due to unregulated spills into waterways or the ocean during plastic production and transportation (Jiang et al. 2021; Kershaw 2015). Further, they are estimated to be the second largest direct source of MP pollution in the ocean by weight. An estimated 10 trillion plastic pellets are swept into waterways annually, adding to and increasing the harmfulness of plastic pollution in the environment (As You Sow 2022).

26.2 Presence and Sources of Plastic Nurdles in the Environment

26.2.1 In the Terrestrial Environment

Due to the overuse and manufacturing of raw plastic nurdles since 1940, different types of plastic nurdles can be found throughout the environment (Mexia 2022). Nurdles can be lost to the environment at all stages of the plastics supply chain where they are handled, including at the manufacturing site; during transportation, loading, storage; and at the fabrication facility. Frequent accidental spills during the manufacturing, transport, and distribution of plastic nurdles have increased their presence in the terrestrial environment. Nurdle spills during truck transportation via highways are reported commonly (Annette and Gaëlle, 2020). For instance, truck accidents in northern France in February 2016 on the expressway between Boulogne Sur Mer and Marquise and in the Morbihan region in Brittany in November 2019 caused spills of 8 and 28 tons of nurdles, respectively, initiating a massive disaster and long-lasting effects to the Denacre stream, Wimereux River, the Rochette and Slack beaches, and ultimately the North Sea (Annette and Gaëlle, 2020).

26.2.2 In the Marine Environment

Because of their buoyancy, small size, and light weight, nurdles are hard to contain when spilled and have been recorded washing up on beaches around the world (Eriksen et al. 2013; Fernandino et al. 2015; Tunnell et al. 2020). When spilled and not cleaned up, most of these small, lightweight nurdles float in water and are easily blown, washed, or brushed into drains and ultimately end up in the sea. In the sea, the nurdle spread is wide and quick and results in them reaching ocean waters and beaches around the world from the middle of the Pacific to the

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Arctic Circle. Furthermore, there has been an increase in the number of large spills of nurdles at sea when ships lose containers full of nurdles due to accidents, technical difficulties, or bad weather (Sewwandi et al. 2022b). When leaked into the environment, nurdles can be further dispersed via wind, surface water currents, and tides or deposited in coastal areas (Karkanorachaki et al. 2018).

Plastic nurdles have been found on beaches and surface seawater in direct contact with polymer manufacturing industries worldwide since the twentieth century. Yearly, an estimated 250 000 tons of nurdles enter the ocean. Although pellet abundance in different coastal areas is studied extensively, the results cannot be compared as the mesh sizes of the plankton nets that were used to gather samples during the studies differ (Morris and Hamilton 1974). Thus, distribution of nurdles varies and is greatly influenced by the degree of turbulence, stability of bottom sediments, and water currents (Morris and Hamilton 1974). Wind patterns can also affect plastic accumulation, circulation, and distribution in the marine environment (Shaw and Mapes 1979).

Rotterdam in the Netherlands and Antwerp in Belgium have been identified as major European ports where continuous pellet pollution occurs due to the shipping of plastic pellets and accidental pollution (Annette and Gaëlle, 2020). Through several case studies, it has been revealed that plastic pellet pollution is pervasive and recurrent. As illustrated in Figure 26.1, nurdle pollution is common on the coastline of European countries such as France, Denmark, Belgium, the Netherlands, Norway, and Sweden. Pellet pollution in the Atlantic Ocean has been overlooked: abundant PS nurdles were found on beaches and in surface seawater (Carpenter et al. 1972; Kartar et al. 1973; Morris and Hamilton 1974).

26.2.2.1 Nurdle Distribution on Beaches in the Atlantic Ocean in the Twentieth Century

In 1972, white plastic pellets were encountered in surface (neuston) nets during sampling of the pelagic *Sargassum* community in different locations in the western Sargasso Sea. An average of 3500 plastic particles/km^2 was recorded for the range of 50–12000 plastic particles/km^2 abundance (Carpenter Edward and Smith 1972). Several

Figure 26.1 Marine plastic nurdle pollution reported in countries worldwide.

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sampling points were within major shipping lanes from Europe to Central America and the Panama Canal. Although the first evidence in the United States of nurdles in the environment was found in 1971 during sampling at Niantic Bay (Northeastern Long Island Sound), the first scientific report was published in 1972 and found widespread PS spherules in the coastal waters of southern New England (Carpenter et al. 1972). After that, nurdle pollution was found in different locations in Buzzards Bay, Vineyard Sound, Rhode Island Sound, Great Salt Pond, and Long Island Sound in New England with a range of 0.00–2.58 spherules/m^2 of average abundance (Carpenter et al. 1972).

Studies by Kartar et al. (1973) and Kartar et al. (1976) reported the presence of PS spherules in the Severn Estuary, UK. Translucent to clear PS spherules containing gaseous voids were found with a mean abundance of 1996.4 spherules/km^2 at Delaware Bay in 1974 during the investigation of plastic in a wide area of surface water of the Northwestern Atlantic. The sources of the spherules were identified as wastewater discharge from plastic-producing and processing industries located along the East coast of the United States, Connecticut, New York, and New Jersey (Colton et al. 1974). When pellet spillage occurs on riversides, it also influences the presence of plastic nurdles in coastal waters as river water carries various wastes and ends its journey in a bay. Identical spherules were found in 1974 at the bottom of rivers in Connecticut and Chicopee, coastal beaches, and plastic manufacturing factories in Massachusetts. The factories are situated close to those two rivers and beaches; therefore, waste effluents of polymer industries are sources of nurdle spillage (Hays and Cormons 1974). Different types of plastic pellets (low-density polyethylene [LDPE] 87%, high-density polyethylene [HDPE] 8%, ethyl vinyl acetate [EVA] 4%) of various colors (opaque, cream-yellow, amber, white, orange, and clear to translucent) and shapes (button-like, conical, and round pellets) were found on 13 beaches on the Costa del Sol of Spain in 1982 (Shiber 1982). The first evidence of nurdles in the United Kingdom was reported in 1972. Transparent-white and green-brown pellets were found in plankton samples collected from the Bristol Channel, UK; nurdles were most abundant between Holm Island and Nish Point, located in the inner part of the channel (Morris and Hamilton 1974). The presence of nurdles Atlantic Ocean beaches has also been frequently reported during the twenty-first century.

26.2.2.2 Nurdle Distribution on Beaches in the Atlantic Ocean in the Twenty-First Century

In 2018, during the Great Global Nurdle Hunt, nurdles were found on 73% of 279 beach areas in the UK: a cove in Tregantle, Cornwall, was identified as the most-polluted beach, with more than 400 000 plastic nurdles (Zhongming et al. 2019). A large quantity of PE nurdles (120 million) with 1484 nurdles per m^2 was found on beaches in La Pineda in Tarragona, in northeast Spain, in late 2018. Another massive occurrence of pellets was found at Miracle Beach in Tarragona (Annette and Gaëlle, 2020). Harbors are also highly contaminated with large quantities of nurdles when plastic production industries are located around those harbors. Unsystematic waste disposal, weak policies at plastic production companies regarding avoiding plastic pellet spills, and structural pollution during production and transportation are the major factors leading to marine nurdle pollution. For instance, millions of plastic nurdles have accumulated in the London Haven area in the Rotterdam harbor due to haphazard disposal by Ducor Petrochemicals BV factories (Annette and Gaëlle, 2020). Antwerp port in Belgium has been polluted with tons of plastic nurdles and is facing persistent pellet pollution. During one study, about 4000 kg of pellets were found in the Antwerp area (Annette and Gaëlle, 2020).

The North Sea is highly polluted with different types of nurdles. The coastline of the Gulf of Mexico in Texas is also polluted with PP and PE nurdles that are highly contaminated with polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) (Taniguchi et al. 2016). Furthermore, nurdle pollution has been dispersed to the beaches of Corpus Christi, Texas, and 2042 nurdles were found on shorelines from Mahahual, Mexico, to Fort Jefferson, Florida (Tunnell et al. 2020). The coastline of Brazil is facing considerable nurdle pollution, with nurdles on 41 beaches on the coast of the state of São Paulo in southeastern Brazil (Jiang et al. 2021). In some cases, nurdle pollution is found on island beaches as well as continental beaches because nurdles are dispersed over long distances by wind and waves. During sample collection within the period 2019–2020 on beaches around Tortuga Bay, located on Santa Cruz Island of the Galápagos Archipelago, Ecuador, a 24.5% of the total beach

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microplastics sample consisted of PE pellets whereas rest of the sample was microplastic fragments (Lewis et al. 2022). This evident the external source of PE pellet pollution in the Tortuga Bay.

26.2.2.3 Nurdle Pollution in the Mediterranean Sea

Nurdle pollution can also be seen on the coastline of the Mediterranean Sea. Cargo loss of plastic nurdles and waste disposal from various polymer industries were recognized as the major sources of nurdle pollution in Lebanon in 1979, with the investigation of 2–5 mm HDPE, PS, and polymethyl methacrylate (PMMA) pellets in opaque-white, amber, and transparent colors on the beaches to the north of Beirut, from Batroun to Jounieh, and to the south from Ramlet-el-Baida to Ras-el-Ain (Shiber 1979). In 2018, 47.8 ± 4.5% of the mean percentage abundance of pre-production plastic nurdles was found in 17 sites at turtle nesting beaches in Cyprus (Duncan et al. 2018). An average nurdle abundance of 126.04 ± 54.1 items/m^2 was found on 13 coastal beaches in Iskenderun Bay, Turkey, in May 2018; moderate pellet pollution was determined by calculating the pellet pollution index (PPI) (Gündoğdu et al. 2022). In addition to the Atlantic Ocean and its seas, enormous work has been performed to assess nurdle pollution on the beaches of other oceans worldwide.

26.2.2.4 Nurdle Distribution on Beaches in the Pacific Ocean

The first evidence of plastic pellets around the industrialized ring of the Pacific Ocean was reported in 1977, revealing clear to translucent colorless PE and PP ovoids and spherules rather than PS and PVC spherules at Ninety Mile Beach, Glinkes Gully, Orewa, and some selected Auckland and Christchurch beaches (Gregory 1977). The pellet abundance was highly variable and greatest (40 000 pellets per m^2) close to New Zealand industrial zones. However, there was also considerable abundance on beaches such as Ninety Mile Beach, Black Head, and Te Waewae, which are located far from potential nurdle contamination areas, showing the independence of industrial discharge from the occurrence of spherules in marine environments (Gregory 1977). The polluted west coastline of South America also contributes to nurdle pollution in the Pacific Ocean. For instance, white and yellow HDPE was abundant in industrialized coastal areas (Lenga Beach) in San Vicente Bay, Chile (Pozo et al. 2020). However, nurdle pollution on beaches in the Pacific Ocean has not been reported often. Consistent with the literature, plastic nurdle distribution has been reported in different countries showing notable nurdle pollution on the coastline of the Atlantic Ocean (Figure 26.1). Irregular waste disposal and accidental spillage during the production and shipping of pre-plastic nurdles have been identified as the main sources of nurdles in marine systems.

26.3 Accidental Spillages of Plastic Nurdles

26.3.1 Reported Maritime Accidents Related to Nurdle Spillage

Over the years, nearly 1400 maritime accidents have occurred worldwide due to causes such as grounding, collisions, fire, pollution, technical failures, and machinery damage (Häkkien et al. 2013; Häkkinen et al. 2013). Most maritime accidents are due to grounding and collisions, but the root causes of some accidents were not identified. The Baltic Sea, where 15% of ship cargo vessel moves, has been identified as the sea most polluted by chemicals and oil due to maritime accidents (Häkkinen et al. 2013). Nurdle pollution due to shipping accidents and storms has happened frequently in recent decades. Massive disasters were reported in New Zealand, Hong Kong, Durban (South Africa), and the North Sea in 2012, 2012, 2017, and 2019, respectively. Recent studies found that an accidental plastic nurdle spill happened due to a strong storm. In 2019, during the shipping accident occurred in the Friesland region, 270 containers fell from the MSC Zoe cargo ship and spilled many plastic pellets. Approximately 700 locations along the Norwegian coast and a few in Denmark and Sweden were polluted a few months after the disaster. In 2020, another maritime disaster happened in the same area: after the incident, about 24 million nurdles were washed onto the Northern Dutch coastline, primarily affecting the biodiversity of Wadden Island. When the vessel MV Trans Carrier was close to the west Danish coast, a container of 26 tons of plastic nurdles ruptured,

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spilling 13 tons of pellets into the North Sea near Denmark, Norway, and Sweden; it was found that 500–600 million pellets were discharged into the North Sea (Annette and Gaëlle, 2020).

Maritime disasters did not often happen in the Indian Ocean. However, due to the strong wind waves came with the upper air cut-off low in 2017, shipping containers of tiny plastic pellets washed off the carrier MSC Susanna, which was anchored in Durban, South Africa (Schumann et al. 2019). Approximately 49 tons (2 billion) of plastic nurdles were washed up on the beaches of north and south Durban a few days after the storm. The northern KwaZulu-Natal coast was significantly polluted, and the nurdle removal process required extensive effort. In 2020, the container vessel CSAV Trancura collapsed at the Nggura container terminal, Eastern Cape, and around 30.18 tons of plastic nurdles were washed ashore at Cape Beach, South Africa. A very recent maritime accident was reported in Sri Lankan coastal waters, becoming the worst and second-worst maritime disasters in the Indian Ocean and global maritime history. The ship X-Press Pearl caught fire and caused massive nurdle pollution, releasing 78 tons of plastic nurdles into the sea (UNEP and UN 2021). Many other maritime accidents that have caused nurdle spillage in marine systems have been reported worldwide. However, some accidents are not reported, and the total damage to the marine environment has not been still estimated.

26.3.2 Fate and Transport of Nurdles in Marine Systems

As illustrated in Figure 26.2, plastic nurdle spillage happens during maritime accidents. The low density of plastic nurdles means they float on seawater and migrate through the water. Therefore, nurdle spillage does not limit them to a particular sea region: they disperse everywhere, with their horizontal transport influenced by wind, waves, and currents (Blake and Charko 2014). More importantly, coastal oceanic currents, which are usually sheared vertically, affect the transport of nurdles into, out of, and within a particular sea region (Kanhai et al. 2022;

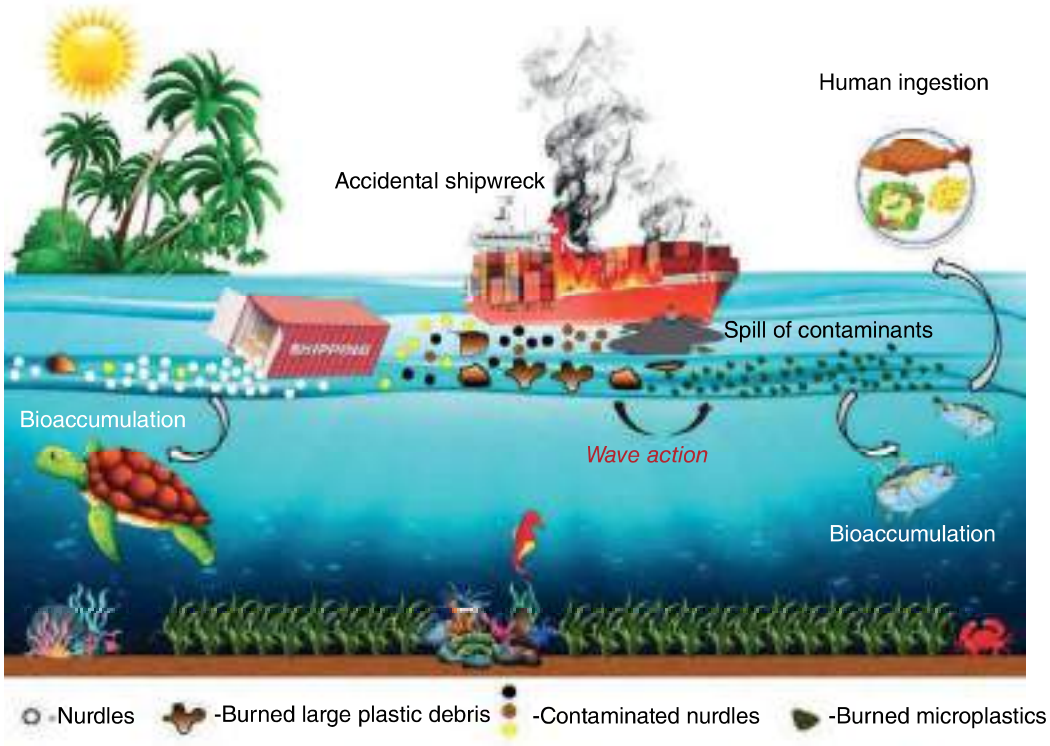

Figure 26.2 Occurrence of maritime accidents, nurdle spillage, and the fate and transport of spilled nurdles in the marine environment.

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Lentz and Fewings 2011). In some cases, nurdles are distributed by wind (Gündoğdu et al. 2022). Therefore, they are found even on remote beach areas after maritime accidents (Schumann et al. 2019). Finally, nurdles can be found on the high-tide line near coastlines and distant seas.

If nurdles are aggregated with other high-density materials in the sea during ship disasters, they are deposited on the sea bed. However, agglomerated nurdles are more buoyant than a single nurdle and are rapidly transported toward coastlines by waves (de Vos et al. 2021). When nurdles wash ashore, they are more likely to mix with sand and be buried on the beach due to the beach's natural and anthropogenic mixing effects and depositional behaviors. Nurdles on the beach are more likely to be pushed back into the sea by the wind. Therefore, a large number of nurdles will never be recovered. Wind direction, wind speed, storms, and heavy rainfall can influence nurdle deposition on beaches. During a nurdle-hunting program at Port Phillip Bay, Australia, nurdle hotspots were found on the beach outside the high-tide line, confirming nurdle distribution by tide currents (Blake and Charko 2014).

Marine organisms are likely to ingest nurdles, mistaking them for food due to their small size and shape, so the nurdles ultimately end up in human stomachs through the food web (Hays and Cormons 1974). Nurdles on beaches and in seawater undergo natural weathering in the presence of UV irradiation and atmospheric oxygen, creating nanoplastics and generating monomers and oligomers (Corcoran 2020). Thus nurdles lead to persistent and long-lasting plastic pollution, causing dangerous long-term effects on the environment.

26.3.3 Impacts of Nurdle Spillage on the Marine Environment

The presence of nurdles in the marine environment is a huge environmental problem, as removing floating, deposited, and buried nurdles requires heavy machinery and an extensive labor force (Annette and Gaëlle, 2020). However, this effort cannot remove all spilled nurdles from the environment because prevailing waves and sand movement readily enhance the deposition of nurdles on beaches, impacting the beaches' biodiversity and beauty (Annette and Gaëlle, 2020; UNEP and UN 2021). The reduced attractiveness of spoiled beaches causes a decline in tourism, ultimately impacting the country's economy. The recovery of nurdles mixed with vegetation close to coastlines is complicated. Further, the removal process disturbs organisms on the beach and naturally deposited sand profiles, damaging fragile ecosystems (Annette and Gaëlle, 2020).

Nurdle spillage in the marine environment directly influences the health and, ultimately, the life of marine organisms. Ingestion of nurdles has been widely reported, and it has been stated that the potential death-leading health impacts (Gregory 2009; Jiang et al. 2021; Nobre et al. 2015). Nearly 220 species of marine animals have ingested MPs to date (Mexia 2022). Fish frequently eat floating nurdles of different colors, mistaking them for food, and are slowly poisoned. Small plastic particles are ubiquitous in shallow benthic living communities, and benthic invertebrates have a greater tendency to ingest MPs of different sizes than pelagic and land-dwelling vertebrates (Graham and Thompson 2009). In addition, nurdles on beaches are a significant threat to living organisms. The fish-egg-like appearance of plastic nurdles can mislead marine wildlife such as common gulls, puffins, and fulmars, which then ingest microplastics (Van Franeker and Law 2015). Seabirds are effective monitors of floating marine plastics, and plastic fragments have been discovered in the stomach of fulmars (Van Franeker and Law 2015). A few white spherules that appeared to be PS pellets were found in gull and turn pellet samples collected at Great Gull Island, New York, in 1971. Gulls and turns regurgitate the indigestible parts of the food they consume in pellet form, revealing that the animal ingested pellets in the marine environment (Hays and Cormons 1974).

Many plastic nurdles have been found on turtle nesting beaches in Cyprus and gray seal breeding beaches in Norfolk, Britain (Duncan et al. 2018; Zhongming et al. 2019). Deleterious impacts on nearly 267 marine organisms, including sea turtles, fish, seabirds, whales, and pinnipeds, due to the ingestion of and entanglement in plastics have been reported for the last two decades (Graham and Thompson 2009). Hundreds of ducks were suspected to have died in the Oslo Fjord and on Norwegian beaches due to nurdle spillage from MV Trans Carrier in the North Sea in 2020. A recent study has discovered that virgin pre-production plastics pellets are more toxic

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than beach-stranded pellets, indicating the danger of nurdle spillages of virgin plastic pellets during maritime accidents (Nobre et al. 2015). Ingesting plastic nurdles can cause various health disorders in marine biota, impairing their biological activities.

Internal and external wounds, blockages in the digestive tract followed by starvation, skin lesions, ulcerating sores, defects in the reproduction system, impaired feeding capacity, and limited predator avoidance are recognized health impacts of plastic nurdles on marine organisms (Gregory 2009). The physical properties of plastic nurdles also cause physiological complications in animal tissues and disruptions in biochemical processes (Graham and Thompson 2009). Nurdles inhibit the appetite of organisms and prevent foraging, reproduction, avoidance of predation, and growth-inhibiting energy production (Graham and Thompson 2009). Short-term ingestion of beach MP leads to decreased jump height and increased body weight, affecting the survival and behavior of beach hoppers (*Platorchestia smithi*) (Tosetto et al. 2016). In addition, nurdles can impact human health. Nanoplastics and MPs created by the degradation of plastic nurdles can be ingested by humans through marine food, sea salt, and drinking water (Fadare et al. 2021; Guilhermino et al. 2021; Weber et al. 2021). People living on beaches and doing beach activities are also more likely to ingest MPs from degraded nurdles and airborne MPs.

26.4 X-Press Pearl Ship Disaster – A Case Study

26.4.1 Nurdle Spillage

The worse nurdle pollution from a single vessel in Sri Lankan maritime history happened as a result of the fire on the MV X-Press Pearl on 25 May 2021, northwest of Colombo Port. When the ship caught fire, 31.9 Metric tons of PS nurdles packs, 81.3 Metric tons of plastic nurdles, 19.3 Metric tons of polymeric beads, 9700.8 Metric tons of epoxy resins, 574 Metric tons of LDPE, 245.4 Metric tons of linear LDPE (LLDPE), and 747.8 Metric tons of HDPE were onboard (UNEP and UN 2021). As illustrated in Figure 26.3a, the ship was partially sunk in the deep sea on 2 June 2021 and lost its cargo into the Sri Lankan sea (UNEP and UN 2021). Floating nurdles could be seen on the ocean water around the shipwreck and in Negambo Lagoon. Nurdles were also distributed along the southern, western, and northern coastlines of Sri Lanka by the prevailing currents (UNEP and UN 2021). Sarakkuwa beach is closest to the shipwreck, and there is a massive accumulation of nurdles, wreckage, damaged containers, and partially burned debris (Figure 26.3b,c). Although nurdle recovery has been performed for the bulk of the nurdles, the recovery process for nurdles mixed with sand requires a massive labor force, time, and additional treatment (Sewwandi et al. 2022b).

26.4.2 Abundance of Nurdles on Sarakkuwa Beach

In October 2021, sand sampling was conducted on a 200 m × 25 m area of the Sarakkuwa beach surface. Seven sampling points were randomly selected on the beach and named A–G (Figure 26.3d). About 1 kg of sand in the upper layer of the beach (5 cm) was collected in glass bottles using a metallic garden shovel. Plastic nurdles were extracted from each sand sample using the density separation, extraction, and quantification procedures reported by Sewwandi et al. (2022b). The greatest nurdle abundance was reported at sampling point A, whereas the mean nurdle abundance on the beach surface was 101.14 nurdles/kg (Figure 26.4a). Nurdle abundance on Sarakkuwa beach before the maritime accident (80 nurdles/m^2) drastically increased after the shipwreck to 11 376 nurdles/m^2 in May 2022, 5264 nurdles/m^2 in June 2022, and 512 nurdles/m^2 in September 2022 (Sewwandi et al. 2022b). Although nurdle abundance on the Sarakkuwa beach surface decreased from May to September, there is still critical nurdle pollution. Plastic nurdles and partially burned plastic debris have begun to mix with sand and were deposited in the first layer of sand (UNEP and UN 2021). When excavating the beach to a 1 m depth during the sampling, buried nurdles could be seen (Figure 26.4b–d), indicating the burial of nurdles by the natural depositional actions of sand and sediment on the beach.

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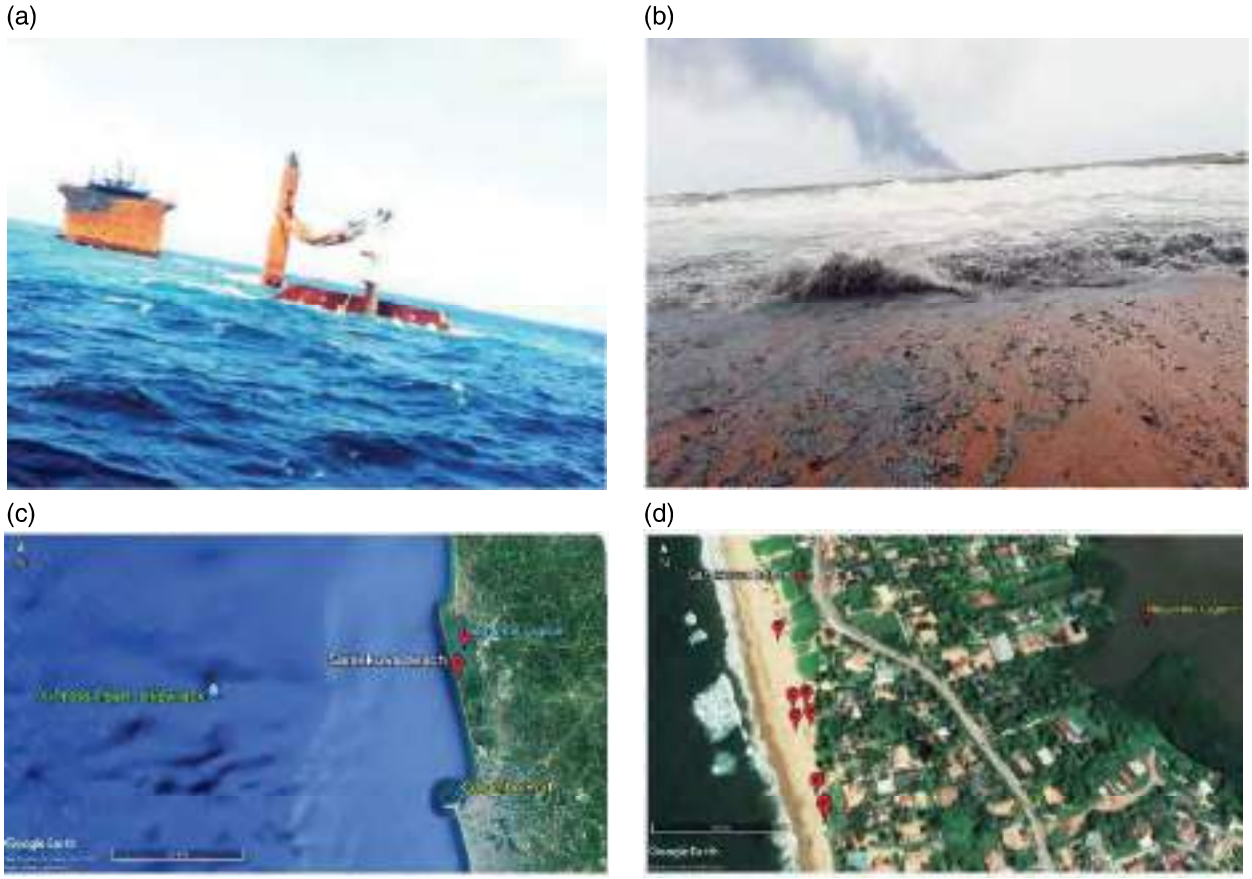

Figure 26.3 (a) Partially sunk MV X-Press Pearl. (b) washed off nurdles on Sarakkuwa beach. (c) Locations of the shipwreck and Sarakkuwa beach. (d) Locations of surface sand sampling points, October 2021. *Source:* (c, d) Google LLC.

26.4.3 Characteristics and Contamination of Spilled Nurdles

Material washed to the Sarakkuwa beach consisted of nurdles and fragmented partially pyrolyzed MPs (Figure 26.5a–d). After we collected samples of nurdles on the beach during a field visit in May 2021, they were categorized by color: white, yellow, brown, and black, as shown in Figures 26.5e–h, respectively. Similar results have been reported describing yellowed and darkened degraded nurdles that sparkled with black inclusions (de Vos et al. 2021). From several studies, nurdles collected at Sarakkuwa were identified as LDPE and HDPE. With a few alterations in the Fourier transform infrared (FTIR) spectrum, some beach nurdles were identified as LDPE (UNEP and UN 2021; Sewwandi et al. 2022b). Also, two different densities (0.93 and 0.96 g/ml) identical to PE confirmed that the spilled nurdles were LDPE or HDPE (de Vos et al. 2021). In addition to LDPE, the lost containers held LLDPE and HDPE (UNEP and UN 2021).

The FTIR spectrum of the black, brown, and yellow nurdles was entirely different from the white nurdles except for the identical bands; new bands were attributed to ─C═O, ─C─O─C, and ─S═O stretching vibrations, indicating that the chemical composition was altered by adding oxygen and sulfur to the LDPE chain (Sewwandi et al. 2022b). The formation of ketone and ester functional groups in the polymer structure is mainly due to the photo-oxidation of plastics when exposed to UV irradiation and atmospheric oxygen over a long periodor extremely exposed to them over a short period (Song et al. 2017). Nurdles deteriorate faster in the presence of air and direct light than in seawater and shade (Biber et al. 2019). Exposure to UV irradiation causes them to change color, turning them yellow in most cases (Corcoran 2020). Therefore the presence of yellow nurdles might be due to UV exposure. In addition, 562.4 metric tons of bright sulfur were onboard the X-Press Pearl (UNEP and UN 2021),

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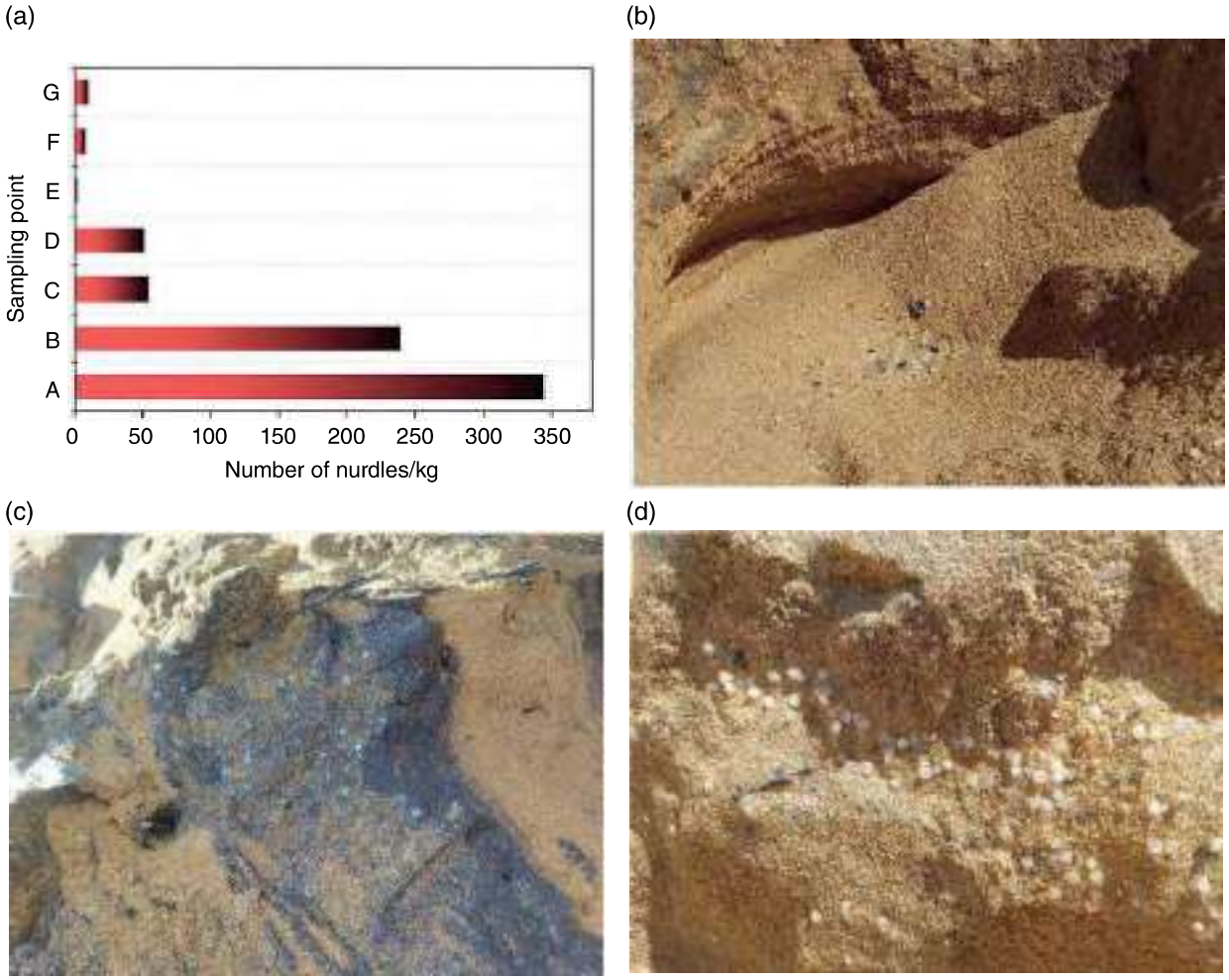

Figure 26.4 (a) Abundance of nurdles at different locations on the Sarakkuwa beach surface. (b–d) Presence of nurdles buried 1 m depth on Sarakkuwa beach.

so the yellow coloration might be due to the addition of sulfur to the LDPE chain. This was further confirmed with the new band formation at 1040–1114/cm, attributed to =S=O (Sewwandi et al. 2022b). Other than the existence of new bands, increasing the transmittance magnitude at the same band is an excellent indicator of the decreasing intensity of the color of nurdles. For instance, in the study by Fotopoulou and Karapanagioti (2012), transmittance magnitudes of the FTIR spectrum were increased when the color of eroded nurdles decreased from dark yellow to off-white. In addition to photodegradation, exposure to heat energy can also influence the degradation of plastic nurdles by denaturing the polymer chain.

In the presence of thermal energy, polymer molecules absorb the activation energy required for molecular scission, leading to fragmentation of the polymer (Das and Tiwari 2017). Onboard containers of plastics and nurdles were directly exposed to the fire, as confirmed by large, partially burned, and melted plastic debris that washed overboard (Figure 26.5a). Large debris with nurdles indicates the accumulation of nurdles onto melted packaging material during the fire (Figure 26.5b,c). In the nurdle samples collected at Sarakkuwa beach, agglomerated nurdles of different colors were found, evidencing the thermal degradation of white nurdles that changed their color, shape, and size (Figure 26.5i). White nurdles might also have turned yellow, brown, and black during fire due to the denaturing of the polymer chain. According to the study by Sewwandi et al. (2022b), yellow, brown, and black nurdles did not exhibit remarkable degradation, indicating that the color change was solely due to photodegradation. However, the nurdles were also contaminated with dirt, plastic substances, and chemicals leaked

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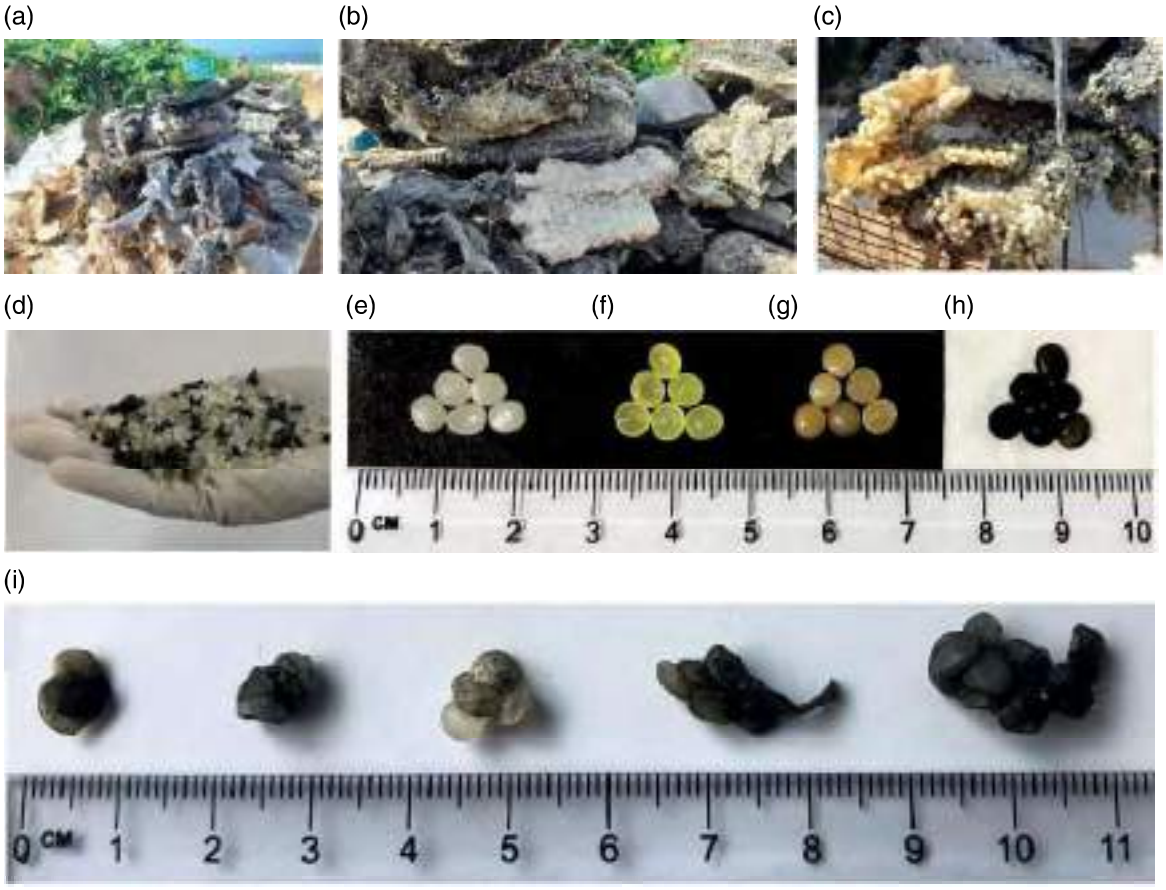

Figure 26.5 (a), (b), (c) Partially burnt large debris, (d) Nurdle sample collected at Sarakkuwa beach, (e) White nurdles, (f) Yellow nurdles, (g) Brown nurdles, (h) Black nurdles, (i) Agglomerated partially burnt nurdles

during the shipwreck (Sewwandi et al. 2022b). The increased hydrogen-to-carbon ratio (H/C) of burned nurdles compared to unburned nurdles indicated that the carbon chains were shortened via fragmentation or the addition of foreign groups to the polymer chain, elucidating the thermal degradation of the nurdles (de Vos et al. 2021).

Due to their hydrophobicity and high volume-to-surface area ratio, MPs have a higher affinity for micropollutants. Therefore, the nurdles were contaminated in the presence of a complex spill. Burned nurdles also showed significant contamination with poly-aromatic hydrocarbons (PAHs) derived during combustion and petroleum-derived biomarkers of fossil fuel leaked and spilled during the shipwreck, evidencing contamination with lubricating and fuel oil leaked from the ship during the fire (de Vos et al. 2021). Further, the nurdles were contaminated with toxic elements; Mo, Cr, Cu, Pb, and Li, which are suspected of leaching into the sea from the onboard cargo during the maritime accident (Sewwandi et al. 2022b). All of the colored nurdles were highly contaminated with Mo, Cr, and Li.

26.4.4 Possible Impacts

Maritime ship accidents frequently result in oil leaks. In the case of the X-Press Pearl, the ship transported many chemicals and polymers, including hazardous and noxious compounds, both organic and inorganic. More than 50 chemical compounds, including polymers, heavy metals, acids and bases, resins, and other materials, were kept in the X-Press Pearl's containers, according to a UN environmental advisory mission assessment (UNEP and UN 2021). The release of these toxic substances into the marine environment can negatively affect that environment and its biodiversity, air quality, terrestrial ecosystems, and the country's economy.

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26.4.4.1 Marine Environment

The ship's oil spill blanketed the marine surface, creating a barrier to oxygen exchange between the ocean and the atmosphere. For a month, oil leaked continuously from the X-Press Pearl's cargo, covering a surface area of about 0.51 km^2. Weathering due to sunlight turns oil slicks into tar-like compounds that sink and last for a long time (Galieriková et al. 2021). Further, the leakage of tons of chemicals, such as nitric acid and sodium hydroxide, from the X-Press Pearl's cargo can change the pH of the water to extreme levels, making the marine environment uninhabitable. Most importantly, releasing potentially toxic elements such as Pb, Mo, and Cu from the cargo ship can raise their level above tolerable limits in the marine environment and make the environment toxic. Thousands of tons of plastic pellets were released during the accident and spread hundreds of kilometers toward the northern and western coasts of Sri Lanka due to wave action and wind speed. According to a recent study by Sewwandi et al. (2022b), plastic pellets from the X-Press Pearl could act as a vector for carrying Pb, Mo, Cu, and Cr toward the shoreline.

26.4.4.2 Impact on Marine Diversity

Living marine organisms, especially sensitive creatures including sea turtles, coral reefs, fish, marine algae, marine mammals, etc., can be killed by the spillage of hazardous chemicals during cargo ship accidents. About 251 turtle carcasses and 33 marine mammals, including whales and dolphins, were collected on the seashore around Sri Lanka during this incident period. This may have been due to the cargo ship's emission of hazardous chemicals. A few turtle shells appeared to have breached, indicating that the chemicals were detrimental to marine life (UNEP and UN 2021). Sea turtles eat sea sponges and seagrasses, and those dietary habits keep the marine bottom healthy by preventing overgrown sea sponges and seagrasses species. As a result, it aids in the formation of coral reefs. The X-Press Pearl's release of hazardous chemicals killed many sea turtles, potentially disrupting the ecological equilibrium.

Coral reefs provide shelter for numerous species. Coral reefs are very sensitive to chemical contamination, which can have deadly effect on reef growth. During the X-Press Pearl accident, hundreds of tons of chemicals such as acid and bases, PCCPs, organic solvents, inorganic salts, resin, and epoxy were released into the western and southern seas of Sri Lanka, where more than 180 indigenous reef species were found, potentially killing and destroying the coral reef. Moreover, the oil coating on the surface has the potential to kill fish eggs and progeny that are floating and surviving on the marine water.

26.4.4.3 Impact on Air Quality

The smoke plume formed by the fire lasted a few days after the incident and stretched over many kilometers, making it a highly visible consequence of the disaster. Burning hazardous goods, including chemicals and plastic, can result in the emissions of dangerous gaseous compounds such as CO, SO_2, NO_2, furans, dioxins, dust particles, and heavy metals into the atmosphere. As reported by the UN, 120 km^2 has been recognized as sensitive to short-term exposure of plumes from incident locations, including densely populated areas (UNEP and UN 2021). This harmful smoke can cause respiratory issues in humans and other living things, particularly sea birds that rely on the marine environment for food.

26.4.4.4 Impact on the Terrestrial Environment

The emission of acidic gas such as NO_2 and SO_2 can lead to acidic rain that can damage marine and terrestrial environments. The marine environment protection authority of Sri Lanka has warned that moderate acid rain might occur during the incident. In addition, plastic pellets and burned and unburned residues washed overboard to coastal area may have long-term effects on the environment. Plastic pellets can retain a high temperature that may affect turtle nesting, as temperature is the main factor determining the gender of the turtle. Moreover, plastic pellets can be a vector for toxic metals to the terrestrial environment as pellets adsorb and desorb depending on environmental conditions (Sewwandi et al. 2022b).

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26.4.4.5 Impact on the Economy

The X-Press Pearl ship incident had an economic impact primarily on two sectors. First, it had short- and long-term impacts on the fishery sector. Fish is one of the major protein sources for the people in Sri Lanka. Due to this incident, the Sri Lankan government informed fishermen to stop fishing temporarily on the northern, western, and southern coastlines of Sri Lanka, which were highly contaminated. As a result, the livelihoods of many fishermen lie below the poverty line. Also, the public's fear of eating contaminated seafood, heightened by a huge increase in turtle, whale, and dolphin fatalities, allegedly harmed consumer trust and resulted in increased consumption of imported fish. Because potentially harmful elements such as Pb, Cu, and Mo can accumulate in the food chain, worldwide markets may exclude Sri Lankan seafood such as fish, crabs, sea cucumber, shrimps, and so on, as Sri Lanka is a fish exporter to nations such as Europe, the United States, and Japan (Ministry of Fisheries 2020). Tourism is the second sector that may have been impacted by this cargo ship incident. The Sri Lankan coast attracts many tourists for whale watching, coral watching, surfing, diving, etc. Owing to the significant contamination, fewer tourists visiting coastal area may lead to economic problems.

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Developmental toxicity of pre-production plastic pellets affects a large swathe of invertebrate taxa

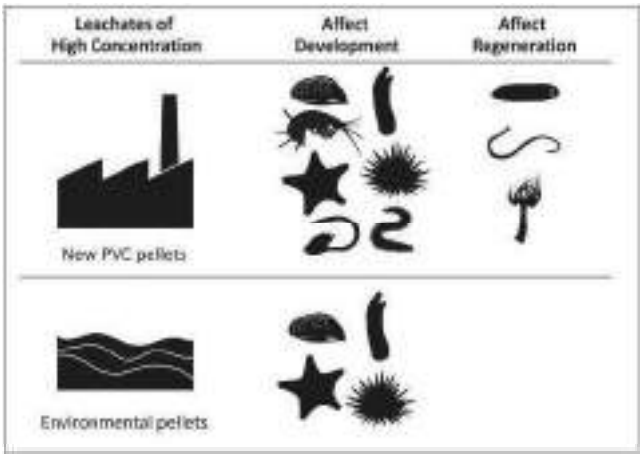
Eva Jimenez-Guri [a,h,1,*], Periklis Paganos [a,2,†], Claudia La Vecchia [a,†], Giovanni Annona [b,†], Filomena Caccavale [a,†], Maria Dolores Molina [c,d,†], Alfonso Ferrández-Roldán [c,e,†], Rory Daniel Donnellan [f,†], Federica Salatiello [a], Adam Johnstone [g], Maria Concetta Eliso [a,3], Antonietta Spagnuolo [a], Cristian Cañestro [c,e], Ricard Albalat [c,e], José María Martín-Durán [f], Elizabeth A. Williams [g], Enrico D'Aniello [a], Maria Ina Arnone [a]

[a] *Stazione Zoologica Anton Dohrn, Department of Biology and Evolution of Marine Organisms, Naples, Italy*
[b] *Stazione Zoologica Anton Dohrn, Department of Research Infrastructures for Marine Biological Resources, Naples, Italy*
[c] *Department of Genetica, Microbiologia i Estadística, Facultat de Biologia, Universitat de Barcelona, Catalunya, Spain*
[d] *Institute of Biomedicine of the University of Barcelona (IBUB), Catalunya, Spain*
[e] *Institut de Recerca de la Biodiversitat (IRBio), Facultat de Biologia, Universitat de Barcelona, Catalunya, Spain*
[f] *School of Biological and Behavioural Sciences, Queen Mary University of London, London, United Kingdom*
[g] *College of Life and Environmental Sciences, University of Exeter, Exeter, United Kingdom*
[h] *Center for Ecology and Conservation, University of Exeter, Cornwall Campus, Penryn, UK*

HIGHLIGHTS

- Leachates of pre-production plastic pellets can affect development or regeneration.
- Ten invertebrate species from all superphyla are affected by pellet leachates.
- Species in the phylum Deuterostomia are most affected.
- Our results show developmental effects happen at high concentrations of pellets.

GRAPHICAL ABSTRACT



* Corresponding author.
E-mail address: eva.jimenez-guri@szn.it (E. Jimenez-Guri).
[1] Present address: Center for Ecology and Conservation, University of Exeter, Cornwall Campus, Penryn, UK.
[2] Present address: Eugene Bell Center for Regenerative Biology & Tissue Engineering, Marine Biological Laboratory, Woods Hole, MA, USA.
[3] Present address: Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Messina, Italy.
[†] These authors contributed equally to the work.

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ABSTRACT

Microplastics pose risks to marine organisms through ingestion, entanglement, and as carriers of toxic additives and environmental pollutants. Plastic pre-production pellet leachates have been shown to affect the development of sea urchins and, to some extent, mussels. The extent of those developmental effects on other animal phyla remains unknown. Here, we test the toxicity of environmental mixed nurdle samples and new PVC pellets for the embryonic development or asexual reproduction by regeneration of animals from all the major animal superphyla (Lophotrochozoa, Ecdysozoa, Deuterostomia and Cnidaria). Our results show diverse, concentration-dependent impacts in all the species sampled for new pellets, and for molluscs and deuterostomes for environmental samples. Embryo axial formation, cell specification and, specially, morphogenesis seem to be the main processes affected by plastic leachate exposure. Our study serves as a proof of principle for the potentially catastrophic effects that increasing plastic concentrations in the oceans and other ecosystems can have across animal populations from all major animal superphyla.

1. Introduction

Plastic contamination has emerged as a significant concern in marine ecosystems due to its pervasive presence and potential impact (Eriksen et al., 2014; Thushari and Senevirathna, 2020). Large plastic items can entangle marine animals, cause physical injuries, and alter or disrupt habitats. In time, with the physical and chemical actions of the environment, plastics can break down and produce secondary microplastics, particles smaller than 5 mm. Other microplastics already arrive as small particles to the environment, known as primary microplastics. Whichever the origin, microplastics possess certain characteristics that make them a particular concern: they have a global distribution, as they are easy to disperse because of their small size; they can be ingested by a wide range of animals, entering the food chain at any trophic level; and they have a relatively larger surface area compared to larger plastic items, allowing them to adsorb, accumulate and carry pollutants from the surrounding environment (Mato et al., 2001). These pollutants can include toxic chemicals and heavy metals, leading to potential risks when ingested by marine organisms, as well as the potential to release these harmful additives into the water, creating additional hazards to marine life and ecosystems (Teuten et al., 2009; Engler, 2012; Gauquie et al., 2015; Rendell-Bhatti et al., 2021; Focardi et al., 2022). Among the significant contributors to primary microplastic pollution, in terms of weight, are pre-production plastic pellets commonly known as nurdles (Sherrington, 2016), the building blocks for plastic products. During manufacturing, these nurdles are combined with various chemical compounds, including plasticizers, stabilizers, and antioxidants, necessary to impart specific physical properties to the final products. These chemical compounds are readily transferred to the water (Mato et al., 2001; Rendell-Bhatti et al., 2021; Paganos et al., 2023) in the case of the nurdles being lost at sea (Sewwandi et al., 2022). Unfortunately, during manufacturing, transport and use, these pellets can be spilled to the environment. Nurdle spills are not uncommon, and around 230.000 tones of these plastics end up in the ocean every year (Sherrington, 2016). Sometimes, these enter the environment in a continuous drip, but others they do it in a massive manner, where tonnes and tonnes of pellets are lost at once (such as in New Zealand and Hong Kong in 2011, South Africa in 2017, the North Sea in 2019, South Africa, the North Sea and New Orleans in 2020, Sri Lanka in 2021, or Portugal in December 2023). Once in the water, the nurdles have the ability to concentrate environmental pollutants and transport and release them to a different location, often far from the source of contamination (Teuten et al., 2009).

Many marine invertebrates commonly undergo embryonic development in the water column, and their larvae are usually planktonic. Their developmental strategy, combined with the absence of a protective eggshell, make them vulnerable to contamination from plastic leachates. Plastic leachate toxicity has been shown to have negative effects on the development of several marine organisms (Li et al., 2016; Oliviero et al., 2019; Gardon et al., 2020), and in particular, plastic pre-production pellet leachates can disrupt the development of sea urchins (Nobre et al., 2015; Rendell-Bhatti et al., 2021; França et al., 2022; Paganos et al., 2023), barnacle larvae (Ward et al., 2022) and to some extent brown mussels (Gandara e Silva et al., 2016). However, there is a lack of knowledge regarding how universal the susceptibility to this contamination is across other animal groups.

Here, we provide a systematic characterisation of the phenotypic abnormalities found during development and asexual reproduction by regeneration in an array of aquatic invertebrates treated with both environmental and industrial pre-production plastic pellet leachates. We select representative species of the aquatic ecosystem, including one mollusc, two annelids, one flatworm, one crustacean arthropod, two echinoderms, two tunicates and one cnidarian, to investigate microplastic-induced abnormalities in organisms across all major animal superphyla (Fig. 1).

2. Materials and methods

2.1. Microplastic leachate preparation

Environmentally retrieved nurdles were obtained from Watergate bay (Cornwall, UK) by Beach Guardian CIC in December 2021 and manually sorted from other plastic particles. Commercial PVC nurdles were purchased from Northern Polymers and Plastics Ltd. (UK) in January 2022. In brief, for each of the plastic particles, pellets were added to filtered seawater (0.22 μm) (FSW) at a concentration of 10% (v/v). Pellets were leached for 72 h on a platform shaker, with continuous shaking at room temperature (ca 18°C). Leachates were obtained by filtering through filter paper in order to remove particles. Leachates were diluted to the final concentration in FSW. Only for *Schmidtea mediterranea*, leachates were obtained and diluted in Planarian Artificial Medium (1X PAM) (Cebrià and Newmark, 2005) rather than FSW. We tested 10% nurdle leachates and 1%, 5% and 10% PVC leachates (v/v), concentrations which had previously been shown to induce aberrant phenotypes in echinoderms (Rendell-Bhatti et al., 2021; Paganos et al., 2023), to produce comparable results with our previous work. Tests with lower concentrations than the ones used here did not produce evident aberrant phenotypes.

2.2. Animal husbandry, fertilisation and embryo exposure

Sexually mature specimens of *Mytilus galloprovincialis* were obtained from Irsvem Srl, a commercial shellfish farm (Bacoli, Napoli, Italy). Animals were mechanically stimulated to promote spawning by scraping the shells to remove adherent organisms and pulling the byssus. Approximately, 20–30 mussels were placed in a tank with Mediterranean FSW at 18 °C and spread to easily monitor the spawning. When mussels began to spawn, each individual was washed and then transferred into a beaker containing 200 ml of Mediterranean FSW to isolate male and female gametes. Eggs were fertilised with an egg/sperm ratio 1:15 in a volume of 50 ml. The resulting zygotes were left to grow at

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18 °C in treatment plates at a concentration of 250 eggs per ml until the developmental stage of interest, the D-larva at 48 h post fertilisazion (hpf).

Platynereis dumerilii gametes were obtained from an in-house culture at the University of Exeter, (UK), with culture conditions based on Hauenschild and Fischer (1969). Batches of embryos were created by allowing a single male and female epitoke to freely spawn in a 100 ml glass beaker with 80 ml 0.22 μm filtered artificial seawater. Developing eggs were stripped of their protective jelly by thorough rinsing through a 100 μm filter mesh cup 1 h after fertilisation. De-jellied fertilised eggs were then added to the different treatments and left to develop in an incubator at a constant temperature of 18 °C with a regular light-dark cycle (16h light, 8h dark) for 96 h.

Parhyale hawaiensis were housed in artificial sea water at 24°C at the University of Exeter, Penryn campus (UK). Sexually mature pairs in amplexus were transferred to beakers containing the different treatments. When the female moults, pairs separate and oocytes are fertilised and deposited in the female's ventral pouch (Rehm et al., 2009). After a few days, females were anesthetised with clove oil (Rehm et al., 2009) and eggs removed and transferred to containers with the same treatment as the parents. This was done to avoid predation of eggs or hatched larvae by the adults. Because of the way *P. hawaiensis* embryos are fertilised, embryos from every pairing were only assigned to one treatment, differing from the other species here studied. Embryos were left to develop at 24°C until hatching occurred.

Paracentrotus lividus were housed in circulating seawater aquaria at 18 °C in the aquarium facility of the Stazione Zoologica Anton Dohrn, Naples (Italy). Gamete acquisition and fertilisations were performed as described elsewhere (Rendell-Bhatti et al., 2021). Embryos were added to treatment beakers immediately after confirmation of fertilisation at a concentration of 50 embryos per ml and left to develop at 18°C until the 48 hpf pluteus stage.

Patiria miniata were housed in circulating seawater at 14 °C, to prevent them from spontaneous spawning, in the aquarium facility of the Stazione Zoologica Anton Dohrn, Naples (Italy). Gametes were retrieved from adults by arm incision and extraction of intact gonads. Eggs were released from the ovaries through manual dissection, while male gonads were placed dry in an Eppendorf tube at 4 °C. Immature oocytes were incubated with 1:1000 dilution of 10 mM 1-Methyladenine in FSW for 1h at 15 °C. Once the germinal vesicle was broken down, an indication of the oocytes' maturity, they were fertilised with a few drops of diluted sperm in FSW (1 μl of dry sperm in 10 ml of FSW). Embryos were then added to treatment beakers at a concentration of 50 embryos per ml and left to develop at 15 °C until 4 days post fertilisation (dpf, bipinnaria larvae stage) in 9:1 diluted FSW (9-parts Mediterranean FSW, 1-part distilled water) to obtain the appropriate salinity of approximately 35 ppt.

Ciona robusta were collected in Taranto (Italy) in March 2023, and left for at least seven days in an aquarium facility at 16–18°C with permanent light to promote gametogenesis at the Stazione Zoologica Anton Dohrn, Naples (Italy). Gametes were obtained as described before (Eliso et al., 2020), with modifications. In brief, oocytes and sperm were harvested from each individual by dissecting the gonoducts sequentially, to avoid self fertilisation. Fertilization was performed by adding diluted sperm (1:100 in FNSW) to the eggs suspension. After 15 min of incubation on a rotating shaker, the fertilised eggs were rinsed in FSW to avoid polyspermy and added to treatment plates about 30 min post-fertilization, with a density of 10 embryos per ml and left to develop at 18°C until the desired developmental stage (hatched larva).

Oikopleura dioica specimens were cultured in the animal facility of the University of Barcelona (Spain) as previously described (Martí-Solans et al., 2015). Mature females and males were collected separately at day 5, and left to spawn naturally. For each experiment, multiple egg and sperm batches were mixed, *in vitro* fertilised and transferred before the first cell division to treatment plates at 19 °C until the desired larval stage.

Owenia fusiformis collected from the coasts near the Station Biologique de Roscoff were maintained in artificial seawater at the Queen Mary University of London, London (UK) at 15°C. Animals were removed from their sand tubes as described elsewhere (Carrillo-Baltodano et al., 2021) and decapitated with a razor blade just above the first parapodia before being left to regenerate in seawater supplemented with penicillin (100U/ml) and streptomycin (200 μg/ml) at 19°C.

Schmidtea mediterranea from an asexual clonal line were housed at 20 °C in 1X PAM water (Cebrià and Newmark, 2005) at the University of Barcelona (Spain). Animals were fed twice per week with organic veal

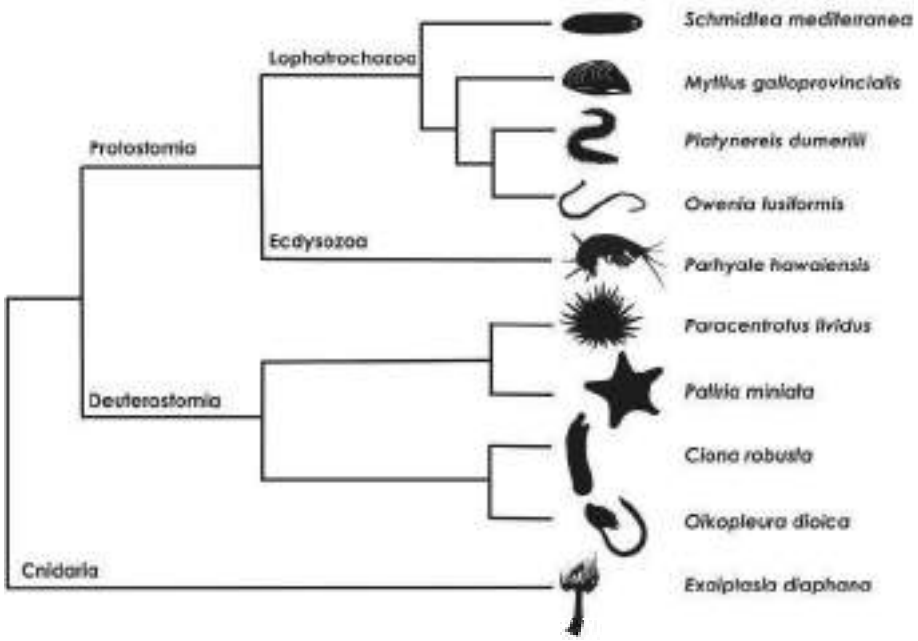

Fig. 1. Phylogenetic tree. A schematic representation of the phylogenetic relationships among the species studied in this work. Representatives of the three major bilateria superphyla are used (Protostomia (Lophotrochozoa and Ecdysozoa) and Deuterostomia), as well as a representative of the radiata (Cnidaria). *O. dioica* by Josep Martí-Solans (CC0 1.0).

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liver and were starved for at least 1 week before experiments. Pre-pharyngeal amputation was performed using a razor blade. After amputation, animals were immediately transferred to treatment plates at 20 °C and left to regenerate until observations at five and seven days.

Exaiptasia diaphana (formerly *Aiptasia pallida*) polyp specimens were housed in circulating seawater aquarium facility at the Stazione Zoologica Anton Dohrn, Naples (Italy). For our experimental purposes, they were kept starved in crystallizing dishes at 24 °C in a light/dark cycle of 12/12 h. Pedal lacerations were collected manually and placed in a 12-well plate, one laceration per well. They were allowed to regenerate in FSW for one week. After that time, FSW was replaced with leachate solution at the defined concentration, and regenerating fragments were incubated at 18°C for one week.

2.3. Phenotypical observations

Larvae of the species object of the study were arrested by fixing them in 4% PFA and imaged using either a Leica M165C with a Leica DFC295 camera, or a Leica DMi8 with a Leica flexacam C3 microscope. *O. dioica*, *S. mediterranea* and *E. diaphana* were imaged alive using an Olympus SZX16 stereomicroscope, an sCM EX-3 high end digital microscope camera (DC.3000s, Visual Inspection Technology) and a Zeiss AXIO Zoom V16 microscope equipped with Axiocam 208 colour camera, respectively. Larvae were classified into two groups: normal developed larvae and aberrant larvae, including phenotypes ranging from delayed to totally aberrant. However, notes were made in the phenotypes that, despite looking normal, were not quite like the controls, as well as for delayed larvae that looked otherwise correct. Statistical differences were analysed by performing One-Way ANOVA followed by Post Hoc Tukey HSD. Mussel area size differences between controls and treated animals for each individual spawning ($n = 6$ spawning events) were calculated with ImageJ and differences were analysed by performing unpaired t-tests.

2.4. S. mediterranea immunohistochemistry and cell proliferation counts

Whole-mount immunohistochemistry in planarians was performed as previously described (Ross et al., 2015; Fraguas et al., 2021). The following antibodies were used: mouse anti-SYNAPSIN, used as pan-neural marker (anti- SYNORF1, Developmental Studies Hybridoma Bank, Iowa City, IA, USA) diluted 1:50; mouse anti-VC1(Sakai et al., 2000), specific for planarian photosensitive cells (anti-arrestin, kindly provided by H. Orii and Professor K. Watanabe) diluted 1:15000; rabbit anti-phospho-histone H3 (Ser 10) to detect cells at the G2/M phase of cell cycle (H3P, Cell Signaling Technology) diluted 1:300. The secondary antibodies Alexa 488-conjugated goat anti-mouse and Alexa-568-conjugated goat anti-rabbit (Molecular Probes, Waltham, MA, USA) were diluted 1:400 and 1:1000, respectively. Samples were mounted in 70% glycerol before imaging. Fixed and stained animals were observed with a Leica MZ16F stereomicroscope and imaged with a ProgRes C3 camera (Jenoptik, Jena, TH, Germany). Confocal images were obtained with a Zeiss LSM 880 confocal microscope (Zeiss, Oberkochen, Germany). Image processing and quantifications were performed with Adobe Photoshop and ImageJ 2. Counting of the H3P-positive cells was carried out manually and normalized by the total body area. Statistical analyses and graphical representations were performed using GraphPad Prism 9. A box plot displaying the minimum, lower first quartile, median, upper third quartile, and maximum values was used to represent the data. Kruskal-Wallis test was performed to compare the means between conditions after discarding data normality and homogeneity for some samples using the Shapiro-Wilk test.

3. Results

3.1. Plastic pellet leachates affect a large swathe of animal phyla

We tested the effects of leachates of high concentrations of new and beach plastic pellets on the development of *Mytilus galloprovincialis* (mollusc), *Platynereis dumerilii* (annelid), *Parhyale hawaiensis* (arthropod), *Paracentrotus lividus* and *Pariria miniata* (echinoderms), and *Ciona robusta* and *Oikopleura dioica* (tunicates) (Fig. 2), and on the regeneration capacity of *Owenia fusiformis* (annelid), *Schmidtea mediterranea* (platyhelminth) and *Exaiptasia diaphana* (cnidaria) (Fig. 3). Our results showed that the effects were treatment and dose-dependent, as well as species-specific (Fig. 4).

We observed *M. galloprovincialis* larvae at 48 hpf. At this stage, the controls displayed normal D-larvae phenotype, with a well-formed early shell that covered the mantle of the larvae (Marin, Le Roy & Marie, 2012) (Fig. 2. A1; Supplementary figure 1. A). Nurdle-leachate-treated larvae had a very similar phenotype to the controls, but they were slightly smaller in size ($p < 0.05$) (Fig. 2. A2; Supplementary figure 1. A, B, F). No differences were detected between 1% PVC-leachate treated embryos and controls (Supplementary Figure 1. C), but at 5% there was a significative reduction in size, with a misshaped shell in what we classified as an aberrant larva with protruding mantle (Fig. 2. A3; Supplementary figure 1. D). At 10% PVC-leachate, the larvae did not develop properly and remained arrested around the trochophore stage, barely forming, in some instances, a very rudimentary incipient shell (Fig. 2. A4; Supplementary figure 1. E).

Platynereis dumerilii develops first into a trochophore larvae, followed by a nectochaete larval stage (Özpolat et al., 2021). We assessed morphological changes at 4 dpf, the nectochaete larva. At this point, control and nurdle-treated larvae looked the same, with normal segmentation, chaetae, digestive system and lipid droplet distribution (Fig. 2. B1, B2). However, larvae treated with PVC leachates did not develop properly. For 1% PVC leachate-treated larvae, despite looking otherwise normal, a few of the animals showed a deformed gut phenotype (not shown). This gut phenotype was more pronounced and common in 5% PVC-treated animals (Fig. 2. B3). While the rest of the larvae could be considered normal, the developing digestive system showed a probable over-extension of the foregut tissue, and the lipid droplet distribution was also aberrant. In the 10% PVC leachate treatment, many larvae failed to complete the trochophore-to-nectochaete transition (Fig. 2. B4). Where these larvae had chaetae, they showed that segmentation was not properly completed, and they resembled a truncated malformed nectochaete. The lipid droplet distribution of these larvae was also abnormal. A normal nectochaete should have four prominent lipid droplets, with two larger and two smaller droplets, sitting just below the foregut-mouth region, but these larvae showed more droplets, and oddly distributed. A normal trochophore displays four big lipid droplets (Fischer et al., 2010), and the higher number of droplets seen in the truncated nectochaete could be a remnant of the failed transition between the two larval stages. The larvae that became more like nectochaete also showed apparent problems with the developing gut similar to what is seen at 5% PVC, potentially due to an inhability to differentiate the foregut from the rest of the gut, or over-proliferation of the foregut.

Parhyale hawaiensis hatches into a juvenile larva after about 10 dpf. Control larvae showed a normal phenotype, with a normal head with two antennae segments, a thorax with two claws and five legs and an abdomen (Fig. 2. C1). No changes were seen in the nurdle or 1% PVC treatments (Fig. 2. C2; not shown). For 5% PVC leachate-treated animals, about half of the larvae showed malformed appendages, both at the level of the head, where the antennae formed but were deviated toward the posterior of the head, and the thorax, where claws and legs were malformed and twisted (Fig. 2. C3). None of the 10% PVC leachate-treated embryos developed properly and all died *in ovo* (Fig. 2. C4).

Paracentrotus lividus were imaged at 48 hpf, at pluteus larva stage.

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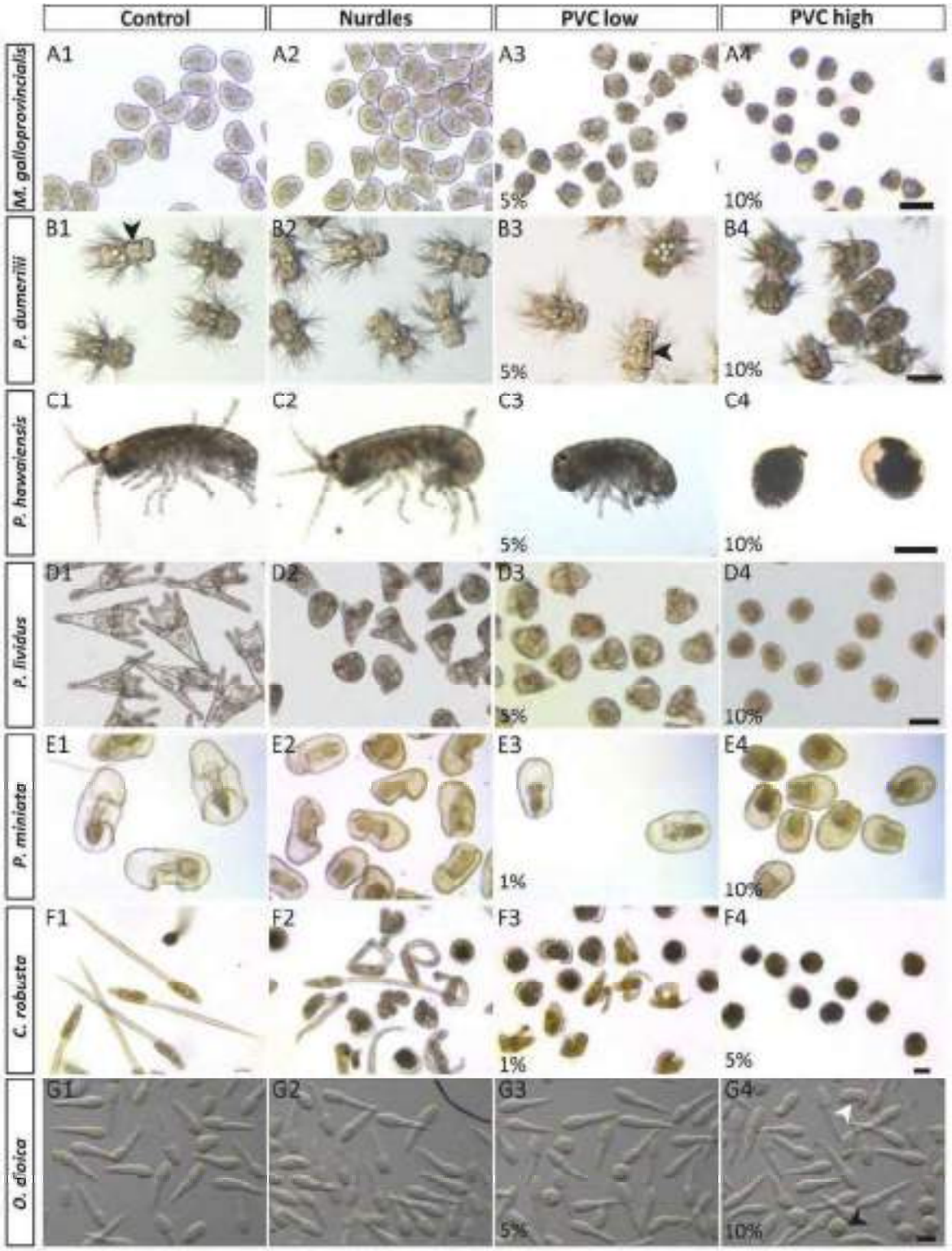

Fig. 2. Morphological effects on larval development. Representative pictures of the phenotypes observed for every studied species as they undergo each treatment. See text for details. Columns are different treatments: (1) Control; (2) Nurdle; (3) PVC low, represents the lowest concentration tested (between 1% and 5% PVC) resulting in a significant phenotype; (4) PVC high, represents the concentration at which the most aberrant phenotype was obtained (10% PVC for all species except for *C. robusta*, which was already at 5%). Lines are different species, as shown in left panel. (B1) White asterisks show an example of normal number of lipid droplets; black bracket and arrowhead show an example of normal foregut. (B3) White asterisks show an example of abnormal number of lipid droplets; black bracket and arrowhead show an example of an enlarged foregut. (G4) White arrowhead points to a kinked-tail phenotype, black arrowhead points to a golf ball phenotype. Scale bars are 110 μm for all animals except *P. hawaiensis* which represents 200 μm.

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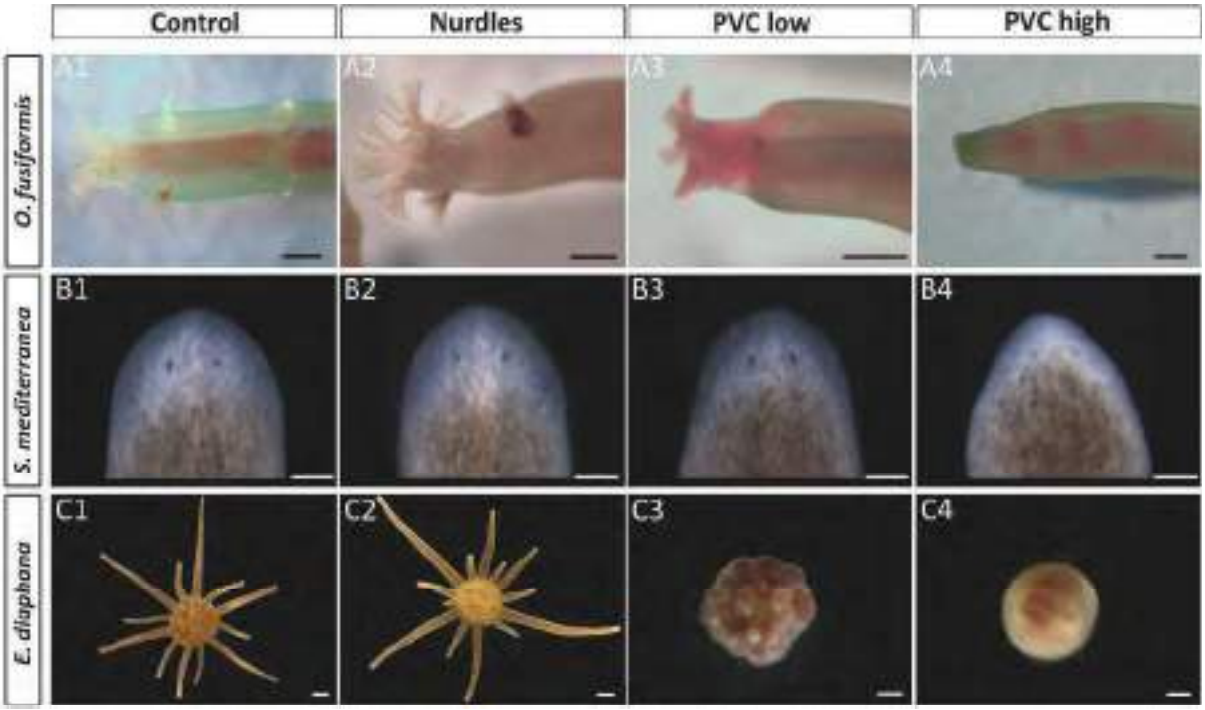

Fig. 3. Morphological effects on regeneration. Representative pictures of the phenotypes observed for every studied species as they undergo each treatment. See text for details. Columns are different treatments: (1) Control; (2) Nurdle, 10% nurdle leachates; (3) PVC low, 5% PVC leachates; (4) PVC high, 10% PVC. Lines are different species, as shown in left panel. A and B show only the anterior regenerating heads of the animal. A, anterior to the left; B, anterior to the top. Scale bars represent 500 μm for *O. fusiformis* and 200 μm for *S. mediterranea* and *E. diaphana*.

Control larvae are bilaterally symmetrical four-arm pluteus, with the typical tripartite gut, ciliary band and skeletal rods (Fig. 2. D1). Nurdle leachate-treated larvae are either delayed or malformed (Fig. 2. D2; Fig. 4. D). These malformations include shorter or absent arms, probably due to skeletogenic impairment and a bell-shaped morphology consistent with a radialisation problem. This phenotype agrees with the one observed before in this species (Rendell-Bhatti et al., 2021), if slightly milder, probably due to different plastic particles used (see discussion below). All PVC leachate treatment concentrations show developmental abnormalities in *P. lividus*. 1% PVC leachate-treated larvae are delayed, with no other clear phenotypic abnormality (not shown; Fig. 4. D). 5% PVC leachate-treated embryos display a bell-shape, being clearly radialised. Malformation of the skeleton and of the distribution of the pigment cells is also evident (Fig. 2. D3). 10% PVC-treated larvae have a very extreme phenotype. In some cases, they exhibit a radialised phenotype with no elongation of the arms and a lack of pigment cells. In other cases, the archenteron has not even elongated and, in most cases, the embryo has not proceeded post-gastrulation (Fig. 2. D4).

Patiria miniata produce a bipinnaria larvae (Yankura et al., 2010). Control larvae at 4 dpf show a typical young bipinnarial larva phenotype, including a partitioned digestive tract, elongated coeloms that will give rise to the hydrovascular organ (Perillo et al., 2023) and a well-formed ciliary band (Fig. 2. E1). All treated larvae show some delay or aberrant phenotypes. For nurdle-leachate-treated embryos, larvae resemble late gastrulae (Fig. 2. E2), delayed more than 24 h from the normal developmental milestone. In many cases the gut appears like a non-partitioned tube, accompanied by ectodermal deficits. For instance, ectodermal regions such as the ciliary band and oral hood are missing. Last but not least, the elongation of the coelom appears to be delayed. For PVC-leachate treated embryos, a concentration-dependent delay in development is seen, with animals looking like late gastrula when treated with 1% PVC-leachates (Fig. 2. E3), to mid gastrula, with some misshaping of the elongating archenteron at 10% (Fig. 2. E4).

Ciona robusta tadpole larvae have two main structures: the trunk, which contains the adhesive organ (palps), the brain vesicle with two pigmented sensory organs (otolith and ocellus), endoderm and mesenchyme; and a straight tail for locomotion, bearing the neural tube, notochord, endodermal strand and muscles, all covered by the larval tunic. Control larvae showed a normal trunk and straight tail containing vacuolated notochord cells (Fig. 2. F1), while all the treatments compromised the normal embryo development. Nurdle-leachate-treated larva showed a shorter, kinked or coiled tail, often disorganized in its internal structure. In most cases, the trunk shape was abnormal, the sensory vesicle was deformed, although carrying both pigmented organs, and the adhesive organ was misshaped. (Fig. 2. F2). The phenotype for 1% PVC leachate-treated larvae was very similar to the observed for nurdle leachates (Fig. 2. F3), although a higher percentage of embryos did not hatch and were still in the chorion. However, at 5% PVC leachate treatments, the larvae were not formed, but instead, unhatched round individuals were obtained. There were, however, two pigmented spots, probably a hint of structures corresponding to the otolith and the ocellus, demonstrating development had proceeded, but morphogenesis had not been successful, thus producing aberrant embryos (Fig. 2. F4).

Oikopleura dioica develops extremely fast, with hatchling larvae appearing at 3.6 hpf at 19 °C and larval development lasting a further 7 h only, when the juvenile form is ready to make the first house (Ferrández-Roldán et al., 2019). The larvae, as in *C. robusta*, consist of a trunk that will house all the organs in the adult, and the tail with the notochord, the muscle cells and the nervous system. We only observed a significant shift from the controls at the highest concentration of PVC leachates (10%) when the percentage of malformed larvae increased (Fig. 2. G4, Fig. 4. G). These malformations affected the tail, which appeared shorter or kinked, and the trunk, which was misshaped. We also saw a higher proportion of animals that arrested their development at a pre-tailbud stage, previously described as a golf ball phenotype (Torres-Águila et al., 2018).

Owenia fusiformis is capable of anterior regeneration after traumatic injury. Three days after amputation, the blastema is formed, and

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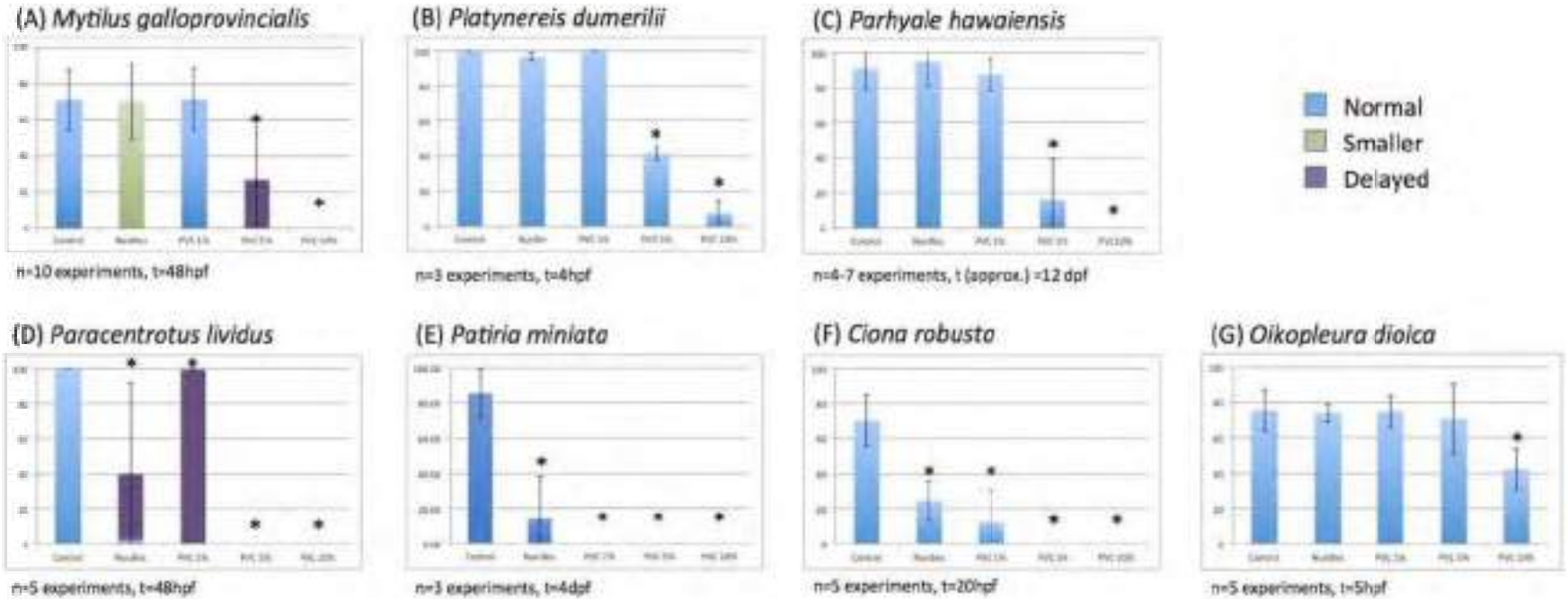

Fig. 4. Percentage of normal developmental phenotypes obtained for each species studied in each treatment. Percentage of normal embryos is depicted in blue. When embryos are delayed but otherwise normal they are depicted in purple. Smaller than normal but otherwise normal embryos are shown in green. Number of biological replicas and time of observation are stated under each species graph. Error bars show standard deviations. Asterisks indicate differences from the controls have statistic significance (One-Way ANOVA followed by Post Hoc Tukey HSD).

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differentiation and regeneration are complete seven days after injury (Marilley and Thouveny, 1978). At this time point, we found no differences between controls and nurdle leachate-treated animals (Fig. 3. A1, A2). Heads regenerated to create fully formed tentacles and eyes. Animals treated with 5% PVC leachates looked normal (Fig. 3. A3), but showed a less elaborate branching in the crown of tentacles, and two out of six did not develop the eyes properly. Likewise, five out of six of the 10% PVC leachate-treated animals regenerated properly but the branching pattern of the tentacles looked delayed. One animal failed to undergo morphogenesis at this concentration after creating an elongated blastema (Fig. 3. A4).

The asexual strain of *Schmidtea mediterranea* uses stem-cell based regeneration as its main reproductive strategy, and can regenerate new heads, tails, sides, or entire organisms from small body fragments in a process taking days to weeks (reviewed in (Reddien, 2018)). We found no differences in regeneration between controls and nurdle or 5% PVC leachate-treated animals (Fig. 3. B1–B3; Supplementary Figure 2). However, animals treated with 10% PVC leachates developed a smaller blastema than the controls and, at 7 days after amputation, they have regenerated smaller eyes and brains (Fig. 3. B4; Supplementary Figure 2)). To investigate the proliferative rate of stem cells, we identified the G2/M stage of the cell cycle by performing immunostaining against a phosphorylated form of Histone-3. We quantified the total number of mitoses in amputated planarians regenerating anterior wounds at 5 days after amputation and observed a significant decrease in the number of mitotic stem cells in 10% PVC leachate-treated animals, but not in any other treatment (Supplementary Figure 2).

Exaiptasia diaphana exhibits asexual reproduction capability, growing from pedal lacerations, a small portion of tissue deriving from the margin of the pedal disk and the body column. This produces crescent-shaped fragments that successfully regenerate into fully formed polyps within a few weeks (Clayton and Lasker, 1985; Presnell, Wirsching & Weis, 2022) (Fig. 3. C1). Fourteen days post-laceration, the morphology is adult-like, differing only for the smaller size. Treatment with nurdle leachate at a concentration of 10% did not seem to affect the external morphology, which remained comparable to the control (Fig. 3. C2). At a concentration of 1% PVC, the morphology of the polyps was also equivalent to the control group (not shown). However, higher concentrations of PVC leachate displayed concentration-dependent effects on normal development. Specifically, treatment with 5% PVC leachate caused developmental delays and reduced tentacle length without affecting the overall number of tentacles (Fig. 3. C3). This result was consistent with the development period (Presnell, Wirsching & Weis, 2022). Furthermore, at a concentration of 10% PVC leachate, the regeneration of *E. diaphana* was severely compromised. Despite remaining alive, the laceration was covered with a protective mucous membrane (typical of new pedal lacerations), and the animal maintained its initial state without any signs of tentacle or gut formation (Fig. 3. C4).

4. Discussion

4.1. Developmental susceptibility across animal superphyla

The species employed in this study showed different developmental susceptibility to the treatments (Fig. 4). In summary, all species were affected by new PVC particle leachates, but only some deuterostomes and the mussels had a clear response to environmental nurdle leachates. *P. dumerilii*, *O. dioica* or *P. hawaiensis* are unaffected by nurdle leachate treatment. For PVC treatments, some species are affected already at the lower tested concentrations, like *C. robusta* and *P. miniata*, which show severe phenotypes already at 1%, while the rest show clear aberrations at 5%, except for *O. dioica* which seems to be more resistant and is only affected by the 10% treatment.

For deuterostomes, in the case of the echinoderms *P. lividus* and *P. miniata* the effect seems to start early, with problems with gastrulation and archenteron elongation, as well as embryonic axis formation, as seen in other studies for *P. lividus* and *S. purpuratus* (Rendell-Bhatti et al., 2021; Paganos et al., 2023). In agreement with the phenotypes we observe, molecular data for *S. purpuratus* treated with 10% PVC leachates had previously shown downregulation of genes involved in the secondary axis formation as well as in the cell specification of certain cell types (Paganos et al., 2023). Looking into the tunicates, *C. robusta* is affected by all treatments while *O. dioica* is more resilient, only showing aberrant phenotypes at the higher concentration of PVC. In both cases, we believe axial patterning and cell specification are correct, but that morphogenesis is altered. This is clear for the treatments that display weaker phenotypes, where structures like the trunk and the tail have formed, but the morphology of these structures is aberrant (*C. robusta*, Fig. 2. F2, F3; *O. dioica*, Fig. 2. G4). In the most extreme phenotypes, both species display a golf ball phenotype. In *C. robusta* it is still possible to identify the two pigmented spots within the otherwise amorphous ball phenotype. For *O. dioica,* both aberrant phenotypes observed here are also seen when this animal is exposed to diatom bloom-derived biotoxins (Torres-Águila et al., 2018). Molecular analysis of the golf ball phenotype in *O. dioica* has previously showed that cell and tissue specification in this phenotype are correct, but that it is morphogenesis that is at fault (Torres-Águila et al., 2018), and we believe this is also the case here. All protostomes tested, *M. galloprovincialis*, *P. dumerilii* and *P. hawaiensis,* display a later effect at lower PVC concentrations, since they show correct axis specification and early morphogenesis. The appendage malformation in *P. hawaiensis* and the aberrant gut formation in *P. dumerilii* nectochaete larvae and the failure to produce a shell in *M. galloprovincialis* point to later gene regulatory pathways being affected in these cases. However, high PVC concentrations affect larval metamorphosis in *P. dumerilii*, as seen with the inability to properly transit from trochophore to nectochaete larva, and *P. hawaiensis* embryos fail to complete their developmental program.

4.2. Effects on regeneration

Regeneration is a type of asexual reproduction strategy widely adopted among aquatic invertebrates by which an animal can regrow certain body parts from just a part of the original organism. Studying regeneration is important to understand healing and repair mechanisms, including those happening in humans (Mehta and Singh, 2019). Regeneration involves three main events: wound healing, cell population mobilisation (of stem cells, dedifferentiated or transdifferentiated cells) and tissue morphogenesis. *E. diaphana* can regenerate a whole polyp from a small part of the peduncle (pedal laceration) (Clayton, 1985). In the planarian *S. mediterranea*, residing pluripotent cells called neoblasts are recruited in the wound site to generate a blastema, which will then differentiate, and morphogenetic processes will assure that the correct pattern is formed to create the missing body parts (Reddien, 2018). Following anterior amputation in *O. fusiformis*, several tissue rearrangements are in place to generate a blastema where epidermal and muscle cells proliferate (Fontés et al., 1983). In our study, we see a clear hindering of the regenerative process in *E. diaphana* treated with PVC leachates (Fig. 3. A3, A4). In the case of this species, wound healing takes place before we expose the animals to the treatment. Later, we cannot discern if the regeneration is obstructed at the level of cell mobilisation or tissue morphogenesis. The regeneration defects of PVC leachates in *S. mediterranea* and *O. fusiformis* are much milder (Fig. 3. B1–B4, C1–C4). While *O. fusiformis* mostly shows only a delay of the regeneration process at the highest concentration of PVC leachates, the planarian displays aberrant regeneration with the formation of a smaller blastema and regenerating smaller eyes. In this case, we were able to pinpoint a reduction in the proliferation of the stem cells as well as in the differentiation of the nervous system and the new eyes (Supplementary Figure 2). This points to a correct wound healing and cell mobilisation in the planarians, and alteration in cell proliferation being the main cause of the failure in proper regeneration in this species. Whichever the

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mechanisms impeded by plastic leachate treatment in each of these species, there is a hindrance in regeneration because of these treatments, showing that asexual reproduction can also be affected by microplastic contamination. Indeed, nanoplastics have been found to delay regeneration in *Girardia tigrina* (Cesarini et al., 2023a) and *Hydra vulgaris* (Cesarini et al., 2023b), but to the best of our knowledge, no report has shown effects of plastic leachates on regeneration prior to our work. However, with the species sampled here, our results suggest that regeneration is more resilient to plastic contamination than development is. Further analysis of the cellular types and gene expression after infliction of the wound will be necessary to determine if pluripotent-cell recruitment and proliferation are happening correctly and if tissue morphogenesis is affected. Knowing the effects that plastic contamination can have in the regenerative processes will be informative both for the effects in asexual reproduction in marine invertebrates and for the study of possible consequences for tissue healing and regeneration in other species, potentially including vertebrates and humans subjected to plastic exposure.

4.3. Chemical pollutants in the water

During the production process of plastics, a variety of chemicals are added to give them particular characteristics. More than 10.000 additives have been identified in plastics, of which over 2.400 are classified as substances of potential concern by the European Union standards for persistence, bioaccumulation and/or toxicity criteria (Wiesinger, Wang & Hellweg, 2021). Marine microplastics have been linked to harmful plastic additives from manufacturing, but also to environmental pollutants absorbed from the surrounding seawater that have been incorporated once the particles have been lost in the environment, such as polychlorinated biphenyls (PCBs) or polycyclic aromatic hydrocarbons (PAHs) (Mato et al., 2001; Endo et al., 2005; Rios, Moore & Jones, 2007; Hirai et al., 2011; Rochman et al., 2019; Verla et al., 2019). Hence, plastic leachates are formed by a complex mixture of compounds. However, most of those additives or combinations of them have not been widely studied, and their effects are poorly understood (Wiesinger, Wang & Hellweg, 2021). Animals exposed to microplastics and their associated contaminants may face significant threats, as these plastic additives known to be toxic compounds have been detected leaching from marine plastic (Teuten et al., 2009; Engler, 2012; Gauquie et al., 2015; Rendell-Bhatti et al., 2021; Paganos et al., 2023). This is also true for other organisms, as microplastic leachates are known affect plants and bacteria. Seed germination of several plant species is impaired by microplastic leachates from diverse origin and polymer types (Pflugmacher et al., 2020; Schiavo et al., 2020; He et al., 2023), and the growth phytoplankton can be inhibited by microplastic leachates (Simon, Hartmann & Vollertsen, 2021; Focardi et al., 2022). Moreover, chemicals leached from PVC particles can enrich genes related to microbial pathogenesis within a bacterial community (Vlaanderen et al., 2023), and prokaryotic phytoplankton growth can be affected, in both directions depending on the species, by PVC leachates, reshaping the composition of the marine microbiome (Tetu et al., 2019; Focardi et al., 2022).

We have previously determined the content of persistent organic pollutants (POPs) and other contaminants in the leachates of these pellets (Rendell-Bhatti et al., 2021; Paganos et al., 2023). In no case were any phthalates found in the leachates of either environmental or new plastic particles (Rendell-Bhatti et al., 2021). In 10% nurdle leachates, we had previously found high concentrations of polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), 21 and 5 times higher than normal sea water content (Rendell-Bhatti et al., 2021), which could explain the developmental effects found in *P. lividus* treated with nurdle leachates (Rendell-Bhatti et al., 2021). These chemicals had also been found in similar concentrations in leachates from farming fishing gear in French Polynesia, which also induced developmental defects in the pearl oyster (Gardon et al., 2020). However, the content of POPs in 10% PVC leachates were significantly lower, and the presence of these compounds alone could not explain the stronger developmental abnormalities seen in PVC leachate treated *P. lividus* (Rendell-Bhatti et al., 2021). Analysis of the elemental content of the water leachates by inductively coupled plasma – optical emission spectrometry revealed that 10% PVC leachates contained high amounts of zinc (1 μg g^{-1}), but nurdle leachates did not have higher concentrations of zinc than sea water (Paganos et al., 2023). *E. diaphana* can extract Pb (but not Zn or other heavy metals studied) from pre-production plastic High Density Polyethylene (Diana et al., 2020). The zinc present in the PVC leachates in our study could explain the phenotypes observed with this treatment, which were consistent with classical developmental experiments exposing sea urchin embryos to heavy metals (Mitsunaga and Yasumasu, 1984; Hardin et al., 1992; Kobayashi and Okamura, 2004; Cunningham et al., 2020; Paganos et al., 2023). Since using the same plastic particles, these same chemicals are expected to be the ones responsible for the phenotypes observed in the present study. However, as discussed above, plastic leachates may be composed of hundreds of associated compounds, and the unmeasured chemicals may also be contributing to the effects observed.

4.4. Intraspecific variability of the response

We observed that the impact of each leachate treatment can differ in severity across batches of animals of the same species. Indeed, experiments conducted with animals collected on different days showed more variation compared to those conducted with animals collected on the same day. These differences were particularly noticeable for the nurdle and low PVC concentration leachate treatments, which generally resulted in a lower percentage of aberrant embryos than in the higher PVC leachate treatments (see, for instance, standard deviations for each species in Fig. 4). Oxidative stress is highly involved in the effects of plastic and plastic-leachate treatments in marine larvae ((Paganos et al., 2023); also reviewed in (Hu and Palić, 2020)) and adults (Jeong et al., 2017; Pérez-Albaladejo, Solé & Porte, 2020; Milito et al., 2020; Murano et al., 2023). Recently, our lab and others have shown that adult sea urchins subjected to higher oxidative stress produce less successful embryos than animals in normal physiological conditions (Masullo et al., 2021; Jimenez-Guri et al., 2023). We believe that the intraspecific differences we see here are due, probably amongst other reasons, to the state of the parents before obtaining the gametes for the experiments as well as to the influence of the different genetic backgrounds of the various parents used.

We also detected intraspecific differences due to a batch effect in the particles used. For beach-collected nurdles, we found the phenotypes observed are not always equivalent when different batches of environmental nurdles are used for one species. This is inherent to the sample type, as every environmental nurdle can have a different history from when they were lost at sea and, therefore, can have gathered different types of contaminants in their travel (Teuten et al., 2009). Likewise, different types of new plastic pellets will be supplemented with, and therefore be able to leach, different chemicals at production. Therefore, it is necessary to stress again that different types of nurdles will produce different phenotypes, and that the ones shown here are only examples of what can happen. Moreover, the concentrations of pre-production plastic pellets used in this study to create the leachates are higher than those found in the sea. In the event of a nurdle spill (like the one that occurred in Sri Lanka in 2021 (Sewwandi 22), amongst others), pellets will accumulate mostly in beach sediments and on the water surface, or may sink, and leachates in the water column will be diluted in a really large volume of water. Hence it would require very particular circumstances to achieve these extremely high concentrated plastic leachates. Still, this study constitutes a proof of principle to describe that aquatic animals from different and diverse phyla are susceptible to plastic leachates during development, metamorphosis and regeneration.

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4.5. Interspecific variability of the response

Plastic contamination has been previously shown to affect development in a variety of animals, and plastic leachates are sufficient to cause these effects (Nobre et al., 2015; Li et al., 2016; Gandara e Silva et al., 2016; Oliviero et al., 2019; Gardon et al., 2020; Rendell-Bhatti et al., 2021; Paganos et al., 2023). Micro- and nano-plastics activate oxidative damage and inflammatory responses, leading to adverse outcome pathways in a variety of organisms (Hu and Palić, 2020), while plastic additives have also been shown to induce oxidative stress in aquatic organisms (reviewed in (Pérez-Albaladejo, Solé & Porte, 2020). Previous studies have shown that adult and developing sea urchins exposed to plastic leachates have increased oxidative stress and lower production or maintenance of immune cells (Jimenez-Guri et al., 2023; Paganos et al., 2023). Furthermore, the gene regulatory networks acting early in the development and necessary for proper embryo formation are affected in these animals too (Paganos et al., 2023). It would be of great interest to look into the mechanisms of action of these toxicants, which need to be determined on a case by case basis, to learn how leachates affect the animals studied here. One would expect that detoxification genes can be important in protecting some of the more resilient species. In *O. dioica*, response genes against environmental stress (also known as the defensome (Goldstone et al., 2006)), particularly those dealing with aldehyde detoxification, are upregulated very early in development as a response to biotoxins, where phenocopies of the larval shapes seen in our study are obtained (Torres-Águila et al., 2018). However, *C. robusta* is a species that typically lives in contaminated environments, since it thrives in ports where oil and plastic pollution, amongst others, is high, and should therefore have a very developed detoxification system. Indeed, exposure to metals in *Ciona* is known to upregulate glutathione biosynthesis (Franchi et al., 2012) and upregulate transcription of Cu,Zn superoxide dismutases (Ferro et al., 2013) and metallothionein genes (Franchi et al., 2011), all of which processes are linked to exposure and protection against oxidative stress. However, this particular species is one of the most affected by our treatments. Oxidative stress coping mechanisms, including increasing reduced glutathione, have also been shown to be in place in *M. galloprovincialis* reared in aquaculture environments, which have increased intake of microplastics (Capo et al., 2021), and increased metallothionein expression has also been shown in *M. galloprovincialis* and *S. purpuratus* exposed to microplastics (Paganos et al., 2023; Impellitteri et al., 2023). It would, therefore, be very interesting to study the transcriptomic state of the defensome of the species studied here to correlate the different phenotypes with alterations in these specific genes.

We hypothesised that another possible reason for the interspecific differences in the severity of the phenotypes, besides specific physiological, developmental and metabolic responses to the treatments, would be the speed of development of the different species, as well as the presence of a longer-lasting, stronger chorion, as a physical barrier to the exterior. If an animal is faster at developing, it will make sense that chemicals in the water may have less time to affect their development, as they still need to pass through the chorion before it can generate stress or affect the transcription of genes. On the contrary, it could be that a slow-developer could have more time to react activating the stress-defence response. Chorions are indeed protective barriers against polymer microsphere toxicity in zebrafish embryos (Feng et al., 2013). Here, we have a mix of species that develop extremely fast (*O. dioica* hatches just 4 hpf) to relatively slow (*P. hawaiensis* hatches around 12 dpf). We do not see any emerging pattern that would allow us to determine if developing fast or slow is advantageous against plastic leachate contamination. However, the protective function of the chorion seems not to influence the effect of our treatments: despite *C. robusta* having a very strong chorion (not only composed of a surrounding membrane but also test cells, a group of maternal cells placed between the egg and the membrane, and maternal follicle cells outside the membrane (Kourakis et al., 2021)), it showed a clear and visible impairment in the proper development of the embryos. Notwithstanding the mechanism of each species to cope or react to the plastic leachates, we believe that transcriptomic profiling and determination of the oxidative stress state of these species after treatment could shed light on the mechanisms behind the differences and similarities between them.

4.6. Ecological consequences

The potential biological impacts of plastic pollution have been extensively discussed, including the chemical toxicity from plastic leachates (Oliviero et al., 2019; Ke et al., 2019; Shi et al., 2019; Rendell-Bhatti et al., 2021; Jimenez-Guri et al., 2023; Paganos et al., 2023). These can be modulated by the interaction between the plastic or its leachates and additional factors that, alone or combined, can affect marine species such as pre-existing chemical contamination, UV photoactivation and global change driven stressors such as ocean acidification or increased water temperatures (Andrady, 2011; Gewert, Plassmann & MacLeod, 2015; Koelmans et al., 2016; Torres et al., 2021; Catarino et al., 2022; Romera-Castillo et al., 2023). Assessment reports suggest that microplastic interaction with increasing water temperature, ocean acidification and ocean deoxygenation can affect ingestion and digestion, energy allocation, growth, and fecundity of marine organisms (Catarino et al., 2022). Chemical stressors from plastics have been identified as a possible contributor to biodiversity loss (MacLeod et al., 2021). Embryo development is an extremely robust process that has evolved cellular processes and regulatory pathways to respond to environmental stressors. However, some anthropogenic stressors can elude the mechanisms that act as developmental defences to ensure the right developmental decisions, overwhelming the developmental robustness (Hamdoun and Epel, 2007). Problems in the correct development of embryos can lead to declines in the success of subsequent generations for a particular species. Developmental effects with no detectable phenotypes, which may be happening in the lower concentrations tested here, could also mediate potential transgenerational changes, which in turn may be detrimental. Given that many species have a spawning season, sporadic environmental stressors such as surges in local plastic contamination could impact a particular population's reproductive success. Here, we demonstrate that plastic leachate contamination can affect the development and regeneration of many aquatic species with potentially catastrophic effects that can result in the loss of communities and disruption of ecosystems. Our study provides data showing that microplastic-derived chemical pollution can affect major lineages of marine diversity, pointing to consequences for the health and functioning of marine ecosystems.

5. Conclusions

Leachates of industrial PVC pellets affect all animals tested in a concentration-dependent and species-specific manner. Leachates of environmentally retrieved nurdles at the same high concentrations have a phenotypical effect in fewer species, but still in four out of the ten species tested. Deuterostomes, excluding *O. dioica*, show the highest sensitivity to all leachates. While we acknowledge that this study utilises concentrations of plastics that are way higher than those found in the environment, this work constitutes proof of principle that both new and environmentally retrieved pre-production plastic pellets, at high concentrations, can release enough chemicals to affect the development and regeneration of a wide group of animals. Whether this can be generalised to other types of plastic leachates is plausible but needs to be studied. Moreover, there may be effects that do not show an evident phenotype but may be affecting development, physiology or robustness at a lower level, and cumulative effects may eventually be hindering optimal development, probably including transgenerational effects. Follow-up mechanistic studies to understand the reason for the failure of the developmental and regeneration process and any effects with no detectable phenotypes at lower concentrations would be extremely

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interesting to address the potential ecological consequences of plastic pollution on the marine ecosystem.

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CRediT authorship contribution statement

Eva Jimenez-Guri: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing. **Periklis Paganos:** Writing – review & editing, Methodology, Investigation. **Claudia La Vecchia:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Giovanni Annona:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis. **Filomena Caccavale:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Maria Dolores Molina:** Writing – review & editing, Visualization, Resources, Methodology, Investigation, Formal analysis. **Alfonso Ferrández-Roldán:** Writing – review & editing, Methodology, Investigation, Formal analysis. **Rory Daniel Donnellan:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis. **Federica Salatiello:** Writing – review & editing, Resources. **Adam Johnstone:** Resources, Methodology. **Maria Concetta Eliso:** Resources, Methodology, Writing – review & editing. **Antonietta Spagnuolo:** Methodology, Resources, Writing – review & editing. **Cristian Cañestro:** Resources, Writing – review & editing. **Ricard Albalat:** Resources, Writing – review & editing. **José María Martín-Durán:** Resources, Writing – review & editing. **Elizabeth A. Williams:** Methodology, Resources, Writing – review & editing. **Enrico D'Aniello:** Formal analysis, Methodology, Resources, Writing – review & editing. **Maria Ina Arnone:** Formal analysis, Methodology, Resources, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data is supplied within the figures. Further images can be supplied upon request.

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Appendix A. Supplementary data

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The impacts of weathering on concentration and bioaccessibility of organic pollutants associated with plastic pellets (nurdles) in coastal environments

Xiangtao Jiang, Kaijun Lu, Jace W. Tunnell, Zhanfei Liu *

University of Texas Marine Science Institute, 750 Channel View Drive, Port Aransas, TX 78373, United States of America

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ABSTRACT

Nurdles, the pre-production plastic pellets, are a major source of plastic pollution in marine environments due to unregulated spills during production and transportation. We analyzed the types of plastics and associated organic pollutants on nurdles collected along the shoreline of Gulf of Mexico in Texas. Our results showed that the nurdles were made from polyethylene (81.9%) and polypropylene (18.1%). Polycyclic aromatic hydrocarbons (PAHs, 16 US EPA priority) and polychlorinated biphenyls (PCBs, 7 commercial congeners) sorbed to the nurdles were in concentration ranges of 1.6–14,700 ng/ g and 0–642 ng/ g, respectively. Heavily weathered nurdles tended to have higher concentrations of PAHs and PCBs than lightly weathered ones. The bioaccessibility of sorbed contaminants was evaluated using a simulated intestinal fluid. The results showed that the associated PAHs were more bioaccessible in lightly weathered nurdles (13.1 ± 2.3%) than heavily weathered one (5.3 ± 0.1%), and that no PCBs were bioaccessible. These findings are informative for toxicity evaluation and resource management of plastic debris in coastal environments.

1. Introduction

Global microplastic pollution in the marine environment has raised increasing concern recently due to the large influx of plastic debris to the ocean and its resistance to environmental degradation (Browne et al., 2011; Avio et al., 2017). As one type of microplastics, plastic resin pellets or nurdles, have been constantly documented worldwide for several decades (Carpenter et al., 1972; Carpenter and Smith, 1972; Bourne and Imber, 1982; Gregory, 1999; Moore et al., 2001; do Sul and Costa, 2007; Phillips and Bonner, 2015; Taniguchi et al., 2016; Pozo et al., 2020; Tunnell et al., 2020). Nurdles, often with cylinder or sphere shape (1–5 mm diameter), are manufactured and transported to factories to be melted and molded into final plastic products (Fotopoulou and Karapanagioti, 2012). Without regulation, nurdles are often released unintentionally into the environment at all stages of the plastics supply chain including handling, storage, and transportation (Karlsson et al., 2018). Following environmental leakage, nurdles can be dispersed via wind, surface currents and tides, or deposited in coastal areas (Karkanorachaki et al., 2018). It has been estimated that 230,000 tons of nurdles enter the marine environment annually (Sherrington, 2016).

Polluted nurdles can adsorb persistent organic pollutants (POPs) from the environment due to their hydrophobic nature and relatively large surface area to volume ratios (Mato et al., 2001). A variety of POPs including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dichloro-diphenyl-trichloroethane (DDT) have been detected on nurdles collected from natural waters and beaches (Endo et al., 2005; Ogata et al., 2009; Rios et al., 2010; Zhang et al., 2015; Chen et al., 2018). For example, the International Pellet Watch has been documenting concentrations of PCBs and organochlorine pesticides on nurdles stranded on beaches globally since 2005 (Ogata et al., 2009). The concentrations of pollutants on nurdles depend on their locations and residence times in specific environments (Endo et al., 2005; Ogata et al., 2009). In addition, the aging (weathering) of microplastics can enhance the sorption capability of pollutants, likely due to the occurrence of functional groups on the plastic surface that can promote sorption and/or the increase of specific surface area (Hüffer et al., 2018; G. Liu et al., 2019; J. Liu et al., 2019). Thus, the aging status of nurdles needs to be considered when assessing their environmental risks.

The ingestion of nurdles by marine organisms, such as turtles, fish, and birds, can result in various adverse effects including intestinal blockage, decrease of food consumption, and increased pollutants exposure (Ryan, 1988; Graham and Thompson, 2009; Gregory, 2009; Kühn et al., 2015). For example, Colabuono et al. (2010) detected PCBs and organochlorine pesticides in the ingested plastic pellets from

* Corresponding author.
E-mail address: zhanfei.liu@utexas.edu (Z. Liu).

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seabirds. It has been widely accepted that plastic debris acts as vectors to transport pollutants to different environments, potentially also increasing exposure to marine organisms (Besseling et al., 2013; Ma et al., 2016; Diepens and Koelmans, 2018). Total concentrations of pollutants associated with microplastics are often measured, but the concentration of pollutants released to body fluid of organisms is less reported. Only the released pollutants, or the bioaccessible fraction, are available to accumulate in body tissues or trigger toxic effects (Rostami and Juhasz, 2011). Thus, knowing the total concentration of pollutants alone is insufficient, and it is critical to assess the bioaccessible fraction of the pollutants for better predicting risk.

According to the surveys of the Gulf of Mexico citizen science program, *Nurdle Patrol*, over 150 nurdles per 10-minute survey are often found on beaches along the Texas coasts (Tunnell et al., 2020). To date, the exact abundance and distribution of nurdles along coasts are still under investigation. Further, little information is available about the types and concentrations of POPs associated with nurdles and their bioaccessibility, thus the impact of nurdles, their associated pollutants and potential risk to coastal ecosystems and organisms remain unclear. Using nurdles collected along the Texas shoreline, our main objectives of this study are to: (1) identify the types of polymers that the nurdles are made of and their surface properties, (2) determine the total concentrations and bioaccessible fraction of POPs associated with nurdles, and (3) evaluate the effects of weathering on POPs associated with nurdles.

2. Materials and methods

2.1. Nurdle collection

Nurdles were collected from February to September in 2019 along the high tide line of the beaches from North Padre Island to Galveston in Texas (Fig. 1). Geographic coordinates of the study sites, numbers of nurdles collected, and sampling dates are listed in Table 1. At each sampling site, the nurdles were typically scattered rather than piled together, and they appeared to be sourced from multiple spills based on their different colors, shapes, and weathering degrees, even though they were all made of either polyethylene or polypropylene (details later). Since it is unrealistic to analyze nurdles individually due to the detection limit of the sorbed contaminants and time constraints, we pooled the nurdles together based sampling sites, with ~100 nurdles collected per site except the Galveston site where 3590 nurdles were collected (Table 1).

At all the sampling sites except Galveston, nurdles were collected using solvent-rinsed metal forceps and stored in 25 mL amber glass vials at 4 °C until laboratory analysis. At the Galveston site, nurdles were collected by the Nurdle Patrol citizen science program (Tunnell et al., 2020), and stored at 4 °C at the University of Texas Marine Science Institute until analysis. The average sampling duration at each site was approximately 30 min. The exact sources of the nurdles are unknown, but they may have sourced from multiple spills/manufacturers. In addition, the coastal current in this region (generally flowing southward in winter and northward in summer due to seasonal winds) may have transported the nurdles around depending on season (Weise, 1980).

2.2. Nurdle characterization

The nurdles were immersed in 15 mL ultrapure water and cleaned in a stainless steel ultrasonic bath (FS60 Tabletop, Fisher Scientific) 3 times for 30 min each. The cleaned nurdles were transferred to closed glass petri dishes with solvent-rinsed metal forceps and air-dried.

To identify the polymer type, 10 nurdles were randomly selected from each site and analyzed using Fourier Transform Infrared Spectrometry (FTIR, AIM-9000 FTIR Microscope, Shimadzu). Considering that there were 3590 nurdles collected at the GA site, 50 nurdles were randomly selected for 4 times (200 nurdles total), and analyzed to ensure that the polymer type identified was representative of the whole sample. The polymer was identified by comparing the sample spectra with the standard spectra from the instrument library (LabSolutions IR Software, Shimadzu).

The weathering status of the nurdles was evaluated by their yellowness and the degree of surface corrosion. The yellowness index of a nurdle was calculated based on the images of AIM-9000 microscope and the RGB color values defined by the American standard for testing and materials (ASTM E313, 2020). The degree of surface corrosion was quantified based on the microscopic photo of each side of the nurdle, using the ratio of corroded area over the whole side area. Most nurdles

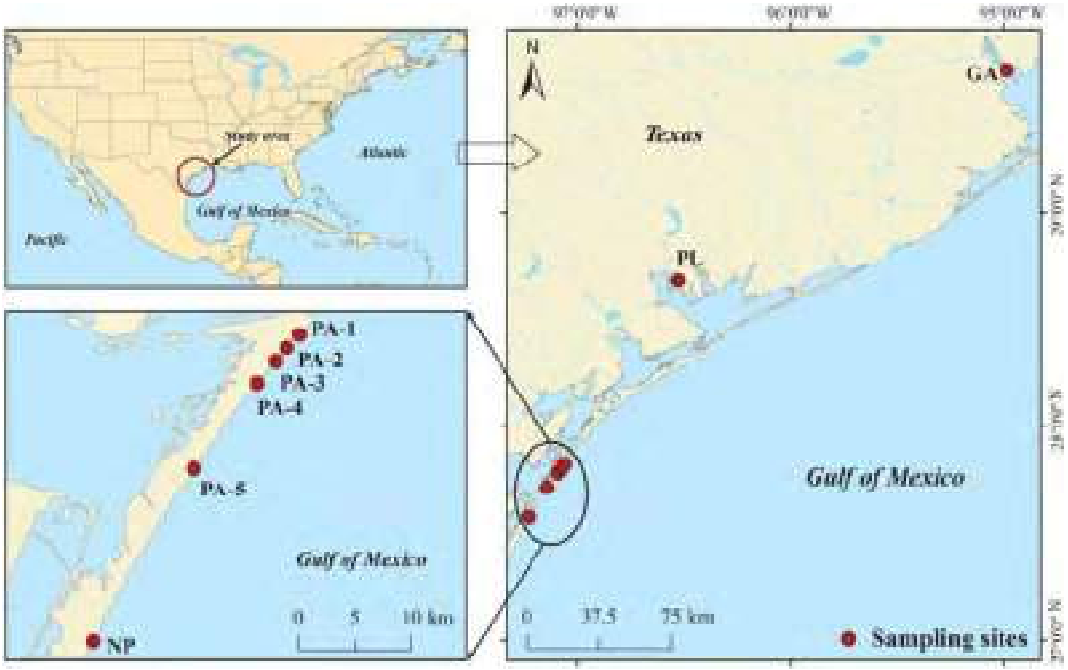

Fig. 1. Sampling sites along the coasts of Texas. Site full name: GA: Galveston site; PL: Port Lavaca site; PA-1: Port Aransas-1 site; PA-2: Port Aransas-2 site; PA-3: Port Aransas-3 site; PA-4: Port Aransas-4 site; PA-5: Port Aransas-5 site; NP: North Padre Island site.

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Table 1
Sample information of nurdles collected from Texas coasts.

Beach name	Abbreviation	Latitude	Longitude	Sampling date	No. nurdles
Galveston, Morgan's point	GA	29°40′34.68″N	94°59′20.04″W	06/14/19	3590
Port Lavaca, Cox creek	PL	28°41′19.3″N	96°31′42.8″W	07/12/19	112
Mustang Island, Port Aransas	PA-1	27°49′20.19″N	97° 3′30.17″W	09/17/19	129
Mustang Island, Port Aransas	PA-2	27°48′42.53″N	97° 4′6.77″W	09/18/19	131
Mustang Island, Port Aransas	PA-3	27°48′03.4″N	97° 4′38.8″W	09/17/19	103
Mustang Island, Port Aransas	PA-4	27°47′0.82″N	97° 5′31.08″W	09/18/19	109
Mustang Island, Port Aransas	PA-5	27°42′53.77″N	97° 8′33.49″W	09/17/19	117
North Padre Island	NP	27°34′39.20″N	97°13′21.06″W	02/17/19	113

were lightly colored, including transparent, white and yellow (due to aging rather than pre-production), whereas only a few nurdles from the Galveston site were dark-colored, including black, red, green, and blue. Of the lightly colored ones, nurdles with yellowness index ≥40% or surface corrosion area ≥ 50% were categorized as heavily weathered (Ogata et al., 2009), whereas the remaining nurdles were classified as lightly weathered.

Of the light-colored nurdles selected from the Galveston site, 4 lightly- and 4 heavily-weathered ones were analyzed with a Low-Vacuum Scanning Electron Microscope (SEM, JELO6490, JELO) to obtain submicron-scale images before further chemical analyses.

To analyze POPs, nurdles from each site were selected to form 5 subsamples, each with 20 nurdles, based on their weathering status. For the dark-colored nurdles at Galveston site, only 8 out of 40 were surface corroded, thus their weathering degree was not evaluated; instead, the 40 nurdles were divided into two subsamples, 20 black and 20 dark-colored. The polymeric types of these 40 nurdles were further identified by FTIR (Fig. S1).

2.3. Pollutants extraction and purification

PAHs and PCBs on nurdles were analyzed following the method described in Zhang et al. (2015), with modifications. Briefly, each nurdle subsample was incubated with 20 mL dichloromethane (DCM, spiked with 10 μL surrogate standards including deuterated phenanthrene, or phe-d_{10}, for PAHs and PCB-204 for PCBs), and extracted in an ultrasonic bath for 30 min. The extraction was repeated three times and extracts were combined. The combined extract was concentrated with a mild flow of nitrogen stream, purified on column (packed with active silica gel with 1 cm sodium sulfate layer on the top), and eluted with hexane and hexane/DCM (1:1, V: V). Both elution fluids were collected and concentrated to 1 mL with a mild flow of nitrogen stream, and stored at 4 °C before further analysis.

All solvents (hexane, acetone, and DCM) were purchased from Fisher Scientific in Optima grade. The silica gel and sodium sulfate were purchased from Thermo Fisher Scientific in chromatographic grade.

2.4. Bioaccessibility of pollutants associated with nurdles

Bioaccessible pollutants on nurdles were measured using a simulated gut fluid incubation experiment. Briefly, triplicate samples of lightly or heavily weathered nurdles from the Galveston site were incubated in simulated gut fluid according to Voparil and Mayer (2000) and Mohamed Nor and Koelmans (2019), and extracted according to the protocol described in Section 2.3. Each sample (20 nurdles) was transferred to 100 mL simulated gut fluid in a 150 mL amber jar. The simulated gut fluid contained 10 mM of sodium taurocholate and 5.0 g/L of bovine serum albumin in filtered seawater (filtered with 0.7 μm GF/F Whatman glass microfiber filters). The pH of the fluid was adjusted to 4.0 using 1 M HCl, to simulate the acidic gut environment. The final salinity of the fluid was 32.3 PSU. All the bottles were placed on a horizontal platform shaker at 70 rpm at 27 °C for 28 days. Afterward, nurdles were taken out with solvent-rinsed metal forceps and extracted with the method described in Section 2.3. The remaining solutions were spiked with phe-d_{10} and PCB-204, and serially extracted with 25 mL DCM in an ultrasonic bath for 30 min for 3 times. The extracts were combined, concentrated, and purified following the method described in Section 2.3. The pollutants were quantified using gas chromatograph/mass spectrometer (GC/MS, detail later). The bioaccessible fraction refers to those pollutants that remained in the simulated gut fluid solution after the incubation, and the total pollutant concentration was calculated by adding the bioaccessible fraction to POPs remaining on nurdles post-incubation.

2.5. Instrumental analysis

The chemical concentrations (ng/g nurdle dry weight) of 16 priority PAHs listed by the US EPA (ATSDR, 2007) and 7 PCB congeners were measured, including naphthalene (Nap), acenaphthene (Ace), acenaphthylene (Acy), fluorene (Fl), phenanthrene (Phe), anthracene (An), fluoranthene (Flua), pyrene (Pyr), benzo[*a*]anthracene (BaA), chrysene (Chr), benzo[*b*]fluoranthene (BbF), benzo[*k,j*]fluoranthene (BkF), benzo[*a*]pyrene (BaP), indeno[1-3]pyrene (InP), dibenzo[*a,h*]anthracene (DBA), and benzo[*ghi*]perylene (BgP), PCB-28, PCB-52, PCB-101, PCB-153, PCB-138, PCB-180 and PCB-209.

PAHs and PCBs were analyzed on a GC/MS (QP2010 plus, Shimadzu) equipped with an RXi-1MS capillary column (20 m × 0.18 mm i.d., film thickness 0.18 μm), with helium as the carrier gas at a flow rate of 0.8 mL min^{-1}, and selective ion monitoring mode. The measurement of PAHs followed the method of Wang et al. (2014) with some modifications. Briefly, 1 μL of the solution was injected with a split ratio of 1/20. The oven temperature was held at 60 °C for 1 min, increased to 240 °C at a rate of 10 °C min^{-1}, and then increased to 280 °C at a rate of 4 °C min^{-1} and held for 3 min. For PCBs, 2 μL of the solution was injected with a split ratio of 1/10. The oven temperature was increased from 50 °C to 320 °C at a rate of 5 °C min^{-1}, and held for 10 min.

2.6. Statistical and graphical analyses

Vigorous quality controls were implemented to ensure the correct identification and accurate quantification of the target compounds. All glassware was combusted at 450 °C for 2 h before use, and other wares were thoroughly rinsed with hexane and DCM before use. Two empty glass vials as blanks for each sampling site were analyzed following the same procedures, and the results showed that all the targeted compounds were below detection limit. The method's detection limit (MDL) was 10 times of the standard deviation of the minimum standard solution. The MDLs were 0.3 ng/ g for PAHs and 0.5 ng/ g for PCBs. The average recovery rates for phe-d_{10} and PCB-204 were 91.3 ± 7.3% and 86.1 ± 6.0%, respectively.

To be consistent with other studies (Ogata et al., 2009; Zhang et al., 2015), median values for the concentration of analyzed pollutants were reported. The ratios of selected PAH isomers were calculated to identify the source of PAHs according to Budzinski et al. (1997).

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3. Results

3.1. Characterization and weathering degree of the nurdles

We randomly selected 320 nurdles collected at all sites from Texas coasts to determine the polymer type. Based on the FTIR results, 58 nurdles (18.1%) were made of polypropylene (PP), and the rest 262 (81.9%) were polyethylene (PE) (Figs. 2A and B; S2). From the weathering index, PE nurdles were both lightly and heavily weathered (Section 2.2), whereas the PP nurdles were only lightly weathered.

In addition to the weathering index (Section 2.2), the surface of several selected nurdles was imaged by SEM. The morphology of lightly and heavily weathered nurdles differed greatly. There were more mechanically eroded cracks and grooves on the surface of heavily weathered nurdles than lightly weathered ones (Fig. 2C and D). In addition, based on the FTIR spectra of the PE nurdles, we observed new absorption peaks at 1500–1800 cm^{-1}, representing ester carbonyl (-COO-) and ketone (C=O) groups (Fig. 2A); these peaks were likely produced as a result of weathering (Waldman and De Paoli, 1998; Fotopoulou and Karapanagioti, 2012).

3.2. Total concentrations of PAHs associated with nurdles

PAHs were detected on nurdles from all sampling sites. The total concentrations of PAHs (∑−16 PAHs) at individual sites varied up to 5 orders of magnitude, ranging from 1.6 to 14,699.8 ng/g-nurdle (Fig. 3A). The median concentrations of ∑−16 PAHs on nurdles from different sites were listed in Table 2. The highest concentrations of ∑−16 PAHs were found at two sites, with median and maximum concentrations of 937.5 and 14,699.8 ng/g-nurdle at GA, and 2008.5 and 5041.5 ng/g-nurdle at PA-1 (Table 2; Fig. 3A). The NP site, which is the least populated, showed the lowest PAH concentration (20.4 ng/g-nurdle for median concentration, Table 2). In addition, heavily weathered nurdles tended to accumulate more PAHs than lightly weathered ones (Fig. 3A).

High molecular weight PAHs (4–6 benzene rings) were the dominant ones from all sampling sites, with their proportions ranging from 64% to 94% of the total PAHs (Fig. S3). In contrast, the two- and three-ring PAHs represented a small fraction of the total and were undetectable in some samples. In regard to weathering, lightly weathered nurdles had relatively lower proportions of PAHs of 5–6 rings, while heavily weathered nurdles had relatively lower proportions of PAHs of 2–3 rings (Fig. 4).

3.3. Total concentrations of PCBs associated with nurdles

Different from PAHs, PCBs on nurdles samples were not all detectable. The median concentrations of ∑−7 PCBs at most sites were below the detection limit. But similar to PAHs, the total concentration of PCBs (∑−7 PCBs) varied greatly among the individual sites, ranging from 0 to 642.4 ng/g-nurdle (Fig. 3B). Table 3 showed the maximum concentration of ∑−7 PCBs among the sites. The most dominant PCBs detected were PCB-153 and PCB-138, with detection rates of 40.4% and 42.8% of total PCBs, respectively. Consistent with PAHs, the highest concentration of ∑−7 PCBs was found at the GA site (642.4 ng/g-nurdle). Heavily weathered nurdles also adsorbed more PCBs than lightly weathered ones (Fig. 3B).

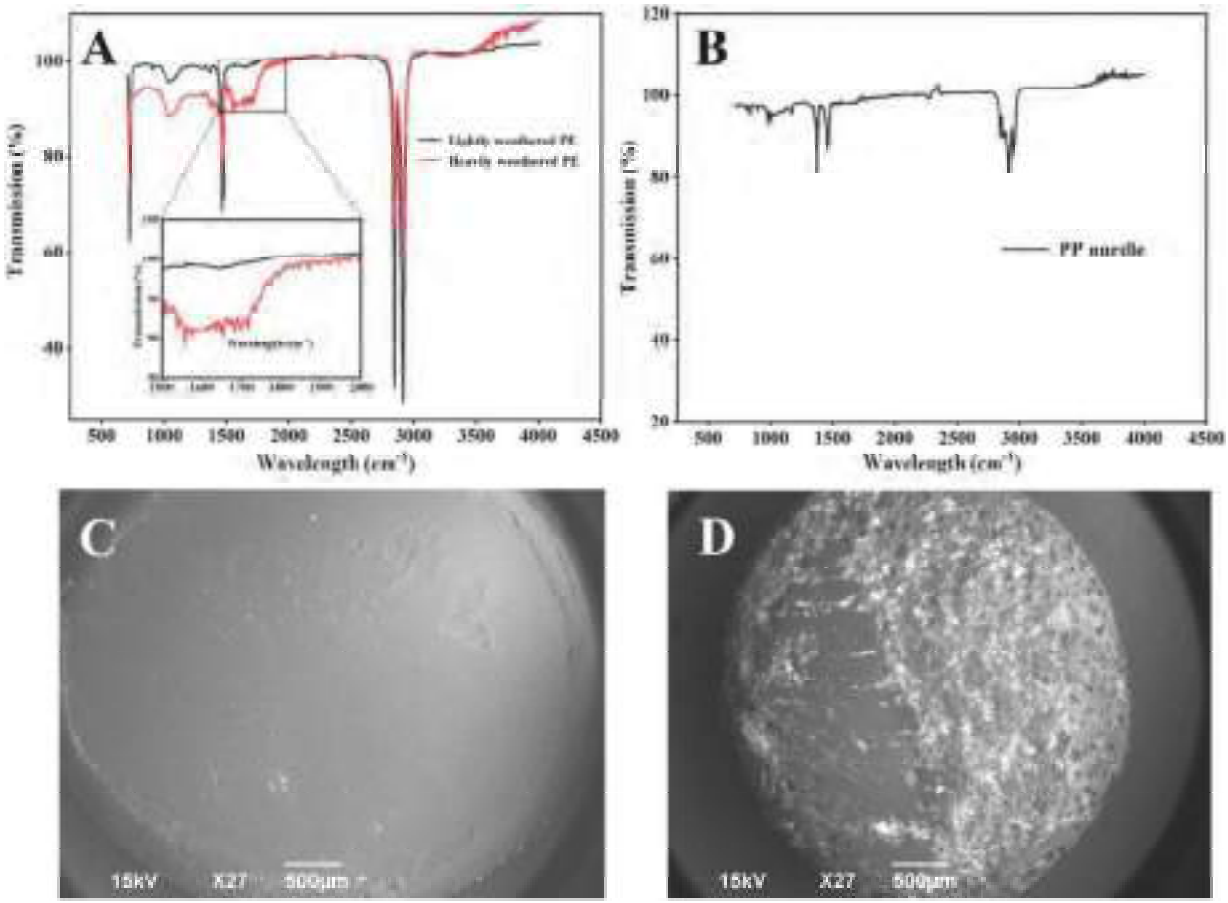

Fig. 2. FTIR spectra of PE-nurdles (A) and PP-nurdle (B) and SEM image of lightly weathered nurdle (C) and heavily weathered nurdle (D).

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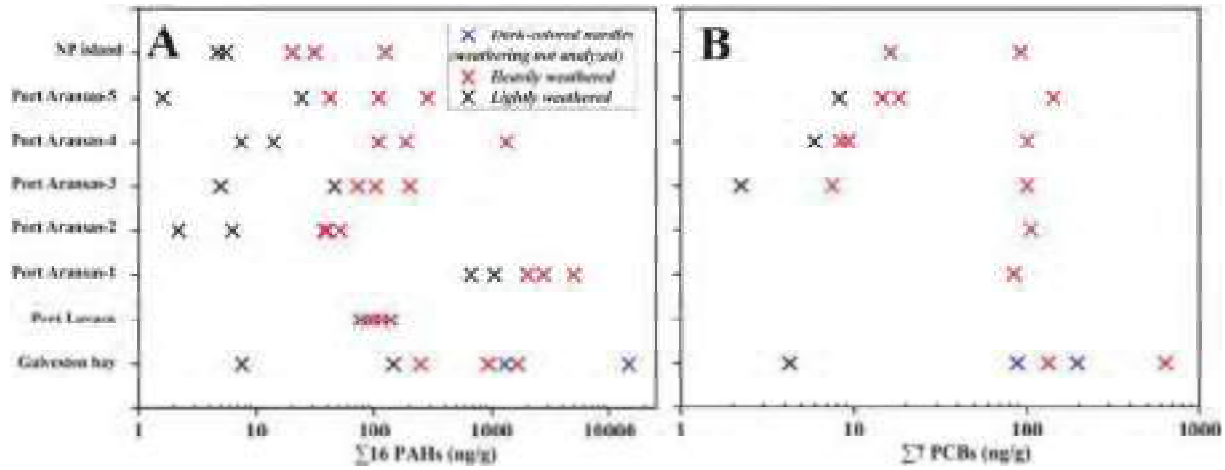

Fig. 3. Total concentration of PAHs (A) and PCBs (B) in nurdles from all the sampling sites. Black crosses: lightly weathered nurdles; red crosses: heavily weathered nurdles; blue crosses: dark-colored nurdles. Each cross represents a sampling subset of 20 nurdles. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 2
Median concentrations of PAHs (ng/g-nurdle) in nurdles from Texas coasts.

	GA	PL	PA-1	PA-2	PA-3	PA-4	PA-5	NP
Naphthalene	3.6	0.1	12.7	0.0	0.0	0.8	0.0	0.0
Acenaphthylene	0.3	2.8	0.2	0.0	0.3	0.0	0.1	0.1
Acenaphthene	0.0	0.4	11.2	1.0	1.0	1.4	0.4	0.0
Fluorene	10.9	1.0	28.6	0.1	0.0	0.1	0.2	0.3
Phenanthrene	79.2	11.1	276.1	0.0	8.4	0.9	6.4	1.2
Anthracene	8.7	0.7	28.5	0.0	0.3	1.6	5.0	0.3
Fluoranthene	215.3	20.7	1046.9	0.3	1.6	1.9	0.4	0.4
Pyrene	171.6	3.2	499.7	0.1	1.8	1.7	0.1	0.3
Benz[*a*]anthracene	134.3	11.0	43.0	3.0	1.5	8.9	1.7	2.7
Chrysene	4.8	10.1	28.6	2.7	1.4	2.0	1.5	1.4
Benzo[*b*]fluoranthene	34.3	4.6	57.0	0.0	0.1	4.9	3.8	1.9
Benzo[*k*]fluoranthene	13.3	4.6	57.0	0.0	0.4	7.7	3.8	1.9
Benzo[*a*]pyrene	22.2	1.5	3.1	0.3	0.7	0.6	0.0	0.0
Indeno[1,2,3-*cd*]fluoranthene	1.9	6.3	2.1	0.0	0.1	1.4	3.7	1.7
Dibenz[*a*,*h*]anthracene	0.6	2.6	0.0	0.0	0.7	0.0	0.2	0.0
Benzo[*ghi*]perylene	8.9	1.2	0.6	0.0	0.1	0.0	0.4	0.0
∑−16 PAHs	937.5	100.4	2008.5	38.0	72.3	110.1	42.3	20.4

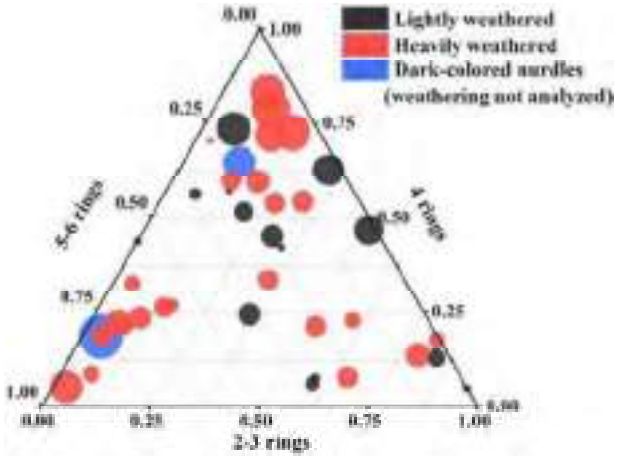

Fig. 4. Ternary plot of PAHs composition. Diameters of sample circles were normalized by the natural logarithm of total PAHs concentration at each site.

3.4. Bioaccessibility of pollutants associated with nurdles

Bioaccessibility is defined as the total amount of a given contaminant that is released from its matrix in the gastrointestinal tract of an organism, which may enter the circulatory system by absorption (Kramer and Ryan, 2000; Hale et al., 2012). For PAHs, after 4 weeks of incubation, the ∑−16 PAHs concentrations on heavily weathered nurdles were higher than those on lightly weathered ones (*t*-test, $P = 0.003$), with concentrations of 149.2 ± 14.6 and 86.2 ± 18.3 ng/g-nurdle for heavily and lightly weathered nurdles, respectively (Fig. 5A). The bioaccessible proportions of PAHs accounted for 13.1 ± 2.3% of the total PAHs in lightly weathered nurdles (10.4 ± 0.3 ng/g-nurdle), which was higher than those of heavily weathered nurdles (5.3 ± 0.1% of the total PAHs, 7.8 ± 0.3 ng/g-nurdle, Fig. 5A; *t*-test, $P = 0.007$). The types of bioaccessible PAHs also differed between lightly and heavily weathered nurdles. In the lightly weathered nurdles, bioaccessible PAHs were

Table 3
Maximum concentrations of PCBs (ng/g-nurdle) in nurdles from Texas coasts.

	GA	PL	PA-1	PA-2	PA-3	PA-4	PA-5	NP
PCB 28	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PCB 52	23.5	0.0	0.0	0.7	0.5	0.0	1.0	0.0
PCB 101	20.0	0.0	0.0	3.9	0.0	0.0	6.2	0.0
PCB 153	176.7	0.0	1.1	3.6	2.2	3.6	23.2	2.7
PCB 138	129.5	0.0	5.7	3.2	5.3	5.7	12.4	12.7
PCB 180	155.4	0.0	0.0	0.0	0.0	0.0	19.5	1.0
PCB 209	136.3	0.0	77.4	94.7	101.0	94.7	85.1	91.9
∑−7 PCBs	642.4	0.0	84.3	106.1	101.0	101.3	143.2	91.9

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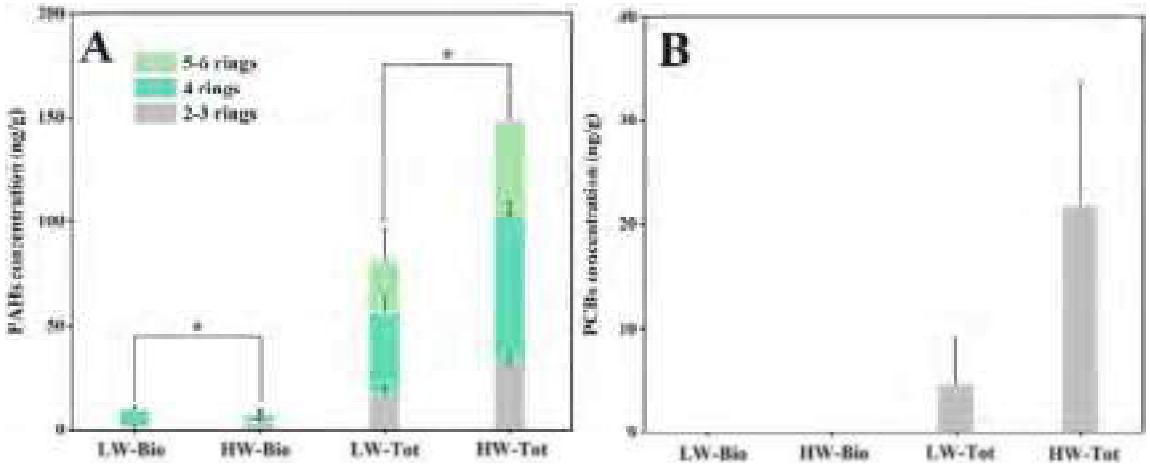

Fig. 5. Concentrations of bioaccessible and total PAHs (A) and PCBs (B) in different nurdles from the Galveston site. LW- Bio: bioaccessible pollutants of lightly weathered nurdles; HW- Bio: bioaccessible pollutants of heavily weathered nurdles; LW-Tot: total pollutants of lightly weathered nurdles; HW-Tot: total pollutants of heavily weathered nurdles. Data are the averages of three individual experiments; error bars represent the standard deviations. Asterisks indicate significant differences between two groups.

dominated by PAHs of 4–6 rings (84.0%), whereas in the heavily weathered nurdles, bioaccessible PAHs were consisted of PAHs of 3 rings and 4–6 rings (49.6% and 50.4%, respectively, Fig. 5A).

However, no bioaccessible PCBs were detected (Fig. 5B). The $\sum$−7 PCBs concentrations on both lightly and heavily weathered nurdles were 4.8 ± 4.4 and 21.8 ± 11.7 ng/g-nurdle, respectively (Fig. 5B). Consistent with PAHs, heavily weathered nurdles accumulated more PCBs than lightly weathered ones.

4. Discussion

4.1. Concentrations and sources of PAHs and PCBs on nurdles

PAHs and PCBs were detected on nurdles collected along the Texas coast, with large variations in concentrations between sampling sites and individual groups. This variability is consistent with previous studies (Frias et al., 2010; Antunes et al., 2013; Zhang et al., 2015; Chen et al., 2018). The large concentration variations may be attributed to several factors: polymer type (Mato et al., 2002), slow sorption time of hydrophobic organic pollutants (Mato et al., 2002), different adjacent environments (Zhang et al., 2015), and different residence times of the nurdles in the environment (Endo et al., 2005).

Concentrations of PAHs at sites GA and PA-1 were higher than those at other sites in this work (Fig. 3A) and other reports of open ocean nurdles. For example, Zhang et al. (2015) reported 136–2384 ng/g of PAHs on nurdles from 2 beaches in China, and Chen et al. (2018) reported 62–102 ng/g of PAHs on nurdles from open ocean. The high contaminant concentrations at sites GA and PA-1 could be attributed to the density of anthropogenic activities there. The abundant oil and gas industries near GA, such as crude oil refineries and dense transportations (Overton et al., 2004), increase the potential release of oil-related pollutants. There are also many small oil spills, such as the 2014 Texas City Y spill at Galveston ship channel (Bacosa et al., 2016), which could contribute to the observed high contaminant concentrations. In addition, the high flow of visitors to the popular ocean-view scenic spots along Texas coasts (Legislative budget board staff, 2019, https://www.lbb.state.tx.us), increases the release of fuel-burning, a major source of incomplete combustion PAH products. The maximum concentration of PAHs was found on the dark-colored nurdles (mainly black) from the GA site (Fig. S1 for example). Consistent with these results, Antunes et al. (2013) found that black nurdles tend to have high concentrations of PAHs and PCBs, which may be related to their chemical composition. Although the black nurdles are made of PE, they may also have durable polyurethane components to extend the product lifetimes, which has a high sorption capacity for organic pollutants (Zia et al., 2007).

The composition of PAHs has been commonly used to indicate the source of PAHs, distinguishing petrogenic sources (e.g., oil spills) from pyrogenic sources (e.g., vehicle exhaust and incomplete combustion; Budzinski et al., 1997). Generally, low molecular weight PAHs with 2–3 rings are derived from petrogenic sources and high molecular weight PAHs with 4–6 rings are from pyrogenic sources. In our study, PAHs on nurdles at all sites were dominated by high molecular weight PAHs (Figs. 4 and S3), which suggested that combustion of fossil fuel was the primary source of PAHs on nurdles. However, the composition of PAHs on nurdles was different from the composition of PAHs in sediments in this area (Liu et al., 2011), suggesting that nurdles sorb PAHs selectively, which is consistent with laboratory plastic adsorption experiment (Guo et al., 2012; Endo and Koelmans, 2016). High molecular weight PAHs, which are more hydrophobic, are adsorbed more easily by hydrophobic plastics. The different PAH compositions of lightly and heavily weathered nurdles also underscore the potential selectivity of PAHs on nurdles (Fig. 4).

The ratios of specific individual PAHs can also be used as source indicators. For example, an Ant/(Ant + Phe) ratio greater than 0.1 or Flu/(Flu + Pyr) ratio greater than 0.4 indicates that the PAHs are derived from combustion source, whereas an Ant/ (Ant + Phe) ratio less than 0.1 or Flu/(Flu + Pyr) ratio less than 0.4 indicates an oil/petroleum source (Budzinski et al., 1997; Yunker et al., 2002). Our results showed that only 1 subsample had Ant/(Ant + Phe) ratio less than 0.1 and Flu/(Flu + Pyr) ratio less than 0.4, whereas the others had the Ant/(Ant + Phe) ratio greater than 0.1 or Flu/(Flu + Pyr) ratio greater than 0.4. This pattern suggested that the dominant source of PAHs on nurdles was incomplete combustion of fossil fuels (Fig. S4).

The bioaccessibility of PAHs (5–13%, Fig. 5A) on either lightly or heavily weathered nurdles were up to 2 orders of magnitude greater than those reported for coastal sediments (0.02–0.06%, Wang et al., 2014). Structural and compositional differences between plastic and sediments may affect the bioaccessibility of sorbed pollutants. The strong sorption ability (both physical and chemical) of sedimentary organic matter for hydrophobic pollutants, as well as the abundant micropore (<2 nm) structures in sediments (Liu and Lee, 2006; Cheng et al., 2012), may explain the low bioaccessibility of PAHs in sediments (Ehlers and Luthy, 2003). In comparison, PAHs are sorbed to the surface of plastics by weaker hydrophobic forces (G. Liu et al., 2019). There may be a lower abundance of micropore structures on nurdles compared with sediments, thus leading to the greater bioaccessibility of PAHs on

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nurdles. Consequently, once these pollutants-associated nurdles are ingested by marine organisms, the pollutants may be more easily released or leached to the gastrointestinal environment of organisms, potentially causing acute and chronic toxic effects. Overall, the high PAH concentrations and high bioaccessibility, when compared to PAHs associated with sediments using a same gut fluid mimic (Wang et al., 2014), indicated a potential risk of the associated PAHs on nurdles to marine organisms. Further exposure studies are needed to evaluate the effects.

High concentrations of PCBs were detected on nurdles at the GA site. Apart from the aforementioned black nurdles (dark-colored nurdles), historically heavy PCB contamination in sediments of Galveston Bay could also be a source of PCBs on nurdles (Howell et al., 2008). Consistent with other studies in this region, the dominant congeners of PCBs were 138 and 153 (Antunes et al., 2013; Zhang et al., 2015). For sites except for GA, concentrations of PCBs on nurdles (0–143 ng/g) were slightly lower than those previously reported. For example, the PCB concentrations on nurdles from the west coasts of the USA were in the range of 48–605 ng/g (Ogata et al., 2009). Zhang et al. (2015) also reported PCBs in the range of 22–323 ng/g on nurdles from the beaches in China. Note that only the selected 7 PCB congeners were measured in our study, compared to 13–20 PCBs congeners reported in other studies (Ogata et al., 2009; Zhang et al., 2015), thus the PCBs measured in this work are generally in a lower level than other reports. Nevertheless, the relatively high concentrations of PCBs on nurdles from this work suggested that their potential risk could not be ignored. In addition, Ogata et al. (2009) demonstrated a positive correlation between PCBs concentrations on nurdles and those in nearby mussels, thus the occurrence of high PCBs concentration on the GA nurdles suggests ecotoxicological risk to organisms in the adjacent environment.

4.2. Effects of weathering on nurdles

The weathering of nurdles is commonly observed in field samples, as their color and surface property change with aging (Turner and Holmes, 2011; Fotopoulou and Karapanagioti, 2012). In our study, the "yellowing" of nurdles was observed (Fig. S1), and the weathering was also reflected from the new absorption peaks occurred in the FTIR spectra (Fig. 2A). These data all indicated that these nurdles have undergone different degrees of photo-oxidative weathering. During solar radiation, some plastic additives may quench free radicals produced by ultraviolet light (UV) exposure, leading to a series of photochemical reactions. For example, phenolic antioxidants cause the generation of quinonoidal types of structures, which lead to the nurdle yellowing (Endo et al., 2005). Meanwhile, solar irradiation also contributes to the generation of oxygen-containing functional groups. Consistent with our data, Gulmine et al. (2003) detected C═O stretching (ketone groups) at 1710 cm^{-1} in PE after exposure to UV light (0.35 ± 0.03 W/m^2 at 340 nm). Yang et al. (2005) also observed the appearance of ester group in 1740 cm^{-1} in low-density PE after exposure to UV light. Thus, the relative abundance of carbonyl groups and hydroperoxide groups may be related to the degree of plastic discoloration and the extent of weathering (Turner and Holmes, 2011; Brandon et al., 2016). Interestingly, similar to our study, Fotopoulou and Karapanagioti (2012) observed that PP nurdles collected from the field did not show a strong signal of functional group generation although the nurdle surface was clearly eroded. These contrasting patterns may indicate different weathering pathways for PE and PP nurdles, and further studies are needed to differentiate the rates and pathways of weathering for PE and PP.

The weathering of plastics due to mechanical forces has also been consistently evaluated in field samples. Our SEM results showed that heavily weathered nurdles exhibited a high extent of cracks and micropores on the surface (Fig. 2C and D). Likewise, scratches, creases, grooves, micropores, and cracks are often observed in plastic marine debris as a result of physical friction and mechanical forces (Fotopoulou and Karapanagioti, 2012; Wang et al., 2017; Zhou et al., 2018). This mechanical weathering tends to increase the surface area to volume ratios and the abundance of micropores (<2 nm) on the surface of plastics (Cheng et al., 2012). For example, Fotopoulou and Karapanagioti (2012) found that the specific surface area of eroded PE and PP nurdles was much higher than that of virgin nurdles, and that this trend was particularly pronounced for eroded PP nurdles. J. Liu et al. (2019) also discovered the increase of surface area and micropore volume of laboratory UV/O_3 treated polystyrene particles.

4.3. Effects of weathering on pollutants associated with nurdles

Weathering alters the physicochemical properties of plastics and may affect their sorption capability for pollutants. The sorption mechanisms of pollutants on plastic mainly include partition, hydrogen bonding, π-π bonding, and electrostatic attraction (G. Liu et al., 2019). Since PAHs and PCBs are highly hydrophobic, without aromatic structures in the plastic polymer chain that is key to π-π bonding, the dominant adsorption mechanism is likely to be physical adsorption, such as hydrophobic interaction and van der Waals forces. Heavily weathered nurdles, with higher specific surface area and increased micropore structures, may have high adsorption capacity for hydrophobic organic pollutants through physical adsorption and hydrophobic-effect-driven micropore filling (Wu and Gschwend, 1988). The change of crystallinity fraction could also contribute to the sorption. According to Andrady (2017), higher crystallinities in semi-crystallized plastics such as PE and PP results in a lower adsorption capacity of POPs. During the later stage of weathering, crosslinking due to oxidation may decrease the crystalline fraction of the plastic (Andrady, 2017), thus increasing the sorption potential. In our study, the eroded surface and brittle nature of heavily weathered nurdles indicate an increase in the amorphous area (and a decrease in the crystalline fraction), which may explain the higher concentrations of pollutants observed. Previous studies have demonstrated this enhanced adsorption of pollutants on aged than virgin plastics (J. Liu et al., 2019; P. Liu et al., 2019; P. Liu et al., 2020). It was also reported that discolored plastic pellets, presumably highly weathered, had higher concentrations of PCBs (Endo et al., 2005).

Knowing the bioaccessible fraction of sorbed pollutants on nurdle surface is critical for evaluating the mobility of the pollutants and risks to organisms. Our results showed that the bioaccessible fraction of PAHs was much lower in the heavily weathered nurdles than those lightly weathered ones. Slow desorption kinetics or irreversible adsorption of nonpolar/weak polar pollutants in plastics may be the reason for this pattern (Valsaraj and Thibodeaux, 1999; Liu et al., 2018). Two possible mechanisms have been proposed: the physical entrapment of POPs within glassy (highly crystallized) polystyrene plastic inner matrices, and the slower diffusion rate of pollutants from the micropore matrices (Valsaraj and Thibodeaux, 1999; Liu et al., 2018). We speculate that the latter mechanism may better explain our results, as the weathering of nurdles at an early stage may create more micropores and increase crystallinity due to chain scission, forming complex structure on the nurdle surface to sorb weak polar PAHs. These structures can entrap these pollutants and make them difficult to desorb, thus explaining a lower bioaccessibility of pollutants in heavily weathered nurdles. Yet, we did not observe any bioaccessible of PCBs. A related study reported that 14–42% of sorbed PCBs on low density-PE strips were bioaccessible (Mohamed Nor and Koelmans, 2019). The major difference between this study and ours is the plastic weathering degree. Although the polymer type of plastic in both studies was PE, the PE strips used by Mohamed Nor and Koelmans (2019) were cut from commercially available zipper bags, which are more pristine. In contrast, the nurdles (sizes of mm) obtained in this study have undergone more extensive weathering, resulting in tight sorption of PCBs. PCBs have larger structures than PAHs with the same number of benzene rings due to the larger size of chlorine atom (Li et al., 2019); this can make the micropore entrapment effect stronger on the nurdle surface, inhibiting the desorption of large-sized PCBs. In addition, the field-collected nurdles may have biofilms

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and/or organic matter stranded on the microstructures, which may bind with, or seal, the PCBs more tightly, making it hard from them to desorb. The exact mechanism for the irreversible sorption of PCBs warrants further work.

Overall, the weathering of plastic increased the sorption of hydrophobic organic pollutants on nurdles, but decreased the bioaccessibility of PAHs. However, we only monitored nonpolar and weak-polar pollutants, not the polar and hydrophilic ones such as some pharmaceuticals and personal care products. Weathering induces oxygen-containing functional groups on plastics, and these polar groups may be particularly important in controlling the sorption/desorption of polar and hydrophilic pollutants (Liu et al., 2018; P. Liu et al., 2019; Yu et al., 2020).

5. Conclusion

In this study we investigated the polymer type, weathering status, and concentrations of associated PAHs and PCBs on nurdles collected from Texas shorelines. The nurdles were predominantly PE, followed by PP. The levels of pollutants on nurdles varied greatly depending on collection site, which may be related to the contamination levels of the surrounding environment. In addition, PAHs showed a relatively higher bioaccessibility in a gut fluid mimic, while PCBs on nurdles were not bioaccessible at all. Our results also showed that weathering strongly increased the sorption of pollutants on nurdles but decreased their bioaccessibility. Considering that nurdles may have different weathering degrees and encounter various pollutants in environments, the sorbed pollutants may have different bioaccessibilities according to their affinities to hydrophobic surfaces. Our results demonstrate that just measuring total concentrations of pollutants on nurdles may not be sufficient to evaluate the chemical risk of nurdles accurately, and it is critical to also quantify their bioaccessibility.

CRediT authorship contribution statement

XJ: designed the experiment, collected the samples, conducted the analysis, analyzed the data, and wrote the manuscript;

KL: conducted the analysis and wrote the manuscript;

JWT: collected the samples and wrote the manuscript;

ZL: designed the experiment, analyzed the data and wrote the manuscript.

Declaration of competing interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.marpolbul.2021.112592.

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Colonisation of plastic pellets (nurdles) by *E. coli* at public bathing beaches

Alyssa Rodrigues, David M. Oliver, Amy McCarron, Richard S. Quilliam*

Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling, Stirling FK9 4LA, UK

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ABSTRACT

The hard surface of waterborne plastic provides an ideal environment for the formation of biofilm by opportunistic microbial colonisers, and could facilitate a novel means of dispersal for microorganisms across coastal and marine environments. Biofilms that colonise the so-called 'plastisphere' could also be a reservoir for faecal indicator organisms (FIOs), such as *Escherichia coli*, or pathogenic bacteria such as species of *Vibrio*. Therefore, the aim of this study was to map the spatial distribution of beach-cast plastic resin pellets (nurdles) at five public bathing beaches, and quantify their colonisation by *E. coli* and *Vibrio* spp. Nurdles were heterogeneously distributed along the high tide mark at all five beaches, and each beach contained nurdles that were colonised by *E. coli* and *Vibrio* spp. Knowledge of *E. coli* colonisation and persistence on nurdles should now be used to inform coastal managers about the additional risks associated with plastic debris.

1. Introduction

The most abundant form of litter in the marine environment is plastic, which due to its buoyant and persistent characteristics can provide an ideal environment for the formation of biofilm by opportunistic microbial colonisers. The interface between the plastic surface and the environment has been termed the 'Plastisphere' (Zettler et al., 2013), and such biofilm formation on marine plastics could provide plastisphere communities with a niche for protection from harmful UV irradiance and predation.

One of the most common types of plastic in the marine environment are virgin plastic resin pellets (or nurdles), a disc shaped plastic particle, typically 3–5 mm diameter, used as the raw material in the production of many thermally moulded plastic products. Nurdles can be accidentally released into the environment, and commonly enter marine systems through ship spills, road runoff, inland waterways, or wind transfer (Boucher and Friot, 2017). Once in the marine environment, nurdles can be deposited in coastal areas via winds, surface currents, and tides (Karkanorachaki et al., 2018), with the potential to be dispersed over long distances (Karlsson et al., 2018). Therefore, nurdles could act as a significant vector for hitchhiking microbes, and facilitate subsequent transport to beaches, bathing waters and shellfish harvesting waters (Keswani et al., 2016).

In Europe, the Bathing Water Directive (BWD), 2006/7/EC, uses faecal indicator organisms (FIOs), such as *Escherichia coli*, as the key monitoring parameter for regulating compliance of microbial water quality. However, whilst plastic litter in bathing water can influence the survival of *E. coli* (Quilliam et al., 2014), its ability to bind to, and persist in, the plastisphere of marine plastic debris is currently unknown. Thus, an improved understanding of the potential for nurdles to facilitate the survival of FIOs and human microbial pathogens (e.g. species of *Vibrio*), and thus increase human exposure routes by providing a vehicle for dispersal around coastal waters, is clearly an area of marine environmental pollution research that needs urgent investigation. Therefore, the aim of this study was to test the hypothesis that nurdles deposited on bathing beaches can act as a vector for *E. coli* persistence at public bathing beaches.

2. Methods

Nurdles were collected from five EU designated bathing beaches (Fig. 1) situated on the Forth Estuary (East Lothian, Scotland, UK), which are approximately 45 km downstream of the industrial town of Grangemouth, and 30 km downstream from the large urban settlement of Edinburgh. North Berwick (Milsey Bay) is the only sampling site in which the bathing water catchment contains both rural and urban land uses; the other four sites are all predominantly rural catchments. Waste water treatment works (WwTW) within the study area are located in the towns of Gullane and North Berwick, final effluent from these WwTW is discharged approximately 1 km off the coast. Combined sewer overflows (CSOs) and emergency overflows (EOs) are also present within the study area.

All field work was performed in the first two months of the Scottish bathing water season (June and July), when tourist numbers are

* Corresponding author.
E-mail address: richard.quilliam@stir.ac.uk (R.S. Quilliam).

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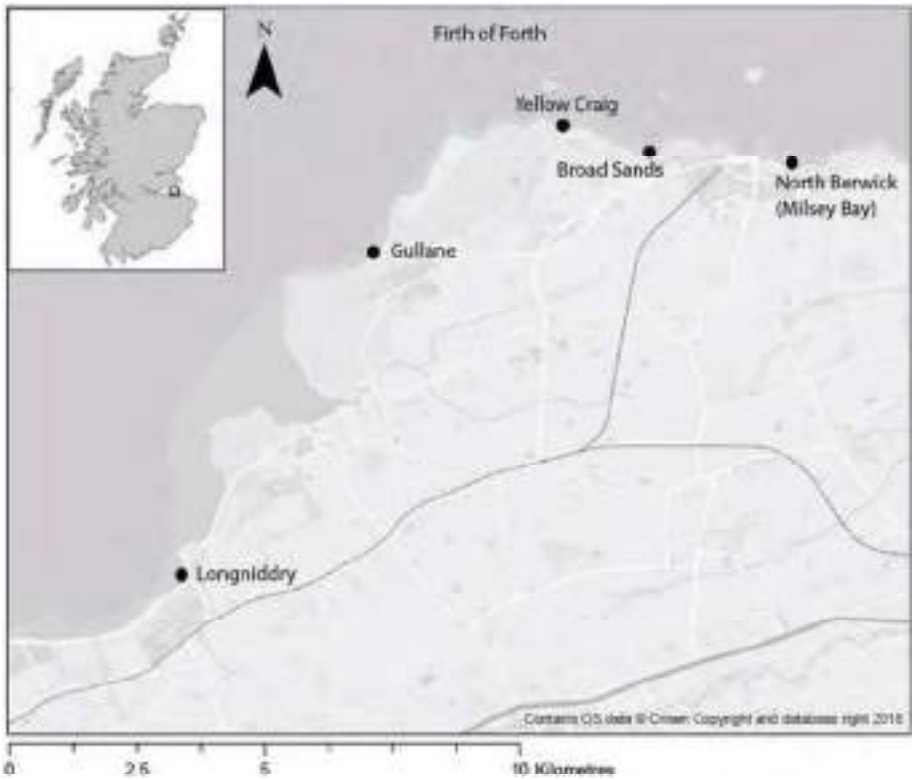

Fig. 1. Spatial locations of the public bathing beaches sampled in this study.

generally at their highest. At each beach, 1 m^2 quadrats were used to sample nurdles in a transect along the high tide line. In areas of higher nurdle density, e.g. areas with seaweed or other organic debris, quadrats were laid more frequently to gain a more focused snapshot of changes in spatial distribution. The top 5 cm of sand within each quadrat was passed through a 2 mm mesh sieve to separate nurdles from sand and other debris. The total number and colour composition of nurdles in each quadrat was recorded, together with the grid reference and distance along the transect. In cases where nurdle counts were in excess of 500 m^{-2}, the number of nurdles was recorded as > 500 m^{-2}. Nurdles from each beach were collected with sterile forceps and a composite sample from each beach transferred to a 50 ml plastic tube wrapped in aluminium foil to avoid exposure to sunlight. All samples were stored at 5 °C and processed within 18 h.

In the laboratory, nurdles were thoroughly rinsed with sterile distilled H_2O, and pre-enriched in LB broth (Fisher Bio-reagents, UK) at 37 °C in a rotating incubator (60 rev min^{-1}) for 18 h, in five individual pseudoreplicate bottles (150–250 nurdles per bottle) per beach. Following the pre-enrichment step, the nurdles were thoroughly rinsed with sterile distilled H_2O to remove any microorganisms not bound within the biofilm and, using sterile forceps, twelve nurdles from each bottle were aseptically placed onto the surface of two different types of selective agar: membrane lactose glucuronide agar (MLGA) for *E. coli*, and thiosulphate citrate bile salts agar (TCBS) (Oxoid, UK) for *Vibrio* spp. Each nurdle was gently pressed into the surface of the agar in order to maximise the possible growth from the biofilm on the surface of the nurdle. All plates were inverted and incubated at 37 °C for 18–24 h. The halos of either *E. coli* or *Vibrio* spp. growing around individual nurdles were enumerated; all plates contained individual nurdles with and without this diagnostic bacterial growth, demonstrating that the pre-enriched media was not acting as an inoculant for uncolonised nurdles, and only those nurdles that were colonised by biofilm at the beach produced bacterial growth on the media.

3. Results and discussion

Plastic nurdles were found at all five public bathing beaches, and were distributed heterogeneously on the sand along the high tide mark (Fig. 2). At each beach, the highest densities of nurdles were found in discrete areas either behind rocks or amongst organic debris and detached seaweeds. The presence of detached seaweed and other debris in these areas may facilitate the settlement of buoyant plastics as the tide goes out (Turner and Holmes, 2011). The direction of prevailing winds and major coastal currents are also key factors influencing the distribution and accumulation of nurdles in coastal zones (Ryan et al., 2018), and beach geomorphology and physical features such as ridges can trap nurdles as the tide retreats (Browne et al., 2015). The dominant winds in Scotland blow from the west to the east, and it is likely that the prevailing winds and dominant eastern currents of the Forth estuary will have played a role in the spatial distribution and accumulation of nurdles at the eastern end of most of these beaches.

Translucent nurdles were the most common colour, although the total colour composition was not significantly different between the beaches (Table 1). The consistency of colour composition suggests that translucent nurdles are produced in higher numbers than other colours, perhaps due to their versatility in the manufacturing process (Turner and Holmes, 2011; Karkanorachaki et al., 2018). Importantly, translucent nurdles are inconspicuous in beach sand and could easily be overlooked, particularly if other organic debris is present. This can pose a challenge, both for accurate quantification and their removal during beach cleaning (Hidalgo-Ruz et al., 2012). The density of nurdles in this study was relatively low compared with previous reports (Ryan et al., 2018); although as these beaches are popular with tourists, it is likely that intensive beach cleaning or mechanical grooming had been undertaken prior to the bathing season. However, as the tides submerge these beaches twice a day, there is the opportunity for the constant addition and removal of beach cast nurdles with the ebb of the tide.

Nurdles colonised by *E. coli* and *Vibrio* spp. were found at all five beaches (Table 2), with high levels of *Vibrio* colonisation (> 75%

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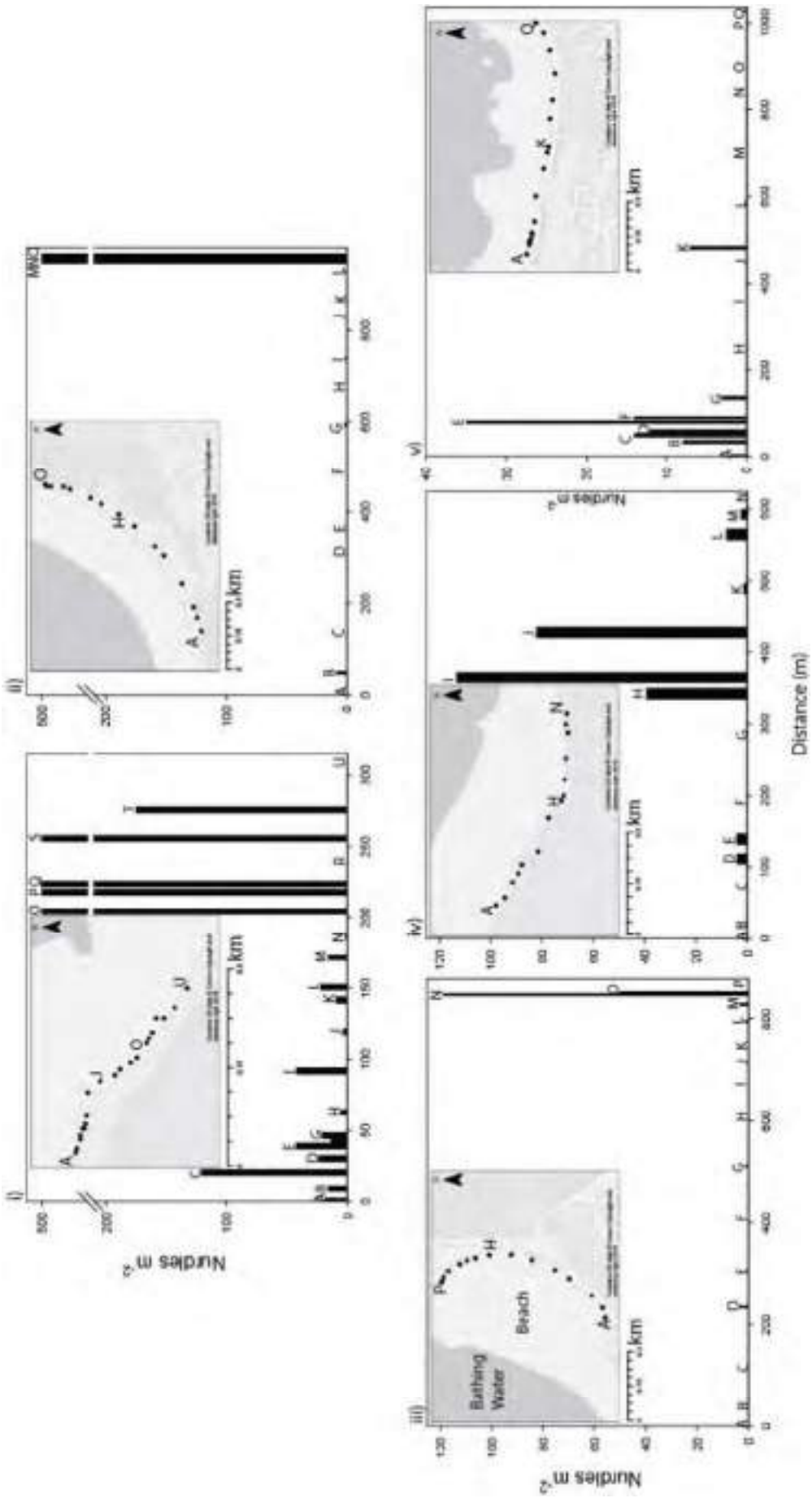

Fig. 2. Spatial distribution of beach-cast nurdles from five UK public bathing beaches: Yellow Craig (i); Gullane (ii); Longniddry (iii); Broad Sands (iv); North Berwick (v). Each map insert shows the quadrat sampling points, which are coupled with the accompanying letters above the bars.

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Table 1
Total colour composition of nurdles collected from five bathing beaches.

	Colour (%)						
	Translucent	White	Black	Yellow	Blue	Green	Other
Broad Sands	93	2	0	3	1	1	0
Gullane	93	1	1	2	1	0	2
Longniddry	87	0	1	6	4	0	2
North Berwick	88	1	4	0	1	0	6
Yellow Craig	92	2	0	3	3	0	0

Table 2
Colonisation of nurdles by *E. coli* and *Vibrio* spp.

	Colonisation (%)	
	E. coli	*Vibrio* spp.
Broad Sands	12	78
Gullane	43	80
Longniddry	15	95
North Berwick	9	82
Yellow Craig	24	50

colonised) at four of the beaches. Colonisation by either *E. coli* or *Vibrio* spp. did not significantly differ between the different coloured nurdles and colonisation by *E. coli* was consistently lower than colonisation by *Vibrio* spp. (Table 2). Plastic nurdles deposited at the high tide mark on beaches could have become colonised by *E. coli* during their time in the sea, or by direct contact at the beach, e.g. by either bird or dog faeces. However, plastic debris can quickly become colonised by biofilm in the environment (Amaral-Zettler et al., 2015), and it is most likely that *E. coli* colonisation occurred in faecally-contaminated seawater, arising from either agricultural run-off or sewage discharge. Microbial colonisation of environmental plastics is influenced by the time the plastic has been in the environment, with those that have been in the environment for longer more likely to come into contact with a diverse range of microorganisms (Kirstein et al., 2018). Furthermore, older, and more degraded plastics often have pits, grooves and scratches on the surface, which increases the surface area for microbial colonisation (Fotopoulou and Karapanagioti, 2012). Most beaches are subject to semidiurnal high tides, and consequently beach cast nurdles can be submerged twice a day. Submergence by potentially contaminated water could promote *E. coli* recruitment into the biofilm and nurdles could then either remain on the beach or be washed back out to sea with the ebb of the tide.

Vibrio spp. are ubiquitous in the marine environment, and the high colonisation of nurdles in this study suggests that *Vibrio* spp. may make up part of the autochthonous biofilm community on the majority of plastics found on beaches. Whilst the culture-dependent methods used here do not differentiate between *Vibrio* spp., potentially pathogenic species (e.g. *V. cholerae*, *V. vulnificus* and *V. parahaemolyticus*) have previously been isolated from plastic debris in coastal and estuarine regions of the North Sea (Kirstein et al., 2016). *Vibrio* spp. are more likely to colonise plastics that already contain a biofilm compared with bare microplastics (Yokota et al., 2017), although whether *E. coli* similarly prefers to bind to an existing biofilm, or whether they can efficiently bind to uncolonised plastic debris remains unknown. The type of plastic, together with seasonal and spatial factors are important for promoting microbial colonisation of plastics in the open ocean (Kirstein et al., 2018), with evidence that bacteria more readily colonise plastics in low nutrient environments (Amaral-Zettler et al., 2015). Subsequently, the longer a nurdle has been in the environment, the higher the chance of it becoming colonised by microbial biofilm and the greater the risk of being colonised by potential pathogens or FIOs prior to it being deposited on beaches.

This under-investigated point of contact between humans and potentially plastic polluted beach sands, could lead to higher exposure rates of the public to reservoirs of potential pathogens and FIOs associated with plastic debris (Keswani et al., 2016). At EU designated bathing waters, improvements could be made to Bathing Water Profiles (BWPs) by detailing beach stranded plastics as a possible source of FIOs and potential pathogens, which are harmful to human health. This could improve beach management strategies for the protection of public health, through increased removal effort, particularly of inconspicuous microplastics such as nurdles, from beach sands at designated bathing waters.

4. Conclusion

There is currently a significant lack of data on the negative implications of marine plastics capable of supporting diverse microbial communities and potentially disseminating FIOs and/or pathogenic microorganisms within the marine and coastal environment. The potential for the wider global dissemination of FIOs and human pathogens by marine plastic debris vectors is further exacerbated by future climate change scenarios, in particular the projected increases in surface water temperature, which could increase the geographical range of new and emerging diseases into coastal and marine environments. Changes in climate are also driving an increased frequency and intensity of coastal inundation, and storm surges could amplify the risk of plastic debris being delivered to the beach environment, particularly during the absence of seasonal beach cleaning by local authorities. Knowledge of *E. coli* colonisation and persistence on nurdles should now be used to inform bathing water managers about the additional risks associated with plastic debris and allow appropriate regulations to be implemented to help reduce the risks of illness from contact with nurdles at public beaches.

Acknowledgements

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First evidence of microplastic "nurdle" consumption by fish in south-eastern Australia

Jeremy K. Day [a,*], Daniel S. Swadling [b], Megan J. Huggett [a], Troy F. Gaston [a]

[a] School of Environmental and Life Sciences, University of Newcastle, NSW 2258, Australia
[b] Fisheries Research, Port Stephens Fisheries Institute, NSW Department of Primary Industries, Taylors Beach, NSW 2316, Australia

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ABSTRACT

"Nurdles" are small, spherical pellets used in plastic manufacturing which can pollute waterways and there are increasing reports of nurdle ingestion by fishes worldwide. We investigated nurdle occurrence for two ecologically and economically important species with differing diets, *Chrysophrys auratus* (pink snapper) and *Achoerodus viridis* (blue groper) in south-eastern Australia. Gut contents of 111 *C. auratus* revealed 8.1 % (nine individuals) ingested nurdles, while there were no nurdles within 39 *A. viridis*. Furthermore, larger sized *C. auratus* had a significantly greater likelihood of containing nurdles. This first report of nurdles in fish from south-eastern Australia suggests that consumption varies between and within species. We attribute this to different feeding strategies and suggest *C. auratus* indirectly consume nurdles when foraging in sediments or consuming prey like invertebrates or small fish. Importantly, our study raises the potential for nurdles as a source of microplastics in fishes, highlighting the need for research into potential implications.

Microplastics are a ubiquitous form of pollution in the world's oceans and they are reported to be ingested by a range of marine organisms (Kühn et al., 2015; Forrest and Hindell, 2018; Tunnell et al., 2020). "Nurdles" are small (< 1–5 mm) pellets used in plastic manufacturing and are a type of microplastic increasingly reported in nearshore marine environments and within the guts of marine fauna (Nelms et al., 2018; Adika et al., 2020; Sewwandi et al., 2023). It is estimated that 230,000 tonnes of nurdles enter the world's oceans annually (Spalding et al., 2021) due to accidental spillage during the production process (Schumann et al., 2019; Sewwandi et al., 2023) and when shipping containers go overboard (Sewwandi et al., 2023). Nurdles have the potential to disperse rapidly across the marine environment via wind, waves and ocean currents (Schumann et al., 2019; Strydom et al., 2020) and upon reaching the seafloor they can become buried amongst sediments (Ogbuagu et al., 2022; Perera et al., 2022) and have the potential to impact marine environments at various depths (Duncan et al., 2019; Schumann et al., 2019).

Nurdles are "primary microplastics" meaning they already exist in microplastic form (< 5 mm), while conventional plastics produce "secondary microplastics" as they fragment (Worm et al., 2017; Pham et al., 2021; Wootton et al., 2021). Nurdles can show physical weathering like chips, lines and scratches (Jiang et al., 2021; Perera et al., 2022) and degrade when exposed to sunlight (Sewwandi et al., 2023). They come in various hues and shapes which can make them identifiable after spill incidents (Schumann et al., 2019; Perera et al., 2022; Sewwandi et al., 2023). Major spill incidents have occurred in Durban (South Africa) in 2017 (Strydom et al., 2020), Europe in 2020 (Sewwandi et al., 2023), Sri Lanka in 2021 (Sewwandi et al., 2023), Hong Kong (China) in 2012 (Sewwandi et al., 2023) and in South Australia in 2018 (Dal Santo et al., 2021) and Victoria in 2019 (Sherow, 2022). It has been reported that nurdles have been found in beach sediments in over 50 countries spread across the world (http://www.pelletwatch.org/index.html).

Microplastics can enter marine food webs by either direct or secondary ingestion. Direct ingestion occurs when fishes ingest microplastics accidentally such as inhalation while filter feeding (Ory et al., 2018) or when foraging in contaminated sediments (Wootton et al., 2021). Secondary ingestion occurs when predators eat prey containing microplastics (Nelms et al., 2018; Wootton et al., 2021). Regarding nurdles, the mechanisms for their ingestion remain less understood than microplastics more generally. However, it is likely that direct ingestion occurs given nurdles closely resemble fish eggs and settle in sediments (Nelms et al., 2018; Sewwandi et al., 2023). Moreover, secondary ingestion may also occur as nurdles have recently been found in planktivorous fishes (Adika et al., 2020) and crustaceans including

* Corresponding author.
E-mail address: Jeremy.Day10@uon.edu.au (J.K. Day).

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prawns (Ogunola et al., 2022) and burrowing crabs (Ogbuagu et al., 2022) which are common prey items for fishes (Curley et al., 2013).

Microplastics have been found in hundreds of marine taxa worldwide (Kühn et al., 2015; Tunnell et al., 2020) and can affect all trophic levels (Adika et al., 2020; Ombongi et al., 2021), whereas much fewer studies report incidences of nurdles. For example, nurdles have been found in several species of carnivorous Sparidae and planktivorous Dorosomatidae fishes in West (Adika et al., 2020) and South Africa (Ombongi et al., 2021). Other work reports nurdles in ~ 27 % of dissected *Dosidicus gigas*, an aggressive predatory cephalopod (Braid et al., 2017) and there are also observations of nurdles in sea turtles (Duncan et al., 2019; Choi et al., 2021) and seabirds (Floren and Shugart, 2017). Previous research has suggested that ingesting microplastics such as nurdles affects animal health, as they can carry various pollutants on their surfaces, (Zhang et al., 2015; Jiang et al., 2021) or cause intestinal (Gregory, 2009; Kühn et al., 2015; Jiang et al., 2021) and respiratory blockages (Zheng et al., 2024).

Previous studies have documented microplastics within numerous fish species in south-eastern Australia (Puskic and Coghlan, 2021, Wootton et al., 2021) yet it remains unclear whether nurdles are being ingested by fish in this region. A survey of microplastics in New South Wales (NSW) comprising 876 fish from 140 species reported microplastics to be present in the guts of the planktivores *Atypichthys strigatus* and *Scorpus linolata,* benthic invertivores *Chironemus marmoratus* and *Notolabrus gymnogenis* and herbivore *Prionurus maculatus* (Puskic and Coghlan, 2021). Furthermore, another study observed low abundance of microplastics in fish guts from southern Australia compared to similar global studies and reported the average microplastic load being 0.94 pieces per fish, although this varied between species, locations, diets and habitats (Wootton et al., 2021). However, these studies have not reported nurdles in fish guts, despite spill incidents occurring and nurdles being found in beach sediments in south-eastern Australia (Dal Santo et al., 2021; Sherow, 2022).

In this study, we investigate the incidence of microplastic nurdles in the guts of two sympatric rocky reef fishes *Chysophyrus auratus* (pink snapper) and *Achoerodus viridis* (eastern blue groper) in NSW, Australia. Both *C. auratus* and *A. viridis* make good study species to compare rates of nurdle ingestion because they have markedly different diets and life histories which may affect their potential exposure to nurdles. Specifically, *C. auratus* consumes other fishes and invertebrates, often from soft sediments and reefs (e.g., crustaceans, worms and snails; Godfriaux, 1969; Choat and Kingett, 1982; Curley et al., 2013) and *A. viridis* primarily feeds on emergent invertebrates such as crustaceans, snails and urchins in turf and barrens patches on reefs (Curley et al., 2013; Gillanders, 1995a). Both species show hermaphroditism though they have different life histories, with sex determination for *C. auratus* and *A. viridis* occurring at small (~ 250 mm Total Length [TL], the total length of a fish from nose to fork tip; Choat and Kingett, 1982; Curley et al., 2013) and large (> 400 mm TL) body lengths, respectively (Gillanders 1995b, 1997; Curley et al., 2013). While *C. auratus* is a highly targeted species for commercial and recreational fishers (Stewart et al., 2001; Wortmann et al., 2018) and *A. viridis* is a highly valued recreational fish and key tourist attraction for divers (Lee et al., 2015, 2017), both species are ecologically important predators which contribute to the structure of nearshore rocky reef assemblages (Curley et al., 2013; Lee et al., 2015; Day et al., 2023a). Previous research on commercially caught *C. auratus* reported the species to contain more than one piece of microplastic in their guts on average in southern Australia (Wootton et al., 2021) and microplastics have not been reported in previous gut content analyses from New Zealand (Usmar, 2012). To our knowledge there are no studies that have searched *A. viridis* for microplastics.

The aim of this study was to determine rates of nurdle presence within *C. auratus* and *A. viridis* on rocky reefs from NSW and test whether this differed between species, sex, location and fish length. We predicted that *C. auratus* would have greater rates of nurdle ingestion due to its benthic feeding and affinity for eating small fish and crustaceans compared to *A. viridis* (Curley et al., 2013). We also predicted that larger individuals would have more nurdles in their guts because as *C. auratus* grow they consume larger items such as fish, molluscs and echinoids which may increase their chance of secondary ingestion (Godfriaux, 1969; Usmar, 2012; Curley et al., 2013). Comparatively, a relationship exists between fish length and sex for *A. viridis* with the female fish being much smaller (Curley et al., 2013; Lee et al., 2017) which could mean males contain greater rates of nurdles. Furthermore, latitude was included as a variable for the location where fish were collected because nurdle exposure and pollution may vary spatially across NSW.

Fish gut samples for *C. auratus* and *A. viridis* were collected from 15 nearshore locations spanning ~ 1, 250 km of coastline in NSW in 2021 and 2022 (Fig. 1). Most samples were received as part of an ongoing project where recreational fishers in NSW may donate their catch frozen with the guts intact after they have removed the fillets for consumption (Day et al., 2021, 2023b). In total, 111 *C. auratus* (260–762 mm TL, $\bar{x} \pm$ SD = 402.6 ± 104.7 mm, 76 ♂: 35 ♀) and 39 *A. viridis* (245–782 ± 26.9 mm TL, $\bar{x}$ = 457.8 ± 168.1 mm SD, 13 ♂: 26 ♀) were obtained with 92 % (102 *C. auratus*) and 85 % (33 *A. viridis*) supplied via donations. Fewer donations of *A. viridis* were received than *C. auratus*, likely due to *C. auratus* being targeted and retained more regularly by recreational fishers (Kingsford et al., 1991). We collected a small number of juvenile *C. auratus* (< 300 mm TL) and *A. viridis* (< 400 mm TL) under permit to supplement the donations which were stored in zip-lock bags after dissection. Samples were euthanized via ice slurry or stung a blow to the head, labelled with the date and location of catch and stored frozen for later dissection. Due to the proximity of the sites, data for *C. auratus* collected in Anna Bay, Boat Harbour Bay, Broughton Island, Fingal Bay, Fingal Island, Little Rocky, Moon Island and Nelson Bay were pooled with the Port Stephens location; Port Kembla and Sandon Point were pooled with Wollongong; and Gerroa, Kiama and Sussex Inlet were pooled with the Jervis Bay location (Fig. 1).

Fishes were dissected by making an incision from the anus to the throat and removing the gut contents intact. Fishes with broken guts or guts that were visibly empty were not analysed and none of the collected or donated fishes were washed. It was important to measure Gut Fullness

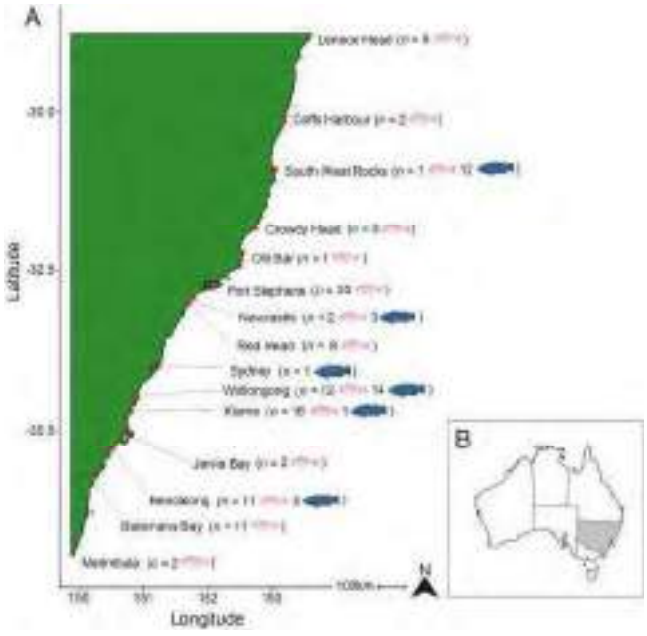

Fig. 1. Site map showing (A) all fishes (*Chrysophyrus auratus* [pink snapper, shown pink] and *Achoerodus viridis* [Eastern blue groper, shown blue]) collected along the East coast of New South Wales (NSW), and (B) the position of NSW on the Australian coastline, shown by a red 'x'.

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Index (GFI, %) because fish which had eaten more food may have a higher risk of ingesting nurdles (Ronda et al., 2023). Guts (stomach and intestines) were weighed whole before being flushed with distilled water to remove the contents, with the empty gut membrane then weighed whole to obtain GFI. We estimated GFI according to the following equation from previous studies (Williams, 1981, Day et al., 2021)

GFI = (total gut weight (g) – gut membrane weight (g) * 100) / total gut weight (g)

Generalised Linear Models (GLM's) were used to test the hypothesis that nurdles would be present in fish guts depending on fish body length (TL), sex, GFI, or latitude (a proxy for location). GLM's were done using the "glmmTMB" package (Brooks et al., 2017) and were structured with a log link and a binomial distribution with nurdles being either present (1) or absent (0) in guts. Binomial was the most appropriate distribution as we did not count numbers of individual nurdles in fish guts but rather recorded them on a presence / absence basis. Fish length, GFI and latitude were run as continuous variables and showed no evidence of collinearity (Pearson's correlation $\rho < 0.24$) and fish sex was a factor. Fishes which presented intermediate sex (i.e., such as in the few sub-legal sized fish we collected) were removed from analyses ($n = 8$). We included an interaction between fish length and sex in the model and validated the model by assessing diagnostic plots using the 'DHARMa' package (Hartig, 2022). The significance of model terms was determined using Likelihood Ratio tests implemented with the "Anova" function in the "car" package (Fox and Weisberg, 2018). All statistical analyses and plots were developed using the statistical program R (R R Core Team, 2021) and the associated packages mentioned above as well as "lme4" (Bates et al., 2015), "ggplot2" (Wickham, 2016) and "dplyr" (Wickham et al., 2023).

Nurdles encountered in this study were spherical, < 1–3 mm in diameter and coloured brown, yellow and white. They were mostly opaque, although a minority were translucent (Fig. 2) which suggests UV degradation (Sewwandi et al, 2023) and some showed scratched weathering described by Perera et al., (2022). Nurdles were encountered in 8.1 ± 2.6 % of *C. auratus* samples across all locations (nine detections overall; 2 ♂: 7 ♀, 362–710 mm TL, $\bar{x} = 531.3 \pm 51.2$ mm TL) whereas no nurdles were found in *A. viridis* (Fig. 2). Specifically, nurdles were found in three *C. auratus* individuals from Port Stephens (1 ♂: 2 ♀, 410–710 mm TL, $\bar{x} = 520 \pm 95.4$ mm TL) and Kiama (1 ♂: 2 ♀, 383–665 mm TL, $\bar{x} = 507.7 \pm 83$ mm TL), two at Crowdy Head (2 ♀, 671 and 702 mm TL) and one at Merimbula (1 ♀, 326 mm TL) (Fig. 1). Other microplastics like fishing line and a fragment of clear plastic were found in one fish each from Port Stephens and Red Head, respectively (Fig. 2).

The total body length of *C. auratus* was the only significant predictor for nurdle presence in the model ($X^2_1 = 7.93$, $P = 0.0049$), with the likelihood of nurdles being found increasing from 1.7 ± 1.8 % to 47.8 ± 12.8 % as length rose from 300 mm to 700 mm (Fig. 3A). Despite the interaction between length and sex being not significant ($X^2_1 = 2.06$, $P = 0.1513$), it was notable that all fish containing nurdles greater than 600 mm TL were female (Fig. 3A). The variables of sex ($X^2_1 = 0.82$, $P = 0.365$), GFI ($X^2_1 = 0.04$, $P = 0.8337$) and latitude ($X^2_1 = 1.35$, $P = 0.2452$) were all not significant. Predictions of nurdle occurrence based on sex were 5.2 ± 2.4 % and 7.7 ± 2.4 % SE for males and females, respectively (Fig. 3B). The likelihood of nurdles being encountered within *C. auratus* showed negligible change as GFI increased (Fig. 3C) and a weak negative relationship with latitude (Fig. 3D).

Our findings indicate strikingly different rates of nurdle occurrence between species, with no nurdles found in *A. viridis*. This occurred despite both fishes having mouth gape sizes large enough at juvenile and adult body size to easily ingest nurdles < 3 mm. We propose that this is due to the different feeding strategies exhibited by these species. For instance, *A. viridis* has a narrower diet, typically eating exposed invertebrates on rocky reefs (Curley et al., 2013; Gillanders, 1995a). Comparatively, *C. auratus* are described as generalist carnivores that feed on smaller fish and invertebrate prey from soft sediments (Godfriaux, 1969; Curley et al., 2013; Wootton et al., 2021). We contend that this diet may result in direct nurdle consumption if *C. auratus* ingest

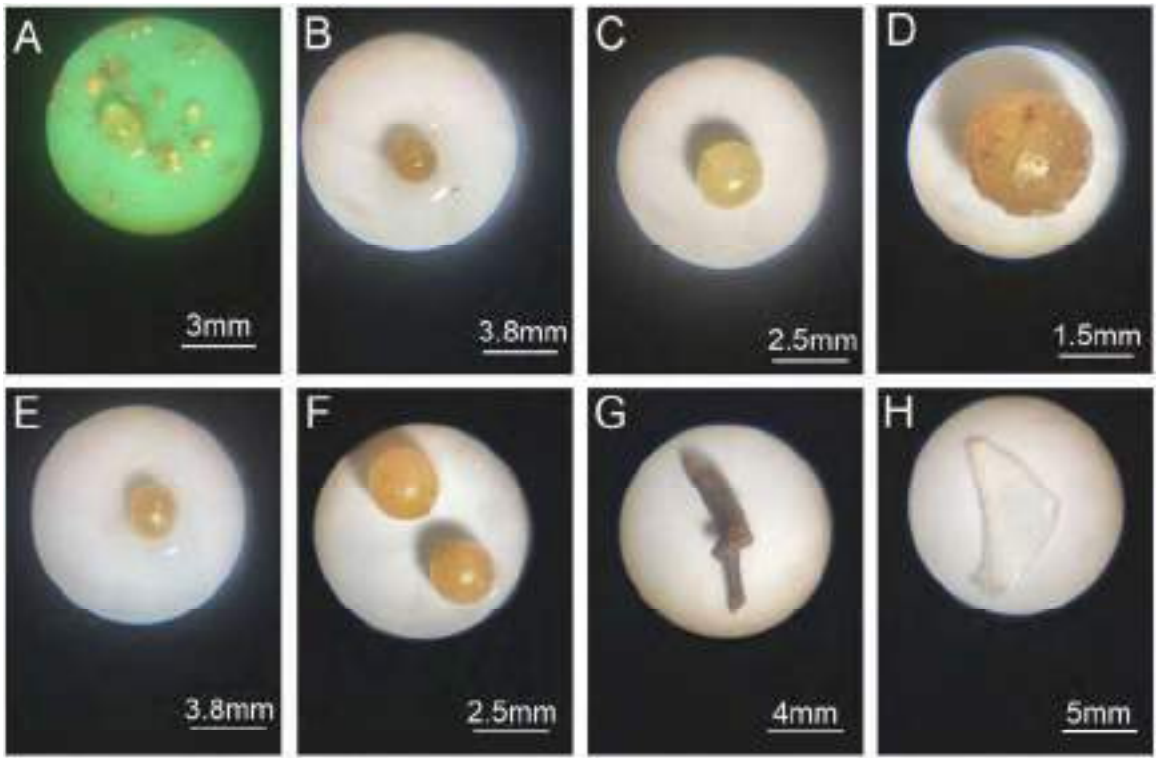

Fig. 2. Microplastics found in the guts of *Chrysophyrus auratus* displayed in dissection trays to show (A) large and small nurdles, (B) to (F) large nurdles able to be picked up with tweezers and examined, (G) monofilament fishing line and (H) a shard of hard, translucent plastic.

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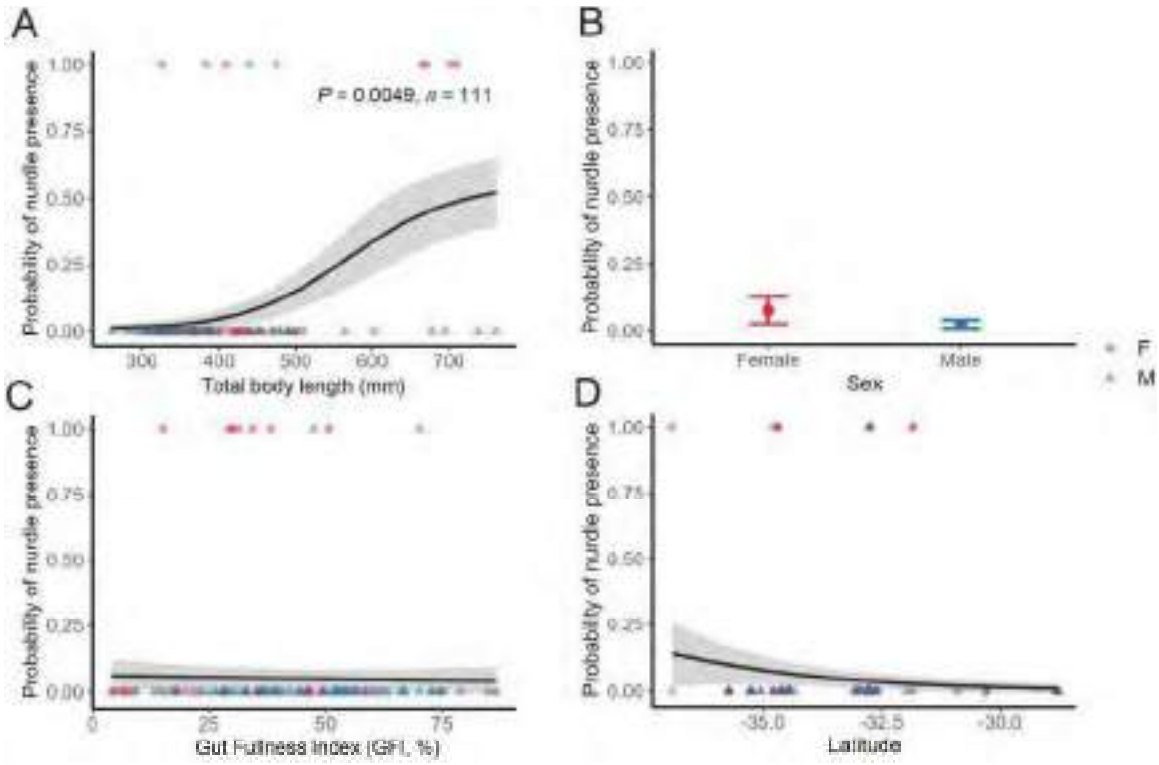

Fig. 3. Model predictions from a Generalized Linear Model (GLM) showing how nurdle presence within *Chysophrys auratus* varied with (A) Total body length (mm), (B) sex, (C) Gut Fullness Index (GFI, %) and (D) latitude. Colours of datapoints denote sex of fish while the grey shaded area and error bars represent ± SE.

sediments that contain nurdles when foraging, or via secondary ingestion when eating fish contaminated by nurdles. Nurdle ingestion has been reported previously for other species of Sparids such as *Acanthopagrus berda* in South Africa (Ombongi et al., 2021) and *Dentex angolensis* in West Africa (Adika et al., 2020). For *D. angolensis*, the source of nurdles has been suggested to be planktivorous prey which it commonly consumes (Adika et al., 2020). However, these previous studies on Sparids have not reported a significant effect of fish size, whereas large *C. auratus* in the current study had the greatest rates of nurdles in their guts. This was despite medium to small fishes (< 400 mm TL) making up the majority (63.1 %) of our samples (Online supplementary material Table S1, Fig. S1).

Diets of *C. auratus* change throughout their life history, but they forage for prey in soft sediment at all body sizes (Colman, 1972; Usmar, 2012). It has been reported that *C. auratus* mainly eat amphipods and mysid shrimp when small (< 300 mm TL) before moving on to a diet which includes burrowing crabs and snails at medium body size (> 300 TL) and hermit crabs and other fishes at large body sizes (> 400 mm TL) (Godfriaux, 1969, Colman, 1972, Usmar, 2012). Considering large *C. auratus* have a greater tendency to eat teleosts (Godfriaux, 1969, Colman, 1972) and our findings of more nurdles in large fish, we postulate that this may be a main source of nurdles (Braid et al., 2012; Forrest and Hindell, 2018). However, since nurdles were only found in a in a limited number of fish (9 individuals), determining links between fish size and nurdle occurrence may require further research to understand the mechanisms for their ingestion and potential prey items that act as sources. Future research on nurdle ingestion should include chemical confirmation of their composition which while unlikely, may have affected the reliability of our data.

In conclusion, we present the first report of microplastic nurdle ingestion by fish in south-eastern Australia. In this initial report, we make the novel observation that *C. auratus*, particularly large individuals, are at higher risk of ingesting nurdles compared to *A. viridis*. We propose that differences in diet and feeding strategies both between and within species influenced ingestion rates of nurdles. This is corroborated by recent work reporting that rates of microplastics in the guts of fishes (Wootton et al., 2021) and invertebrates (Porter et al., 2023) differ between species with different feeding styles. However, it should be noted that in other studies microplastic or nurdle loads did not vary based on feeding ecology, fish species, or size (Gad, 2020; Toner, 2020). Since our results show that *C. auratus* is ingesting nurdles in NSW, we suggest that future research into the prevalence and potential implications of nurdles as a source of microplastic pollution and the factors determining their presence within fishes of this region is warranted.

CRediT authorship contribution statement

Jeremy Day: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Troy Gaston**: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Megan Huggett**: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **Daniel Swadling**: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Jeremy K. Day reports financial support was provided by Ecological Society of Australia Ltd. Jeremy K. Day reports financial support was provided by Ozfish Australia. Jeremy K. Day is employed on a casual basis at the Department of Primary Industries, Fisheries, New South

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Wales. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

I have included a statement in the manuscript showing where my data is available online in a figshare repository

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.rsma.2024.103715.

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Impacts of spilled debris from the X-Press Pearl disaster in Sri Lanka on marine plankton

Sinja Rist [a,b,*], Kevin Ugwu [b,c], Marta Sampalo [b], Therese M. Karlsson [d], Chalani H. Rubesinghe [e], Andrea Acosta-Dacal [f], Octavio Pérez-Luzardo [f,g], Manuel Zumbado [f,g], Rodrigo Almeda [b]

[a] National Institute of Aquatic Resources (DTU Aqua), Technical University of Denmark, Kgs. Lyngby, Denmark
[b] University Institute for Research in Sustainable Aquaculture and Marine Ecosystems (IU-ECOAQUA), University of Las Palmas de Gran Canaria, Spain
[c] Department of Science and Environment, Roskilde University, Roskilde, Denmark
[d] International Pollutants Elimination Network (IPEN), Gothenburg, Sweden
[e] Centre for Environmental Justice (CEJ), Sri Lanka
[f] Toxicology Unit, Research Institute of Biomedical and Health Sciences (IUIBS), University of Las Palmas de Gran Canaria, Paseo Blas Cabrera s/n, 35016, Las Palmas de Gran Canaria, Spain
[g] Spanish Biomedical Research Center in Physiopathology of Obesity and Nutrition (CIBERObn), Spain

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ABSTRACT

Accidents of ships carrying diverse hazardous chemicals and plastics can lead to complex spills of pollutants in marine ecosystems. One such incident was the catastrophic fire on the container ship X-Press Pearl which sank off the Sri Lankan coast in 2021. Explosions and fire resulted in plastic pellets and burnt clumps of melted plastic and combustion residues washing ashore. In this study, we analyzed the acute toxicity of the leached chemicals from this debris on various planktonic organisms: phytoplankton (*Rhodomonas salina*), meroplankton (*Paracentrotus lividus* larvae) and holoplankton (*Acartia tonsa* nauplii and adults). Acute exposures were conducted with a range of leachate dilutions for 72 h. The growth of *R. salina* was slightly affected by the leachates. Larvae of *P. lividus* showed a concentration-dependent reduction in growth and normal development (EC_{50} 0.56 g L^{-1}), with 94% of larvae showing malformations in the highest concentration. The hatching of *A. tonsa* decreased from 89% in the control to 29% at 0.75 g L^{-1}. Nauplii mortality reached 46% and there was a trend of decreased growth. Mortality of the adults increased with concentration, reaching 51% in the highest concentration. Our results show that the complex mixture of spilled chemicals and debris from the X-Press Pearl accident can potentially harm the planktonic food web, particularly zooplankton. These findings highlight the urgent need for effective mitigation strategies and response measures to reduce impacts of accidental spills in sensitive and ecologically relevant areas, especially those located in major shipping lanes, such as the Sri Lankan coastal waters.

1. Introduction

Shipping accounts for approximately 90% of the global transport of goods (AGCS, 2023; Wan et al., 2022) and continues to expand at a fast rate. From 1980 to 2020, the total weight of goods moved by containers worldwide increased nearly twentyfold (Wan et al., 2022). The current trend favors large container vessels carrying above 15,000 TEUs (20-foot container equivalent units) (AGCS, 2023). These ships frequently transport a wide variety of hazardous materials, presenting an ecological risk to the marine environment if leaks or spills occur. There were several cases of large spills of plastic pellets within the last decade, notably of 49 tons in Durban, South Africa in 2017 (Schumann et al., 2019) and 25 tons in Galicia, Spain in 2023 (Vidal-Abad et al., 2024). Saliba et al. (2022) provide a detailed list of spills from ships worldwide between 1917 and 2021. The loss of cargo or entire ships is not uncommon; for instance, over 300 cargo ships were lost between 2013 and 2022, and recent reports indicate that 3100 containers were lost annually between 2020 and 2021 (AGCS, 2023). The total number of container ship accidents has also risen over the past decade (Wan et al., 2022). One of the most common causes leading to these losses and

* Corresponding author. National Institute of Aquatic Resources (DTU Aqua), Technical University of Denmark, Kgs. Lyngby, Denmark.
E-mail address: siri@aqua.dtu.dk (S. Rist).

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accidents is fires, which are often attributed to improper declaration, documentation and packaging of hazardous cargo (AGCS, 2023). Such incidents can result in severe and complex spills into the marine environment, particularly through the release of oil, plastics, and hazardous and noxious substances (HNS). When transported together, accidental spills of these goods can involve a wide range of pollutants and complex chemical mixtures, challenging the assessment of their environmental impacts (Cunha et al., 2015; Rocha et al., 2016) and the formulation of effective response measures (de Vos et al., 2022; Wan et al., 2022).

In May 2021, Sri Lanka experienced the "worst catastrophe in its maritime history", when the container ship 'X-Press Pearl' caught fire and sank 18 km off the coast of Colombo (Partow et al., 2021). The fire was caused by a leakage of nitric acid, of which the ship carried 25 tons. Besides this, the X-Press Pearl also carried 348 tons of bunker fuel, 9700 tons of epoxy resin, 1680 tons of plastic pellets, 1040 tons of caustic soda, and 210 tons of methanol. Thus, the sinking of the X-Press Pearl resulted in a highly complex spill of chemicals and materials, and the largest spill of plastic pellets (also known as nurdles) ever recorded (Partow et al., 2021; Rubesinghe et al., 2022). These pellets were largely polyethylene with a regular spherical shape and smaller than 5 mm in diameter, i.e., primary microplastics (Sewwandi et al., 2022). While the cargo manifest also included polystyrene, polypropylene, polybutadiene rubber, expandable polymeric beads and polycarbonate, the only pellets washed ashore were polyethylene (Partow et al., 2021; Rubesinghe et al., 2022). Tons of these pellets were found on beaches, together with bigger clumps of burnt plastic, combustion remnants and oil-plastic agglomerates. Chemical analyses revealed that these clumps had a much more complex chemical composition than the pellets as a result of heat, combustion and contact with other chemicals (de Vos et al., 2022), including residues of fossil fuels and combustion-derived polyaromatic hydrocarbons (PAHs) (James et al., 2023). This incident illustrates how catastrophic ship accidents and spills can result in highly complex and 'unique' forms of pollution, requiring further investigations into impacts as well as appropriate response measures.

Adverse impacts on the marine ecosystem are inevitable after a spill of this magnitude. Stranding of 251 turtles, 28 dolphins and 5 whales on Sri Lankan beaches was noted two months after the accident (Partow et al., 2021), and although the direct relation to the accident was questioned, locals reported unusually high numbers of dead animals and carcasses that showed signs of burning (Regan and Thornton, 2021). While the impacts of the accident on larger animals (including fish, marine mammals, turtles and sea birds) have been discussed in the literature (Vithanage et al., 2024), information on the consequences at the base of marine food webs is missing. The impacts on smaller organisms like plankton are not directly visible but crucial to understand since they are key players in marine food webs. Changes in plankton communities can have knock-on effects on higher trophic levels, including fish which are an important resource in the area.

The aim of this study was to assess the impact of washed-ashore clumps and plastic pellets from the X-Press Pearl accident on marine plankton. In the environment, these debris (clumps and pellets) undergo weathering and fragmentation, which is expected to lead to the release of smaller particles and promote the leaching of potentially toxic contaminants. Thus, we hypothesize that the leachates from these spilled debris adversely affect marine plankton. We determined the acute toxicity of leachates from the washed-ashore clumps and plastic pellets on representative species of phytoplankton, meroplankton and holoplankton. Our findings contribute to understanding the potential ecological risk associated with complex spills in marine environments.

2. Materials and methods

2.1. Sampling

The samples of plastic pellets and clumps of burnt plastics were collected from four locations along the western coast of Sri Lanka; two locations north of the ship accident and two in the south (Fig. 1). The sample collection was conducted in September 2021, four months after the accident. The biggest clumps were collected from Sarakkuwa beach, where the pollution was especially high (Sewwandi et al., 2022). To minimize cross contamination, the samples were collected wearing gloves and using aluminum foil. After being photographed at the collection site, the samples were wrapped in aluminum foil, sealed and shipped to Spain for testing. There, they were stored at 4 °C in the dark until the start of the experiments (summer 2022).

2.2. Preparation of leachates

All experiments were carried out using UV-treated and 0.1 μm-filtered seawater (FSW) (35 psu salinity, 20 °C, pH 8.02, >90% oxygen saturation) of oceanic characteristics collected from the coast of Gran Canaria, Spain (27°59′27″N, 15°22′01″W). Before starting a bioassay, the seawater underwent triple filtration: first with an activated carbon coconut shell filter (5 μm), followed by a polypropylene melt-blown filter (1 μm), and finally a polyethersulfone membrane filter (0.1 μm).

For the preparation of leachates, we made a mixture of four collected samples, representing different types of washed-ashore materials (i.e., plastic pellets and burnt clumps, Fig. 2). Subsamples of each were micronized using a laboratory mill (IKA A 11 basic analytical mill) using dry ice and subsequently fractionated into two sizes (<250 μm and 250–1000 μm) using metal sieves. Keeping the two size fractions separate, the samples were then mixed with the following masses: 207 mg of sample 1, 4057 mg of sample 2, 2659 mg of sample 3, and 9714 mg of sample 4. The chosen masses were based on the amount of micronized material that we were able to obtain from each sample, since some fragmented more easily than others. These mixtures were stored in glass vials at −20 °C to minimize chemical degradation until use. Leachates in seawater were obtained according to previously published protocols with minor modifications (Almeda et al., 2023; Page et al., 2022). Briefly, leachates of both size fractions were prepared by adding particles to glass bottles with FSW at a concentration of 1 g L^{-1}. The bottles were closed air-free and placed on rollers (LLG-UniROLLER 6 easy) at 15 rpm in darkness for 72 h. After this, the bottle contents were filtered on 0.7 μm glass fiber filters to remove all particles and the collected solution was used as the leachate stock (i.e., 100%). The pH of the leachates was measured in triplicate to ensure it did not differ from the FSW. For the exposure experiments, the following dilutions of the stock were prepared for the size fraction <250 μm: 75%, 50%, 25%, 12.5% and 6.25%, corresponding to a particle equivalent concentration of 0.75, 0.5, 0.25, 0.125 and 0.0625 g L^{-1}. This wide range of concentrations was chosen due to the unknown degree of toxicity and to allow for comparisons to previous studies with plastic leachates and planktonic organisms (Bournaka et al., 2023; Page et al., 2022; Rist et al., 2023). For the 250–1000 μm fraction, only two dilutions, 75% and 25% (i.e., 0.75 and 0.25 g L^{-1}), were prepared to determine the influence of particle size on leachate toxicity. In all exposure experiments we had nine treatment groups: control (FSW), the five dilutions and the stock of the small fraction, and the two dilutions of the large fraction. All exposures lasted for 72 h, a common duration in ecotoxicological experiments.

2.3. Chemical analysis of leachates and micronized particles

The leachates and micronized particles of both size fractions were analyzed for 338 different organic compounds (Table S1). Additionally, the leachates were tested for 50 elements (Table S2). The limits of detection of the detected analytes are provided in Table S3.

2.3.1. Analysis of organic compounds in leachates

To prepare for analysis, the samples were thawed and placed on an orbital shaker for 2 h. An aliquot of 50 mL was transferred into another vessel, and 10 μL of a procedural internal standard (P-IS) solution at 1 μg mL^{-1} (acenaphthalene-d10, chrysene-d12, phenanthrene-d10, PCB 200,

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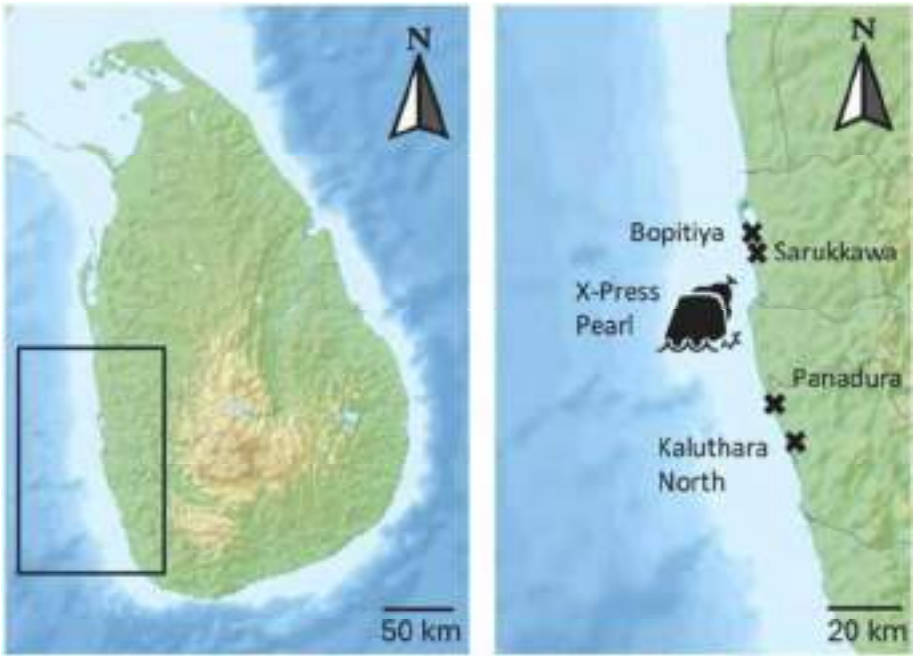

Fig. 1. Sampling locations: Sarakkuwa (7°6′41.61″N, 79°50′32.46″E), Panadura (6°42′38.00″N, 79°54′6.00″E), Kalutara North (6°36′24.00″N, 79°56′55.00″E), and Bopitiya (7° 3′55.00″N, 79°51′8.00″E) of the Sri Lankan west coast.

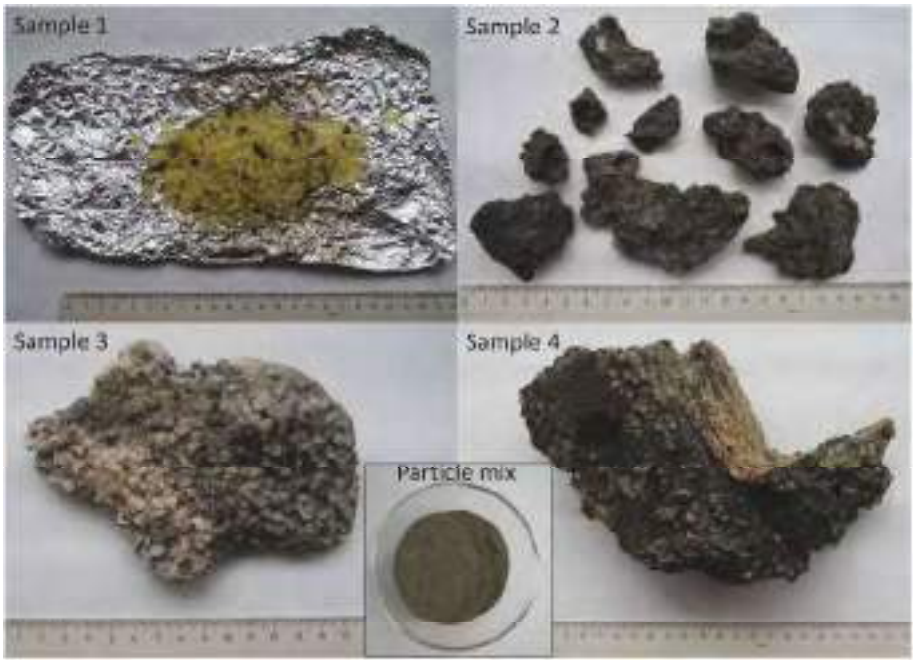

Fig. 2. The four washed-ashore materials that were used to make the micronized particle mixture for leachates (small picture in bottom center).

atrazine-d5, carbendazim-d3, chlorpyrifos-d10, cyromazine-d4, diazinon-d10, linuron-d3, and pirimicarb-d6) were added. The solution was left in darkness for 1 h. All samples were extracted and analyzed in triplicate. Then, they were submitted to solid-phase extraction using 200 mg (3 mL) Chromabond® C18ec columns (Macherey-Nagel, Germany) mounted in a vacuum manifold (Waters Corporation, USA). Before applying the samples, the columns were cleaned and conditioned with 2 mL of methanol and 2 mL of water/n-propanol (85:15, v/v). Next, 50 mL of the leachates were passed through the cartridge under vacuum at a flow rate of 1.5 mL min^{-1}. The column was washed with 1 mL of the water/n-propanol solution, and then dried under high vacuum for 30 min. Finally, the compounds were eluted from the column with 1 mL of dichloromethane (DCM).

2.3.2. Analysis of organic compounds in micronized particles

For this analysis, 5 mL of a CHX:AE mixture (1:1, v/v) were added into a glass centrifuge tube containing 1 ± 0.05 g of micronized particles and 10 μL of the P-IS solution. The mixture was shaken vigorously and subjected to ultrasonication for 20 min (Selecta, Barcelona, Spain). The samples were then shaken for 24 h on a rotary shaker (Ovan, Barcelona, Spain). Next, the 5 mL of solvent were transferred to another glass tube and the process was repeated two more times until a final volume of 15

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mL of the extractant was reached after 72 h. Finally, 1 mL of this mixture was filtered through a 0.20 μm Chromafil® PET filter (Macherey-Nagel, Düren, Germany) to an amber glass chromatography vial and evaporated in a vacuum concentrator RVC 2–25 CD plus (Christ, Germany) to dryness. The samples were resuspended in 100 μL CHX and analyzed by GC–MS/MS.

2.3.3. Elemental analysis in leachates

An aliquot of 40 mL of the leachates was transferred from the glass container into a 50 mL Falcon tube, vortexed, and placed in an ultrasonic bath for 30 min. Once sonicated, the samples were centrifuged at 2500 rpm for 3 min. A direct dilution of the sample was made at 1:10, using a solution of HNO_3 (2%). For this purpose, 1800 μL of 2% nitric acid and an aliquot of 200 μL of the sample were added to the vial and shaken.

2.3.4. QC/QA and instrumental analysis

Quality controls and blanks for leachate and particle extraction were prepared in autoclaved seawater and virgin low density polypropylene pellets (Sigma-Aldrich, ref. 428,116), respectively, using the same methodology as for the samples. All samples were spiked 1 h before the extraction with the mix standard solution and/or with the P-IS solution. For quantification purposes, 10-point calibration curves in DCM or CHX ranging between 0.195 and 100 ng mL^{-1} were used for leachates and micronized particles.

The analysis of both leachate and particle extracts was performed using a 7890 B GC System coupled to a Triple Quad 7010 mass spectrometer (Agilent Technologies, Palo Alto, CA, USA). All GC parameters have been described previously and retention times, precursor, fragment ions, and collision energies for each compound and equipment used for each compound are listed in Table S1 (Camacho et al., 2019; Rist et al., 2023).

For the elemental analysis, two complementary calibration curves covering the range 0.03–300 ng mL^{-1} (ten levels) were used. One contained the essential elements, major heavy metals, and some of the ATSDR (Agency for Toxic Substances and Disease Registry) list, and the other consisted of a multi-element mixture custom-made from individual elements containing the rare earth (REE) and minority elements (ME).

The elemental analysis was performed using an Agilent 7900 ICP-MS (Agilent Technologies) equipped with standard nickel cones and a crossflow nebulizer with a make-up gas port (× 400 nebulizer, Savillex Corporation, MN, USA) for all measurements. Daily, the ICP-MS was optimized using a tuning solution consisting of a mixture of Cs (cesium), Co (cobalt), Li (lithium), Mg (magnesium), Tl (thallium) and Y (yttrium) (Agilent Technologies). The entire procedure can also be found in previous publications (Rodríguez-Hernández et al., 2019).

2.4. Toxicity test with marine microalgae

The cryptophyte *Rhodomonas salina* was used as a model species of marine phytoplankton due to its widespread occurrence and use in ecotoxicology (Oliveira dos Anjos et al., 2023; Page et al., 2022; Thomas et al., 2020) as well as its importance in aquaculture (Oostlander et al., 2020). *Rhodomonas* species have a worldwide distribution in aquatic environments, including the Indian Ocean and waters of the Laccadive Sea (GBIF, 2024).

Cultures of *R. salina* were grown in glass flasks containing autoclaved FSW (1 atm, 120 °C, 20 min) and B1 enriched medium (Hansen, 1989). Using a temperature-controlled incubator (Equitec ERIS 40255), growing conditions were maintained at 20 °C and on a 12:12 h light/-dark cycle with an intensity of 100 μmol m^{-2} s^{-1} without aeration or agitation. Before the experiment, the culture was diluted by 1/3 three times per week to ensure exponential growth at the start. Weekly checks with an inverted microscope (DMi1 Leica) were carried out to ensure a good state of the culture.

Exposure was conducted in 34 mL glass bottles, filled with 25 mL of leachate dilution or FSW as a control. The initial cell concentration was $2{\cdot}10^4$ cells mL^{-1}. Each treatment was tested in triplicate. In all cases, B1 stock solution was added at a concentration of 1.1 mL L^{-1} to ensure nutrient availability. The bottles were incubated for 72 h at the same growth conditions as mentioned above (20 °C, 12:12 h light/dark, 100 μmol m^{-2} s^{-1} without agitation). At the end of the exposure, cell density and mean size (equivalent spherical diameter, ESD) were measured using a Beckman Coulter Multisizer 4 particle counter with an aperture tube of 100 μm. Two measurements per sample were conducted to determine the average concentration of cells in each replicate.

2.5. Toxicity test with echinoderm larvae

The early life stages of echinoderms are commonly used as models for studying the toxicity of plastic leachates due to their sensitivity, ecological relevance and ease of spawning in the lab (Campani et al., 2020; Rendell-Bhatti et al., 2021; Rist et al., 2023). Echinoids are globally distributed invertebrates in marine ecosystems, with up to 60 species in Sri Lankan waters.

In this study, we used the early life stages of the purple sea urchin *Paracentrotus lividus* as models of meroplankton. In the morning of the experiment, adult sea urchins were collected by snorkeling in Arinaga, Gran Canaria, Spain, and transported to the laboratory in cool boxes with *in situ* seawater. Spawning was induced immediately in the laboratory by injecting 1 mL of a 0.55 M KCl solution into the sea urchin mouth with a syringe. The individuals were then placed upside down on beakers filled with FSW. The sperm of spawning males was immediately transferred to small glass vials and stored on ice. Gametes were checked for their quality under a microscope (DMi1 Leica). Only gametes from individuals with actively swimming sperm and evenly round eggs were used for the experiment. Eggs were washed by transferring them to fresh FSW, and some diluted sperm was added. Successful fertilization was confirmed by observing the development of a fertilization envelope around the majority (>90%) of eggs.

Exposure was conducted in small (68 mL) glass bottles filled with 30 mL of leachate dilution or FSW as a control. Each of the nine treatments was done in triplicate. Fertilized eggs were added to reach a density of 30 mL^{-1} (900 per bottle). The bottles were loosely covered with aluminum foil and placed in an incubation chamber at 20 °C in darkness for 72 h. The test was considered valid when control mortality was below 10%. At the end of the exposure, mortality and abnormal development were quantified, and pictures were taken for size measurements. The bottles were closed with a lid and inverted ten times before transferring a 1 mL subsample to a glass bowl. Then, we counted the total number of larvae, the number of abnormally developed and of dead larvae using a stereo microscope (Leica S APO). Simultaneously, another 12 mL were transferred to falcon tubes with the addition of four drops of 10% formalin. Once the larvae had settled, they were transferred to a glass slide and pictures were taken with an inverted microscope with an inbuilt camera (Leica S9i). The length of 20 larvae per replicate was measured using ImageJ.

2.6. Toxicity tests with marine copepods

The copepod *Acartia tonsa* has been used as model species for ecotoxicology experiments since 1977 and is recommended for aquatic toxicity testing by the International Organization for Standardization (ISO). This species is a common toxicological model due to its sensitivity to pollution, ecological relevance, wide distribution, and ease for laboratory culturing (Gorbi et al., 2012). In addition, the genus *Acartia* can be found in the coastal waters around Sri Lanka.

Mature adults of *A. tonsa* from the same cohort (maximum three weeks old to ensure reproductive activity) were obtained from the stock cultures at the University of Las Palmas de Gran Canaria, established from specimens provided by DTU Aqua (strain DFH-ATI). The culture was kept in a temperature-controlled room at 20 °C in 30 L containers

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filled with FSW in the dark and with gentle aeration. Copepods were fed *R. salina* (10^6 cells mL^{-1}) three times per week. For the experiment, the copepods were sorted under a stereo microscope and 20 adults (males and females) were added to each experimental bottle (68 mL glass bottles) with 30 mL of the leachate dilutions or FSW as a control.

Exposure of the nauplii of *A. tonsa* was conducted using eggs from the same stock culture as the adults. The eggs were concentrated with a 20 μm sieve and placed in a glass bowl with FSW. Under a stereo microscope, the eggs were evaluated according to their spherical shape and color, and 30 eggs each were placed in 34 mL glass bottles with 20 mL of the leachate dilutions or FSW as a control. The bottles of both adults and eggs were loosely covered with aluminum foil and placed in an incubation chamber at 20 °C in darkness for 72 h. All treatments were done in triplicate. At the end of the exposure period, hatching success, mortality and size of the nauplii, as well as mortality in adults, were assessed using a stereo microscope. The quality criterion was a mortality of <10% in the controls. For measuring the sizes of the nauplii, they were transferred to falcon tubes with four drops of Lugol's solution. Once the nauplii had settled, they were placed on glass slides and pictures were taken using an inverted microscope with an inbuilt camera. The length of the nauplii was measured using ImageJ.

2.7. Data analysis

The statistical analyses were done in the software R (version 3.6.3) (R Core Team, 2022). Analysis of variance (ANOVA) was used to analyze differences between treatments within the smaller size fraction (<250 μm) for the population growth of *R. salina*, the length of *P. lividus* larvae, the mortality of *A. tonsa* adults and nauplii, and the hatching success of *A. tonsa* nauplii. Tukeys HSD was used as a posthoc test. For the same responses, we tested for differences between the two size fractions (i.e., <250 μm and 250–1000 μm) at the same dilutions (i.e., 75% and 25%) with t-tests. For both ANOVA and *t*-test, we used the Shapiro-Wilks and Fligner-Kileen test to test the assumptions of normality and homogeneity of variances, respectively. In the case of the cell size of *R. salina*, the data was not normally distributed. Therefore, a Kruskal-Wallis test was used as a non-parametric alternative to ANOVA. A dose-response curve was fitted for the abnormal development of *P. lividus*, and the half-maximal effective concentration (EC_{50}) was calculated.

3. Results

3.1. Chemical composition of leachates and micronized particles

In the leachates, three organic compounds were detected at elevated concentration compared to the FSW (Table 1). Acenaphthene exhibited the highest concentration with 0.46 and 0.24 μg L^{-1} in the leachates of the smaller and larger size fraction, respectively. Naphthalene and pyrene were detected at concentrations below 0.1 μg L^{-1}. Seven elements were present at elevated concentration, of which barium (113–120 μg L^{-1}) and zinc (16.2–51 μg L^{-1}) had the highest concentrations. Manganese, iron, nickel, copper and cerium showed concentrations below 1 μg L^{-1} and except cerium, all of these elements were only found in the leachates of the smaller size fraction. In general, the concentrations of organic compounds and elements were higher in the leachates of the smaller size fraction (<250 μm), with the exception of barium and cerium (Table 1).

We additionally analyzed the organic compounds in the micronized particles and detected 28 compounds (Table 2). Of these, 15 were polycyclic aromatic hydrocarbons (PAHs) and exhibited the highest concentrations, all exceeding 500 μg g^{-1}. Many PAHs reached levels of several thousand μg g^{-1}, with benzo(a)pyrene having the highest concentration at 11,434 μg g^{-1}. The sum of total PAHs was 42,315 μg g^{-1} for the smaller size fraction (<250 μm) and 40,387 μg g^{-1} for the larger size fraction (250–1000 μm). After the PAHs, organophosphate flame retardants (OPFRs) were the group with the second highest concentrations. We detected six OPFRs, from 2.3 to 320 μg g^{-1}. Furthermore, we found three polybrominated diphenyl ethers (PBDEs), two polychlorinated biphenyls (PCBs) and two pesticides (Table 2).

3.2. Toxicity to microalgae

The leachate exposure led to a concentration-dependent decrease in cell numbers of *R. salina* up to 0.5 g L^{-1} (50% dilution) (Fig. 3A), from 101,010 cells mL^{-1} in the control to a minimum of 75,085 cells mL^{-1}. This is a decrease of 26%. However, in the two highest leachate concentrations the cell numbers were similar to the control. The leachates of the larger particle size fraction (25b and 75b) showed a significantly higher toxicity than the corresponding concentrations of the smaller size fraction. The cell size of the microalgae was not affected by the leachates at any concentration (Fig. 3B).

3.3. Toxicity to sea urchin larvae

No substantial mortality was found in any treatment (Fig. 4A). The *P. lividus* larvae in the control treatment developed normally, while increasing levels of abnormal development were observed in the leachate treatments (Fig. 4A). Up to an equivalent particle concentration of 0.25 g L^{-1} (25% dilution), the percentage of abnormally developed larvae remained below 20%. However, there was a strong concentration-dependent increase from 0.5 to 1 g L^{-1}, reaching a maximum of 94% abnormally developed larvae. The EC_{50} for abnormal development was a dilution of 56%, corresponding to 0.56 g L^{-1} (Fig. 4B). The treatments with the larger size fraction (25b and 75b, 250–1000 μm) consistently showed lower levels of abnormal development than the respective dilutions of the smaller fraction (Fig. 4A). This was especially pronounced at 0.75 g L^{-1}, with 83% abnormally developed larvae in the smaller fraction versus 20% in the larger fraction.

Table 1
Organic compounds and elements found in the undiluted leachates. Filtered seawater served as a blank. All concentrations are expressed in μg L^{-1}. n.d. not detected. a, b and c are the replicates.

	Blank	Leachate (particles <250 μm)				Leachate (particles >250 μm)		
Organic compound		**a**	**b**	**c**	**Mean ± SD**	**a**	**b**	**Mean ± SD**
Naphthalene	n.d.	0.09	0.08	0.09	0.09 ± 0.00	0.07	n.d.	0.04 ± 0.05
Acenaphthene	0.04	0.47	0.45	0.45	0.46 ± 0.01	0.35	0.13	0.24 ± 0.15
Pyrene	n.d.	0.06	0.06	0.06	0.06 ± 0.00	0.05	0.02	0.04 ± 0.01
Element								
55 Mn	n.d.	0.53	0.43	0.51	0.49 ± 0.05	n.d.	n.d.	n.d.
56 Fe	n.d.	n.d.	n.d.	1.99	0.66 ± 1.15	n.d.	n.d.	n.d.
60 Ni	n.d.	0.11	0.10	0.16	0.12 ± 0.03	n.d.	n.d.	n.d.
63 Cu	n.d.	0.55	0.75	0.38	0.56 ± 0.19	n.d.	n.d.	n.d.
66 Zn	4.71	53.1	50.4	49.5	51.0 ± 1.88	16.0	16.4	16.2 ± 0.23
137 Ba	9.66	118	108	113	113 ± 5.00	120	119	120 ± 1.21
140 Ce	0.08	0.14	0.13	0.12	0.13 ± 0.01	0.24	0.25	0.25 ± 0.00

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Table 2
Organic compounds found in the micronized particles. All concentrations are expressed in μg g^{-1}. a and b are the replicates. OPFRs: organophosphate flame retardants, PAHs: polycyclic aromatic hydrocarbons, PBDEs: polybrominated diphenyl ethers, PCBs: polychlorinated biphenyls.

Compound	Blank	Particles <250 μm			Particles >250 μm		
		a	b	Mean ± SD	a	b	Mean ± SD
OPFRs							
Tributylphosphate	2.87	34.92	40.28	37.6 ± 3.79	34.34	29.94	32.14 ± 3.11
Triethylphosphate	n.d.	7.96	10.87	9.41 ± 2.06	2.28	2.24	2.26 ± 0.03
Triisobutylphosphate	2.81	33.22	40.07	36.65 ± 4.85	34.16	29.79	31.97 ± 3.09
Tris ((2-chloro-1-chloromethyl) ethyl) phosphate	n.d.	4.07	3.43	3.75 ± 0.45	2.61	2.14	2.38 ± 0.33
Tris (2-chloroethyl) phosphate	n.d.	45.71	50.97	48.34 ± 3.72	17.97	18.38	18.17 ± 0.29
Tris (2-chloroisopropyl) phosphate	4.87	282.42	357.74	320.08 ± 53.26	53.02	40.63	46.83 ± 8.76
Pesticides							
Chlorpyrifos	n.d.	1.25	1.29	1.27 ± 0.02	1.45	1.56	1.50 ± 0.08
Hexachlorobenzene	n.d.	0.48	0.49	0.48 ± 0.01	0.49	0.47	0.48 ± 0.01
PAHs							
Acenaphthalene	n.d.	486.62	523.49	505.05 ± 26.07	533.80	517.28	525.54 ± 11.68
Acenaphthene	n.d.	692.11	755.98	724.04 ± 45.17	866.96	839.43	853.19 ± 19.47
Anthracene	n.d.	2520.35	2738.55	2629.45 ± 154.29	3122.36	2962.09	3042.22 ± 113.33
Benzo(a)anthracene	n.d.	1887.82	1914.68	1901.25 ± 18.99	1877.23	1758.49	1817.86 ± 83.96
Benzo(a)pyrene	n.d.	11511.20	11356.30	11433.75 ± 109.53	10530.17	9604.78	10067.48 ± 654.35
Benzo(b)fluoranthene	n.d.	3839.10	4034.41	3936.75 ± 138.11	3485.80	3247.75	3366.78 ± 168.32
Benzo(ghi)perylene	n.d.	4383.43	4690.78	4537.11 ± 217.33	4130.33	3927.81	4029.07 ± 143.2
Benzo(k)fluoranthene	n.d.	494.18	590.14	542.16 ± 67.85	516.49	415.37	465.93 ± 71.5
Chrysene	n.d.	1666.93	1704.06	1685.49 ± 26.26	1570.11	1525.92	1548.01 ± 31.25
Dibenzo(ah)anthracene	n.d.	1738.58	1786.85	1762.72 ± 34.13	1280.05	1067.14	1173.59 ± 150.55
Fluoranthene	n.d.	2869.43	2949.46	2909.44 ± 56.59	2877.22	2780.31	2828.76 ± 68.53
Fluorene	n.d.	938.87	1092.51	1015.69 ± 108.64	1326.12	1278.84	1302.48 ± 33.43
Naphthalene	1.06	644.80	754.90	699.85 ± 77.85	989.59	930.69	960.14 ± 41.64
Phenanthrene	3.35	3595.60	3792.15	3693.88 ± 138.98	4149.21	4081.55	4115.38 ± 47.84
Pyrene	1.73	4249.43	4426.78	4338.11 ± 125.4	4490.09	4091.51	4290.8 ± 281.84
PBDEs							
BDE 47	n.d.	3.05	2.58	2.82 ± 0.33	1.33	1.27	1.30 ± 0.04
BDE 99	n.d.	2.47	2.21	2.34 ± 0.18	1.55	1.39	1.47 ± 0.12
BDE 100	n.d.	1.00	0.94	0.97 ± 0.04	n.d.	n.d.	n.d.
PCBs							
PCB-52	n.d.	1.53	1.59	1.56 ± 0.04	1.84	1.88	1.86 ± 0.03
PCB-77	n.d.	1.30	1.23	1.27 ± 0.05	1.65	1.49	1.57 ± 0.11

We also found a concentration-dependent decrease in larval size (Fig. 4C). Larvae were significantly smaller than the control starting from a concentration of 0.25 g L^{-1}, with the strongest decrease being 45% at the highest concentration. The larvae in both treatments of the larger fraction (25b and 75b) were bigger than in the respective dilutions of the smaller fraction. Similar as for abnormal development, this difference was bigger in the concentration of 0.75 g L^{-1} with an average size of 181 μm in the smaller fraction and 267 μm in the larger fraction.

3.4. Toxicity to copepod nauplii and adults

Both copepod nauplii and adults were significantly affected by the exposure to the leachates. The hatching success of nauplii decreased substantially with increasing leachate concentration, from 89% in the control to a minimum of 29% in the 0.75 g L^{-1} concentration, representing a 67% decrease (Fig. 5A). Even at a concentration of 0.125 g L^{-1}, hatching success was significantly reduced by 41%. Among the hatched nauplii, mortality increased under leachate exposure, reaching a maximum of 46% at 0.75 g L^{-1} (Fig. 5B). In the control, we found only one dead nauplius in one of the three replicates, resulting in an average mortality of 1.5%. There were no significant differences in hatching success or nauplii mortality between the small and large size fractions of the respective dilutions (25 vs 25b, 75 vs 75b). The size of the nauplii ranged between 180 and 200 μm, with a trend of smaller sizes in the highest leachate concentrations (Fig. 5C). While the ANOVA found a significant difference ($p = 0.026$), the posthoc test did not detect significant differences in the pairwise comparisons. The size of nauplii was lowest in the 0.75 g L^{-1} concentration (186.7 μm on average). This treatment was also significantly different from the same concentration of the large size fraction (75b, 194.5 μm on average).

Mortality of adult copepods showed a clear concentration-dependent increase (Fig. 6). While there was no mortality in the control or at the lowest leachate concentrations (0.0625 and 0.125 g L^{-1}), mortality significantly increased to 19% at 0.25 g L^{-1} and reached a maximum of 51% mortality at the highest leachate concentration. There were no significant differences in mortality between the small and large size fractions of the respective concentrations (25 vs 25b, 75 vs 75b).

4. Discussion

4.1. Microalgae

At low and medium leachate concentrations (0.06–0.5 g L^{-1}), the growth of *R. salina* was significantly inhibited by up to 26%, indicating a toxic effect of the leachates. Several other studies reported growth inhibition of microalgae under exposure to plastic leachates (Luo et al., 2019; Schiavo et al., 2021). For *Dunaliella tertiolecta*, this was associated with increases in DNA damage and production of reactive oxygen species (Schiavo et al., 2021). The authors attributed the observed toxicity to the metals in the leachates. The analysis of our leachates revealed the presence of seven metals, although most occurred at low concentrations. Notably though, the average concentration of zinc was 51 μg L^{-1} (Table 1). Growth inhibition of microalgae has been observed for several species at and below this concentration (Wilde et al., 2006; Wong and Chau, 1990). Thus, the observed toxicity might be related to zinc. However, mixtures of metals can result in complex interactions. For instance, Franklin et al. (2002) observed antagonistic effects of zinc and copper in *Chlorella* sp. This complicates the interpretation of potential effect mechanisms. We also detected naphthalene, acenaphthene and pyrene in the leachates, though at much lower concentrations than those found to cause toxic effects in other species of microalgae (Bragin et al., 2016; Kong et al., 2010; Ozhan and Bargu, 2014; Patel and Tiwari, 2015). Even though no toxicity data on these three substances is available for *R. salina*, we deem it unlikely that the observed growth

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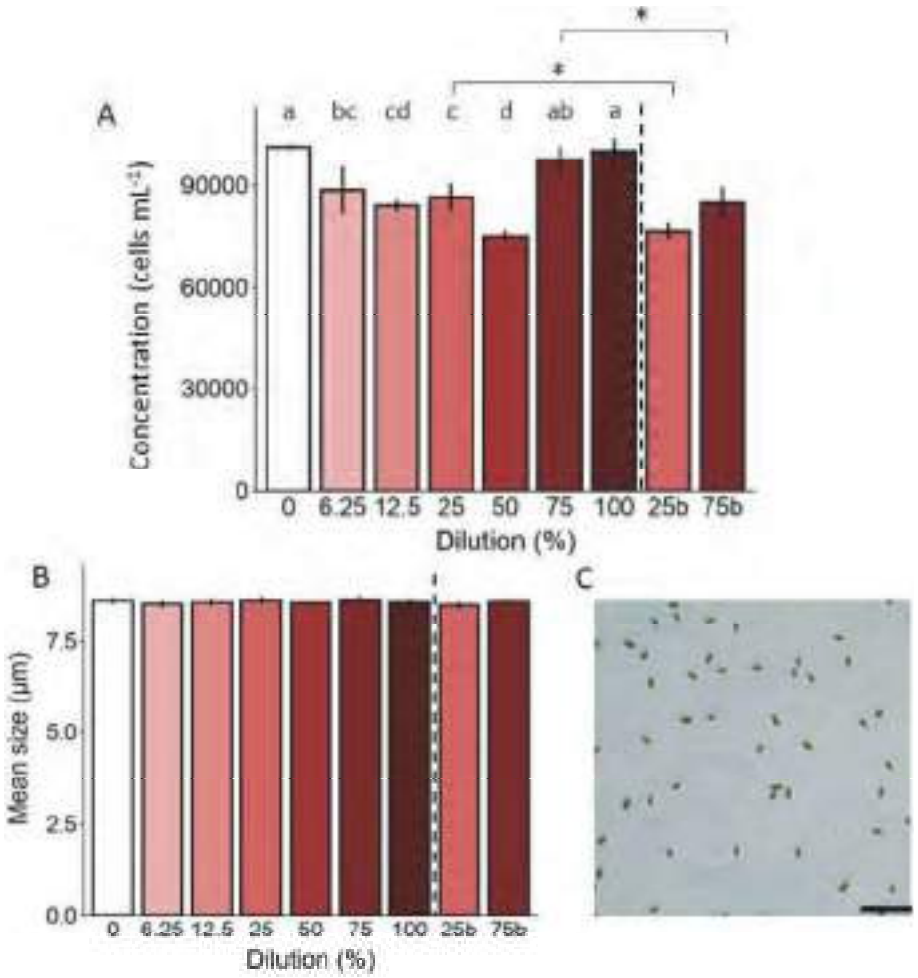

Fig. 3. Abundance (A) and cell size (B) of *Rhodomonas salina* after 72 h exposure to the different leachate dilutions (all made with particles <250 μm, except for 25b and 75b, which were made with particles 250–1000 μm). Data is shown as means ± SD. Small letters indicate the results of Tukey's HSD posthoc test among all treatments with particles <250 μm. Groups that do not share the same letter are significantly different from each other. Asterisks indicate a significant result of a *t*-test. C: Microscope image of *R. salina*. The size of the scale bar is 50 μm.

inhibition was caused by the detected organic compounds.

Surprisingly, at the two highest leachate concentrations we did not find inhibition of growth. In fact, other studies have found that microplastics and plastic leachates can stimulate photosynthesis and subsequently growth of microalgae. Chae et al. (2020) observed enhanced photosynthesis and growth of four species in response to leachates (2 g L^{-1}) of expanded polystyrene. They speculated that trace chemicals in the leachates, such as hexabromocyclododecanes, bisphenol A and UV326, might stimulate photosynthesis. This underlines the complex nature of leachates, being mixtures of chemicals with unknown interactions and combined effects. This complexity greatly hampers the mechanistic understanding of the observed effects.

Our observation of higher growth inhibition in the leachates of the larger size fraction (250–1000 μm) is surprising since the chemical analysis revealed lower concentrations of all detected compounds except for barium and cerium in this fraction. Even though there is no toxicity data for these elements available for marine microalgae, observations with freshwater algae indicate that toxic concentrations are orders of magnitude higher than what we detected in our leachates (Golding et al., 2018; Siciliano et al., 2021). However, our limited target analysis may have missed compounds driving this pattern.

4.2. Sea urchin larvae

Leachate exposure induced abnormal development of *P. lividus* larvae, with an EC_{50} of 0.56 g L^{-1}. This response has also been observed in several studies with other types of plastic leachates (Ferrari et al., 2024; Gambardella et al., 2024; Jimenez-Guri et al., 2023; Martínez-Gómez et al., 2017; Piccardo et al., 2021; Rist et al., 2023; Uribe-Echeverría and Beiras, 2022). Gambardella et al. (2024) analyzed the toxicity of different beach-collected plastic materials using the same method as in the present study and found EC_{50} values in a similar range (0.23–0.82 g L^{-1}). Most other studies reported adverse effects on sea urchin larvae at much higher leachate concentrations. However, the toxicity is highly dependent on the composition of the leachates, which in turn is influenced by the material, the method used for preparing the leachates and the (environmental) fate of the material if it is not virgin. It has been demonstrated that weathering in the field can increase the toxicity of plastic leachates (Ferrari et al., 2024). This could be an important factor in our case since we collected the material four months after the accident, during which period it was subject to weathering.

We found larval size to be a more sensitive response than abnormal development. The length of larvae was already significantly lower in the leachate concentration of 0.25 g L^{-1}, whereas abnormal development only started increasing substantially from 0.5 g L^{-1}. The maximum decrease in length was 45% in the highest concentration, which is very similar to the 49% decrease that was found for leachates of tire wear particles at the same concentration (Rist et al., 2023). Cormier et al. (2021) also reported a decrease in size of *P. lividus* larvae in response to leachates of beach-collected microplastics, although at higher

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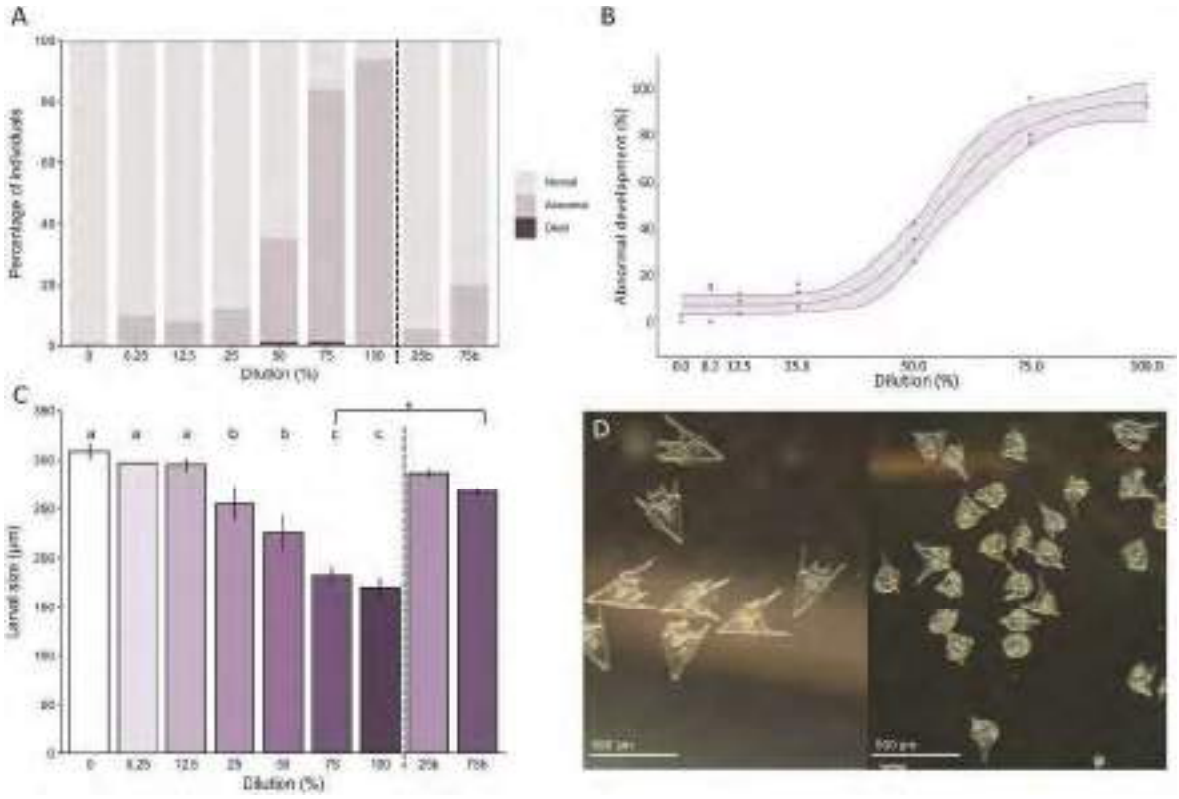

Fig. 4. Development and growth of larvae of *Paracentrotus lividus* after 72 h exposure to a range of leachate dilutions (all made with particles <250 µm, except for 25b and 75b which were made with particles 250–1000 µm). A. Percentage of larvae that were normally developed, abnormally developed or dead. B. Dose-response curve of the percentage of abnormally developed larvae (out of all live larvae at the end of 72 h exposure). The EC_{50} value was 56%. C. Size of the larvae at the end of exposure (means ± SD). 20 individuals were measured per replicate. Small letters indicate the results of Tukey's HSD posthoc test among all treatments with particles <250 µm. Groups that do not share the same letter are significantly different from each other. Asterisk indicates a significant result of a *t*-test. D. Microscope images of normally developed larvae (left, control treatment) and abnormally developed larvae (right, 100% treatment).

concentration (3.3 g L^{-1}).

The leachates of the larger size fraction (250–1000 µm) exhibited a lower toxicity, especially in the higher concentration (75b vs 75, Fig. 4). The smaller surface to volume ratio of larger particles is expected to result in less/slower leaching. This is reflected in our chemical analysis which detected fewer leached compounds and lower concentrations (with two exceptions: Ba and Ce) in the leachates of the larger size fraction (Table 1).

The organic compounds that were detected in our leachates are unlikely to be toxic at the found concentrations (Bellas et al., 2008; Fernández et al., 2006). Also most elements were present at low concentrations (<1 µg L^{-1}), with the exceptions of barium (113 µg L^{-1}) and zinc (51 µg L^{-1}). Barium was reported to cause abnormal development in larvae of *Mytilus californianus* at 200–900 µg L^{-1} (Spangenberg and Cherr, 1996) and to be lethal for embryos of the yellow crab *Cancer anthonyi* at 100 mg L^{-1} (Macdonald et al., 1988). Since no data on barium toxicity to sea urchin larvae is available to date, it remains unclear whether barium could explain some of our observed effects. However, the concentration of zinc overlaps with the reported EC_{50} value for abnormal development of *P. lividus* (49 µg L^{-1}) (Novelli et al., 2003). While zinc is therefore the most likely compound of our leachates to explain the overserved effects, it is important to note that the leachates most likely contained more compounds than we detected. Furthermore, the effects of mixtures cannot be directly inferred from the toxicity of the individual compounds due to complex interactions.

4.3. Copepods

Copepod adults and nauplii showed a similar, concentration-dependent increase in mortality under leachate exposure, both reaching close to 50% mortality at the highest concentrations. Leachates of beach-collected fishing nets caused similar levels of mortality in *A. tonsa* nauplii (LC_{50} 0.9 g L^{-1}) (Gambardella et al., 2024), while a stronger effect (LC_{50} 0.3–0.6 g L^{-1}) was found for leachates of tire wear particles in adults and nauplii of the same species (Bournaka et al., 2023; Moreira et al., 2024). In contrast to our findings, Moreira et al. (2024) reported nauplii to exhibit a slightly higher mortality than adults. In the present study, the hatching success of nauplii was the most sensitive endpoint, with a significant decrease of 41% already at 0.125 g L^{-1} and a minimum of 29% hatching in the highest concentration. This is a stronger response than what was found for leachates of tire wear particles (minimum of 52% hatching at 1 g L^{-1}) (Moreira et al., 2024). Nauplii have previously been described as the most sensitive life stage in copepods (Saiz et al., 2009). Furthermore, Tato et al. (2018) reported several plastic additives to be more toxic to nauplii of *Acartia clausi* than to larvae of *P. lividus*. However, in another study, leachates of beach-collected plastics were more toxic to *P. lividus* than *A. tonsa* (Gambardella et al., 2024). Taken together, these results highlight that sensitivity to leachates does not only vary between species, life stages, and tested materials but also the studied response variables/endpoints.

For *A. tonsa*, we did not find clear differences between the leachates of the two particle sizes (25 vs 25b, 75 vs 75b), in contrast to *P. lividus* and *R. salina*. This could indicate that the observed toxicity in the three species is caused by different compounds or their mixtures in the leachates. The concentrations of the three organic compounds in our leachates are far below levels that are toxic to copepods (Bellas and Thor, 2007; Calbet et al., 2007; Krause et al., 2017; Saiz et al., 2009). The same is true for the detected elements (Arnott and Ahsanullah, 1979; Jensen et al., 2016; Madhupratap et al., 1981), except for zinc, for which Bielmyer et al. (2006) found effects on the reproduction of

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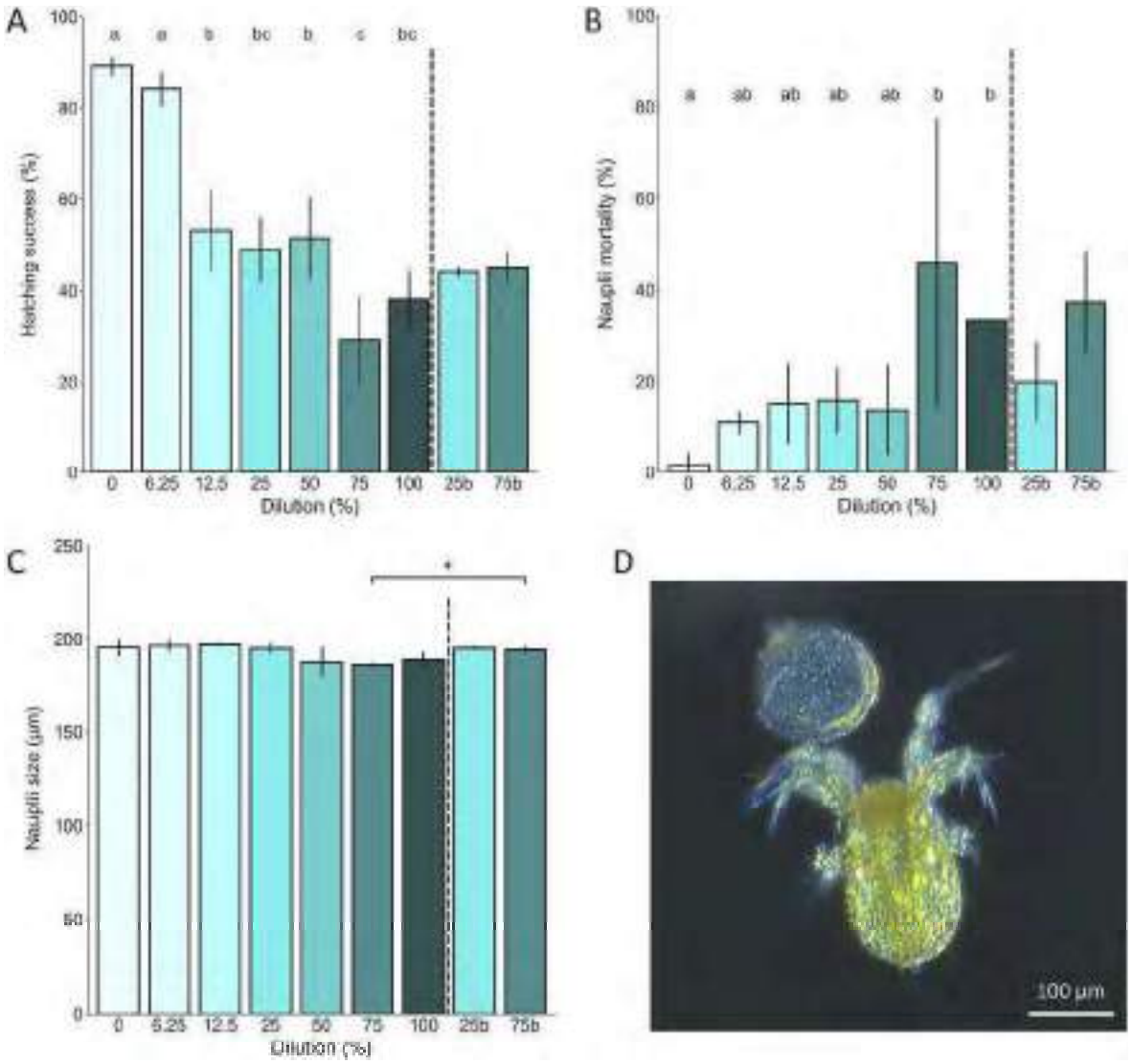

Fig. 5. Hatching, survival and growth of nauplii of *Acartia tonsa* after 72 h exposure to a range of leachate dilutions (all made with particles <250 µm, except for 25b and 75b which were made with particles 250–1000 µm). A. Percentage of hatched individuals. B. Mortality of hatched nauplii. C. Size of the nauplii at the end of exposure. Data is shown as means ± SD. Small letters indicate the results of Tukey's HSD posthoc test among all treatments with particles <250 µm. Groups that do not share the same letter are significantly different from each other. Asterisk indicates a significant result of a *t*-test. D. Microscope image of a live nauplius, next to an eggshell.

A. tonsa at 0.4 µg L^{-1}, although this was through dietary exposure. As discussed above, the observed toxicity of our leachates is therefore likely due to undetected compounds and/or the chemical mixture.

4.4. Chemical analysis

Of the 28 organic compounds that we detected in the micronized particles, only three were present in the leachates. Longer exposures or other leaching media would likely have given different results. Compounds which have a higher log Kow are less likely to leach into water but may leach into organisms upon ingestion, as has been shown for example for benzotriazole UV stabilizers in plastic pellets (Tanaka et al., 2020; Yamashita et al., 2021). Since the samples were collected four months after the accident, it is possible that some compounds had already degraded or leached to the environment. This is supported by the finding of James et al. (2023) that the PAH content of the spilled pellets and burnt plastics decreased by almost 50% within some weeks after the accident. At the same time, the pellets and burnt clumps may have sorbed other pollutants from the surrounding water. It is difficult to determine the origin of the compounds that were present in the particles. The PAHs most likely stem from the fuel oil of the ship (of which it carried 348 tons) as well as combustion processes during the accident. Also James et al. (2023) found evidence for petrogenic and pyrogenic sources of the PAHs. The flame retardants (OPFRs and PBDEs) could originate from materials on the ship since these chemicals have been used widely for decades (Pantelaki and Voutsa, 2019). However, they could also have sorbed to the pellets and burnt clumps in the environment. Both groups of flame retardants have been detected in marine waters (Pantelaki and Voutsa, 2019; Turner, 2022). The PCBs and pesticides are unlikely to originate from the ship since PCBs have been banned for decades and we have no information on pesticides being among the cargo of the X-Press Pearl. It is therefore probable that these came into contact with the pellets and burnt clumps in the marine environment. This is supported by the fact that other studies have found PCBs and pesticides sorbed to pellets in marine waters worldwide (Camacho et al., 2019; Le et al., 2016; Taniguchi et al., 2016).

The majority of organic compounds were present in similar concentrations in the two size fractions of particles (Table 2) but in the

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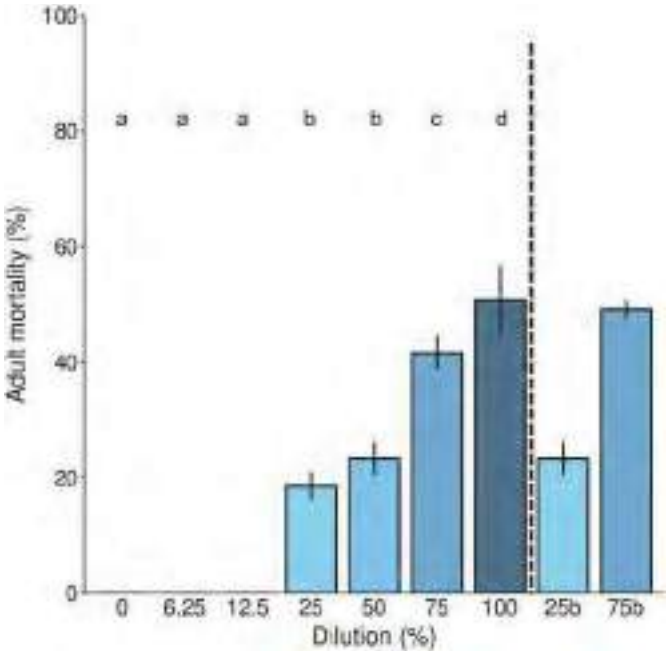

Fig. 6. Mortality of adult *Acartia tonsa* females after 72 h of exposure to a range of leachate dilutions (all made with particles <250 μm, except for 25b and 75b which were made with particles 250–1000 μm). Data is shown as means ± SD. Small letters indicate the results of Tukey's HSD posthoc test among all treatments with particles <250 μm. Groups that do not share the same letter are significantly different from each other.

leachates the concentrations were consistently higher in the smaller size fraction (Table 1). This is caused by the higher surface to volume ratio and demonstrates that particle size is an important factor to consider when comparing leachate studies. Although we analyzed more than 300 compounds, target analysis has the limitation that compounds not included in the method may still have been present in the particles and leachates. For instance, Rubesinghe et al. (2022) found benzotriazole UV stabilizers and bisphenol A in the same materials. Since we did not analyze these, it is unknown whether they were present in the leachates. This emphasizes the importance of well-defined suspect or preferably non-target analyses for the characterization of leachates. Still, also a limited target analysis of the chemicals associated with plastic debris gives valuable information and is recommended to be included more widely within plastic research.

4.5. Implications for the marine environment

Considering the large volumes of spilled materials and substances resulting from the X-Press Pearl accident, it is likely that the plankton community was affected. Adverse effects could persist for a long time, since the burnt clumps remain and degrade/fragment over time, continuing to leach chemicals. The debris were observed to spread with currents (de Vos et al., 2022; Partow et al., 2021), implying that large areas were polluted.

The organism groups tested here are key players in marine food webs and have vital ecological functions globally. Phytoplankton such as *R. salina* are important for primary production (Duarte and Cebrián, 1996; Mattei et al., 2021) and as a food source for zooplankton. Copepods are the most abundant animals in the oceans and important grazers of phytoplankton (Cornils et al., 2018; Humes, 1994), playing a big role in transferring energy to higher trophic levels. Meroplankton, such as larvae of sea urchins, are vital for the recruitment of benthic invertebrate populations (Cowen and Sponaugle, 2009; Treml et al., 2008), which perform many functions including habitat formation (e.g., Commito et al., 2008), improving water and sediment quality (e.g., Fenske, 2002), and serving as an important food source, not only for marine animals but also humans. Thus, big-scale consequences in marine ecosystems are possible when these organisms are affected by pollution.

5. Conclusions

Shipping accidents and associated spills lead to complex pollution of the marine environment. Our study illustrates the broad toxicity that such a spill can have on three major groups of plankton (phytoplankton, meroplankton, holoplankton). Even several months after the accident, the collected debris adversely affected all tested species. Sensitivity, however, differed between species, with nauplii of *A. tonsa* being especially sensitive and *R. salina* being most tolerant. Despite extensive cleaning efforts, the large quantities of spilled material and the wide spread of the debris deem it likely that negative impacts from the X-Press Pearl accident on the affected area continue for a long time. With the increase in global shipping, it is of paramount importance to reduce the risk for accidents and spills from ships. Important steps are to improve the handling and packaging of dangerous goods, as well as their declaration and documentation.

CRediT authorship contribution statement

Sinja Rist: Writing – original draft, Investigation, Formal analysis, Conceptualization. **Kevin Ugwu:** Writing – review & editing, Investigation, Formal analysis. **Marta Sampalo:** Writing – review & editing, Investigation, Formal analysis. **Therese M. Karlsson:** Writing – review & editing, Resources, Conceptualization. **Chalani H. Rubesinghe:** Writing – review & editing, Resources. **Andrea Acosta-Dacal:** Writing – review & editing, Investigation, Formal analysis. **Octavio Pérez-Luzardo:** Writing – review & editing, Resources. **Manuel Zumbado:** Writing – review & editing, Investigation, Formal analysis. **Rodrigo Almeda:** Writing – review & editing, Resources, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envres.2025.121260.

Data availability

Data will be made available on request.

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Microplastics and food shortage impair the byssal attachment of thick-shelled mussel *Mytilus coruscus*

Yueyong Shang [a,f,1], Huaxin Gu [a,f,1], Shanglu Li [c], Xueqing Chang [a,f], Inna Sokolova [d,h], James K. H. Fang [e], Shuaishuai Wei [a,f], Xiang Chen [a,f], Menghong Hu [a,f], Wei Huang [b,g,**], Youji Wang [a,b,f,*]

[a] International Research Center for Marine Biosciences, Ministry of Science and Technology, Shanghai Ocean University, Shanghai, 201306, China
[b] State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, 310012, China
[c] Zhejiang Ocean Monitoring and Forecasting Center, Hangzhou, 310007, China
[d] Department of Marine Biology, Institute for Biological Sciences, University of Rostock, Rostock, Germany
[e] Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
[f] Key Laboratory of Exploration and Utilization of Aquatic Genetic Resources, Ministry of Education, Shanghai Ocean University, Shanghai, 201306, China
[g] Key Laboratory of Marine Ecosystem Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, 310012, China
[h] Department of Maritime Systems, Interdisciplinary Faculty, University of Rostock, Rostock, Germany

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ABSTRACT

Microplastics (MPs) have become a ubiquitous emerging pollutant in the global marine environment. The potential toxic effects of MPs and interactions of MP pollution with other stressors such as food limitation on marine organisms' health are not yet well understood. This study investigated the effects of three-week exposure to different MPs and food shortage on the physical defense mechanisms (byssus production and properties) of *Mytilus coruscus*. Starvation significantly reduced the number of byssus threads, and combined exposure to MPs and food shortage suppressed the adhesion ability and condition index of mussels. The length of the byssus threads was not affected by all experimental exposures. Transcript levels of genes encoding key proteins involved in byssus formation (the mussel foot proteins mfp-1, -2, -3, -4, -5 and -6, and prepolymerized collagen proteins preCOL-D, -P and -NG) were altered by interactions between the MPs and food shortage. These findings show that insufficient food supply can exacerbate the adverse effects of MPs on mussel defense which might have implications for survival and fitness of mussels under food limited conditions (e.g. in winter) in polluted coastal habitats.

1. Introduction

Microplastics (MPs) are broadly distributed and easily transported in the marine environment by wind, land runoff, and ocean currents (Derraik, 2002; Scheurer and Bigalke, 2018). Microplastic pollution is an emerging problem in the marine environment of increasing societal and environmental concerns across the world (Wang et al., 2020a). The impacts of microplastics on marine ecosystems are a matter of intensive investigation and heated debate (Backhaus and Wagner, 2020; Bucci et al., 2020), but many gaps still exist in our knowledge concerning the environmental hazards and risk assessment of microplastics in marine organisms. MPs are almost omnipresent in marine ecosystems and have been found across different trophic levels of the food web and in different tissues of contaminated animals (Browne et al., 2008; Fang et al., 2021). Many marine groups such as benthic filter feeders (including marine bivalves) are potentially exposed to high levels of microplastics, yet the potential harmful biological effects of MPs and the mechanisms underlying these effects are not well understood (Peng

* Corresponding author. International Research Center for Marine Biosciences, Ministry of Science and Technology, Shanghai Ocean University, Shanghai, 201306, China.
** Corresponding author. State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, 310012, China.
E-mail addresses: willhuang@sio.org.cn (W. Huang), youjiwang2@gmail.com (Y. Wang).
[1] These authors contributed equally to this work.

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et al., 2020; Tang et al., 2020).

Marine mytilid mussels have worldwide distribution and play a key role in marine communities serving as ecosystem engineers and a link between producers and higher-level consumers transferring energy, nutrients and accumulated contaminants to the higher levels of the trophic web (Buschbaum et al., 2009; Harris and Carrington, 2020). As significant marine bivalve species with important economic value, the thick shell mussel *Mytilus coruscus* is mainly distributed in waters around the Yellow Sea and the East China Sea (Wang et al., 2020b). Recently, microplastics have been detected along the coast of these seas, where are the habitat of mussels (Zhao et al., 2014; Luo et al., 2019; Teng et al., 2019). Like all suspension feeders, mussels are sensitive to the presence of suspended particles in the water including the MPs (Harris and Carrington, 2020). High concentrations of suspended particles with no nutritional quality such as MPs can interfere with the normal function of the filtration apparatus of the mussels, and potentially have negative downstream effects due to the interference with digestion, mechanical damage or toxicity [reviewed in (Li et al., 2019a)]. Studies showed that MPs can impair feeding behavior, cause physiological disorders and inhibit growth of mussels (Pedersen et al., 2020). Wang et al. (2021) found that physiological effects of plastic particles on the thick shell mussels *Mytilus coruscus* are mediated by food presence. Impaired feeding due to MPs combined with other stressors such as food deficiency (carbon limitation in winter) (Sutherland et al., 2016) could negatively affect the fitness and health status of the mussels leading to trade-offs between energy-demanding processes such as growth, reproduction or defense mechanisms (Sokolova, 2021).

Marine mussels use complex fibrous protein holdfast structures (called byssus threads) with adhesion plaques to attach to hard substrates that enable mussels to inhabit variable marine environments and resists mechanical stresses due to tides or wave action (Hagenau et al., 2014; Li et al., 2019b). The mechanical strength of byssus has important biological consequences for mussels affecting life-history traits, survival, and population dynamics (Carrington, 2002). The byssus threads consist of fibrous chimeric collagens, such as preCols, embedded in a microfibrillar matrix (Sun et al., 2002). At the end of each byssal thread, the adhesive plaque is formed containing a series of mussel foot proteins (MFPs), ensuring attachment to the hard substrate (Lin et al., 2007). Byssus production is energetically costly in mussels accounting from 2 to 10% to almost 50% of daily energy budget depending on the rate of the byssus production (Roberts et al., 2021). Therefore, feeding disturbances due to MP exposures and/or insufficient food availability can impair byssus production due to energy limitations. Furthermore, exogenous environmental contaminants such MPs could adhere or incorporate into the byssus of mussels, potentially impairing the performance of the byssal threads and affecting survival of the mussels (Li et al., 2019b). Weak attachment strength of the byssus might result in the mussels losing hold on the substrate which may interfere with their ability to form natural dense colonies in benthic habitats or cause a decrease of the productivity and commercial yield of the cultured mussels (Martins et al., 2010; Seguin-Heine et al., 2014).

The byssus threads are produced in the ventral groove of the mussels' foot in a complex biologically regulated process that involves deposition and post-translational modification of a highly specific ensemble of 3,4-dihydroxyphenyl-L-alanine (DOPA)-containing proteins including MFPs and prepolymerized collagens (preCOLs) (Lin et al., 2007; Waite, 2017). Like most tightly orchestrated biosynthetic activities, byssus deposition is prone to disturbances by stressors (Newcomb et al., 2020; Waite, 2017), and thus might be sensitive to MPs exposure and food deficiency. However, the potential impacts of MPs and food limitation on this important physical defense mechanism in mussels and the molecular mechanisms associated with these impacts are not yet understood and require further investigation.

The goal of this study was to determine the combined impacts of MPs exposure and food limitation on the physical defense mechanisms (including the number, length, and adhesion strength of the byssus threads) in the thick shell mussel *Mytilus coruscus,* and to test whether the variability in the byssus amount and properties correlate with the overall physiological status (condition index) of the mussels. To gain insight into the potential molecular mechanisms involved in the impaired byssus production, we determined the transcripts of key genes encoding byssus proteins and prepolymerized collagen proteins. The mussels were exposed for three weeks to control conditions (no MPs) and to 2.5 μg/L of polystyrene fluorescent microspheres (2 μm diameter) under two different food supply conditions (unfed and fed ad libitum with *Chlorella vulgaris*). We hypothesized that exposure to MPs and food shortage would reduce the quantity and quality of mussel byssus, and that the impairment of the byssus production will be greater in the mussels with stronger energy deficit (indicated by lower condition index). We also hypothesized that a decrease in the quantity, length or adhesion strength of the byssus might reflect transcriptional suppression or dysregulation of the MPF or preCOL proteins in the mussel foot. This study provides insights into the potential hazards of MPs exposures (alone or combined with food shortage) on an important fitness trait of the mussels that has relevance for the population performance in native habitats and the sustainable development of mussel culture.

2. Materials and methods

2.1. Animals

Totally 500 mussels (wet mass 60.0 ± 5.6 g, shell length 7.5 ± 0.2 cm) were collected from Gouqi Island, Zhejiang, China (30° 43′ 14.268″ N, 122° 47′ 0.3696″ E). The attachments on the surface of the mussel shells were removed, and the healthy mussels with intact shells were placed in a circulating aquaculture system supplied with filtered artificial seawater (ASW). The mussels were kept for 2 weeks at pH 8.08 ± 0.3, ASW salinity 26.0 ± 1.2 PSU, temperature 26.0 ± 1.6 °C, 12 h light: 12 h darkness (comparable to sampling site) to adjust to the laboratory environment, and fed with *Chlorella vulgaris* at a concentration of 2.5 × 10^4 cells/ml twice a day.

2.2. Experimental design

A 2 × 2 full factorial design was used with two MP exposure treatments: 0 μg/L (control) and 2.5 μg/L MPs; and two feeding treatments: no feeding (starvation) and fed twice daily with 2.5 × 10^4 cells/ml *C. vulgaris* (fed groups), resulting in a total of four experimental groups. The concentration of MPs chosen for the experiments was within the range of environmentally relevant concentrations (~3–23 μg/L) reported for contaminated areas (Green et al., 2017). Fluorescent polystyrene microspheres (2 μm, 2.5% w/v) used as model MPs were purchased from BaseLine Chromtech Research Center (Tianjin, China), and the concentration was diluted to one tenth of the original value as the stock solution. For MP exposure, we carefully cut off the byssus threads and transferred mussels into 10 L small glass tanks filled with 8 L (including 8 μl stock solution) of ASW. Water was aerated, and 2.5 × 10^4 cells/ml of *C. vulgaris* (The concentrated algae solution was diluted and counted by the Coulter counter) were added twice daily (6:00 and 18:00) to the tanks containing the fed groups. For each of the four experimental treatments, three replicate tanks were used with the density of 8 mussels per tank. The food residues and feces in each tank were removed, and the ASW was completely replaced daily. The experiment lasted for three weeks, during which time no dead mussels were observed. On the last day of exposure, the indicators related to the physical defense performance of mussels were tested.

2.3. Measurement of parameters

2.3.1. The properties of byssus and condition index

Following exposures, the ASW was gently removed from the tanks (to simulate air exposure during low tide), and five mussels per group

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attached to the bottom of the tank were selected for adhesion testing. The maximum force needed to break away the byssus of the mussel from the bottom of the tank was measured with a dynamometer and considered a proxy for the adhesion strength. With the help of knife byssal plaques were completely stripped away, and the remaining mussels were removed from the tank. Then the shell of mussels (5 per group) was opened and the byssus threads were cut close to the foot with a scissor. The number of byssus threads (NBT) was recorded, and the length was measured by a vernier caliper to the nearest 0.1 mm. Five mussels per group were dissected to separate the soft tissues and shells and dried to constant mass at 60 °C. Condition index (CI) was calculated as follows (Parker et al., 2012):

$$CI = \frac{dtw\ (g)}{dsw\ (g)} \times 100$$

where CI is the condition index, dtw is the dry soft tissue mass (g) and dsw is the dry shell mass (g).

2.3.2. Relative expression of byssus protein gene

The foot of individual mussels (3 per group) was dissected and immediately frozen at −80 °C. Total RNA was extracted from tissues using Trizol Reagent (Invitrogen, CA, USA) according to the manufacturer's instructions. Reverse transcription of DNase-treated RNA was carried out using reverse transcription kit (PrimeScript RT reagent Kit with gDNA Eraser, TaKaRa, Shiga, Japan). Real-time quantitative PCR (qPCR) was performed on ABI 7500 (Applied Biosystems, CA, USA) with SYBR Premix Ex TaqTM (TaKaRa, Shiga, Japan) to quantitate gene expression. Gene-specific primers were synthesized according to Zhao et al. (2017) and the amplification efficiency of the primers was verified by the standard curve (Table 1). The amplification conditions were as follows: 95 °C for 2 min; 40 cycles of 95 °C (15 s), 60 °C (40 s). The mRNA expression levels of the target genes were normalized to 18s rRNA using the $2^{-\Delta\Delta Ct}$ method (Livak and Schmittgen, 2001).

2.4. Statistical analyses

SPSS 25.0 (SPSS Inc., Chicago, IL, USA) was used to test the normality and homogeneity of variance of the data. Two-way ANOVA was used to test the effects of MPs, food and their interactions on the studied traits. Both factors were treated as fixed, with two levels each. Unpaired *t*-test was used to analyze the differences between the pairs of means of interest. The correlation between variables was calculated according to the Pearson coefficient (r). Effects were considered significant if $p < 0.05$.

3. Results

In the absence of MP exposure, the adhesion strength, the number of byssus threads (NBT) and condition index (CI) of the mussels were significantly suppressed by starvation ($p < 0.05$). In MP-exposed mussels, only the NBT (but not the adhesion or CI) significantly decreased in response to starvation ($p < 0.05$). In well-fed mussels, MPs exposure significantly decreased the adhesion and CI of mussels ($p < 0.05$), but did not affect the NBT ($p > 0.05$). In starved mussels, MPs exposure significantly reduced the CI ($p < 0.05$), but not the adhesion or NBT ($p > 0.05$). None of the experimental treatments affected the length of the byssus threads of mussels ($p > 0.05$) (Fig. 1A–D). There was a significant interaction between MPs and food treatment on the adhesion strength of mussels (Supplementary Table 1). The adhesion strength was positively correlated with the NBT and CI of mussels ($p < 0.05$), and the NBT was also positively correlated with CI of mussels ($p < 0.05$) (Fig. 2 A, B).

The mRNA expressions of nine studied genes encoding byssus thread proteins were modulated by exposure to MPs, feeding conditions and their interactions. In the absence of MP exposure, starvation induced a significant increase in the relative mRNA expression of mfp-1, mfp-6, preCOL-D and preCOL-NG ($p < 0.05$), but significantly suppressed the relative expression of mfp-2, mfp-4 and mfp-5 ($p < 0.05$). In the absence of MPs stress, the relative expression of mfp-3 and preCOL-P did not change in response to starvation ($p > 0.05$). In MP-exposed mussels, starvation upregulated mRNA expression of mfp-3 and mfp-6 ($p < 0.05$), but significantly suppressed the relative expression of mfp-4, mfp-5 and preCOL-P ($p < 0.05$). The relative expression of mfp-1, mfp-2, preCOL-D and preCOL-NG were not affected by starvation in MP-exposed mussels ($p > 0.05$) (Fig. 3 and Fig. 4).

In well-fed mussels, MPs exposure significantly downregulated the mRNA levels of mfp-2, mfp-3, mfp-4 and mfp-5 ($p < 0.05$), but significantly increased mfp-1, preCOL-D, preCOL-P and preCOL-NG transcript levels ($p < 0.05$). No significant effect of MP exposure on mfp-6 was observed in well-fed mussels ($p > 0.05$). In starved mussels, MPs exposure significantly suppressed the relative expression of mfp-1, mfp-5, mfp-6, preCOL-D and preCOL-NG ($p < 0.05$), but had no effects on the relative expression of mfp-2, mfp-3, mfp-4 and preCOL-P ($p > 0.05$) (Figs. 3 and 4). Significant interactions between the effects of MPs and feeding were detected for mRNA levels of mfp-1, mfp-2, mfp-3, mfp-4, mfp-5, preCOL-D, preCOL-P, and preCOL-NG genes (Supplementary Table 2).

4. Discussion

Mussels fix themselves to a hard substrate or to the shells of each other by tensile protein-containing byssus threads to resist the impact of waves and predation by natural enemies (Carrington, 2002). The performance of byssus threads is therefore an important factor that determines whether the mussels can survive on the wave-swept shores and defend against predators. Our present study showed that MPs exposure and food shortage significantly reduced the adhesion strength of mussels as well as the number of the produced byssus threads. An earlier study in a related species, *Mytilus edulis*, also found a decrease in the attachment strength of mussels under MPs exposure (Green et al., 2019). Similar to our present study, starvation suppressed the byssus production in freshwater zebra mussels (*Dreissena polymorpha*) (Clarke, 1999) and in juveniles of *Mytilus galloprovincialis* (Babarro et al., 2008). The weakened attachment strength increases the risk of mussels being removed from the adhering substance, and further hinders the formation of

Table 1
The primer information of the genes detected by qPCR.

Gene	Accession No.	Forward primer (5′–3′)	Reverse primer (5′–3′)
18s rRNA	EF613242	CCTTGGTGCTCTTGATTGA	GAACTACGACGGTATCTGAT
Mfp-1	JQ794825	TGGCTACAATTCAAGAACTG	AGAGAAGGATGAGAACGAAT
Mfp-2	KP876473	CGGTCACAGAAGCATCAT	CATCCTCATCGTCGTCATAT
Mfp-3	GQ281052	TTTGCTGGCTTTAGTCCTT	ACCGCTATTCCATCCCTTA
Mfp-4	DQ351535	ACATATTCACAGCCACCAA	TCACCGTATGATTCAAGACA
Mfp-5	GQ281053	TTGGTGCTCGTTCTTGTAA	TGCTACTGCCTCCATAATG
Mfp-6	GU321214-GU321222	CGGTGATTATGATTACAGAGG	GAAGACAGCATCCAGCAT
preCOL-D	EU120661	ACCAAGAGGAGATAGAGGAG	GGCTGTTCTGAGGTCTTC
preCOL-P	EU120663	GATCTTCACATGCATCAGC	CACTGCCACCTCCTAAAC
preCOL-NG	EU120662	ACAAGGACCACAAGGAGAA	ACACCACCAACACCAGTT

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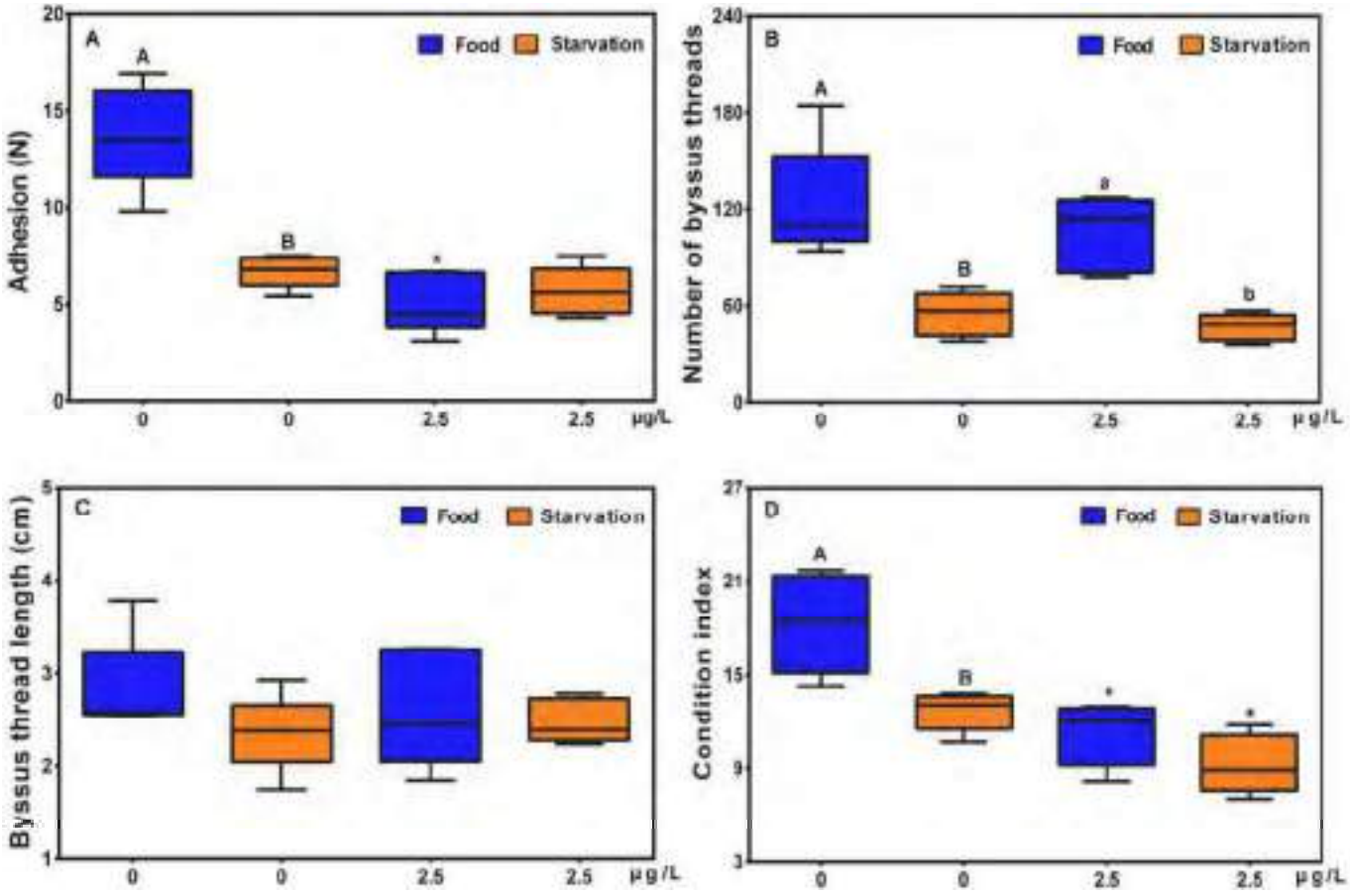

Fig. 1. Adhesion (A), number of byssus threads (NBT, B), byssus thread length (C) and condition index (CI, D) of *M. coruscus* exposed to MPs and different food condition for three weeks.

Letters indicate comparisons between the well-fed and starved groups of mussels within the same MP treatment (uppercase letters – comparisons within the control group, lowercase letter – comparisons within the MP-exposed groups). If the columns do not share a letter, the respective values are significantly different ($p < 0.05$). Shared letter or the absence of letters indicates that the values do not differ between the well-fed and starved mussels ($p > 0.05$). An asterisk indicates a significant difference between the control and MP- exposed groups when compared under the same feeding conditions ($p < 0.05$).

mussel aggregates (Zhao et al., 2017). The formation of mussel aggregates not only improves the success rate of fertilization, but also provides shelter and anti-disturbances for individuals (Liu et al., 2011; Christensen et al., 2015). Therefore, microplastics and food shortages not only increase the risk of predation of mussels, but also reduce the density of mussel populations. Taken together, these findings indicate that byssus production (and consequently, the adhesion strength) of the mussels is sensitive to environmental disturbances and can serve as a proxy of the organismal stress. Unlike the observed plasticity in the byssus thread number, the average length of the threads was conserved in *M. coruscus* and did not change in response to MPs or starvation.

It has been proposed that the MPs can be embedded in the newly secreted byssus of the mussels (Li et al., 2019b) thereby impairing the mechanical properties of byssus threads. In our study, we did not determine incorporation of MPs into byssus and this hypothesis must deserve further investigation. Alternatively, suppressed adhesion capacity of the mussels might be a direct consequence of energy deficiency induced by MP exposure. Thus, the condition index of MP-exposed mussels was lower than in their control counterparts regardless of the feeding conditions. Condition index (CI) reflects the overall health and physiological state of the mussels (Galvao et al., 2015) and commonly correlates with the energy-dependent activities such as gametogenesis, growth and reproduction of bivalves (Bressan and Marin, 1985; Lucas and Beninger, 1985). Condition index is directly correlated with the energy status of bivalves, and nutritive stress or excessive energy demand commonly causes a decline in the CI due to suppressed growth and the loss of glycogen and protein stores (Gabbott and Bayne, 1973; Gabbott and Walker, 1971). Since byssus production is energetically expensive (Roberts et al., 2021), bioenergetic disturbance caused by MP exposure may limit the energy allocation into byssus production decreasing the number of the produced threads and as a consequence, the adhesion strength. This energy limitation hypothesis is supported by the observation of a lower number of byssus threads and suppressed adhesion strength in the starved mussels in both the control and (in the case of NBT) MP-exposed groups of *M. coruscus*. The link between the energy status of the mussels and the byssus properties is further corroborated by significant positive correlations of the adhesion strength and the NBT with the condition index of individual mussels ($p < 0.05$).

The mechanisms of MP-induced energy deficiency in mussels are not known. Suspended MPs can directly interfere with food uptake and digestion capacity of the mussels (Harris and Carrington, 2020; Wang et al., 2020b), but whether these effects occur at low MP concentrations (2.5 μg/L) used in our present study, is unknown. MP exposure might also cause energy disturbance indirectly, due to the elevated levels of cellular stress and tissue damage (Sokolova, 2021). Thus, the ingestion of MPs may cause apoptosis and tissue necrosis in mussels, and reduce the stability of lysosomal membranes and phagocytic activity, which eventually cause toxicity and increase energy demand for stress protection and damage repair (Avio et al., 2015; Canesi et al., 2015; Detree and Gallardo-Escarate, 2017; e Silva et al., 2016; Goncalves et al., 2019; Magni et al., 2018).

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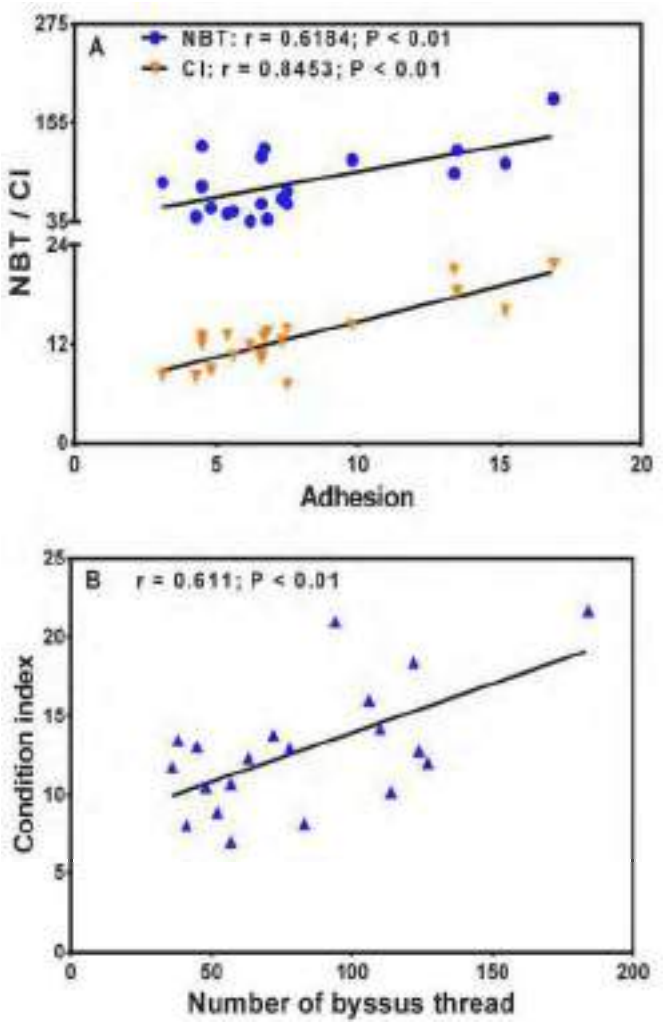

Fig. 2. Correlation analysis between number of byssus threads, condition index and adhesion (A) and between condition index and number of byssus threads (B) in *M. coruscus* exposed to different levels of MPs and feeding conditions.

Exposures to MPs and starvation strongly altered the transcript levels of key byssus protein-encoding genes in *M. coruscus* in stress- and gene-specific fashion indicating that the transcriptional responses of byssus proteins might be mediated by different regulatory mechanisms in starved and MP-exposed mussels. Furthermore, genes encoding different functional groups of byssus proteins (such as the protective coating proteins, adhesive glue proteins, or internal structural and tensile proteins) were differently affected by MP exposure and starvation. Thus, Mfp-1, the only byssus cuticle protein that serves as protective coating of the byssus plaque (Lin et al., 2007), was transcriptionally upregulated in *M. coruscus* in response to MP exposure and starvation. Mfp-1 has the physical properties of weak adhesion, high stiffness and ductility, and its secondary structure is sensitive to temperature and pH (Hwang and Waite, 2012). Upregulation of mfp-1 mRNA might thus indicate increased investment into the external protection of the byssus adhesion plaque under the stressful conditions of MPs exposure and starvation. It is worth noting that the combined stress of starvation and MPs has dampened transcriptional upregulation of mfp-1, indicating that multiple stressors might hinder the secretion of the protective coating of the byssus adhesion plaque.

The transcript levels of the proteins that constitute the core of the adhesion plaque and contribute to its internal structure (including mfp-2 and mfp-4) (Hwang et al., 2010) were downregulated in response to MPs exposure and starvation in *M. coruscus*. Mfp-2 is the most abundant protein in the adhesion plaque that plays a stabilizing role in the plaque (Hwang et al., 2010), whereas Mfp-4 connects the byssal thread to the adhesive plaque (Waite, 2017; Zhao and Waite, 2006). Mfp-2 also interacts with the adhesive "glue" proteins (Mfp-3 and/or Mfp-5) that attach the byssal plaque on substrate (Hwang et al., 2010). The observed decrease in mfp-2 and mfp-4 expression in response to MPs and starvation might therefore impair the structure and stability of the adhesion plaque and contribute to the observed decrease in the adhesion strength of the byssus in the MP-exposed and starved mussels.

The mussel foot proteins Mfp-3, Mfp-5, and Mfp-6 are located at the contact interface between the byssal plaque and the substrate (Kan et al., 2020). Among these proteins, Mfp-3 and Mfp-5 play a critical role in adhesion (Lin et al., 2007; Waite, 2017). In our present study in *M. coruscus*, exposure to MPs downregulated the transcription of mfp-3, -5 and 6, indicating that a decrease in the expression of the adhesive proteins at the byssus-substrate interface might contribute to the compromised attachment capacity of the mussels. Interestingly, the effects of starvation on the transcription of the adhesion proteins were more complex. Starvation suppressed mRNA expression of mfp-5 and increased expression of mfp-6 in *M. coruscus*. Interestingly, Mfp-5 may be related to the ability of mussels to adhere to calcareous matrix materials such as shells (Waite and Qin, 2001), so the reduction of its relative expression level might negatively affect aggregation of the mussels, which would impair their ability to resist natural enemies or dry exposure. Effects on starvation on mfp-3 mRNA levels were dependent on the MP-exposure, so that in the control mussels starvation had no effect on mfp-3 transcripts, whereas in the MP-exposed mussels starvation upregulated mfp-3 mRNA levels partially compensating for the MP-induced suppression. Overall, our present study indicates, transcriptional dysregulation of the adhesion plaque proteins may result in the altered structure, stability and surface interactions of the byssus plaque at the molecular level that might compound the earlier mechanical defects in the byssus structure caused by MP incorporation (Li et al., 2019b).

The mRNA expression levels of prepolymerized collagen proteins preCOL-D, preCOL-P and preCOL-NG were upregulated in response to starvation in *M. coruscus* in the absence of MPs stress, indicating an increase in the deposition of byssus thread fiber. In the well-fed mussels, MPs exposure also led to transcriptional upregulation of all three studied prepolymerized collagen proteins. Since the length of the byssus threads did not change in response to starvation in *M. coruscus*, elevated transcription of byssus fiber proteins observed in the well-fed MP exposed or starved control mussels might indicate deposition of thicker byssus threads. We did not measure the diameter of the byssus threads and this hypothesis requires further investigation. Exposure to MPs modified the transcriptional response of prepolymerized collagen proteins to starvation. Thus, in starved mussels, the exposure to MPs suppressed the expression of preCOL-D and preCOL-NG. This might negatively affect the toughness and elasticity of the distal end of the byssus thread fiber (determined by preCOL-D) (Waite et al., 1998), and impair formation of the bridge between the preCOL-P and preCOL-D, for which preCOL-NG is responsible (Qin and Waite, 1995). Furthermore, under the combined stress of MPs exposure and starvation, a significant decrease in the expression of the preCOL-P gene was observed, which might contribute to the impairment of the internal structure of the byssus thread fiber. An earlier study in mussels also found suppressed expression of preCOL-P and preCOL-NG and elevated expression of preCOL-D mRNA increased under acidification conditions (Zhao et al., 2017) which was proposed to reflect pH-sensitivity of the mussel byssus fibers (Martinez Rodriguez et al., 2015). Our present study shows that the molecular mechanisms involved in the formation of the byssus thread and the adhesion plaque of the mussels are also sensitive to contaminants (such as MPs) and nutritional stress in mussels.

In conclusion, our present study shows that exposure to MPs and food shortage lead to weakening of the defense performance of mussels' byssus threads. These effects likely reflect the energy deficiency

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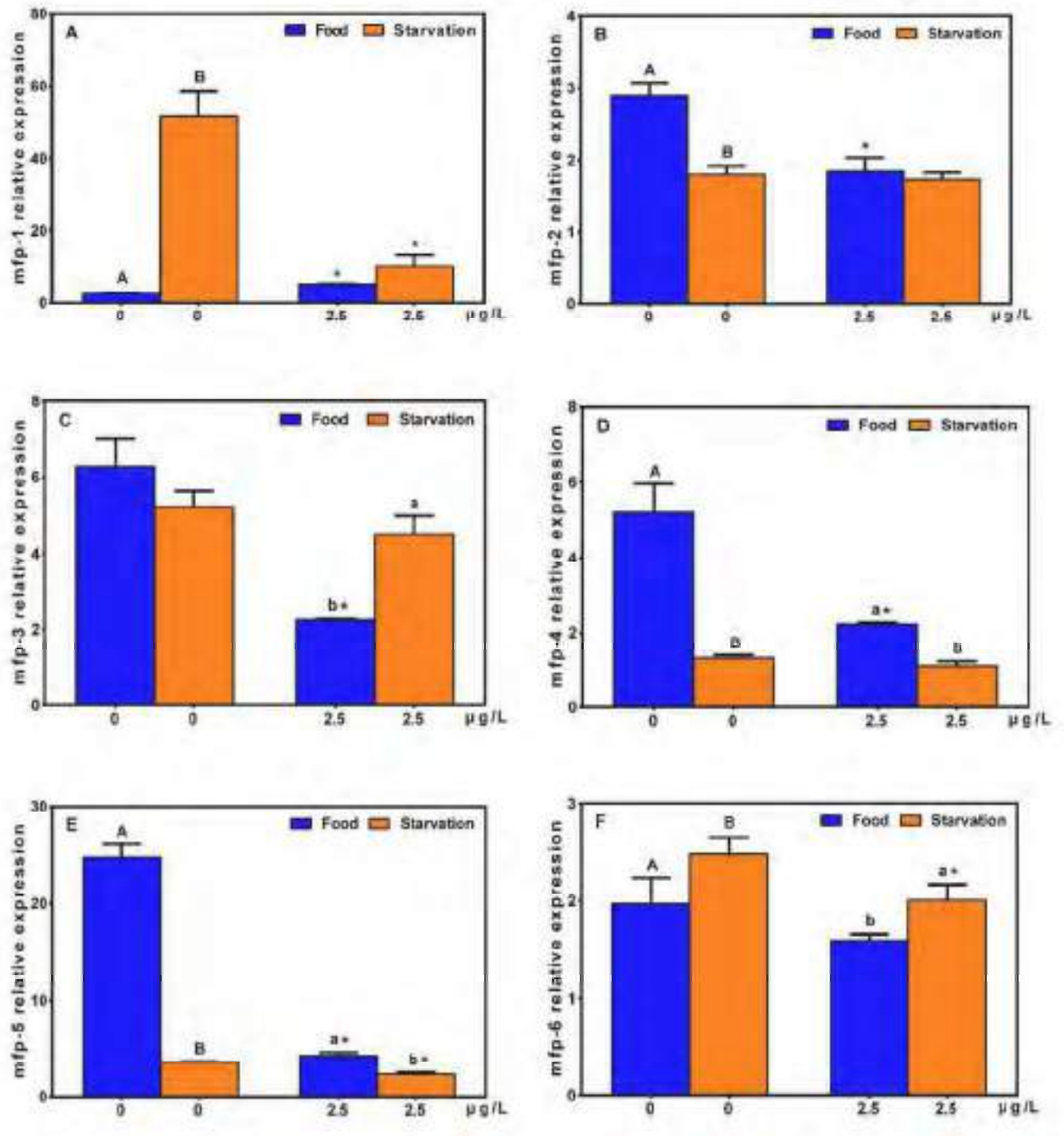

Fig. 3. mRNA expression of genes encoding byssus proteins in *Mytilus coruscus* (mfp-1 (A), mfp-2 (B), mfp-3 (C), mfp-4 (D), mfp-5 (E), mfp-6 (F)). Letters indicate comparisons between the well-fed and starved groups of mussels within the same MP treatment (uppercase letters – comparisons within the control group, lowercase letter – comparisons within the MP-exposed groups). If the columns do not share a letter, the respective values are significantly different ($p < 0.05$). Shared letter or the absence of letters indicates that the values do not differ between the well-fed and starved mussels ($p > 0.05$). An asterisk indicates a significant difference between the control and MP- exposed groups when compared under the same feeding conditions ($p < 0.05$).

(indicated by a decrease in the condition index) caused by these stressors and are mediated by transcriptional dysregulation of expression of the key proteins involved in the formation of the byssus thread and the adhesive plaque of the mussels. At the whole-organism level, a decrease in the number of the byssus threads and their adhesive capacity might have implications for the physical protection of the mussels from dislodgment and predators and affect their survival on high-energy open shores or under aquaculture conditions.

Author contribution statement

Yueyong Shang: Investigation, Writing - Original Draft.
Huaxin Gu: Methodology, Investigation, Writing - Review & Editing.
Xueqing Chang: Investigation.

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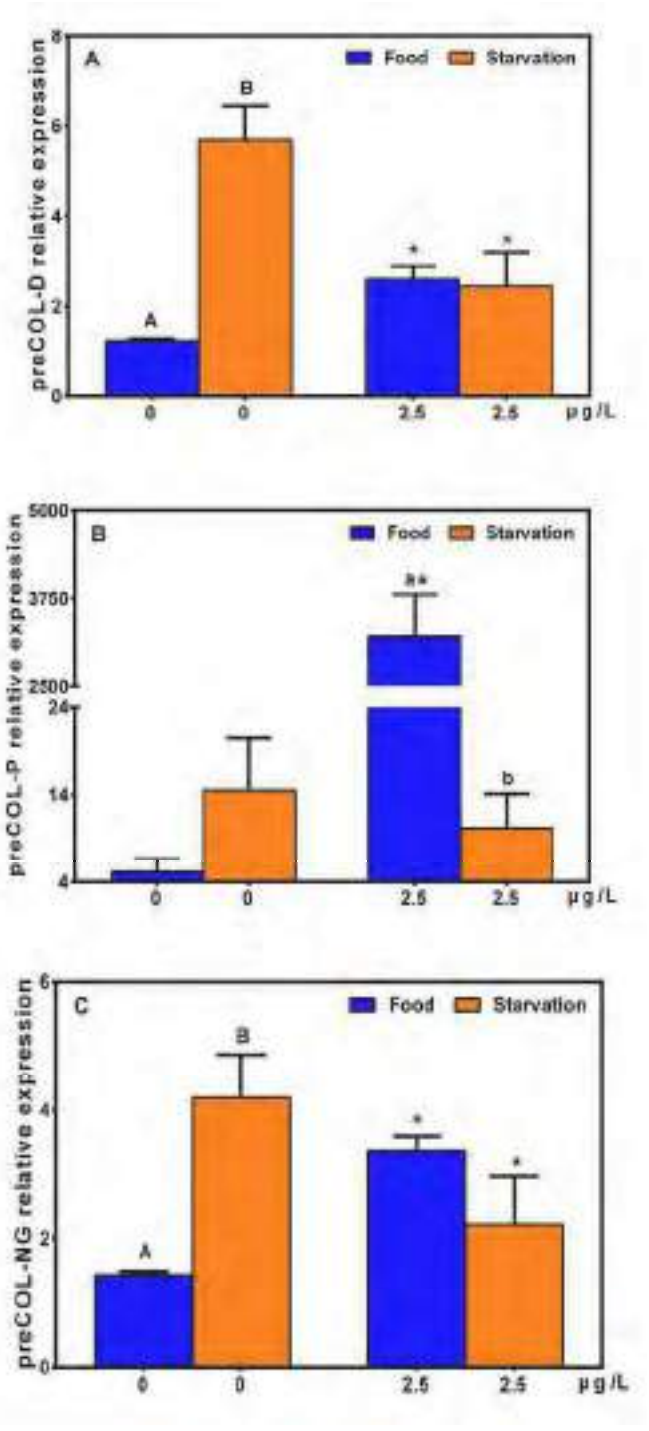

Fig. 4. mRNA expression of genes encoding byssus proteins in *Mytilus coruscus* (preCOL-D (A), preCOL-P (B) and preCOL-NG (C))
Letters indicate comparisons between the well-fed and starved groups of mussels within the same MP treatment (uppercase letters – comparisons within the control group, lowercase letter – comparisons within the MP-exposed groups). If the columns do not share a letter, the respective values are significantly different ($p < 0.05$). Shared letter or the absence of letters indicates that the values do not differ between the well-fed and starved mussels ($p > 0.05$). An asterisk indicates a significant difference between the control and MP- exposed groups when compared under the same feeding conditions ($p < 0.05$).

Shanglu Li: Review & Editing.
Inna Sokolova: Review & Editing.
James K. H. Fang: Review & Editing.
Shuaishuai Wei: Investigation.
Xiang Chen: Formal analysis.
Menghong Hu: Project administration.
Wei Huang: Conceptualization, Methodology, Resources.
Youji Wang: Conceptualization, Resources, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.marenvres.2021.105455.

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ANNEXURE

Formation of Technical committee and details obtained based on the committee recommendation

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By Speed Post

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TAMIL NADU POLLUTION CONTROL BOARD

Proc. No. T1/TNPCB/PWM/ F.011515/ Nurdle Spill/ 2025, Dated: 04.08.2025

Sub: TNPCB – PWM — MSC Elsa-3 ship Wreck-Plastic nurdles spill incident-Formation of Technical Expert Committee – to evaluate Compensation claims for the impact of plastic nurdles and the long-term studies–Committee formed-Orders issued - Regarding.

****

On May 25, 2025, the cargo vessel MSC Elsa-3, a Liberia-flagged ship, sank approximately 38 nautical miles off the Kerala coast, between Vizhinjam and Kochi. The vessel was carrying 640 containers, of which 13 contained only Calcium Carbide, and the remaining 627 contained plastic pellets (nurdles), Marine Gas Oil (MGO), Very Low Sulfur Fuel Oil (VLSFO), and other materials.

Following the incident, plastic nurdles began drifting along the Tamil Nadu coast, with sightings reported in Kanyakumari and Ramanathapuram districts. Additionally, bags of nurdles were found floating near the Nagapattinam district.

In response, a short-term study was conducted by TNPCB through the Suganthi Devadason Marine Research Institute (SDMRI), Tuticorin, Tamil Nadu. Subsequently, it was proposed to carryout long-term studies to ascertain the future Environmental Damage, Ecological damage and Socio-economic losses due the plastic nurdle spill incident

Further, during the review meeting held by the Chief Secretary on 08.07.2025 to assess the actions taken by various departments in response to the plastic nurdle spill, the Department of Environment, Climate Change and Forests was directed to compile and prepare compensation claims related to the environmental impact of the nurdle spill, including those received from the Fisheries Department. These claims are to be submitted to the Tamil Nadu Disaster Risk Reduction Agency (Disaster Management Department) which will initiate the process for filing a Public Interest Litigation (PIL).

In light of the above, a Technical Expert Committee has been constituted to review the claims for the impact of plastic nurdles and the submission of long-term study proposals. The composition of the committee is as follows:

S.No	Name of the Official	Designation
1	Prof. Dr. Ramesh Ramachandran	Former Director, National Centre for Sustainable Coastal Management (NCSCM)
2	Dr. R. Rajamanickam	Retired Additional Chief Environmental Engineer, TNPCB
3	Dr. D. Vasudevan	Retired Joint Chief Environmental Engineer, TNPCB
4	Representative from CSIR-NIO,Goa	

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Tel : 044-22353134 - 139 Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : tnpcb.gov.in

*Thiru. Sai Satyajith, Board Standing Counsel, TNPCB shall be consulted for legal support for compensation related Claims

Terms of Reference (ToR) of the Technical Expert Committee:

1. Claims Rationalization
   - To review and validate methodologies for quantifying:
     - Clean-up and restoration costs (including beaches, mangroves, coral reefs, and seagrass beds).
     - Ecosystem service valuation, especially related to biodiversity impacts.
     - Health and ecological risks due to chemical release and nurdle ingestion.
   - To ensure alignment with applicable national schemes and guidelines (e.g., Plastic Waste Management Rules, 2016; CPCB protocols).

2. **Review of Research Proposals**
   - To critically evaluate the scope, objectives, methodologies, sampling design (spatial/temporal coverage), controls, baseline comparisons, and data analysis plans submitted by reputed institutions.
   - To ensure that the proposed protocols conform to national and international standards for assessing nurdles, microplastics, hydrocarbons, heavy metals, and bioaccumulation in marine organisms.
   - To verify the inclusion of ecologically sensitive areas (e.g., coral reefs, mangroves, seagrass beds, Gulf of Mannar) and stakeholder/community participation.
   - To recommend timelines, milestones and periodic review mechanisms.

3. **Formulation of Standard Operating Procedures (SOPs)**
   - To recommend or assist in the development of SOPs for future nurdle spill response and management efforts.

For Chairperson

To:

1. Prof. Dr. Ramesh Ramachandran Former Director, National Centre for Sustainable Coastal Management (NCSCM)
2. Dr. R. Rajamanickam Retired Additional Chief Environmental Engineer, TNPCB
3. Dr. D. Vasudevan Retired Joint Chief Environmental Engineer, TNPCB
4. Thiru. Sai Satyajith Board Standing Counsel, TNPCB
5. The Director, CSIR-NIO, Goa
6. File Copy

Copy Submitted To:

The Additional Chief Secretary to Government,
Environment, Climate Change & Forests Department,
Secretariat, Chennai-600 009.

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Minutes of the Meeting with Committee Members on Assessment of Environmental Compensation regarding the MSC ELSA 3 Ship Wreckage Incident

Venue:TNPCB Conference Hall

Date: 05.08.2025 **Time:**03.00 pm to 05.00 pm

- The meeting commenced with a welcome address by the **Additional Chief Environmental Engineer, TNPCB**, who initiated discussions on the Environmental Compensation (EC) assessment concerning the MSC ELSA 3 shipwreck and subsequent nurdle spill along the Tamil Nadu coast. The Additional Chief Environmental Engineer welcomed the Expert members, TNPCB Board Standing Counsel, Additional Director, Fisheries Department and representatives from SDMRI, CMFRI, CSIR-NIO, Goa alongwith TNPCB District officials of Kanyakumari and Ramanathapuram districts.
- **The Environmental Engineer, TNPCB**presented an overview of the current status of the nurdle spill, findings from the short-term impact study, updates on the progress of the long-term ecological assessments, and preliminary considerations for calculating Environmental Compensation.
- **Prof. Dr. Ramesh Ramachandran, Founder Director, NCSCM**, presented preliminary details on the compensation claims based on the findings of the short-term study and the TNPCB's Action Taken Report on nurdle accumulation. He emphasized that compensation should not be confined to the quantity of nurdles collected from the two districts alone, but also account for the estimated future arrivals along the coastline, given the ongoing deposition influenced by ocean currents.
- **The District Environmental Engineer, Kanyakumari District and the District Environmental Engineer, Ramanathapuram District**provided district-wise updates on the quantity of nurdles collected to date. They had informed that nurdles are still being washed ashore in their respective districts.

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- **Dr. J.K. Patterson Edward, Director, SDMRI, Thoothukudi**, supported the approach of projecting future nurdle quantities by extrapolating the average collection over the last 68 days. He also recommended including losses related to mussel harvestingas part of the compensation claim, as approximately 400 tons are exported from the Kanyakumari region annually. He highlighted the ecological sensitivity of the Gulf of Mannar, with its seagrass beds and rich biodiversity, which may be vulnerable to nurdle contamination and shall also be included in calculating compensation claims.
- **Mr. Sai Satyajith, Board Standing Counsel, TNPCB**, highlighted that:
    - A baseline ecological study followed by a comparative post-spill damage assessment would strengthen the compensation claim.
    - Claim should also include for thetotal quantity ofnurdle spilloveroccurred due to ship wreckage and introduce a separate head for "estimated future loss".
- **Dr. Mandar Nanajkar, Principal Scientist, CSIR-NIO, Goa,** emphasized the significance of long-term studies, particularly for non-tangible damages. He noted that while the immediate presence of nurdles may not show acute toxicity, weathering and additive leaching over time could lead to bioaccumulation and chronic environmental damage in marine organisms.
- **Representatives from CMFRI, Mandapam Camp** shared that:
    - Higher nurdle deposition was observed in Dhanushkodi (Ramanathapuram District) compared to Kanniyakumari, due to prevailing currents.
    - The significance of Dhanushkodi as a turtle nesting zone (Nov–Dec), where nurdle presence could disrupt nesting and reproductive cycles.
    - In Palk Bay, muddy coastal areas may trap nurdles in sediments, leading to their reappearance over time.
    - They referred to plastic transport models by Prof. Charitha Pattiaratchi (University of Western Australia), which accurately matched observed

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nurdle dispersal patterns and predicted further deposition post-monsoon due to wind shifts.

- In response, **Mr. Sai Satyajith** noted that this scenario provides a strong justification for including remediation costs as part of the compensation claims.
- **Dr. S. Noorjahan Beevi, Additional Director, Department of Fisheries and Fishermen Welfare**, emphasized:
    - Annual sediment deposition of ~3 cm in the Palk Bay and Gulf of Mannar, which serve as breeding zones for a variety of marine organisms.
    - Nurdle accumulation in these breeding grounds could impact reproduction of fish, oysters, mussels, squid, and lobsters, thereby affecting both ecosystem health and export potential.
    - Based on ecological impact and livelihood loss to fisherfolk, the Fisheries Department has submitted a compensation claim of ₹760 crores to the Government of Tamil Nadu.
- **Dr. Loveson Edward L., Senior Scientist & SIC, CMFRI, Tuticorin RS**, added that coastal birds may ingest nurdles mistaking them for food, leading to health complications and bioaccumulation risks.
- **Dr. Mandar Nanajkar** further stated that laboratory tests have shown nurdle ingestion causes fatigue in fish, potentially reducing reproductive capacity and disrupting the marine food chain over the long term.
- **The District Environmental Engineer, Kanyakumari District**reported that small boat fishermen faced physical risks due to floating debris (containers, logs) from the wreck, which could have damaged boats and threaten lives.

After detailed discussion, the Committee recommended the following:

1. Environmental Compensation (EC) should account not only for the nurdles already collected but also for projected future deposition and long-term ecological impacts.

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2. The compensation claim must be structured under multiple heads, including cleanup operations, costs of short- and long-term scientific studies including laboratory analysis carried out by the TNPCB, usage of manpower on monitoring nurdles washed ashore and its response activities, damage to biodiversity and seagrass ecosystems, sediment entrapment, remediation expenses.
3. SDMRI, Thoothukudi shall submit a draft Compensation claim report to the TNPCB on or before 08.08.2025 and the same shall be shared with Expert members and Board Standing Counsel by the TNPCB for further revisions and recommendations.

With the above, the meeting came to an end.

Additional Chief Environment Engineer-II

Annexure

1. Prof. Dr. Ramesh Ramachandran, Founder Director, NCSCM,
2. Dr. R. Rajamanickam, Retired Additional Chief Environmental Engineer, TNPCB
3. Dr. D. Vasudevan, Retired Joint Chief Environmental Engineer, TNPCB
4. Dr. S. Noorjahan Beevi, Additional Director, Department of Fisheries and Fishermen Welfare
5. Thiru. Sai Satyajith, Board StandingCounsel, TNPCB
6. Thiru. A.Shanmugam, Additional Chief Environmental Engineer -II, TNPCB
7. Thiru. S. Bharathidasan, Joint Chief Environmental Engineer -III, TNPCB
8. Dr. S. Chandrasekaran, EE, TNPCB.
9. Tmt. Dhivya Sankari, AE, TNPCB

Virtually Attended

10. Er.G.Ramaraj, Joint Chief Environmental Engineer, Madurai
11. Dr. K.S. Bharathi, District Environmental Engineer, Kanyakumari District
12. Er. R. Dhilip Kumar, District Environmental Engineer, Ramanathapuram District
13. Dr. J.K. Patterson Edward, Director, SDMRI, Thoothukudi
14. Dr. Mandar Nanajkar, Principal Scientist, CSIR-NIO, Goa
15. Dr. Loveson Edward L., Senior Scientist & SIC, CMFRI, Tuticorin RS
16. Scientists from CMFRI, Mandapam camp

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Minutes of the Meeting with Committee Members on Assessment of Environmental Compensation regarding the MSC ELSA 3 Ship Wreckage Incident

Venue: TNPCB Conference Hall
Date: 14.08.2025 **Time:** 04.00 pm to 05.30 pm

The Chairperson, TNPCB, welcomed the committee members and briefed them about the need for the meeting. Dr. R. Ramesh, Technical Committee Member, explained the methodology followed to arrive at the compensation claims, which was then compared with the claims prepared by Dr. Patterson, Director, SDMRI. After detailed discussion, the following decisions were made to further proceed with the assessment of claims:

1. In the claims prepared by SDMRI, the assessment of impacts on the mangrove ecosystem shall be verified, and consultation with the Forest Department shall be undertaken to ascertain the area of mangroves affected.
2. The claims shall also include components such as Public Health Surveillance, Tourism Amenities Remediation, Government Manpower and Analysis, Operational Receptors (saltpans, aquaculture, seawater intakes), Program Management, and Contingency measures.
3. Although the deposition of nurdles has been observed in Kanyakumari and Ramanathapuram districts, details of industries withdrawing seawater for process/cooling purposes shall also be collected from the districts of Tirunelveli, Thoothukudi, Pudukottai, Thanjavur, Thiruvarur, and Nagapattinam.
4. The DEEs of Nagercoil and Ramanathapuram shall be instructed to collect samples from the affected areas every month and have them analysed at the TNPCB laboratory.
5. The DEEs shall also obtain and furnish details of the manpower deployed for cleanup activities, including working hours (attendance), salary details, allowances (if any), and the employer responsible.
6. The DEEs of Nagercoil and Ramanathapuram shall be instructed to furnish the details of expenditure incurred towards sample analysis.
7. SDMRI shall incorporate the changes suggested during the meeting and furnish a revised draft report on or before 19.08.2025.

The meeting came to end with thanks to Chair.

-xx SD xx-
Chairperson

14/8/25
For Chairperson

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Annexure

1. Dr.Jayanthi.M, I.F.S.,Chairperson, TNPCB
2. Prof. Dr. Ramesh Ramachandran, Founder Director, NCSCM,
3. Dr. R. Rajamanickam, Retired Additional Chief Environmental Engineer, TNPCB
4. Dr. D. Vasudevan, Retired Joint Chief Environmental Engineer, TNPCB
5. Thiru. A. Shanmugam, Additional Chief Environmental Engineer -II, TNPCB
6. Thiru. S. Bharathidasan, Joint Chief Environmental Engineer -III, TNPCB
7. Dr. S. Chandrasekaran, EE, TNPCB.
8. Tmt. Dhivya Sankari, AE, TNPCB
9. Dr. R.S. Raubbin, Project Coordinator, PWM cell.

Virtually Attended

10. Dr. K.S. Bharathi, District Environmental Engineer, Kanyakumari District
11. Er. R. Dhilip Kumar, District Environmental Engineer, Ramanathapuram District
12. Dr. J.K. Patterson Edward, Director, SDMRI, Thoothukudi

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TNPCB – O/o. DEE, Tirunelveli – PWM –Plastic Nurdle – MSC ELSA 3 Wreckage – Assessment of Claims – Details - Submitted - Regarding.

From : DEE TNV TNPCB <deetnv@tnpcb.gov.in> Mon, Aug 25, 2025 12:33 PM

Subject : TNPCB – O/o. DEE, Tirunelveli – PWM –Plastic Nurdle – MSC ELSA 3 Wreckage –Assessment of Claims – Details - Submitted - Regarding.

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM TNV TNPCB <jceemtnv@tnpcb.gov.in>

Respected Sir/Madam,

Sub: TNPCB – O/o. DEE, Tirunelveli – PWM –Plastic Nurdle – MSC ELSA 3 Wreckage – Assessment of Claims – Details - Submitted - Regarding.
Ref: Board's Email dated : 18/08/2025.

With respect to the reference cited above, I submit herewith the details of industries in the Tirunelveli District that withdraw seawater for process or cooling purposes given below.

S.No	Name of the unit	Quantity of seawater withdrawn	Purpose of use
1.	M/s. Nuclear Power Corporation of India Limited, Kudankulam Nuclear Power Project (Township) S No 51 To 85, 470 To 593 Chettikulam Village, Radhapuram Taluk, Tirunelveli District	8160.0 KLD	Domestic (Desalination)
2.	M/s. Nuclear Power Corporation of India Limited, Kudankulam Nuclear Power Project Parts Of 170, 172, 176, 177, 214, 218, 220, 221,222, 226, 228, 229,232, 246, 249, 251, 252, 491, 597, 600, 602, 605, 634, 637, 641, 643 -648, 705 736, 883, 884, 886, 887,889, 892, 893, 897, 968, 972, 978, 979, 980, 982, 1032, 1036, 1038, 1042, 1045, 1046, 1051, 1058, 1111 Kudankulam Village and S.Nos. Parts Of 541, 554 And 550 Vijayapatty Village, Radhapuram Taluk, Tirunelveli	12637796 KLD	Cooling
		7003.0 KLD	Domestic (Desalination)

This is submitted for favour of kind information, please.

With Regards,

DEE/TNPCB/TNV

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Email **PWM Sec TNPCB**

Re: O/o.DEE- TNPCB- Rmd-Plastic nurdle -Details for assessment of EC- sumbitted -Reg.

From : DEE RMD TNPCB <deermd@tnpcb.gov.in> Sat, Aug 23, 2025 12:08 PM

Subject : Re: O/o.DEE- TNPCB- Rmd-Plastic nurdle -Details for assessment of EC- sumbitted -Reg. 1 attachment

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Sir/madam,

Details submitted.

O/o.Dee/TNPCB/RMD

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The quantity of manpower deployed for Cleanup activities, working hours (attendance), Salary details and allowances if any. The details such as who paid for them shall also be included.	No People From Panchayat union or volunteers is involved collection of nurdle in Dhanushkodi, Rameswaram taluk, Ramanathapuram district. Only the team from MERC comprising of 120 people including in collection team and supervisor team is in involved in the process of collection segregation team storage of nurdles in Dhanushkodi, in Ramanathapuram District. The salary to the team is given by the MERC itself (internally).
Expenditure made towards sample analysis.	No industries found. No sample taken now.
List of industries (e.g., desalination plants, thermal power plants, etc.) in the districts that withdraw seawater for **process or cooling purposes**. 1. **Daily quantity** of seawater withdrawn. 2. **Purpose of use** (e.g., cooling, desalination, industrial processing).	There is no Thermal Power Plant Located at Dhanushkodi, Rameswaram taluk, in Ramanathapuram District.

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Email **PWM Sec TNPCB**

TNPCB– O/o DEE, Nagercoil–PWM – ELSA Cargo Ship - Plastic nurdle – Details requested for assessment of EC – Submitted –Regarding.

From : DEE NGL TNPCB <deengl@tnpcb.gov.in> Wed, Aug 20, 2025 06:12 PM

Subject : TNPCB– O/o DEE, Nagercoil–PWM – ELSA Cargo Ship - Plastic nurdle – Details requested for assessment of EC – Submitted –Regarding. 2 attachments

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM TNV TNPCB <jceemtnv@tnpcb.gov.in>

RESPECTED SIR/ MADAM,

Details requested for assessment of EC towards plastic nurdle clean up with respect to ELSA Cargo Ship wreckage are submitted below:

Taluk : Agasteeswaram, Kalkulam, Killiyoor
Spreadheet
link: https://docs.google.com/spreadsheets/d/1HlUgIigwz0dpxd1RR2oQW091Woazk_vzk7jNUssTxVE/edit?gid=0#gid=0
Fisheries:Colachel, Thengapattinam, Chinnamuttom
Spreadheet link:
https://docs.google.com/spreadsheets/d/1_wByijb3wjBNa7_DporAUtqWxyER4oNxkFcXTqnD458/edit?gid=462489694#gid=462489694
Town Panchayat Spreadheet link:
https://docs.google.com/spreadsheets/d/1T5P-IZMn8B_Tuj2mTctwZuvggSDaLeliiQlbVxXWEuw/edit?gid=2085591585#gid=2085591585
Block Office Spreadheet link:
https://docs.google.com/spreadsheets/d/1kYv2uQNxjb8GzX96Wdf6og9DiMPla5wrn-X-8qvbJv0/edit?gid=1629344859#gid=1629344859
Municipality : Kollencode Municipality Spreadsheet link:
https://docs.google.com/spreadsheets/d/1bxYPDYz9Y0fi5dijKB_-7DOtjUs_vMWv31zl__WL7kw/edit?gid=0#gid=0

KINDLY DOWNLOAD THE ATTACHMENT PLEASE,

DEE/NGL

DocScanner 18-Aug-2025 5-24 pm.pdf
688 KB

DocScanner 20-Aug-2025 5-54 pm.pdf
506 KB

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3065

19

TAMILNADU POLLUTION CONTROL BOARD

From	To
Dr. K.S. Bharathi, M.E.,Ph.D., District Environmental Engineer, Tamilnadu Pollution Control Board, 318/46A,Water Tank Road, Nagercoil - 629 001.	The Member Secretary (a/c), Tamilnadu Pollution Control Board, 76,Mount Salai, Guindy, Chennai-32.

Letter No.: DEE/TNPCB /NGL /TECH-203/ELSA/2025 dated: 20.08.2025

Respected Madam,

Sub: TNPCB – O/o DEE, Nagercoil – PWM – ELSA Cargo Ship - Plastic nurdle – Details requested for assessment of EC – Submitted – Regarding.

Ref: 1. Board's Email dated 14.08.2025.
2. T.O Letter No.: DEE/TNPCB/NGL/TECH-203/ELSA/2025 dated: 18.08.2025 (copy submitted).

--OOO---

With reference to the Board's Email cited above, the details regarding Nurdle spill from MSC ELSA 3 are submitted as detailed below.

Sl.No	Details requested	Reply submitted
1	The quantity of manpower deployed for Cleanup activities, working hours (attendance), Salary details and allowances if any. The details such as who paid for them shall also be included.	The details regarding the manpower engaged for cleanup activities are submitted through spreadsheet link.
2	Expenditure made towards sample analysis.	It is submitted that coastal samples were collected by the AEL, TNPCB on 29.05.2025, 30.05.2025 and 31.05.2025. In this regard, the Deputy Chief Scientific Officer, Advanced Environmental Laboratory, Tirunelveli vide Lr.No.AEL/TNPCBd/ TNV/Test Report-95/2025 Dt: 18.06.2025 has informed that the analytical charges of the samples collected is Rs. 1,56,240/-

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3	List of industries (e.g., desalination plants, thermal power plants, etc.) in the districts that withdraw seawater for process or cooling purposes	It is submitted that in Kanniyakumari District no industries draw seawater for process or cooling purposes. It is also submitted that no 17 category industries are located in Kanniyakumari District.

It is also submitted that as instructed monthly samples will be collected from the affected areas and will be analysed through Advanced Environmental Laboratory, Tamilnadu Pollution Control Board, Tirunelveli.

Submitted for kind information please.

Encl: As above.

20/8/2025

District Environmental Engineer,
Tamilnadu Pollution Control Board,
Nagercoil.

20/08/25

Copy submitted to The JCEE(M),Tamilnadu Pollution Control Board, Tirunelveli - for kind information please.

TAMILNADU POLLUTION CONTROL BOARD

From,	To,
Dr. K.S. Bharathi, M.E.,Ph.D., District Environmental Engineer, Tamilnadu Pollution Control Board, 318/46A,Water Tank Road, Nagercoil - 629 001.	1.The Tahsildar, Kalkulam Taluk, Kalkulam @ Thuckalay, Kanniyakumari. 2. The Tahsildar, Killiyoor Taluk, Killiyoor, Kanniyakumari. 3. The Tahsildar, Agasteeswaram Taluk, Agasteeswaram, Kanniyakumari. 4.The Deputy Director of Fisheries, Fisheries and Fishermen Welfare Department, Vadasary, Kanniyakumari District. 5. The Assistant Director, (Village Panchayats), Collectorate Campus, Kanyakumari District, @Nagercoil. 6. The Assistant Director (Town Panchayat), Nagercoil, Kanniyakumari District.

Letter No.: DEE /TNPCB /NGL /TECH-203/ELSA/2025 dated:18.08.2025

Sir/Madam,

Sub: TNPCB– O/o DEE, Nagercoil– PWM – ELSA Cargo Ship – Nurdles Spill – Certain details on Clean up drive – requested –Regarding.

Ref: 1.W.P. MD No.16258 of 2025 filed by Thiru.S.M. Anthony Muthu and 2 others. before the Hon'ble Madurai Bench of Madras High Court.

2.E-mail dated 18.08.2025 received from the Chairperson, Tamilnadu Pollution Control Board, Chennai

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I invite your attention to the reference 1st cited, wherein a Writ petition in W.P. MD No.16258 of 2025 has been filed by Thiru.S.M. Anthony Muthu and 2 others before the Hon'ble Madurai Bench of Madras High Court against the Secretary, Ministry of Ports, Shipping and Waterways (MoPSW) and 5 others with the following prayers:

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1. to issue a **WRIT OF MANDAMUS** or any other order in the nature of writ directing the respondents to remove the plastic remove the plastic pellets and other in materials the sea waters abutting hazardous Kanyakumari District caused by the sinkage of the Cargo Vessel MSC ELSA 3 and to pass any other further or other order or orders as this Hon'ble Court may deem fit and proper in the facts and circumstances of the case and thus render justice.
2. to grant an order of **Interim Direction** directing the respondents to declare the sinkage of the Cargo Vessel MSC ELSA 3 as a state disaster and thus render justice.
3. to grant an order of **Interim Direction** directing the respondents to provide proper relief assistants to the fishermen community in Kanyakumari District affected by the sinkage of the CargoVessel MSC ELSA 3 and thus render justice.
4. to **permit** the petitioners to file a single writ petition and thus render justice.

In this regard the Chairperson, TNPCB, Chennai during the zoom meeting conducted on 14.08.2025 instructed the DEE, TNPCB, Nagercoil to furnish the details on the quantity of manpower deployed for Cleanup activities, working hours (attendance), Salary details and allowances if any.

Hence, it is requested to update the above said details in the spreadsheet attached herewith and forward the same to deengl@tnpcb.gov.in **on or before 19.08.2025**, so as to furnish the same to the TNPCB, Corporate Office, Chennai for taking further action.

This may be treated as **Most Urgent.**

Encl: As above

18/8/25

District Environmental Engineer,
Tamilnadu Pollution Control Board,
Nagercoil.

1.Copy submitted to the Member Secretary, TNPCB, Chennai for kind information please.

2.Copy submitted to the JCEE (M), TNPCB, Tirunelveli for kind information please.

3.Copy submitted to the District Collector, Kanniyakumari District for kind information please.

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Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Agasteeswaram	1	06.06.2025	8 Hours	5	500	3750	-	TNPCB
	2	23.06.2025	8 Hours	4	400	3000	-	TNPCB
	3	24.06.2025	8 Hours	7	700	5250	-	TNPCB
	4	25.06.2025	8 Hours	7	700	5250	-	TNPCB
	5	26.06.2025	8 Hours	4	400	3000	-	TNPCB
	6	27.06.2025	8 Hours	3	300	2250	-	TNPCB
	7	28.06.2025	8 Hours	4	400	3000	-	TNPCB
	8	01.07.2025	8 Hours	2	200	1500	-	TNPCB
	9	02.07.2025	8 Hours	2	200	1500	-	TNPCB
	10	03.07.2025	8 Hours	2	200	1500	-	TNPCB

3070

Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Kalkulam	1	28.05.2025	-	-	-	-	-	-
Kalkulam	2	29.05.2025	8 Hours	8	1820	5840	1825	TNPCB
Kalkulam	3	30.05.2025	8 Hours	9	3540	6570	-	TNPCB
Kalkulam	4	31.05.2025	8 Hours	6	2550	4380	320	TNPCB
Kalkulam	5	01.06.2025	8 Hours	-	2760	-	210	TNPCB
Kalkulam	6	02.06.2025	8 Hours	10	3500	7300	3007	TNPCB
Kalkulam	7	03.06.2025	8 Hours	11	2470	8030	1020	TNPCB
Kalkulam	8	04.06.2025	8 Hours	11	1700	8030	0	TNPCB
Kalkulam	9	05.06.2025	8 Hours	11	2988	8030	0	TNPCB
Kalkulam	10	06.06.2025	8 Hours	8	1992	5840	0	TNPCB
Kalkulam	11	07.06.2025	8 Hours	13	2866	9490	0	TNPCB
Kalkulam	12	08.06.2025	8 Hours	1	250	730	0	TNPCB
Kalkulam	13	09.06.2025	8 Hours	13	2570	9490	0	TNPCB
Kalkulam	14	10.06.2025	8 Hours	8	2080	5840	0	TNPCB
Kalkulam	15	11.06.2025	8 Hours	12	2480	8760	0	TNPCB
Kalkulam	16	12.06.2025	8 Hours	13	1850	9490	0	TNPCB
Kalkulam	17	13.06.2025	8 Hours	12	2424	8760	0	TNPCB
Kalkulam	18	14.06.2025	8 Hours	12	2424	8760	0	TNPCB
Kalkulam	19	15.06.2025	8 Hours	0	0	0	0	TNPCB

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Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Kalkulam	20	16.06.2025	8 Hours	10	2080	7300	0	TNPCB
Kalkulam	21	17.06.2025	8 Hours	10	2080	7300	0	TNPCB
Kalkulam	22	18.06.2025	8 Hours	8	0	5840	0	TNPCB
Kalkulam	23	19.06.2025	8 Hours	3	0	2190	0	TNPCB
Kalkulam	24	20.06.2025	8 Hours	3	0	2190	634	TNPCB
Kalkulam	25	21.06.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	26	22.06.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	27	23.06.2025	8 Hours	17	0	12410	0	MERC
Kalkulam	28	24.06.2025	8 Hours	19	0	13870	0	MERC
Kalkulam	29	25.06.2025	8 Hours	17	0	12410	0	MERC
Kalkulam	30	26.06.2025	8 Hours	14	0	10220	0	MERC
Kalkulam	31	27.06.2025	8 Hours	10	0	7300	0	MERC
Kalkulam	32	28.06.2025	8 Hours	22	0	16060	0	MERC
Kalkulam	33	29.06.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	34	30.06.2025	8 Hours	10	0	7300	0	MERC
Kalkulam	35	01.07.2025	8 Hours	16	0	11680	0	MERC
Kalkulam	36	02.07.2025	8 Hours	14	0	10220	0	MERC
Kalkulam	37	03.07.2025	8 Hours	16	0	11680	0	MERC
Kalkulam	38	04.07.2025	8 Hours	2	0	1460	0	MERC

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Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Kalkulam	39	05.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	40	06.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	41	07.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	42	08.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	43	09.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	44	10.07.2025	8 Hours	7	0	5110	0	MERC
Kalkulam	45	11.07.2025	8 Hours	7	0	5110	0	MERC
Kalkulam	46	12.07.2025	8 Hours	4	0	2920	0	MERC
Kalkulam	47	13.07.2025	8 Hours	4	0	2920	0	MERC
Kalkulam	48	14.07.2025	8 Hours	11	0	8030	0	MERC
Kalkulam	49	15.07.2025	8 Hours	9	0	6570	0	MERC
Kalkulam	50	16.07.2025	8 Hours	11	0	8030	0	MERC
Kalkulam	51	17.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	52	18.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	53	19.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	54	20.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	55	21.07.2025	8 Hours	3	0	2190	0	MERC
Kalkulam	56	22.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	57	23.07.2025	8 Hours	3	0	2190	0	MERC

Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Kalkulam	58	24.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	59	25.07.2025	8 Hours	3	0	2190	0	MERC
Kalkulam	60	26.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	61	27.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	62	28.07.2025	8 Hours	3	0	2190	0	MERC
Kalkulam	63	29.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	64	30.07.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	65	31.07.2025	8 Hours	3	0	2190	0	MERC
Kalkulam	66	01.08.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	67	02.08.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	68	03.08.2025	8 Hours	2	0	1460	0	MERC
Kalkulam	69	04.08..2025	8 Hours	3	0	0	0	MERC

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Name of the Taluk	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup (Aapdamitra)	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Killiyoor	1	28.05.2025	8 Hours	5	500	3750	-	TNPCB
	2	29.05.2025	8 Hours	20	2000	15000	-	TNPCB
	3	30.05.2025	8 Hours	18	1800	13500	-	TNPCB
	4	31.05.2025	8 Hours	21	2100	15750	-	TNPCB
	5	01.06.2025	-	-	-	-	-	TNPCB
	6	02.06.2025	8 Hours	14	1400	10500	-	TNPCB
	7	03.06.2025	8 Hours	20	2000	15000	-	TNPCB
	8	04.06.2025	8 Hours	20	2000	15000	-	TNPCB
	9	05.06.2025	8 Hours	15	1500	11250	-	TNPCB
	10	06.06.2025	8 Hours	21	2100	15750	-	TNPCB
	11	07.06.2025	8 Hours	28	2800	21000	-	TNPCB
	12	08.06.2025	-	-	-	-	-	TNPCB
	13	09.06.2025	8 Hours	26	2600	19500	-	TNPCB
	14	10.06.2025	8 Hours	28	2800	21000	-	TNPCB
	15	11.06.2025	8 Hours	31	3100	23250	-	TNPCB
	16	12.06.2025	8 Hours	27	2700	20250	-	TNPCB
	17	13.06.2025	9 Hours	29	2900	21750	-	TNPCB
	18	14.06.2025	10 Hours	23	2300	17250	-	TNPCB

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S. No.	Name of the Fishing Division	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
1	Colachel	28.05.2025	8 hr / day/ Person	6	0	0	0	
2	Colachel	29.05.2025	8 hr / day/ Person	3	0	0	0	
3	Colachel	30.05.2025	8 hr / day/ Person	3	0	0	0	
4	Colachel	31.05.2025	8 hr / day/ Person	4	0	0	0	
5	Colachel	01.06.2025	8 hr / day/ Person	3	0	0	0	
6	Colachel	02.06.2025	8 hr / day/ Person	3	0	0	0	
7	Colachel	03.06.2025	8 hr / day/ Person	3	0	0	0	
8	Colachel	04.06.2025	8 hr / day/ Person	3	0	0	0	
9	Colachel	05.06.2025	8 hr / day/ Person	4	0	0	0	
10	Colachel	06.06.2025	8 hr / day/ Person	4	0	0	0	
11	Colachel	07.06.2025	8 hr / day/ Person	4	0	0	0	
12	Colachel	08.06.2025	8 hr / day/ Person	4	0	0	0	
13	Colachel	09.06.2025	8 hr / day/ Person	4	0	0	0	
14	Colachel	10.06.2025	8 hr / day/ Person	4	0	0	0	
15	Colachel	11.06.2025	8 hr / day/ Person	4	0	0	0	
16	Colachel	12.06.2025	8 hr / day/ Person	4	0	0	0	
17	Colachel	13.06.2025	8 hr / day/ Person	4	0	0	0	
18	Colachel	14.06.2025	8 hr / day/ Person	4	0	0	0	

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S.No.	Name of the Fishing Division	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
1	Thengapattinam	28.05.2025	112	14	0	0	0	
2	Thengapattinam	29.05.2025	112	14	0	0	0	
3	Thengapattinam	30.05.2025	112	14	0	0	0	
4	Thengapattinam	31.05.2025	112	14	0	0	0	
5	Thengapattinam	01.06.2025	112	14	0	0	0	
6	Thengapattinam	02.06.2025	112	8	0	0	0	
7	Thengapattinam	03.06.2025	80	9	0	0	0	
8	Thengapattinam	04.06.2025	80	8	0	0	0	
9	Thengapattinam	05.06.2025	80	9	0	0	0	
10	Thengapattinam	06.06.2025	80	1	0	0	0	
11	Thengapattinam	07.06.2025	80	9	0	0	0	
12	Thengapattinam	08.06.2025	80	3	0	0	0	
13	Thengapattinam	09.06.2025	80	9	0	0	0	
14	Thengapattinam	10.06.2025	80	8	0	0	0	
15	Thengapattinam	11.06.2025	80	9	0	0	0	
16	Thengapattinam	12.06.2025	80	3	0	0	0	
17	Thengapattinam	13.06.2025	80	8	0	0	0	
18	Thengapattinam	14.06.2025	80	8	0	0	0	
19	Thengapattinam	15.06.2026	80	10	0	0	0	

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S. No.	Name of the Fishing Division	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
1	Chinnamuttom	28.05.2025	8 hr / day/ Person	11	0	0	0	
2	Chinnamuttom	29.05.2025	8 hr / day/ Person	11	0	0	0	
3	Chinnamuttom	30.05.2025	8 hr / day/ Person	11	0	0	0	
4	Chinnamuttom	31.05.2025	8 hr / day/ Person	11	0	0	0	
5	Chinnamuttom	01.06.2025	8 hr / day/ Person	11	0	0	0	
6	Chinnamuttom	02.06.2025	8 hr / day/ Person	3	0	0	0	
7	Chinnamuttom	03.06.2025	8 hr / day/ Person	3	0	0	0	
8	Chinnamuttom	04.06.2025	8 hr / day/ Person	4	0	0	0	
9	Chinnamuttom	05.06.2025	8 hr / day/ Person	1	0	0	0	
10	Chinnamuttom	06.06.2025	8 hr / day/ Person	0	0	0	0	
11	Chinnamuttom	07.06.2025	8 hr / day/ Person	0	0	0	0	
12	Chinnamuttom	08.06.2025	8 hr / day/ Person	0	0	0	0	
13	Chinnamuttom	09.06.2025	8 hr / day/ Person	2	0	0	0	
14	Chinnamuttom	10.06.2025	8 hr / day/ Person	2	0	0	0	
15	Chinnamuttom	11.06.2025	8 hr / day/ Person	2	0	0	0	
16	Chinnamuttom	12.06.2025	8 hr / day/ Person	0	0	0	0	
17	Chinnamuttom	13.06.2025	8 hr / day/ Person	1	0	0	0	
18	Chinnamuttom	14.06.2025	8 hr / day/ Person	1	0	0	0	

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ELSA Details - Puthalam Town Panchayat

Name of the Town Panchayat	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remarks if any
					Food	Wages			
Puthalam	1	28.05.2025	0	0	0	0	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், புத்தளம் பேரூராட்சிக்குட்பட்ட சொத்தவிளை கடற்கரையில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம், உணவு மற்றும் இதர செலவினங்களுக்கு ரூ.83720/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
Puthalam	2	29.05.2025	0	0	0	0	0	0	
Puthalam	3	30.05.2025	9	9	720	7650	14400	0	
Puthalam	4	31.05.2025	9	10	800	8500	2390	0	
Puthalam	5	01.06.2025	8	4	320	3400	0	0	
Puthalam	6	02.06.2025	8	6	480	5100	0	0	
Puthalam	7	03.06.2025	8	6	480	5100	0	0	
Puthalam	8	04.06.2025	8	6	480	5100	0	0	
Puthalam	9	05.06.2025	8	5	400	4250	0	0	
Puthalam	10	06.06.2025	8	7	560	5950	0	0	
Puthalam	11	07.06.2025	8	8	640	6800	0	0	
Puthalam	12	08.06.2025	0	0	0	0	0	0	
Puthalam	13	09.06.2025	8	2	0	1700	0	0	
Puthalam	14	10.06.2025	8	3	0	2550	0	0	
Puthalam	15	11.06.2025	8	3	0	2550	0	0	
Puthalam	16	12.06.2025	8	2	0	1700	0	0	
Puthalam	17	13.06.2025	8	2	0	1700	0	0	
Puthalam	18	14.06.2025	0	0	0	0	0	0	
		Total		**73**	**4880**	**62050**	**16790**		

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ELSA Details - Mandaikkadu Town Panchayat

Name of the Town Panchayat	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remarks if any
					Food	Wages			
Mandaikkadu	1	28.05.2025	0	0	0	0	0	-	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், மண்டைக்காடு பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.1700/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
Mandaikkadu	2	29.05.2025	0	0	0	0	0	-	
Mandaikkadu	3	30.05.2025	0	0	0	0	0	-	
Mandaikkadu	4	31.05.2025	0	0	0	0	0	-	
Mandaikkadu	5	01.06.2025	0	0	0	0	0	-	
Mandaikkadu	6	02.06.2025	0	0	0	0	0	-	
Mandaikkadu	7	03.06.2025	0	0	0	0	0	-	
Mandaikkadu	8	04.06.2025	0	0	0	0	0	-	
Mandaikkadu	9	05.06.2025	8	2	0	1700	0	-	
Mandaikkadu	10	06.06.2025	0	0	0	0	0	-	
Mandaikkadu	11	07.06.2025	0	0	0	0	0	-	
Mandaikkadu	12	08.06.2025	0	0	0	0	0	-	
Mandaikkadu	13	09.06.2025	0	0	0	0	0	-	
Mandaikkadu	14	10.06.2025	0	0	0	0	0	-	
Mandaikkadu	15	11.06.2025	0	0	0	0	0	-	
Mandaikkadu	16	12.06.2025	0	0	0	0	0	-	
Mandaikkadu	17	13.06.2025	0	0	0	0	0	-	
Mandaikkadu	18	14.06.2025	0	0	0	0	0	-	
		Total		**2**	**0**	**1700**	**0**		

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ELSA Details - Manavalakurichi Town Panchayat

Name of the Town Panchayat	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remarks if any
					Food	Wages			
Manavalakurichi	1	28.05.2025	8	5	0	4250	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், மணவாளக்குறிச்சி பேரூராட்சிக்குட்பட்ட சின்னவிளை கடற்கரை பகுதியில் கரை ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்களுக்கான ஊதிய செலவினங்களுக்கு ரூ.86700/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது. இத்தொகையில் கல்குளம் வட்டாட்சியர் அவர்களால் 23.06.2025 அன்று ரூ.38250/- பேரூராட்சிக்கு வழங்கப்பட்டது. மீதமுள்ள நிலுவை தொகை ரூ.48450/- இப்பேரூராட்சிக்கு வழங்கப்படவேண்டியுள்ளது.
Manavalakurichi	2	29.05.2025	8	5	0	4250	0	0	
Manavalakurichi	3	30.05.2025	8	5	0	4250	0	0	
Manavalakurichi	4	31.05.2025	8	5	0	4250	0	0	
Manavalakurichi	5	01.06.2025	8	5	0	4250	0	0	
Manavalakurichi	6	02.06.2025	8	5	0	4250	0	0	
Manavalakurichi	7	03.06.2025	8	5	0	4250	0	0	
Manavalakurichi	8	04.06.2025	8	5	0	4250	0	0	
Manavalakurichi	9	05.06.2025	8	5	0	4250	0	0	
Manavalakurichi	10	06.06.2025	8	5	0	4250	0	0	
Manavalakurichi	11	07.06.2025	8	5	0	4250	0	0	
Manavalakurichi	12	08.06.2025	8	2	0	1700	0	0	
Manavalakurichi	13	09.06.2025	8	5	0	4250	0	0	
Manavalakurichi	14	10.06.2025	8	5	0	4250	0	0	
Manavalakurichi	15	11.06.2025	8	5	0	4250	0	0	
Manavalakurichi	16	12.06.2025	8	5	0	4250	0	0	
Manavalakurichi	17	13.06.2025	8	5	0	4250	0	0	
Manavalakurichi	18	14.06.2025	8	5	0	4250	0	0	
Manavalakurichi	19	15.06.2025	8	0	0	0	0	0	
Manavalakurichi	20	16.06.2025	8	5	0	4250	0	0	
Manavalakurichi	21	17.06.2025	8	5	0	4250	0	0	
Manavalakurichi	22	18.06.2025	8	5	0	4250	0	0	
		Total		**102**	**0**	**86700**	**0**	**0**	

ELSA Details - Kallukoottam Town Panchayat

Name of the Town Panchayat	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remarks if any
					Food	Wages			
Kallukoottam	1	28.05.2025	8	6	0	5100	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், கல்லுக்கூட்டம் பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.39100/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
Kallukoottam	2	29.05.2025	8	6	0	5100	0	0	
Kallukoottam	3	30.05.2025	8	6	0	5100	0	0	
Kallukoottam	4	31.05.2025	8	6	0	5100	0	0	
Kallukoottam	5	01.06.2025	8	6	0	5100	0	0	
Kallukoottam	6	02.06.2025	8	6	0	5100	0	0	
Kallukoottam	7	03.06.2025	8	6	0	5100	0	0	
Kallukoottam	8	04.06.2025	8	2	0	1700	0	0	
Kallukoottam	9	05.06.2025	8	2	0	1700	0	0	
Kallukoottam	10	06.06.2025	0	0	0	0	0	0	
Kallukoottam	11	07.06.2025	0	0	0	0	0	0	
Kallukoottam	12	08.06.2025	0	0	0	0	0	0	
Kallukoottam	13	09.06.2025	0	0	0	0	0	0	
Kallukoottam	14	10.06.2025	0	0	0	0	0	0	
Kallukoottam	15	11.06.2025	0	0	0	0	0	0	
Kallukoottam	16	12.06.2025	0	0	0	0	0	0	
Kallukoottam	17	13.06.2025	0	0	0	0	0	0	
Kallukoottam	18	14.06.2025	0	0	0	0	0	0	
		Total		**46**		**39100**			

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ELSA Details - Palapallam Town Panchayat

Name of the Town Panchayat	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remarks if any
					Food	Wages			
Palapallam	1	28.05.2025	8	5	0	4250	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், பாலப்பள்ளம் பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.83300/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
Palapallam	2	29.05.2025	8	15	0	12750	0	0	
Palapallam	3	30.05.2025	8	15	0	12750	0	0	
Palapallam	4	31.05.2025	8	15	0	12750	0	0	
Palapallam	5	01.06.2025	8	10	0	8500	0	0	
Palapallam	6	02.06.2025	8	15	0	12750	0	0	
Palapallam	7	03.06.2025	8	5	0	4250	0	0	
Palapallam	8	04.06.2025	8	2	0	1700	0	0	
Palapallam	9	05.06.2025	8	1	0	850	0	0	
Palapallam	10	06.06.2025	8	2	0	1700	0	0	
Palapallam	11	07.06.2025	8	2	0	1700	0	0	
Palapallam	12	08.06.2025	8	2	0	1700	0	0	
Palapallam	13	09.06.2025	8	2	0	1700	0	0	
Palapallam	14	10.06.2025	8	1	0	850	0	0	
Palapallam	15	11.06.2025	8	5	0	4250	0	0	
Palapallam	16	12.06.2025	8	1	0	850	0	0	
Palapallam	17	13.06.2025	0	0	0	0	0	0	
Palapallam	18	14.06.2025	0	0	0	0	0	0	
		Total		**98**	**0**	**83300**	**0**	**0**	

S. No.	Name of the Block	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
1	Agasteeswaram	30.05.2025 to 28.06.2025	144	96	19200	67200	1800	-
2	Rajakkamnagalam	30.05.2025 to 14.06.2025	2160	270	nil	nil	No	–
3	Kurunthancode	29.05.2025 to 09.06.2025	120	350	3500	262500	-	-
4	Killiyoor	28.05.2025 to 14.06.2025	All days 8 am to 3 pm	272	Nil	231200	-	-
5	Munchirai	28/5/2025 to 14/6/2025	8 am to 3 pm	249	No	No	No	

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Name of the Block	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Agasteeswaram	1	28.05.2025	-	-	-	-	-	-
Agasteeswaram	2	29.05.2025	-	-	-	-	-	-
Agasteeswaram	3	30.05.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	4	31.05.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	5	01.06.2025	-	-	-	-	-	-
Agasteeswaram	6	02.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	7	03.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	8	04.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	9	05.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	10	06.06.2025	8 hours	9	1800	6300	300	Nil
Agasteeswaram	11	07.06.2025	-	-	-	-	-	-
Agasteeswaram	12	08.06.2025	-	-	-	-	-	-
Agasteeswaram	13	09.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	14	10.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	15	11.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	16	12.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	17	13.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	18	14.06.2025	8 hours	6	1200	4200	-	Nil
Agasteeswaram	19	23.06.2025	8 hours	2	400	1400	200	Nil
Agasteeswaram	20	24.06.2025	8 hours	5	1000	3500	500	Nil
Agasteeswaram	21	25.06.2025	8 hours	3	600	2100	300	Nil
Agasteeswaram	22	27.06.2025	8 hours	3	600	2100	300	Nil
Agasteeswaram	23	28.06.2025	8 hours	2	400	1400	200	Nil
			144	**96**	**19200**	**67200**	**1800**	

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Name of the Block	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Rajakkamnagalam	1	28.05.2025	0	-	-	-	-	-
	2	29.05.2025	0	-	-	-	-	-
	3	30.05.2025	192	24	Nil	Nil	Nil	-
	4	31.05.2025	336	42	Nil	Nil	Nil	-
	5	01.06.2025	104	13	Nil	Nil	Nil	-
	6	02.06.2025	232	29	Nil	Nil	Nil	-
	7	03.06.2025	120	15	Nil	Nil	Nil	-
	8	04.06.2025	120	15	Nil	Nil	Nil	-
	9	05.06.2025	80	10	Nil	Nil	Nil	-
	10	06.06.2025	96	12	Nil	Nil	Nil	-
	11	07.06.2025	72	9	Nil	Nil	Nil	-
	12	08.06.2025	32	4	Nil	Nil	Nil	-
	13	09.06.2025	112	14	Nil	Nil	Nil	-
	14	10.06.2025	104	13	Nil	Nil	Nil	-
	15	11.06.2025	168	21	Nil	Nil	Nil	-
	16	12.06.2025	168	21	Nil	Nil	Nil	-
	17	13.06.2025	112	14	Nil	Nil	Nil	-
	18	14.06.2025	112	14	Nil	Nil	Nil	-
			2160	**270**				

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Name of the Block	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Kurunthancode	1	28.05.2025	-	-	-	-	-	-
	2	29.05.2025	10	60	6000	45000	0	No
	3	30.05.2025	10	68	6800	51000	0	No
	4	31.05.2025	10	33	3300	24750	0	No
	5	01.06.2025	10	19	1900	14250	0	No
	6	02.06.2025	10	17	1700	12750	0	No
	7	03.06.2025	10	17	1700	12750	0	No
	8	04.06.2025	10	22	2200	16500	0	No
	9	05.06.2025	10	22	2200	16500	0	No
	10	06.06.2025	10	21	2100	15750	0	No
	11	07.06.2025	10	21	2100	15750	0	No
	12	08.06.2025	10	18	1800	13500	0	No
	13	09.06.2025	10	32	3200	24000	0	No
			120	**350**	**35000**	**262500**	**0**	**0**

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Name of the Block	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Killiyoor	1	28.05.2025	8 hours	17	Nill	14450	0	No
	2	29.05.2025	8 hours	51	Nill	43350	0	No
	3	30.05.2025	8 hours	31	Nill	26350	0	No
	4	31.05.2025	8 hours	31	Nill	26350	0	No
	5	01.06.2025	0	0	Nill	0	0	No
	6	02.06.2025	8 hours	10	Nill	8500	0	No
	7	03.06.2025	8 hours	10	Nill	8500	0	No
	8	04.06.2025	8 hours	10	Nill	8500	0	No
	9	05.06.2025	8 hours	10	Nill	8500	0	No
	10	06.06.2025	8 hours	12	Nill	10200	0	No
	11	07.06.2025	8 hours	11	Nill	9350	0	No
	12	08.06.2025	8 hours	7	Nill	5950	0	No
	13	09.06.2025	8 hours	12	Nill	10200	0	No
	14	10.06.2025	8 hours	12	Nill	10200	0	No
	15	11.06.2025	8 hours	12	Nill	10200	0	No
	16	12.06.2025	8 hours	12	Nill	10200	0	No
	17	13.06.2025	8 hours	12	Nill	10200	0	No
	18	14.06.2025	8 hours	12	Nill	10200	0	No
				272		**231200**		

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Name of the Block	S. No.	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
Munchirai	1	28.05.2025	8 am to 3 pm	5	No	No	No	No
	2	29.05.2025	8 am to 3 pm	6	No	No	No	No
	3	30.05.2025	8 am to 3 pm	6	No	No	No	No
	4	31.05.2025	8 am to 3 pm	15	No	No	No	No
	5	01.06.2025	8 am to 3 pm	15	No	No	No	No
	6	02.06.2025	8 am to 3 pm	5	No	No	No	No
	7	03.06.2025	8 am to 3 pm	21	No	No	No	No
	8	04.06.2025	8 am to 3 pm	21	No	No	No	No
	9	05.06.2025	8 am to 3 pm	21	No	No	No	No
	10	06.06.2025	8 am to 3 pm	21	No	No	No	No
	11	07.06.2025	8 am to 3 pm	21	No	No	No	No
	12	08.06.2025	8 am to 3 pm	21	No	No	No	No
	13	09.06.2025	8 am to 3 pm	21	No	No	No	No
	14	10.06.2025	8 am to 3 pm	21	No	No	No	No
	15	11.06.2025	8 am to 3 pm	21	No	No	No	No
	16	12.06.2025	8 am to 3 pm	21	No	No	No	No
	17	13.06.2025	8 am to 3 pm	21	No	No	No	No
	18	14.06.2025	8 am to 3 pm	21	No	No	No	No
				247				

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
1	Kollancode	28.05.2025	8 Hours	6	-	5100	-	-	
2		29.05.2025	8 Hours	6	-	5100	-	-	
3		30.05.2025	8 Hours	7	-	5950	-	-	
4		31.05.2025	8 Hours	14	-	11900	-	-	
5		01.06.2025	8 Hours	12	-	10200	-	-	
6		02.06.2025	8 Hours	10	-	8500	-	-	
7		03.06.2025	8 Hours	17	-	14450	-	-	
8		04.06.2025	8 Hours	5	-	4250	-	-	
9		05.06.2025	8 Hours	6	-	5100	-	-	
10		06.06.2025	8 Hours	6	-	5100	-	-	
11		07.06.2025	8 Hours	8	-	6800	-	-	
12		08.06.2025	8 Hours	6	-	5100	-	-	
13		09.06.2025	8 Hours	9	-	7650	-	-	
14		10.06.2025	8 Hours	9	-	7650	-	-	
15		11.06.2025	8 Hours	10	-	8500	-	-	
16		12.06.2025	8 Hours	12	-	10200	-	-	
17		13.06.2025	8 Hours	4	-	3400	-	-	
18		14.06.2025	8 Hours	4	-	3400	-	-	
1	Agasteeswaram	28.05.2025	-	-	-	-	-	-	
2		29.05.2025	-	-	-	-	-	-	
3		30.05.2025	8 Hours	6	1200	4200	-	Nil	
4		31.05.2025	8 Hours	6	1200	4200	-	Nil	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
5		01.06.2025	-	-	-	-	-	-	
6		02.06.2025	8 Hours	6	1200	4200	-	Nil	
7		03.06.2025	8 Hours	6	1200	4200	-	Nil	
8		04.06.2025	8 Hours	6	1200	4200	-	Nil	
9		05.06.2025	8 Hours	6	1200	4200	-	Nil	
10		06.06.2025	8 Hours	9	1800	6300	300	Nil	
11		07.06.2025	-	-	-	-	-	-	
12		08.06.2025	-	-	-	-	-	-	
13		09.06.2025	8 Hours	6	1200	4200	-	Nil	
14		10.06.2025	8 Hours	6	1200	4200	-	Nil	
15		11.06.2025	8 Hours	6	1200	4200	-	Nil	
16		12.06.2025	8 Hours	6	1200	4200	-	Nil	
17		13.06.2025	8 Hours	6	1200	4200	-	Nil	
18		14.06.2025	8 Hours	6	1200	4200	-	Nil	
19		23.06.2025	8 Hours	2	400	1400	200	Nil	
20		24.06.2025	8 Hours	5	1000	3500	500	Nil	
21		25.06.2025	8 Hours	3	600	2100	300	Nil	
22		27.06.2025	8 Hours	3	600	2100	300	Nil	
23		28.06.2025	8 Hours	2	400	1400	200	Nil	
1	Rajakkamnagalam	28.05.2025	0	-	_	_	_	_	
2		29.05.2025	0	-	-	-	-	-	
3		30.05.2025	192	24	Nil	Nil	Nil	-	
4		31.05.2025	336	42	Nil	Nil	Nil	-	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
5		01.06.2025	104	13	Nil	Nil	Nil	-	
6		02.06.2025	232	29	Nil	Nil	Nil	-	
7		03.06.2025	120	15	Nil	Nil	Nil	-	
8		04.06.2025	120	15	Nil	Nil	Nil	-	
9		05.06.2025	80	10	Nil	Nil	Nil	-	
10		06.06.2025	96	12	Nil	Nil	Nil	-	
11		07.06.2025	72	9	Nil	Nil	Nil	-	
12		08.06.2025	32	4	Nil	Nil	Nil	-	
13		09.06.2025	112	14	Nil	Nil	Nil	-	
14		10.06.2025	104	13	Nil	Nil	Nil	-	
15		11.06.2025	168	21	Nil	Nil	Nil	-	
16		12.06.2025	168	21	Nil	Nil	Nil	-	
17		13.06.2025	112	14	Nil	Nil	Nil	-	
18		14.06.2025	112	14	Nil	Nil	Nil	-	
1	Kurunthancode	28.05.2025	-	-	-	-	-	-	
2		29.05.2025	10	60	6000	45000	0	No	
3		30.05.2025	10	68	6800	51000	0	No	
4		31.05.2025	10	33	3300	24750	0	No	
5		01.06.2025	10	19	1900	14250	0	No	
6		02.06.2025	10	17	1700	12750	0	No	
7		03.06.2025	10	17	1700	12750	0	No	
8		04.06.2025	10	22	2200	16500	0	No	
9		05.06.2025	10	22	2200	16500	0	No	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
10		06.06.2025	10	21	2100	15750	0	No	
11		07.06.2025	10	21	2100	15750	0	No	
12		08.06.2025	10	18	1800	13500	0	No	
13		09.06.2025	10	32	3200	24000	0	No	
1	Killiyoor	28.05.2025	8 hours	17	Nill	14450	0	No	
2		29.05.2025	8 hours	51	Nill	43350	0	No	
3		30.05.2025	8 hours	31	Nill	26350	0	No	
4		31.05.2025	8 hours	31	Nill	26350	0	No	
5		01.06.2025	0	0	Nill	0	0	No	
6		02.06.2025	8 hours	10	Nill	8500	0	No	
7		03.06.2025	8 hours	10	Nill	8500	0	No	
8		04.06.2025	8 hours	10	Nill	8500	0	No	
9		05.06.2025	8 hours	10	Nill	8500	0	No	
10		06.06.2025	8 hours	12	Nill	10200	0	No	
11		07.06.2025	8 hours	11	Nill	9350	0	No	
12		08.06.2025	8 hours	7	Nill	5950	0	No	
13		09.06.2025	8 hours	12	Nill	10200	0	No	
14		10.06.2025	8 hours	12	Nill	10200	0	No	
15		11.06.2025	8 hours	12	Nill	10200	0	No	
16		12.06.2025	8 hours	12	Nill	10200	0	No	
17		13.06.2025	8 hours	12	Nill	10200	0	No	
18		14.06.2025	8 hours	12	Nill	10200	0	No	
1	Munchirai	28.05.2025	8 am - 3 pm	5	No	No	No	No	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
2		29.05.2025	8 am - 3 pm	6	No	No	No	No	
3		30.05.2025	8 am - 3 pm	6	No	No	No	No	
4		31.05.2025	8 am - 3 pm	15	No	No	No	No	
5		01.06.2025	8 am - 3 pm	15	No	No	No	No	
6		02.06.2025	8 am - 3 pm	5	No	No	No	No	
7		03.06.2025	8 am - 3 pm	21	No	No	No	No	
8		04.06.2025	8 am - 3 pm	21	No	No	No	No	
9		05.06.2025	8 am - 3 pm	21	No	No	No	No	
10		06.06.2025	8 am - 3 pm	21	No	No	No	No	
11		07.06.2025	8 am - 3 pm	21	No	No	No	No	
12		08.06.2025	8 am - 3 pm	21	No	No	No	No	
13		09.06.2025	8 am - 3 pm	21	No	No	No	No	
14		10.06.2025	8 am - 3 pm	21	No	No	No	No	
15		11.06.2025	8 am - 3 pm	21	No	No	No	No	
16		12.06.2025	8 am - 3 pm	21	No	No	No	No	
17		13.06.2025	8 am - 3 pm	21	No	No	No	No	
18		14.06.2025	8 am - 3 pm	21	No	No	No	No	
1	Puthalam	28.05.2025	0	0	0	0	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், புத்தளம் பேரூராட்சிக்குட்பட்ட சொத்தவிளை கடற்கரையில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில்
2		29.05.2025	0	0	0	0	0	0	
3		30.05.2025	9	9	720	7650	14400	0	
4		31.05.2025	9	10	800	8500	2390	0	
5		01.06.2025	8	4	320	3400	0	0	
6		02.06.2025	8	6	480	5100	0	0	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
7		03.06.2025	8	6	480	5100	0	0	பணியாளர்கள் ஊதியம், உணவு மற்றும் இதர செலவினங்களுக்கு ரூ.83720/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
8		04.06.2025	8	6	480	5100	0	0	
9		05.06.2025	8	5	400	4250	0	0	
10		06.06.2025	8	7	560	5950	0	0	
11		07.06.2025	8	8	640	6800	0	0	
12		08.06.2025	0	0	0	0	0	0	
13		09.06.2025	8	2	0	1700	0	0	
14		10.06.2025	8	3	0	2550	0	0	
15		11.06.2025	8	3	0	2550	0	0	
16		12.06.2025	8	2	0	1700	0	0	
17		13.06.2025	8	2	0	1700	0	0	
18		14.06.2025	0	0	0	0	0	0	
1	Mandaikkadu	28.05.2025	0	0	0	0	0	-	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், மண்டைக்காடு பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.1700/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
2		29.05.2025	0	0	0	0	0	-	
3		30.05.2025	0	0	0	0	0	-	
4		31.05.2025	0	0	0	0	0	-	
5		01.06.2025	0	0	0	0	0	-	
6		02.06.2025	0	0	0	0	0	-	
7		03.06.2025	0	0	0	0	0	-	
8		04.06.2025	0	0	0	0	0	-	
9		05.06.2025	8	2	0	1700	0	-	
10		06.06.2025	0	0	0	0	0	-	
11		07.06.2025	0	0	0	0	0	-	

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					Food	Wages			
12		08.06.2025	0	0	0	0	0	-	
13		09.06.2025	0	0	0	0	0	-	
14		10.06.2025	0	0	0	0	0	-	
15		11.06.2025	0	0	0	0	0	-	
16		12.06.2025	0	0	0	0	0	-	
17		13.06.2025	0	0	0	0	0	-	
18		14.06.2025	0	0	0	0	0	-	
1	Manavalakurichi	28.05.2025	8	5	0	4250	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், மணவாளக்குறிச்சி பேரூராட்சிக்குட்பட்ட சின்னவிளை கடற்கரை பகுதியில் கரை ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்களுக்கான ஊதிய செலவினங்களுக்கு ரூ.86700/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது. இத்தொகையில் கல்குளம் வட்டாட்சியர் அவர்களால் 23.06.2025 அன்று ரூ.38250/- பேரூராட்சிக்கு வழங்கப்பட்டது. மீதமுள்ள நிலுவை தொகை ரூ.48450/- இப்பேரூராட்சிக்கு வழங்கப்படவேண்டியுள்ளது.
2		29.05.2025	8	5	0	4250	0	0	
3		30.05.2025	8	5	0	4250	0	0	
4		31.05.2025	8	5	0	4250	0	0	
5		01.06.2025	8	5	0	4250	0	0	
6		02.06.2025	8	5	0	4250	0	0	
7		03.06.2025	8	5	0	4250	0	0	
8		04.06.2025	8	5	0	4250	0	0	
9		05.06.2025	8	5	0	4250	0	0	
10		06.06.2025	8	5	0	4250	0	0	
11		07.06.2025	8	5	0	4250	0	0	
12		08.06.2025	8	2	0	1700	0	0	
13		09.06.2025	8	5	0	4250	0	0	
14		10.06.2025	8	5	0	4250	0	0	
15		11.06.2025	8	5	0	4250	0	0	
16		12.06.2025	8	5	0	4250	0	0	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
17		13.06.2025	8	5	0	4250	0	0	
18		14.06.2025	8	5	0	4250	0	0	
19		15.06.2025	8	0	0	0	0	0	
20		16.06.2025	8	5	0	4250	0	0	
21		17.06.2025	8	5	0	4250	0	0	
22		18.06.2025	8	5	0	4250	0	0	
1	Kallukoottam	28.05.2025	8	6	0	5100	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், கல்லுக்கூட்டம் பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.39100/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
2		29.05.2025	8	6	0	5100	0	0	
3		30.05.2025	8	6	0	5100	0	0	
4		31.05.2025	8	6	0	5100	0	0	
5		01.06.2025	8	6	0	5100	0	0	
6		02.06.2025	8	6	0	5100	0	0	
7		03.06.2025	8	6	0	5100	0	0	
8		04.06.2025	8	2	0	1700	0	0	
9		05.06.2025	8	2	0	1700	0	0	
10		06.06.2025	0	0	0	0	0	0	
11		07.06.2025	0	0	0	0	0	0	
12		08.06.2025	0	0	0	0	0	0	
13		09.06.2025	0	0	0	0	0	0	
14		10.06.2025	0	0	0	0	0	0	
15		11.06.2025	0	0	0	0	0	0	
16		12.06.2025	0	0	0	0	0	0	
17		13.06.2025	0	0	0	0	0	0	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
18		14.06.2025	0	0	0	0	0	0	
1	Palapallam	28.05.2025	8	5	0	4250	0	0	கொச்சி சரக்கு கப்பல் கவிழ்ந்ததில், பாலப்பள்ளம் பேரூராட்சிக்குட்பட்ட கடற்கரை பகுதியில் ஒதுங்கிய பிளாஸ்டிக் துகள்களை சேகரித்த வகையில் பணியாளர்கள் ஊதியம் ரூ.83300/- பேரூராட்சி பொது நிதியிலிருந்து செலவு மேற்கொள்ளப்பட்டுள்ளது.
2		29.05.2025	8	15	0	12750	0	0	
3		30.05.2025	8	15	0	12750	0	0	
4		31.05.2025	8	15	0	12750	0	0	
5		01.06.2025	8	10	0	8500	0	0	
6		02.06.2025	8	15	0	12750	0	0	
7		03.06.2025	8	5	0	4250	0	0	
8		04.06.2025	8	2	0	1700	0	0	
9		05.06.2025	8	1	0	850	0	0	
10		06.06.2025	8	2	0	1700	0	0	
11		07.06.2025	8	2	0	1700	0	0	
12		08.06.2025	8	2	0	1700	0	0	
13		09.06.2025	8	2	0	1700	0	0	
14		10.06.2025	8	1	0	850	0	0	
15		11.06.2025	8	5	0	4250	0	0	
16		12.06.2025	8	1	0	850	0	0	
17		13.06.2025	0	0	0	0	0	0	
18		14.06.2025	0	0	0	0	0	0	
1	Colachel	28.05.2025	8 hr/ day / Person	6	0	0	0		
2		29.05.2025	8 hr/ day / Person	3	0	0	0		

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
3		30.05.2025	8 hr/ day / Person	3	0	0	0		
4		31.05.2025	8 hr/ day / Person	4	0	0	0		
5		01.06.2025	8 hr/ day / Person	3	0	0	0		
6		02.06.2025	8 hr/ day / Person	3	0	0	0		
7		03.06.2025	8 hr/ day / Person	3	0	0	0		
8		04.06.2025	8 hr/ day / Person	3	0	0	0		
9		05.06.2025	8 hr/ day / Person	4	0	0	0		
10		06.06.2025	8 hr/ day / Person	4	0	0	0		
11		07.06.2025	8 hr/ day / Person	4	0	0	0		
12		08.06.2025	8 hr/ day / Person	4	0	0	0		
13		09.06.2025	8 hr/ day / Person	4	0	0	0		
14		10.06.2025	8 hr/ day / Person	4	0	0	0		
15		11.06.2025	8 hr/ day / Person	4	0	0	0		

3099

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
16		12.06.2025	8 hr/ day / Person	4	0	0	0		
17		13.06.2025	8 hr/ day / Person	4	0	0	0		
18		14.06.2025	8 hr/ day / Person	4	0	0	0		
1	Thengapattinam	28.05.2025	112	14	0	0	0		
2		29.05.2025	112	14	0	0	0		
3		30.05.2025	112	14	0	0	0		
4		31.05.2025	112	14	0	0	0		
5		01.06.2025	112	14	0	0	0		
6		02.06.2025	112	8	0	0	0		
7		03.06.2025	80	9	0	0	0		
8		04.06.2025	80	8	0	0	0		
9		05.06.2025	80	9	0	0	0		
10		06.06.2025	80	1	0	0	0		
11		07.06.2025	80	9	0	0	0		
12		08.06.2025	80	3	0	0	0		
13		09.06.2025	80	9	0	0	0		
14		10.06.2025	80	8	0	0	0		
15		11.06.2025	80	9	0	0	0		
16		12.06.2025	80	3	0	0	0		
17		13.06.2025	80	8	0	0	0		
18		14.06.2025	80	8	0	0	0		

3100

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
19		15.06.2026	80	10	0	0	0		
1	Chinnamuttom	28.05.2025	8 hr / day/ Person	11	0	0	0		
2		29.05.2025	8 hr / day/ Person	11	0	0	0		
3		30.05.2025	8 hr / day/ Person	11	0	0	0		
4		31.05.2025	8 hr / day/ Person	11	0	0	0		
5		01.06.2025	8 hr / day/ Person	11	0	0	0		
6		02.06.2025	8 hr / day/ Person	3	0	0	0		
7		03.06.2025	8 hr / day/ Person	3	0	0	0		
8		04.06.2025	8 hr / day/ Person	4	0	0	0		
9		05.06.2025	8 hr / day/ Person	1	0	0	0		
10		06.06.2025	8 hr / day/ Person	0	0	0	0		
11		07.06.2025	8 hr / day/ Person	0	0	0	0		
12		08.06.2025	8 hr / day/ Person	0	0	0	0		

3101

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
13		09.06.2025	8 hr / day/ Person	2	0	0	0		
14		10.06.2025	8 hr / day/ Person	2	0	0	0		
15		11.06.2025	8 hr / day/ Person	2	0	0	0		
16		12.06.2025	8 hr / day/ Person	0	0	0	0		
17		13.06.2025	8 hr / day/ Person	1	0	0	0		
18		14.06.2025	8 hr / day/ Person	1	0	0	0		
1	Agasteeswaram	06.06.2025	8 Hours	5	500	3750	-	TNPCB	
2		23.06.2025	8 Hours	4	400	3000	-	TNPCB	
3		24.06.2025	8 Hours	7	700	5250	-	TNPCB	
4		25.06.2025	8 Hours	7	700	5250	-	TNPCB	
5		26.06.2025	8 Hours	4	400	3000	-	TNPCB	
6		27.06.2025	8 Hours	3	300	2250	-	TNPCB	
7		28.06.2025	8 Hours	4	400	3000	-	TNPCB	
8		01.07.2025	8 Hours	2	200	1500	-	TNPCB	
9		02.07.2025	8 Hours	2	200	1500	-	TNPCB	
10		03.07.2025	8 Hours	2	200	1500	-	TNPCB	
1	Kalkulam	28.05.2025	-	-	-	-	-	-	
2		29.05.2025	8 Hours	8	1820	5840	1825	TNPCB	
3		30.05.2025	8 Hours	9	3540	6570	-	TNPCB	

3102

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
4		31.05.2025	8 Hours	6	2550	4380	320	TNPCB	
5		01.06.2025	8 Hours	-	2760	-	210	TNPCB	
6		02.06.2025	8 Hours	10	3500	7300	3007	TNPCB	
7		03.06.2025	8 Hours	11	2470	8030	1020	TNPCB	
8		04.06.2025	8 Hours	11	1700	8030	0	TNPCB	
9		05.06.2025	8 Hours	11	2988	8030	0	TNPCB	
10		06.06.2025	8 Hours	8	1992	5840	0	TNPCB	
11		07.06.2025	8 Hours	13	2866	9490	0	TNPCB	
12		08.06.2025	8 Hours	1	250	730	0	TNPCB	
13		09.06.2025	8 Hours	13	2570	9490	0	TNPCB	
14		10.06.2025	8 Hours	8	2080	5840	0	TNPCB	
15		11.06.2025	8 Hours	12	2480	8760	0	TNPCB	
16		12.06.2025	8 Hours	13	1850	9490	0	TNPCB	
17		13.06.2025	8 Hours	12	2424	8760	0	TNPCB	
18		14.06.2025	8 Hours	12	2424	8760	0	TNPCB	
19		15.06.2025	8 Hours	0	0	0	0	TNPCB	
20		16.06.2025	8 Hours	10	2080	7300	0	TNPCB	
21		17.06.2025	8 Hours	10	2080	7300	0	TNPCB	
22		18.06.2025	8 Hours	8	0	5840	0	TNPCB	
23		19.06.2025	8 Hours	3	0	2190	0	TNPCB	
24		20.06.2025	8 Hours	3	0	2190	634	TNPCB	
25		21.06.2025	8 Hours	2	0	1460	0	MERC	
26		22.06.2025	8 Hours	2	0	1460	0	MERC	

3103

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
27		23.06.2025	8 Hours	17	0	12410	0	MERC	
28		24.06.2025	8 Hours	19	0	13870	0	MERC	
29		25.06.2025	8 Hours	17	0	12410	0	MERC	
30		26.06.2025	8 Hours	14	0	10220	0	MERC	
31		27.06.2025	8 Hours	10	0	7300	0	MERC	
32		28.06.2025	8 Hours	22	0	16060	0	MERC	
33		29.06.2025	8 Hours	2	0	1460	0	MERC	
34		30.06.2025	8 Hours	10	0	7300	0	MERC	
35		01.07.2025	8 Hours	16	0	11680	0	MERC	
36		02.07.2025	8 Hours	14	0	10220	0	MERC	
37		03.07.2025	8 Hours	16	0	11680	0	MERC	
38		04.07.2025	8 Hours	2	0	1460	0	MERC	
39		05.07.2025	8 Hours	2	0	1460	0	MERC	
40		06.07.2025	8 Hours	2	0	1460	0	MERC	
41		07.07.2025	8 Hours	2	0	1460	0	MERC	
42		08.07.2025	8 Hours	2	0	1460	0	MERC	
43		09.07.2025	8 Hours	2	0	1460	0	MERC	
44		10.07.2025	8 Hours	7	0	5110	0	MERC	
45		11.07.2025	8 Hours	7	0	5110	0	MERC	
46		12.07.2025	8 Hours	4	0	2920	0	MERC	
47		13.07.2025	8 Hours	4	0	2920	0	MERC	
48		14.07.2025	8 Hours	11	0	8030	0	MERC	
49		15.07.2025	8 Hours	9	0	6570	0	MERC	

3104

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
50		16.07.2025	8 Hours	11	0	8030	0	MERC	
51		17.07.2025	8 Hours	2	0	1460	0	MERC	
52		18.07.2025	8 Hours	2	0	1460	0	MERC	
53		19.07.2025	8 Hours	2	0	1460	0	MERC	
54		20.07.2025	8 Hours	2	0	1460	0	MERC	
55		21.07.2025	8 Hours	3	0	2190	0	MERC	
56		22.07.2025	8 Hours	2	0	1460	0	MERC	
57		23.07.2025	8 Hours	3	0	2190	0	MERC	
58		24.07.2025	8 Hours	2	0	1460	0	MERC	
59		25.07.2025	8 Hours	3	0	2190	0	MERC	
60		26.07.2025	8 Hours	2	0	1460	0	MERC	
61		27.07.2025	8 Hours	2	0	1460	0	MERC	
62		28.07.2025	8 Hours	3	0	2190	0	MERC	
63		29.07.2025	8 Hours	2	0	1460	0	MERC	
64		30.07.2025	8 Hours	2	0	1460	0	MERC	
65		31.07.2025	8 Hours	3	0	2190	0	MERC	
66		01.08.2025	8 Hours	2	0	1460	0	MERC	
67		02.08.2025	8 Hours	2	0	1460	0	MERC	
68		03.08.2025	8 Hours	2	0	1460	0	MERC	
69		04.08..2025	8 Hours	3	0	0	0	MERC	
1	Killiyoor	28.05.2025	8 Hours	5	500	3750	-	TNPCB	
2		29.05.2025	8 Hours	20	2000	15000	-	TNPCB	
3		30.05.2025	8 Hours	18	1800	13500	-	TNPCB	

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S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)	Remark if any
					Food	Wages			
4		31.05.2025	8 Hours	21	2100	15750	-	TNPCB	
5		01.06.2025	-	-	-	-	-	TNPCB	
6		02.06.2025	8 Hours	14	1400	10500	-	TNPCB	
7		03.06.2025	8 Hours	20	2000	15000	-	TNPCB	
8		04.06.2025	8 Hours	20	2000	15000	-	TNPCB	
9		05.06.2025	8 Hours	15	1500	11250	-	TNPCB	
10		06.06.2025	8 Hours	21	2100	15750	-	TNPCB	
11		07.06.2025	8 Hours	28	2800	21000	-	TNPCB	
12		08.06.2025	-	-	-	-	-	TNPCB	
13		09.06.2025	8 Hours	26	2600	19500	-	TNPCB	
14		10.06.2025	8 Hours	28	2800	21000	-	TNPCB	
15		11.06.2025	8 Hours	31	3100	23250	-	TNPCB	
16		12.06.2025	8 Hours	27	2700	20250	-	TNPCB	
17		13.06.2025	9 Hours	29	2900	21750	-	TNPCB	
18		14.06.2025	10 Hours	23	2300	17250	-	TNPCB	

3106

S. No.	Name of the Municipality	Date of cleanup activity carried out	Working hours	No. of persons involved in the cleanup	Amount paid		Other allowances if any	Agency involved in payment (TNPCB / MERC)
					Food	Wages		
1	Kollancode	28.05.2025	8 Hours	6	_	5100	_	_
2		29.05.2025	8 Hours	6	_	5100	_	_
3		30.05.2025	8 Hours	7	_	5950	_	_
4		31.05.2025	8 Hours	14	_	11900	_	_
5		01.06.2025	8 Hours	12	_	10200	_	_
6		02.06.2025	8 Hours	10	_	8500	_	_
7		03.06.2025	8 Hours	17	_	14450	_	_
8		04.06.2025	8 Hours	5	_	4250	_	_
9		05.06.2025	8 Hours	6	_	5100	_	_
10		06.06.2025	8 Hours	6	_	5100	_	_
11		07.06.2025	8 Hours	8	_	6800	_	_
12		08.06.2025	8 Hours	6	_	5100	_	_
13		09.06.2025	8 Hours	9	_	7650	_	_
14		10.06.2025	8 Hours	9	_	7650	_	_
15		11.06.2025	8 Hours	10	_	8500	_	_
16		12.06.2025	8 Hours	12	_	10200	_	_
17		13.06.2025	8 Hours	4	_	3400	_	_
18		14.06.2025	8 Hours	4	_	3400	_	_

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Tamil Nadu Pollution Control Board, Advanced Environmental Laboratory,
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Test Report

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SAMPLE DETAILS			
Lab Code	02792526TNV to 02832526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	Sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	29.05.2025, 03.46 pm to 07.57 pm		
Sample Received Date & time	30.05.2025, 10.15 am		
Analysis Started on	30.05.2025	Analysis Completed on	09.06.2025
Point of Collection	1. Naduthurai 2. Inayam 3. Midalam 4. Colachel 5. Mandaikadu		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0279 2526TNV	0280 2526TNV	0281 2526TNV	0282 2526TNV	0283 2526TNV	
1	pH @ 25°C	-	7.84	7.92	7.93	7.96	7.99	6.5 – 8.5
2	Colour	CU	5	5	10	5	5	No noticeable colour
3	Odour	-	Mild fishy	Mild fishy	Mild fishy	Mild fishy	Odourless	No noticeable offensive odour
4	Turbidity	NTU	0.77	0.33	1.22	0.53	0.72	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	-	-	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.8	6.4	6.9	6.5	6.7	4.0 mg/l
7	BOD	mg/L	<2	2.7	<2	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0279 2526TNV	0280 2526TNV	0281 2526TNV	0282 2526TNV	0283 2526TNV	
1	Fecal Coliform	MPN/100 ml	9.4	17.7	30.9	69.3	31.1	100/100 ml

18/06/2025

Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 2 of 9

SAMPLE DETAILS			
Lab Code	02842526TNV to 02882526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	Sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	30.05.2025, 02.02 pm to 7.57 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	6. Neerodi 7. Marthandamthurai 8. Vallavilai 9. Eraviputhenthurai 10. Ezhudesam Chinnathurai		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0284 2526TNV	0285 2526TNV	0286 2526TNV	0287 2526TNV	0288 2526TNV	
1	pH @ 25°C	-	7.98	7.97	8.01	8.04	8.03	6.5 – 8.5
2	Colour	CU	5	10	10	5	5	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	14.45	16.50	15.14	15.25	7.49	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.6	6.8	6.2	6.8	6.9	4.0 mg/l
7	BOD	mg/L	<2	<2	<2	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0284 2526TNV	0285 2526TNV	0286 2526TNV	0287 2526TNV	0288 2526TNV	
1	Fecal Coliform	MPN/ 100 ml	10.5	9.3	10.8	20.2	41.1	100/100 ml

18/06/2025

Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 3 of 9

SAMPLE DETAILS			
Lab Code	02892526TNV to 02932526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	30.05.2025, 03.45 pm to 05.56 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	11. Thoothoor 12. Poothurai 13. Erayumanthurai 14. Mulloorthurai 15. Ramanthurai		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0289 2526TNV	0290 2526TNV	0291 2526TNV	0292 2526TNV	0293 2526TNV	
1	pH @ 25°C	-	8.04	8.01	8.09	8.10	8.10	6.5 – 8.5
2	Colour	CU	5	5	10	5	5	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	12.27	8.33	8.66	10.25	12.89	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.8	6.6	6.7	6.4	6.7	4.0 mg/l
7	BOD	mg/L	<2	2.6	2.1	<2	2.5	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0289 2526TNV	0290 2526TNV	0291 2526TNV	0292 2526TNV	0293 2526TNV	
1	Fecal Coliform	MPN/100 ml	65.7	10.8	10.5	9.3	10.7	100/100 ml

18/06/2025

Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Tamil Nadu Pollution Control Board, Advanced Environmental Laboratory,
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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 4 of 9

SAMPLE DETAILS			
Lab Code	02942526TNV to 02982526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	30.05.2025, 06.15 pm to 06.50 pm and 31.05.2025, 08.38 am to 09.57 am		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	16. Enayam Puthenthurai 17. Enayam Chinnathurai 18. Chinnavilai 19. Kurumpanai 20. Vaniyakudi		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0294 2526TNV	0295 2526TNV	0296 2526TNV	0297 2526TNV	0298 2526TNV	
1	pH @ 25°C	-	8.18	8.09	8.17	7.83	7.92	6.5 – 8.5
2	Colour	CU	5	5	5	5	10	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	12.57	11.25	10.36	15.25	5.35	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.8	6.7	6.8	6.4	6.4	4.0 mg/l
7	BOD	mg/L	2	<2	<2	<2	2.4	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0294 2526TNV	0295 2526TNV	0296 2526TNV	0297 2526TNV	0298 2526TNV	
1	Fecal Coliform	MPN/100 ml	18.7	25.1	16.6	16.4	32.1	100/100 ml

18/06/2025
Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 5 of 9

SAMPLE DETAILS			
Lab Code	02992526TNV to 03032526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	Sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	31.05.2025, 10.18 am to 11.30 am		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	21. Kodimunai 22. Simon Colony 23. Kottilpaadu 24. Puthur 25. Periyavilai		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0299 2526TNV	0300 2526TNV	0301 2526TNV	0302 2526TNV	0303 2526TNV	
1	pH @ 25°C	-	8.01	7.99	8.05	8.07	8.10	6.5 – 8.5
2	Colour	CU	5	5	5	5	5	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	6.38	12.25	13.25	15.25	11.25	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	-	-	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.6	6.8	6.6	6.4	6.3	4.0 mg/l
7	BOD	mg/L	2	2	2	2	2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0299 2526TNV	0300 2526TNV	0301 2526TNV	0302 2526TNV	0303 2526TNV	
1	Fecal Coliform	MPN/100 ml	34.6	11.8	14.1	23.4	25.7	100/100 ml

18/06/2025
Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Test Report

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SAMPLE DETAILS			
Lab Code	03042526TNV to 03082526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	31.05.2025, 11.55 am to 01.20 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	26. Melakadiyapattinam 27. Keezhakadiyapattinam 28. Mela Muttom 29. Keezha Muttom 30. Rajakkamangalam		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0304 2526TNV	0305 2526TNV	0306 2526TNV	0307 2526TNV	0308 2526TNV	
1	pH @ 25°C	-	8.09	8.06	8.09	8.17	8.10	6.5 – 8.5
2	Colour	CU	5	5	10	10	5	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	8.35	11.25	19.30	12.25	8.35	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.9	6.8	6.9	6.9	6.8	4.0 mg/l
7	BOD	mg/L	<2	<2	<2	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0304 2526TNV	0305 2526TNV	0306 2526TNV	0307 2526TNV	0308 2526TNV	
1	Fecal Coliform	MPN/100 ml	26.6	30.9	32.0	36.8	51.2	100/100 ml

18/06/2025
Dr. M. Sakthivel,

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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 7 of 9

Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

SAMPLE DETAILS			
Lab Code	03092526TNV to 03132526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	31.05.2025, 01.36 pm to 04.02 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	31. Periyakadu 32. Pozhikarai 33. Puthenthurai 34. Azhikaal 35. Kesavaputhenthurai		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0309 2526TNV	0310 2526TNV	0311 2526TNV	0312 2526TNV	0313 2526TNV	
1	pH @ 25°C	-	8.09	8.12	8.10	8.09	8.07	6.5 – 8.5
2	Colour	CU	5	5	5	5	5	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	12.51	10.35	12.62	8.55	9.62	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	Plastic pellets	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.7	6.8	6.9	6.8	6.9	4.0 mg/l
7	BOD	mg/L	<2	<2	<2	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0309 2526TNV	0310 2526TNV	0311 2526TNV	0312 2526TNV	0313 2526TNV	
1	Fecal Coliform	MPN/100 ml	18.1	21.1	23.0	35.0	67.5	100/100 ml

18/06/2025

Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

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Test Report

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SAMPLE DETAILS			
Lab Code	03142526TNV to 03182526TNV		
Nature of Sample	Five numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	31.05.2025, 04.06 pm to 05.39 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	36. Pallam 37. Manakudi 38. Keezhamanakudy 39. Kovalam 40. Kanyakumari		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0314 2526TNV	0315 2526TNV	0316 2526TNV	0317 2526TNV	0318 2526TNV	
1	pH @ 25°C	-	8.15	8.17	8.15	8.14	8.09	6.5 – 8.5
2	Colour	CU	5	5	5	5	10	No noticeable colour
3	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	11.45	12.64	9.25	15.20	15.35	30 NTU
5	Floating matters	-	Plastic pellets	Plastic pellets	Plastic pellets	-	-	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.8	6.8	6.7	6.9	6.8	4.0 mg/l
7	BOD	mg/L	<2	<2	<2	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT					STANDARDS
			0314 2526TNV	0315 2526TNV	0316 2526TNV	0317 2526TNV	0318 2526TNV	
1	Fecal Coliform	MPN/100 ml	26.2	33.3	46.3	31.1	34.6	100/100 ml

18/06/2025

Dr. M. Sakthivel,
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AEL, TNPCB, Tirunelveli

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Test Report

Report No:	AEL/TNV/Test Report- 95/2025, dated: 18.06.2025	Page 9 of 9

SAMPLE DETAILS			
Lab Code	03192526TNV to 03202526TNV		
Nature of Sample	Two numbers of Coastal water samples		
Sample Conditions at Receipt	sealed & fastened		
Sample Quantity & Packing	2.5 litres in plastic container, 300 ml DO fixed bottle, 250 ml in sterile container for Microbiology		
Date and time of Collection	31.05.2025, 06.20 pm to 06.43 pm		
Sample Received Date & time	31.05.2025, 9.30 pm		
Analysis Started on	02.06.2025	Analysis Completed on	09.06.2025
Point of Collection	41. Chinnamuttom 42. Arockiyapuram		

TEST RESULTS – CHEMICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT		STANDARDS
			03192526TNV	03202526TNV	
1	pH @ 25°C	-	8.12	8.06	6.5 – 8.5
2	Colour	CU	5	5	No noticeable colour
3	Odour	-	Odourless	Odourless	No noticeable offensive odour
4	Turbidity	NTU	13.25	20.25	30 NTU
5	Floating matters	-	-	-	No visible / obnoxious floating debris, oil slick, scum
6	Dissolved Oxygen	mg/L	6.8	6.9	4.0 mg/l
7	BOD	mg/L	<2	<2	3mg/l
8	Oil & Grease*	mg/L	<0.1	<0.1	0.1 mg/l

TEST RESULTS – MICROBIOLOGICAL PARAMETERS

Sl. No.	PARAMETERS	UNIT	RESULT		STANDARDS
			03192526TNV	03202526TNV	
1	Fecal Coliform	MPN/100 ml	30.9	22.5	100/100 ml

18/06/2025
Dr. M. Sakthivel,
Deputy Chief Scientific Officer,
AEL, TNPCB, Tirunelveli

Unless otherwise specified, the results presented in this report pertain exclusively to the tested samples, which are retained for 15 days from the date of test completion. For regulatory samples, retention will follow the specific period mandated by the relevant requirements. The testing activities are performed in permanent facility located at AEL, TNPCB, Tirunelveli.

3117

3118

Report of analysis of water samples collected from Kanyakumari Coast and cost incurred for analysis

TAMILNADU POLLUTION CONTROL BOARD

Advanced Environmental Laboratory, Tirunelveli.

TO

THE DISTRICT ENVIRONMENTAL ENGINEER
NAGERCOIL.

Invoice No: 95
Date: 18.06.2025

Sample Code No. : 279 to 320

Sl. No.	Description	No. of Samples	Rate Rs. P.	Amount Rs. P.
01.	Coastal Samples	42	720.00	30240.00
02.	Sampling & Transportation Charges	42	3000.00	126000.00
	Total			**156240.00**
	(Rupees One lakh fifty six thousand two hundred and forty only)			

Deputy Chief Scientific Officer,
Advanced Environmental Laboratory,
Tamil Nadu Pollution control Board,
Tirunelveli.

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Email **PWM Sec TNPCB**

O/o.DEE, TNPCB - Nagapattinam - Plastic Nurdle MSC ELSA 3 Wreckage - Assessment of Claims - Details submitted - Reg

From : DEE NPM TNPCB <deenpm@tnpcb.gov.in> Tue, Aug 19, 2025 12:29 PM

Subject : O/o.DEE, TNPCB - Nagapattinam - Plastic Nurdle MSC ELSA 3 Wreckage - Assessment of Claims - Details submitted - Reg

1 attachment

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM CUD TNPCB <jceemcud@tnpcb.gov.in>

Sir,

Submitted. Please find the attachment.

DEE/TNPCB/NPM

20250819075442449.pdf
423 KB

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3121

3122

TAMIL NADU POLLUTION CONTROL BOARD

From	To
Er. G. Ravichandran, M. E., District Environmental Engineer, Tamil Nadu Pollution Control Board, District Collectorate Master Complex, Nagapattinam – 611 003.	The Member Secretary, Tamil Nadu Pollution Control Board, No. 76, Mount Salai, Guindy, Chennai – 600 032.

Letter No. DEE/TNPCB/NPM/F-28 Tech/2025, Dated: 18.08.2025

Sub : O/o. DEE, TNPCB, Nagapattinam – Industries – List of Industries that withdraw Sea Water for their Process or Cooling purposes located in the Nagapattinam and Mayiladuthurai District – Details Submitted - Reg.

Ref : Email received from the PWM Section, TNPCB Dated : 14.08.2025

****

With reference to the above cited, I submit herewith the list of Industries that withdraw Sea Water for their Process or Cooling purposes located in the Nagapattinam and Mayiladuthurai District within this Office jurisdiction of O/o. DEE, TNPCB, Nagapattinam.

This is submitted for favour of kind information and necessary action please.

Encl : As stated above

18.08.2025

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Nagapattinam.

19/8/25

Copy submitted to: The Joint Chief Environmental Engineer (M), Tamil Nadu Pollution Control Board, Cuddalore for kind information please.

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1579760/2025/DD,DOECC

Nagapattinam District

S. No	Industry Name	Product	Water Consumption Details	Present Status of unit (Under Operation / Not in operation)	Consent Status
1.	M/s . GHCL Limited, S. F. No. 134,etc., Kadinavayal Village, Vedaranyam Taluk, Nagapattinam District.	Common Salt – 40000 MT/Month	4000 KLD Sea Water is utilized as raw material for their process	Unit is under operation	RCO Proc No. F.0036NPM/ OL/DEE/TNPCB/NPM/W&A/ 2023 Dated: 19/07/2023 with validity upto 31/03/2027
2.	M/s. Chemplast Sanmar Limited, S. F. No. 15/1 to 15/9B, 16/1,16/2,17/1A to 17/1D,17/2A,18/1,18/2,19/1 to 19/5 & Unsurveyed swamps (1415.42 Ha), Kodiyakadu Village, Vedaranyam Taluk , Nagapattinam District .	Common Salt – 400000 MT/Annum	21,00,000 KL/Month Sea Water is utilized as raw material for their process	Unit is under operation	RCO Proc. No. F.0403NPM/ OL/DEE/TNPCB/NPM/W&A/ 2022 Dated: 18/05/2022 with validity upto 31/03/2032
	Mayiladuthurai District				
1.	M/s. PPN Power Generating Company Private Limited, S. F. No. 193,194, etc., Pillai Peruma Nallur Village, Tharangampadi Taluk, Mayiladuthurai District.	Electrical Power Generation using Natural Gas – 320 MW	887732.4 KLD Sea Water is utilized as Cooling and Boiler Feed	Unit was not in operation	RCO Proc No. F.0018NPM/ RL/JCEE-M/TNPCB/NPM/ W&A/2025 Dated: 09/07/2025 with validity upto 31/03/2026

18-08-2025

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Nagapattinam.

18/8/25

18/8/25

Email **PWM Sec TNPCB**

O/o.DEE, TNPCB, Thanjavur -PWM- Plastic nurdle _MSC ELSA 3 Wreckage-Assessment of Claims-Details Submitted - Reg

From : DEE TNJ TNPCB <deetnj@tnpcb.gov.in> Mon, Aug 18, 2025 06:58 PM

Subject : O/o.DEE, TNPCB, Thanjavur -PWM- Plastic nurdle _MSC ELSA 3 Wreckage-Assessment of Claims-Details Submitted - Reg

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM TRY TNPCB <jceemtry@tnpcb.gov.in>

Sir/Submitted,
With respect to Thanjavur District Nil- Industries are not withdrawing Seawater for process or cooling purposes.

This is submitted for favour of kind information please.

Thanks & Regards
O/o.DEE/TNPCB/Thanjavur

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Email **PWM Sec TNPCB**

O/o. DEE, TNPCB, Pudukkottai – PWM- Plastic nurdle - MSC ELSA 3 ship Wreckage - Assessment of Claims-Details requested for assessment of claims – Details submitted - Reg.

From : DEE PDK TNPCB <deepdk@tnpcb.gov.in> Mon, Aug 18, 2025 05:58 PM

Subject : O/o. DEE, TNPCB, Pudukkottai – PWM- Plastic nurdle - MSC ELSA 3 ship Wreckage - Assessment of Claims-Details requested for assessment of claims – Details submitted - Reg. 1 attachment

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM TRY TNPCB <jceemtry@tnpcb.gov.in>

Respected Sir,

Please find the attached file

Regards

DEE/TNPCB/PDK

Plastic nurdle _0001.pdf
172 KB

TAMILNADU POLLUTION CONTROL BOARD

LiFE Lifestyle for Environment

From
Thiru. K. Selvakumar, M.E.,
District Environmental Engineer,
Tamil Nadu Pollution Control Board,
No.01, SIPCOT Industrial Complex,
SIPCOT Post, Pudukkottai – 622 002.
E.Mail ID: deepdk@tnpcb.gov.in

To
The Member Secretary,
Tamil Nadu Pollution Control Board,
76, Mount Salal,
Guindy,
Chennai-32

Lr.No.2248/DEE/TNPCB/PDK/2025 Dated: 18.08.2025

Respected Madam,

Sub: O/o. DEE, TNPCB, Pudukkottai – PWM- Plastic nurdle - MSC ELSA 3 ship Wreckage - Assessment of Claims-Details requested for assessment of claims – Details submitted - Reg.

Ref: E-mail message received from Board office on 14.08.2025

With reference to the above, I submit to inform that there is no industries (e.g. desalination plants, thermal power plants, etc.,) for withdrawl of seawater for industrial process or cooling (or) desalination purposes in Pudukkottai District. Hence the report may be taken as "NIL".

This is submitted for favour of kind information and necessary action please.

18/8/25

District Environmental Engineer
Tamil Nadu Pollution Control Board
Pudukkottai

18/8/25

Copy submitted to:

The Joint Chief Environmental Engineer (M), Tamil Nadu Pollution Control Board, Trichy for kind information please.

Email **PWM Sec TNPCB**

TNPCB - O/o. DEE, Thiruvarur – PWM – Plastic nurdles spill incident – MSC ELSA 3 Wreckage – Assessment of Claims – Details Submitted - Reg.

From : DEE TVR TNPCB <deetvr@tnpcb.gov.in> Mon, Aug 18, 2025 05:15 PM

Subject : TNPCB - O/o. DEE, Thiruvarur – PWM – Plastic nurdles spill incident – MSC ELSA 3 Wreckage – Assessment of Claims – Details Submitted - Reg. 1 attachment

To : PWM Sec TNPCB <pwmsec@tnpcb.gov.in>

Cc : JCEEM CUD TNPCB <jceemcud@tnpcb.gov.in>

Sir/Madam,

Please find the attachment.

With Regards,
DEE,
TNPCB,
Thiruvarur.

PWM Covering Letter.pdf
98 KB

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LiFE Lifestyle for Environment

TAMIL NADU POLLUTION CONTROL BOARD

Plastic Pollution Free Tamil Nadu

From	To
Er. B. Ahalya, M.E., District Environmental Engineer, Tamil Nadu Pollution Control Board, No.2, Sri Guru Nagar, 1st Street, Vijayapuram, Thiruvavur – 610 001.	The Member Secretary, Tamil Nadu Pollution Control Board, No.76, Mount Salai, Guindy, Chennai – 600 032.

Letter No. DEE/TNPCB/TVR/ 2025, Dated: 18.08.2025

Madam,

Sub: TNPCB - O/o. DEE, Thiruvarur – PWM – Plastic nurdles spill incident – MSC ELSA 3 Wreckage – Assessment of Claims – Details Submitted - Reg.

Ref: Board's e-mail dated:14.08.2025.

****

With reference to the cited above, I submit to state that the details requested for assessing the claims regarding nurdle spill incident from the Wreckage of the MSC ELSA 3 ship as follows,

1. List of industries in the Thiruvarur District that withdraw seawater for the process or cooling purposes – **Nill.**
2. Daily Quantity of seawater withdrawn & Purpose of use – **Not applicable.**

This is submitted for the favour of kind information please.

18/08/2025

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Thiruvavur.

18/8/25

Copy submitted to: The Joint Chief Environmental Engineer (M), Cuddalore, for favour of kind information please.

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1. Introduction:

A Liberian cargo ship MSC ELSA-3 sank with 640 containers in the Arabian Sea on 24.05.2025 at about 38 Nautical Miles off Vizhingam coast of Kerala. Out of those 640 containers, 13 containers were reported to contain dangerous material. As per the Kerala State Disaster Management Authority (KSDMA) report, the following materials were present in the containers.

- Plastic Pellets (Nurdles)
- Calcium Carbide
- Marine Gas Oil (MGO)
- Very Low Sulphur Fuel Oil (VLSFO)

Some dangerous materials were also spread into the sea and raised environmental concerns.

Impact of South West Monsoon:

Due to South West Monsoon, some containers and spilt materials were moved towards the coast and got deposited in the shorelines of Tamil Nadu.

Role of District Administration and Departments involved:

The district administration took up the clean-up drive on the deposited pollutants and other measures in coordination with the following Departments/ agencies.

1. Department of Environment
2. Tamil Nadu Pollution Control Board (TNPCB)
3. Fisheries and Fishermen Welfare Department
4. Concerned local bodies

Clean up drive was initiated on 28.05.2025 and undertaken till 14.06.2025 by the District administration in coordination with the district level officials of various departments. Over 300 workers including Aapda Mitras, Sagar Mitras, Sanitary Workers and Government Officials were involved in these works on a daily basis.

The bags were stored in the respective fishing harbour sites under the jurisdiction of the Assistant Directors (Fisheries). Due to the monsoon, clean up activities were temporarily stopped from 15.06.2025 to 21.06.2025. During this period, the bags stored in the respective harbour sites were sieved and repacked into bags of 25 kg and shifted to Jeppiar Fishing Harbour Warehouse at Muttom, which is the common storage site. The washed ashore container was transported to Tuticorin port. The barrel is in the Jeppiar Fishing Harbour, Muttom.

2. **Action taken by the Fisheries and Fishermen Welfare Department:**

The Department of Fisheries and Fishermen Welfare Department have taken the following steps to mitigate the environmental issues due to the plastic nurdles washed ashore and deposited in the shores.

Warning and creation of awareness:

Instructions have been issued to the fishermen villages not to touch or handle the materials ashore. This information was spread among the fisherfolk through Public announcement and shared through whatsapp groups.

Engagement of Sagar Mitras:

The Fisheries and Fishermen Welfare Department has engaged Sagar Mitras and fishermen volunteers in the affected coastal villages. They have been instructed to monitor the coastal areas continuously and identify the places where the plastic nurdles deposited and inform the same directly to the District administration.

Coordination in Cleaning activities:

The Department of Fisheries and Fishermen Welfare is coordinated with the Local Administration and Revenue Department in removal of plastic pellets safely.

Kanniyakumari District:

The plastic pellets were washed ashore and deposited in the coastal areas of Kanniyakumari District due to South West Monsoon and sea currents. Plastic Pellets, Wooden boards, Iron materials, Aluminium sheets are washed ashore in 37 fishermen villages from Manakkudi to Neerodi in the West Coast of Tamil Nadu. Near Vaniyakudi one container was washed ashore.

Department of Fisheries and Fishermen Welfare requested Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU), Central Marine Fisheries Research Institute (CMFRI) and Suganthi Devadason Marine Research Institute (SDMRI), Thoothukudi to take up a study on the impact of this

pollutant deposition on fisheries. On the request of Fisheries and Fishermen Welfare Department, the officials of Tamil Nadu Dr. J.Jayalalitha Fisheries University have collected fish samples on 30.05.2025 to study the impact on the marine lives. The Interim Report have been furnished by the TN Dr.J.Jayalalitha Fisheries University.

The recommendation of the Interim Report are as follows:

1. It is crucial to clean up nurdles promptly after they are released. Early clean up is essential because nurdles can be mistaken for food by wild life, leading to their ingestion and the accumulation of pollutants within their bodies. This accumulation can tahen increase as these animals are consumed by larger predators, resulting in biomagnification, where pollutants become more concerntrated in higher trophic levels.
2. The sensory evaluation revealed no evidence of PAH contamination or tainted flavour, it is recommended to expand the testing protocol to include chemical analysis of seafood tissue using GC-MS/MG (Gas Chromatography- Mass Spectrometry/ Mass Spectrometry). This will enable the detection and quantification of polycyclic aromatic hydrocarbons (PAHs), which are critical indicators of oil spill related contamination. Sensory methods, though effective for preliminary screening cannot quantify low-level PAH residues that my post long-term health risks. Therefore, GC-MS/MS testing is essential to ensure that PAH concentrations in fish and shellfish remain within the Maximum Residue Limits (MRL) as defined by international food safety standards.
3. Gut content study showed that there is no abnormal things observed in the gut of the fish samples.

Further, a team consisting of Scientists from Central Marine Fisheries Research Centre (CMFRI) have visited Melakurumpanai and Enayam coastal villages and collected samples of sea water, sediments and plastic pellets. However, the report from CMFRI is awaited. In this regard, no response

received from Suganthi Devadason Marine Research Institute (SDMRI), Thoothukudi.

Removal of spilt materials:

Under the coordination of the District Administration and as per the guidelines issued, teams were formed in fishermen villages, Plastic pellets were removed from the shores from 30.05.2025 with the help of the teams and volunteers.

As per the instructions of the District Collector, the plastic pellets removed and collected were stored in the Block Development Offices and Municipality Store Rooms. From 16.06.2025 onwards, the collected materials are stored in the Jeppiar Fishing Harbour under the control of Pollution Control Board. The removal of plastic pellets was stopped on 15.06.2025 due to heavy rain. Removal of plastic pellets are resumed on 23.06.2025 and the work is carried out by the employees of Marine Emergency Response Centre (MERC) and handed over to Pollution Control Board. As on 26.06.2025 the plastic pellets collected are stored in gunny bags of 25 Kg each in the Muttom Jeppiar Fishing Harbour as detailed below:

Killiyoor Taluk	-	720 bags.
Kalkulam Taluk	-	247 bags.
Agastheeswaram Taluk	-	163 bags.
TOTAL	**-**	**1130 bags**

(1130 x 25 Kg = 28,250 Kg)

Ramanathapuram District :

The plastic pellets deposited in the coastal areas of Rameswaram, Dhanushkodi and Thenkadal areas of Ramanathapuram District were removed and collected in 80 gunny bags and stores safely in the Tahsildar Office, Rameswaram.

3. DETAILS OF THE COMPENSATION PROPOSED

Kanniyakumari District has 71.5 km of coast line and 42 fishing villages. Sardine, Mackerels, Cuttle fishes, white baits, ribbon fish, seer fish, rock perches etc. are most commonly landed fishes of the district. In which, about 50% of the catch belongs to the clupeiods family, 19% are carangids, 17% trichiurids and 11% scrombroids. Also 90% of the catch is contributed from the pelagic fishery. The main fishing season commences during the onset of south-west monsoon (June) and extends upto end of north east monsoon (December).

As the accident occurred right during the onset of the peak fishing season, it obviously affected the fishing activities. Similarly, about 50% of the catch belongs to the clupeiods family, which are small fishes like sardines. Ingestion of plastic nurdle kind of pollutant into their diet will have cascading effects through the food chain of large marine animals and eventually reaching the human consumption. Also, in order to restore the damages done to the sea environment through this accident, stock enhancement programmes like sea ranching and installation of artificial reefs are essential.

I. Impact study on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts

Rationale of the study

The Liberia-flagged container ship MSC ELSA 3 sank roughly 38 nautical miles off the southwest coast between Vizhinjam and Kochi during May 2025. In the days following, hundreds of tons of plastic nurdles washed ashore on beaches of Kerala and started spreading along the coasts of Tamil Nadu.

Plastic nurdles are the raw material commonly used in the production of many thermally molded plastic products. Plastic nurdles are known to have negative impacts on natural ecosystems. Ocean waves enforce the horizontal and vertical transportation and mixing of plastics with sediments . Ingestion of plastic particles can lead to clogging or damage of the digestive system of some marine animals causing a physical and ecological downgrading. Smaller plastic particles obtained from the weathering of plastic nurdles and their derived pollutants and byproducts can enter the trophic chain via ingestion by filterfeeders (e.g., bivalves), which may ingest them due to their low selective feeding behavior. They pose a risk to wildlife and shellfish and small invertebrates may be exposed to higher amounts of micro and nano plastics following nurdles' mechanical breakdown. The nurdles can be entrained into the sediment bed, with the risk of endangering benthic ecosystems and habitats. In addition to the negative consequences on the natural environment, nurdles may pose a risk to human health. Consumption of fish and seafood which ingested nurdles is a concern. Also, the nurdles have been reported to enable attachment of toxic substances and organic pollutants that can concentrate 10,00,000 times more on nurdles' surface than on water. Additionally, nurdles may act as fomites of human pathogens such as *Escherichia coli* and *Vibrio* spp.

The plastic nurdles have now dispersed as far as the Ramnad coast located hundreds of kilometers away from the site the ship sank, raising widespread concern among local fishermen, environmentalists, and regulatory authorities. There is growing apprehension that these nurdles pose a

significant threat to marine biodiversity, fisheries resources, and the overall health of coastal ecosystems. Additionally, the potential contamination of seafood has sparked serious food safety concerns among consumers.

In light of these concerns, the present study is proposed with the following objectives:

1. Objectives

1. To assess the status of plastic nurdles in coastal waters, sediment and benthic communities along the contaminated coast
2. To study the associated contaminants of plastic nurdles such as heavy metals, PAH, pesticides and pathogens along the contaminated coast
3. To investigate the human health implication upon consumption of contaminated fish and shellfish
4. To map the spatial patterns of plastic nurdles pollution and associated contaminants using GIS for identifying high-risk zones and potential sources of contamination.

3. Work Plan

3.1 Methodology

1**. To assess the status of plastic nurdles in coastal waters, sediment and benthic communities along the contaminated coast**

Water and sediment samples will be collected from Kanyakumari, Thoothukudi and Ramnad coastal regions. Beach sediment samples will be collected using 50×50 cm quadrats, with the top 5 cm of sediment carefully scooped and stored in clean, labeled containers. For surface water sampling, a manta trawl equipped with a 330 µm mesh net will be deployed over standardized distances to collect floating debris. Subsurface and benthic samples will be obtained using grab samplers or sediment corers.

In the laboratory, samples will be dried and sieved using a series of mesh sizes (e.g., 5 mm, 1 mm, and 300 µm) to isolate potential nurdles. Density separation will be performed using a saturated salt solution (either NaCl or $ZnCl_2$), allowing plastic particles to float while heavier materials settle.

Floating materials will be filtered and examined under a stereomicroscope for visual identification based on color, shape, and texture. Digital images will be captured for documentation and further analysis.

To confirm the polymer composition, selected nurdles will be analyzed using Fourier Transform Infrared Spectroscopy (FTIR). To study the contaminant profiling, adsorbed pollutants will be extracted using appropriate solvents and analyzed via Gas Chromatography-Mass Spectrometry (GC-MS).

2. To study the associated contaminants of plastic nurdles such as heavy metals, PAH, pesticides and pathogens along the contaminated coast

To investigate the associated contaminants of plastic nurdles along the contaminated coast, samples will be collected from selected coastal locations identified as potential pollution hotspots. At each site, nurdles will be separated from sediment samples through sieving and density separation using a saturated NaCl or $ZnCl_2$ solution. Collected nurdles will be stored in pre-cleaned glass vials or aluminum foil to prevent cross-contamination.

For heavy metal analysis, nurdles will be digested using a mixture of concentrated nitric acid and perchloric acid in a microwave digestion system. The digested solution will then be analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) to quantify metals such as lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), and zinc (Zn) by standard protocol.

To detect polycyclic aromatic hydrocarbons (PAHs) and pesticides, nurdles will undergo solvent extraction using organic solvents like hexane or dichloromethane in an ultrasonic bath or Soxhlet apparatus. The extracts will be concentrated and subjected to cleanup using silica gel column chromatography.

For pathogen analysis, nurdles will be rinsed with sterile saline solution and vortexed to detach biofilm-associated microbes. The resulting suspension will be filtered and cultured on selective media to identify bacterial indicators such as *Escherichia coli*, *Vibrio spp.*, or *Salmonella spp.*. For molecular-level identification, DNA will be extracted and analyzed using quantitative PCR (qPCR) or 16S rRNA gene sequencing to characterize the microbial community associated with the nurdles.

All results will be statistically analyzed to determine the spatial variation and correlation of contaminant levels with site-specific factors such as land use, tidal patterns, and proximity to pollution sources. Mapping tools (e.g., GIS) will be used to visualize contamination hotspots. The outcomes will provide critical insight into the role of plastic nurdles as vectors for hazardous chemical and biological contaminants in the marine environment and will support the development of targeted mitigation strategies.

2. To investigate the human health implication upon consumption of contaminated fish and shellfish

Fish and shellfish samples will be collected from coastal regions identified as nurdle-contaminated zones based on preliminary field surveys or existing pollution data. Sampling will be conducted seasonally from multiple locations to account for temporal and spatial variability. Commonly consumed species (e.g., *Sardinella spp.*, *Rastrelliger kanagurta*, *Perna viridis*, and *Meretrix meretrix*) will be selected based on local consumption patterns and availability (FAO, 2018).

Collected organisms will be immediately placed in sterile, ice-packed containers and transported to the laboratory under cold chain conditions to prevent degradation. In the lab, fish and shellfish will be washed, measured, and dissected under sterile conditions. Edible tissues (muscle and hepatopancreas) will be homogenized and stored at −20°C until analysis (Lusher et al., 2017).

Tissue samples will be digested using a microwave-assisted acid digestion protocol (USEPA Method 3052) with a mixture of nitric and perchloric acid. The digested solution will be filtered and analyzed using **Inductively Coupled Plasma Mass Spectrometry (ICP-MS)** or **Atomic Absorption Spectrophotometry (AAS)** for the detection of metals such as lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), and zinc (Zn) (Muralidharan et al., 2017).

Lipid-rich tissues will be extracted using a modified QuEChERS method (Anastassiades et al., 2003), followed by cleanup with Florisil column chromatography. The concentrated extracts will be analyzed using **Gas Chromatography–Mass Spectrometry (GC-MS)** for the quantification of polycyclic aromatic hydrocarbons (PAHs) and selected organochlorine and organophosphate pesticides (Gupta et al., 2021).

Reference standards from certified agencies (e.g., Sigma-Aldrich) will be used for calibration. Quality control will be ensured by using blanks, duplicates, and standard reference materials (e.g., NIST SRM 2976).

For microbial analysis, shellfish and fish tissues will be aseptically rinsed and homogenized in sterile phosphate-buffered saline. Serial dilutions will be cultured on selective media (e.g., MacConkey agar, TCBS agar, and XLD agar) to identify pathogenic bacteria such as *Escherichia coli*, *Vibrio spp.*, and *Salmonella spp.* Molecular confirmation will be carried out using **PCR and qPCR** targeting species-specific genes (Sapkota et al., 2008; Harvell et al., 1999).

Health risk assessments will be performed by estimating dietary exposure to contaminants using the following formulas:

- **Estimated Daily Intake (EDI):**
  EDI=C× IR/BW
  Where *C* = contaminant concentration (mg/kg), *IR* = ingestion rate (kg/day), *BW* = average body weight (kg).

- **Target Hazard Quotient (THQ):**
  THQ=EDI/RfD

  Where *RfD* = oral reference dose (mg/kg/day). THQ > 1 indicates potential health risk (USEPA, 2000).

- **Carcinogenic Risk (CR):**
  CR=EDI×CSFCR = EDI \times CSFCR=EDI×CSF
  Where *CSF* = cancer slope factor. CR > 10^{-4} indicates significant cancer risk.

Seafood consumption rates will be obtained from local dietary surveys or existing literature (BIS, 2012). Risk estimates will be compared with international safety limits (e.g., WHO, FAO, USEPA, EFSA).

4. To map the spatial patterns of nurdle pollution and associated contaminants using GIS for identifying high-risk zones and potential sources of contamination.

All sampling coordinates and analytical data will be integrated into a Geographic Information System (GIS) platform such as ArcGIS or QGIS. Spatial layers including nurdle abundance, contaminant concentrations, and site characteristics will be created. Interpolation methods such as Inverse Distance Weighting (IDW) or Kriging will be used to estimate unsampled values, generating continuous surface maps. Additional spatial analyses, including proximity buffers around industrial areas and hydrological features, will be performed to identify potential sources of contamination. Multi-criteria decision analysis (MCDA) will be applied within GIS to rank areas by contamination risk, considering nurdle density, pollutant load, and ecological sensitivity. High-risk zones and potential source areas will thus be identified and visualized. Statistical analysis using software such as R or SPSS will also be performed to understand correlations between nurdle occurrence, contaminants, and environmental factors. The resulting maps and data will support targeted monitoring, cleanup efforts, and policy recommendations.

Outreach programme

Based on the results, the stake holders will be sensitized on the impact of plastic nurdles on the environment

BUDGET: **Rs. 49.40 Lakh**

Items	Rs. In
I. Non-Recurring:	
(a) Equipment:	
1. Sediment grab (Grab sampler) (1 Unit)	3.00
2. Water sampler (1 Unit)	3.00
3. Trinocular Microscope along with camera and system	5.00
Total – Non-Recurring	**11.00**
II. Recurring:	
(a) Manpower	
1. Senior Research Fellows (1 No. x 12 Months x Rs.	4.80
2. Field Assistants (1 No. x 12 Months x Rs. 20,000)	2.40
(b) Travel Expenses	2.00
I Other items	
1. Museum Jars (Assorted size)	1.50
2. Consumables a. Chemicals & Glassware b. Stationaries	15.00
3. Fish specimens	3.00
4. Boat hiring charges	1.20
5. Items like plastic bottles, insulated boxes , balance, vernier caliber etc.,	0.50
6. GIS Mapping (QGIS, Arc GIS), Hiring Drone –	3.00
7. Conducting awareness programme	2.00
8. Operational Expenses	3.00
Total – Recurring	**49.4**
Grand Total	**49.40**

II. Compensation proposed for the fishermen of Kanniyakumari and Ramanathapuram Districts

There are 1,386 mechanized, 8,105 motorized and 125 non-motorized registered fishing crafts in the affected areas (Base of Operation: Kanniyakumari, Colachel, Thangapattinam and Rameswaram). Similarly, 51,557 active fishermen 55,602 fisherwomen reside in the affected areas as follows.

S No	Base of Operation	Fisher men	Fisher women	Fishing crafts		
				MFB	CC Motorized	CC Non-Motorized
1	Chinnamuttom	8153	9219	60	1100	30
2	Colachel	11566	10377	82	1664	28
3	Thengapattanam	14516	13075	566	4427	7
4	Rameswaram	17322	22931	678	914	60
	Total	**51557**	**55602**	**1386**	**8105**	**125**

Since the fishing ban period in the east coast is followed from 15.04.2025 to 14.06.2025 and in the West coast from 01.06.2025 to 31.07.2025, Mechanized Fishing Boats (MFB) of the east coast did not venture for fishing during this period due to fishing ban period. However, the fishing boats which were in fishing in the West coast could involve in fishing for a period of 4 days from 28.05.2025 to 31.05.2025 due to this pollutant issue during their non-fishing ban period.

Similarly, the motorized and non-motorized country crafts were also not ventured for fishing for a period of 5 days from 28.05.2025 to 01.06.2025.

The revenue loss to the fishermen and fishing boats during these 5 days has been worked out in the following rates.

S No	Particulars	Average Wage/ Day (Rs)	80% compensation in average Wage (Rs)	Loss of 5 days

1	Fishermen engaged as fishing labours	3000	2400	12,000
2	Fisherwomen engaged as fishing labourers	2000	1600	8,000

S No	Particulars	Average income loss/ day (Rs)	50% Avg Compensation / Day	Loss of days
1	Mechanized Fishing boats	4,000	2000	4
2	Motorized country crafts	2,000	1000	5
3	Non-Motorized country crafts	1,000	500	5

Therefore, it is proposed to compensate the fishermen and fishing crafts (motorized and non-motorized) in the following rates.

Sl No	Particulars	Nos	Rate (Rs)	Days	Total Amount (In Rs)
1	Fishermen	51557	2400	5	61,86,84,000
2	Fisherwomen	55602	1600	5	44,48,16,000
	Total (A)				**106,35,00,000**
1	Mechanized Fishing Boats (West Coast – Colachel and Thengapattinam)	648	2000	4	51,84,000
2	Motorized country crafts	8105	1000	5	4,05,25,000
3	Non-Motorized country crafts	125	500	5	3,12,500
	Total (B)				**4,60,21,500**
	Grand Total (A+B)				**110,95,21,500**

Therefore, a total amount of **Rs 110.95 crore** may be claimed to compensate the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.

III. Compensation proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants

Kanniyakumari District, located at the southernmost tip of Tamil Nadu, is uniquely positioned where the Arabian Sea, Bay of Bengal, and the Indian Ocean converge. The coastal length of the district extends around 71.5 Kms in length, whereas 60 km covers the west coast and the remaining 11.5 kms covers the east coast and is studded with 42 fishing villages that supports vibrant marine ecosystems and characterized by the availability of a wide array of marine species. Its strategic location and rich oceanographic features contribute to a productive fishing sector that plays a central role in the local economy and sustains thousands of coastal families. In coastal villages of Kanniyakumari District, the density of population is as high as 1000 per square kilometer. The 71.5 km long coast has a heavy concentration of fisher-folk, almost one village per 1.7 km. Also, it is to highlight that fishing is the major occupation next to Agriculture in Kanniyakumari district. Per capita income of the district is Rs 1,98,398/. based on Government of Tamil Nadu data 2022-23.

The **MSC ELSA 3 wreck** off the coast of Kerala during the month of May 2025 has led to a significant environmental crisis, particularly due to the release of **plastic nurdles**—small, pellet-like raw plastic materials used in manufacturing which washed ashore along Manakudy, Chinnavilai, Kodimunai, Kurumbanai, Midalam, Enayam, Erayumanthurai, Eraviputhenthurai, Vallavilai and Neerody fishing villages of Kanniyakumari district. These nurdles posed a severe threat to the marine and coastal ecosystem. Moreover, the cleanup of nurdles proved challenging due to their small size and vast spread, requiring continuous community and governmental efforts.

Impact on the Wadge Bank:

The Wadge Bank (72°20’ N, 77°52’ E) is a fertile fishing found where rich marine biological diversity occurs. Wadge bank may also be defined as a place of marine environment, where there is a rich availability of fish food

organisms. It is located south of Kanyakumari (Cape Comorin), and is a continental shelf nearly 80 kilometers (50 miles) seaward from the coast of Kanyakumari.

The eastern half of the bank is flatter and shallower (average depth about 22 fathoms), than the western (average depth about 36 fathoms) and its edge drops off more suddenly to extreme depths. The physical features of the water like under-water current, tides and waves will have less impact on the fishes and animals of this region. Fishes select this region for feeding and breeding purposes. Throughout the maritime countries of the world there are about twenty such wedge banks. Of this one is situated near Kanyakumari on the coastline of Kanniyakumari District on the eastward as well as on the westward Region. Here representatives of fish species of the three seas occur.

While specific quantifiable figures for the "total available resources in metric tonnes" across all species in Wadge Bank are not readily available, the region is consistently described as abundant in fishery resources, rich in biodiversity, significant for specific species like sharks and carangids and also high productivity.

The accidental release and spread of plastic nurdles from incidents like the MSC ELSA 3 wreck have raised serious concerns about the health of this ecologically and economically vital region. Nurdles, which resemble fish eggs, are easily mistaken for food by a variety of marine species, including pelagic fish, plankton feeders, and filter feeders—many of which are commercially valuable. Ingestion of these microplastics leads to internal blockages, starvation, and bioaccumulation of toxins, threatening fish health and reducing catch quality. This contamination not only impacts the reproductive cycles and survival of marine life but also affects the livelihoods of thousands of fishers dependent on the Wadge Bank’s resources.

Systematic survey shall be proposed by Fishery Survey of India to find out the actual pelagic and demersal fishery resources of wadge bank at

present condition and the data shall be matched with their available records to find out the actual impact.

Possible effects on the Estuaries of the District

Some of the significant estuaries in the district include Thengapattinam Estuary (Tamiraparani River) which located near the west coast, Manakudy Estuary (Pazhayar River), known for mangrove rehabilitation projects, Rajakkamangalam Estuary and Colachel and Muttom Backwaters

The **Manakudy Estuary**, located near Nagercoil in Kanniyakumari District, is a vital coastal ecosystem formed by the confluence of the Pazhayar River with the Arabian Sea. This estuarine region is ecologically rich and supports a diverse range of flora and fauna, including mangrove forests, which play a critical role in coastal protection and fish breeding. The estuary serves as an important nursery ground for various finfish and shellfish species such as mullets, prawns, crabs and sea bass, making it a hotspot for small-scale and artisanal fisheries. Local communities heavily depend on the estuary for their livelihoods, engaging in both capture fisheries and post-harvest activities. In recent year, the Government and NGOs have undertaken mangrove restoration projects in Manakudy, enhancing biodiversity and fish stocks. Despite facing threats from pollution, encroachments, and climate change, the estuary remains a key contributor to the district's fisheries sector and a model site for community-based coastal resource management.

The accumulation of nurdles in estuaries, including the sensitive Manakudy Estuary, possibly disrupted the habitats of juvenile fish, crustaceans, and migratory birds. Marine organisms often mistake nurdles for food, leading to ingestion that can cause internal injuries or death, severely impacting the local food chain.

Relevant project for the replenishment of the estuarine area specifically Manakudy estuary in which nurdles accumulation was reported comparatively high shall be proposed for enhancing the fishery resources in that area.

Adverse impact on Squid and Mussel fisheries:

The accumulation of plastic nurdles along the coastal and offshore waters of Kanniyakumari District, poses a serious threat to the delicate squid breeding grounds in the region. Squid, which spawn in shallow coastal waters and along the nutrient-rich seabeds of the Wadge Bank, require clean, oxygenated environments to lay their gelatinous egg masses which may be affected by these accumulations. Juvenile squids and other planktonic organisms may ingest these nurdles, mistaking them for prey, leading to internal injuries, malnutrition, and increased mortality. As squid are a high-value resource for local fishers in areas like Colachel, Manakudy, Enayam and Wadge Bank, any disruption to their reproductive cycle has direct economic consequences. The long-term presence of nurdles can degrade natural habitats and weaken the productivity of these breeding zones, emphasizing the urgent need for mitigative measures.

The intertidal zones and estuarine areas of Kanniyakumari district has reports alarming levels of nurdle accumulation, where they blend with sand and organic debris. This poses a significant threat to local marine biodiversity, especially the mussel fishery, which is a critical livelihood resource for coastal communities in the district. Mussels, being filter feeders, are particularly vulnerable to microplastic contamination, as they can ingest nurdles either directly or through bioaccumulation in the food web. This ingestion not only affects mussel growth, reproduction, and

survival rates but also reduces their market value due to food safety concerns among consumers. Moreover, the decline in mussel population and quality can have cascading effects on the coastal economy and marine ecosystem balance.

General impact on the fisheries resources of the District

The district has access to both pelagic (surface-dwelling) and demersal (bottom-dwelling) species, including economically valuable species.

a. Pelagic Fish

- Species: Indian mackerel, sardines, tuna, anchovies, seer fish
- Seasons: June–October (peak season)
- Methods: Gill nets, Long lines, Trammel nets

b. Demersal Fish

- Species: Groupers, snappers, perches, rays, skates
- Habitat: Rocky and reef bottoms in mid-depth waters
- Methods: Bottom trawling, hook-and-line

c. Crustaceans & Mollusks

- Species: Crabs, lobsters, squids, cuttlefish, Mussels
- Seasons: October -December (Mussels), July -September (Squids and Cuttle Fishes)
- Harvest Methods: Diving, traps, trawls, cast nets

d. Estuarine and Backwater Resources

- Notable Area: Manakudi estuary
- Species: Mullet, crabs, prawns, small fish
- Seasonal use: Post-monsoon breeding grounds and juvenile fish nurseries

Estimated fish landings of Kanniyakumari district for the year 2024-25 is 100509.32 tonnes. Of which, 80 % of the catch is contributed by the following species

Sl No	Name of the species	Total catch for the year 2024-25 (in tonnes)	Percentage contribution (%)	Value (Rs in crores)
1	Trigger fishes	34264	34.00	1027.92
2	Cephalopods	8856	8.90	2214.00
3	Tuna and its variety	8183	8.14	1472.94
4	Mackerel	5484	5.45	329.04
5	Lizard fish	4357	4.36	130.71
6	Groupers	3076	3.08	922.80
7	Indian scad	2492	2.49	14.95
8	Thread fin bream	2272	2.27	454.40
9	Lethrinids	2219	2.22	665.70
10	Ribbon fish	2216	2.22	132.96
11	Carangids	2127	2.13	638.10
12	Snappers	2121	2.12	636.30
13	Anchovies	2012	2.01	160.96
14	Barracudas	1744	1.74	436.00

Other prominent species includes

Sl No	Name of the species	Total catch for the year 2024-25 (in tonnes)	Percentage contribution (%)	Value (in crores)
1	Sharks, Skates and Rays	1621	1.62	567.35
2	Seer fish	1324	1.32	662.00
3	Oil sardines	1107	1.10	99.63

4	Lesser sardines	1015	1.05	81.20
5	Penaeid prawns	1013	1.01	354.55
6	Non penaeid Prawns	958	0.95	86.22
7	Red mullets	803	0.80	96.36
8	Crabs	531	0.5	185.85
9	Mussels	515	0.5	206.00
10	Lobsters	115	0.1	92.00

Anticipated loss and possible mitigation measures

Total value of the above mentioned prominent fish species is around Rs 12,000 Crores. 5 % value loss of the total fish catch of 24 listed species due to restricted fishing and also apprehension among the local public regarding the consumption of fish is being calculated and the amount arrived is Rs 600 crores.

Creation of corpus fund of Rs 600 crore towards carrying out stock replenishment measures:

It is proposed to create a corpus using the above compensation that is to be received towards the loss of the total fish catch of 24 listed species due to restricted fishing and also apprehension among the local public regarding the consumption of fish. It expected that the corpus would earn tentative interest amount of **Rs 40 crores annually** with the interest rate of 6-6.50%. This amount will be used as recurring revenue towards the following long term measures for the replenishment of the fish stock in the affected area.

Ecological Restoration & Fish Stock Replenishment Projects

1. Wadge Bank Restoration Initiative

- Taking up systematic pelagic and demersal fishery surveys.
- Creation of marine sanctuaries for 2–3 years in heavily impacted zones to allow natural regeneration.

- Introduction of artificial reefs and Fish Aggregating Devices (FADs) to aid fish habitat recovery.

2. Estuarine Rehabilitation with special focus to Manakudy Estuary

- "Manakudy Estuarine Recovery Project" will be launched under this initiative, in which the following activities will be taken up.
    - Expansion of mangrove restoration (including native species).
    - Desilting and bio-remediation of nurdle-contaminated estuary zones.
    - Creation of community-based aquaculture zones (mullet, crabs, prawns) with pollution monitoring systems.

3. Mussel and Squid Habitat Protection Program

- Mapping and demarcation of mussel beds and squid spawning zones for protection.
- Promotion of sustainable mussel farming techniques in cleaner, deeper estuarine or offshore sites.
- Development of spawning sanctuaries for squid with seasonal restrictions and monitoring.

Long-Term Scientific & Institutional Measures

1. Plastic Pollution Response Cell (PPRC) – Kanniyakumari
    - Establish a district-level task force for rapid response, monitoring and research on marine plastic incidents.
    - Collaborate with IMD, CMFRI, ICAR, IIT-Madras for tech-based plastic pollution tracking.
2. Community Marine Stewardship Program
    - Training and employment of local youth as "Coastal Biodiversity Guardians."
    - Include beach nurdle watch programs, citizen science monitoring and eco-tourism awareness drives.

3. Pollution Impact Research Fund

- Providing annual grant for marine toxicology, microplastic food chain studies and health impact assessments.
- Development of Research-backed policies for safe seafood certification to regain consumer confidence.

IV. Promotion of off shore fishing by providing subsidy (80%) for constructing deep sea fishing vessels

The fishing grounds of Kanniyakumari District form a lifeline for thousands of coastal families and serve as a hub of marine biodiversity. Protecting these grounds especially from pollution incidents such as the recent nurdle spill is vital for ecological balance, food security, and economic resilience. Any environmental degradation here directly threatens fishery sustainability, coastal livelihoods, and marine ecosystem health.

Hence, to mitigate the long term effects on the fisheries resources and also to enhance the livelihood of the fishermen of the district, the following proposals shall also be proposed with mentioned units and amount.

Component	Funding pattern	Total cost (Rs in crore)
Promotion of off shore fishing by providing subsidy (80%) for constructing deep sea fishing vessels.	100 boats @ total cost 1.20 crores each. 80 % subsidy amount – 96 lakhs	96.00

V. Sea ranching programmes for Marine fishery stock enhancement

Sea ranching is an artificial recruitment of aquatic organisms into their natural habitat for stock improvement or enhancing the production or for conservation of resources. With the development technologies of controlled breeding, seed production and nursery rearing, the programmes of sea ranching of aquatic organisms have been on rise. It is a sustainable practice to replenish depleted fish stocks and restore ecological balance.

Rationale of the Proposal

1. To replenish depleted fish and shellfish populations in affected coastal waters.
2. To manage and conserve the fishery resource for sustainability.
3. Restoration of Ecosystem.
4. To increase the income of fisher folk and improve the standards of living.
5. For the welfare of the fishers depending on the marine ecosystem for their livelihood.
6. Stock enhancement of natural ecosystem by hatchery reared juveniles/fry as a measure to enhance depleting capture fisheries.
7. To manage of conserve wild fisheries
8. To support fisherfolk through long-term restoration of their fishing grounds.
9. To rehabilitate critical habitats affected by the pollution.

Objectives

The coastal fish habitats are affected by the pollution as well as excess fishing pressure in the inshore region. In order to redress these problems over the exploitation and the depletion of resources sea ranching of commercial shrimp species and fin fish species are to be carried out. Moreover, the Department of Fisheries aims to improve the wild fisheries of

Indian white shrimp, Tiger shrimp and Sea bass and there by enhancing the natural ecosystem.

Hence, it is proposed to ranch three commercially important species viz., Penaeus indicus (Indian white Prawn), Penaeus monodon (Tiger shrimp) and Lates calcarifer (Sea bass).

Proposed Target Species for Ranching

Species Name	Common Name
Penaeus indicus	Indian White Shrimp
Lates calcarifer	Sea Bass
Penaeus monodon	Tiger shrimp

Justification of the Proposal

Kanyakumari district and Ramanthapuram district has a total fisherfolk population of about 79,533 fishermen and 86,065 fisherwomen who are directly or indirectly dependent on marine fisheries for their livelihood. Besides, industrial, urban pollution, and other anthropogenic activities have also adverse affected the fish stocks, resulting in reduction and diminishing fish populations. In order to address the problems of over-exploitation and depleting resources, sea ranching of commercially important species will enhance the biological productivity and also will help for conservation and increase fishery resources of the coastal waters thereby improving the catch of traditional and small scale fishermen. Moreover, the Department aims at enhancing depleting capture fisheries and to manage and conserve of wild fisheries.

Estimated Cost

For Sea bass

Total seeds: 10,00,000

Per seed cost: Rs.50

Total project seed budget: Rs.5 Crore

District	Seed (Sea bass)	Cost of seed(in Rs.)
Kanniyakumari	3,00,000	1,50,00,000
Tirunelveli	2,00,000	1,00,00,000
Thoothukudi	2,00,000	1,00,00,000
Ramanthapuram	3,00,000	1,50,00,000
Total	**10,00,000**	**5,00,00,000**

For Penaeus monodon and Penaeus indicus

Total seeds: 50,00,000

Per seed cost: Rs.0.75

Total project seed budget: Rs.37.5 Lakhs

District	Seed (in Nos)	Cost of seed(in Rs.)
Kanniyakumari	15,00,000	11,25,000
Tirunelveli	10,00,000	7,50,000
Thoothukudi	10,00,000	7,50,000
Ramanthapuram	15,00,000	11,25,000
Total	**50,00,000**	**37,50,000**

Total Cost Estimate

Sl.No	Particulars	Cost in Rs.
1	Seed cost	5,37,50,000
2	Seed packing and transportation	10,00,000
	Total	**5,47,50,000**

Expected Outcomes

- Restoration of fish and shrimp stock in affected areas.
- Enhanced livelihood security of **fisher families**.
- Cleaner, restored marine habitats promoting long-term sustainability.

- Community-based custodianship of marine resources.

Implementation Agencies

- Department of Fisheries and Fishermen Welfare, Tamil Nadu
- CMFRI (Central Marine Fisheries Research Institute)
- KUFOS / TNFU

VI. Installation of artificial reefs for fishery stock conservation an enhancement

This incident of release of pollutants into sea resulted in destroying marine life, livelihoods and causing permanent damage to biodiversity. Further, some marine mammals and reptiles such as turtles are vulnerable to adverse effects from contamination and disturbing the ecological balance.

Hence, as a measure to improve the coastal marine fisheries by stock enhancement, it has been proposed to deploy artificial reefs in **37 locations** in Kanniyakumari District and **03 location** in Ramanathapuram District. Installation of artificial reefs would be helpful for the artisanal fishermen to exploit the fish stocks.

Artificial reefs are man-made or natural objects placed in selected areas of the marine environment to provide or improve solid and rough bottom habitat and thereby increase the productivity and availability of certain fish valuable to man. Artificial Reefs provide shelter, calm waters, influence water currents so that fish save energy while swimming against the current and attract smaller organisms which are vital sources of Food for different marine species.

An Artificial reef is an underwater artificial habitat for marine life. It helps in augmenting the productivity of the marine ecosystem. It increases the available area for food, shelter and breeding activities for fishes and other marine organisms. This also enhances the fish production through increased breeding activity and survival of young ones. Moreover, it act as a barrier for bottom trawling operations by mechanized boats in these areas and prevents the destruction of reefs which are the natural breeding habitats.

Installed artificial reefs serve as visual reference points for fish that forage away from the reef and increase the all over reef area which can host a larger number of reef fish. These reefs can be used to enhance existing rough bottom habitat, develop quality fishing ground close to access areas

and helps in fisheries management, to enhance the wild population in aquaculture systems.

Development of environment friendly artificial reefs favors the epifauna filter-feeding community to act as biofilters; enlarge and allow rehabilitation of stressed natural habitats, and quantitatively boosts many marine species.

AREA OF IMPLEMENTATION:

120 units will be installed in **40 coastal villages** of Kanniyakumari District and Ramanathapuram Districts.

BUDGET OUTLAY:-

It is proposed to install **120** artificial reef sets at **40** villages in the inshore area of Kanniyakumari and Ramanathapuram Districts of Tamil Nadu. Total amount required for the project is **Rs.38,13,00,000/- (Rupees Thirty eight crore and thirteen lakh only)**

Sl. No	Description	Unit cost (in Rs)	No. of Units	Total amount (in Rs.)
1	Fabrication of different modules of Artificial Reef including Artificial Reefs Deployment cost	31,00,000	120 units	37,20,00,000-
2	2.5% Administrative cost including Bench Mark Survey, Monitoring & Documentation			93,00,000
Total cost				**38,13,00,000-**

VII. Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts.

1. Rationale of the study

The Liberia-flagged container ship MSC ELSA 3 sank roughly 38 nautical miles off the southwest coast between Vizhinjam and Kochi during May 2025. In the days following, hundreds of tons of plastic nurdles washed ashore on beaches of Kerala and started spreading along the coasts of Tamil Nadu.

Plastic nurdles are the raw material commonly used in the production of many thermally molded plastic products. Plastic nurdles are known to have negative impacts on natural ecosystems. Ocean waves enforce the horizontal and vertical transportation and mixing of plastics with sediments . Ingestion of plastic particles can lead to clogging or damage of the digestive system of some marine animals causing a physical and ecological downgrading. Smaller plastic particles obtained from the weathering of plastic nurdles and their derived pollutants and byproducts can enter the trophic chain via ingestion by filter feeders (e.g., bivalves), which may ingest them due to their low selective feeding behavior. They pose a risk to wildlife and shellfish and small invertebrates may be exposed to higher amounts of micro and nano plastics following nurdles' mechanical breakdown. The nurdles can be entrained into the sediment bed, with the risk of endangering habitats. In addition to the negative consequences on the natural environment, nurdles may pose a risk to human health. Consumption of fish and seafood which ingested nurdles is a concern. Also, the nurdles have been reported to enable attachment of toxic substances and organic pollutants that can concentrate 10,00,000 times more on nurdles' surface than on water. Additionally, nurdles may act as fomites of human pathogens such as *Escherichia coli* and *Vibrio* spp.

Plastic nurdles inside mouth of fish

Oil spills have a significant negative impact on fish production by contaminating aquatic habitats with toxic substances such as polycyclic aromatic hydrocarbons (PAHs), which affect fish health by damaging gills, impairing liver function, and disrupting reproductive systems, leading to reduced spawning success and lower survival rates of eggs and larvae. In addition, oil pollution depletes oxygen levels in water, alters food availability, and damages critical nursery and breeding grounds such as mangroves and coral reefs. Prolonged exposure to oil can cause bioaccumulation of toxins in fish tissue, making them unsafe for human consumption and reducing their market value.

There is an urgent need to establish a dedicated laboratory to study the impact of oil spills and plastic nurdles on the environment and seafood safety due to the increasing frequency of marine pollution events and their consequences. A well-equipped laboratory would enable comprehensive monitoring, toxicological assessments, and analysis of bioaccumulation in marine species. It would also support research into long-term ecological impacts, inform regulatory policies, and guide cleanup and mitigation strategies. Establishing such a facility is essential for protecting marine biodiversity, ensuring seafood safety, and supporting evidence-based environmental management.

The impact of oil pollution may lead to depletion of fish stocks in the coming days. The plastic nurdles have now dispersed as far as the Ramnad

coast located hundreds of kilometers away from the site the ship sank, raising widespread concern among local fishermen, environmentalists, and regulatory authorities. There is growing apprehension that these nurdles pose a significant threat to marine biodiversity, fisheries resources, and the overall health of coastal ecosystems. Additionally, the potential contamination of seafood has sparked serious food safety concerns among consumers.

In light of these concerns, the present study is proposed with the following objectives:

1. Objectives

1. To assess the status of plastic nurdles in coastal waters, sediment and benthic communities along the contaminated coast
2. To establish the Soil and Water Quality laboratory for testing of oil and plastic pollution
3. To assess the stock status and gut content analysis for the selected major group of marine fish species along the southern coast of Tamil Nadu.
4. To study the associated contaminants of plastic nurdles such as heavy metals, PAH, pesticides and pathogens along the contaminated coast
5. To investigate the human health implication upon consumption of contaminated fish and shellfish
6. To map the spatial patterns of plastic nurdles pollution and associated contaminants using GIS for identifying high-risk zones and potential sources of contamination.

3. Work Plan

3.1 Methodology

1. To assess the status of plastic nurdles in coastal waters, sediment and benthic communities along the contaminated coast

Water and sediment samples will be collected from Kanyakumari, Thoothukudi and Ramnad coastal regions. Beach sediment samples will be collected using 50×50 cm quadrats, with the top 5 cm of sediment carefully scooped and stored in clean, labeled containers. For surface water sampling, a manta trawl equipped with a 330 µm mesh net will be deployed over standardized distances to collect floating debris. Subsurface and benthic samples will be obtained using grab samplers or sediment corers.

In the laboratory, samples will be dried and sieved using a series of mesh sizes (e.g., 5 mm, 1 mm, and 300 µm) to isolate potential nurdles. Density separation will be performed using a saturated salt solution (either NaCl or $ZnCl_2$), allowing plastic particles to float while heavier materials settle. Floating materials will be filtered and examined under a stereomicroscope for visual identification based on color, shape, and texture. Digital images will be captured for documentation and further analysis.

To confirm the polymer composition, selected nurdles will be analyzed using Fourier Transform Infrared Spectroscopy (FTIR). To study the contaminant profiling, adsorbed pollutants will be extracted using appropriate solvents and analyzed via Gas Chromatography-Mass Spectrometry (GC-MS).

2. To establish the Soil, Water and fish Quality laboratory for testing of oil and plastic pollution

There is no separate laboratory for monitoring oil and coastal pollution in Tamilnadu. The important water quality parameters such as dissolved oxygen, pH, alkalinity, CO_2, Hardness, salinity, BOD, COD, Total suspended solids, H_2S, nitrate, nitrite, phosphate and, oil spill, heavy metals have to be monitored regularly for the better production and to maintain pollution free environment. A detailed survey of the water and sediment quality parameters is therefore essential to provide a better status report on the pollution in the coastal region. So, it becomes essential to establish a well-equipped laboratory to analyze the water and sediment quality characteristics of the selected locations. The Fisheries College & Research Institute, Thoothukudi being located in this region shall therefore be chosen

as an ideal place for the establishment of this laboratory as it has technical expertise with experience in these areas. There a separate infrastructure facility with 5000 sq ft. with the equipments is highly essential

6. **To assess gut content and stock status of the selected marine group of fish along the Gulf of Mannar region, Southern Tamil Nadu**

Sample collection:

A representative of fish specimens will be collected and preserved in ice for further transportation to the laboratory. The Morphometric measurements of each individual sample will be taken before dissection: for fish, Total Length (TL) and for crab, Carapace width (CW) and Total Weight (TW). Length measurements will be made to the nearest centimetres (cm), while the weight measurement to the nearest gram (g).

- Collection of major groups of fish species from three sampling stations like Pamban Fishing Harbour, Thoothukudi Fishing Harbour and Chinnamuttam fishing harbour for fish identification up to species level along the coast of south Tamil Nadu.
- Collection of occurrence and abundance data of major groups of fish species landed in the sampling stations.
- Analysis of gut contents of selected major groups of fish species to study their feeding biology.

Stock assessment of major group of fish species

The length and weight data of the selected *major group of fish species* will be collected fortnightly along the Gulf of Mannar region for a period of 12 months.

Estimation of von bertalanffy growth parameters

The VBGF growth parameters like asymptotic length (L_∞), growth coefficient (K) were estimated using the ELEFAN I developed by Pauly and David (1987) using FiSAT II software package (Gaynilo et al., 2005).

The VBGF equation is as follows:

$$L_t = L_\infty [1 - \exp^{(-K*(t-t_0))}]$$

Where,

L_∞= Asymptotic length

K = Growth coefficient or curvature parameter

t_0 = Initial condition parameter or arbitrary origin of growth

e = Base of natural logarithm

t = time

Estimation of growth performance index (ǿ)

The growth performance index will be calculated from the final estimates of asymptotic length (L_∞) and growth coefficient (K) (Pauly and Munro, 1984) using the formula as mentioned below:

$$\text{Phi } (Ø) = \log K + 2 \log L_\infty$$

Estimation of mortality parameters

The total instantaneous mortality coefficient (Z) will be estimated by length converted catch curve method using FiSAT software. The natural mortality coefficient (M) was estimated by Pauly's equation (1984) considering the mean annual habitat temperature (29^0C), asymptotic length (L_∞) and growth coefficient (K) of VBGF growth equation. The coefficient of fishing mortality (F) was calculated using the following relationship,

$$Z = F + M$$

Exploitation ratio (E) was estimated using the following equation,

$$E = F/Z$$

To assess the stock of selected major group of fish species fish species

- The total length of the fish specimen will be measured to the nearest 0.1 cm, and the total body weight to the nearest 0.1 g.
- Catch and effort data of selected major marine groups of species will be collected from the selected sampling stations.
- The length-weight relationships will be estimated using Le Cren (1951).
- The growth parameters, mortality rates, length at first capture (Lc) and exploitation rates will be obtained using the FAO ICLARM Stock Assessment (FiSAT) II package (Gayanilo et al. 2005).
- The exploitation ratio (E), relative yield per recruitment, maximum sustainable yield will also be estimated (Beverton and Holt's, 1957; Gulland, 1979; Sparre et al. 1989).
- Surveying and documentation of the gears and crafts used to catch major groups of fish species. Analysis and interpretation of data.

4. To study the associated contaminants of plastic nurdles such as heavy metals, PAH, pesticides and pathogens along the contaminated coast

To investigate the associated contaminants of plastic nurdles along the contaminated coast, samples will be collected from selected coastal locations identified as potential pollution hotspots. At each site, nurdles will be separated from sediment samples through sieving and density separation using a saturated NaCl or $ZnCl_2$ solution. Collected nurdles will be stored in pre-cleaned glass vials or aluminum foil to prevent cross-contamination.

For heavy metal analysis, nurdles will be digested using a mixture of concentrated nitric acid and perchloric acid in a microwave digestion system. The digested solution will then be analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) to quantify metals such as lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), and zinc (Zn) by standard protocol.

To detect polycyclic aromatic hydrocarbons (PAHs) and pesticides, nurdles will undergo solvent extraction using organic solvents like hexane or dichloromethane in an ultrasonic bath or Soxhlet apparatus. The extracts will be concentrated and subjected to cleanup using silica gel column chromatography.

For pathogen analysis, nurdles will be rinsed with sterile saline solution and vortexed to detach biofilm-associated microbes. The resulting suspension will be filtered and cultured on selective media to identify bacterial indicators such as *Escherichia coli*, *Vibrio spp.*, or *Salmonella spp.*. For molecular-level identification, DNA will be extracted and analyzed using quantitative PCR (qPCR) or 16S rRNA gene sequencing to characterize the microbial community associated with the nurdles.

All results will be statistically analyzed to determine the spatial variation and correlation of contaminant levels with site-specific factors such as land use, tidal patterns, and proximity to pollution sources. Mapping tools (e.g., GIS) will be used to visualize contamination hotspots. The outcomes will provide critical insight into the role of plastic nurdles as vectors for hazardous chemical and biological contaminants in the marine environment and will support the development of targeted mitigation strategies.

5. To investigate the human health implication upon consumption of contaminated fish and shellfish

Fish and shellfish samples will be collected from coastal regions identified as nurdle-contaminated zones based on preliminary field surveys or existing pollution data. Sampling will be conducted seasonally from multiple locations to account for temporal and spatial variability. Commonly consumed species (e.g., *Sardinella spp.*, *Rastrelliger kanagurta*, Carangids, Lethrinus, crab etc.) will be selected based on local consumption patterns and availability (FAO, 2018).

Collected organisms will be immediately placed in sterile, ice-packed containers and transported to the laboratory under cold chain conditions to

prevent degradation. In the lab, fish and shellfish will be washed, measured, and dissected under sterile conditions. Edible tissues (muscle and hepatopancreas) will be homogenized and stored at −20°C until analysis (Lusher et al., 2017).

Tissue samples will be digested using a microwave-assisted acid digestion protocol (USEPA Method 3052) with a mixture of nitric and perchloric acid. The digested solution will be filtered and analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or Atomic Absorption Spectrophotometry (AAS) for the detection of metals such as lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr), and zinc (Zn) (Muralidharan et al., 2017).

Lipid-rich tissues will be extracted using a modified QuEChERS method (Anastassiades et al., 2003), followed by cleanup with Florisil column chromatography. The concentrated extracts will be analyzed using Gas Chromatography–Mass Spectrometry Mass Spectrometry (GC-MS/MS) for the quantification of polycyclic aromatic hydrocarbons (PAHs) and selected organochlorine and organophosphate pesticides (Gupta et al., 2021).

Reference standards from certified agencies (e.g., Sigma-Aldrich) will be used for calibration. Quality control will be ensured by using blanks, duplicates, and standard reference materials (e.g., NIST SRM 2976).

For microbial analysis, shellfish and fish tissues will be aseptically rinsed and homogenized in sterile phosphate-buffered saline. Serial dilutions will be cultured on selective media (e.g., MacConkey agar, TCBS agar, and XLD agar) to identify pathogenic bacteria such as *Escherichia coli*, *Vibrio spp.*, and *Salmonella spp.* Molecular confirmation will be carried out using PCR and qPCR targeting species-specific genes (Sapkota et al., 2008; Harvell et al., 1999).

Health risk assessments will be performed by estimating dietary exposure to contaminants using the following formulas:

Estimated Daily Intake (EDI):

EDI=C× IR/BW

Where *C* = contaminant concentration (mg/kg), *IR* = ingestion rate (kg/day), *BW* = average body weight (kg).

Target Hazard Quotient (THQ):

THQ=EDI/RfD

Where *RfD* = oral reference dose (mg/kg/day). THQ > 1 indicates potential health risk (USEPA, 2000).

Carcinogenic Risk (CR):

CR=EDI×CSFCR = EDI \times CSFCR=EDI×CSF

Where *CSF* = cancer slope factor. CR > 10^{-4} indicates significant cancer risk.

Seafood consumption rates will be obtained from local dietary surveys or existing literature (BIS, 2012). Risk estimates will be compared with international safety limits (e.g., WHO, FAO, USEPA, EFSA).

6. To map the spatial patterns of nurdle pollution and associated contaminants using GIS for identifying high-risk zones and potential sources of contamination.

All sampling coordinates and analytical data will be integrated into a Geographic Information System (GIS) platform such as ArcGIS or QGIS. Spatial layers including nurdle abundance, contaminant concentrations, and site characteristics will be created. Interpolation methods such as Inverse Distance Weighting (IDW) or Kriging will be used to estimate unsampled values, generating continuous surface maps. Additional spatial analyses, including proximity buffers around industrial areas and hydrological features, will be performed to identify potential sources of contamination. Multi-criteria decision analysis (MCDA) will be applied within GIS to rank areas by contamination risk, considering nurdle density, pollutant load, and ecological sensitivity. High-risk zones and potential source areas will thus be identified and visualized. Statistical analysis using software such as R or

SPSS will also be performed to understand correlations between nurdle occurrence, contaminants, and environmental factors. The resulting maps and data will support targeted monitoring, cleanup efforts, and policy recommendations.

Outreach programme

Based on the results, the stakeholders will be sensitized on the impact of plastic nurdles on the environment through trainings

Budget

Items	Rs. In lakh
I. Non-Recurring:	
Laboratory Building (5000 sq.ft@ Rs. 3500/sq.ft.)	200.00
(a) Equipment:	
GC-MS/MS (for PAH analysis during oil spill , other Persistent organic pollutants, Dioxins etc.)	200.00
Scanning Electron Microscope (analyze the morphology and chemical composition of pollutants at a microscopic level, helping to identify sources and understand their behavior.)	150.00
ATR-FTIR (useful for characterizing particulate matter, microplastics, and other contaminants)	25.00
Sediment grab (Grab sampler) (1 Unit)	3.00
5. Water sampler (1 Unit)	3.00
6. Phase contrast Microscope along with camera and system (2 Unit)	40.00
7. Deep Freezer along with stabilizers and installation (3 Units)	1.50
8. Automatic Tissue processor with accessories	10.00
9. Automatic Tissue Embedded with accessories	10.00
10.Fully automatic Microtome with accessories	10.00
11.Total Organic Carbon analyser	25.00

12.CHNS Analyser	30.00
13. Flame photometer	10.00
14. Water Purification System (Millipore)	15.00
15. Mobile water quality monitoring unit with minimum infrastructure	50.00
Non-Recurring	**782.5**
II. Recurring:	
(a) Manpower	
1. Senior Research Fellows (2 Nos. x 12 Months x Rs. 40,000)	9.60
2. Field Assistants (2No. x 12 Months x Rs. 20,000)	4.80
(b) Travel Expenses	2.00
I Other items	
1. Museum Jars (Assorted size)	2.00
2. Consumables a. Chemicals & Glassware b. Stationaries	15.00
3. Fish specimens	6.00
4. Boat hiring charges	3.00
5. Items like plastic bottles, insulated boxes , balance, vernier caliber, plankton net etc.,	1.50
6. GIS Mapping (QGIS, Arc GIS), Hiring Drone – outsourcing	3.00
7. Conducting awareness programme	2.00
8. Operational Expenses	3.00
Total – Recurring	**51.9**
Grand Total	**834.40**

Place of work: Fisheries College and Research Institute, Thoothukudi.

Duration of the project: One year

Overall Cost Abstract

S No	Particulars	Amount (Rs in crore)
1	A detailed study by the Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU) to learn the long term impact of the deposition of pollutants and remedial measures.	0.50
2	Compensate claim to the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.	110.95
3	Compensation proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants	600.00
4	Promotion of off shore fishing to compensate the fishery stock reduction in inshore area by providing subsidy (80%) for constructing deep sea fishing vessels	96.00
5	Sea ranching has to be undertaken as direct Fish stock enhancement measure	5.47
6	To conserve the fishery resources and enhance the fish stock by supporting the natural breeding process, 120 units of artificial reefs are proposed to be installed in 40 villages	38.13
7	Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts	8.34
	Total	**760.39**

Sd/- K.V.Muralidharan
Director
Fisheries and Fishermen Welfare Department

for Director
Fisheries and Fishermen Welfare Department

Minutes of the meeting of 08.07.2025 -reg

Tamilnadu SEOC < tnstateeoc1@gmail.com >

Mon, 28 Jul 2025 5:38:32 PM +0530

To "tndoe"<tndoe@nic.in>,"tamilnadudoe"<tamilnadudoe@gmail.com>,"forsec" <forsec@tn.gov.in>,"ahsec"<ahsec@tn.gov.in>,"tnpcb-chn"<tnpcb-chn@gov.in>,"tnpcbmembersecretary" <tnpcbmembersecretary@gmail.com>,"memsec"<memsec@tnpcb.gov.in>,":" <coffisheries@gmail.com>,"adgpoperations28@gmail.com" <adgpoperations28@gmail.com>,"Operations"<marutham28@gmail.com>,"ops-east"<ops-east@indiancoastguard.nic.in>,"rhq-east"<rhq-east@indiancoastguard.nic.in>,"tech-east"<tech-east@indiancoastguard.nic.in>,"postmaster"<postmaster@niot.res.in>,"admin" <admin@ncscm.res.in>,"nccr"<nccr@nccr.gov.in>,"cccdm.au" <cccdm.au@gmail.com>

Respected Sir / Madam,

Please see the attached file.

Regards,
Commissioner of Disaster Management,
Tamil Nadu Disaster Risk Reduction Agency,
O/o Commissionerate of Revenue Administration
and Disaster Management,
Ezhilgam, Chepauk,
Chennai - 5

1 Attachment(s)

minutes of the meeting 08.07.2…
675.5 KB

COMMISSIONERATE OF REVENUE ADMINISTRATION AND DIASTER MANAGEMENT
TAMIL NADU DISASTER RISK REDUCTION AGENCY

From:
Tmt. Sigy Thomas Vaidhyan,I.A.S.,
Commissioner (Disaster Management)
Tamil Nadu Disaster Risk
Reduction Agency,
Chepauk, Chennai – 600 005.

To:
As per the annexure
(w.e)

Lr. No. P&CB /01/773 / 2025, Dated: 28.07.2025

Sir/Madam,

Sub: Disaster Management– Review meeting on accumulated Nurdles washed ashore due to MSC Elsa 3 ship wreckage - under the chairmanship of , the Chief Secretary to Government on 08.07.2025 at 4.00 P.M – Approved Minutes of the meeting enclosed- Regarding.

Ref:
1. Govt.Lr.No:10594/DM.1(2)/2025-1 dated: 27.06.2025.
2. This office letter No.P&CB/01/773/2025 dated 10.07.2025
3. Govt.Lr.No:10594/DM.1(2)/2025-1 dated: 22.07.2025

***

I invite your attention to the above references cited.

2) The approved copy of the Minutes of the meeting held under the Chairmanship of Chief Secretary to Government on 08.07.2025 to review the action taken on accumulated Nurdles washed ashore due to MSC Elsa 3 ship wreckage is enclosed herewith for pursuing necessary action.

Yours faithfully,
Sd/- C. Muthukumaran,
Joint Director, DM
For Commissioner (DM)

28/7/25
Assistant Commissioner-V

28/7/25.

ANNEXURE

Sl.No	Name of the Official (Tvl) / Designation
1	The Additional Chief Secretary to Government, Environment, Climate Change and Forests, Secretariat, Chennai – 9.
2	The Principal Secretary, Animal Husbandary, Dairy and Fisheries Department, Secretariat, Chennai – 9.
3	The Director, Environment & Climate Change Department, Nandanam, Chennai – 35.
4	The Chairperson, Tamil Nadu Pollution Control Board, 76,Mount Salai, Guindy, Chennai - 32
5	The Commissioner, Fisheries Department, Nandanam, Chennai - 35
6	The Additional Director General of Police (Operations), Tamil Nadu Disaster Response Force,, Marudham Boat Club Road, Nandanam, Chennai -35.
7	The Commandant , Indian Coast Guard, Rajaji Salai, Near Napier Bridge, Chennai - 9
8	The Scientist – E, National Institute of Ocean Technology, Velachery-Tambaram Main Road, Pallikaranai, Chennai-100.
9	The Director, National Centre For Sustainable Coastal Management, Ministry of Environment, Forest and Climate Change (MoEF&CC) Anna University Campus Chennai – 600025
10	The Scientist – G, National Centre for Coastal Research(NCCR) NIOT Campus, Velacherry-Tambaram Main Road, Pallikaranai, Chennai-100.
12	The Regional Officer, Regional Institute of CSRHQ(E)
13	Professor & Director, Centre for Climate Change and Disaster Management, Dept of Civil Engineering, Anna University, Chennai – 600025

MINUTES OF THE MEETING CHAIRED BY CHIEF SECRETARY TO GOVERNMENT TO REVIEW THE AFTERMATH OF SINKING OF SHIP MSC ELSA 3

The meeting was held on 08.07.2025 under the chairmanship of Chief Secretary to discuss the action taken by Stakeholders Departments and District Collectors of Kanniyakumari and Ramanathapuram in the aftermath of sinking of ship MSC ELSA 3.

The list of participants is enclosed in the ANNEXURE.

At the outset the Additional Chief Secretary to Government, Revenue and Disaster Management Department welcomed the officials and briefed the background of the incident. The District Collectors also briefed the Chief Secretary to Government regarding the cleaning of plastic nurdles from the coast.

After detailed deliberations, the following decisions were made in the meeting.

1. As per the Hon'ble Madurai Bench of Madras High Court's direction in W.P. (MD) No. 16258 of 2025, a report will be filed by the Additional Chief Secretary, Commissioner of Revenue Administration. The Environment, Climate Change and Forests Department, Tamil Nadu Pollution Control Board, Fisheries and Fisherman Welfare Department and the District Collectors of Kanniyakumari and Ramanathapuram shall provide inputs for the report to be filed in the Court. This will be done by the Disaster Management Department.
2. The claims and costs will be prepared by the Environment, Climate Change and Forests Department after collecting the inputs from Fisheries and Fisherman Welfare Department and filed before Director General, Shipping.
3. Fisheries and Fisherman Welfare Department and Tamil Nadu Pollution Control Board to continue the long-term impact assessment / studies in a coordinated manner without any over lapping.

Finally, the Commissioner, Disaster Management thanked the Chief Secretary, Additional Chief Secretaries, Secretaries, Experts, Scientists and all other officials who participated in the meeting.

N. MURUGANANDAM
CHIEF SECRETARY TO GOVERNMENT

//TRUE COPY//

22/07/2025

SECTION OFFICER

22.07.2025

3176

Speed Post

DEPARTMENT OF FISHERIES AND FISHERMEN WELFARE

From
Thiru.K.V.Muralidharan, IAS.,
Director,
Fisheries and Fishermen Welfare,
Nandanam, Chennai – 600 035.

To
The Director,
Department of Environment & Climate Change,
Anna Salai, Nandanam,
Chennai-35

R.C.No. 15020/P3/2025, Date:23.10.2025

Sir,

Sub : Fisheries and Fishermen Welfare – Disaster Management- Accumulated nurdles washed ashore due to MSC Elsa 3 ship wreckage held on 08.07.2025- Proposal sent- Regarding

Ref : 1. Compensation proposal for ship wreckage sent by this office on 04.09.2025

2. Tamil Nadu Environment Department e-mail dated:16.10.2025.

With regard to the reference 1st cited, a communication has been received vide reference 2nd cited from the Tamil Nadu Environment Department stating that the total compensation figure mentioned in the proposal does not correspond with the cost abstract breakup provided and further it has been requested to inform the basis of budget estimate.

It is informed that based on the meeting Chaired by the Chief Secretary to Government, the proposal was subsequently revised. However, the revised total amount was not reflected in the abstract. The abstract seeking compensation amount of **Rs. 859.39 crore is enclosed herewith for perusal**.

Further, it is informed that the budget estimated is based on the inputs received from the concerned Assistant Director of Fisheries and the budget cost were calculated and consolidated accordingly.

Encl: as above

Sd/-K.V.Muralidharan
Director
Fisheries and Fishermen Welfare

23/10/2025

for Director
Fisheries and Fishermen Welfare

File No. DOECC/1012/2025-A1-GIS (Computer No. 272365)
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Fisheries and Fishermen Welfare Department

WRECKAGE OF CARGO SHIP MSC ELSA 3

Abstract

A total of **Rs 859.39 crore** is assessed for claim towards the compensation of livelihood loss to the fishermen, study the long term impact and remedial measures and environment and biodiversity restoration measures as follows.

i. A detailed study has to be undertaken at a total project cost of Rs 50 lakh by the Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU) to learn the long term impact of the deposition of pollutants and remedial measures.

ii. A total amount of Rs 110.95 crore is claimed to compensate the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.

iii. Compensation for an amount Rs 600 crore proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants

iv. Promotion of off shore fishing to compensate the fishery stock reduction in inshore area by providing subsidy (80%) for constructing deep sea fishing vessels at cost of Rs 96 crore.

v. Sea ranching has to be undertaken as direct Fish stock enhancement measure at a total cost of Rs 5.47 crore.

vi. To conserve the fishery resources and enhance the fish stock by supporting the natural breeding process, 120 units of artificial reefs are proposed to be installed in 40 villages at a total cost of Rs 38.13 crore.

vii. Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts at a cost of Rs 8.34 crore.

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Overall Cost Abstract

S No	Particulars	Amount (Rs in crore)
1	A detailed study by the Tamil Nadu Dr J Jayalalithaa Fisheries University (TNJFU) to learn the long term impact of the deposition of pollutants and remedial measures.	0.50
2	Compensate claim to the wage loss to the fishermen and revenue loss to the fishing boats in the affected areas of Kanniyakumari and Ramanathapuram Districts.	110.95
3	Compensation proposed against the reduction in fish catch and reduction in consumption due to the apprehension of plastic and other pollutants	600.00
4	Promotion of off shore fishing to compensate the fishery stock reduction in inshore area by providing subsidy (80%) for constructing deep sea fishing vessels	96.00
5	Sea ranching has to be undertaken as direct Fish stock enhancement measure	5.47
6	To conserve the fishery resources and enhance the fish stock by supporting the natural breeding process, 120 units of artificial reefs are proposed to be installed in 40 villages	38.13
7	Establishment of a laboratory for long term monitoring the impact on the oil and plastic pollution along Kanyakumari, Thoothukudi and Ramanathapuram coasts	8.34
	Total	**859.39**

Sd/-K.V.Muralidharan
Director
Fisheries and Fishermen Welfare

23/10/2025

for Director
Fisheries and Fishermen Welfare

23/10/25

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Environment, Climate Change and
Forest (EC.2) Department,
Secretariat, Chennai – 600 009.
Phone: 044-25665508
E-mail :eccfd@tn.gov.in

Letter (D) No.274, dated 24.11.2025

From
Tmt. Supriya Sahu, I.A.S.,
Additional Chief Secretary to Government

To
The Director,
Department of Environment and Climate Change,
Chennai-35.

Sir,

Sub: Environment, Climate Change – Environmental and Livelihood loss due to Wreckage of Cargo ship MSC ELSA-3 off Tamil Nadu Coast – Comprehensive compensation cost covering Environmental damage and Livelihood loss to fisherman in Tamil Nadu Coast – Regarding.

Ref:
1. Minutes of the review meeting held by Chief Secretary to Government on 29.05.2025 and 08.07.2025.
2. From the Chairperson, Tamil Nadu Pollution Control Board, letter No.T1/TNPCB/PWM/F.011515/Govt./ Nurdle Spill/2025, dated 25.8.2025.
3. Government letter (D) No.1452/EC.2/2025-7, dated 22.09.2025.
4. From the Chairperson, Tamil Nadu Pollution Control Board, letter No.T1/TNPCB/PWM/F.011515/Nurdle Spill/2025, dated 07.10.2025 addressed to the Director, Department of Environment and Climate Change.
5. From the Director, Fisheries and Fishermen Welfare, Letter No.15020/P3/2025-2, dated 23.10.2025 addressed to the Director, Department of Environment and Climate Change.
6. From the Director, Department of Environment and Climate Change, letter No.efile.1012/2025/JDO/AE, dated 23.10.2025.

=======

In the circumstances stated in your letter sixth cited, the Government hereby accept the proposal for the environmental comprehensive compensation claim cost of Rs.1041.805 crore, (Rupees one thousand fourty one crore eighty lakh and five thousand only) towards compensation for (i) environmental damage

rehabilitation of critical habitats / restoration of natural eco system (Fisheries Department), due to accumulation of plastic nurdles in Tamil Nadu Coast on the aftermath of the sinkage of cargo ship MSC Elsa – 3 and direct you to submit the same before the Directorate General (DG) Shipping and other concerned authorities.

2. I am also to request you to send the Action Taken Report, to Government, immediately.

Yours faithfully,

24.11.25

for Additional Chief Secretary to Government

24/11/2025

BEFORE THE HON'BLE HIGH COURT OF KERALA AT ERNAKULAM

I.A. NO. 4 OF 2025

IN

WP(PIL) NO. 70 OF 2025

CHARLES GEORGE : Petitioner

Vs.

UNION OF INDIA & OTHERS : Respondents

COUNTER AFFIDAVIT
FILED ON BEHALF OF RESPONDENT NO. 6 - THE DIRECTOR GENERAL OF SHIPPING

I, Giridhar P Shenoy S/o. Padmanabha Shenoy, aged 56 years, residing at Mercantile Marine Department quarters, Willingdon Island, Kochi PIN – 682 009, and working as Nautical Surveyor cum DDG (Tech) in the office of the Mercantile Marine Department, at Kochi PIN – 682 009, do hereby solemnly affirm and state as follows:-

1. I am working as Nautical Surveyor cum DDG (Tech) in the office of the Mercantile Marine Department, Kochi PIN – 682 009; and I am conversant with the facts of the case as borne out from official records. I am competent and duly authorised to swear and sign this reply Affidavit, for and on behalf of Respondent No. 6 - the Directorate General of Shipping, in the above case.

समुद्री वाणिज्य विभाग MERCANTILE MARINE DEPARTMENT कोच्ची KOCHI

2. It is respectfully submitted that the Petitioner has preferred Interlocutory Application No. 4 of 2025 in the above Writ Petition. Accordingly, this Counter Affidavit is being filed on behalf of Respondent No. 6 to apprise this Hon'ble Court of subsequent developments on the subject-matter, without prejudice to the submissions already placed on record, and with liberty to submit further affidavits as may be necessitated by future circumstances.

3. It is respectfully submitted that the above Writ Petition has been tagged along with other connected cases WP (PIL) 50 of 2025 and WP (PIL) 60 of 2025. In the Counter Affidavit submitted in WP (PIL) 50 of 2025 the position, as then prevailing, was duly placed before this Hon'ble Court. Since then, salvage operations have commenced, and the situation in respect of MSC Elsa 3 continues to evolve.

4. Without prejudice to the above, even going by the Petitioner's perspective, it is most humbly submitted the concerns raised by the Petitioner except towards the removal of wreck and submerged cargo (Containers) herein have already been addressed and have become infructuous. In this regard, the factual scenario of the case as per records maintained by the Respondent No. 6 are provided below.

PARA-WISE REPLY:

5. It is respectfully submitted before this Hon'ble Court that save and except what is specifically admitted herein, all other averments, allegations, contentions, and submissions made in the present I.A. No. 4 of 2025 in the above Writ Petition are specifically and

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unequivocally denied in fact and in law. Unless specifically mentioned as admitted, the allegations and contentions raised by the Petitioner to the extent it affects or relates to the Respondents No. 6, are wholly denied. Nothing stated in the said Application shall be deemed to have been admitted by Respondent No. 6 merely by way of lack of specific traverse.

6. It is respectfully submitted before this Hon'ble Court that with regard to para 1 and 2 of the I.A., the Respondent No. 6 respectfully states that the contents are matters of record and do not call for any response.

7. It is respectfully submitted before this Hon'ble Court that with regard to para 3 of the I.A., the averments are partly admitted and partly denied. It is submitted that while environmental concerns have been duly noted, the Owners have failed to respond in writing to repeated notices issued by Respondent No. 6 regarding wreck removal. It is further submitted that issues of cargo misdeclaration and illegal transportation of foreign waste require to be taken up with the vessel owners, i.e., Respondent No. 3 in the subject writ petition. Such information was not part of the cargo manifest submitted by the Owners.

8. It is respectfully submitted before this Hon'ble Court that with regard to para 4 and 5 of the I.A., the Respondent No. 6 respectfully states that the contents are matters of record and do not call for any response.

9. It is respectfully submitted before this Hon'ble Court that with regard to para 6, 7, 8, 10, and 11 of the I.A., the Respondent No. 6

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respectfully submits that these averments are not within its domain; and hence, no reply is necessitated.

10. It is respectfully submitted before this Hon'ble Court that, with reference to paragraphs 9 and 12 of the I.A., the Respondent No. 6 submits that the position of MSC ELSA 3 has been duly marked on the Automatic Identification System (*hereinafter referred to as* 'AIS') tracker under MMSI 994196042 for the wreck which is at location Latitude 09° 18' 50.022" N and Longitude 076° 07' 58.967" E. A true copy of the correspondence dated 30.05.2025 issued by the Directorate of Lighthouses and Lightships (hereinafter referred to as "DGLL") containing the AIS tracker details and marking the distance of the wreck is annexed hereto and marked as **Exhibit R6(A)**.

11. Furthermore, it is respectfully submitted that as per SITREP 8 dated 30.05.2025, a multibeam survey of the wreck site was done on 29.05.2025 by the tug 'Ocean Pioneer'. Upon completion of the said survey, the MSC Elsa 3 wreck was positioned at the same location as marked in the DGLL correspondence, at Latitude 09, 18' 50.022N and Longitude 76, 07' 58.967E. The true copy of SITREP 8 dated 30.05.2025 highlighting the position of the wreck site is annexed hereto and marked as **Exhibit R6(B)**.

12. It is respectfully submitted before this Hon'ble Court that with regard to para 13 of the I.A., the contents largely do not concern Respondent No. 6. However, it is placed on record that the cargo manifest disclosed by MSC and made public by the State of Kerala and KSDMA is, to the best knowledge of Respondent No. 6, the official cargo manifest submitted by the Owners at the initial stage.

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13. It is respectfully submitted before this Hon'ble Court that with regard to para 14 and 15 of the I.A., Respondent No. 6 respectfully submits that these averments are not within its domain and hence craves leave to submit that no response is required.

14. It is respectfully submitted before this Hon'ble Court that with regard to para 16 and 17 of the I.A., while the contents are not directly concerning Respondent No. 6, it is submitted that container retrieval operations at sea were initially undertaken by T&T Salvage, whereas onshore recovery and cleanup is ongoing and being carried out by Marine Emergency Response Centre (*hereinafter referred to as* 'MERC'). These activities were publicly documented, and daily updates were provided in the Situation reports (*hereinafter referred to as* 'SITREPs') issued by Respondent No. 6 and uploaded on the Kerala State Disaster Management Authority (*hereinafter referred to as* 'KSDMA') website, as well as in MERC Daily Progress Report (*hereinafter referred to as* 'DPR').

15. It is respectfully submitted that subsequent developments were officially reported through daily Situation Reports (hereinafter referred to as 'SITREP') issued by Respondent No. 6 and published on the Kerala State Disaster Management Authority (hereinafter referred to as 'KSDMA') website and the said SITREPs form part of the public record.

16. It is respectfully submitted that relief measures to coastal communities were in progress and that coordination among the various responding agencies was continuing both in relation to the salvage activities and the protection of the shoreline. It is further respectfully submitted that the local authorities and disaster

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response volunteers had been engaged in cleaning debris along the shoreline and monitoring affected areas for potential risks to coastal communities.

17. It is respectfully submitted that plastic nurdles from damaged containers had, however, been observed along the Kerala coast and parts of the South Tamil Nadu coast. These nurdles were being collected on a daily basis under supervision of MERC by volunteers who were engaged by them. It is submitted that, as of the latest update, approximately 703 metric tonnes of plastic nurdles had been collected through these efforts.

18. It is respectfully submitted that Respondent No. 6 duly coordinated between all agencies, and local administration to oversee salvage operations, monitor hazards, and ensure compliance with safety protocols. It is respectfully submitted that MERC, an agency appointed by the owners, had further cleared a number of containers from the site, and all operations were conducted under strict safety monitoring. The SITREP highlighted ongoing efforts to quantify and mitigate environmental impact and to provide timely updates to the public and authorities.

19. It is respectfully submitted that only light oil sheen had been observed on the surface of the water in the vicinity of the wreck site. This had been effectively dispersed both by the standby vessel stationed at site and by the natural phenomenon of wave action.

20. It is respectfully submitted that, owing to the proactive measures undertaken by Respondent No. 6, the Indian Coast Guard (*hereinafter referred to as* 'ICG'), and the Salvors engaged by the vessel owners, the risk of an oil spill from the sunken vessel was

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effectively contained by 15.06.2025, i.e. before the onset of the monsoon. The divers had sealed all fuel tank openings, thereby preventing any large-scale discharge of oil into the marine environment.

21. It is respectfully submitted that due to the change in prevailing weather conditions and the onset of monsoon, the vessel owners thereafter appointed new salvors, SMIT Salvage, to take forward and continue with the salvage operations in the present matter as per the applicable requirements. A true copy of the said email dated 23.06.2025 from the owners is annexed hereto and marked as **Exhibit R6(C)**. The salvors had accordingly commenced the oil extraction operations from the wreck as indicated in SITREP 44 dated 05.08.2025, which is annexed hereto and marked as **Exhibit R6(D)**.

22. It is further humbly submitted that a series of daily coordination meetings since 24.05.2025, were being held, chaired by Respondent No. 6 with participation from the vessel owners (Mediterranean Shipping Company), ICG, Information Fusion Centre - Indian Ocean Region (IFC-IOR), Salvors, Protection and Indemnity Club (*hereinafter referred to as* 'P&I Club'), the International Tanker Owners Pollution Federation (ITOPF), National Disaster Management Authority (NDMA), Kerala and Tamil Nadu Port Authorities, and the state agencies.

23. It is most respectfully submitted that these coordination meetings were held taking into account the environmental threat posed by the casualty, as the uncontrolled release of the cargo and oil from the sunken vessel would result in serious ecological consequences, including but not limited to irreversible damage to marine

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biodiversity, disruption of coastal ecosystems, and adverse impacts on the livelihoods of coastal fishing communities. It is further submitted that while the initially appointed salvors, T&T Salvage, had commenced firefighting measures and planning for towage operations, the subsequently appointed SMIT Salvage undertook and initiated the oil capping operations.

24. Respondent No. 6 respectfully submits that the paramount priority was the removal of oil from the wreck to mitigate the risk of environmental damage. The salvage operations are presently ongoing under the supervision of the competent authorities. All necessary and appropriate directions have already been issued to the salvors to undertake retrieval of the Voyage Data Recorder (*hereinafter referred to as* 'VDR'). It is further submitted that the said VDR has not yet been retrieved as of this date.

25. It is respectfully submitted before this Hon'ble Court that with regard to para 18 of the I.A., the demand that Respondent No. 6 retrieve the VDR, logbook, voyage chart, and salvage contract details from Respondent No. 3 (Owners/MSC), is misconceived. The VDR has not yet been retrieved, as salvage operations remain underway.

26. It is respectfully submitted before this Hon'ble Court that with regard to para 19, 20, 21, and 22 of the I.A., Respondent No. 6 respectfully submits that these averments are not within its domain; and hence, no reply is necessitated.

27. It is respectfully submitted that reference may be invited to the earlier affidavit filed by the answering Respondents, wherein the position relating to salvage operations, removal of oil, and coastal

clean-up had already been placed on record. The present affidavit is filed to provide updates with respect to the continuing measures undertaken on those aspects, and more importantly, to highlight the failure of the vessel interests to engage with the question of wreck removal in a timely and responsible manner.

28. In respect of the marine incident involving **'MSC-ELSA 3' (IMO No. 9123221)**, I humbly submit the following:-

28.1. It is respectfully submitted that operations for the removal of oil from the wreck had been initiated on 05.08.2025 post the mobilization of DSV SOUTHERN NOVA on site and were concluded on 24.09.2025. Respondent No. 6 had been maintaining close coordination with the Owners of the vessel, the P&I insurers, and the Flag State authorities to ensure that the process of oil removal and subsequent wreck removal shall be undertaken in a systematic and timely manner, consistent with international safety and environmental protocols.

28.2. It is respectfully submitted that, pursuant to the directions of Respondent No. 6 and in continuation of the coordinated efforts undertaken therein, the oil recovery operations from the sunken vessel MSC ELSA 3 were successfully concluded. As per the operational timeline provided by M/s SMIT Salvage, the appointed salvor, offshore recovery commenced following mobilization and preparatory activities in June 2025. The recovery of safely accessible and pumpable pollutants from the vessel's fuel tanks was completed on 24.09.2025, involving the removal of approximately 371.1 Metric Tonnes of oil and associated residues. Subsequently, the process of

demobilization, site clearance, and equipment retrieval was finalized on 26.09.2025, marking the completion of the oil recovery project.

28.3. The detailed activity schedule evidencing the sequence of operations, including vessel mobilization, subsea survey, pumping operations, and completion certification, is as per the SMIT DPR 96 for 29.09.2025. The said report demonstrates that all oil recovery and associated environmental mitigation measures were carried out in a safe, professional, and environmentally compliant manner under the supervision of the concerned authorities. A true copy of the said SMIT DPR 96 dated 29.09.2025 is annexed hereto and marked as **Exhibit R6(E)**.

28.4. It is respectfully submitted that a total of sixty-six (66) containers had washed ashore following the incident. All such containers were subsequently retrieved by MERC. It is further respectfully submitted that none of the sixty-six (66) containers contained hazardous cargo, and hence no direct hazard or damage was reported on account of them.

28.5. It is respectfully submitted that plastic nurdles from damaged containers had, however, been observed along the Kerala coast and parts of the South Tamil Nadu coast. These nurdles were being collected on a daily basis under supervision of MERC by volunteers who were engaged by them.

28.6. It is further submitted that the recovery of plastic nurdles from the affected coastal stretches has continued under the

supervision of MERC in coordination with the Kerala State Government and other stakeholders. As per the latest DPR 127 issued by MERC dated 04.10.2025, a total of 7,02,914 kilograms (approximately 703 metric tonnes) of nurdles have been recovered as on 04.10.2025. The report records that out of this quantity, 4,36,137 kilograms have been segregated and transported to the designated warehouse facilities for safe storage and further disposal.

28.7. The district-wise breakup, as reflected in the said DPR, indicates the recovery efforts undertaken in Thiruvananthapuram, Kollam, Kanyakumari, and Rameshwaram, with 560 volunteers and 430 MERC personnel engaged in the operations. The cleanup and segregation process has been conducted on a daily basis under strict environmental monitoring, ensuring that the recovered material is handled in accordance with prescribed pollution-control and waste management norms. A true copy of the MERC DPR dated 04.10.2025 is annexed hereto and marked as **Exhibit R1(F)**.

28.8. It is respectfully submitted that Respondent No. 6 had been continuously monitoring the situation and issuing necessary directions to ensure that the salvage and response actions were properly executed, including the ongoing process of wreck removal in respect of MSC Elsa 3.

28.9. It is respectfully submitted that as per the Salvors, the scope of the salvage operation is limited to the removal of oil from the wreck in order to mitigate immediate pollution risks.

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28.10. It is respectfully submitted that Respondent No. 6, in discharge of its statutory duties, had already issued formal notices to the Flag State authorities of the vessel, as well as to the vessel owners and their Protection and Indemnity (P&I) insurers, on 30.05.2025 and 05.08.2025.

28.11. It is respectfully submitted that the communication dated 25.05.2025 addressed to the Maritime Authority of Liberia, in its capacity as the Flag State of the sunken vessel MSC Elsa 3, constituted the initial formal intimation issued by Respondent No. 6. Through this letter, the Flag Administration was specifically requested to direct the vessel owners to undertake pollution prevention measures, to submit a retrieval plan for adrift containers including those containing hazardous materials, and to initiate appropriate arrangements for the removal of the wreck of the sunken vessel. A true copy of the said mail dated 25.05.2025 issued by Respondent No. 6 is produced herewith and marked as **Exhibit R6(G)**.

28.12. It is most respectfully reiterated that Respondent No. 6 had issued a notice under Section 356(J) of the Merchant Shipping Act, 1958 and Article 9 of the Nairobi International Convention on the Removal of Wrecks, 2007 dated 30.05.2025 bearing File No: 25-35011/1/2025-NT - DGS to the Owners, P&I insurer and the flag state administration, Liberia Maritime Authority of MSC Elsa 3. A true copy of the said notice dated 30.05.2025 issued by Respondent No. 6 is produced herewith and marked as **Exhibit R6(H)**.

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28.13. It is most respectfully submitted that Respondent No. 6 had also issued a further notice dated 05.08.2025, bearing File No. 25-35011/1/2025-NT-DGS, to the Flag State Administration, namely the Liberia Maritime Authority, in continuation of its earlier communications. By this notice, Respondent No. 6 reiterated the request for urgent action regarding the removal of the wreck of MSC ELSA 3, drawing reference to Section 356(J) of the Merchant Shipping Act, 1958 and Article 9 of the Nairobi International Convention on the Removal of Wrecks, 2007. The said notice specifically emphasised that the wreck lay within India's Exclusive Economic Zone (EEZ), posed significant concerns relating to navigational safety, environmental hazards, and marine pollution, and accordingly urged the Flag State to issue necessary instructions to the vessel owners/managers for commencing coordination with Indian authorities for wreck removal operations at the earliest. A true copy of the said notice dated 05.08.2025 is produced herewith and marked as **Exhibit R6(I)**.

28.14. By way of these notices, the addressees were specifically called upon to undertake the removal of the wreck in accordance with their international obligations and responsibilities under maritime law. It is submitted that the Owners and the vessels P&I insurers yet to respond in writing to repeated notices issued by Respondent No. 6 regarding wreck removal. Hence, Respondent No. 6 humbly prays before this Hon'ble Court to give appropriate directions to the vessel owners and their P&I insurers to duly take cognizance and respond on the subject-matter.

28.15. It is respectfully submitted that, given the criticality of the matter and the need to ensure coordinated and expeditious action on issues relating to wreck removal and associated pollution prevention measures, Respondent No. 6 convened an online stakeholder meeting on 17.09.2025. The said meeting was attended by the concerned parties, including representatives of the vessel owners, the P&I insurers, the Flag State Administration, and other relevant stakeholders, wherein the matter of wreck removal of MSC Elsa 3 was deliberated in detail.

28.16. It is further submitted that post the above-mentioned coordination meeting, Respondent No. 6 received a letter dated 18.09.2025 in response regarding the wreck removal of MSC Elsa 3 on behalf of the flag state of the vessel, Liberian Maritime Administration. However, it is respectfully stated that a formal response from the Owners and the vessel's P&I insurer is still awaited. A true copy of the letter dated 18.09.2025 from the Liberian Maritime Administration is produced herewith and marked as **Exhibit R6(J)**.

28.17. It is respectfully submitted that despite the issuance of such communications, no substantive or satisfactory response has been received either from the vessel owners and their insurers. The absence of any affirmative action from their side has resulted in the issue of wreck removal remaining unresolved, notwithstanding the fact that oil removal operation from the sunken wreck have been completed and shoreline

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clean-up have been progressing satisfactorily under the oversight and coordination of the Respondent No. 6.

28.18. It is respectfully submitted that the wreck of MSC Elsa 3 continues to pose risks to navigational safety, the marine environment, and to the livelihoods of coastal communities, and therefore, the inaction of the vessel owners, insurers, and the Flag State cannot be countenanced. The Directorate has, to the extent possible, pursued all available channels to secure their cooperation, but is yet to receive firm response.

28.19. In these circumstances, it is most respectfully prayed that this Hon'ble Court may be pleased to issue suitable directions to the vessel owner to take immediate and effective steps for the removal of the wreck from its present location. Such directions are warranted not only to safeguard the marine environment and coastal communities but also to uphold the rule of law in ensuring that vessel owners and Flag States discharge their obligations under applicable conventions and statutes.

29. In respect of the marine incident involving **'WAN HAI 503' (IMO No. 9294862)**, I submit the following :

29.1. Owing to the concerted and continuous efforts of the 6th respondent-DG Shipping in coordination with all relevant stakeholders, the casualty vessel MV WAN HAI 503 has been successfully towed outside the limits of the EEZ of India. As a result, the vessel no longer poses any imminent threat to the Indian coastline or marine environment.

29.2. At present, no environmental hazard has been reported, and no subsequent environmental damage has arisen from the incident. It is further respectfully submitted that no oil spill or leakage has been reported subsequent to the initial fire incident.

29.3. Apart from the previously recovered empty tank container and the vessel's lifeboat, no additional containers or cargo debris from the subject vessel have washed ashore along the Indian coastline.

30. It is further respectfully submitted that a consolidated copy of all the subsequent SITREPs, including SITREP 25 dated 17.06.2025 to SITREP 46 dated 08.08.2025 in respect of 'MSC ELSA 3' is produced herewith and marked as **Exhibit R6(K)**, to apprise this Hon'ble Court of ongoing developments and any additional measures taken in respect of the MSC Elsa 3 incident.

31. It is further respectfully submitted that a consolidated copy of all the subsequent SITREPs, including SITREP 09 dated 16.06.2025 to SITREP 35 dated 24.07.2025 in respect of 'WAN HAI 503' is produced herewith and marked as **Exhibit R6(L)**, to apprise this Hon'ble Court of ongoing developments and any additional measures taken in respect of the WAN HAI 503 incident.

32. I respectfully submit that the situation in respect of both the marine incidents is evolving; and therefore, the respondents may be permitted to file further Affidavit(s), as and when found necessary.

What is stated in paragraphs 1 to 32 above is true to my knowledge, and is based on information and belief derived from records and I believe the same to be true.

01/12/25

Dated this the 1st day of December, 2025

01/12/25

DEPONENT

कप्तान. जी.पी. शेनोय
CAPT. G.P. SHENOY
नॉटिकल सर्वेक्षक व उप महानिदेशक (तक.)
Nautical Surveyor-cum-D.D.G. (Tech.)

Solemnly affirmed and signed before me by the Deponent on this the 1st day of December, 2025 at my office at Ernakulam.

ATTESTING OFFICER

सेंथिल कुमार जयरामन
SENTHIL KUMAR JAYARAMAN
प्रधान अधिकारी-सह-संयुक्त महानिदेशक (तकनीकी)
Principal Officer-cum-Joint Director General (Tech)
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
मर्केंटाइल मरीन विभाग / Mercantile Marine Department
विलिंग्डन द्वीप, कोच्चि / Willingdon Island, Kochi - 682 009

भारत सरकार
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
दीपस्तंभ और दीपपोत निदेशालय
'दीपभवन', एम.जी.मार्ग, घाटकोपर (पूर्व), मुंबई 400077
दूरभाष : 022 - 25068390 फ़ैक्स : 022 - 25060996
ई-मेल: dte-mum@gov.in

Govt. of India,
Ministry of Ports, Shipping and Waterways
DIRECTORATE OF LIGHTHOUSES & LIGHTSHIPS
'Deep Bhavan', M.G.Road, Ghatkopar (E), Mumbai 400077
Tel. : 022 - 25068390 Fax : 022 - 25060996
E-Mail : dte-mum@gov.in

e-mail/ ई मेल

HYDRO
DEHRADUN
FAX : 0135 - 2748373
Email : msis-inho@navy.gov.in

OFFICER-IN-CHARGE,
NAVAL CHART DEPOT,
S.B.S.ROAD, MUMBAI.
FAX : 022 - 22751049
Email : ncdn- inho-navy@ gov.in

VIRTUAL AIS WRECK MARKING (MMSI 994196042) BEING TRANSMITTED TO MARK THE WRECK OF MSC ELSA-3 AT LOCATION 09^0 18' 50.022 N, 076^0 07' 58.967 E [.] INFORM MARINERS [.] DEEP SENT[.] COAST SENT[.]

EM-Mum-10026/1/2021-Electrical

Date: 30.05.2025

Copy for information through e-mail to:-

1. The Chief Hydrographer to the Govt. of India, National Hydrographic Office, 107-A, Rajpur Road, Post Box No 75, Dehradun-248 001.
2. The Officer-in-Charge, Naval Chart Depot, Castle Park, SBS Road, Mumbai-23
3. The Director General of Lighthouses & Lightships, Deep Bhavan, Noida
4. The Director General Shipping, i-Think Techno Campus, Kanjurmarg (E), Mumbai
5. The Deputy Director General, Directorate of Lighthouses & Lightships, Mumbai.
6. The Officer-in-charge, MRCC, Mumbai

(के सुधीश /K Sudheesh)
स. का. अभियंता (ई) / Asst. Executive Engineer (E)
कृते निदेशक /For Director

SITREP – 8, 1800 hrs on 30/05/2025

Sinking of MSC ELSA 3 (IMO no – 9123221, Flag Liberia) South West of Kochi

1. Incident Overview:

On 24 May 2025 at approximately 1300 hrs IST, the container vessel MSC ELSA 3, operated by MSC Ship management Ltd., developed a severe starboard list while enroute from Vizhinjam to Kochi, about 30 nautical miles southwest of Kochi Port. By 1515 hrs IST, the list had increased to 30 degrees and stabilized. On the morning of 25th May, at approximately 0750 hrs, the vessel sank about 13 nautical miles off the Kerala coast, as a result of which, all deck containers went adrift in the surrounding waters and the containers in the cargo hold submerged with the vessel.

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Figure 1: Containers recovered on the Coastline and adrift

A total of 57 beached containers have been identified by Kerala State Disaster Management Authority along a 120 km coastal stretch, with personnel being mobilized accordingly. Plan of Action of for the salvor's team on 30/05/2025 for Kollam:

Site 1: **Mundakkal Beach**

At Mundakkal Beach, operations will focus on the recovery of the reefer container and the paper rolls from the shoreline. In addition, efforts will be made to secure floating cotton bundles to prevent further dispersal and damage.

Site 2: **Shaktikulangara**

Of the 6 containers remaining at the site, 1 will be loaded onto a trailer and transported to Kollam Port. This operation is scheduled to begin at 0800 hrs. The remaining 5 containers, which are damaged, will be dismantled and sent to Kollam Port today via trucks.

Site 3: **Alappad**

Out of the 2 containers at the site, the reefer container currently located on the beach is scheduled for transportation to Kollam Port. Loading will begin as soon as the trailer arrives on site. The second container, which is damaged, will be cut and transported to Kollam Port later today.

Site 4: **Neendakara**

Out of the 5 containers at the site, work will be carried out today on 3. Operations will begin at 0800 hrs, starting with the 20-foot container near the church. For the 2 40-foot containers near the hospital, a JCB has arrived at 0600 hrs to level the ground, allowing the crane to access them. The remaining 2 containers are currently inaccessible, and work to create an access path will also commence today.

Parts of a refer container have washed off at Kovalam beach. The salvors team is trying to find whether accounted for in present list. Salvage and shifting of the piece of the container to a safer place will be planned and executed soon.

Figure 2: Part of reefer container beached

A multibeam survey of the wreck site had been completed using Tug 'Ocean Pioneer' on 29.05.2025, evening hours and have positioned the vessel at Lat 09, 18' 50.022N, Long 76, 07' 58.967 E. The highest point of the vessel has been identified at 33m with the maximum depth being approximately 51m.

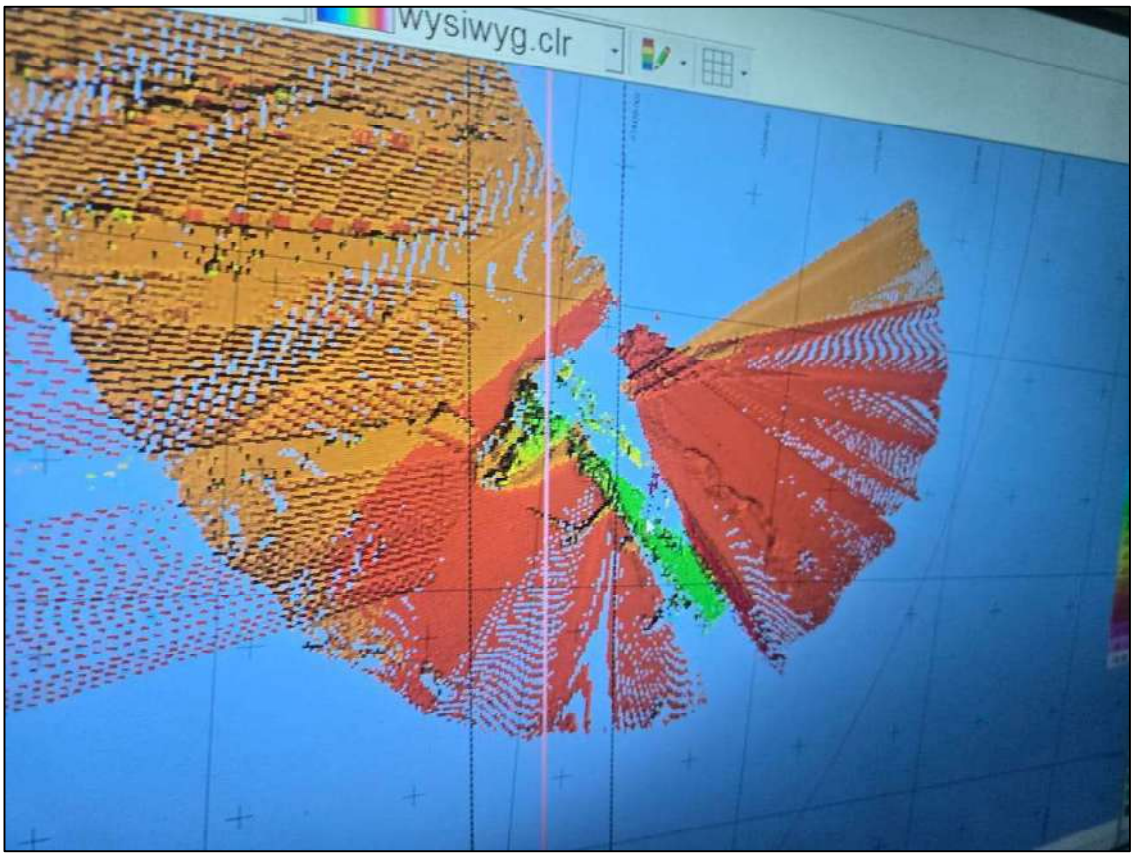

Figure 3: Position of the vessel as identified the multibeam survey

The readiness of DSV SEAMEC III is being assessed for mobilisation. The vessel is equipped to carry out diving and capping operations, which are expected to commence within seven days, subject to favourable weather. Discussions with the operator are underway regarding diving gear, saturation divers, and onboard personnel.

Nand Saarthi is scheduled to arrive by midnight and will mount oil spill response (OSR) equipment for immediate deployment by tomorrow morning. Offshore Warrior is also expected to arrive by 31.05.2025, morning hours and will conduct surveys for loose containers at the incident site. Both Nand Saarthi and Offshore Warrior will be equipped with OSR gear but are not capable of performing capping operations.

The salvor has confirmed that a sufficient quantity of oil booms is available and ready for deployment as soon as the required locations are identified. These booms are currently distributed across Kollam and Alleppey.

The Kerala State Pollution Control Board (KSPCB) recommended deploying oil containment booms around the incident site to prevent further spread of oil towards the shore. However, the technical feasibility of laying buoys in the prevailing rough weather conditions is under examination and will be confirmed shortly.

4. Additional Support:

DGS has advised that virtual markers be implemented and coordinated through DGLL. These markers will be visible on AIS and should be communicated effectively to the local fishing community. **The area surrounding the wreck, initially identified as a 500-meter exclusion zone, will now be extended to a 1-kilometer no-fishing and no-sailing zone by State authorities.**

Further, suggestion was also received from State authorities that heavy containers located on the seabed must be individually marked with surface buoys to warn local fishermen of their presence. Sorbent pads must be placed along the Kerala coast, with particular attention to fish landing centres between Ernakulam and Thiruvananthapuram.

Furthermore, the salvors must arrange for additional oil booms to be deployed at the mouths of rivers and lakes to prevent inland contamination in the event of further leakage.

The local government and district administrations have engaged volunteer for cleanup activities in Trivandrum. In Kanyakumari, preparations for nurdle cleanup have been initiated in consultation with the TNDMA and the district collector. MERC Teams are en route to commence field activities in Kanyakumari.

The customs department is also fully engaged in the operations of recovery of containers and its content. All recovered cargo is to be routed through Kollam and Vizhinjam Port under their supervision. Discussions are ongoing regarding the separation and processing of nurdles from sand and subsequent handover to customs.

The ICG has also been engaged in discussions on diving operations and a decision will be made based on the result of the multibeam survey.

Divers for SEAMEC III are to be brought directly to Kochi from South Africa, with visa facilitation to be expedited by DGS, if necessary at the request of salvors.

5. Situation Assessment:

The vessel has been located through multibeam sonar imaging and is confirmed to be resting on its starboard side. A preliminary survey has provided sufficient data for the salvage team to begin preparing for capping and containment operations. Despite challenges posed by rough sea conditions, initial assessments indicate that weather windows can be optimised to carry out critical salvage activities in the coming days.

ETV 'Water Lily' has also arrived at the incident location on 30th AM hours and is coordinating with ICG in datum position and carrying out search for adrift containers and also available for further assistance.

Survey and response assets are actively being mobilised. Diving and capping activities are sought to be handled by SEAMEC III tentatively, which has sailed from Chennai and is expected off Kochi by 5th or 6th June. The DSV is to be assessed for its readiness

for suitability in the present operation, and discussions are underway with operators to ensure that diving personnel and equipment are made available in time.

While there is no immediate large-scale oil spill, minor traces of oil sheen have been observed, and proactive containment is deemed essential. Light oil continues to ooze out from the wreck site producing an oil sheen which is being tackled by the ICG surface assets by using oil dispersants and surface action for dispersion. Booms have been prepositioned and are available for deployment across Kollam and Alleppey, though feasibility assessments are ongoing due to adverse weather

Each agency engaged on ground has been asked to submit Detailed Project Reports (DPRs) capturing their respective areas of responsibility and progress by end of each day. Clarity is sought based on the result of the multibeam survey, enabling a more decisive course of action, particularly for oil containment and submerged container salvage which as per salvors will be undertaken by 'Offshore warrior' (Multi Beam survey) and 'Nand Sarthi' (OPR) in coming 2-3 days.

6. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

7. Coordination Measures

A series of coordination meetings since the 24th of May 2025, chaired by DG Shipping with participation from ICG, IFC-IOR, MSC, T&T Salvage, P&I Club, ITOPF, National Disaster Management Authority (NDMA), port authorities, and state agencies, and, on 28.05.2025 a meeting was convened in hybrid mode under the chairmanship of the Director General of Shipping, with the presence of state authorities in Kochi, focused on streamlining the response to the MSC Elsa 3 incident. Key directives are focused on mobilisation of salvors for salvage of containers that are ashore as well as adrift, and the plan for pollution mitigation, and regular six-hourly updates from the shipowner.

Refer to SITREP – 6 for the overall coordination measures being undertaken

Annexure 1

Containers List 30-05-2025 , 6.00 pm				
Sl No	District	Taluk	Container Details	No.of containers
1	Kollam	Kollam	Unidentified	11
2	Kollam	Karunagappaly	Unidentified	10
3	Kollam	Kollam	Identified	18
4	Kollam	Karunagappally	Identified	4
5	Alappuzha	Karthikappally	Identified	2
6	Trivandrum	Trivandrum	Identified	1
7	Trivandrum	Varkkala	Identified	3
8	Trivandrum	Neyyattinkara	Identified	4
9	Trivandrum	Trivandrum	Unidentified	2
10	Trivandrum	Chirayankeezhu	Identified	1
12	Trivandrum	Neyyattinkara	Unidentified	1
Total Containers landed				**57**
Kerala State Disaster Management Authority				

Thanks and Best Regards,

Capt. Harinder Singh,
Nautical Surveyor and Deputy Director General (Tech)
The Directorate General of Shipping, Mumbai.
Email: singh.harinder@gov.in
Tel: 022 2575 2063 / 022 25752040 (Ext:216)
Mob: 9819796759

---- On Mon, 23 Jun 2025 18:16:16 +0530 **<manish.gupta@msc.com>** wrote ---

To:
The Director General of Shipping
Ministry of Ports, Shipping and Waterways
Government of India
Mumbai

Subject: Response to Formal Notice dated 11 June 2025 regarding Salvage Operations of MSC Elsa 3 and Environmental Concerns – further update

Dear Sir,

Our consultants, Brand Marine have discussed with SMIT Salvage company on the proposal for the oil removal operations and the remaining operations in relation to the Elsa 3. MSC is now in the process of onboarding SMIT salvage for continuing with the operations.

As soon as the contract with SMIT is finalised, we expect SMIT to submit their final fuel extraction plan for MSC and Brand Marine's review, which we will then share with you accordingly.

Whilst we are awaiting an update on the above, we have been advised that due to safety reasons, the oil removal operations are recommended to be conducted only after the monsoon period is over and therefore no time is being lost towards the onboarding of SMIT and the revision in the oil removal plan.

Please also note that while the oil removal operations are being finalized, MERC has now finalised the caretaking plan and the same has been provided to your office by Capt. Ajay from Brand Marine earlier today. The tug 'Canara Megh' has departed from Mumbai yesterday at 0940 Lt. and MERC will update the ETA to Kochi in due course.

The Canara Megh will take over duties from Nand Saarthi, upon arrival at Kochi and Nand Saarthi and T&T Salvage will be demobilized from the project.

MERC also continues to undertake the onshore cleanup operations.

We shall keep you updated.

Thanks and Best Regards

Capt. Manish Ashok Gupta
General Manager - (Safety, Quality & Insurance) / DPA

MSC SHIPMANAGEMENT LIMITED
MSC House, 8 Spyrou Kyprianou Avenue, Limassol, CY-3070, Cyprus.
T: +357 25 844 842 **M:** +357 9972 3516 **W:** www.msc.com

Sensitivity: Internal

From: Manish Gupta (MSC SHIPMANAGEMENT)
Sent: Friday, 13 June 2025 8:57 pm
To: Capt. Harinder <singh.harinder@gov.in>
Cc: Joanne Clark <joanne.clark@north-standard.com>; Deepak Agarwal (MSC SHIPMANAGEMENT) <deepak.agarwal@msc.com>; Dhananjay Javadekar (MSC India) <dhananjay.javadekar@msc.com>; keralasdma@gmail.com; abulkalam.azad <abulkalam.azad@gov.in>; Ankur Varma (MSC India) <ankur.varma@msc.com>; bodh.raj73 <bodh.raj73@gov.in>; Ajithkumar Sukumaran <cs-dgs@nic.in>; dgcommcentre-dgs <dgcommcentre-dgs@nic.in>; dhq4 <dhq4@indiancoastguard.nic.in>; Gillian Clark <gillian.clark@north-standard.com>; gp.shenoy <gp.shenoy@gov.in>; Mahendra Bhasin (MSC CREWING SERVICES MUMBAI) <mp.bhasin@msc.com>; mrcc-west <mrcc-west@indiancoastguard.nic.in>; mrsc-kochi <mrsc-kochi@indiancoastguard.nic.in>; Naresh Malhotra (MSC Geneva) <naresh.malhotra@msc.com>; Salvatore Savarese (MSC Geneva) <salvatore.savarese@msc.com>; nmsarb <nmsarb@indiancoastguard.nic.in>; ops-cgcws <ops-cgcws@indiancoastguard.nic.in>; ops-west <ops-west@indiancoastguard.nic.in>; po.mmd-ker <po.mmd-ker@gov.in>; Prashant Kumar (MSC SHIPMANAGEMENT) <prashant.kumar@msc.com>; Abhay Bhonge (MSC SHIPMANAGEMENT) <abhay.bhonge@msc.com>; Raffaele Porzio Operation (MSC Geneva) <raffaele.porzio@msc.com>; shitesh.ranjan <shitesh.ranjan@gov.in>; Sudhanshu K Sinha (MSC SHIPMANAGEMENT) <sudhanshuk.sinha@msc.com>; senthil.kumar30 <senthil.kumar30@gov.in>; opesh.sharma <opesh.sharma@navy.gov.in>; director-ship <director-ship@gov.in>; usma-psw <usma-psw@gov.in>; Madhav Patil <madhavpatil.dgs@gov.in>; DGS Nautical DEO <nautical.deo3-dgs@gov.in>; nautic.lgassit1-dgs <nautic.lgassit1-dgs@gov.in>; dg-dgs <dg-dgs@gov.in>; Laurent Audaz (MSC Geneva) <laurent.audaz@msc.com>; Rosanna Aponte (MSC Geneva) <rosanna.aponte@msc.com>; Ronell A Ashtamker (MSC

Directorate General of Shipping

SITREP – 44, 1800 hrs on 05/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The salvage operation for the sunken MSC *Elsa 3* has entered a critical preparatory phase, following the observation of an oil sheen extending approximately 1.5 nautical miles from the wreck site. The Indian Coast Guard has been closely monitoring the situation, and aerial surveillance is underway using a Dornier aircraft. While no major spill has been confirmed, the possibility of a leak due to engine room disturbance has necessitated heightened vigilance.

The *Southern Nova* (DSV), mobilized for the next phase of fuel extraction, is currently stationed offshore and ready to commence operations. However, due to prevailing sea conditions, safe personnel and equipment transfer has not been feasible via the Offshore Monarch. Consequently, a formal request has been made for port clearance at Kollam to allow boarding of personnel and loading of gear from a safer location. The customs and immigration processes are being coordinated with the relevant authorities, and documentation (IGM/EGM, crew lists, etc.) is being compiled by MERC and MSC.

In light of the risk indicators observed, salvors have been clearly advised to keep oil spill containment and recovery gear ready for immediate deployment. This preparedness is critical to ensure swift response in the event of a discharge during operations.

4. Situation Assessment:

While the sheen remains limited in scope, this development highlights the need for the salvage team to transition swiftly into operational mode.

To facilitate this, it is imperative that the owners and salvors obtain necessary clearances from the Customs authorities expeditiously, allowing the DSV *Southern Nova* to berth at Kollam Port and begin loading of equipment and personnel.

Furthermore, Owners and salvors have been instructed to formally write to the Indian Coast Guard for any assistance in pollution response near the wreck site. The strategic deployment of such a support vessel will significantly enhance the response readiness for oil containment and recovery during fuel extraction and dive operations. It was also conveyed that the propeller wash is being done by Canara Megh to disperse the sheen which is also being further aided by the weather which is aiding natural weathering.

The Directorate General of Shipping has committed to issuing formal communications to support this inter-agency coordination, while Kollam Port continues to provide active facilitation. Ensuring synchronized action across all stakeholders is vital at this juncture to maintain momentum and minimize environmental risks.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

सागराः सुपन्थानः सन्तु

SALVAGE	DAILY PROGRESS REPORT (DPR 96)	Quality Form SSF-001 Revision 2 Page 1 of 6

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PROJECT NAME	: MSC ELSA 3	**DPR NO.**	: 96
PROJECT NO.	: SNL252125	**DATE**	: 29-09-2025
CONTRACT FORM	: **Wreckhire 2010**		

CONTACT INFORMATION SMIT SALVAGE B.V. **E-mail : salvage@smit.com**

Rosmolenweg 20, 3356 LK, Papendrecht, The Netherlands, www.smit.com. Phone: 24/7 +31 10 454 99 11

AA) GENERIC

To Client	: BRAND Marine Consultants	**FAO**	Capt. Ajay Prasad
E-mail Client	: ajay.prasad@brand-marine.com		
C.C.	: james.swinburn@brand-marine.com; ketan@vmw.co.in; mscelsa3@smit.com; j.sheilds@smit.com; salvage@smit.com; g.verver@smit.com; j.mooij@smit.com; kyi.chan.wai@smit.com; m.schreurs@smit.com; r.janssen@smit.com; p.vt.hof@smit.com; f.staphorst@smit.com; r.de.haan@smit.com; l.pierik@smit.com;Department.Salvage.Operations.RTM@smit.com; project@merc-india.com; Vivian.dsouza@brand-marine.com; Rohit.Mann@brand-marine.com; adeline.goh@brand-marine.com; cj.erasmus@smit.com		
From Salvage Master	: Jaco Sluijmers		
Location (coordinates)	: Approx. 38 nautical miles from port/city of Cochin, India @ Lat 09°18.512'N and Long 076°07.58'E		

BB1) WEATHER ON LOCATION

Actual weather report	0600 hrs	1200 hrs	1800 hrs	2400 hrs
Wind Direction & Speed (Bft)				
Sea state				
Swell height and direction				
Visibility				
Meteorological Situation/ predictions				

BB2) WEATHER FORECASTED

Heavy Weather / Tropical

None expected at this time.

Weather Synopsis

Good day. Currently, weak monsoonal troughing continues to occur over much of the Arabian Sea. Monsoonal troughing is forecast to continue to weaken through the end of the forecast period. Aside from this, equatorial troughing is also forecast to continue to occur between 14N and 10S through the end of the forecast period.

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Monday, 29 Sep, 2025 — Favorable | Approaching Thresholds | Above Thresholds

Forecast Valid	Wind (kts) Dir	10M	50M	100M	Seas (meters) Dir	Sig	Max	Per	Primary Wave Type	Vis (NM)	Sky Conditions / Advisory	SST °F °C	Precip Total (inch/mm)	Air Temp (°F/°C) Currents (kts)
Mon 0500LT	W	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	4	Cloudy Isolated Shwrs / Squalls, Reduced Vis	81° 27°	0.04 / 1	81° / 27° NNW @ 0.3
Mon 0600LT	W	13G18	14G19	15G20	W	1.5	2.5	8	Sea / Swell	4	Mostly Cloudy Isolated Shwrs / Squalls, Reduced Vis	81° 27°	0.05 / 1	81° / 27° NNW @ 0.3
Mon 0700LT	W	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	13	Mostly Cloudy Isolated Shwrs / Squalls	81° 27°	0.03 / 1	81° / 27° NNW @ 0.3
Mon 0800LT	W	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	13	Mostly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.3
Mon 0900LT	W	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	13	Mostly Cloudy Isolated Shwrs / Squalls	81° 27°	0.08 / 2	81° / 27° NNW @ 0.3
Mon 1000LT	W	14G18	15G19	16G20	W	1.5	2.5	8	Sea / Swell	8	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	0.1 / 3 Minor Flooding	82° / 28° NNW @ 0.3
Mon 1100LT	W	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	8	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	0.1 / 3 Minor Flooding	82° / 28° NNW @ 0.4
Mon 1200LT	WNW	14G19	15G20	15G20	W	1.5	2.5	8	Sea / Swell	8	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace Minor Flooding	81° / 27° NNW @ 0.4
Mon 1300LT	WNW	14G18	15G19	16G20	W	1.5	2.5	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.5
Mon 1400LT	WNW	14G19	16G21	16G21	W	1.5	2.5	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	0.03 / 1	81° / 27° NNW @ 0.6
Mon 1500LT	WNW	15G19	16G20	17G21	W	1.5	2.5	8	Sea / Swell	13	Cloudy Isolated Shwrs / Squalls	81° 27°	0.03 / 1	82° / 28° NNW @ 0.6
Mon 1600LT	WNW	15G20	16G21	17G22	W	1.5	2.5	8	Sea / Swell	9	Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.6
Mon 1700LT	WNW	15G20	16G21	17G22	W	1.5	2.5	8	Sea / Swell	9	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.6
Mon 1800LT	WNW	14G20	15G21	16G22	W	1.5	2.5	8	Sea / Swell	9	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.5
Mon 1900LT	WNW	13G18	14G19	15G20	W	1.5	2.5	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	0.05 / 1	81° / 27° NNW @ 0.5
Mon 2000LT	WNW	13G19	14G20	14G20	W	1.5	2.4	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	0.05 / 1	81° / 27° NNW @ 0.5
Mon 2100LT	WNW	13G18	14G19	15G20	W	1.5	2.4	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	81° 27°	Trace	81° / 27° NNW @ 0.4
Mon 2200LT	WNW	13G19	14G20	14G20	W	1.4	2.4	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	80° 27°	Trace	81° / 27° NNW @ 0.4
Mon 2300LT	WNW	12G17	13G18	13G18	W	1.4	2.3	8	Sea / Swell	13	Partly Cloudy Isolated Shwrs / Squalls	80° 27°	0.08 / 2	81° / 27° NNW @ 0.4

CC) SUMMARY OPERATIONAL ACTIVITIES

From	To	Description activity
0000	2400	DSV SOUTHERN NOVA moored in Kollam port
0000	2400	PSV OFFSHORE MONARCH moored in Kollam Port
0000	2400	Tug CANARA MEGH moored in Kollam Port
AM	PM	SMIT personnel offshore + onshore working on daily project documentation and logistics
AM	PM	MERC Logistics team engaged in planning of SMIT Salvage team and its sub-contractors and organize their demobilisation
AM	PM	MERC Liaison with local Authorities for Support and organize the discharge of the recovered hydrocarbons/ oily water substances
0800	1500	SMIT Salvage, DECO and Airpac team prepare to disembark the Southern Nova
1501	1510	Salvage teams disembark the DSV and heading for the Immigration office
1511	1900	Team clear Immigration
1700	1830	Transfer final diving gas quads from MERC warehouse to the Offshore Monarch

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1901	2100	All cleared and heading for hotel in Trivandrum

DD) OPERATIONS PLANNED NEXT 24 HOURS

No.	Operations planned
1	Salvage teams and subcontractors traveling home
2	SOUTHERN NOVA heading for Singapore
3	OFFSHORE MONARCH heading Kochi to discharge the recovered hydrocarbons
4	CANARA MEGH heading for Mumbai

EE) CONTRACTUAL MILESTONES

Date	Description Milestone
17-06-25	Tug CANARA MEGH hired, mobilization for caretaking activities on site MSC ELSA 3
21-06-25	BIMCO Wreckhire contract signed with client MSC, delivery July 17 @ 0000am
22-06-25	Tug CANARA MEGH Departed from Mumbai heading for Kochi port
27-06-25	Tug CANARA MEGH arrived in Kochi port
28-06-25	Tug CANARA MEGH on wreck location and commenced with caretaking activities/ duties
17-07-25	DSV SOUTHERN NOVA moored at the SSE yard for construction works
25-07-25	PSV OFFSHORE MONARCH loading 8x ISO Tank containers and the requested dive gases in Mumbai
03-08-25	SOUTHERN NOVA on site
04-08-25	PSV OFFSHORE MONARCH moored in Kollam Port awaiting salvage team
09-08-25	DSV SOUTHERN NOVA on site calibrating DP system
10-08-25	WROV commence with USBL calibrations and surveys to identify potential (navigational) hazards
16-08-25	Both vessels on site awaiting preferred weather to Blow Down the Saturation divers
18-08-25	Blow down Saturation divers
20-08-25	Diver deployed and commence working on the ELSA 3
24-08-25	Hottap FO T14C P and commence pumping.
25-08-25	Recovery of safely accessible and pumpable pollutants from FO TK14CP completed (approximately 13m^3, subject to confirmation following further checks).
09-09-25	Install C-Track survey equipment on board CANARA MEGH
11-09-25	Tug CANARA MEGH commence with Bathymetry/ Multibeam survey
19-09-25	Bathymetry/ Multibeam survey completed, demob surveyors and equipment
24-09-25	Fuel removal obligation completed incl. additional lashing and securing works on various containers
26-09-25	@ 1330 hrs "Completion of project"

FF) CRAFT ON HIRE (@24:00)

Name item	Company	On hire	Off Hire	Location
Tug CANARA MEGH	MERC	17 June 2025		Kollam port

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DSV SOUTHERN NOVA	Shelf Subsea	(16/07 @ 1730 hrs vessel sails to anchorage) 17 July 2025 moored at the SSE yard in Tuas		Kollam port
PSV OFFSHORE MONARCH	MERC	26-07-25 @ 0000 hrs		Kollam port

GG) EQUIPMENT ON HIRE (@24:00)

Name item	Company	QTY #	On hire	Off Hire	Location
Oil Spill Response Kit	MERC	1	26 June 2025		Canara Megh
SMIT equipment	SMIT Salvage	Various	15 June 2025		Southern Nova
Abrasive cutting	DECO	Various	14 June 2025		Southern Nova
Cutting gas (16x) and oxygen (20x) quads	MERC	-	24 July 2025		Offshore Monarch
Lashing gear / sea fastening and rigging equipment / 20' Container lifting frame	MERC	-	25 July 2025		Offshore Monarch
Cavi Blaster	Shelf Subsea	1	21 July 2025		Southern Nova
Deployment Shute	Shelf Subsea	1	21 July 2025		Southern Nova
Tooling Lars	Shelf Subsea	1	21 July 2025		Southern Nova
20' ISO Tank containers	MERC	8	22 July 2025		Offshore Monarch
Steam plant	Airpack Rentals	1	23 July 2025		Southern Nova
Air compressor DECO	Aver Asia	1	23 July 2025		Southern Nova
Dive gasses	MSC	Various as ordered by Shelf Subsea	26 July 2025		Offshore Monarch
125kva Generator	Local company	1	15 Aug 2025	29 Sept 2025	

HH) PERSONNEL

#	Name	Position	Comp.	On	Off	Location
1.	Administrator	Office support/admin	SMIT	30 June 2025		Dutch office
2.	Raden Hidaya	SHEQ Engineer	SMIT	17 July 2025		Traveling
3.	Erik Abundo	Rigger / Welder	SMIT	17 July 2025		,,
4.	Micheal Basco	Diving Supervisor	SMIT	17 July 2025		,,
5.	Butch Tolentino	Rigger	SMIT	17 July 2025		,,
6.	Hlaing Myint	Salvage Engineer	SMIT	17 July 2025		,,
7.	Syed Noor	Rigger	SMIT	17 July 2025		,,
8.	Elizardo Abundo	Superintendent	SMIT	17 July 2025		,,
9.	Gary Garena	Rigger / SAT Diver	SMIT	18 July 2025		,,
10	Ketan Gajjar	Laison Officer	MERC	27 July 2025		Remote
11	Vivek Sumra	Port Coordinator	MERC	27 July 2025		Kollam
12	Raju. B / Suryakant. s	Logistics Coordinator	MERC	27 July 2025		Kochi
13	Bhargav Panchashera	Logistics Executive	MERC	27 July 2025		Kollam

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14	Sander Lucassen	Sat Diver	SMIT	29 July 2025	24 Sept 2025	
15	Vincent Koning	Salvage Engineer	SMIT	30 July 2025	24 Sept 2025	
16	Felix Hoogerwerf	Sat Diver	SMIT	30 July 2025		Traveling
17	Micheal Vreekamp	Sat Diver	SMIT	30 July 2025		,,
18	Scot Nieva	Sat Diver	SMIT	30 July 2025		,,
19	Chanyut Iamsa-ard	Rigger	SMIT	30 July 2025		,,
20	J. Hadrien	Technician	DECO	30 July 2025		,,
21	Unaï Tolin	Technician	DECO	30 July 2025		,,
22	Manish Sharma	Technician	Airpack	02 Aug 2025		,,
23	Manot Decharit	Rigger	SMIT	10 Aug 2025		,,
24	Rene Schmidt	Salvage Superintendent	SMIT	20 Aug 2025		,,
25	Craig Erasmus	Sr Salvage Master	SMIT	20 Aug 2025	24 Sept 2025	,,
26	Bart vd Gun	Salvage Supervisor	SMIT	31 Aug 2025		,,
27	DJ Koetsier	Rigger	SMIT	31 Aug 2025		,,
28	Arnaud Nicolas	Technician	DECO	31 Aug 2025		,,
29	Jordy Veen	Salvage Supervisor	SMIT	08 Sep 2025		,,
30	Ahmad Haikal	Shore Co-ordinator	SMIT	08 Sep 2025		TRV
31	Mortada Meskin	Supervisor	DECO	14 Sep 2025		Traveling
32	Willem de Boer	Supervisor	DECO	14 Sep 2025		,,
33	Rune Goossens	Technician	DECO	14 Sep 2025		,,
34	Murugesan Kur	Technician	Airpack	14 Sep 2025		,,
35	Jaco Sluijmers	Sr Salvage Master	SMIT	21 Sep 2025		TRV
36	Richard Schravemade	Salvage Engineer	SMIT	21 Sep 2025		,,
37	Jeffrey Fortes	Sat Diver	SMIT	21 Sep 2025		,,

II) VISITORS

No.	Name	Position	Company	On	Off	Location
1.	Vivian Dsouza	Consultant	Brand Marine Consultants	23 Aug 25		Kochi
2.	Capt Ajay Prasad	Senior Consultant	Brand Marine Consultants	10 Sep 25		TRV

JJ) POINTS OF CONSIDERATION (SMIT SALVAGE)

No.	Description
1.	On September 26 @ 1330 hours official notification received concerning "Completion of Project"

KK) REMARKS (CLIENT REPRESENTATIVE)

No.	Description
1.	

LL) APPROVAL & SIGNATURE

SALVAGE	DAILY PROGRESS REPORT (DPR 96)	Quality Form SSF-001 Revision 2 Page 6 of 6

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SMIT REPRESENTATIVE	
Name	**Position**
Jaco Sluijmers	Sr. Salvage Master
Signature	Digital copy

CLIENT REPRESENTATIVE	
Name	
Signature	

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY - TOTAL

As on 04-Oct-2025

Sl. No.	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Warehouse (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel
1	Thiruvananthapuram	36,925	1,10,143	3,22,239		542	259
2	Kanyakumari	0	25,760	35,440		0	30
3	Rameshwaram	1,325	92,625	43,650		0	105
4	Kollam	0	0	34,808		18	36
		38,250	2,28,528	4,36,137	7,02,914	560	430

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY - THIRUVANANTHAPURAM (As on 04/Oct/2025)

Sl. No.	Date	Type of Site	Location	Segregated (Kgs/Approx.)	Non-segregated (Kg)	Segregated and Transported to Kollam Port (Kg)	Total (Kg)	Remarks	No. of Volunteers	No. of MFRC personnel
1		Static Site	Grove Beach, Kovalam	12.922	741	45.890				
2			Veli Beach	7.251	8.320	26.840				
3			Perumathura Beach	14.119	6.581	48.320				
4			Vizhinjam Harbour	698	1.354	5.270				
	03-07-2025		Kovalam, Pozhiyoor, Vizhinjam, Veli			9.050		Transported 10834 Kg non-segregated and 6027 segregated nurdles into Kollam port.		
			Kovalam, Pozhiyoor, Vizhinjam, Perumathura			9.170				
	11-07-2025		Veli, Perumathura			9.690		Transported 6000 Kg non-segregated and 3690 segregated nurdles into Kollam port.		
	12-07-2025		Kovalam, Perumathura			9.720		Transported 5524 Kg non-segregated and 3196 segregated nurdles into Kollam port.		
	14-07-2025		Kovalam, Perumathura			9.400		Transported 5675 Kg non-segregated and 2735 segregated nurdles into Kollam port.		
	15-07-2025		Kovalam, Veli			9.660		Transported 6574 Kg non-segregated and 2286 segregated nurdles into Kollam port.		
	17-07-2025		Kovalam, Perumathura			9.170		Transported 5302 Kg non-segregated and 4868 segregated nurdles into Kollam port.		
	19-07-2025		Veli			9.650		Transported 6919 Kg non-segregated and 2633 segregated nurdles into Kollam port.		
	21-07-2025		Veli			9.700		Transported 7630 Kg non-segregated and 1870 Kg segregated nurdles into Kollam port.		
	25-07-2025		Veli			9.750		Transported 5500 Kg non-segregated and 3250 Kg segregated nurdles into Kollam port.		
	26-07-2025		Kovalam, Veli			9.170		Transported 5614 Kg non-segregated and 3556 Kg segregated nurdles into Kollam port.		
	28-07-2025		Perumathura Beach			6.520		Transported 6520 Kg segregated nurdles into Kollam port.		
	29-07-2025		Veli Beach			6.170		Transported 5002 Kg unsegregated and 1168 Kg segregated nurdles into Kollam port		
	30-07-2025		Kovalam Beach			6.040		Transported 3955 Kg unsegregated and 2085 Kg segregated nurdles into Kollam port		
	01-08-2025		Perumathura Beach			7.140		Transported 1831 Kg unsegregated and 5309 Kg segregated nurdles into Kollam port		
	02-08-2025		Kovalam Beach			6.710		Transported 6710 Kg segregated nurdles into Kollam port		
	04-08-2025		Veli Beach			6.600		Transported 5738 Kg unsegregated and 862 Kg segregated nurdles into Kollam port		
	07-08-2025		Veli Beach			6.580		Transported 3711 Kg unsegregated and 2859 Kg segregated nurdles into Kollam port		
	09-08-2025		Veli Beach			6.600		Transported 4723 Kg unsegregated and 1877 Kg segregated nurdles into Kollam port		
	11-08-2025		Kovalam Beach			6.170		Transported 1689 Kg unsegregated and 4481 Kg segregated nurdles into Kollam port		
	14-08-2025		Perumathura Beach			3.350		Transported 456 Kg unsegregated and 2894 Kg segregated nurdles into Kollam port		
	14.08.2025		Veli Beach			3.300		Transported 2239 Kg unsegregated and 1061 Kg segregated nurdles into Kollam port		
	18-08-2025		Veli, Leela			6.670		Transported 4988 Kg unsegregated and 1582 Kg segregated nurdles into Kollam port		
	21.08.2025		Veli, Leela			6.190		Transported 5673 Kg unsegregated and 517 Kg segregated nurdles into Kollam port		
	27-08-2025		Veli Beach			6.110		Transported 4711 Kg unsegregated and 1599 Kg segregated nurdles into Kollam port		
	30-08-2025		Perumathura, Leela Beach			9.700		Transported 1877 Kg unsegregated and 6823 Kg segregated nurdles into Kollam port		
	19-09-2025		Veli, Leela, Perumathura Beach			9.750		Transported 1980 Kg unsegregated and 6770 Kg segregated nurdles into Kollam port		
	Before 6...July	Dynamic sites	From dynamic sites		83.215					
5			Cherjuthura Beemapally		705					
6			Thumba		480					
7			Gloria Beach							
8			Somatheeram		0					
9			St. Andrews and St. Michaels Beach		0					
10			Poovar sandbar/poovar south		160					
11			Pozhiyoor beach		645					
12			Shangumugham Beach		0					
13			Vettor Beach		186					
14			Azhvalam Beach							
15			Aadiyirukkam Beach		0					
16			Sannukka Beach	2.035	0					
17			Kottappuram							
18			Kunnuthura		96					
19			Pullavila beach		230					
20			Vettukad		0					
21			Vettukkadu		0					
22			Black Sand Beach, Varkala		0					
23			Papanasham Beach, Varkala		0					
24			Kothickod beach, Varkala		180					
25			Varkala Beach		0					
26			Varkala Cliff		0					
27			Pozhiyoorkara Beach		110					
28			Odayam Beach/Edava		0					
29			Kappil Beach, Varkala		148					
30			Pallam Market		0					
31			Cherjunnattam		6.896					
32			Poonthura Beach		226					
33			Athimala Beach		13					
34			Valiyathura Beach		234					
35			Kochupally Beach		0					
				36.925	1.10.145	3.22.230	4.69.307		542	259

EXECUTIVE SUMMARY: NURDLE WRIGHT RECOVERY- KOLLAM (As on 04-Oct-2025)								
Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated	Segregated and Transported to Kollam port (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel
1	Before 24-06-2025	Thanni	0	0	32,434			
2	Before 24-06-2025	Azheekkal	0	0	675			
3	05-07-2025		0	0	92			
4	07-07-2025		0	0	157			
5	08-07-2025		0	0	100			
6	10-07-2025		0	0	72			
7	11-07-2025		0	0	117			
8	12-07-2025		0	0	0			
9	14-07-2025		0	0	63			
10	15-07-2025		0	0	0			
11	16-07-2025		0	0	0			
12	17-07-2025		0	0	0			
13	18-07-2025		0	0	0			
13	19-07-2025		0	0	0			
14	20-07-2025		0	0	0			
15	21-07-2025		0	0	0			
16	22-07-2025		0	0	0			
17	23-07-2025	Thanni	0	0	78			
18	24-07-2025		0	0	0			
19	25-07-2025		0	0	0			
20	26-07-2025	Thanni	0	0	44			
21	27-07-2025	Thanni	0	0	0			
22	28-07-2025	Thanni	0	0	56			
23	29-07-2025	Thanni	0	0	51			
24	30-07-2025		0	0	0			
25	31-07-2025		0	0	0			
26	01-08-2025	Azheekkal	0	0	139			
27	02-08-2025	Azheekkal	0	0	78			
28	03-08-2025	Azheekkal	0	0	0			
29	04-08-2025	Thanni	0	0	18			
30	05-08-2025	Kappil	0	0	7			
31	06-08-2025	Kappil	0	0	15			
32	07-08-2025	Thanni	0	0	18			
33	08-08-2025	Thanni	0	0	21			
34	09-08-2025	Thanni	0	0	13			
35	10-08-2025	Thanni	0	0	9			
36	11-08-2025	Thanni	0	0	14			
37	12-08-2025	Thanni	0	0	5			
38	13-08-2025	Thanni	0	0	30			
39	14-08-2025	Thanni	0	0	4			
40	15-08-2025	Thanni	0	0	0			
41	16-08-2025	Thanni	0	0	7			
42	17-08-2025	Thanni	0	0	8			
43	18-08-2025	Thanni	0	0	7			
44	19-08-2025	Thanni	0	0	14			
45	20-08-2025	Thanni	0	0	14			
46	21-08-2025	Thanni	0	0	12			
47	22-08-2025	Thanni	0	0	30			
48	23-08-2025	Kappil	0	0	4			
49	24-08-2025	Kappil	0	0	4			
50	25-08-2025	Kappil	0	0	9			
51	26-08-2025	Kappil	0	0	7			
52	27-08-2025	Eravipuram	0	0	21			
53	28-08-2025	Eravipuram	0	0	4			
54	29-08-2025	Eravipuram	0	0	19			
55	30-08-2025	Eravipuram	0	0	11			
56	31-08-2025	Eravipuram	0	0	9			
57	01-09-2025	Eravipuram	0	0	8			
58	02-09-2025	Eravipuram	0	0	7			
59	03-09-2025	Eravipuram	0	0	9			
60	04-09-2025		0	0	0			
61	05-09-2025		0	0	0			
62	06-09-2025		0	0	0			
63	07-09-2025		0	0	0			
64	08-09-2025	Thanni	0	0	6			
65	09-09-2025	Thanni	0	0	10			
66	10-09-2025	Thanni	0	0	13			
67	11-09-2025	Thanni	0	0	9			
68	12-09-2025	Thanni	0	0	16			
69	13-09-2025	Thirumullavaram	0	0	7			
70	14-09-2025	Thirumullavaram	0	0	6			
71	15-09-2025	Thirumullavaram	0	0	8			
72	16-09-2025	Thirumullavaram	0	0	18			
73	17-09-2025	Thirumullavaram	0	0	8			
74	18-09-2025	Pozhikara	0	0	15			
75	19-09-2025	Pozhikara	0	0	15			
76	20-09-2025	Eravipuram	0	0	7			
77	21-09-2025	Eravipuram	0	0	14			
78	22-09-2025	Eravipuram	0	0	11			
79	23-09-2025	Thirumullavaram	0	0	17			
80	24-09-2025	Kappil	0	0	10			
81	25-09-2025	Pozhikara	0	0	15			
82	26-09-2025	Eravipuram	0	0	14			
83	27-09-2025	Eravipuram	0	0	12			
84	28-09-2025	Eravipuram	0	0	8			
85	29-09-2025	Eravipuram	0	0	12			
86	30-09-2025	Thanni	0	0	7			
87	01-10-2025	Thirumullavaram	0	0	7			
88	02-10-2025	_	0	0	0			
89	03-10-2025	Pozhikara	0	0	15			
90	04-10-2025	Paravur	0	0	15			
			0	0	34,808	34,808	18	36

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY - KANYAKUMARI (As on 04-Oct-2025)

Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Jeppiaar Fishing Harbour (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel	Remarks
1	26-06-2025	Kilkyoor, Thengapattanam			28,250				
2	06-07-2025	Jeppiar Harbour							
3	07-07-2025	Jeppiar Harbour							
4	08-07-2025	Jeppiar Harbour		25					
5	09-07-2025	Thengapattanam and Kanyakumari							
6	10-07-2025				3,175				127 bags of pure segregated nurdles (3175 Kg) collected from 22nd June till 10th July were transferred to the authorities.
7	11-07-2025		0		150				
8	12-07-2025		0	400	125				
9	13-07-2025		0	480	70				
10	14-07-2025		0	500	100				
11	15-07-2025		0	380	125				
12	16-07-2025		0	560	70				
13	17-07-2025		0	575	100				
14	18-07-2025		0	600	50				
15	19-07-2025		0	600	75				
16	20-07-2025		0	0	125				
17	21-07-2025		0	480	125				
18	22-07-2025		0	760	100				
19	23-07-2025		0	600	125				
20	24-07-2025		0	740	125				
21	25-07-2025		0	700	100				
22	26-07-2025		0	640	100				
23	27-07-2025		0	600	0				
24	28-07-2025		0	600	150				
25	29-07-2025		0	580					
26	30-07-2025		0	460					
27	31-07-2025		0	420	125				
28	01-08-2025		0	100					
29	02-08-2025		0	575					
30	03-08-2025		0	0	125				
31	04-08-2025		0	400					
32	05-08-2025		0	350					
33	06-08-2025		0	420					
34	07-08-2025		0	420	100				
35	08-08-2025		0	440	100				
36	09-08-2025		0	420					
37	10-08-2025		0	340					
38	11-08-2025		0	200	125				
39	12-08-2025		0	160	0				
40	13-08-2025		0	160	0				
41	14-08-2025		0	320	75				
42	15-08-2025		0	0	0				
43	16-08-2025		0	700	0				
44	17-08-2025		0	450	0				
45	18-08-2025		0	600	0				
46	19-08-2025		0	460	225				
47	20-08-2025		0	360	375				
48	21-08-2025		0	250	75				
49	22-08-2025		0	260	0				
50	23-08-2025		0	250	0				
51	24-08-2025		0	200	0				
52	25-08-2025		0	100	225				Segregation happens at Jeppiar Harbour only. Segregated and transported to Jeppiar Harbour means these are segregated and are ready to be handed over to the authorities. Whenever they are handed over, it will be updated.
53	26-08-2025		0	200	0				
54	27-08-2025		0	200	0				
55	28-08-2025		0	120	100				
56	29-08-2025		0	120	0				
57	30-08-2025		0	140	0				
58	31-08-2025		0	100	0				
59	01-09-2025		0	120	0				
60	02-09-2025		0	120	0				
61	03-09-2025		0	100	0				
62	04-09-2025		0	140	0				
63	05-09-2025		0	0	0				
64	06-09-2025		0	0	0				
65	07-09-2025		0	0	0				
66	08-09-2025		0	100	0				
67	09-09-2025		0	160	0				
68	10-09-2025		0	160	0				
69	11-09-2025		0	150	75				
70	12-09-2025		0	120	0				
71	13-09-2025		0	150	0				
72	14-09-2025		0	200	0				
73	15-09-2025		0	140	0				
74	16-09-2025		0	160	0				
75	17-09-2025		0	140	0				
76	18-09-2025		0	180	175				
77	19-09-2025		0	200	0				
78	20-09-2025		0	120	0				
79	21-09-2025		0	140	0				
80	22-09-2025		0	200	0				
81	23-09-2025		0	400	0				
82	24-09-2025		0	325	0				
83	25-09-2025		0	200	200				
84	26-09-2025		0	320	0				
85	27-09-2025		0	320	0				
86	28-09-2025		0	200	0				
87	29-09-2025		0	240	0				
88	30-09-2025		0	180	0				
89	01-10-2025		0	220	0				
90	02-10-2025		0	180	200				
91	03-10-2025		0	120	0				
92	04.10.2025		0	160	0				After segregation at Jeppiar Fishing Harbour, the sand debris is being removed which accounts for the decrease in weight. The weight of segregated nurdles will be updated after bagging is complete
			0	25,760	35,440	61,200	0	30	

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY - RAMESHWARAM (As on 04-Oct-2025)

Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Vadakode (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel	Remarks
1		Dhanushkodi		0	1,400				
2	06-07-2025	Dhanushkodi			800				
3	07-07-2025	Dhanushkodi			1,150				
4	08-07-2025	Dhanushkodi			2,375				
5	10-07-2025				1,150				
6	11-07-2025				875				
7	12-07-2025			361.4	750				
8	13-07-2025			1488.5	1,200				
9	14-07-2025			1669	1,100				
10	15-07-2025			1894	1,325				
11	16-07-2025			1745.2	1,150				
12	17-07-2025			2164.1	1,150				
13	18-07-2025			2210.05	1,275				
14	19-07-2025			2157.72	1,325				
15	20-07-2025		1,325	1965.8	1,300				
16	21-07-2025			2127.5	1,325				
17	22-07-2025			2230.7	1,325				
18	23-07-2025			2216.6	900				
19	24-07-2025		0	0	0				
20	25-07-2025		0	2278.05	825				
21	26-07-2025		0	2284	2,100				
22	27-07-2025		0	2335					
23	28-07-2025		0	2242					
24	29-07-2025		0	2080					
25	30-07-2025		0	1985					
26	31-07-2025		0	1763					
27	01-08-2025		0	1320					
28	02-08-2025		0	1143	1,050				
29	03-08-2025		0	1081	0				
30	04-08-2025		0	969	0				
31	05-08-2025		0	1015	0				
32	06-08-2025		0	1068	2,125				
33	07-08-2025		0	1019					
34	08-08-2025		0	1074					
35	09-08-2025		0	1076					
36	10-08-2025		0	968	25				
37	11-08-2025		0	1004					
38	12-08-2025		0	1073					
39	13-08-2025			1022	900				
40	14-08-2025		0	1077	1,050				
41	15-08-2025		0	0	0				
42	16-08-2025		0	1041	0				
43	17-08-2025		0	956	0				
44	18-08-2025		0	937	0				
45	19-08-2025		0	912					
46	20-08-2025		0	918	3,275				
47	21-08-2025		0	911	0				
48	22-08-2025		0	972	0				
49	23-08-2025		0	854	400				
50	24-08-2025		0	750	0				
51	25-08-2025		0	798	0				
52	26-08-2025		0	765	0				
53	27-08-2025		0	485	0				
54	28-08-2025		0	589	0				
55	29-08-2025		0	593	1,950				
56	30-08-2025		0	782	100				
57	31-08-2025		0	724	0				
58	01-09-2025		0	953	0				
59	02-09-2025		0	745	0				
60	03-09-2025		0	764	0				
61	04-09-2025		0	710	0				
62	05-09-2025		0	898	0				
63	06-09-2025		0	758	0				
64	07-09-2025		0	816	0				
65	08-09-2025		0	757	0				
66	09-09-2025		0	812	5,000				200 bags collected and cleaned from municipal office
67	10-09-2025		0	838	675				
68	11-09-2025		0	849	0				
69	12-09-2025		0	905	0				
70	13-09-2025		0	956	0				
71	14-09-2025		0	882	0				
72	15-09-2025		0	835	425				
73	16-09-2025		0	863	0				
74	17-09-2025		0	425	0				
75	18-09-2025		0	729	0				
76	19-09-2025		0	921	0				
77	20-09-2025		0	829	875				
78	21-09-2025		0	932	0				
79	22-09-2025		0	781	0				
80	23-09-2025		0	851	425				
81	24-09-2025		0	994	0				
82	25-09-2025		0	470	0				
83	26-09-2025		0	882	0				Transported 2330 Kg of sand back to the beach
84	27-09-2025		0	966	0				
85	28-09-2025		0	849	0				
86	29-09-2025		0	793	0				Transported 4080 Kg of sand back to the beach
87	30-09-2025		0	733	0				
88	01-10-2025		0	838	575				
89	02-10-2025		0	801	0				
90	03-10-2025		0	677	0				
91	04-10-2025		0	718	0				After segregation at Vadacode, the sand is being transferred back to the beach, which accounts for the decrease in weight. The weight of segregated nurdles will be updated after bagging is complete
			1,325	92,625	43,650	1,37,600	0	105	

Marine Casualty Involving MV MSC ELSA 3 (IMO 9123221) – Request for Investigation and Cooperation

DGCOMMCENTRE DG SHIPPING MUMBAI < dgcommcentre-dgs@nic.in >

Sun, 25 May 2025 12:54:11 +0530

To "investigations"<investigations@liscr.com>

Cc "Shyam Jagannathan"<dg-dgs@gov.in>,"Abul Kalam Azad" <abulkalam.azad@gov.in>,"Anish Joseph"<anish-dgs@gov.in>,"Daniel John Joseph"<danieljohn-dgs@gov.in>,"Capt.Harindar Singh" <singh.harinder@gov.in>,"Control Room"<controlroom-mopsw@gov.in>,"Control Room"<controlroom-mopsw@nic.in>,"Madhav Patil"<madhavpatil.dgs@gov.in>

MSG E-3083
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Maritime Authority of Liberia

Dear Sir/Madam,

Greetings from the Directorate General of Shipping, Indian Maritime Administration.

We write to formally notify your esteemed Administration of a very serious marine casualty involving the container vessel MSC ELSA 3 (IMO No. 9123221), managed by MSC Ship Management Ltd., and to request your cooperation in the matter.

On 24 May 2025, while transiting from Vizhinjam to Cochin, the vessel developed a severe starboard list approximately 30 nautical miles southwest of Kochi Port, at position 09°30.1’N / 075°46.638’E. By 1515 IST, the list had increased to 30 degrees and reached a temporary state of equilibrium. The Indian Coast Guard immediately initiated aerial surveillance and life-saving efforts, supported by Indian Navy units.

Of the 24 crew members, 21 were safely evacuated. The remaining 3 crew members, who initially stayed on board in connection with salvage coordination, were subsequently evacuated on 25th May and confirmed safe. Although no ingress of water, fire, or pollution was observed, the listing rendered certain life-saving appliances inaccessible, requiring emergency aerial deployment of additional equipment.

Following directives from Indian authorities, the vessel’s owners engaged professional salvors and appointed technical experts to assess the situation and implement pollution prevention measures.

Regrettably, on 25 May 2025 at 0750 IST, the vessel sank at position 09°18.75'N / 076°08.16'E, approximately 13 nautical miles off the Kerala coast.
In view of the potential environmental and navigational hazards arising from:
• Containers adrift, including 13 IMDG Class 4.3 (Calcium Carbide) units, and

• The presence of 367 tonnes of heavy fuel oil and 64 tonnes of diesel oil,

We kindly request the Maritime Authority of Liberia to instruct the owners to:
1. Ensure all necessary pollution prevention measures are implemented without delay,
2. Submit a retrieval plan for the adrift containers, especially those containing hazardous cargo,
3. Initiate arrangements for the removal of the wreck, and
A formal notice under Section 356-J of the Indian Merchant Shipping Act, 1958 (as amended) was issued by MMD Kochi to the General Manager, MSC Ship Management, via email on 24 May 2025 at 1817 IST.

India, as the concerned coastal State, will be conducting an independent investigation into the casualty. We request confirmation as to whether the Liberian Flag Administration intends to participate or coordinate in the said investigation.

We look forward to your cooperation and timely response on this important matter.

Sincerely,
Capt. Harinder Singh
Nautical Surveyor & Deputy Director General (Technical)
Directorate General of Shipping
Government of India

Best Regards,
DG(S)Commcentre
Directorate General of Shipping,
Tel# +91-22-22614646, +91-22-22610606
Fax# +91-22-22613636
Mob.+91 8657549760/+91 9869065444
Email: dgcommcentre-dgs@nic.in, dgcommcentre-ssas@lrit.gov.in

भारत सरकार/ GOVERNMENT OF INDIA
पत्तन,पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
नौवहन महानिदेशालय, मुंबई
DIRECTORATE GENERAL OF SHIPPING, MUMBAI

File No: 25-35011/1/2025-NT - DGS **Date**: 30.05.2025

NOTICE UNDER SECTION 356(J) OF MERCHANT SHIPPING ACT, 1958 AND ARTICLE 9 OF THE NAIROBI INTERNATIONAL CONVENTION ON THE REMOVAL OF WRECKS 2007

Subject: Sinking of the vessel *MSC ELSA 3* (IMO no.: 9123221, Flag: Liberia) at position Lat 09, 18' 50.022N, Long 76, 07' 58.967 E – reg.

Whereas, the container vessel *MSC ELSA 3* (IMO no.: 9123221, Flag: Liberia), owned and operated by Mediterranean Shipping Co SA, chemin Rieu, 12-14, 1208, Geneva, Switzerland and managed by MSC Ship management Ltd., Cyprus, developed a severe starboard list while enroute from Vizhinjam to Kochi, about 30 nautical miles southwest of Kochi Port.

Accordingly, a notice under Section 356-J of the Merchant Shipping Act, 1958, dated 24.05.2025, has already been issued by the Mercantile Marine Department (MMD), Kochi to take immediate action to prevent the likely escape of oil from the vessel into the sea due to severe listing.

Whereas, the vessel *MSC ELSA 3*, capsized and sank on 25.05.2025 at approximately 0750 hrs, off the Kerala coast at position Lat 09, 18' 50.022N, Long 76, 07' 58.967 E. And whereas the said vessel has sunk and is currently discharging oil into the marine environment, thereby posing a potential and serious threat of pollution to the Indian Exclusive Economic Zone and its coastline.

It is further noted that the vessel was laden with containerised cargo, including dangerous goods classified under Class 4.3 and Class 9 under the International Maritime Dangerous Goods (IMDG) Code, in addition to other environmentally sensitive cargo such as plastic nurdles, which pose a severe risk to the marine ecosystem.

Furthermore, it has also come to the attention of this Directorate that multiple containers have detached from the vessel and are now possibly scattered on the seabed, rendering the sea area a navigational hazard. In addition, some containers and their contents have been observed to have drifted away from the sunken vessel and/or reached the coastlines of Kerala and Tamil Nadu.

This situation necessitates immediate and effective remedial action, including salvage operations for removal of the sunken ship, removal of the oil from the ship, recovery of the cargo of containers and contents, and the proper and environmentally compliant disposal, in order to mitigate further risk to marine safety and the coastal environment.

Now, therefore, in exercise of the powers conferred under Section 356-J of the Merchant Shipping (MS) Act, 1958, the Directorate General of Shipping hereby directs the Master, Owner, Agent, Charterer, Managers, and Operators of the said vessel to undertake all necessary and immediate measures to prevent, contain, and mitigate pollution of the Indian waters and coastline resulting from the sinking of *MSC Elsa 3*.

In pursuance of **Section 356-J(2) of the MS Act**, and **Article 9 of the Nairobi International Convention on the Removal of Wrecks 2007** (Nairobi Convention) on the *'measures to facilitate the removal of wrecks'*, the following actions, among others as may be deemed necessary, shall be undertaken without delay, and with due regard to prevailing environmental standards and maritime and other safety protocols:

1. Initiation of action for the removal of the sunken vessel, including all on-deck and under-deck containerised cargo, located at position Lat 09° 18' 50.022" N, Long 76° 07' 58.967" E;
2. Deployment of resources for the removal of oil slicks observed on the sea surface;
3. Execution of appropriate and environmentally safe measures to disperse oil slicks on the surface of the sea;
4. Implementation of containment measures to prevent further escape of oil from the sunken vessel;
5. Safe and effective removal of any remaining oil contained within the vessel;
6. Recovery of containers, including those with IMDG cargo that have become detached and are presently resting on the seabed;
7. Removal of containers and debris, including those with IMDG cargo that are floating or have drifted ashore along the Indian coastline;
8. Collection and disposal of cargo that has been spilled into the marine environment or washed ashore, including hazardous or potentially polluting substances; and
9. Immediate removal of plastic nurdles across stretches of shoreline, with due care taken to prevent further harm to the marine ecosystem.

The concerned parties are hereby instructed to inform this Directorate of the status of actions undertaken at the earliest and to provide timely and regular updates to all relevant authorities until the completion of all remedial measures.

This notice is issued with the approval of the Competent Authority.

Yours faithfully,

(Capt. Anish Joseph)
Dy. Nautical Advisor -cum-
Sr. Dy. Director General (Tech)
Directorate General of Shipping, Mumbai

To,

1. **The Master of the vessel MSC Elsa 3** (IMO no.: 9123221).
2. **The Ship Owner & Operator –** Mediterranean Shipping Co SA, chemin Rieu, 12-14, 1208, Geneva, Switzerland.
3. **The Ship Managers -** MSC SHIP MANAGEMENT LIMITED, MSC House, 8 Spyrou Kyprianou Avenue, Limassol, CY-3070, Cyprus. Kind Attn: Capt. Manish Ashok Gupta, General Manager- (Safety, Quality & Insurance)/ DPA,
4. **Protection & Indemnity (P&I) Insurers of the vessel -** NorthStandard, 100, The Quayside, Newcastle upon Tyne, NE1 3DU, United Kingdom. Kind Attn: Gillian Clark.
5. **The Flag State Administration -** Deputy Commissioner of Maritime Affairs, Republic of Liberia, 22980 Indian Creek Drive, Suite 200 Dulles, Virginia 20166 USA

Copy to:

1. **Kerala State Government -** Office of the Chief Secretary, Government of Kerala, Secretariat, Thiruvananthapuram - 695001.
2. **Tamil Nadu State Government -** Office of the Chief Secretary, Government of Tamil Nadu, Secretariat, Chennai - 600009.
3. **Kerala State Maritime Board -** Chief Executive Officer, Kerala Maritime Board, HO TC XXII/1666 (4&5), 1st Floor, Mulamoottil Building Pipinmoodu, Sasthamangalam Thiruvananthapuram, Kerala – 695010.

4. **Tamil Nadu State Maritime Board -** Chief Executive Officer, Tamil Nadu Maritime Board, No. 171, South Kesavaperumal Puram, Off Greenways Road, Raja Annamalaipuram, Chennai - 600 028.
5. **Kerala State Disaster Management Authority** (KSDMA) **-** Commissioner, Disaster Management, Vikas Bhavan, PO, Observatory Hills, opposite Kanakakkunnu Palace, Nanthancodu, Thiruvananthapuram, Kerala 695033.
6. **Tamil Nadu State Disaster Management Authority** (TNSDMA) **-** Commissioner, Disaster Management, Commissionerate of Revenue Administration Exhilagam, Chepauk, Chennai-5.
7. The **Nautical Advisor** to the Govt of India, Directorate General of Shipping, Mumbai.
8. The **Chief Surveyor** with the Govt. of India, Directorate General of Shipping, Mumbai.
9. The **Chief Ship Surveyor** with the Govt. of India, Directorate General of Shipping, Mumbai.
10. **MMD, Kochi -** Principal Officer, Mercantile Marine Department, Willingdon Island, Kochi, Kerala 682009.
11. **Indian Coast Guard -** MRCC, Mumbai, Hqrs Coast Guard Region (West), Worli Sea Face, Post – Worli Colony, Mumbai – 400 030. Kind Attn: The Officer-in-Charge.
12. **Recognised organisation of the vessel -** Bureau Veritas Marine Division (BV) , Reg Off:72, Business Park, 3rd Floor Marol Industrial Area, MIDC Cross Road, Andheri East, Mumbai – 400 093.
13. **Salvors -** T&T SALVAGE ASIA, PTE LTD, No. 29 Tuas Avenue 4, Singapore 639379.
14. The Chairman, **Cochin Port Authority**, Willingdon Island, Kochi, Kerala 682009.

भारत सरकार/ GOVERNMENT OF INDIA
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
नौवहन महानिदेशालय, मुंबई
DIRECTORATE GENERAL OF SHIPPING, MUMBAI

File No.: 25-35011/1/2025-NT-DGS **Dated: 05.08.2025**

To,
Margaret C. Ansumana,
Deputy Commissioner of Maritime Affairs, R.L.,
Liberian Maritime Authority,
Congo Town, Opposite Ministerial Complex,
Liberia

Sub: Request for Response and Action Regarding Wreck Removal of MSC ELSA 3 – reg.

Sir,

I am directed to refer to our earlier communication dated 25.05.2025, addressed to the Maritime Authority of Liberia in its capacity as the Flag State of the sunken vessel *MSC ELSA 3*. The letter had formally requested the Flag Administration to direct the Owners of the vessel to carry out the following:

i. To ensure that all necessary pollution prevention measures are implemented without delay,
ii. To submit a retrieval plan for adrift containers, particularly those containing hazardous materials, and
iii. To initiate appropriate arrangements for the removal of the wreck of the sunken vessel.

2. While we acknowledge the immediate response of the flag state to carry out the investigation and appointment of R.I. Mr. Vinod Vijaymohan as the investigating officer in this regard, however, the formal response or action has yet to be communicated with respect to the initiation of wreck removal operations.

3. Kind reference is also invited to this Directorate's notice dated 30.05.2025 issued under Section 356-J of the Merchant Shipping Act, 1958 and Article 9 of Nairobi International Convention on the Removal of Wrecks, 2007 (Nairobi Convention). The said notice emphasised that the wreck of *MSC ELSA 3* lies off the Kerala coast within India's Exclusive Economic Zone (EEZ), and poses ongoing concerns related to navigational safety, potential environmental hazards, and marine pollution. Given the gravity of the matter and the responsibilities of the Flag Administration under applicable international conventions, including the Nairobi Convention, the urgent attention and reply on this specific issue are respectfully solicited.

4. It is therefore requested that the Liberian Maritime Authority urgently take cognizance of this matter and issue necessary instructions to the owners/managers of *MSC ELSA 3* to commence coordination with Indian authorities for planning and execution of wreck removal operations at the earliest.

05/08/25

5. A prompt response in this regard will be highly appreciated, to ensure continued cooperation and effective action in the interest of maritime safety and environmental protection.

This is issued with the approval of the Competent Authority.

Yours faithfully,

05/08/25

(Capt. Anish Joseph)
Deputy Nautical Adviser -cum-
Sr. Dy. Director General (Tech.)

Enclosure: As above.

Copy to,

1. The **Master** of the vessel MSC Elsa 3 (IMO no.: 9123221).
2. The **Ship Owner & Operator** – Mediterranean Shipping Co SA, chemin Rieu, 12-14, 1208, Geneva, Switzerland.
3. The **Ship Managers** - MSC SHIP MANAGEMENT LIMITED, MSC House, 8 Spyrou Kyprianou Avenue, Limassol, CY-3070, Cyprus. Kind Attn: Capt. Manish Ashok Gupta, General Manager- (Safety, Quality & Insurance)/ DPA,
4. **Protection & Indemnity (P&I) Insurers** of the vessel - NorthStandard, 100, The Quayside, Newcastle upon Tyne, NE1 3DU, United Kingdom. Kind Attn: Gillian Clark.
5. **MMD, Kochi** - Principal Officer, Mercantile Marine Department, Willingdon Island, Kochi, Kerala 682009.
6. **Recognised Organisation of the vessel** - Bureau Veritas Marine Division (BV) , Reg Off:72, Business Park, 3rd Floor, Marol Industrial Area, MIDC Cross Road, Andheri East, Mumbai – 400093.

Liberia Maritime Authority
1948 Maritime Drive
Congo Town
1000 Monrovia , 10 Liberia
P.O BOX 10-9042

September 18, 2025

Government of India
Attn: Capt. Anish Joseph, Deputy Nautical Adviser
Ministry of Ports, Shipping and Waterways
Directorate General of Shipping
Mumbai, India

RE: MSC ELSA 3 (IMO No. 9123221)

Dear Capt. Anish Joseph,

The Liberian Maritime Authority ("LiMA") presents its compliments to the Ministry of Ports, Shipping, and Waterways, Directorate General of Shipping, India. LIMA values the spirit of collaboration that underpins our shared responsibilities as Flag and Coastal States.

LiMA acknowledges with appreciation the receipt of your communication concerning the sinking of the Liberian flagged vessel MSC ELSA 3 (IMO No. 9123221) off the Kerala Coast at position Lat 09°18′50.022″N, Long 76°07′58.967″E. LiMA assures you of its full cooperation in the salvage operations, including wreck removal, and in measures aimed at the protection of the marine environment.

Should you require any further assistance, LiMA is fully engaged and remains at your disposal at all times.

LiMA avails itself of this opportunity to renew to the Directorate General of Shipping, India, the assurances of its highest consideration.

Yours faithfully.

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Margaret Ansumana
Senior Deputy Commissioner of Maritime Affairs
Republic of Liberia

Directorate General of Shipping

SITREP – 25, 1800 hrs on 17/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

As of 16 June 2025, the SEAMAC III has been demobilised and is proceeding to Mumbai. Air-diving equipment is being removed, and the vessel has vacated operations after completing the capping and plugging of the identified fuel oil tanks. Preparations are now underway to transition to the next phase involving saturation diving operations. The alternate vessel to Nand Saarthi (NS), *Canara Megh*, currently stationed in Mumbai, is being readied to take over from NS. Once formalities and bunkering are completed, she will sail to Kochi for mobilisation.

At present, *Nand Saarthi* remains at Kochi port due to prevailing adverse sea conditions. Upon improvement in weather, it will sail to the wreck site. Oil recovery equipment onboard *Nand Saarthi* is to be transferred to *Canara Megh* for the next phase. All accessories and gases remain available and are being held for deployment once the new contractor takes over.

Onshore, MERC has continued container recovery activities at Kollam, focusing on submerged containers using divers. Beach cleanup operations continue across Trivandrum with approximately 160 volunteers deployed. However, cleanup work was slower on the previous day due to intermittent rain. At Rameshwaram, a team of 22 members remains engaged at the site. In Kanyakumari, while weather halted active cleaning, the transfer of collected nurdles to centralised storage continues.

The Indian Coast Guard (ICG) has conducted aerial sorties using Dornier aircraft equipped with Pollution Surveillance Systems (PSS). No oil slick was observed approximately 60 NM from the wreck site. Additional sorties are planned to continue monitoring the situation.

4. Situation Assessment:

The salvage operations have now transitioned into a standby/care-taking phase pending the mobilisation of the new contractor. The timeline for saturation diving operations is currently under revision, considering the peak monsoon conditions and associated operational and environmental risks. The current weather patterns present a narrow and fragmented working window, making it unsuitable for stable and safe oil extraction efforts. Further delay would provide a more reliable window to safely conduct hot tapping and oil recovery.

T&T has confirmed that critical diving systems and consumables, including Helios gases, are being preserved for transfer to the new platform. DG Shipping has instructed finalisation of alternate contractor onboarding and has directed MSC and P&I Club to submit a revised operational plan with updated and weather-adjusted timelines.

The disposal and handling of plastic nurdles remains a concern. Customs authorities have requested treating the recovered nurdles as bonded cargo. Approximately 65–75 tons are now stored shore-side, awaiting a final disposal decision. The DG Shipping has reiterated the need for an SOP that balances environmental safety with regulatory compliance. ITOPF has confirmed that recovered nurdles include varying polymer grades, posing challenges to standardised disposal methods.

ICG continues to maintain regular surveillance. Satellite imagery from ITOPF is awaited to confirm shoreline and offshore oil traces. The air sorties and continuous coastal vigilance, in combination with onshore cleanup efforts, have been instrumental in monitoring post-wreck environmental impacts.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 26, 1800 hrs on 18/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The tug *Nand Saarthi* remains in Kochi, monitoring the wreck site. No oil sheen or leakage has been observed in the vicinity. The air-diving operations have concluded, and all fuel oil tanks onboard MSC Elsa 3 have been successfully capped. SEAMEC III is being demobilised and is scheduled to depart Kochi Port for Mumbai on 19 June, following the offloading of equipment and scheduled bunkering.

Canara Megh, the designated replacement tug, remains anchored off Mumbai due to adverse weather. Bunkering and provisioning have been delayed, and efforts are being made to find alternate sheltered locations to expedite operations. The estimated timeline for *Canara Megh*'s arrival in Kochi is 24–26 June, subject to weather improvement and successful fuelling. The tug will be deployed for guarding and response duties during the upcoming saturation diving operations.

Onshore, cleanup activities are ongoing in Trivandrum, Kollam, and Rameshwaram. At Kollam, submerged container recovery is underway, with diving teams mobilised to retrieve four remaining containers. One additional container door was recovered and delivered to port. In Trivandrum and Kollam, volunteers continue shoreline cleaning operations, while in Rameshwaram, senior MERC personnel have been deployed to coordinate efforts. Re-stranding of nurdles continues to be observed, with MERC

proceeding under the assumption that these are associated with the MSC Elsa 3 incident.

4. Situation Assessment:

The salvage operation has now entered a transition phase. T&T Salvage is demobilising assets, and a new contractor is being onboarded by MSC and the P&I Club to undertake the critical phase of oil extraction. BMC Consultants confirmed that the draft contract with SMIT Salvage has been received and is under final review, along with the caretaker plan for the wreck site. Once finalised, these will be shared with all stakeholders. The transition is expected to be completed within the next week, subject to weather and asset readiness.

Given the onset of peak monsoon conditions and forecasted sea state, stakeholders have advised deferring full-scale saturation diving operations. This decision has been made to minimise risk to divers, prevent secondary pollution during extraction, and ensure the integrity of fuel transfer hoses from depth. Temporary storage of Heliox gases and diving equipment has been arranged in Kochi, with intent to repurpose these for the upcoming operations.

The Directorate General of Shipping continues to lead coordination efforts through daily reviews, inter-agency liaison, and regulatory oversight. Close cooperation is ongoing with the Indian Coast Guard, which confirmed via aerial sorties that no new oil sheens were observed. ITOPF is continuing to support technical assessments and has committed to sharing satellite imagery of the affected coastline for monitoring purposes. The P&I Club remains engaged in supporting the transition logistics and claims management.

A final disposal mechanism for the recovered plastic nurdles is pending confirmation. Discussions between MERC, Customs, and ITOPF are underway to determine whether the material will be treated as cargo to be returned to the owners or processed through authorised recycling channels. A formal SOP is being developed in this regard.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 27, 1800 hrs on 19/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Monitoring and surveillance efforts at the wreck site of MSC ELSA 3 continue. Tug *Nand Saarthi* remains deployed at the wreck position and has reported the presence of a light rainbow sheen in the vicinity of the vessel, approximately 50 metres wide and 1 kilometre in length, dissipating naturally thereafter. No recoverable oil has been observed. Based on prior dive inspections, all fuel oil tanks and vents have been capped and sealed. No structural damage or significant deformation was noted on the vessel hull during the earlier operations. The current light sheen is assessed to be the result of residual contamination from mechanical spaces such as the engine room or crane assemblies, and is expected to continue dissipating naturally over time due to flushing by sea action.

The air diving phase has been formally concluded, with *SEAMAC III* departing Kochi Port at 0930 hrs today for Mumbai. The saturation diving system equipment and gases have been safely offloaded and stored. The replacement tug *Canara Megh*, which is to take over guard and response duties at the wreck site, remains anchored off Mumbai due to adverse weather. Following intervention by DGS, Mumbai Port has agreed to allow the vessel to berth for bunkering. Once weather permits and bunkering is complete, the tug is expected to depart for Kochi, with an ETA of 4–5 days.

Shoreline clean-up operations continue at Trivandrum, Kollam, and Kanyakumari. Submerged container retrieval is ongoing at Kollam under challenging weather conditions. Diving teams have been deployed to attach rigging to submerged broken containers during low tide windows. A total of 61 containers have been recovered to port to date, with 4 submerged containers under active salvage. Trivandrum continues to face a shortage of volunteers, with only 190 presents against a minimum requirement of 250. Efforts are being made to address this shortfall with the local administration.

A formal SOP has been issued, in coordination with Customs, for temporary storage of nurdles. Approximately 450 bags have been deposited in a designated warehouse at Kollam Port. The nurdles are being treated as cargo and will be handled accordingly under customs oversight.

Indian Coast Guard continues aerial surveillance over the wreck site. A sortie undertaken on 18 June at 0930 hrs reported no significant oil sheen. Another surveillance flight was scheduled for 1700 hrs today. No ICG surface assets are currently stationed at the wreck position, but vessels are on standby at Kochi.

MSC and the P&I Club have confirmed that formal arrangements are being finalised for transitioning to a new contractor for saturation diving and fuel extraction. The tentative start date for oil recovery operations will be communicated at the earliest, with detailed plans and a revised timeline to be submitted by MSC/Brand Marine Consultants within 48 hours.

4. Situation Assessment:

The light sheen observed around the MSC ELSA 3 wreck continues to be monitored. It is not associated with any active fuel leakage from sealed tanks, and is likely the result of residual contamination from engine spaces or machinery areas. Natural dissipation is expected, and no immediate intervention is warranted at this stage. Continued surveillance will be maintained by *Nand Saarthi* and periodic aerial sorties by the ICG.

The demobilisation of *SEAMAC III* marks the completion of the initial phase of capping and air diving. Preparations are underway to bring in *Canara Megh* as the new tug under charter from MERC, with fuel extraction operations to commence under a new

salvage contractor. The situation remains stable, but continued delays in operational mobilisation pose reputational and environmental risks, especially with monsoon intensifying.

Onshore, MERC is progressing with clean-up and recovery under weather constraints. The clean-up operations at affected beaches are continuing, but the shortfall in volunteer mobilisation remains a concern. Deployment of dedicated resources has helped sustain momentum. Temporary storage arrangements for recovered nurdles have been established in consultation with Customs, and formal handovers are being coordinated.

Daily inter-agency coordination led by the Directorate General of Shipping continues, involving all key stakeholders including MSC, P&I, MERC, ICG, ITOPF, and salvage consultants. Efforts remain focused on maintaining on-site surveillance, ensuring smooth contractor transition, and sustaining coordinated response operations both offshore and onshore.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 28, 1800 hrs on 20/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Patrol and surveillance operations at the wreck site continue through Tug Nand Saarthi, which has resumed offshore duties after a temporary port call for crew rotation and supplies. The vessel is maintaining observation on-site. Weather remains a significant constraint, and temporary visibility of oil sheen has been attributed to residual pollutants from machinery spaces and structural crevices.

SEAMEC III has departed from Kochi Port on the morning of 20 June 2025 and is en route to Mumbai for demobilisation. All diving-related equipment is being offloaded. The Heliox gas cylinders have been secured and stored by MSC at a designated yard for use in future diving operations by the incoming contractor.

Canara Megh, the identified replacement tug, has completed bunkering as of late evening on 19 June at Mumbai anchorage. Weather permitting, the vessel will depart shortly for Kochi. Upon arrival, it will embark oil spill response equipment and take over patrolling duties from Nand Saarthi.

Onshore, container recovery operations are progressing at Kollam, where MERC has deployed dive teams to extract submerged containers. One container is currently being retrieved. Simultaneously, beach cleanup and nurdle collection efforts are underway across affected districts. At Trivandrum, 190 volunteers have been deployed with assurances from the District Collector to increase this number to 300–350 from

21 June. Similar operations continue at Kanyakumari and Rameshwaram. Approximately 75 tonnes of nurdles have been collected and are being prepared for relocation to Kollam Port for storage and customs processing. An agreement for temporary warehousing is being finalised to enable smooth logistical handover and further disposal planning.

4. Situation Assessment:

The wreck remains stable on the seabed, with no structural deformations observed that would indicate large-scale fuel breaches (assessment done during air dive operations). The visible oil sheen is considered to be the result of residual machinery oil and other pollutants naturally seeping from onboard equipment and fixtures, not from the fuel tanks, all of which were capped during earlier diving operations. These sheens are light, not recoverable, and expected to dissipate through natural weathering processes. Daily surveillance is being undertaken by Nand Saarthi, and additional aerial sorties are being conducted by the Indian Coast Guard. No major oil slicks have been reported.

The operational transition from T&T Salvage to a new contractor is underway. Brand Marine Consultants, overseeing the transition, have confirmed that contracting with SMIT Salvage is in its final stages. The formal oil removal plan and timelines will be communicated once the contract is signed. Tentatively, commencement of saturation diving operations for oil extraction will be indicated upon signing of contract which again will be subject to weather and readiness of resources.

The Directorate General of Shipping continues to coordinate all activities with Indian Coast Guard, State Authorities, Shipowners, Salvors, MERC, P&I Club and other stakeholders through daily monitoring and inter-agency meetings. All environmental protection and pollution mitigation measures are being prioritised. Updates on recovery efforts and beachside contamination continue to be compiled for tracking and regulatory purposes.

The situation remains under active monitoring, and the readiness for escalation of operational measures continues in parallel with stakeholder engagement. Further updates will follow.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 29, 1800 hrs on 23/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Tug Nand Saarthi remains deployed at the wreck site, carrying out patrols and monitoring operations. The latest reports confirm the presence of a light rainbow sheen around the wreck, covering an approximate area of 1 kilometre by 50 metres. The sheen is observed to dissipate naturally beyond this range, and no significant changes have been reported in the past 48 hours. SEAMAC III departed Kochi port this morning and is currently en route to Mumbai for off-hiring, with arrival expected by 24 June 2025.

The replacement tug, Canara Megh, departed Mumbai this morning following weather-induced delays. The vessel is expected to reach Kochi by 28 June 2025, where MERC personnel will board and the vessel will take over caretaking duties from Nand Saarthi, subject to operational readiness and favourable conditions.

Onshore, agreements have been finalised with relevant authorities for the storage of recovered nurdles at Kollam Port and Vizhinjam Port. Shifting of approximately 190 tonnes of nurdles from Trivandrum beaches to port storage facilities will commence from 24 June 2025 under the supervision of Customs and the Pollution Control Board. Cleanup efforts continue along affected shorelines with increased volunteer mobilisation. Trivandrum District Administration and disaster management agencies

have facilitated the deployment of 500 volunteers across key locations, including Trivandrum, Kanyakumari, and Rameshwaram.

Indian Coast Guard continues daily aerial surveillance over both the MSC ELSA 3 wreck site and WAN HAI 503 area using Dornier aircraft. Patrols remain in place, and today's sortie was launched at 1000 Hrs, with updates awaited.

4. Situation Assessment:

The consistent light rainbow sheen observed near the wreck site is attributed to residual contaminants from enclosed compartments such as the engine room, machinery spaces, and structural components with trapped oil or lubricants. These residual discharges are minor and dissipate naturally due to sea conditions, with no evidence suggesting active fuel leaks from sealed tanks. Available underwater inspections during the earlier capping operations confirmed the tank openings are secure and no major hull deformation has been detected.

Given the ongoing light sheen, continuous observation is being maintained by Nand Saarthi at the site, complemented by aerial surveillance from the Indian Coast Guard. Experts have assessed that this type of light contamination is expected to persist intermittently until complete natural flushing occurs, which may take several weeks depending on sea conditions.

The offshore response is in a transition phase, with SEAMAC III demobilised and the replacement vessel, Canara Megh, expected to take over patrol and monitoring responsibilities by the end of June. Preparations for oil removal operations are underway, with Brand Marine Consultants and SMIT Salvage working on finalising a comprehensive removal and caretaking plan. However, no formal revised plan for oil extraction or wreck removal has been submitted by MSC as yet. DG Shipping has reiterated the requirement for immediate submission of a firm operational plan.

Onshore, the nurdle recovery and storage operation has been stabilised, with temporary storage solutions at port facilities secured and logistics commencing imminently. Volunteer participation has improved, though continued replenishment of nurdles on beaches requires sustained cleanup and monitoring efforts. Disposal and recycling solutions for the recovered nurdles are under discussion between Customs, the Pollution Control Board, and other relevant authorities.

Ongoing coordination between DG Shipping, State Authorities, MSC, Salvors, Indian Coast Guard, and other stakeholders continues to ensure environmental risks are mitigated and offshore operations resume promptly.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 30, 1800 hrs on 24/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The transportation of nurdles from Trivandrum to Kollam Port commenced today with the arrival of the first truck at Kollam Port at 1800 hrs. The consignment was weighed on arrival, recording a gross weight of 18,550 kg. Unloading of the sacks has begun at Zone 5 of the MERC warehouse within Kollam Port premises, following which the truck will return to Trivandrum for the next batch of nurdles. This activity marks the start of the planned systematic transfer of recovered nurdles, supported by close coordination with District Authorities, Port Administration, Customs, Pollution Control Board, and Disaster Management agencies.

Separately, a floating container suspected to be from MSC ELSA 3 was spotted near Alappuzha. Immediate salvage efforts were initiated with two teams mobilised: one offshore team onboard the hired fishing vessel Ann Mary, and a second land-based response team deployed via Thottappally. The container was confirmed to originate from MSC ELSA 3 and contained polymers of ethylene (nurdles), some of which were found floating near the wreck and collected onboard Nand Saarthi. Nand Saarthi remains on site conducting monitoring operations, while efforts to connect and recover the drifting container are ongoing, complicated by weather conditions and visibility constraints.

Meanwhile, the daily beach cleanup continues with intensified efforts across all locations. At Trivandrum, a record 560 volunteers were deployed. MERC is closely coordinating with all authorities to increase volunteer strength, particularly in heavily impacted areas. A trial transport activity of nurdles from Kovalam to Kollam Port has been successfully initiated using fully enclosed, pre-weighed and tarpaulin-lined trucks, ensuring contamination-free movement of materials.

4. Situation Assessment:

The recovery and safe storage of nurdles from the coastal belt is progressing in a phased, controlled manner, with significant support from state and district authorities. However, the sighting of the floating container near Alappuzha, later confirmed as part of MSC ELSA 3's lost cargo, highlights persisting offshore risks. The contents of the container have already begun dispersing, posing renewed environmental challenges both at sea and along the coastline. Immediate containment and recovery of this drifting container is crucial to prevent further spread of nurdles into sensitive marine and coastal ecosystems.

At the wreck site, Nand Saarthi remains deployed for continuous monitoring and response, reporting a light, non-recoverable rainbow sheen around the area, likely from residual oils trapped in engine spaces or machinery components. No significant oil leak has been detected from the sealed fuel tanks, indicating that prior containment measures remain intact. That said, natural dissipation of minor sheens will continue over time and is being monitored by both the salvors and the Indian Coast Guard through surface and aerial surveillance.

MERC has also initiated coordinated sea and land-based operations to secure the floating container, working with local fisheries authorities to overcome challenges posed by fishing restrictions and vessel availability. Additionally, ITOPF has commissioned drift trajectory modelling to predict nurdle dispersion, aiding rapid deployment of cleanup teams to potential landfall sites.

The replacement tug Canara Megh is excepted to arrive on site by the 28th, awaiting favourable weather. The transition of oil removal operations to a new contractor is under discussion, with MSC expected to confirm a revised salvage plan and timeline

shortly. Overall, the situation remains dynamic, with offshore response, environmental containment, and onshore cleanup proceeding under close inter-agency coordination.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 31, 1800 hrs on 25/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The container salvage operation near Alappuzha continues, with both offshore and shoreline teams mobilized. Despite persistent monitoring throughout the previous night and into the morning, the container itself has not been sighted. However, at approximately 1315 hrs today, the offshore fishing vessel Ann Mary reported floating pellet bags drifting towards the coastline. MERC teams were immediately deployed along the affected shoreline to initiate recovery. As of this report, a total of 64 intact pellet bags have been recovered and safely loaded onto a transport truck by the MERC salvage team. The recovery operation remains active as additional pellet bags continue to wash ashore across multiple locations in the area.

Offshore, Nand Saarthi remains on site near the MSC ELSA 3 wreck, maintaining surveillance under challenging weather conditions. The vessel has reported no significant oil sheen today, though previous light rainbow sheen observed yesterday has naturally dissipated. Canara Megh, chartered by MERC to assume duties from Nand Saarthi, is in transit to Kochi for deployment.

The nurdle transportation operation from Trivandrum to Kollam Port continues in coordination with Customs and Port authorities. The first batch of 18.5 metric tonnes has been successfully transported and secured at the designated MERC warehouse

within Kollam Port. Further transfers are underway as part of the broader environmental mitigation strategy.

MSC is expected to finalise the contract with the newly appointed salvor by the end of the day today. However, the Name of the salvor and the proposed operational timelines are yet to be communicated to the Indian authorities. It was requested that information be shared at the earliest to enable effective coordination.

4. Situation Assessment:

The floating pellet bags recovered today confirm partial loss of cargo from the container last sighted offshore, which is now presumed submerged or disintegrated due to adverse sea conditions. The situation underscores the potential for continued wash-up of nurdles and packaging materials along the coastline in the coming days. Shoreline teams remain actively engaged to mitigate the impact, with systematic monitoring and recovery operations in place.

At sea, while oil spill risk remains contained, isolated instances of non-recoverable, light sheen persist around the wreck site, likely due to residual contaminants in machinery spaces or structural voids. Continuous observation and aerial monitoring by the Indian Coast Guard are ongoing to detect any escalation.

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Onshore, the steady but limited volunteer turnout at Trivandrum restricts the pace of shoreline cleanup. Enhanced support from district authorities has been requested to augment manpower and sustain response momentum.

Simultaneously, finalization of the revised salvage contract and oil removal plan by MSC remains pending but is expected imminently. This is critical to addressing environmental risks from the sunken vessel, particularly as monsoon conditions intensify. DGS has reiterated the necessity for a firm, executable salvage timeline to be shared at the earliest to ensure operational preparedness and public confidence.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping, 9th Floor Beta Building, I-Think Techno Campus, Kanjurmarg (East), Mumbai - 400 042 (India)

Directorate General of Shipping

SITREP – 32, 1800 hrs on 26/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The offshore response for MSC Elsa 3 is progressing with the replacement guard vessel, Canara Megh, having departed Mumbai and currently en route to Kochi Port. The vessel is expected to arrive on 27th June 2025, after which essential oil spill response equipment will be loaded in coordination with MERC. Following this, Canara Megh will proceed to the wreck site to relieve Nand Saarthi, which continues to maintain guard duties and monitoring operations at the site. Nand Saarthi remains on standby to respond to any new developments until the vessel handover is complete.

SMIT Salvage has been formally appointed as the new contractor for the extraction of oil and wreck removal. The mobilisation of the Diving Support Vessel from Singapore is underway, with its arrival expected around 1st August 2025, subject to favourable weather conditions. Preparations for saturation diving and fuel extraction are ongoing, with operational planning in advanced stages.

Onshore, recovery efforts continue under the MERC framework. A container floating near Alappuzha triggered a coordinated response with both sea and shore teams deployed. So far, 105 intact pellet bags have been recovered from the coastline in that area, with operations continuing as additional debris is expected to wash ashore.

The transport of cleaned plastic pellets (nurdles) from Trivandrum to Kollam Port remains on schedule. As of today, six truckloads have been completed, amounting to

45.567 metric tons transferred to the designated MERC warehouse at Kollam Port. Further transportation operations are planned to continue daily.

4. Situation Assessment:

The salvage and pollution response operations remain in a critical preparatory phase, with offshore oil extraction yet to commence. The arrival of Canara Megh on 28th June 2025 will restore full guard vessel capability at the wreck site, ensuring continuous monitoring and readiness to respond to any contingencies. Until the new Diving Support Vessel arrives and saturation diving begins, interim monitoring and containment measures will remain in place.

Weather conditions remain a key factor, with July expected to present limited workable windows for offshore diving operations. August has been identified as the most suitable period to commence the complex fuel extraction process, with approximately 70% operational workdays projected based on historical weather data. The fishing ban currently in place will be lifted during this period, necessitating coordination with state authorities to establish exclusion zones around the wreck to avoid interference with the salvage operation.

Recovery for debris and nurdle contamination along the Kerala coastline continues; efforts have been effective, with significant volumes of nurdles already transported to

secure storage in Kollam Port. Discussions with Customs, Pollution Control Board, and other agencies are ongoing to finalise long-term disposal, segregation, and recycling mechanisms.

The sighting and recovery of floating containers and pellet bags near Alappuzha underscores the need for continued vigilance, both offshore and along the coastline. Comprehensive inter-agency coordination remains in place, led by the Directorate General of Shipping, to manage all aspects of offshore readiness, onshore recovery, and environmental protection.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 33, 1800 hrs on 27/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Onshore response efforts continue to progress under the supervision of the MERC. The transportation of cleaned plastic pellets (nurdles) from Veli Beach to Kollam Port remains ongoing, with two additional truckloads dispatched today. A total of 790 bags weighing 14.032 metric tons were moved on 27 June 2025, bringing the cumulative transported quantity to approximately 59.6 metric tons since the commencement of operations on 24 June 2025. Further nurdle transportation from both Veli Beach and Perumathura Beach is scheduled for tomorrow.

Shoreline cleanup efforts have mobilised approximately 490 volunteers across Trivandrum, Rameswaram, and Kanyakumari. Recovery operations also targeted floating pellet bags reported near shore, with 8 to 9 bags retrieved from the coastline within the last 24 hours. Discussions regarding the final disposal plan for recovered nurdles are underway with relevant stakeholders, including MSC.

Offshore, the vessel transition is progressing. The tug Canara Megh arrived at Kochi Port and is currently being loaded with oil spill response equipment and personnel, including two divers equipped for contingency recovery of floating containers. The vessel is expected to sail by the evening of 27 June to relieve Nand Saarthi at the wreck site by the following morning. Nand Saarthi has remained on station, monitoring the site.

4. Situation Assessment:

While onshore recovery and transportation of nurdles have stabilised, the continued surfacing of floating pellet bags near the shoreline remains a concern. Drone and field surveillance efforts are being maintained to monitor for new hotspots. Despite significant quantities of recovered nurdles, a final disposal mechanism has yet to be formally concluded, requiring coordinated engagement with MSC, Customs, and other authorities.

Offshore, the operational readiness of Canara Megh for wreck-site monitoring and potential floating container recovery represents a positive development. However, the timeline for oil extraction and full-scale wreck removal remains contingent on the mobilisation of the new contractor engaged by MSC. The Directorate General of Shipping has reiterated the need for updated master logs on nurdle recovery, precise container status, and formalisation of disposal protocols. Additionally, aerial and sea patrols by the Indian Coast Guard continue to monitor the incident area, with no major changes reported as of today.

5. Environmental Risks:

<u>Refer to SITREP – 6, 1800 hrs on 28/05/2024</u>

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 34, 1800 hrs on 30/06/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The transition of salvage operations from T&T Salvage to SMIT Salvage has been formally completed as of 28th June 2025 at 1000 hours. The Canara Megh is presently deployed on-site for caretaking duties, conducting 24-hour monitoring operations with reports being relayed every six hours. VHF safety broadcasts are being transmitted hourly to warn passing traffic to maintain a one nautical mile exclusion zone around the wreck location. Weather conditions at the site are reported as long swells of approximately three metres with moderate wind speeds of 12–15 knots. No visible oil sheen or floating debris has been reported in the latest assessments.

On the shoreline, coordinated clean-up operations continue. The recovered plastic nurdles from impacted beaches in Trivandrum and Kollam districts are being systematically transported to Kollam Port. As of 30th June 2025, a total of approximately 106.823 metric tons of nurdles have been moved to the designated MERC warehouse at Kollam Port. Volunteer mobilisation remains strong, with 456 volunteers engaged in Trivandrum and additional teams supporting operations in Kollam, Rameshwaram, and Kanyakumari.

Container recovery operations are nearing completion, with three sunken containers remaining to be salvaged. These operations are expected to conclude within the week. Pollution Control Board (PCB) officials have conducted preliminary water sampling,

with reports awaited. Planning is underway to establish a weekly water quality monitoring protocol both along the shoreline and at the wreck site.

4. Situation Assessment:

The handover of salvage responsibilities to SMIT Salvage marks a critical milestone in stabilising the response effort. With the Southern Nova Dive Support Vessel prepared and audited in Singapore, mobilisation for fuel extraction and further technical operations is progressing. Engagement with MSC, MERC, and Brand Marine Consultants ensures alignment on the next operational phase.

The estimated nurdle cargo based on manifests indicates 72 containers with a total net weight of 1,559 metric tons. However, only eight containers with plastic nurdles are confirmed to have been released from the deck, with ongoing shoreline arrivals observed, particularly along Kerala and Tamil Nadu coasts. Recovered nurdles are being secured in bonded storage at Kollam Port, with disposal protocols being finalised in consultation with Customs and relevant agencies. Material collected in Tamil Nadu remains stored at designated sites pending State Government disposal instructions.

Pellet containers on MSC ELSA III			
Location	**Number of containers**	**Total number of packages (pellet bags)**	**Total net cargo weight (kg)**
Above deck	48	47,780.00	1,041,138.00
Below deck	24	23,760.00	518,076.00
Total	72	71,540.00	1,559,214.00
Known pellet containers released from wreck.			
Kerala shoreline	8	7,920.00	172,762.00

Environmental surveillance remains robust. No significant oil sheen or floating containers have been detected by aerial sorties or on-site monitoring in recent days. Continued vigilance around the site is essential, including routine water sampling, particularly in ecologically sensitive regions like the Gulf of Mannar.

Overall, response efforts are stabilised, though the focus must remain on finalising container recovery, enhancing environmental monitoring, accelerating nurdle disposal, and preparing for the next operational phase under SMIT Salvage's direction.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping, 9th Floor Beta Building, I-Think Techno Campus, Kanjurmarg (East), Mumbai - 400 042 (India)

Directorate General of Shipping

SITREP – 35, 1800 hrs on 02/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The salvage operations and coastal cleanup efforts in response to the MSC ELSA 3 incident are progressing steadily under close inter-agency coordination. MERC has confirmed that the vessel Canara Megh continues to perform 24/7 caretaking duties at the wreck site, with no fresh sightings of oil sheen reported in the vicinity.

Shoreline cleanup operations are ongoing from Trivandrum up to Rameshwaram and Kanyakumari. Recovery of plastic pellets (nurdles) continues, with a total of approximately 350 tonnes collected at Kollam/Trivandrum, 200 tonnes at Rameshwaram, and 50 tonnes at Kanyakumari so far.

Additionally, water quality monitoring is ongoing, with 20 samples taken since May 26th, all of which have returned normal results. Weekly testing continues with the Kerala Pollution Control Board, and arrangements are in place to communicate these results through official channels.

Regarding the wreck site, SMIT Salvage has reported that the Dive Support Vessel (DSV) and support personnel are fully prepared in Singapore. Induction training for approximately 30 staff members has been planned, with mobilisation to site expected shortly. The salvage team has indicated that diving operations will commence within 24 hours of the DSV's arrival at the wreck site. The remaining three containers are expected to be recovered within the week, and arrangements are underway to shift

collected nurdles from customs control to the designated port warehouse for further processing.

4. Situation Assessment:

The latest assessments indicate that the containment and monitoring measures at the wreck site remain effective, with no significant oil leaks or environmental hazards reported as of date. The continued absence of oil sheen suggests effective sealing of fuel tanks and containment systems.

A critical area of focus remains the verification of hazardous cargo onboard. MSC has confirmed the presence of 13 containers listed under the IMDG Code but has been directed to re-examine the cargo manifest for potential marine pollutants. Additionally, the Directorate has emphasised strict compliance with instructions from MMD Kochi, particularly regarding cargo categorisation and environmental risks.

While the salvage mobilisation is on track, the current phase of operations depends on the timely arrival of the DSV and seamless commencement of oil extraction efforts. The ongoing claims process, initiated by affected stakeholders, is under review by MSC and the P&I Club, with DGS urging expedited responses, especially concerning claims forwarded by the Kerala Government. Inter-agency collaboration remains crucial to ensure environmental safety, effective containment, and timely resolution of outstanding operational and regulatory requirements.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 36, 1800 hrs on 05/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The coastal cleanup operations continue to be actively undertaken by MERC teams across Trivandrum, Rameshwaram, and Kanyakumari. Field teams remain deployed along the affected stretches, with additional cleaning planned in backwater regions to target hard-to-access areas. Transportation of recovered nurdles from shoreline locations to the designated warehouse at Kollam Port remains ongoing. An estimated 450 to 500 tonnes of nurdles have been collected so far, with an updated and verified figure expected by 6th July.

Meanwhile, the vessel Canara Megh continues patrolling the wreck site under the caretaking phase. No sightings of floating containers, oil sheen, or marine pollution have been reported during recent surveillance operations.

Salvage operations are progressing with necessary preparations underway. SMIT Salvage has confirmed that mobilisation of salvage equipment remains on schedule, with departure set for 24th July and site arrival by 1st August. Diving operations are planned to commence immediately upon arrival. Divers' visa processing and induction formalities are also ongoing with necessary support sought from the Directorate General of Shipping to expedite clearances.

Indian Coast Guard assets, including a patrol vessel and Dornier sorties, continue routine surveillance near the wreck site. No oil sheen, floating debris, or fishing vessel damage has been reported in recent aerial and surface patrols.

4. Situation Assessment:

The overall response remains stable, with progress made in shoreline cleanup, nurdle transportation, caretaker operations, and operational readiness for oil removal and wreck salvage. A comprehensive disposal plan for recovered nurdles remains pending, with coordination required between MERC, Clean Kerala, MSC, and statutory authorities to ensure environmental compliance and safe handling. It is noted that some nurdles washing ashore may still be remnants from the initial spill, highlighting the need for sustained shoreline surveillance and recovery efforts.

On the cargo front, MSC has confirmed that 13 containers on board the MSC ELSA 3 are classified under the IMDG Code. A full legal and technical review is underway regarding hazardous cargo allegations and possible misdeclaration concerns. DGS has emphasised the need for immediate verification of shipper documentation, including bills of lading, packaging details, and multimodal transport declarations to identify any discrepancies. Investigations are also being initiated following complaints from fishermen about containers reportedly affecting fishing nets.

SMIT Salvage has undertaken to define a 1 nautical mile restricted navigational zone around the wreck site, for which coordinates are awaited to facilitate issuance of an official advisory by DGS.

While caretaker operations and coastal cleanup efforts remain effective, close inter-agency coordination is essential to resolve pending cargo-related concerns, finalise disposal protocols for recovered materials, and ensure readiness for the upcoming salvage and oil removal operations under challenging monsoon conditions.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 37, 1800 hrs on 09/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

As of 9 July 2025, ongoing coordination among the Directorate General of Shipping (DGS), MSC, SMIT Salvage, Brand Marine Consultants (BMC), and other stakeholders remains focused on monitoring the salvage mobilisation and environmental containment efforts. No deviation in the timeline for salvage mobilisation has been reported, with the new salvage team continuing preparatory work. A joint visit was undertaken by MSC, SMIT, and Brand Marine to the Indian Coast Guard and the Directorate to review and align on the newly submitted salvage plan.

For the onshore efforts, in Trivandrum district, the MERC-led shoreline recovery operations continue steadily, with nurdle recovery and transportation logistics being coordinated daily. The MERC has also updated the district-wise recovery figures and submitted revised data sheets for central collation.

4. Situation Assessment:

While salvage mobilisation remains on schedule, the operational environment continues to be challenged by regulatory coordination and environmental sensitivities. A key concern is the restricted permission for using seawater flushing for nurdle segregation at the Rameshwaram site, currently not permitted by local authorities.

However, the method has proven effective in Trivandrum, and MERC has been directed to submit a formal request to DGS for onward communication to the Tamil Nadu State Disaster Management Authority (TNSDMA). DGS has confirmed its willingness to escalate this matter once the request is formally received.

The volume of nurdles being recovered daily highlights the scale of environmental impact. As of the latest report, the total recovered nurdles exceeds 450.0 tonnes, highlighting the necessity of sustained inter-agency coordination. The continued support of the Kerala and Tamil Nadu State Disaster Management Authorities, Pollution Control Boards, district administrations, and the Customs Department has been essential in facilitating the uninterrupted logistics chain for recovery and temporary storage at Kollam Port.

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY						
Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Warehouse (Kg)	Total (Kg)
1		Thiruvananthapuram	21,721	1,62,085	1,43,141	
2		Kanyakumari	450	100	30,900	
3		Rameshwaram	0	64,758	5,725	
4		Kollam	0	0	33,358	
			22,171	2,26,943	2,13,124	4,62,238

The light sheen occasionally reported near the wreck site is being continuously monitored by Canara Megh, and no escalation in environmental risk has been noted. With the operational phase of the new salvage contractor nearing commencement, DGS has reiterated the need for strict adherence to the approved salvage plan, and timely mobilisation of all personnel and equipment.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 38, 1800 hrs on 11/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

As of 11 July 2025, the MSC ELSA 3 incident response continues to proceed on multiple operational fronts. Salvage preparations by SMIT Salvage remain on track, with mobilisation of the Diving Support Vessel (DSV) from Singapore scheduled to commence around 24 July and arrival at site expected by 1 August. Weather forecasting is actively being monitored through a 21-day window to facilitate operational readiness. In the interim, the tug Canara Megh continues to undertake on-site caretaking duties without disruption, following a routine personnel change.

On the environmental side, the Marine Emergency Response Centre (MERC) has confirmed that a total of approximately 477 metric tons of plastic nurdles have been recovered from affected coastal stretches. Active collection is ongoing with the deployment of floating booms and boat-based retrieval supported by ITOPF guidance. A volunteer workforce of approximately 700–800 persons—of which 514 are currently deployed in Trivandrum—remains consistently engaged in beach cleanup efforts. Final recovery operations for sunken containers (washed ashore) are underway and are expected to be completed within the weekend.

Figure 1: Nurdle cleanup operations are currently underway in the Swamp at Veli

Legal and regulatory reviews concerning hazardous cargo onboard MSC ELSA 3 are also advancing. MSC has reported that documentation reviews for the 244 containers under scrutiny for IMDG Code compliance are still in progress, with updates anticipated by mid-next week. Coordination between MSC, the P&I Club, and legal counsel is ongoing to finalise submissions in response to the PIL and related inquiries.

4. Situation Assessment:

The overall operational landscape remains stable but requires continued coordination across salvage, environmental recovery, and legal compliance domains. Salvage preparations are moving forward as scheduled, but the commencement of extraction operations remains contingent on favourable weather and completion of mobilisation logistics. The interim caretaking operation by Canara Megh has ensured that the wreck site remains monitored and secure.

From an environmental standpoint, the nurdle recovery efforts have been notably extensive, with approximately 477 metric tons collected to date. However, continued stranding of pellets and the need for consistent manpower indicate that the situation

still demands sustained daily intervention. The deployment of containment booms and expansion of sea-based retrieval efforts marks an adaptive shift in strategy to limit further dispersal.

Figure 2: Deployment of booms

The review of container contents, particularly those flagged for hazardous materials, remains a critical compliance issue. Delays in finalising this review, coupled with the impending requirement to respond to the PIL, underline the importance of prompt and accurate documentation by MSC and its appointed consultants. Finalisation of disposal plans for the recovered nurdles in Kerala and Tamil Nadu also remains pending, adding a regulatory dimension to the ongoing environmental response.

In summary, while the operational tempo has been maintained and coordinated well. There are several sensitive transition points that will need resolution in the coming week to maintain momentum and mitigate environmental and legal risks.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 39, 1800 hrs on 14/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The MERC remains actively engaged in both shoreline monitoring and nurdle recovery efforts. On 14 July 2025, a floating object was reported off Fort Kochi Beach. MERC personnel were immediately mobilised and successfully secured the item. Upon inspection, it was assessed that the object is not associated with MSC ELSA 3. The structure appears to resemble a floating platform component and no identifying container number or vessel markings were found. MERC has confirmed that the item does not belong to the MSC ELSA 3 wreck.

Onshore cleanup and transportation of nurdles continue with momentum. On 14 July, truck was dispatched from Perumathura and Kovalam beaches to Kollam Port, carrying a total of 365 bags, weighing 8,400 kilograms. The subsequent disposal or recycling of nurdles in accordance with the guidelines are being finalised with Customs and the Pollution Control Board. The cumulative volume of plastic pellets recovered and transported from affected beaches between until 14 July 2025 now stands at 169.459 metric tons. MERC and the District Administration have ensured a steady operational tempo despite occasional weather-related constraints, with volunteers continuing to play an instrumental role in the daily cleanup efforts.

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY FOR DG SHIPPING								
Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Warehouse (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel
1		Thiruvananthapuram	26,280	1,89,126	1,61,059		469	312
2		Kanyakumari	345	980	31,425		0	69
3		Rameshwaram	0	69,711	6,875		0	112
4		Kollam	0	0	33,647		0	54
			26,625	2,59,816	2,33,006	5,19,447	469	547

Figure 1: Detailed volunteer deployment and nurdles recovery as on 13.07.2025

4. Situation Assessment:

The shoreline response operations continue to show effective coordination between district authorities and MERC, with swift mobilisation and clearance of reported items along the coastline.

The progressive increase in nurdle recovery and the smooth transport logistics underline a well-executed plan led by the Trivandrum District authorities and MERC, supported by volunteers.

The offshore mobilisation for oil removal operations remains on track, with the Diving Support Vessel (DSV) scheduled to berth in Singapore for equipment loading on 17 July and depart for Kochi by 24 July. The offshore team is expected to be mobilised from Kochi with operations beginning by 1 August 2025. Preparatory arrangements for crew visas and offshore deployment is being coordinated by the salvors and the owners and no bottlenecks have been reported.

MERC has confirmed that the vessel Canara Megh continues to perform 24/7 caretaking duties at the wreck site, with no fresh sightings of oil sheen reported in the vicinity.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 40, 1800 hrs on 1/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

As of 16 July 2025, with active coordination of the Directorate General of Shipping and MERC the activities continue to progress. A significant development pertains to the mobilisation of the Diving Support Vessel (DSV), a DP2-class vessel equipped with a full saturation diving system. The vessel is scheduled to depart Singapore on 24 July 2025 and proceed directly to the MSC ELSA 3 wreck site, approximately 14 nautical miles off the Kerala coast, without making a port call in India. Onboard operations, including hot tapping and oil recovery from the sunken vessel, are expected to commence immediately upon arrival at the site.

An official communication has been received from the salvage team confirming the mobilisation plan and requesting assistance in informing the concerned state authorities. DG Shipping has taken note and is facilitating coordination to ensure the SMIT/MERC/BMC team receives the necessary support from local agencies to enable seamless operations during this critical next phase.

Onshore, the nurdle recovery and transportation effort continues to yield significant results. The cumulative weight of nurdles recovered across Thiruvananthapuram, Kanyakumari, Rameshwaram, and Kollam districts now stands at approximately 540.248 metric tons. Of this, 250.129 metric tons have been segregated and moved to designated warehouses. This effort has been made possible through the combined

manpower of 475 volunteers and 578 MERC personnel, with major contributions from the Trivandrum site, where volunteer mobilisation remains active.

EXECUTIVE SUMMARY: NURDLE WEIGHT RECOVERY FOR DG SHIPPING

Sl. No.	Date	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Warehouse (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel
1		Thiruvananthapuram	26,295	1,88,040	1,78,119		475	328
2		Kanyakumari	570	1,940	31,425		0	77
3		Rameshwaram	0	73,274	6,875		0	113
4		Kollam	0	0	33,710		0	60
			26,865	2,63,254	2,50,129	5,40,248	475	578

Figure 1: Detailed volunteer deployment and nurdles recovery as on 16.07.2025

Figure 2: Cleanup Operations in Kerala

4. Situation Assessment:

The mobilisation of DSV marks a transition into the offshore oil recovery phase of the MSC ELSA 3 incident response. As the wreck lies beyond the territorial waters of Kerala, no port entry is planned, and the vessel is expected to operate entirely

offshore. Relevant state and port authorities are being informed to ensure that the salvage team can proceed without procedural delays or hindrances. Close coordination with customs and immigration authorities has been initiated in anticipation of any remote clearance requirements for equipment or personnel.

Onshore operations remain stable but resource-intensive. Nurdle recovery has now crossed the approximate 540-ton mark. The MERC-led logistics chain for sorting, bagging, and transporting pellets to the Kollam warehouse is functioning efficiently. However, volunteer mobilisation in districts such as Kanyakumari and Rameshwaram remains low, highlighting the need for continued support from local administrations. Trivandrum continues to be the focal point of activity, both in terms of recovery volume and personnel engagement.

With the arrival of DSV and commencement of saturation diving operations imminent, inter-agency readiness and operational synchronisation remain critical. The overall response system remains on high alert, with DG Shipping overseeing the transition into full-scale offshore salvage and oil removal.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 41, 1800 hrs on 18/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The salvage mobilisation operations for MSC ELSA 3 are progressing as per schedule. Equipment loading onto the DP2 Diving Support Vessel (DSV) *Southern Nova* has commenced in Singapore, with hard mobilisation initiated on 17 July. The vessel is slated for departure on 24 July and is expected to reach the wreck site by 1 August 2025. Weather conditions remain favourable for the planned operations. Caretaking activities at the wreck site continue, maintaining vessel monitoring until the full salvage team arrives.

Onshore, the Maritime Emergency Response Centre (MERC) has reported substantial progress in plastic nurdle recovery. As of 18 July, over 540 tonnes of nurdles have been collected from affected beaches. Of this, 258 tonnes have already been transported to the Kollam Port warehouse for temporary storage. Volunteer deployments are now limited to Trivandrum, with 486 active volunteers and an overall personnel strength of 581. Volunteer operations in Kollam, Kanyakumari, and Rameshwaram have been concluded.

In parallel, the Kanyakumari District Administration confirmed that 21 metric tonnes of plastic nurdles have been transferred to the central storage warehouse, pending further instructions from the state government regarding disposal.

4. Situation Assessment:

The upcoming mobilisation of Southern Nova marks a critical transition into the next operational phase, which focuses on deep-sea fuel extraction from MSC ELSA 3 using saturation diving. The structured mobilisation timeline and favourable weather outlook are expected to support smooth deployment and initiation of activities at the wreck site located beyond the territorial waters of Kerala. The vessel is planned to proceed directly to site without making a port call, for which support and clearance from relevant state authorities is being sought.

As on 18 July 2025

Sl. No.	Location	Segregated (Kg)	Non-Segregated (Kg)	Segregated and Transported to Warehouse (Kg)	Total (Kg)	No. of Volunteers	No. of MERC personnel
1	Thiruvananthapuram	26,069	1,81,876	1,86,289		486	329
2	Kanyakumari	740	3,075	31,425		0	75
3	Rameshwaram	0	77,183	6,875		0	117
4	Kollam	0	0	33,710		0	60
		26,809	2,62,134	2,58,299	5,47,242	486	581

Figure 1: Nurdles recovery data along with Volunteers deployed as on 18 July 2025

Onshore, the significant volumes of nurdles recovered and transferred for secured storage reflect the successful coordination between MERC, district administrations, and volunteer teams.

Overall, with at-sea and shoreline operations reaching a mature stage, coordinated execution and stakeholder engagement remain vital for closing out response milestones and transitioning into the long-term recovery and disposal phases.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

DIRECTORATE GENERAL OF SHIPPING
नौवहन महानिदेशालय
MUMBAI
INDIA
सागराः सुपन्थानः सन्तु

Directorate General of Shipping

SITREP – 42, 1800 hrs on 21/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Preparations for the next phase of salvage operations on the sunken MSC ELSA 3 have intensified with final mobilisation activities underway in Singapore. The DP2 Diving Support Vessel (DSV), equipped with a saturation diving system, is scheduled to depart on 24 July 2025 and will proceed directly to the wreck site. The project team intends to operate the vessel entirely offshore, without entering port, and will begin diving operations immediately upon arrival.

In the meantime, Canara Megh continues caretaking duties at the wreck site but had returned to Kollam over the weekend due to rough weather offshore. Redeployment is contingent on weather improvement. Kollam Port has emerged as the preferred logistical hub for the upcoming diving operation owing to its proximity, adequate draft (7 meters), and historical support to the salvage team. Immigration clearance is being arranged through the FRRO at Trivandrum, with full backing from the port and state maritime authorities.

Onshore, MERC continues daily cleanup and logistics operations. As of 18 July, 557 metric tons of nurdles have been collected from the affected shoreline areas, of which 266 MT have been transferred to the Kollam warehouse. Segregation of the remaining quantity is ongoing.

4. Situation Assessment:

The mobilisation of *Southern Nova* signals a critical transition into deep-sea fuel extraction and high-risk underwater operations requiring uninterrupted logistical and regulatory coordination. The strategy to operate directly offshore has been planned for this phase. However, immigration protocols and project crew access require clearances that are being actively pursued with the FRRO in Trivandrum and support from DG Shipping. A formal request has been raised for DG Shipping to issue a letter facilitating immigration and port pass arrangements through Kollam.

Kollam has been reaffirmed as the optimal base for project coordination, offering efficient turnaround times (approximately 4.5 hours to the site) and administrative ease compared to Kochi. Previous similar operations from Kollam reinforce its suitability, especially with robust institutional support from Kerala Maritime Board and Kollam Port Authority. The involvement of Pollution Control Boards and district administrations in Kanyakumari and Kollam continues to ensure regular oversight.

Additionally, MERC has reiterated the need for updated guidance from Tamil Nadu authorities concerning the disposal of stored nurdles in Kanyakumari, as no final directive has yet been received.

As the response transitions into technically intensive salvage and waste management phases, institutional coordination, regulatory facilitation, and state-level cooperation will be crucial in maintaining momentum and achieving operational closure.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 43, 1800 hrs on 04/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DSV Southern Nova, a DP2 vessel, with a saturation diving system, has arrived at the wreck site of MSC ELSA 3 and is currently positioned approximately 14 nautical miles off the coast of Kerala. Preparatory work for the underwater fuel extraction phase is underway. Personnel transfer to the Southern Nova began on 03 August using PSV Offshore Monarch, after initial difficulties with Canara Megh due to persistent swell conditions. The transfer operations are being planned for execution in controlled batches during daylight hours, ensuring compliance with safety and immigration protocols. Coordination with FRRO, Trivandrum and port authorities has facilitated smooth documentation and logistical support.

Further, pollution prevention and control measures remain in place with booms placed onboard support vessels and pollution response teams on standby. Dive operations are expected to commence once final on-site safety checks are completed and sea conditions allow for stable deployment of divers and recovery systems. The Canara Megh, having provided offshore standby support, has returned to Kollam Port due to adverse weather and will be redeployed based on operational requirements.

Onshore, the marine environmental response continues with focused efforts on cleanup and transport of spilled nurdles. As of 04 August 2025, a total of approximately 625 metric tons of nurdles have been collected and transported to the Kollam

warehouse from affected coastal areas in Kerala and Tamil Nadu. Collection and segregation activities remain ongoing, supported by over 900 deployed personnel, including volunteers and MERC teams. However, formal responses from the Tamil Nadu State Government regarding disposal arrangements remain pending.

4. Situation Assessment:

With the arrival of the DSV *Southern Nova*, the operation has moved into a critical phase focused on submerged fuel extraction from the wreck. The requirement for close coordination between the Salvage Master and vessel Master remains essential for safe initiation of saturation diving. Weather remains a limiting factor, especially with rough sea conditions affecting crew mobility and limiting equipment deployment particularly the placement of marker buoys at the site.

Given the continued observation of nurdle recharges along the coastline and the confirmed number of 65 containers carrying plastic pellets, it is anticipated that shoreline wash-ups will persist intermittently. The current deployment model for volunteers is being adjusted based on localised recharge patterns. Furthermore, oil spill contingency preparedness has become more crucial with the onset of underwater works, prompting the need for meticulous coordination with the Indian Coast Guard.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 44, 1800 hrs on 05/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The salvage operation for the sunken MSC *Elsa 3* has entered a critical preparatory phase, following the observation of an oil sheen extending approximately 1.5 nautical miles from the wreck site. The Indian Coast Guard has been closely monitoring the situation, and aerial surveillance is underway using a Dornier aircraft. While no major spill has been confirmed, the possibility of a leak due to engine room disturbance has necessitated heightened vigilance.

The *Southern Nova* (DSV), mobilized for the next phase of fuel extraction, is currently stationed offshore and ready to commence operations. However, due to prevailing sea conditions, safe personnel and equipment transfer has not been feasible via the Offshore Monarch. Consequently, a formal request has been made for port clearance at Kollam to allow boarding of personnel and loading of gear from a safer location. The customs and immigration processes are being coordinated with the relevant authorities, and documentation (IGM/EGM, crew lists, etc.) is being compiled by MERC and MSC.

In light of the risk indicators observed, salvors have been clearly advised to keep oil spill containment and recovery gear ready for immediate deployment. This preparedness is critical to ensure swift response in the event of a discharge during operations.

4. Situation Assessment:

While the sheen remains limited in scope, this development highlights the need for the salvage team to transition swiftly into operational mode.

To facilitate this, it is imperative that the owners and salvors obtain necessary clearances from the Customs authorities expeditiously, allowing the DSV *Southern Nova* to berth at Kollam Port and begin loading of equipment and personnel.

Furthermore, Owners and salvors have been instructed to formally write to the Indian Coast Guard for any assistance in pollution response near the wreck site. The strategic deployment of such a support vessel will significantly enhance the response readiness for oil containment and recovery during fuel extraction and dive operations. It was also conveyed that the propeller wash is being done by Canara Megh to disperse the sheen which is also being further aided by the weather which is aiding natural weathering.

The Directorate General of Shipping has committed to issuing formal communications to support this inter-agency coordination, while Kollam Port continues to provide active facilitation. Ensuring synchronized action across all stakeholders is vital at this juncture to maintain momentum and minimize environmental risks.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

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Directorate General of Shipping

SITREP – 45, 1800 hrs on 06/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DSV *Southern Nova*, a DP2-classed dive support vessel, successfully berthed at Kollam Port at 0930 hrs on 06 August 2025. Following coordination with relevant port and government authorities, including FRRO (Immigration), Customs, and the Port Authority of Kollam, a team of 60 salvage experts completed the required immigration and health formalities. The onboarding process was completed by 1425 hrs.

All bunkering and provisioning requirements have been met, with the vessel now equipped to sustain continuous operations offshore for more than 45 days. Seven trucks carrying oxygen cylinders (for divers) arrived from Cochin and were safely transferred onboard, in addition to essential salvage personnel and equipment arriving via *Offshore Monarch*. *Southern Nova* is now in a state of full operational readiness.

Visual documentation of the vessel's deck layout, onboard systems, and diving and tank-cleaning equipment is to be prepared and submitted. Meanwhile, the shore clean-up and back-end waste management efforts remain ongoing. As of now, a cumulative total of 629 metric tons of plastic nurdles have been transported and stored in the Kollam warehouse. However, document verification for recent transfers is still pending due to the diversion of field teams to support offshore mobilization.

4. Situation Assessment:

With the onboarding phase complete and equipment mobilized, *Southern Nova* is prepared to commence offshore operations at the earliest, weather-permitting. The Salvage Master, in consultation with the vessel's command and meteorological advisors, is expected to make the departure call within the next 24 to 48 hours, based on updated weather models and on-site reconnaissance inputs.

The Indian Coast Guard (ICG) has been engaged in aerial surveillance of the wreck site. Video footage from these sorties is crucial in validating sea and wreck conditions prior to the vessel's offshore deployment. DGS has specifically advised the salvors to keep oil spill response equipment on immediate standby for deployment, given the risk of fuel leakage during extraction activities. The DSV is expected to be deployed on 09th August at the wreck site.

Further, the Directorate has reiterated the urgency for expeditious clearance from the Customs Department, particularly for specialized equipment and support materials being shipped into the country for this phase. The salvors have also been advised to formally approach the Indian Coast Guard for the possible deployment of a ICG asset should there arise a requirement of assistance in pollution response. This will ensure rapid response capability in case of any marine pollution incident during underwater tank extraction and transfer.

With all preparatory elements in place and institutional support extended, the salvage operation is expected to transition into active fieldwork imminently. Coordination among all stakeholders will continue to be critical to the success and safety of the ongoing intervention.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 46, 1800 hrs on 08/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DP2 DSV *Southern Nova*, carrying salvage equipment and personnel, is scheduled to sail out from Kollam Port on the morning of 9 August 2025 at 1000 hrs. On-board preparations, including deck rearrangement and ballasting using 40 tonnes of fresh water, are being undertaken to optimize vessel stability and readiness for immediate offshore deployment. Upon reaching the wreck site, ROV calibration and wet testing will be initiated, followed by diver saturation and subsea surveys. Six tanks are confirmed to be loaded onto *Southern Nova*, with two remaining on *Offshore Monarch*, which will continue to operate as a supporting PSV throughout the salvage operations.

A container recently recovered from the sea was secured by *Canara Megha* and brought to Kollam Port. Initial inspection confirmed it to be empty. The container has been temporarily stored at port premises, with rigging work in progress for its formal unloading and assessment. *Canara Megha* will resume her offshore caretaking duties following this task. Customs and immigration formalities for all 65 onboard salvage personnel have been completed smoothly with full cooperation from authorities, enabling operational timelines to be maintained.

4. Situation Assessment:

The salvage operations are advancing into a critical phase involving saturation diving and subsea inspection, including assessment of potential obstacles around the wreck. This is expected to commence within the next 48 hours following ROV validations. Divers will also begin work on checking and securing all fuel vents to prevent leaks and initiate recovery operations. Continuous deployment of the *Offshore Monarch* alongside *Southern Nova* ensures operational flexibility and standby support at the site.

From the shoreline, clean-up efforts remain active, with 600 volunteers currently engaged. However, the daily collection of nurdles has plateaued, with the cumulative recovery estimated to be in the range of 629–639 metric tons. Coastal monitoring continues due to intermittent reports of nurdle washups, which are being responded to promptly. The OSR equipment has been confirmed to be on board *Canara Megha*, ensuring preparedness for any eventualities offshore. The coordinated engagement between MERC, SMIT, and all involved agencies has ensured the operation remains on schedule and in compliance with all regulatory protocols.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

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Directorate General of Shipping

SITREP – 9, 1800 Hrs on 16/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1200 hrs on 16.06.2025, *WAN HAI 503* remains under controlled tow at position 10°01.88'N, 075°12.02'E, approximately 58 nautical miles west of Azhikod, holding a westerly course at a reduced speed of 0.3 to 0.6 knots.

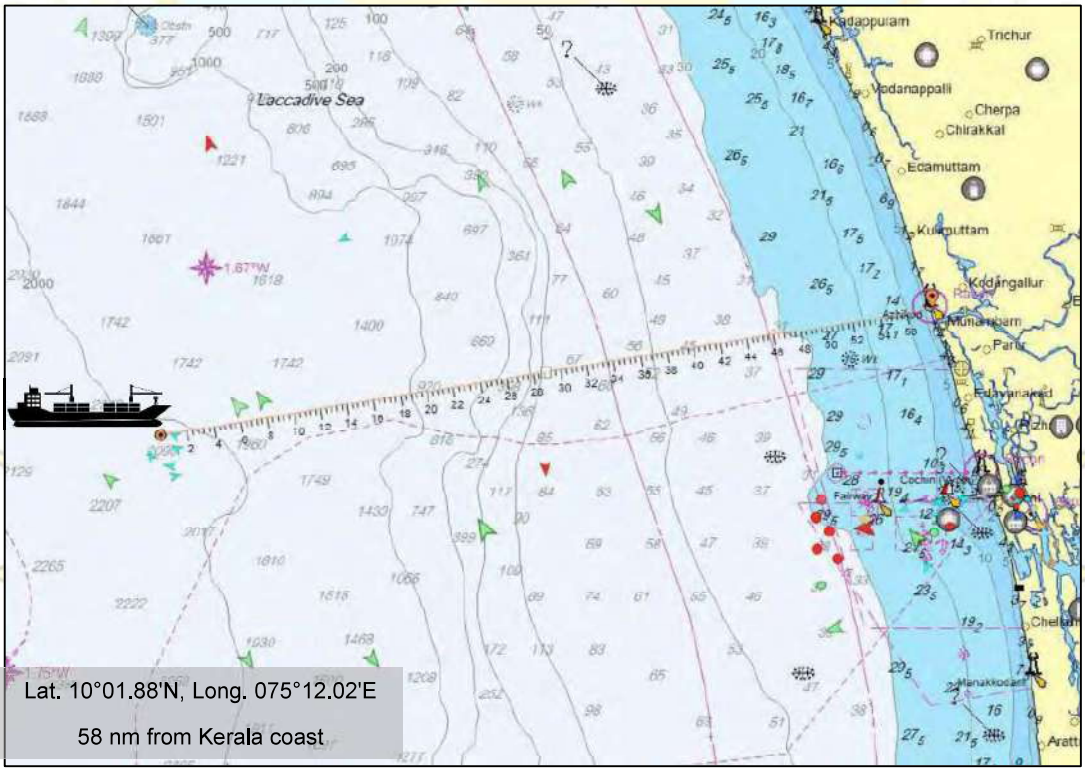

Figure 1: Position of WAN HAI 503 as on 16.06.2025 1200 hrs

The towline remains connected via *Offshore Warrior*, maintaining the vessel's offshore position and preventing further drift towards the Indian coastline or Lakshadweep islands. The vessel remains structurally afloat but continues to present persistent fire hazards in multiple compartments. While boundary cooling operations have successfully suppressed fires at Frames 49–51, where only white and light grey smoke is observed, new flare-ups persist forward near Frame 103–113 and a smaller fire continues near the forecastle on the port side. Dense smoke remains present in the forward starboard section, beneath the container base forward of the accommodation. Overall, fire suppression remains partially effective, but hotspots continue to require constant attention. Weather conditions continue to challenge ongoing operations, with sustained westerly winds of 32–40 knots, intermittent heavy rain, gusts up to 52 knots, and poor visibility.

4. Additional Support

The Directorate has maintained continuous multi-agency deployment to sustain both firefighting and towing operations. Seven tugs — *Offshore Warrior*, *Triton Liberty*, *Boka Winger*, *Saroja Blessing*, *Saksham*, *Garnet*, and *ETV Water Lily* — are deployed on site, executing boundary cooling in rotation, targeting high-risk cargo bays and maintaining the vessel's structural temperature balance.

Figure 2: Tugs conducting fifi operation

Offshore Warrior continues to maintain towing control while *Boka Winger* remains prepared to assume towing responsibility when required. Planning for establishing a

second towline remains a key operational priority, with two proposals under consideration: Option A (replacing the soft line using Offshore Warrior) and Option B (laying an independent tow via a separate tug), with the latter option currently being operationally favoured for safety and redundancy.

Firefighting foam supplies are being enhanced after the existing foam showed limited effectiveness; Pyrocool firefighting agent is being mobilised from the US and is being expedited for deployment. Additional firefighting teams continue to arrive, with eight personnel already deployed on-site, twelve more on standby in Kochi, and further reinforcements en route from Europe and the US pending visa clearances. Indian Coast Guard remains actively engaged with one vessel onsite, continuing aerial surveillance and providing mid-sea bunkering support for *Offshore Warrior* at controlled tow speeds of 1.5–2 knots. Indian Navy remains engaged, though operational arrangements are underway for the eventual release of *Triton Liberty* once personnel transfer can be safely executed via alternate tugs as three salvage team personnel are onboard Triton Liberty. The Navy has also offered helicopter winching support, subject to improving weather windows, for personnel transfer or towline operations if required.

Additionally, salvage teams have successfully removed a washed-up container and a lifeboat from coastal areas; these remain under customs control pending transfer to bonded facilities. ITOPF continues to provide shoreline monitoring, environmental modelling, and contingency planning support in coordination with

Figure 3: Lifeboat and container landed onshore on late hours on 15 Jun

5. Situation Assessment:

While immediate coastal threat remains contained, *WAN HAI 503* continues to present significant operational, environmental, and safety risks due to its persistent onboard fires, structural vulnerability, and highly volatile cargo composition. Stabilisation has successfully arrested coastal drift; however, current weather forecasts predict continued rough seas, westerly winds of 50–60 kmph, and intermittent heavy rainfall in the region for the next several days, complicating both firefighting and towing operations.

Securing a second towline remains the most critical priority to provide redundancy and improve stability for future long-haul towing, with eventual relocation options being evaluated for potential port of refuge outside Indian EEZ. Simultaneously, discussions continue with Kerala State authorities and shoreline response agencies to ensure readiness in the unlikely event of any rapid drift shift toward Indian waters. ITOPF has advised continued shoreline readiness, even as the vessel is progressively moved further offshore, to account for any container drift or unforeseen environmental spill scenarios.

Medical response efforts continue for the injured crew members, with five crew members still hospitalised including three in Intensive Care Unit (ICU). Ongoing liaison with families is being facilitated by the owners and authorities. At present, real-time coordination remains under the operational leadership of the Directorate General of Shipping, with constant updates provided to the Ministry of Ports, Shipping & Waterways and oversight from the highest levels of government.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 10, 1800 Hrs on 17/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 17 June 2025, *MV WAN HAI 503* is positioned at 10°03.64'N, 075°00.41'E, approximately 68.5 nautical miles off the Kerala coast, maintaining a slow north westward drift on course 250° at 1.0 knots.

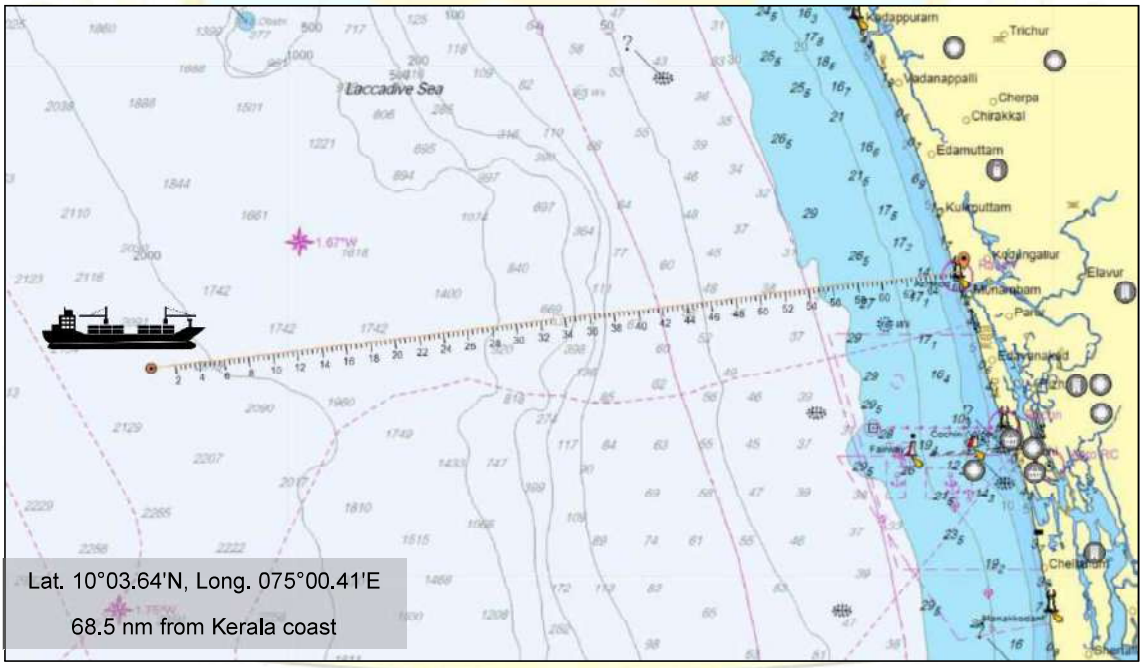

Figure 1: Position of WAN HAI 503 as on 17.06.2025 1800 hrs

The vessel remains connected via a single towline to *Offshore Warrior*, which continues to maintain her offshore position. Weather at the site remains adverse, with

westerly winds between 29–34 knots, gusting up to 39 knots, intermittent heavy rainfall, and periods of zero visibility, all of which are significantly impeding firefighting and boarding operations.

The condition of the fire onboard continues to show incremental improvement. Grey smoke is still observed in the midship area near Frame 113 (Bay 14) and at Frame 37–39, indicating persistent heat concentration. Light white smoke is intermittently visible forward of the accommodation block at Bay 50 on the starboard side. No naked flames have been reported in the accommodation or aft sections. Boundary cooling is being effectively maintained on deck, and internal compartments are being monitored through thermal imaging. The vessel remains afloat and stable, although her structural condition, particularly in high-heat-exposed zones, remains under close evaluation by the salvage team.

4. Additional Support

Firefighting and boundary cooling efforts continue in rotation with the support of four actively engaged tugs: *Boka Winger*, *Garnet*, *Saksham*, and *ETV Water Lily*, each targeting identified risk zones across the vessel, with emphasis on the midship and forward areas. The operational plan involves continuation of this rotation, ensuring uninterrupted cooling and containment.

Figure 2: Tug 'Boka Winger' conducting fifi operation

Offshore Warrior remains in command of towing and is also receiving bunkering support from the Indian Coast Guard to sustain operations, though the bunkering operations to further replenish the vessel were not successful owing to adverse weather conditions. While *Triton Liberty* has been released for redeployment by the Indian Navy, *Saroja Blessing*, which returned to port for engine repairs, is expected to be operational by midnight and may be tasked with laying the second towline, subject to prevailing conditions. Additional international salvage personnel including Dutch, Filipino, and Indian, are scheduled to board, along with specialised firefighting resources and equipment, including SCBAs and thermal cameras.

Figure 3: Towline connected to Offshore Warrior

MERC and SpillTech are now jointly managing the shoreline response mechanism, operating a 24x7 unit for container recovery and HAZMAT handling. Coordination for the mobilisation and visa facilitation of SpillTech's experts is ongoing. Environmental

support continues through ITOPF, and efforts are underway to assess and expedite high-capacity salvage tugs from regional hubs, including Sri Lanka and Singapore.

5. Situation Assessment:

The firefighting operation has achieved partial containment, with a noticeable reduction in visible flames and smoke intensity across most zones. Persistent smoke at multiple frames (particularly 113 and 37–39) and the history of internal flare-ups require sustained firefighting pressure, especially under continuing adverse weather. The vessel's reduced speed and maintained offshore trajectory are positive developments; however, the absence of a second towline remains a vulnerability. Establishing towline is crucial, given the dynamic sea state and the structural stresses already endured by the vessel.

Stability assessments suggest the vessel is operating within 90% of acceptable seagoing conditions, but targeted hull strength evaluations, especially near high-heat zones such as Bay 3 and forward sections, remain a priority.

Contingency discussions for a Port of Refuge continue, with Jebel Ali under primary consideration, subject to complete fire suppression, structural integrity assessments, and regulatory permissions. Alternatives in Bahrain, Sri Lanka, Malaysia, and Qatar are also under review. Identification of a body reportedly washed ashore near the Kerala coast is currently under verification, with support from local authorities.

The Directorate General of Shipping continues to lead the real-time coordination of all stakeholders, with regular operational briefings being submitted to the Ministry of Ports, Shipping and Waterways and reviewed at the highest levels of government. Efforts remain focused on fire suppression, structural safety, and safe relocation of the vessel out of Indian waters under controlled tow.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 11, 1800 Hrs on 18/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 0600 hrs on 18 June 2025, MV WAN HAI 503 is positioned at 09°52.70'N, 074°58.23'E, approximately 75 nautical miles off the Kerala coast, moving southwest at a course of 245° at a speed of 1.0 knot.

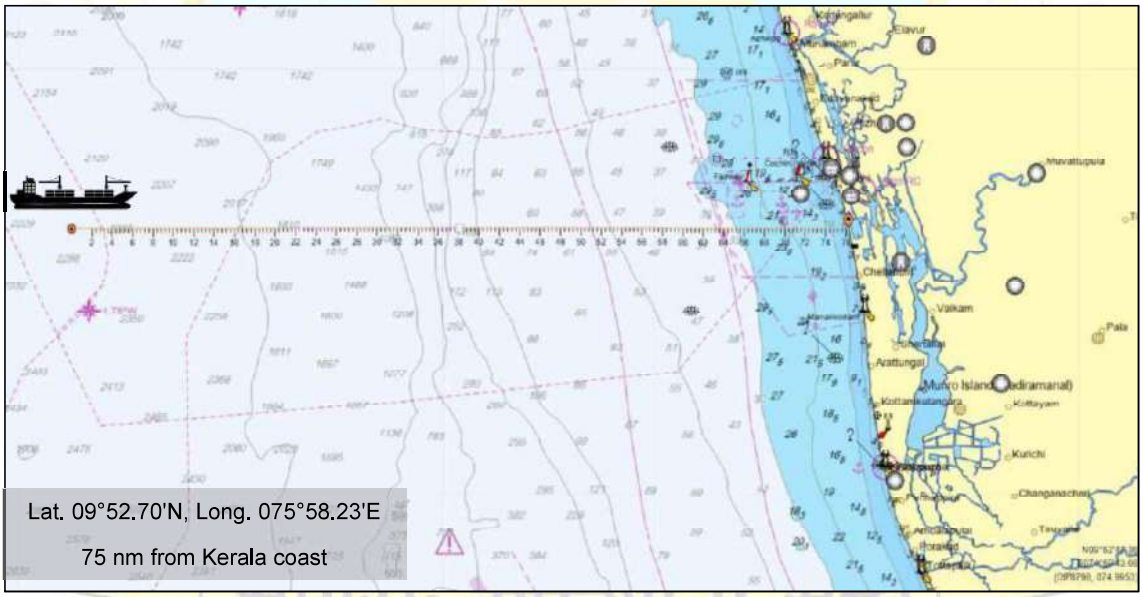

Figure 1: Position of WAN HAI 503 as on 17.06.2025 0600 hrs

The weather remains challenging, with westerly winds ranging between 22–24 knots and gusting up to 30 knots, accompanied by intermittent rain and poor visibility. Visible fire onboard has continued to subside; white smoke is now observed at midship, grey

smoke forward of the accommodation block, and a minor active flame is noted on the starboard side. No fire is currently visible on the port side of the casualty. Firewatch operations are being maintained onboard through visual surveillance and thermal detection.

Towline control was successfully transferred from Offshore Warrior to Boka Winger at 0932 hrs with the assistance of ETV Water Lily. The transition was undertaken smoothly and has enabled Offshore Warrior to return to Kochi for urgent refuelling and provisioning. Firefighting and boundary cooling operations are being undertaken in rotation by Boka Winger, Saksham, and ETV Water Lily, all of which continue to maintain deck and structural cooling to prevent re-ignition.

4. Additional Support

The salvage team has expanded its operations with firefighting force now prepared to join operations. Eight firefighters will be deployed from Garnet. A second team of 11 salvors is awaiting mobilisation aboard Saroja Blessing, which remains in port due to issues with the vessel's master. Efforts are underway to resolve this and redeploy Saroja as soon as possible. Triton Liberty, which was previously released, may be requested again to provide interim support if deployment delays persist.

Figure 2: Tug conducting fifi operation

Further operational enhancement is expected with the planned mobilisation of two high-capacity salvage tugs — GH Voyager from Singapore (210-tonne bollard pull) and Virgo from Sharjah. These are under technical inspection, and contractual arrangements have been initiated. In addition, a specially procured batch of 15 drums of Pyrocool, a specialised firefighting agent, has been dispatched from the United States and is expected to reach Dubai by 21 June. Once onboarded onto a support vessel, it is scheduled to reach the site before 25 June. The salvage team is also securing high-performance synthetic tow ropes from Singapore, which are pending customs clearance and will be used for improved towing reliability.

Figure 3: Ongoing Towing and Firefighting operations

Shoreline response operations continue under the supervision of MERC and SpillTech, who are actively monitoring the coast for drifting containers or hazardous debris. A human body suspected to be linked to the casualty has been recovered near the Kerala coast and is currently under verification by local authorities. Shipowners have confirmed they are in coordination with police and their legal advisors to manage the identification process with due sensitivity, given the emotional condition of the surviving crew.

5. Situation Assessment:

The firefighting operations have made steady progress, with a visible decline in active flames and a shift from dark to lighter smoke, suggesting the effectiveness of boundary cooling and surface suppression. However, the presence of residual hotspots, particularly near the starboard midship and forward accommodation zones, requires continued attention. The current holding position at 75 NM from the Indian coastline is considered operationally ideal for logistical access while minimising nearshore risk. The Directorate has advised that holding at this range is optimal to ensure day-return operations for supplies and personnel, without straining support logistics.

Despite progress, the absence of a second towline continues to pose a critical risk, particularly with the onset of the southwest monsoon. Tandem towing using a secured chain or wire remains the goal, with plans to undertake the second towline connection once *Saroja Blessing* is deployed or an alternate asset becomes available. Sea conditions have improved slightly, with swells around 3–3.5 metres, enabling safer transitions between vessels. The salvage master continues to assess the best strategy for secure long-range towing.

Discussions regarding the Port of Refuge are ongoing. Jebel Ali and ports in the UAE remain primary candidates, though monsoon-related risks for westward passage are under evaluation. Ports in Sri Lanka, Malaysia, and Singapore are also being considered. The selection will depend on vessel stabilisation, fire extinguishment, and the receiving port's willingness and readiness to manage damaged cargo, hazardous waste, and structural inspections. A comprehensive criteria matrix is being developed by the salvage team to facilitate formal submissions to the identified ports.

Environmental risk remains moderate at this stage, with no visible oil sheen or spill observed. ITOPF continues to support shoreline risk modelling, while P&I Club representatives are coordinating with local authorities for potential claims processes related to cleanup and third-party damages. The Directorate remains in continuous coordination with all relevant stakeholders and is actively supervising the evolving operational plan to ensure that stabilisation, firefighting, and safe relocation of the vessel remain on track.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 12, 1800 Hrs on 19/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 0600 hrs on 19 June 2025, *MV WAN HAI 503* is positioned at 09°40.74'N, 075°04.96'E, approximately 72 nautical miles off the Kerala coast, on a south-southeast drift course of 150° at a speed of 1.6 knots.

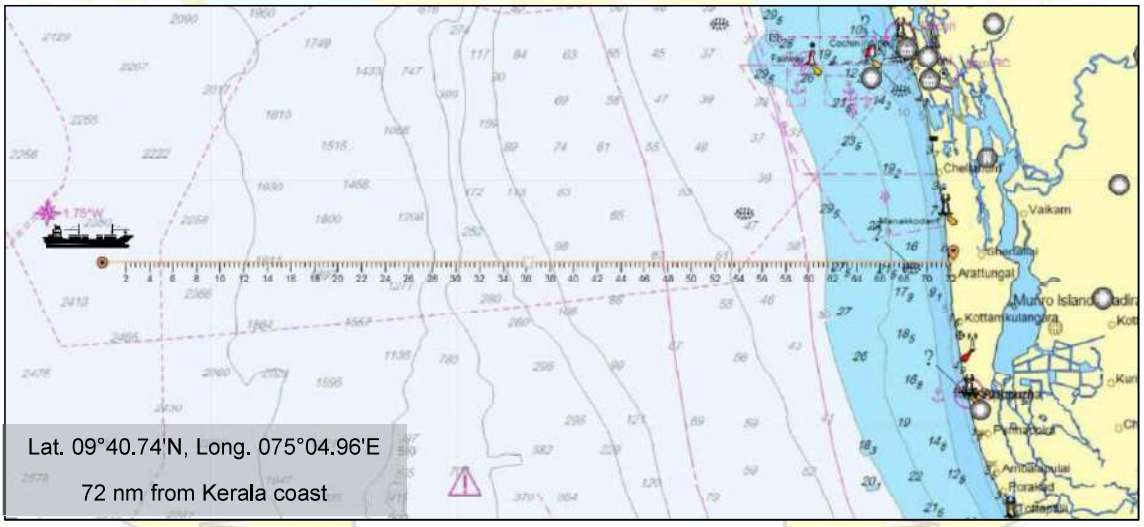

Figure 1: Position of WAN HAI 503 as on 19.06.2025 0600 hrs

Weather conditions have marginally improved, with westerly winds ranging from 12 to 17 knots and reduced rainfall, offering relatively stable conditions for the ongoing operation. The vessel is currently emitting white smoke from the forecastle through the midship area, while light grey smoke persists near the starboard side of the accommodation block. No flames have been observed on the port side. These

developments indicate a gradual reduction in fire intensity, although localised smouldering remains in isolated compartments.

Figure 2: Aerial assessment indicates only white smoke, no flames sighted

Firefighting and boundary cooling operations are being carried out in rotation by Saksham and ETV Water Lily, with firefighting teams maintaining continuous fire watch across critical zones. Towing responsibilities were successfully transferred from Offshore Warrior to Boka Winger, which is now maintaining the vessel's position offshore. The transition was completed at 0932 hrs with assistance from ETV Water Lily. Offshore Warrior has departed for Kochi to replenish fuel, provisions, and onboard supplies and is expected to return to station upon completion of turnaround.

4. Additional Support

Reinforcement efforts continue to be executed in a phased manner, both at sea and from port. *Saroja Blessing*, having completed bunkering and crew replacement, has

been redeployed and is en route to re-join the site operations. The vessel is being specifically tasked with supporting the connection of the second towline. *Garnet* has been temporarily released to Kochi and may return for drone-based thermal imaging and logistics support. Simultaneously, a 13-member firefighting team has boarded *Offshore Warrior* and is scheduled to attempt stern boarding of the casualty once the vessel returns to station. The plan is to utilise non-helicopter means for boarding where possible, though ICG support remains on standby for winching operations if required.

Figure 3: Condition of the WAN HAI 503 on 19 Jun

Efforts are underway to install two 125kVA generators aboard the casualty using tug-based transfer, to restore onboard emergency power for firefighting equipment and internal access systems. Onshore, the Directorate has coordinated with port and customs authorities to expedite vessel clearances and facilitate immigration procedures for incoming international salvage personnel. Discussions are also being held with local agencies to enable flexible vessel use for returning salvage crew, minimising procedural delays.

5. Situation Assessment:

Fire containment continues to progress steadily, with a marked reduction in heat signatures as recorded by thermal imaging. Temperatures within affected zones have dropped below 175°C, and visible fire activity remains isolated to smoke emissions, suggesting successful boundary cooling. Nonetheless, the structural integrity of the fire-impacted areas, particularly around the midship and forward compartments,

remains a concern. Sustained FiFi operations remain critical in this window to suppress residual heat and prevent re-ignition as weather conditions fluctuate.

Towing stability is currently being maintained by *Boka Winger* with the aim of positioning the vessel further offshore in anticipation of monsoonal weather patterns. The establishment of a second towline remains a high priority to ensure redundancy. *Saroja Blessing* has been tasked with this responsibility, and a messenger-wire-based approach is under consideration for safer and more durable wire rope deployment. Contingency plans for replacing the existing towline—suspected to have degraded—are also under active evaluation.

Strategic discussions regarding a Port of Refuge continue. *Hambantota* (Sri Lanka) has emerged as the preferred destination due to WAN HAI's prior commercial association with the terminal operator, a relatively short transit distance (approx. 480 NM), and preliminary willingness expressed by the port operator. However, formal clearance from Sri Lankan authorities remains pending. Jebel Ali and Bahrain are being evaluated as alternative options. Criteria being assessed include fire suppression capacity, structural inspection infrastructure, scrap cargo handling ability, and waste/water disposal facilities. Additionally, geopolitical and navigational factors such as avoidance of the Strait of Hormuz and monsoonal exposure are being carefully weighed.

Search and rescue operations for the four missing crew members have concluded as per protocol. Kochi Police have now requested that WHL provide the profiles of the missing crew members to facilitate identification. Additionally, they have asked for DNA and fingerprint data to support further investigation. At present, the identification of the recovered body has not yet been confirmed or completed. Though local police have informed that a body recovered ashore shows a high probability of being linked to one of the missing Indonesian crew. Confirmation is awaited through further identification measures being coordinated by the shipowner with the family. The P&I Club is in the process of establishing a single contact window for claims processing and has assured continued support to affected parties.

The Directorate General of Shipping continues to coordinate the multi-agency emergency response, providing operational leadership, resolving procedural delays,

and ensuring resource availability, while maintaining regular communication with MoPSW and all concerned authorities.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 13, 1800 Hrs on 20/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 0600 hrs on 20 June 2025, *MV WAN HAI 503* is located at position 09°54.7'N, 074°58.4'E, approximately 72 nautical miles from the Indian coast, maintaining a north-westward drift at a course of 320° and speed of 0.7 knots.

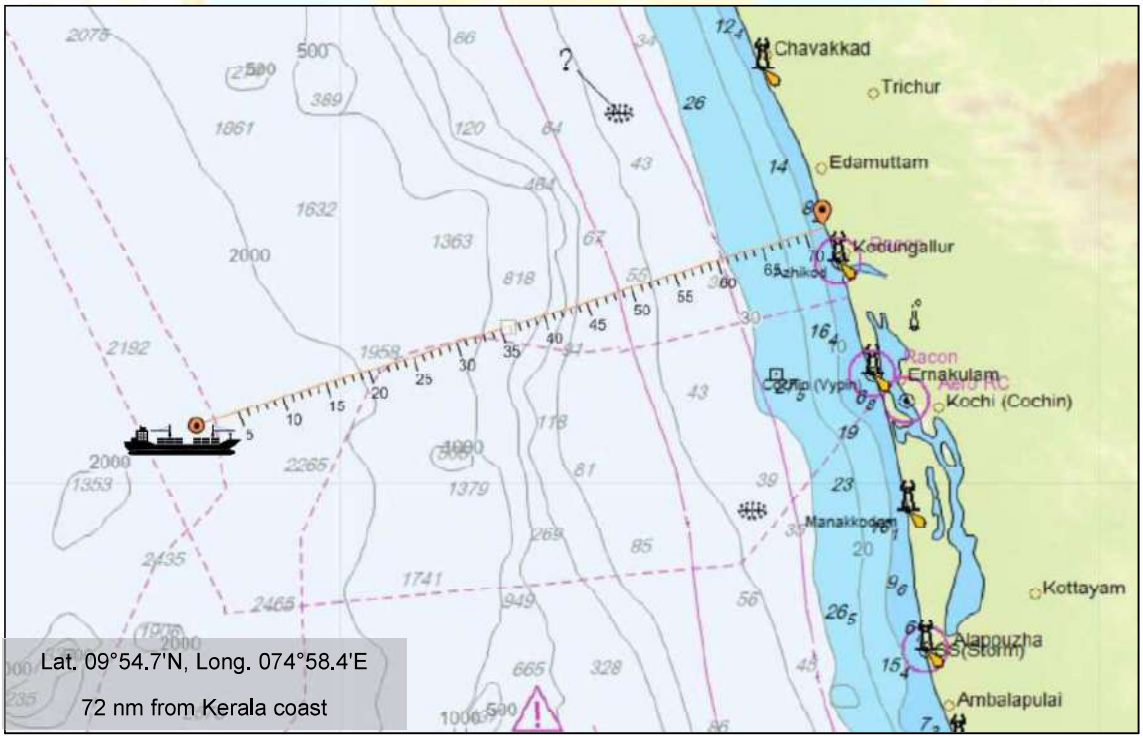

Figure 1: Position of WAN HAI 503 as on 20.06.2025 0600 hrs

Weather conditions remain moderate, with westerly winds between 12–16 knots, allowing salvage teams to sustain operations onboard. Smoke emissions persist in multiple sections of the vessel, with light white smoke rising from Bay 14, light grey smoke observed near Bay 35, and white smoke also seen from Bay 50. These emissions are being contained through ongoing boundary cooling.

Figure 2: Aerial assessment indicates only white smoke, no flames sighted

The vessel has now been successfully secured with two independent towlines. At 1730 hrs, dual 96 mm synthetic tow ropes were connected to the casualty by the salvage team, enhancing towing stability and risk mitigation. The towline initially held by Boka Winger was formally transferred back to Offshore Warrior, which has now resumed primary towing duties. This transfer was facilitated with the support of ETV Water Lily.

Firefighting, boundary cooling, and fire watch continue in rotation by Saksham and Water Lily as per the six-hour operational plan.

4. Additional Support

Reinforcement and logistical efforts continue to expand on site. At 1406 hrs, seven personnel—five T&T salvors and two professional firefighters—successfully boarded MV WAN HAI 503 to undertake internal fire damage assessment, secure the Voyage Data Recorder (VDR), and prepare access to midship and aft compartments. Additional safety gear is being mobilised to enable deeper internal inspections and potential deployment of Pyrocool fire suppressant once high-temperature zones are confirmed.

Figure 3: Condition of the vessel on 20 Jun. 25

Saroja Blessing, now onsite, has been actively supporting operations including the second towline connection and internal logistics. Pyrocool reserves carried aboard are scheduled for deployment in critical compartments within the coming days. Garnet is being prepared at Kochi port with additional salvage and firefighting equipment for rapid deployment, while SCI Panna is under consideration to replace underperforming assets at site, subject to technical and commercial evaluation.

Two portable generators have also been mobilised and positioned to restore onboard power for machinery access and lighting within compartments impacted by fire or structural collapse. Meanwhile, Indian Coast Guard continues aerial surveillance of the site, and has confirmed that *OPV Vikram* will replace the currently deployed Coast

Guard vessel, thereby maintain operational readiness while enable a phased withdrawal as salvage teams assume full control.

5. Situation Assessment:

The firefighting effort continues to show progressive containment, with no visible open flames and gradual dissipation of dense smoke in most affected areas. Nonetheless, persistent smouldering and inaccessible zones require continued boundary cooling and targeted suppression. Structural stability assessments confirm that the vessel remains afloat with no major compromise to overall integrity, although isolated compartments, particularly Bay 3, remain under monitoring for signs of water ingress. Cell guide collapse and deck damage have been noted, but the forecastle remains largely intact.

The successful deployment of two high-strength synthetic tow ropes marks a key milestone in the operation, substantially enhancing control of the casualty in high seas and enabling future long-haul towing. Plans are underway to replace one of the current synthetic lines with a steel wire towline as a long-term configuration to mitigate wear under monsoonal stress. The vessel's current distance from shore (approx. 72 NM) remains within the operationally safe buffer zone, and towing control has prevented any adverse drift toward the Indian coastline.

Discussions regarding a suitable Port of Refuge are actively progressing. *Hambantota*, Sri Lanka remains the leading candidate, with terminal operator support already secured. Final clearance from Sri Lankan authorities is awaited. Other ports under consideration include *Jebel Ali*, *Bahrain*, and *Colombo*, subject to logistical, environmental, and political evaluation. The Directorate has emphasised the need to finalise the port selection in coordination with ship-owners and MPA Singapore at the earliest to initiate the phased oil removal and structural assessment of the casualty.

Efforts to identify the recovered body suspected to be one of the four missing crew continue, with DNA and fingerprint data now submitted to Kochi police. The Ship-owners have initiated a coordinated liaison with family members of the missing crew and provided support for the medical care of those hospitalised. Two of the injured

crew are likely to be discharged shortly, while ICU patients remain stable and in contact with their families.

The Directorate General of Shipping remains in operational command of the multi-agency response, overseeing firefighting strategy, salvage coordination, environmental risk mitigation, and logistical facilitation in real-time, while continuing to report directly to the Ministry of Ports, Shipping and Waterways.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 14, 1800 Hrs on 21/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 21 June 2025, MV WAN HAI 503 is located at 10°12.46'N, 074°39.30'E, approximately 91 nautical miles from the Kerala coast, drifting at a speed of 0.7 knots on a 295° course.

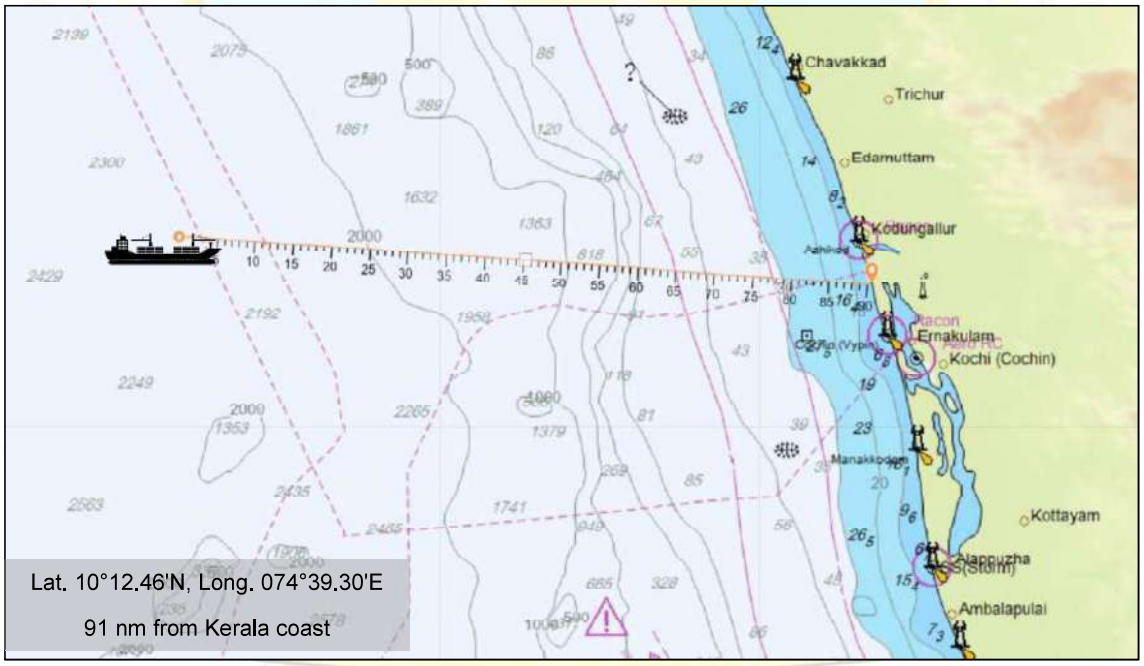

Figure 1: Position of WAN HAI 503 as on 21.06.2025 1800 hrs

Weather at the site remains operationally manageable with north-westerly winds ranging from 24–26 knots. The vessel remains under two secured towlines connected

through Offshore Warrior, maintaining position and preventing any drift toward the Indian coast.

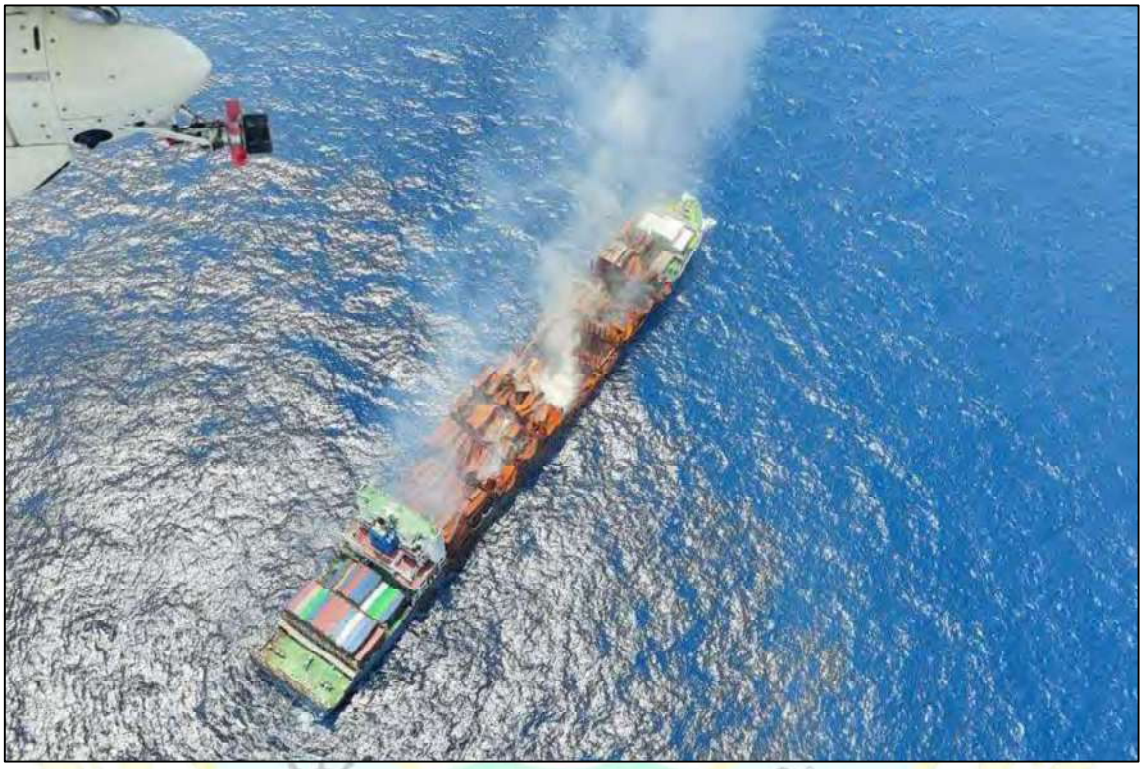

Figure 2: Aerial assessment indicates only white smoke, no flames sighted

Fire conditions onboard have improved, though localised smoke emissions persist. Grey smoke continues to rise from cargo hold areas between Bays 4–9, while light grey smoke is noted at Bay 14 and near Bay 37–39. Grey smoke from the hold area is also visible near Bays 33–35. No flames are currently visible on either port or starboard sides. Thermal imaging indicates a general decline in temperatures across the vessel. The hottest zones were recorded around Frame 123 (Bay 33) with a temperature of 55°C, and Bay 35 at 48°C, while areas such as Bay 39–50 now register ambient heat levels (32–36°C), suggesting that the fire has been largely suppressed.

Firefighting, boundary cooling, and fire watch are being carried out in rotation by *Saksham*, *Water Lily*, *Saroja Blessing*, and *Boka Winger*. At 1406 hrs, three personnel, a Salvage Master and two professional firefighters, boarded the casualty to conduct onboard inspections. Notably, ingress of water has been identified in the engine room, with estimated water levels of approximately 10 metres. The emergency generator appears unaffected and could be repurposed to power internal systems. Two Self-

Contained Breathing Apparatus (SCBA) units have also been transferred to the casualty via *Water Lily* for safe entry into restricted spaces.

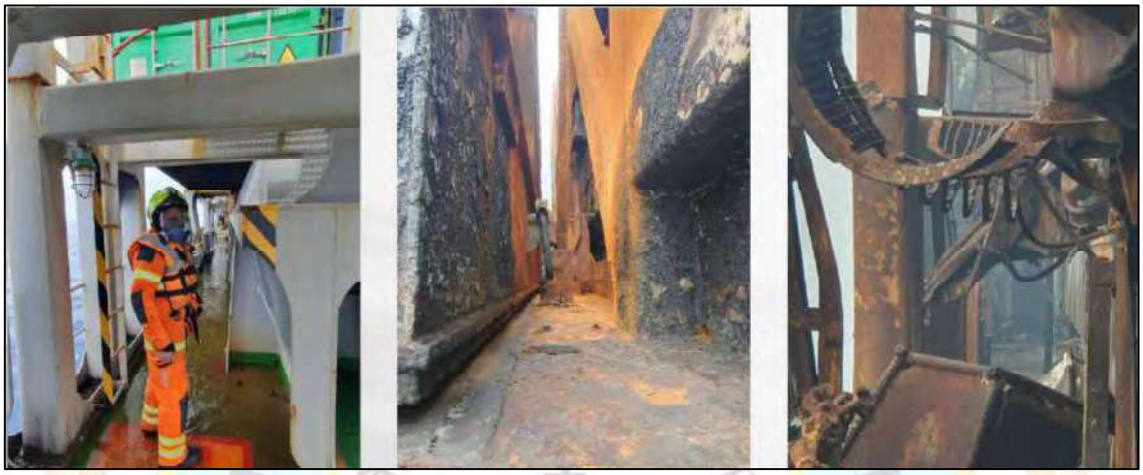

Figure 3: Personnel onboard assessing the vessel condition

4. Additional Support

The second tow rope—measuring 96 mm—was successfully connected to the casualty on 20 June, and the previously chafed rope from Boka Winger has been replaced. Current towing is being managed by Offshore Warrior, while Boka Winger remains available for additional FiFi (firefighting) support. Salvage personnel onboard continue to expand access inside the vessel, supported by equipment and supplies transferred via support tugs. Temperature gauging operations are being conducted

Figure 4: Vessel being towed by Offshore Warrior while Boka Winger remains available for additional firefighting support

systematically, and critical heat signature zones have been clearly mapped to guide targeted firefighting and ventilation.

Saroja Blessing continues to serve dual functions: boundary cooling and onboard deployment logistics, including thermal imaging surveys. Meanwhile, *SCI Panna* remains on standby (may not be used for the operation at all), and the high-capacity tug *Virgo* is en route from the UAE, expected to arrive within five days. Two portable generators are being prepped for installation onboard the casualty to restore basic onboard power to assist in the recovery of the Voyage Data Recorder (VDR), cargo hold ventilation, and deck lighting. The VDR has been retrieved and transferred to *Offshore Warrior* but awaits formal handover to MMD Kochi for investigation and data extraction. All coordination for VDR transfer and documentation is underway with the Directorate and Kochi authorities.

Shoreline monitoring continues under MERC and ITOPF. No new debris or drifting containers have been reported along the Kerala coast. One body previously recovered is being verified through DNA analysis in coordination with Kochi Police. Immigration and customs coordination for salvage crew changes and equipment mobilisation is being expedited through direct liaison between DGS and regional authorities.

5. Situation Assessment:

The vessel is currently stable under dual tow and maintaining position well clear of Indian coast, thus significantly reducing coastal risk. Thermal imaging reports and onboard inspections confirm that the fire is largely under control, with no active flames and declining temperatures. Persistent grey smoke in the midship and forward holds suggests the presence of deep-seated smouldering, which remains under continuous boundary cooling. Firefighting teams have been advised to prioritise targeted suppression in areas with residual heat, particularly in Bay 33–35 and Frame 103–123. The ingress of water in the engine room, while significant, is currently static and not presenting an immediate stability hazard.

The emergency generator's operability provides a critical opportunity to restore partial onboard power, supporting safer navigation through debris and improved internal communication. Structural assessments by T&T indicate buckling of steel components

in the midsection, likely caused by temperatures reaching 800–900°C during peak fire exposure. Collaboration with DNV's Emergency Response Service (ERS) is ongoing to assess structural strength and vessel stability for long-haul towing to a Port of Refuge.

Figure 5: Onboard assessment of the vessel

Hambantota, Sri Lanka, remains the preferred Port of Refuge. A site visit by the salvage team is scheduled early next week to coordinate with port authorities on the vessel's condition, draft, berthing requirements, and onboard hazards. Dubai and Far East ports such as Singapore and Malaysia remain backup options. Route planning (via east or west of Sri Lanka) will be finalised post-site assessment, based on prevailing sea and monsoon conditions.

The Directorate General of Shipping continues to provide unified command and daily oversight of salvage, firefighting, port clearance, and inter-agency coordination. Regular SITREPs are being shared with MoPSW, and coordination with MPA Singapore, vessel owners, salvage contractors, and Indian authorities remains uninterrupted to ensure the safe resolution of the incident.

सागराः सुपन्थानः सन्तु

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 15, 1800 Hrs on 22/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 22 June 2025, *MV WAN HAI 503* is positioned at 10°00.67'N, 075°06.78'E, approximately 70 nautical miles off the Indian coast, drifting at a course of 225° with a speed of 1.3 knots.

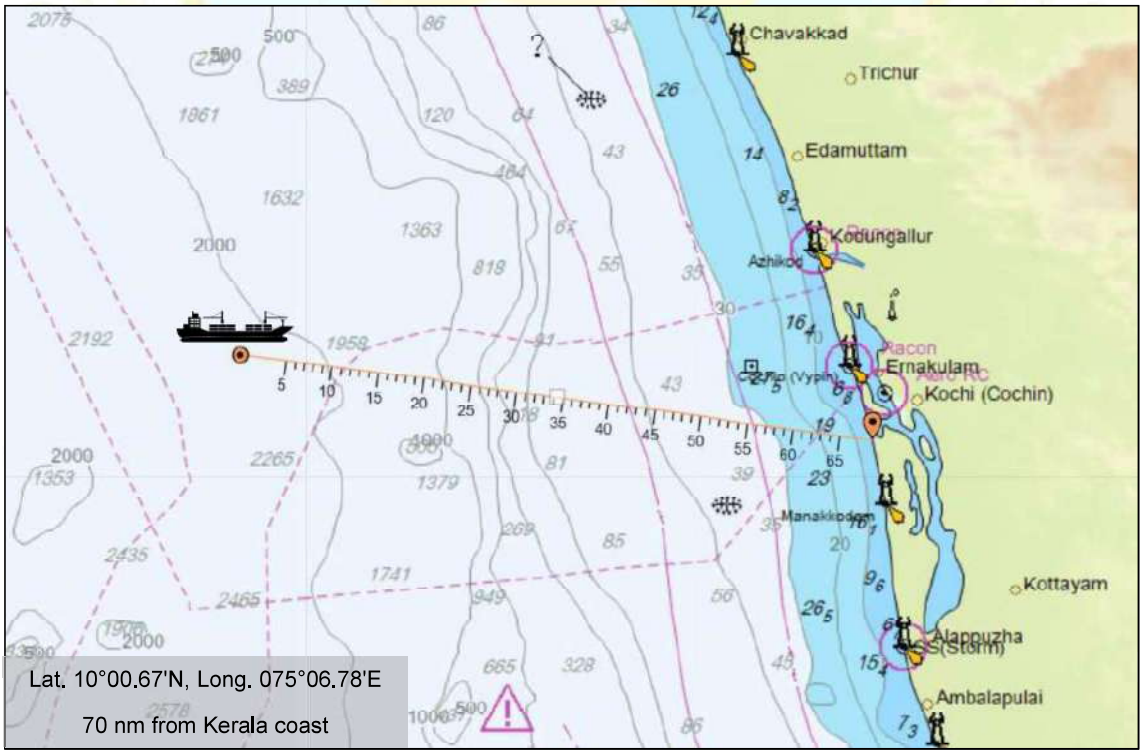

Figure 1: Position of WAN HAI 503 as on 22.06.2025 1800 hrs

Weather at the site remains challenging with moderate to rough seas, squalls, and westerly winds ranging from 14 to 16 knots. The vessel remains under dual towlines, with *Offshore Warrior* maintaining towing control.

Figure 2: Visuals of vessel as on 22.06.2025, 1220 hrs

Fire activity onboard remains active but localised. Bay 14 has witnessed a reignition with visible black smoke, while light grey smoke continues to be emitted from Bays 4–9 and 37–39. Firefighting efforts are ongoing with rotation between *Boka Winger*, *Saksham*, *Saroja Blessing*, and *Water Lily* as required. Boundary cooling has resumed and thermal imaging has been deployed to monitor evolving hotspots. The engine room continues to show signs of water ingress with the aft draft having increased by approximately 30 cm. Draft readings currently stand at 11.0 m (Forward Port), 10.8 m (Forward Starboard), and 12.6 m at midship, indicating hydrostatic balance at midsection but growing concern at the aft.

4. Additional Support

Operational support on site continues to be maintained by four principal vessels: *Saroja Blessing* (thermal imaging), *Boka Winger* (firefighting), *Water Lily*, and *Saksham* (fire watch and draft monitoring). Thermal imaging and structural assessments are guiding real-time firefighting decisions. Seven personnel including

the Salvage Master and two firefighters were deployed aboard the casualty on 21 June and continue internal checks on engine room flooding, generator status, and critical systems.

A diving operation is scheduled for 23 June to locate the source of the flooding and examine any hull breach or ducting damage. T&T has also been directed to deploy submersible pumps and assess the status of the emergency generator and the main switchboard. While the emergency generator appears unaffected, its use remains pending proper testing. Additional firefighting supplies, including Pyrocool, are in transit aboard *Virgo*, currently en route to Fujairah.

The VDR has been retrieved and is expected to be delivered ashore, following the applicable SOPs and procedures in coordination with Indian authorities. The assigned Master of WAN HAI 503 is scheduled to arrive in Kochi by 25 June, and VDR data extraction is scheduled for 26 June under his supervision. The P&I Club has been

requested to ensure legal witness presence. All related customs and logistics clearances are being coordinated.

5. Situation Assessment:

Urgent Measures Required – WAN HAI 503 to Be Kept Outside Indian EEZis not mitigated.

In light of ongoing drift and ICG's observations, a contingency plan is under review to tow the vessel 200 NM away from the Indian coastline. If no further shore-based support is required, this directive may be implemented within the next 24 hours. The final decision will be based on the salvor's submission, diving results, and engine room stability.

The scheduled Port of Refuge visit to Hambantota on 24 June remains on track, contingent on clearances and environmental safety protocols. All stakeholders have been instructed to finalise route options, taking into account weather windows, firefighting status, and structural integrity. Should the casualty show signs of worsening stability, emergency relocation will be executed without delay.

The Directorate General of Shipping continues to oversee and coordinate all inter-agency efforts to ensure the safe management of the incident and protection of India's maritime environment and coastline.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping, 9th Floor Beta Building, I-Think Techno Campus, Kanjurmarg (East), Mumbai - 400 042 (India)

Directorate General of Shipping

SITREP – 16, 1800 Hrs on 23/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1200 hrs on 23.06.2025, MV WAN HAI 503 remains under tow at position 10°03.17'N, 074°58.16'E, approximately 72 nautical miles from the Indian coastline, making a course of 350° at 1.5 knots.

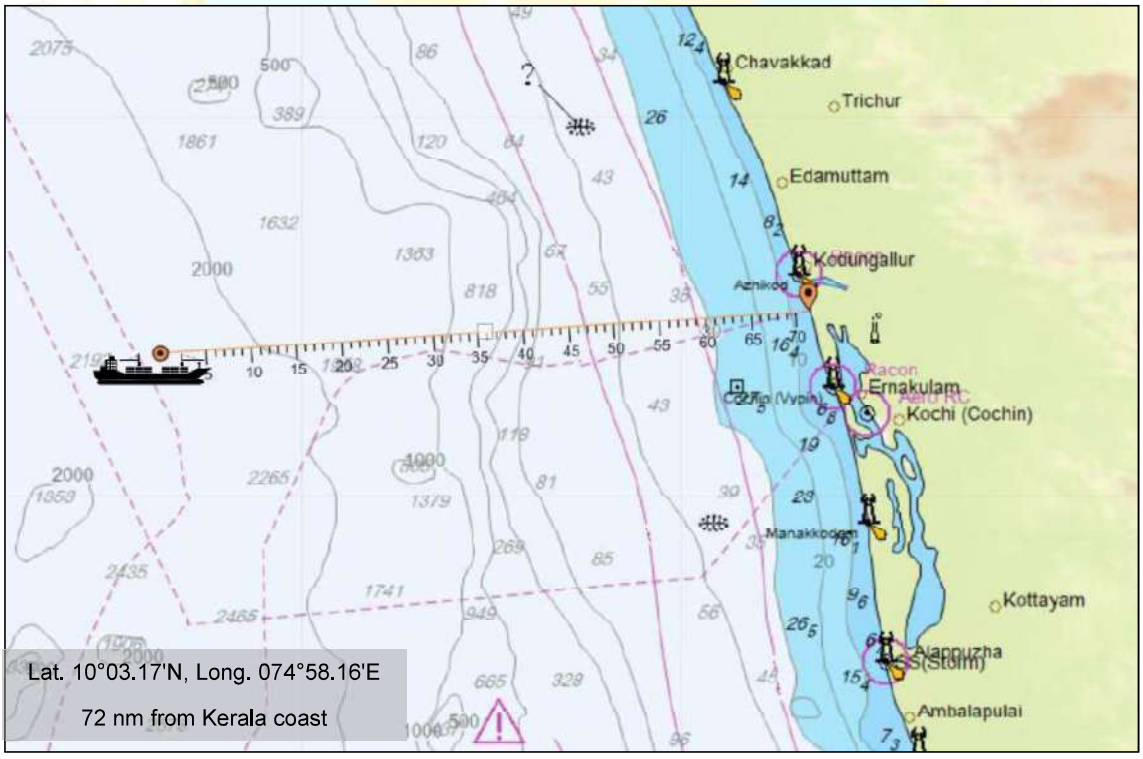

Figure 1: Position of WAN HAI 503 as on 23.06.2025 1200 hrs

The vessel continues to emit grey smoke from Bay 14 and thick white and grey smoke between Bays 27-33, with light white smoke observed near Bay 38. Boundary cooling operations and fire watch are ongoing, carried out in rotation by tugs Boka Winger, Saroja Blessing, and Water Lily. Offshore Warrior is maintaining position through the primary tow arrangement. Thermal imaging conducted earlier today recorded temperatures peaking at 64.7°C between Frames 93 and 103, correlating with intermittent flare-ups observed in recent days. Two of the forward hatches remain open, with Hold No.4 partially opened for ventilation and access.

Figure 2: Condition of the vessel on 22.06.2024, 1220 hrs

Draught measurements indicate the vessel remains stable with forward draught readings at 10.6m (port) and 10.4m (starboard), while the midship markings are submerged at approximately 12.6m. The aft draught remains submerged but unchanged. Despite visual perception of increased trim aft, onsite assessments attribute this to weather conditions, with no significant structural changes reported.

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4. Additional Support

Salvors have confirmed the engine room atmosphere is gas-free, allowing safe access for ongoing inspection and future dewatering operations. Emergency generator activation remains pending due to non-functional batteries; replacements have been

dispatched onboard tug Saksham and will be delivered shortly. Firefighters and salvage teams are coordinating to access the vessel's forecastle via multiple routes, with ongoing discussions regarding safe boarding options. Yokohama fenders have been mobilised to facilitate safe personnel and equipment transfer.

The process to reinforce tow arrangements is underway. Salvors plan to replace the current tow line with more robust towing gear stored onboard Saksham, expected to depart shortly. Offshore Warrior will complete bunkering operations at sea to sustain extended towage. Simultaneously, dive inspections of the hull are planned to assess potential ingress points and enable engine room dewatering.

Salvage assets Atlantis Virgo, carrying critical fire suppression materials (Pyrocool) and additional tow gear, departed Fujairah and is en route, with arrival expected by 29.06.2025. These resources will significantly enhance onboard fire management and long-term stabilisation efforts.

5. Situation Assessment:

The vessel's condition remains stable with a slight list of approximately 4°, confirmed through bridge-level inspection. Intermittent flare-ups within the cargo holds are attributed to residual burning of stored commodities as advised by fire experts. Boundary cooling remains the primary firefighting strategy to minimise additional water ingress and manage heat build-up. Complete extinguishment of internal fires is considered viable only upon access to port facilities equipped for container removal and deep access.

Environmental concerns persist due to onboard heavy fuel oil (HFO) and marine gas oil (MGO) inventories. ITOPF assessments indicate a risk of persistent oil pollution affecting adjacent states should containment fail. The Directorate has reiterated to salvors the urgency of finalising dewatering operations, reinforcing tow arrangements, and moving the casualty a minimum of 100 nautical miles southwest, off Trivandrum, within the next 48 hours. This directive prioritises reducing coastal environmental risks during the monsoon period.

Port of refuge options continue to be explored. Salvors are instructed to formalise this within 48 hours while progressively relocating the vessel further offshore, as a precautionary measure. Preparations for potential oil removal operations are to commence immediately, aligned with weather conditions and vessel stability.

A structured salvage timeline and comprehensive risk mitigation plan remain awaited from salvors. The Directorate will enforce necessary measures to safeguard Indian waters and coastal interests should these actions not progress satisfactorily within stipulated timeframes.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 17, 1800 Hrs on 24/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 0600 hrs on 24.06.2025, MV WAN HAI 503 remains under tow at position 10°12.80'N, 074°58.47'E, approximately 71 nautical miles from the Indian coast, maintaining a slow westerly drift at 0.5 knots on a course of 289°.

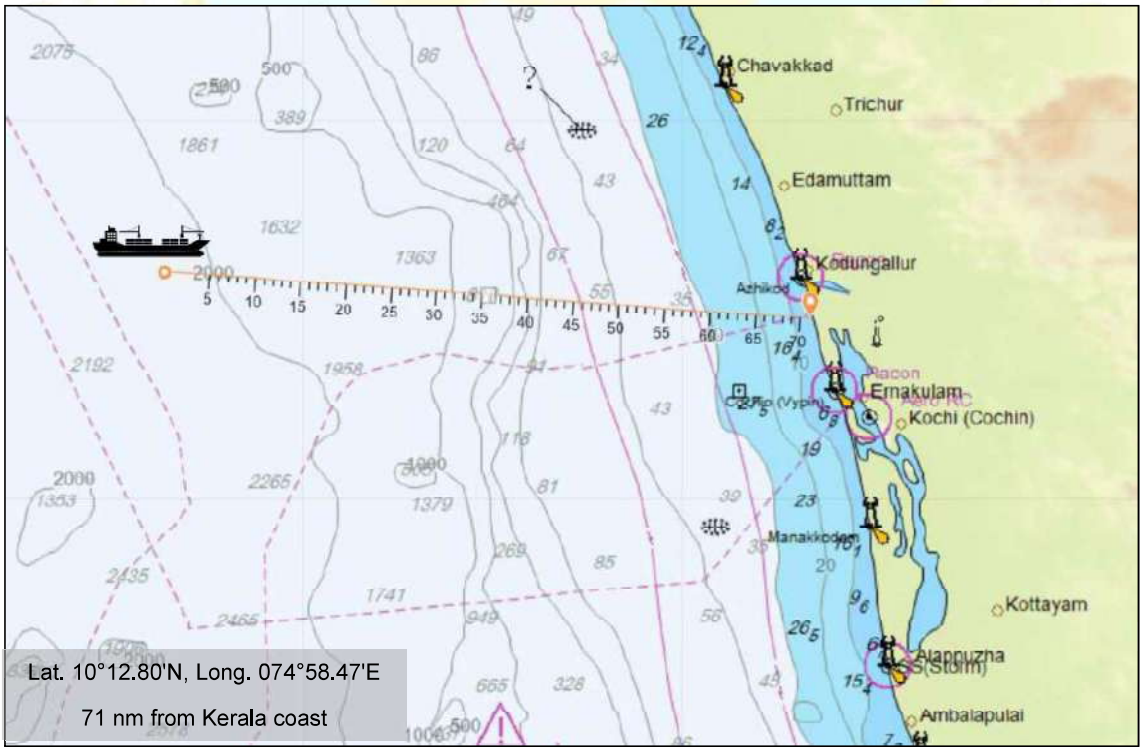

Figure 1: Position of WAN HAI 503 as on 23.06.2025 1200 hrs

The vessel remains hydrostatically stable with no significant change in draft or list, though a consistent 4.4° port list is reported. Latest thermal imaging indicates a general cooling trend across structural frames, with temperatures ranging between 27°C to 37°C. However, smoke conditions remain concerning, with light white smoke at Bay 14, dense grey and black smoke between Bays 27-33, and white smoke emanating near Bay 37-39. Salvage teams have commenced onboard inspections under challenging weather conditions, focusing on dewatering the engine room, securing the forecastle for further tow arrangements, and fire management.

Figure 2: Draft & list of the vessel

4. Additional Support

Offshore support vessels Boka Winger, Saroja Blessing, and Water Lily continue to maintain boundary cooling, fire watch, and transportation of salvage personnel and equipment. Offshore Warrior holds the primary tow connection to maintain the vessel's offshore position. Salvage resources have been augmented with the recent arrival of

Saksham, carrying essential Yokohama fenders, submersible pumps, portable generators, and firefighting gear to enhance operational safety and facilitate onboard dewatering. A combination of pneumatic, submersible, and independent power-pack driven pumps are now staged for immediate deployment in the engine room. Salvage divers and senior personnel have boarded to assess the vessel's internal conditions, especially in critical areas such as the forecastle and accommodation sections. The CO_2 fire suppression system onboard remains operational, offering contingency options for isolated fire outbreaks within the cargo holds.

5. Situation Assessment:

The vessel's structural condition remains broadly stable, with no major deterioration observed; however, the presence of intermittent smoke and gas pockets within the cargo holds necessitates continued vigilance. The salvage master has confirmed safe but restricted access to the forecastle and underdeck passage on the port side, while starboard access remains unsafe due to high gas concentrations. Dewatering of the engine room is a high priority, with equipment deployment commencing as soon as weather conditions allow. Plans for reinforcing the towline system are in progress, with new towing arrangements being prepared on site.

The Directorate has directed that the casualty be progressively towed further offshore, aiming for a minimum 100 nautical mile buffer from the Indian coast and Lakshadweep islands within the next 72 hours. Salvors have been instructed to expedite stabilisation works, with particular emphasis on relocating the vessel towards a southeasterly direction to minimise coastal and environmental risks. Coordination efforts for potential ports of refuge continue to secure a suitable location for final salvage operations, including bunker removal and structural repairs. Contingency discussions are also ongoing with alternate ports, given the evolving risk scenario.

Further updates will be provided following completion of onboard dewatering efforts, dive inspections, and the next salvage team assessment.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 18, 1800 Hrs on 25/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 25.06.2025, MV WAN HAI 503 remains under controlled tow, positioned at 09° 58.47' N 075° 00.09' E, approximately 70 Nautical Miles off Kochi, progressing on a south-southeasterly course at an average speed of 3.0 knots.

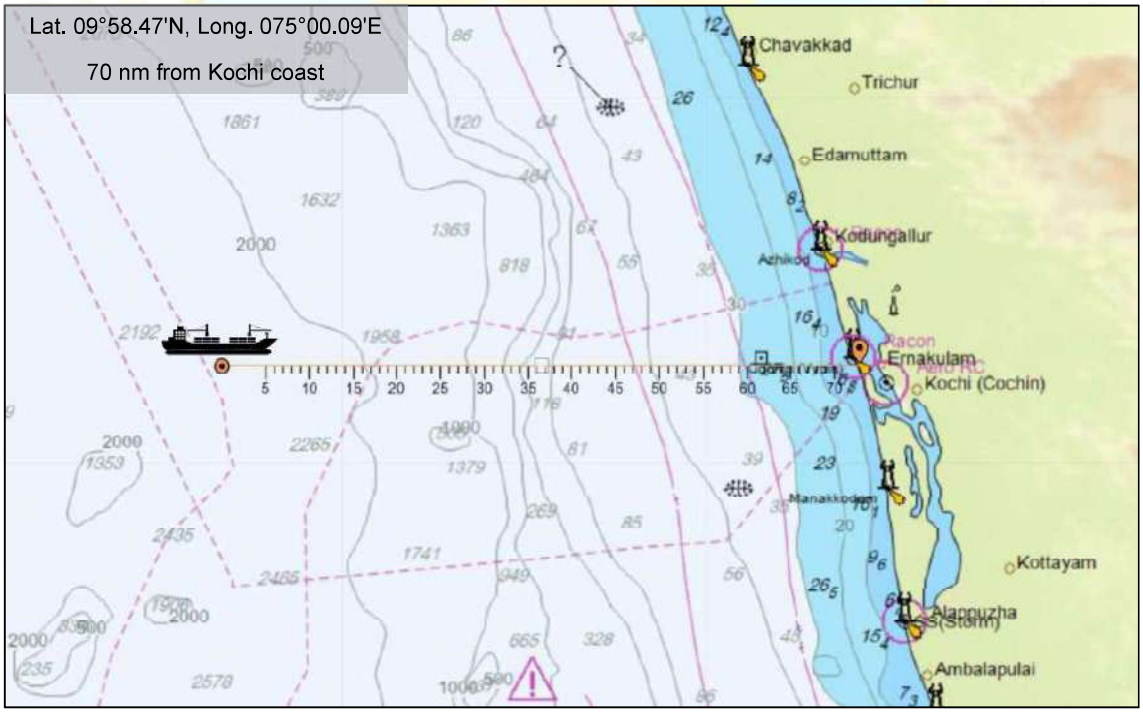

Figure 1: Position of WAN HAI 503 as on 25.06.2025 1800 hrs

The towage operation, being undertaken by Offshore Warrior, is directed towards the area off Vizhinjam, with an expected arrival by 27th June AM. Weather conditions in the area remain rough, with winds recorded at 22-24 knots from 250°, and prevailing sea states continue to challenge onboard activities. Smoke conditions persist, with dense black smoke observed between Bay 27 to Bay 37, and light grey smoke noted from Bay 37 to Bay 39. No active flames have been reported at present.

4. Additional Support

Onsite firefighting and boundary cooling operations are ongoing, with coordinated efforts by Boka Winger, Saksham, and Water Lily. These assets are engaged in continuous fire watch and cooling cycles to manage the thermal risk onboard. Offshore Warrior continues to maintain towage stability. Measures are also underway to replace the soft tow connections with permanent wire ropes, though progress has been hampered by prevailing weather conditions. Salvors have been instructed to prioritise the immediate connection of permanent tow lines at the earliest safe opportunity. Simultaneously, medical assistance has been arranged for the salvage crew of Saroja Blessing, who reported symptoms of illness upon returning to port.

5. Situation Assessment:

While the vessel remains structurally afloat, concerns persist regarding the residual fire hotspots in cargo holds and the emission of dense black smoke from midship sections, indicating ongoing smouldering. The vessel's drift trajectory has been stabilised, and the controlled towage away from the Indian coastline and Exclusive Economic Zone (EEZ) is progressing as per instructions from the Directorate. Challenges in boarding operations due to adverse weather continue to delay critical tasks, including final towline reinforcements and equipment transfers. Efforts to secure permanent towing arrangements, transfer salvage teams, and assess onboard conditions are being closely coordinated. The Directorate has reiterated that towage away from the Indian EEZ is to continue without interruption, with priority being the safety of the crew, environmental protection, and stabilisation of the casualty. Compliance with these directives is being strictly monitored.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 19, 1800 Hrs on 26/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 25.06.2025, MV WAN HAI 503 remains under tow approximately 88 Nautical Miles off the Indian coastline, positioned at Lat. 09°16.73'N Long. 074°49.96' E, proceeding west-southwest at speeds between 1.2 to 3 knots with heavy rolling and pitching due to persistent rough sea conditions.

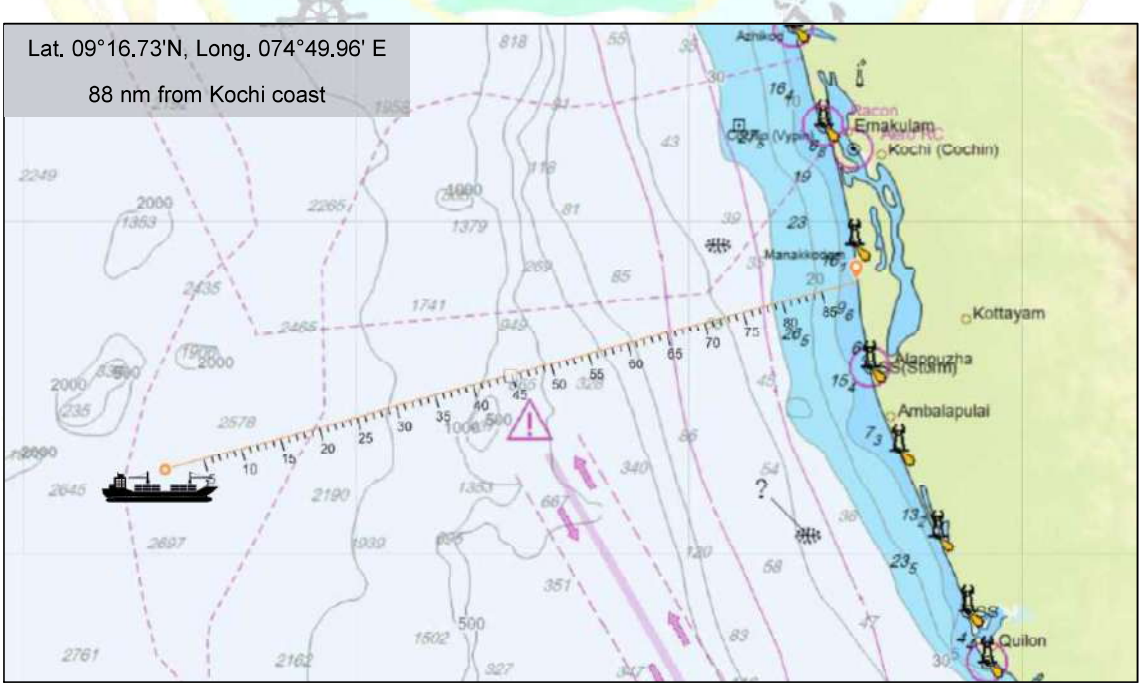

Figure 1: Position of WAN HAI 503 as on 26.06.2025 1800 hrs

Approximately 90 miles have been covered so far, with the vessel expected to exit the Indian EEZ by late 27th or early 28th June, weather permitting.

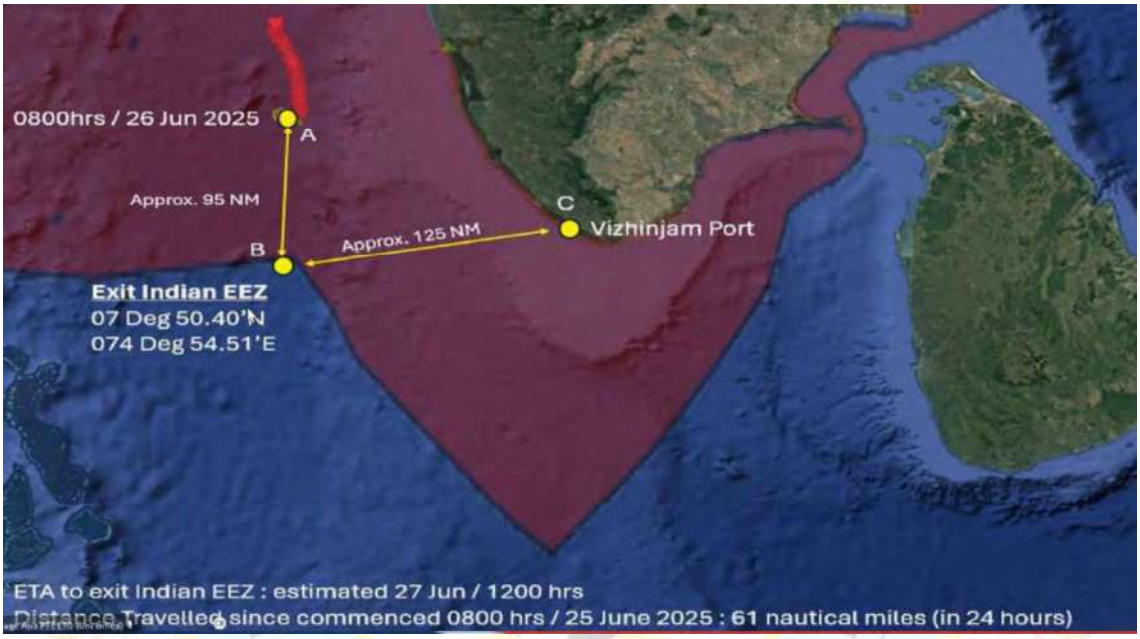

Figure 2: Estimated trajectory for vessel movement

The fire situation in cargo hold no. 4 remains critical. Structural failures, including a partial hatch collapse and container stack collapse in the forward section, have increased ventilation, allowing strong winds to exacerbate the smouldering fire, particularly in containers storing plastic resin. Thermal imaging indicates hotspots at frames 83, 93, and 103 with temperatures peaking at 228°C. Dense black smoke continues to emit from hold no. 4, with boundary cooling being conducted continuously by tugs Saksham and Water Lily from both port and starboard sides.

Despite multiple boarding attempts, salvage teams have been unable to safely access the vessel due to deteriorating weather and safety risks, including unknown contaminants in the flooded engine room. Searches for the missing crew member

remain a top priority during each boarding attempt, though no remains have been found to date.

The port midship draft markings remain obscured due to heat-related paint damage, not submersion. Stability remains a concern due to flooding in the engine room and limited dewatering capability at present.

4. Additional Support

Salvage resources currently deployed include Offshore Warrior (towing), Saksham, Water Lily (boundary cooling, firefighting), and Saroja Blessing (carrying additional equipment and independent pumps). Pyrocool firefighting material remains en route aboard Virgo, scheduled to arrive by 29th June.

Figure 3: Vessel condition on 26 Jun. 25

A complete suite of salvage equipment, including independent pumps with 800-900 cubic meters per hour capacity, power packs, compressors, hot-tapping units, de-

fuelling gear, and fast-response firefighting kits are staged onboard tugs. Salvage divers with contaminated water dive suits are present onsite but have not been cleared to enter the flooded engine room pending water quality testing to assess chemical hazards from compromised container cargo.

VDR remains secured onboard Offshore Warrior, with transfer to Water Lily planned at the earliest opportunity for subsequent delivery to MMD Kochi. CO_2 reserves are confirmed available, with 198 bottles on site. However, CO_2 deployment in cargo hold no. 4 remains unfeasible due to structural breaches. Salvors plan to deploy CO_2 in holds 5 and 6 once structural integrity checks are completed.

WAN HAI Lines continues to pursue Port of Refuge approval, with agency coordination and harbour master engagement underway. Crew members injured during the initial incident remain stable, with ICU cases showing signs of recovery.

5. Situation Assessment:

The vessel remains exposed to compounded risks from ongoing fires, uncertain hazardous cargo, and rough weather conditions hampering onboard operations. The presence of over 280 containers with incomplete manifest data continues to pose a significant hazard to firefighting teams, though updated information has now been received from WAN HAI Lines and is under ITOPF review for hazardous material classification.

Firefighting teams face substantial challenges due to open ventilation in hold no. 4, which continues to feed the smouldering fires despite boundary cooling efforts. Inaccessible sections and unknown cargo content restrict direct firefighting options. Salvors have confirmed that excessive water application remains constrained to avoid worsening the engine room flooding, which currently contributes to compromised vessel stability.

Towing operations towards international waters are a critical priority to mitigate coastal environmental risks. The Directorate has directed T&T Salvage to maintain course and speed to expedite the vessel's exit from the EEZ. Replacement of Boka Winger remains pending following the owner's refusal to extend deployment beyond

contractual obligations. Salvors are coordinating alternative tug resources from Sri Lanka and anticipate Atlantis Virgo's arrival to supplement the towing and firefighting operation.

Weather conditions are expected to improve temporarily, providing a narrow window for critical actions. The Directorate has instructed that, weather permitting, salvage teams must prioritise boarding to commence dewatering of the engine room, conduct necessary fire suppression within accessible areas, and assess hull and pipeline integrity before CO_2 deployment.

The Directorate also emphasises that salvors must test the engine room water for contamination prior to diving operations to safeguard personnel. Should conditions permit, divers may seal internal pipe leaks to isolate the engine room and enable effective dewatering. Immediate focus remains on stabilising the vessel, maintaining fire control, and securing a safe tow beyond Indian jurisdiction.

Coordination with all stakeholders continues, with clear directives issued to WAN HAI Lines to provide comprehensive container manifest data and assist with expediting all approvals for Port of Refuge access. T&T Salvage has been instructed to finalise plans for ETV replacement, initiate hard wire towline installation when feasible, and prepare contingency measures for all salvage operations.

The Directorate reiterates that environmental protection, crew safety, and vessel stabilisation remain paramount, with all available resources to be deployed toward achieving these objectives in the shortest possible timeframe.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 20, 1800 Hrs on 27/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hours on 27th June 2025, MV Wan Hai 503 is positioned at 09° 06.52' N, 074° 23.49' E, approximately 120 nautical miles from the Indian coastline, progressing westward at a speed of 0.5 knots under moderate sea conditions with westerly winds of 18 to 20 knots.

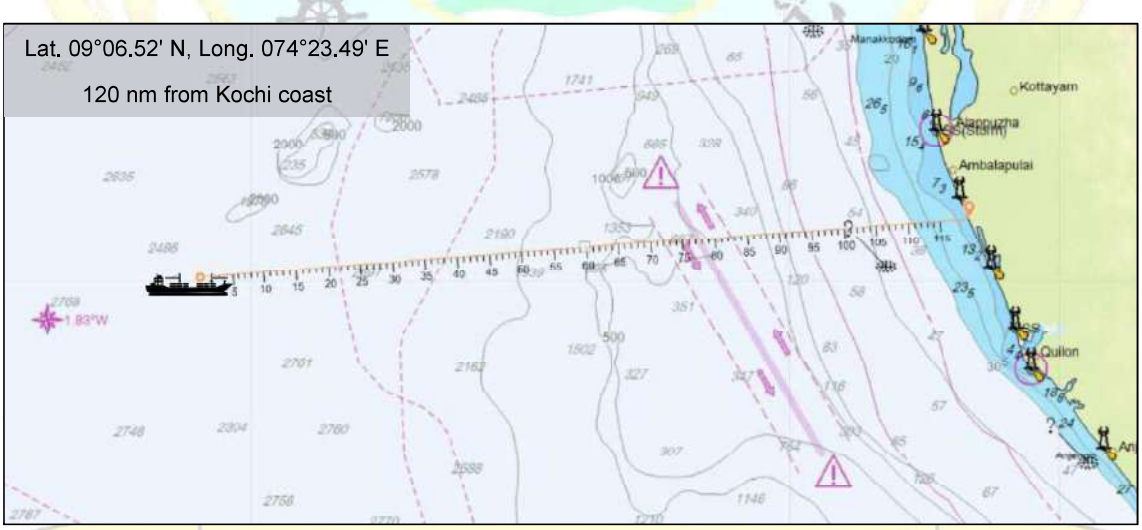

Figure 1: Position of WAN HAI 503 as on 27.06.2025 1800 hrs

Offshore Warrior continues towing operations with approximately 75% power utilisation, amending course as required to facilitate boundary cooling and other critical response efforts.

The salvage team, comprising the Salvage Master, firefighters, and support personnel, successfully boarded the vessel this morning under a temporary window of improved weather. Emergency generator power has been restored with the installation of new batteries, enabling limited onboard operations. Two wire pennants have been secured to the vessel's bollards, reinforcing towline arrangements.

CO_2 has been released into cargo hold no. 5 following verification of procedures and system integrity. Grey smoke remains visible on the starboard side between Bays 33-35. No further remains of the missing crew have been located despite repeated inspections. Water ingress in the engine room has increased to cylinder head level, with minimal water detected in the steering gear room, suspected to have entered via the upper deck access door.

4. Additional Support

Tug Saksham is alongside the casualty vessel facilitating salvage gear and personnel transfer, while Water Lily is engaged in the transfer of personnel and the Voyage Data Recorder (VDR), which has now been shifted to Water Lily for transport to Kochi Port. Offshore Warrior maintains towing operations aimed at moving the vessel out of the Indian Exclusive Economic Zone (EEZ), with approximately 82 nautical miles remaining to exit Indian jurisdiction.

Saroja Blessings is currently enroute to the casualty location with critical firefighting and pumping equipment, including independent pumps, compressors, and shallow-water diving apparatus. Additionally, Tug SCI Panna is scheduled to depart post bunkering at 2000 hours on 27th June to replace Saroja Blessing, while Atlantis Virgo is expected on-site by 30th June with additional salvage materials, including Pyrocool fire suppressant.

Equipment has been prioritised for rapid deployment, including submersible pumps, pneumatic and hydraulic pumps, generator-supported systems, and safety apparatus for hazardous entry. Water sampling and safety assessments are being arranged

before diving operations can be approved within the flooded engine room, considering potential chemical contamination from cargo ingress.

5. Situation Assessment:

The operational environment remains challenging, with heavy swell and rolling conditions limiting safe access to the casualty for comprehensive firefighting and dewatering efforts. The vessel's draft has increased but remains within permissible parameters, and structural stability assessed at 75.9% of allowable sea forces. However, the presence of unknown cargo—over 280 containers with incomplete declarations—continues to pose uncertainty regarding fire escalation risks and crew safety.

Figure 2: Condition of the vessel on 27 Jun 2025

The partial collapse of deck structures over cargo hold no. 4 has compromised containment, with wind-driven air ingress fuelling smouldering fires, particularly in containers suspected to hold plastic resin. While boundary cooling is ongoing via available tugs, direct internal firefighting remains constrained until access is viable.

Dewatering of the engine room is deemed a critical immediate priority to mitigate stability concerns and enable safer ongoing operations. The restored emergency generator allows for essential power supply to pumps, with supplementary systems staged for rapid deployment. CO_2 suppression in cargo hold no. 5 has been

completed, with caution exercised regarding potential pipeline damage across the vessel's compromised structure.

The vessel is projected to exit the Indian EEZ within the next 24-36 hours, weather permitting. Coordination with authorities for potential Port of Refuge entry at a port remains active, with efforts supported by the flag state and salvage representatives. Contingency planning for alternative ports in the Far East remains under consideration.

The Directorate has reinforced directives for expedited dewatering, continuous towing beyond the EEZ, and sustained firefighting readiness. Replacement plans for the ETV Water Lily are progressing, with final timelines subject to weather and operational requirements. The Directorate is closely monitoring all developments to ensure environmental protection, navigational safety, and continued risk mitigation in coordination with all stakeholders.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 21, 1800 Hrs on 28/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

The vessel WAN HAI 503 continues its towage operation towards exiting the Indian Exclusive Economic Zone (EEZ). As of 1200 hrs on 28 June 2025, the vessel was located at position 08° 34.86'N, 074° 22.43'E, approximately 129 nautical miles from the Indian coastline, proceeding on a southerly course at a speed of 2.9 knots.

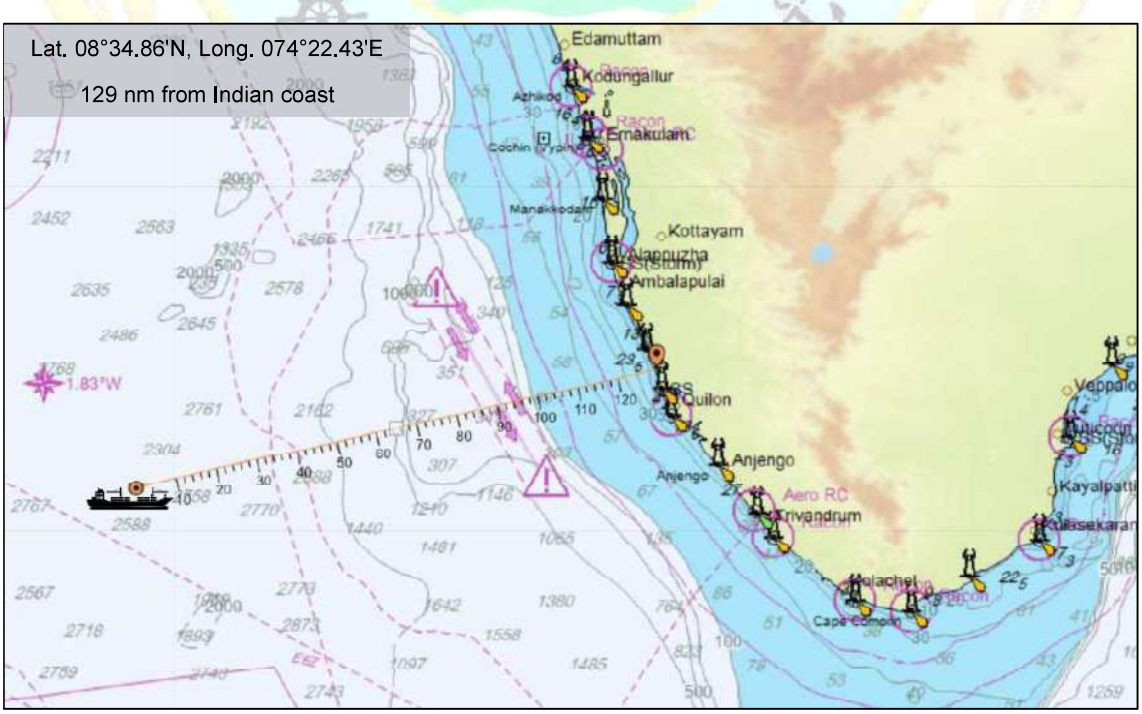

Figure 1: Position of WAN HAI 503 as on 28.06.2025 1200 hrs

Offshore Warrior remains engaged in towing the vessel with approximately 54 nautical miles remaining to exit the Indian EEZ. The vessel continues to experience moderate to rough sea conditions with winds ranging from 25 to 28 knots, gusting up to 42 knots during squalls.

On-board conditions remain challenging. Cargo Hold No. 4 continues to emit mixed smoke, with intermittent flare-ups observed. Thermal imaging conducted by Saksham indicates persistent elevated temperatures within Hold No. 4, particularly in areas affected by collapsed containers and compromised deck hatches. As of now, direct access to the casualty by salvage personnel remains limited due to heavy rolling, pitching, and prevailing swells. A salvage team transfer attempt by Saksham was aborted earlier today due to unsafe conditions.

Firefighting operations are ongoing with Saroja Blessings maintaining boundary cooling and fire watch. The salvage team has confirmed that approximately 500 to 800 cubic metres of water have been pumped out of the flooded engine room using portable equipment. Further dewatering is subject to improved weather and safe boarding conditions.

4. Additional Support

Tug Offshore Warrior continues to maintain towing operations despite experiencing significant rolling and pitching due to the long swells. Two soft towlines remain in place for the casualty, with replacement by wire towlines pending a suitable weather window. The vessel's draft remains largely unchanged, with portions of the port midship markings obscured, likely due to paint peeling in the fire-affected areas.

The salvage team on site remains equipped with FiFi systems, portable pumps, and firefighting resources. Atlantis Virgo, carrying Pyrocool fire suppressant, is expected to arrive on site by 30 June 2025 to support targeted firefighting efforts. Water Lily has been tasked with logistical runs for fresh water, bunkers, and is also transporting the ship's VDR to port for handover to the Mercantile Marine Department (MMD) Kochi.

The Indian Coast Guard has been actively supporting the operation with aerial surveillance from Kochi and has mobilised ICGS Sujit to assist with medical

evacuation for salvage divers suffering from seasickness and exhaustion. The salvage logistics base is being shifted to Trivandrum to facilitate easier support as the vessel progresses southward.

5. Situation Assessment:

The vessel remains in a structurally compromised but stable condition, with primary risks stemming from the persistent smouldering fire in Cargo Hold No. 4, the residual flooding within the engine room, and unpredictable weather patterns. High winds and swells have severely limited boarding operations, complicating firefighting and dewatering efforts. The exposed opening on the forward section of Cargo Hold No. 4 continues to channel airflow into the hold, exacerbating flare-ups and making containment difficult.

Figure 2: Condition of the vessel on 28June 2025

The ongoing boundary cooling remains the primary fire mitigation strategy, with additional efforts to initiate dewatering of the engine room using available portable equipment. CO_2 has been release in Hold No. 5 using 126 cylinders from the CO2 Bank.

Efforts are underway to secure a Port of Refuge, pending formal clearance. The vessel is expected to exit the Indian EEZ within the next 24 hours, after which only routine updates to MPA Singapore will continue unless further Indian support is requested.

The situation remains dynamic, with priority actions focusing on continued towage beyond the EEZ, enhanced fire suppression upon Virgo's arrival, safe dewatering of the engine room, and securing approval for port shelter. All agencies remain on high alert to ensure the situation does not escalate further.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 22, 1800 Hrs on 30/06/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hrs on 30 June 2025, MV WAN HAI 503 remains positioned at 07°52.60'N, 074°50.09'E, maintaining a steady course of 290° with a speed of 0.8 knots, approximately 130 nautical miles off the Indian coastline, outside the EEZ boundary.

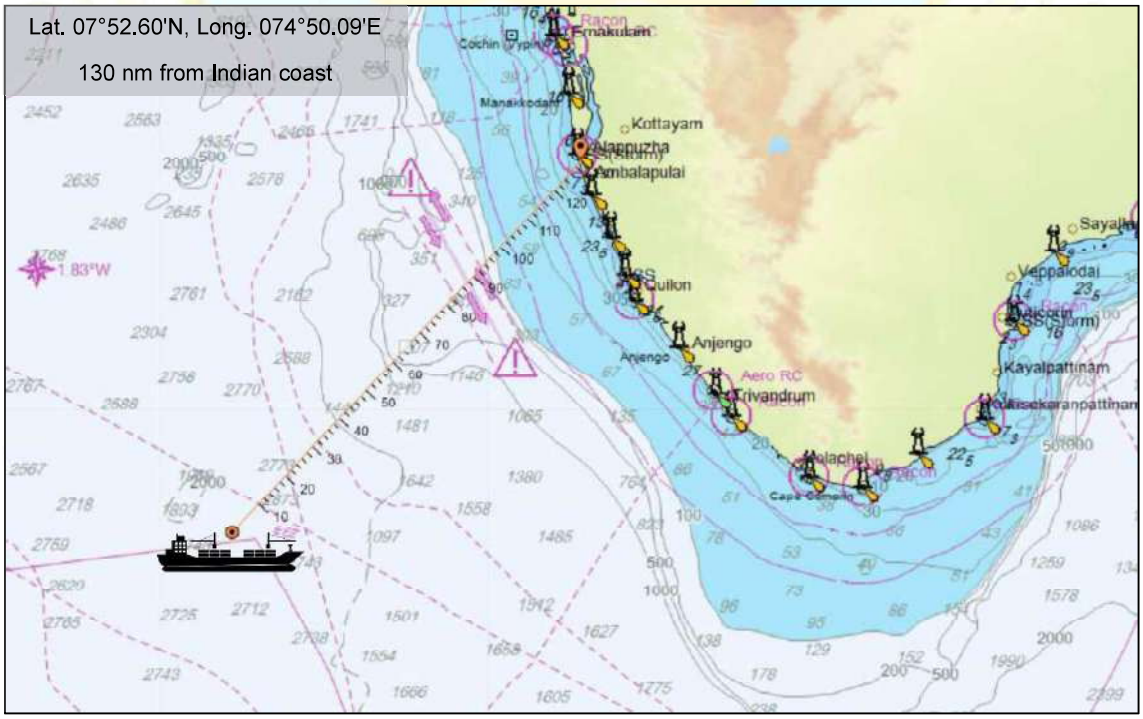

Figure 1: Position of WAN HAI 503 as on 30.06.2025 1800 hrs

The vessel's drift remains controlled through coordinated towing operations. Light smoke continues to emanate from the area forward of the accommodation block, indicating residual smouldering within cargo hold no. 4, though no visible flames have been reported.

Dewatering operations commenced at 0730 hrs with four pumps (150–250 m^3/hour each) deployed to remove water from the flooded engine room. Dewatering operations are ongoing with five pumps actively discharging water from the flooded engine room and interconnected compartments. The source of water ingress is suspected to be linked to interconnected compartments between the engine room and cargo hold no. 3. Water quality remains relatively stable, with minimal oil traces, suggesting no significant new ingress.

4. Additional Support

The multi-agency response continues with effective resource deployment on-site. Water Lily has been engaged in personnel and material transfers, successfully receiving salvage equipment from '**Saroja Blessing'** earlier today. '**Saksham**' remains prepared for further support, and '**Saroja Blessing'** is on standby for firefighting and material supply operations. Salvage teams on board the vessel has resumed equipment installation and pump operation, with five pumps now functioning continuously to extract water. **'Offshore Warrior'** is maintaining towage operations, keeping the vessel clear of the Indian EEZ, with current power utilisation at 75%.

Preparations are in place to maintain uninterrupted dewatering overnight. Salvors aim to stabilise internal flooding to facilitate safe boarding and enable further fire suppression measures, including enhanced boundary cooling and application of additional firefighting agents as weather permits.

Additional assets, including '**Atlantis Virgo**' and '**SCI Panna'**, are en route to the site with firefighting equipment and Pyrocool (7000 litres), expected to enhance fire suppression efforts within the next 24 hours. Preparations for continuous overnight pumping operations are underway, with emergency evacuation plans in place to ensure personnel safety during night-time activities. The intention is to sustain 24/7

dewatering using both hydraulic and submersible pumps, supplemented by emergency power from the vessel's own systems and portable generators.

5. Situation Assessment:

The fire situation remains contained, with only light smoke observed, the presence of plastic cargo within cargo hold no. 4 continue to pose smouldering risks. The sustained operation of five pumps has shown positive results in managing engine room flooding, but full dewatering remains essential to assess damage to machinery spaces and restore emergency power systems.

Given prevailing sea conditions and vessel stability, Offshore Warrior will maintain current towage direction to keep WAN HAI 503 outside the Indian EEZ. Further attempts to access the forward sections of the vessel for additional firefighting and structural assessment will be undertaken once dewatering sufficiently reduces on board risks.

Figure 2: Condition of the vessel

Port of Refuge discussions remain focused, where positive initial engagements have occurred. Formal submission of the required document package to authorities is in progress, though final approvals are contingent upon demonstrating vessel stability,

extinguishment of smouldering, and safe dewatering. Alternative ports options remain under evaluation.

The vessel remains in a high-density shipping corridor, necessitating continuous traffic warnings to passing vessels. The Directorate has directed enhanced navigational warnings to prevent incidents in this critical route between Sri Lanka and the Gulf of Aden. Indian Coast Guard assets continue to provide aerial surveillance and maritime monitoring, with readiness to intervene if necessary.

The immediate operational priorities include sustained dewatering, preparation for Pyrocool application to fully suppress smouldering, finalisation of port of refuge arrangements, and ensuring the vessel's position remains secure beyond the EEZ. Continuous inter-agency coordination, including with MPA Singapore, ITOPF, and Indian authorities, is ongoing to manage the situation effectively and prevent environmental or navigational hazards.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 23, 1800 Hrs on 01/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

The salvage operations on MV Wan Hai 503 continue amidst challenging weather conditions. As of the latest update, the vessel remains approximately 130 nautical miles off the Indian coastline, positioned near the limits of the Indian EEZ. Five pumps are operational onboard, with over 5,000 cubic meters of water successfully pumped out from the flooded engine room, reducing water levels by approximately 1.75 meters. Dewatering continues, with indications of limited water ingress from Cargo Hold No. 3, which remains under assessment.

Light smoke persists forward of the accommodation block, with cargo hold temperatures stabilizing. The Offshore Warrior maintains towing operations, with the vessel holding position beyond the EEZ. Structural evaluations indicate localized heat-induced buckling between Frames 103–113; however, independent assessments by T&T Salvage, DNV, and naval architects confirm that the vessel retains structural strength and remains stable.

4. Situation Assessment:

Firefighting and dewatering operations have achieved measurable progress. Risk assessments conducted by T&T Salvage highlight that offshore oil removal remains unsafe under current conditions, with preferred options being defueling alongside a

wharf at a Port of Refuge. The salvage team continues preparations to transition from soft to wire towlines, advance dewatering, and monitor vessel integrity. A clear and definite plan for oil transfer and moving the vessel to port of refuge is expected from the owners and salvors at the earliest. If there's a delay in the salvage operation then vessel has to be towed further South to keep the vessel 200 nautical miles away from Indian Coast.

5. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

6. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 24, 1800 Hrs on 02/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

The vessel remains positioned safely outside the Indian Exclusive Economic Zone (EEZ), under continuous tow by Offshore Warrior. Salvage operations have made steady progress, with critical dewatering and firefighting measures currently underway.

Figure 1: Condition of the vessel

Following a brief improvement in weather conditions earlier in the day, a 16-member salvage team successfully boarded the vessel. Their immediate priorities included

conducting a thorough search for the missing crew member within accessible areas of the casualty. Unfortunately, no signs of the missing person were discovered.

The salvage team has activated five pumps onboard, dewatering both the engine room and the affected cargo holds. This has led to a significant reduction in engine room water levels, by approximately 3.5 metres, reducing the vessel's overall draft and providing a safer operational environment.

The visible fire onboard has largely been contained, with only light smoke emanating forward of the accommodation block and from cargo hold no. 4. No active flames have been observed in the most recent operations.

Continuous hull and hold temperature monitoring is being carried out using thermal imaging to assess structural heat stress and potential flare-ups. Additionally, the application of approximately 9000 litres of Pyrocool firefighting agent has been completed, effectively reducing hotspot temperatures, particularly in cargo hold no. 4, where maximum recorded temperatures have now fallen to 64°C on the port side and 68°C on the starboard side.

4. Additional Support:

Offshore Warrior remains the primary towing platform, maintaining the vessel’s position outside the EEZ. Saroja Blessings, Saksham, Water Lily, SCI Panna, and the recently deployed tug Virgo are engaged in critical support operations including boundary cooling, material transfer, thermal imaging, and personnel rotation. The firefighting team has shifted focus to localised boundary cooling operations using hatch-cover mounted arrangements to target specific heat-affected zones.

Approximately 6000 litres of Pyrocool remain in reserve for any escalation, with an additional supply pre-positioned in Singapore for rapid deployment. CO_2 injection into cargo hold no. 5 has been initiated to suppress internal smouldering, with two further CO_2 discharges kept ready if required. In parallel, the salvage team has commenced ventilation of starboard side tunnels to reduce hazardous gas concentrations, allowing safer forward access and potential operations on the bow.

Figure 2: Pyrocool Application

Preparations are ongoing to rig a Dyneema towline on the bow as an alternative towing arrangement, providing flexibility should existing tow connections be compromised. Furthermore, replacing the current soft towlines with steel or Dyneema ropes remains a high priority, subject to operational windows and prevailing sea conditions. SCI Panna continues to provide coastal support within India's jurisdictional limits.

5. Situation Assessment

Cargo hold no. 4 continues to have elevated temperatures (approx. 64°C port side, 68°C starboard side) and ongoing smouldering of cargo, including plastic resin containers. Hold no. 5 starboard side shows localized high temperatures but remains contained following CO2 release. The engine room remains partially flooded, with water ingress suspected from cargo holds. Pumping efforts are steadily reducing water levels, and full dewatering is a prioritised, weather permitting. The missing crew search remains ongoing in accessible areas.

High winds and swells are intermittently limiting operations; however, salvage crews have maximized available weather windows for critical tasks. A detailed Port of Refuge proposal is under preparation for submission. Vessel stability assessments, bunker

and ballast soundings, and ventilation of enclosed spaces continue in parallel to ensure readiness for further movement.

The situation requires continued focus on dewatering, fire containment and formalizing safe entry into a Port of Refuge. All government agencies, remain engaged in ensuring environmental protection, safety of life, and mitigation of escalation risks.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 25, 1800 Hrs on 03/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

The vessel continues to be held in position outside the Indian Exclusive Economic Zone (EEZ) through towing operations conducted by Offshore Warrior. The vessel is currently located at latitude 07° 25.15'N and longitude 074° 42.90' E, with a course of 200° and an average speed of 2.3 knots. The weather on site remains moderate, with wind speeds recorded at approximately 12 to 14 knots from 245°, accompanied by moderate sea conditions.

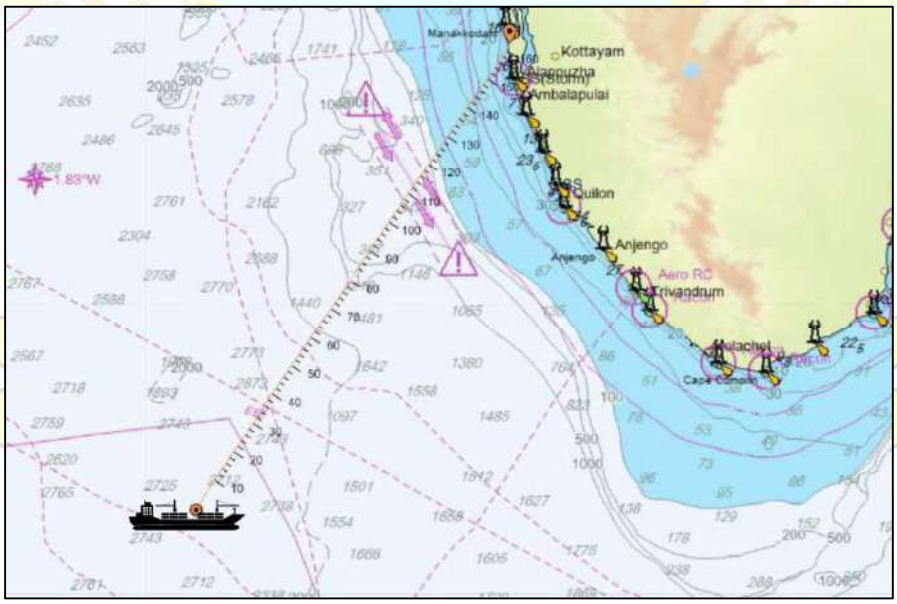

Figure 1: Position of the vessel on 03.07.2025 1800 hrs

The vessel is emitting light grey smoke from the cargo hold area between Bay 35 and Bay 45 as of 03rd July 0001 hrs. Dewatering operations have been progressing steadily, with around 4.5 meters of water successfully pumped out from the engine room space. The salvage team has maintained continuous monitoring of hull and hold temperatures in accessible areas to assess the fire and structural situation onboard.

Figure 2: Condition of the vessel

Engine room dewatering has lowered water levels to approximately 3.5–3.7 meters, enabling soundings and inspections. Salvage teams onboard are conducting continuous dewatering operations, with the primary focus on tracing the source of ingress, likely from cargo hold no. 3.

Hull temperature surveys on both port and starboard sides show elevated readings, particularly on the starboard side, which remains the main fire-affected zone. Hold no. 1 recorded temperatures of 82°C, with holds 4 and 5 still retaining heat, though no active flames are visible. Residual combustion remains localised and contained, with temperatures gradually trending downward.

4. Additional Support:

As part of the salvage operations, multiple assets are deployed at the site. Saksham and SCI Panna are engaged in fire watch activities, while Water Lily remains

responsible for transferring salvage personnel and equipment. Salvage operations are ongoing, with four personnel currently on-board Wan Hai 503 overseeing pump operations. Offshore Warrior continues to manage the vessel's tow, holding her position beyond the EEZ boundary. Advantis Virgo remains on standby at the site to provide additional firefighting and operational support as required.

Towline replacement with a steel/dyneema line is underway, subject to sea conditions. Hull temperatures and structural conditions are being closely monitored. Salvage teams continue structural assessments. A formal risk assessment remains a prerequisite for any enclosed space entry, prioritising personnel safety over operational expediency.

5. Situation Assessment

The fire situation aboard remains stable, with no active flames reported and residual combustion confined. Temperature trends show gradual improvement, with general cooling observed across monitored areas.

Dewatering progress in the engine room is critical to trace the ingress source and stabilise the vessel. However, due to the heat retained within cargo holds, particularly hold no. 5, continued monitoring and readiness for firefighting remain essential. Pyrocool application within holds is not viable until safer working conditions are established.

The port clearance remains pending for Port of Refuge. WAN HAI Lines is actively engaged with identified port authorities to expedite the process.

Given the uncertainty surrounding port entry clearance, the Indian Coast Guard has proposed repositioning the vessel southeast towards the India–Sri Lanka–Maldives tri-junction area, approximately 20–25 nautical miles from the current location, to ensure safer standoff. The Directorate General of Shipping has endorsed this precautionary approach and directed the salvage team to explore the feasibility of such a relocation, subject to operational conditions. DGS reiterated the need for a permanent solution through Port of Refuge entry or repositioning outside all EEZs, at

the earliest opportunity, while commending the salvage teams for stabilisation efforts and progress on dewatering and fire control.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 26, 1800 Hrs on 04/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

The vessel continues to be held in position outside the Indian Exclusive Economic Zone (EEZ) through towing operations conducted by Offshore Warrior. The vessel was located at latitude 07° 45.83'N and longitude 074° 50.98' E as on 04.07.2025, 0600 hrs, with a course of 280° and an average speed of 1.0 knots.

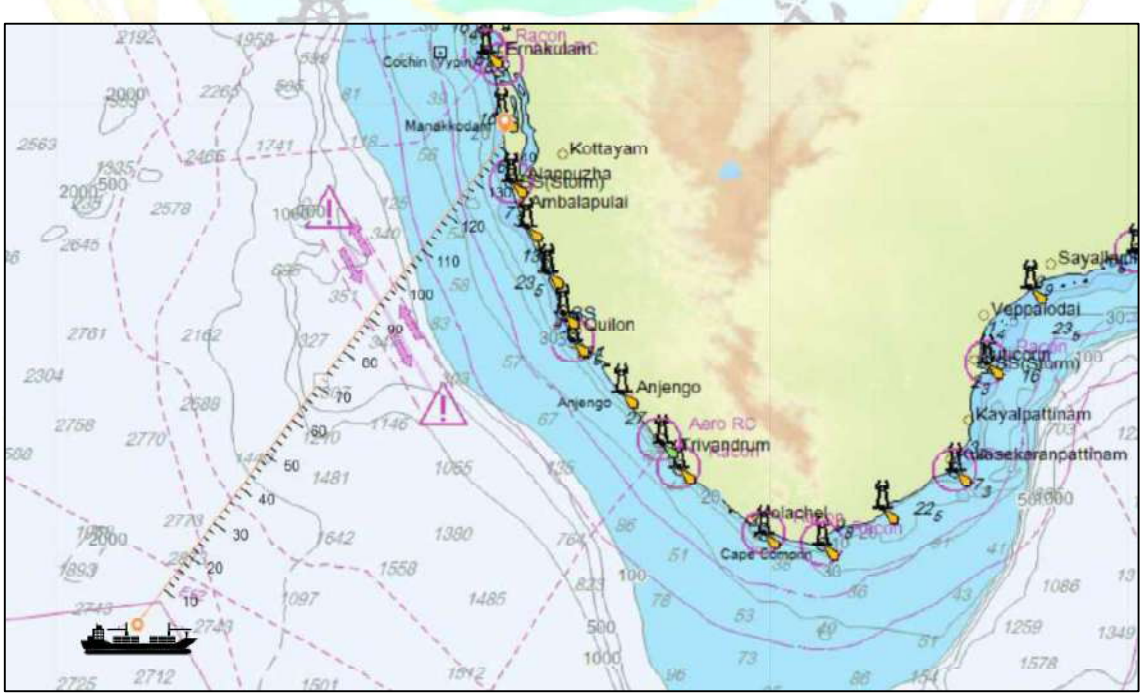

Figure 1: Position of the vessel on 04.07.2025 0600 hrs

The condition of the vessel remains under continuous monitoring. Visible light grey smoke persists from Bay 29 to 35, indicating ongoing smouldering in cargo hold no. 4, which remains the primary zone of concern. Wind conditions have been fluctuating, with increased gusts observed during the day, exacerbating the smouldering fire and complicating localized firefighting efforts. Despite attempts, Pyrocool application was aborted due to high winds and unstable deck conditions, making precise deployment unsafe and ineffective at sea.

Figure 2: Condition of the vessel as on 03.07.2025

Dewatering operations in the engine room were temporarily halted due to malfunction of the power pack essential for pump operations. Repairs are underway to restore continuous dewatering. Notably, the stern draft has increased, suggesting successful prior dewatering, though updated soundings are awaited. Recent temperature surveys indicate elevated readings in cargo hold no. 4, peaking at approximately 92°C, while temperatures in hold no. 5 have shown slight reduction, though residual heat persists due to the compartment being sealed with CO_2.

The vessel remains under tow by Offshore Warrior, holding position outside the Indian EEZ with a controlled speed. Salvage teams have boarded as weather permitted, performing structural assessments, temperature checks, and continuous search for the missing crew member in accessible areas. No signs have been found to date.

Meanwhile, Saksham has returned to Kochi Port for crew rotation and equipment adjustments.

4. Additional Support:

The salvage response continues to be supported by a multi-vessel arrangement. Offshore Warrior maintains towage and position control, utilizing approximately 75% power capacity. Water Lily is engaged in personnel and equipment transfers between Offshore Warrior, Wan Hai 503, and other support units. Advantis Virgo remains on standby for firefighting operations and carries approximately 11,000 litres of Pyrocool onboard. An additional 15,000 litres of Pyrocool are scheduled to arrive in Singapore, with contingency plans for airlifting to India, subject to Port of Refuge outcomes.

SCI Panna continues to provide fire watch and boundary cooling assistance as required. The Maritime and Port Authority of Singapore has emphasized the need for effective localized cooling and access to sheltered waters to allow for safer and comprehensive fire suppression.

5. Situation Assessment

The primary threat stems from smouldering in cargo hold no. 4, exacerbated by strong winds, damaged deck infrastructure, and inaccessible zones. With on-deck Pyrocool application restricted by sea conditions, comprehensive firefighting remains dependent on securing Port of Refuge access or reaching a more sheltered area.

Dewatering of the engine room remains a priority, with planned resumption once power pack repairs are completed. Tunnel connections between cargo hold no. 3 and the engine room remain a possible ingress point for water, complicating stability efforts. Full structural assessments, especially of ballast and bunker tanks, are pending.

The Indian Coast Guard has recommended repositioning the vessel approximately 200 nautical miles (Lat. 04°43'N, Long. 077°03'E) southeast to the India–Sri Lanka–Maldives tri-junction, balancing safety, operational flexibility, and minimizing regional

environmental risk. Final clearance for Port of Refuge is awaited, with Wan Hai Lines actively engaging in documentation and negotiations.

Continuous monitoring, cautious firefighting, and phased salvage actions remain in effect to prevent escalation.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 27, 1800 Hrs on 05/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1200 hours on 5th July 2025, MV Wan Hai 503 remains under tow by Offshore Warrior, maintaining its position outside the Indian EEZ. The vessel's coordinates are 07° 34.26'N, 074° 29.80' E, with a course of 260° and speed of approximately 1.2 knots. Weather conditions remain moderate, with winds from 262° at 16 knots, and no significant operational impact reported from sea state.

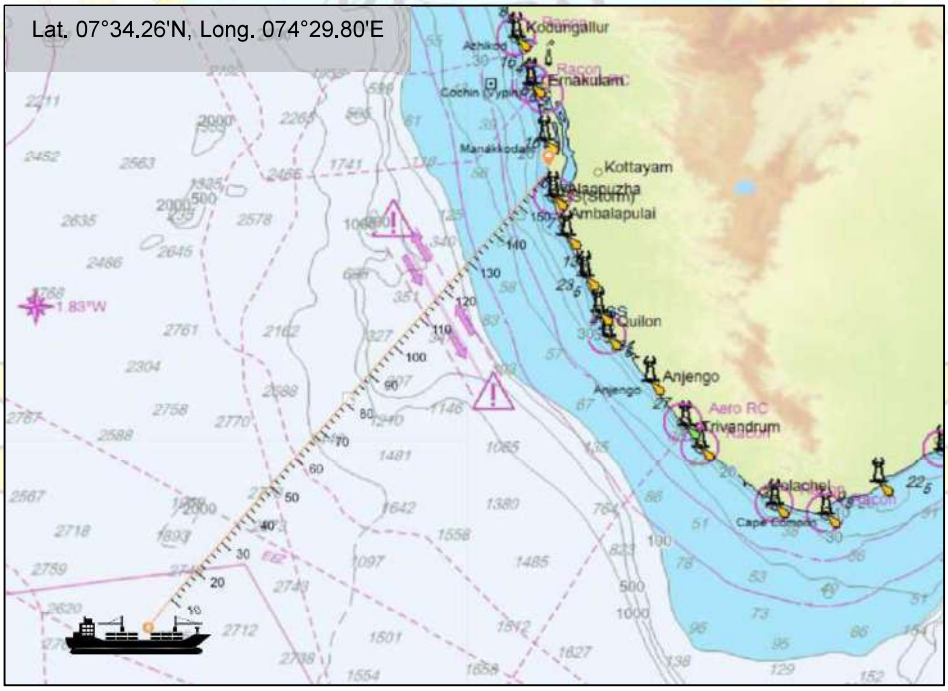

Figure 1: Position of the vessel on 04.07.2025 0600 hrs

Visible black smoke continues to emit from the casualty, though onboard temperature readings reflect gradual improvement in affected areas, but residual heat within cargo holds persists, particularly in Hold No. 4. Isolated flare-ups and intermittent smoke are anticipated to recur, attributed to the nature of the residual cargo smouldering within enclosed spaces.

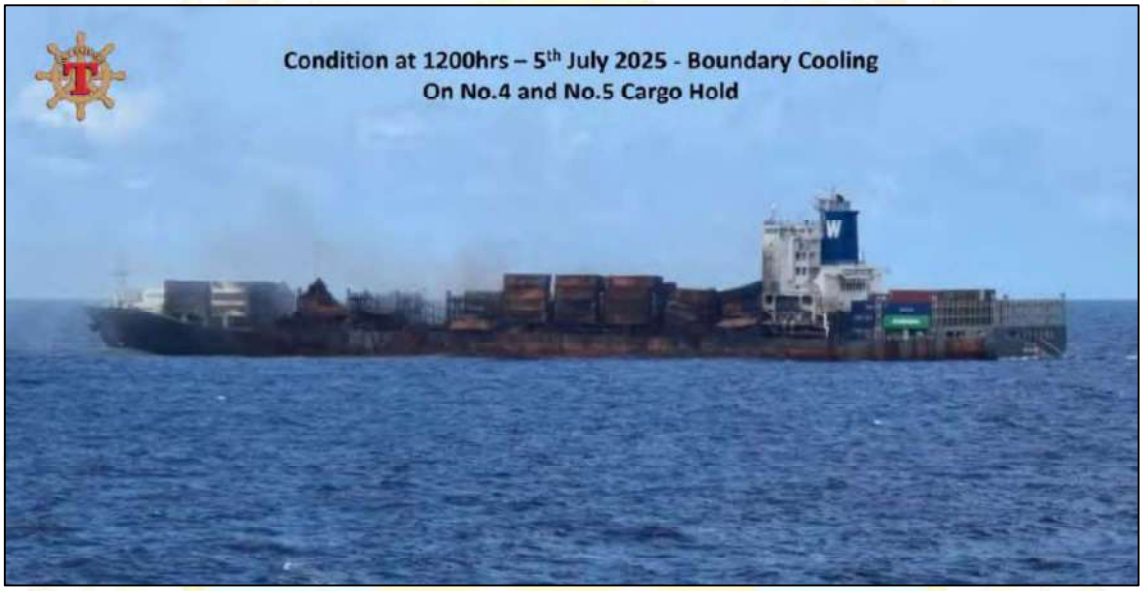

Figure 2: Condition of the vessel on 05 July 2025

The salvage team currently consists of five firefighters and five salvors. Dewatering efforts have successfully reduced engine room water levels to approximately two meters, though additional pumping is ongoing to identify and control the ingress source, which is suspected to be linked to previous firefighting water runoff.

The hydraulic Power Pack, which encountered debris-related malfunctioning, has been restored, with one hydraulic pump and one electric pump operational for dewatering. The vessel's name and flag markings remain visible, and the general structural condition is reported stable at this stage.

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4. Additional Support:

Firefighting and boundary cooling operations are being undertaken by SCI Panna and Advantis Virgo. The teams onboard these vessels are maintaining fire suppression

efforts as required, with an emphasis on controlling temperature escalation and preventing fire spread.

Water Lily continues to provide critical support for personnel and material transfers between salvage assets and the casualty vessel. The vessel has been effective in ensuring logistics continuity, given the limitations in transferring using larger vessels alongside WAN HAI 503 due to sea conditions.

Offshore Warrior remains engaged in towing operations, with preparations underway to replace the existing soft towline with a steel wire rope as soon as favourable weather permits. The replacement is considered a priority for ensuring secure long-term towage, especially ahead of anticipated deteriorating weather.

Virgo remains equipped with an additional stock of Pyrocool for localized fire suppression, should conditions allow its application. Saksham has returned to Kochi Port for flag state formalities and crew change and is expected to rejoin operations upon completion of customs processes.

The salvage team is also preparing for increased Pyrocool deployment, with logistics in place to mobilize 15,000 litres of additional supply from Singapore if required.

5. Situation Assessment

The overall fire remains localized and is assessed to be under control; however, elevated temperatures within Hold No. 4 and inaccessible areas limit further inspection and tank soundings. The portside forward area remains unsafe for entry until further cooling is achieved. Small flare-ups, smoke, and high heat in isolated compartments continue to present operational constraints.

Dewatering of the engine room remains the top priority, with the immediate goal of reducing water levels to trace and rectify the ingress point. Divers are on standby but are not being deployed inside the engine room at present due to concerns over water contamination from unknown cargo residues. Controlled dewatering will proceed to lower water levels sufficiently for inspection without necessitating diver entry.

The situation demands operational patience, with timelines contingent on prevailing fire conditions and vessel stabilization. Efforts are being made to maintain the current position, balancing logistical access, safety, and proximity to support assets.

Port of Refuge discussions remain active and the vessel remains within logistical support range of Kochi, facilitating continued resupply and operational support. Stakeholders have been urged to prioritize securing the forward forecastle area, completing towline replacement, conducting bunker tank soundings, and ensuring structural and environmental safety before any further relocation or port entry is executed.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 28, 1800 Hrs on 07/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1200 hours on 07 July 2025, MV WAN HAI 503 remains positioned beyond the Indian Exclusive Economic Zone (EEZ) at coordinates 07° 47.28' N, 074° 32.31' E. The vessel is maintaining a westerly course of 280° with a speed of approximately 0.7 knots under tow by Offshore Warrior.

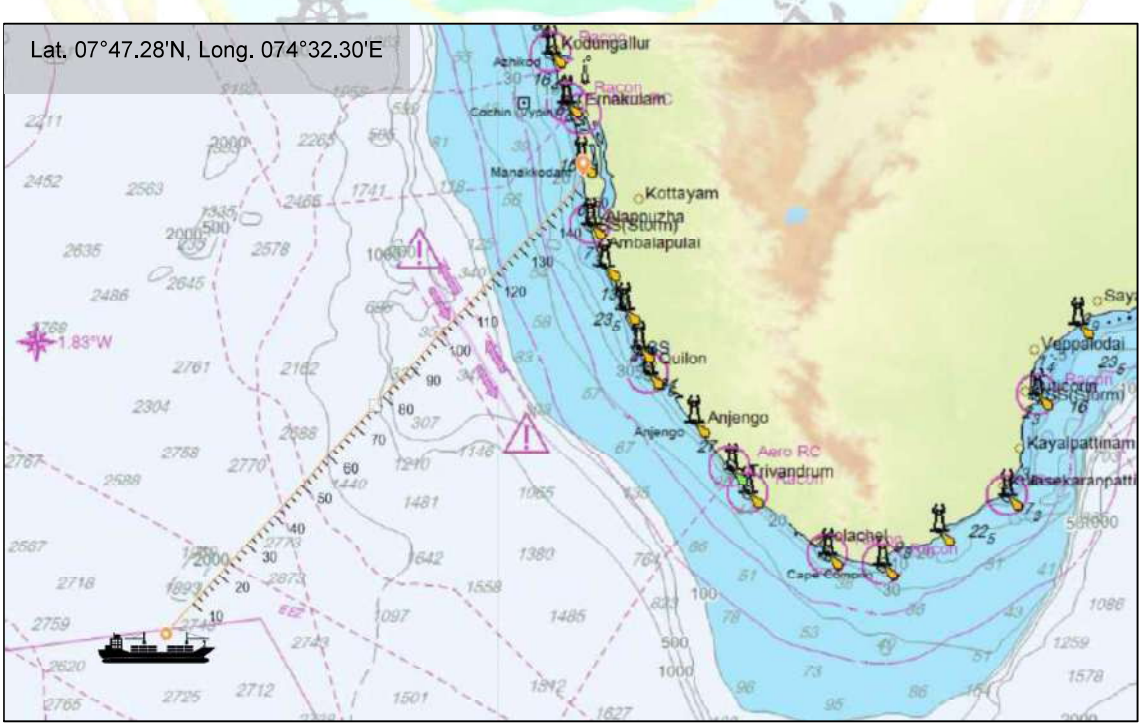

Figure 1: Position of the vessel on 07.07.2025 1200 hrs

Weather conditions at the site are moderate, with prevailing westerly winds of 15 to 20 knots, contributing to a steady sea state. Observations from the salvage team confirm the presence of light smoke emanating from the cargo hold area between bays 35 to 45. No visible flames have been reported at this time, indicating that the fire has been largely contained, though residual smouldering persists within localized hotspots. The vessel remains structurally intact, and there has been no escalation in onboard hazards during the reporting period.

4. Additional Support:

Multiple support assets remain deployed around MV WAN HAI 503 to assist with the firefighting, salvage, and logistical operations. Offshore Warrior continues to tow the casualty vessel, ensuring it is held beyond the Indian EEZ. A steel tow line has been connected to the stern of the vessel. Tug Advantis Virgo and SCI Panna remain on standby at the site, ready to engage in firefighting, boundary cooling, or emergency interventions as needed. Both vessels are equipped for immediate response should conditions onboard deteriorate.

Figure 2: Vessel condition

Water Lily remains a key logistical platform, facilitating the transfer of salvage personnel, materials, and essential supplies, including food and equipment, between the casualty vessel and support vessels. This logistical support is critical for maintaining 24/7 salvage operations, particularly in view of the extended offshore positioning of the vessel.

Coordination between these assets continues to be maintained to ensure operational readiness, while salvage activities onboard are paced according to weather and safety conditions.

5. Situation Assessment

The situation onboard MV WAN HAI 503 remains under control but with close operational monitoring. The residual smoke in the midship section indicates the presence of isolated smouldering zones, though active flame presence has not been observed. Boundary cooling operations have been kept on standby, with Advantis Virgo and SCI Panna prepared to initiate firefighting or containment measures if there is any change in fire intensity.

The vessel's position outside the EEZ continues to be managed effectively by Offshore Warrior, maintaining a safe distance from Indian coastal waters.

Water Lily remains engaged in routine transfer operations, ensuring that salvage teams and materials are moved efficiently to support dewatering, stability management, and fire suppression systems onboard.

Moving forward, the immediate operational focus will remain on continuous towing operations to maintain safe positioning outside the EEZ, readiness of firefighting and boundary cooling teams onboard support vessels, and sustaining logistical lines for personnel rotation and material transfer. Salvage teams will continue to monitor hull temperatures and onboard conditions, with further assessments planned as weather permits.

Efforts remain aligned with the broader objective of stabilizing the vessel, minimizing environmental risk, and preparing for eventual relocation to a Port of Refuge when feasible.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 29, 0800 Hrs on 10/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 0600 hours on 10 July 2025, MV *Wan Hai 503* remains under tow by Offshore Warrior, maintaining a controlled heading of 319° at a speed of 0.3 knots. The vessel's current position is 07° 49.79'N, 074° 43.51'E, situated beyond the Indian EEZ. The prevailing weather consists of winds from 305° at 20–22 knots, with moderate to rough sea conditions and high swells affecting operations.

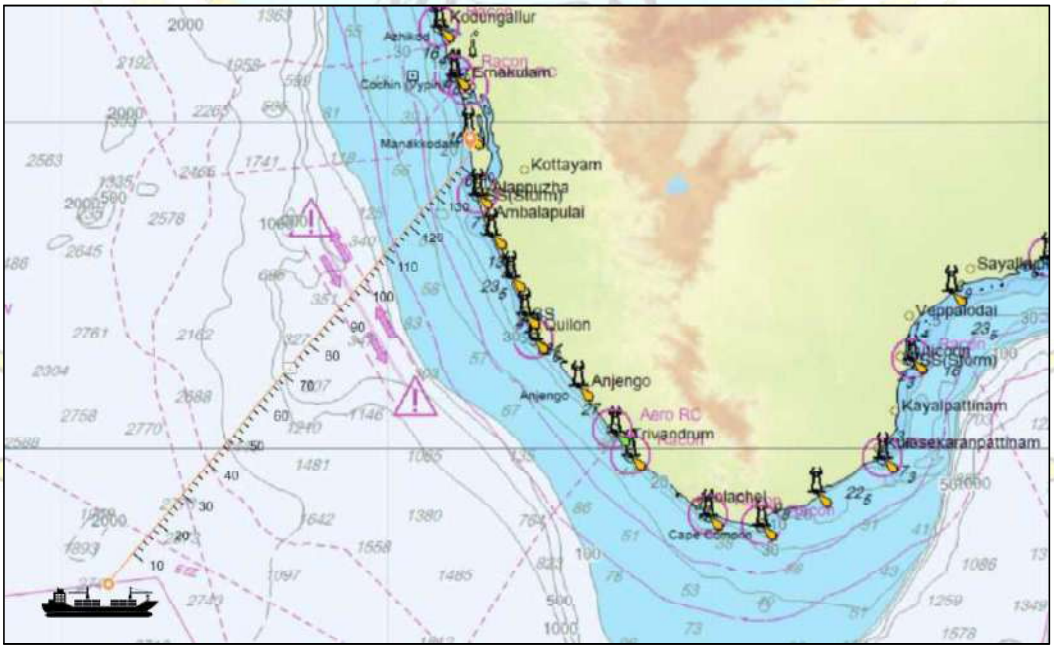

Figure 1: Position of the vessel on 10.07.2025 0600 hrs

Onboard, light grey smoke is still observed emanating between Bay 33 to Bay 38, corresponding to cargo hold no. 4, where residual smouldering continues. No active flames have been reported, and the situation remains stable. Thermal imaging continues to be employed for monitoring heat levels across affected compartments.

Dewatering of the engine room has progressed significantly. As of last evening, five onboard pumps had reduced the water level to approximately 0.3 metres (1 foot), improving accessibility for ongoing inspection and stability recovery efforts. The vessel's name and port of registry are now visible, indicating improved external visibility.

4. Additional Support:

The salvage operations continue to be supported by a coordinated fleet of response assets. SCI Panna remains stationed on site and continues to conduct fire watch duties. Water Lily is actively engaged in personnel and material transfers between support vessels and the casualty vessel. Despite swell-related boarding challenges, critical movements were maintained to sustain onboard salvage efforts.

Figure 2: Condition of the vessel

Advantis Virgo is on standby for immediate fire-fighting (FiFi) or boundary cooling if required. Saksham, having departed Kochi, is expected to reach the casualty site to

augment salvage efforts and may participate in inspection or pump deployment, subject to weather permitting.

Onboard the casualty, salvage teams are operating pumps in round-the-clock shifts. The engine room water level has been reduced to approximately 0.3 meters (1 foot), following overnight dewatering. Inspection of hold no. 4 has commenced, and options are being explored for possible pump installation to expedite hold water removal. The team is also evaluating whether a second release of CO_2 in hold no. 5 is warranted based on ongoing thermal observations.

5. Situation Assessment

The overall onboard situation is stable and improving, with active measures in place to mitigate fire risks and address flooding. While no new fire escalation has been reported, smoke persists, and thermal surveys confirm elevated readings, especially in the starboard section of cargo holds 4 and 5. Temperature readings of 130–140°C were previously recorded but have shown a declining trend over the last 48 hours.

Structural access remains limited and tunnel access areas are unsafe for entry due to heat and possibility of hazardous gases. Salvors are exercising extreme caution and will conduct further enclosed space entries only after formal risk assessments are complete.

The engine room is now accessible, and work continues to trace the suspected leak path, likely originating from cargo hold no. 3. However, further pump installation and complete compartment soundings remain contingent on weather improvement and reduced internal heat.

The Port of Refuge issue remains unresolved. Discussions have been ongoing with the Harbour Master, and document submissions have been made by WAN HAI Lines and T&T Salvage. Simultaneously, contingency options are being pursued in coordination with the Maritime and Port Authority (MPA).

The Directorate has reiterated that the vessel cannot remain in its current location in the absence of confirmed Port of Refuge clearance; relocation southward must be

undertaken. The vessel is currently at the India–Sri Lanka–Maldives tri-junction area, and should be shifted 200 NM south off Sri Lanka for this purpose. The ETV Water Lily will be released once Saksham or another private tug (e.g., Nand Sarthi) arrives to take over operational responsibilities.

The Directorate has emphasized the need for finalisation of PoR permissions within the next 2–3 days, failing which the vessel must be moved if such a move is necessitated.

The Indian Coast Guard continues aerial and maritime surveillance of the site and has confirmed that no new debris or pollution has been observed drifting toward the Indian coastline.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 30, 1800 Hrs on 11/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1200 hrs on 11 July 2025, the container vessel *MV Wan Hai 503* continues to be towed safely by *Offshore Warrior*, maintaining position outside the Indian Exclusive Economic Zone (EEZ), currently located at 07° 41.02'N, 074° 41.29'E.

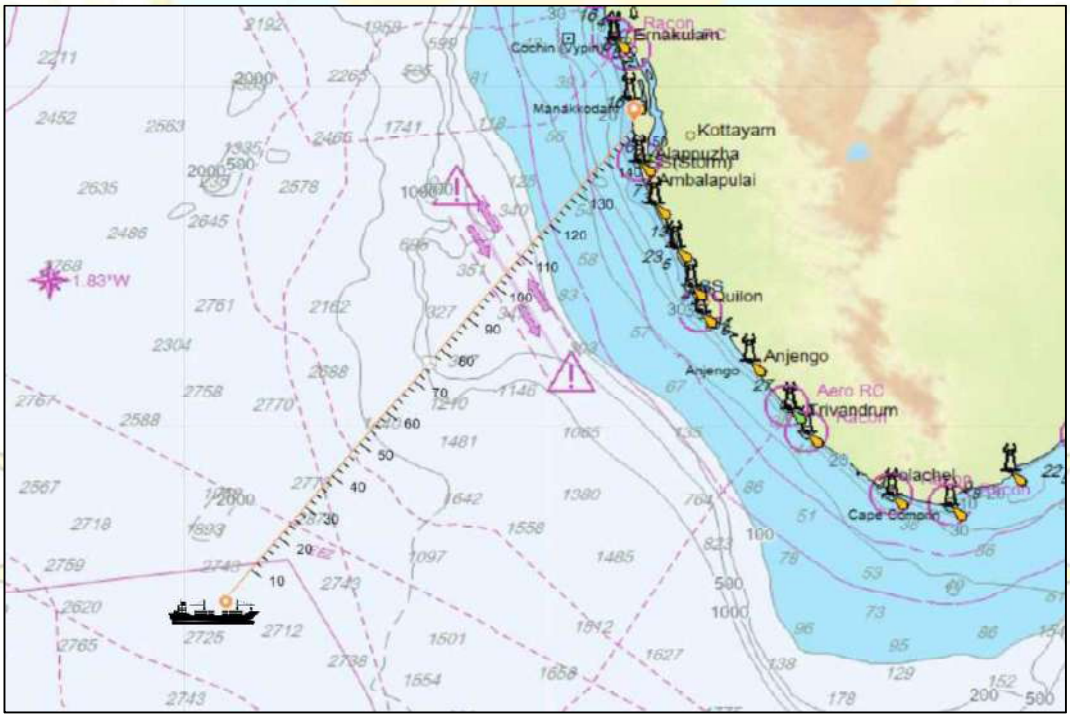

Figure 1: Position of the vessel on 11.07.2025 1200 hrs

The vessel is making slow headway with a course of 080° and a speed of 2.3 knots. Weather remains moderately challenging, with prevailing winds from 285° at 22–25 knots and moderate to rough seas. The vessel stability has been sustained, and towing operations are continuing smoothly.

There is light white smoke emanating from cargo hold Bay Nos. 33 to 37. This smoke is consistent with residual smouldering and heat retention in cargo hold No. 4, which has shown persistent elevated temperatures. However, there are no reports of visible flame or escalation of fire at this stage. The on-board salvage team has confirmed that five pumps are operational and that continuous dewatering efforts are ongoing. The engine room water level is now below the floor plate, and preparations are underway to inspect the suspected ingress path through the pipe duct as water levels allow.

4. Additional Support:

The salvage operations continue to be supported by a coordinated fleet of response assets. **Offshore Warrior** is engaged in towing operations and continues to hold the casualty steady in open seas. The tow remains secure and effective despite swell conditions.

Figure 2: Condition of the vessel on 11th July 2025

Advantis Virgo is on standby near the casualty, equipped with Pyrocool, firefighting resources, and thermal imaging equipment. The vessel remains prepared for immediate deployment should any escalation occur or localized flare-up be detected.

Water Lily is actively engaged in logistical support, including personnel transfers, movement of firefighting material, delivery of provisions, and standby for assisting salvage operations. Salvage personnel were rotated and resupplied via *Water Lily* during the early hours of the day.

Saksham is positioned in proximity for fire watch and possible reboarding, particularly in anticipation of inspections or firefighting action. The tug is also prepped for salvage assistance and has previously delivered equipment including SCBA sets and high-capacity pumps

In addition, *Nand Saarthi* is scheduled to reach Kochi on 13 July and is expected to relieve *Water Lily* on site by 14 July evening. This transition is crucial to free the ETV *Water Lily* for potential redeployment during the ongoing southwest monsoon season, where its availability may be urgently required elsewhere.

5. Situation Assessment

The firefighting and dewatering strategy is yielding gradual but consistent progress. Thermal imaging has shown a downward trend in the overall heat signatures, particularly in cargo holds Nos. 2, 4, and 5. Cargo hold No. 4, previously the site of recurring flare-ups and suspected plastic resin cargo combustion, now shows temperatures stabilizing in the 90–100°C range, though localized hotspots remain under observation.

Hold No. 5 continues to retain residual heat despite the prior release of CO_2, due to the compartment being sealed with limited ventilation. This containment has prevented complete dissipation of superheated gases. Temperatures in Hold No. 5 remain elevated (~130°C), and further cooling measures are under review. Hold Nos. 1, 2, and 6 are currently assessed to be within acceptable thermal limits, indicating no active combustion.

No significant flames have been reported in the past 48 hours. CO monitoring levels remain elevated around some cargo holds, and salvors are using portable sensors and spot-checks to manage atmospheric conditions. Due to container collapse and obstructed access, full inspection of tunnel spaces and enclosed sections has not yet been completed. Entry into such areas is subject to formal risk assessments and weather permitting.

Dewatering operations are progressing positively. The use of multiple pumps, including submersibles, hydraulic units, and air-operated devices, has led to a steady reduction in the engine room water level. Once completely drained, inspection of the suspected ingress route from cargo hold No. 3 will commence. At present, cargo holds No. 3 and 5 continue to show retained water, and soundings will be repeated after further drainage.

Port of Refuge coordination continues. A formal document package has been submitted and is under review. The Directorate has reiterated the importance of progressing toward a definitive operational conclusion, either through approved entry into a Port of Refuge or positioning into a more sheltered and secure zone beyond the EEZ.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 31, 1800 Hrs on 14/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 1800 hours on 14 July 2025, the casualty vessel *Wan Hai 503* remained under tow by Offshore Warrior and maintained her position outside the Indian Exclusive Economic Zone (EEZ) at 07°39.84'N, 074°50.57'E, heading 290° at a speed of 1.4 knots.

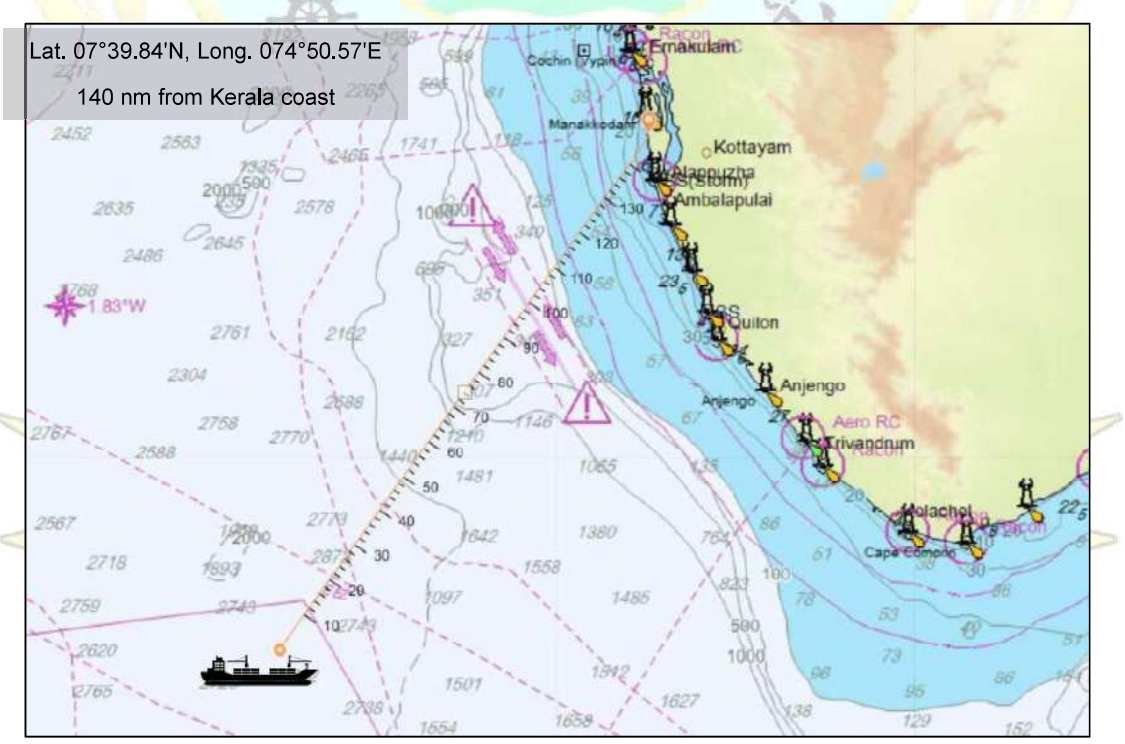

Figure 1: Position of the vessel on 14.07.2025 1800 hrs

Weather conditions remain challenging, with wind gusts recorded up to 62 knots and swell heights between 2.0 to 2.5 meters, leading to rough sea conditions.

Light grey smoke continued to be observed from cargo bay numbers 33 to 37. The condition is reported as stable, with no visible escalation. However, the onboard salvage team also reported a strong ammonia smell emanating from Hold No. 7, which may be attributed to rotting organic cargo. Preliminary indications suggest the possible presence of hydrogen sulphide (H_2S), presenting hazardous enclosed space conditions. Formal chemical assessment and safe chemical neutralization procedures are being explored.

As on 1500 hrs, six salvage personnel remain onboard *Wan Hai 503*. Adverse sea conditions prevented the full team from boarding. Multiple boarding attempts throughout the day had to be aborted, and two personnel sustained injuries during one of the attempts, highlighting the inherent risks of personnel transfer operations under current sea conditions.

4. Additional Support:

Nand Saarthi arrived on site at 1236 hrs to support salvage operations and commenced material transfer to Offshore Warrior and Advantis Virgo. While the tug is operational, the salvors have requested continued deployment of ETV *Water Lily* to maintain reliable and safe personnel transfer capability, citing its proven role and experienced crew. *Water Lily* also completed partial personnel transfer from Offshore Warrior to *Wan Hai 503* but could not complete the operation due to the deteriorating sea state.

Advantis Virgo and *Saksham* remained on standby for firefighting and boundary cooling operations. However, given the rough sea conditions, active intervention has been limited to essential support. SCI Panna has been demobilized and will not be replaced at this stage, as the existing complement of support vessels is considered adequate by the salvors for the current phase of operations.

The salvage team is currently exploring alternate means of supplying food and essential provisions to the onboard crew, given that evacuation is presently not possible due to weather and sea state.

5. Situation Assessment

The condition onboard *Wan Hai 503* is stable but continues to require sustained support. Hold No. 6 is reportedly being dewatered, and preparations are ongoing to control and monitor other affected holds. The ingress of water into cargo holds is also a result of boundary cooling operations in deck hatch gaskets, as observed in other similar incidents. Due to water in the engine room, dewatering must be carried out with portable pumps on a hold-by-hold basis.

Figure 2: Condition of the vessel

The salvage team emphasized that firefighting is currently limited to containment rather than full extinguishment, and complete suppression will likely require the vessel to be alongside in a Port of Refuge. A comprehensive Port of Refuge proposal has been compiled and is under review authorities. Phase II planning, including debunkering, hazardous cargo handling, and final fire suppression, will be initiated

once approval is granted. DNV-ERS is coordinating stability and structural integrity verification, which are preconditions for approval.

Given the prevailing monsoon conditions and rough seas, relocation of the vessel is not currently advised. However, a cautious shift 50 NM southward of the current position may be considered if conditions necessitate.

In summary, the response has transitioned into a controlled salvage operation with careful risk mitigation. The safety of onboard personnel, environmental protection, and vessel stabilization remain top priorities. Active firefighting readiness is in place with Virgo and Saarthi, and continued presence of *Water Lily* has been requested to ensure safe personnel transfer capability until conditions improve.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 32, 1800 Hrs on 16/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

Figure 1: Condition of the vessel

As of 16 July 2025, the situation onboard MV Wan Hai 503 has shown further stabilization. The vessel is currently being towed by Advantis Virgo, following a successful handover from Offshore Warrior, which is now en route to port for bunkers and resupply. Towing operations are being conducted in rough seas and heavy swell conditions. Displacement has reduced by approximately 9,000 tonnes due to

extensive dewatering, leading to an increased freeboard and improved visibility of draft marks, including the transom stern, where the aft draft is estimated at 14.0 meters.

The engine room is nearly dry, with water levels reduced to 70 cm through continuous pumping. Cargo Holds No. 2 and No. 3 are reported to be significantly dewatered, while Hold No. 6 has seen a reduction in water level from 7.5 to 5 meters. Cargo Hold No. 7 remains dry but is emitting hydrogen sulphide (H_2S), indicating potential hazardous gas presence and the need for further ventilation and chemical treatment.

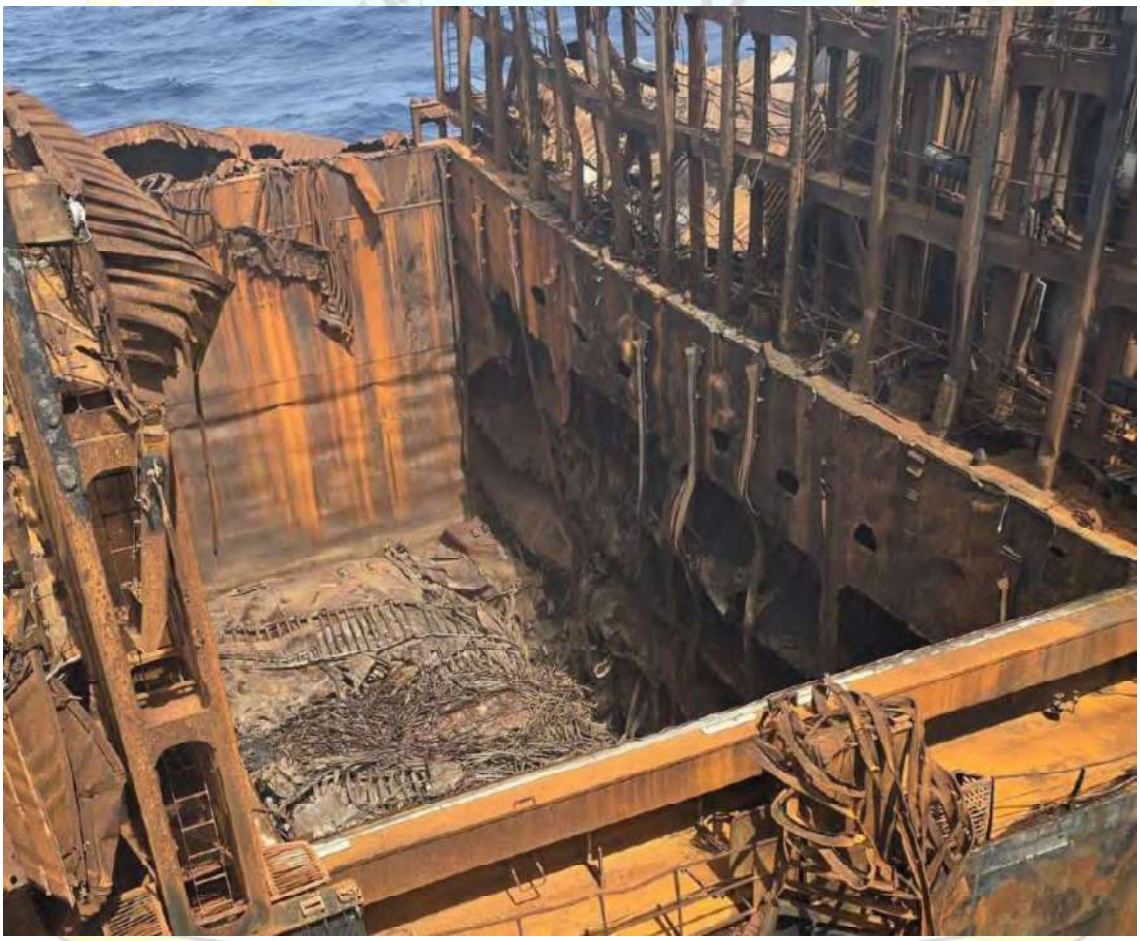

Figure 2: Cargo Hold No 2/3

Light grey smoke continues to emanate from Bays 33 to 37, but there are no visible flames. Hotspot temperatures remain steady, and no escalation has been observed. Cargo hold temperature readings, taken over the past week, confirm a plateau in heat levels, suggesting the fire is under control. Structural monitoring is ongoing, with no immediate threats reported. The engine room is accessible, but poor weather and high

freeboard have made boarding operations difficult. At present, six salvage personnel remain onboard and will stay until sea conditions improve.

4. Additional Support:

Several vessels remain actively engaged in supporting salvage operations. Advantis Virgo has assumed the primary towing role and is standing by with Pyrocool for localized application, while Water Lily continues to manage personnel and equipment transfers. Saksham is currently in port for bunkering and collection of additional fire suppression supplies. Nand Saarthi remains onsite, assisting with logistics.

Port of Refuge coordination efforts are progressing. Phase 1 of the salvage plan, detailing safe towage to port, has already been submitted to the authorities, and Phase 2, concerning cargo discharge and disposal, is nearing completion. Constructive engagement has been undertaken with port authorities, and the MPA (Singapore) is also actively supporting discussions to facilitate safe access.

Structural and stability assessments are underway with DNV ERS, which is receiving updated data on cargo hold and tank soundings, as well as draft readings. Due to the significant improvement in vessel condition, the salvage team is approaching completion of Phase 1 readiness, which would deem the vessel safe for entry into sheltered waters for final remediation and cargo operations.

5. Situation Assessment

The vessel is now in a more controlled and safer condition. All visible flames are extinguished, and thermal readings across cargo holds suggest a cooling trend. With successful dewatering of engine room, Cargo Holds No. 2, 3, and partial reduction in Hold No. 6, the vessel's trim and list have been improved. Despite rough weather, the vessel has not exhibited any signs of instability.

Challenges remain in safely transferring personnel due to heightened freeboard and rough sea state. The presence of H_2S gas in Cargo Hold No. 7 presents a hazardous environment that must be ventilated before any entry. Additionally, concerns regarding

potential water absorbed in cargo within containers persist, possibly explaining discrepancies in displacement and draft calculations.

Soundings of bunker tanks are incomplete, though preliminary estimates suggest approximately 2,400 tonnes of fuel remain onboard. No signs of oil leakage or migration into cargo spaces have been observed. Once structural stability and draft criteria are verified, either a green or amber signal for port entry will be pursued.

The salvage team's focus is now on completing tank soundings, verifying longitudinal strength, and finalizing preparations for the Port of Refuge entry. Weather permitting, Saksham will return with Pyrocool and critical equipment to enable final phase stabilization.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 33, 1800 Hrs on 18/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

As of 18th July 2025, MV WAN HAI 503 continues to remain under tow and under close operational surveillance. The vessel is drifting slowly in a southeasterly direction, amid persistent rough sea conditions with wind gusts reaching up to 40 knots. There are no visible naked flames aboard, and the fire appears to be under control, however, residual heat remains in Bay Nos. 33 to 37 of Cargo Hold No. 4. The temperature monitoring had to be temporarily deprioritized due to reallocation of resources to dewatering operations, which continue to be a major focus.

Dewatering is actively ongoing in Cargo Hold No. 6 and the engine room. These efforts have shown gradual and steady progress despite weather-related limitations. Gas conditions within the cargo holds continue to be hazardous, restricting entry and preventing detailed inspection or further cargo assessments at this stage. The ship's stability remains under control, and residual smoke from the forward holds has reduced significantly.

On 15th July, during the towline transfer from Offshore Warrior to Atlantis Virgo, the main towline parted. Emergency tow connection was immediately established. By 17th July, a permanent towing arrangement was reconnected, however, Advantis Virgo

reported fouling of its starboard propeller from the entanglement, rendering it operable only on one engine.

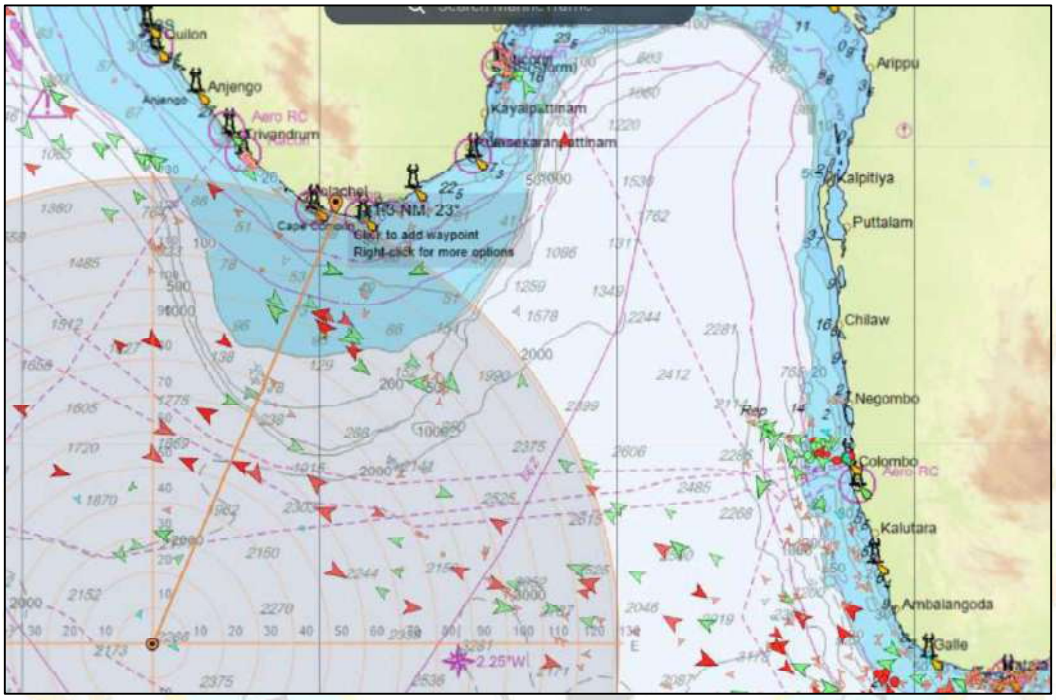

Figure 1: WAN HAI 503 presently 130 nm from Cape Comorin(India) and 200 nm from Colombo (Sri Lanka)

4. Additional Support:

Coordination among assets has been a critical aspect of the ongoing operation. The salvers have requested Directorate General of Shipping (DGS) for continuous availability of Emergency Towing Vessel (ETV) coverage at the site, especially in light of Offshore Warrior's temporary absence for bunkering. The request is till return of Offshore Warrior post bunkering operations which is around 21st July 2025.

Water Lily has continued to serve as a critical link for personnel transfer and logistical support, while Atlantis Virgo remains at the site providing emergency towing capacity until Offshore Warrior resumes her station.

5. Situation Assessment

The overall condition of the vessel has improved steadily over the past week, particularly in terms of onboard flooding and fire control. With the engine room water level under control and the pumping operation in Cargo Hold No. 6 continuing, salvors now report a more stable internal condition. No. 2 and 3 holds appear to be dry, and the engine room is reportedly being maintained at a depth of approximately 50 cm,

which reflects a substantial improvement in on-board conditions. The salvers have confirmed that approximately 2300 MT bunkers are still on-board.

As part of the mid-term operational plan, progress has been made toward identifying Port of Refuge. T&T Salvage, along with Wan Hai Lines, has conducted discussions and site visits with identified port authorities and waste management contractor of the port. The proposed two-stage approach includes:

- Navigating to a position close to the port for final dewatering and condition assessment, followed by
- Formal entry into port once pre-arrival conditions are met.

The salvage team will continue to monitor hull temperature, structural safety, and gas conditions inside the cargo holds. DGS has emphasized that all asset coordination must be maintained to prevent operational lapses, especially with no further extensions planned for ETV deployment.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 34, 1800 Hrs on 21/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

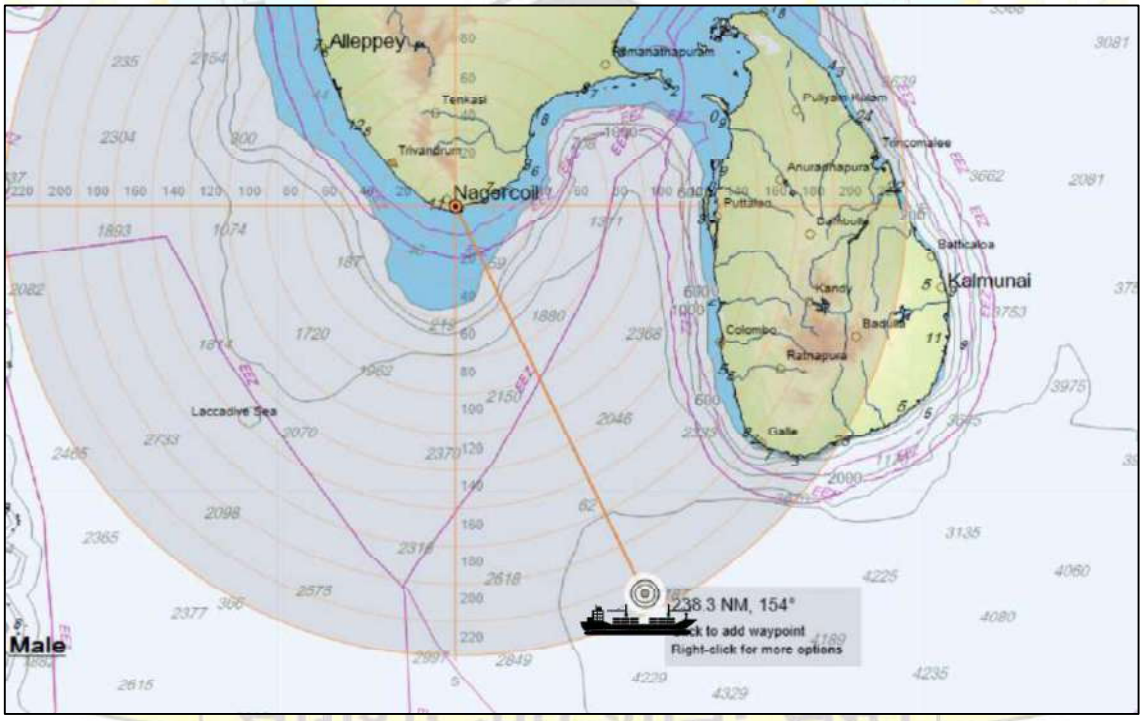

Figure 1: Position of the vessel

As of 21 July 2025, the casualty vessel *Wan Hai 503* remains in a stable condition. Grey smoke was last observed in the vicinity of cargo holds no. 3 and 4 on the afternoon of 20 July, consistent with previously reported patterns of residual

combustion due to unextinguished smouldering cargo. The vessel remains stable and continues to weather rough conditions with gusting winds over 30 knots and swells. She is currently located approximately 238 NM southeast of the Indian EEZ boundary and has been drifting along with prevailing ocean currents in the absence of active tow. Connection with the Offshore Warrior is scheduled to be re-established upon its return from Cochin, where it had proceeded for replenishment of bunkers, stores, and freshwater.

Salvage operations continue on board with a 16-member team having boarded the casualty. The salvage team now intends to remain on board continuously to maintain operation tempo and stability. Essential amenities such as cooling appliances and food supplies have already been provided to support extended stays. Dewatering of the engine room, cargo holds, and duct keel continues, with improved control achieved in most spaces. Notably, cargo holds no. 2 and 3 appear dry, while engine room water level is being maintained at approximately 50 cm. Pumping in hold no. 6 is ongoing.

4. Additional Support:

Offshore Warrior is en route back to the casualty site from Kochi and is expected to arrive on 22 July. Once reconnected, it will re-establish tow and return the vessel toward the Indian EEZ as previously committed to Sri Lankan authorities. The salvage team has also mobilized an additional tug, *Advantage Libra*, which departed from Khor Fakkan on 20 July and is expected on-site by 27 July. This will augment the operational fleet and provide greater redundancy for towage and salvage work, particularly in light of upcoming potential port entry.

Advantis Virgo, having suffered propeller issues during prior maneuvers, is planned to return to Colombo for underwater inspection and repair after Offshore Warrior takes over towing duties. Until then, it remains on standby. Meanwhile, *Saksham* is actively engaged in fire watch and boundary cooling as required. *Water Lily* continues to serve as the primary platform for safe personnel transfer to and from the casualty.

5. Situation Assessment

The overall salvage and stabilization picture is cautiously optimistic. The casualty vessel has shown structural resilience. The recurrence of grey smoke emissions is anticipated and attributed to residual combustion within affected cargo holds. Given the limitations of safe access to these areas, boundary cooling remains the feasible mitigation approach at present. The emergency towline that parted earlier is being recovered and stored aboard the casualty vessel as a precaution. A backup towline is also being prepared.

The salvage team's ability to remain on board continuously marks a positive shift in operations, reducing reliance on the single transfer boat (*Water Lily*) and allowing uninterrupted oversight. Planning is also progressing for final stages of casualty removal. Port of refuge coordination continues.

In terms of pollution response, *Wan Hai Lines* has communicated its decision, based on inputs from ITOPF and shoreline drift modelling, to discontinue contractual ties with SpillTech and MERC for shoreline clean-up, citing minimal ongoing risk. However, MERC remains on standby should future response be necessary. The Directorate General of Shipping (DGS) has taken note and will revert formally upon review.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 35, 1800 Hrs on 24/07/2025

Explosion on WAN HAI 503 (IMO no – 9294862, Flag Singapore) West of Kerala

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders. MPA Singapore assumed responsibility for further coordination efforts regarding the vessel to proceed to port of refuge. This is the last SITREP since the vessel is well beyond Indian EEZ and there's no concern to the Indian Coast.

1. Incident Overview:

Refer to SITREP – 2, 2200 hrs on 09/06/2025

2. Response Actions Initiated:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

3. Present Status:

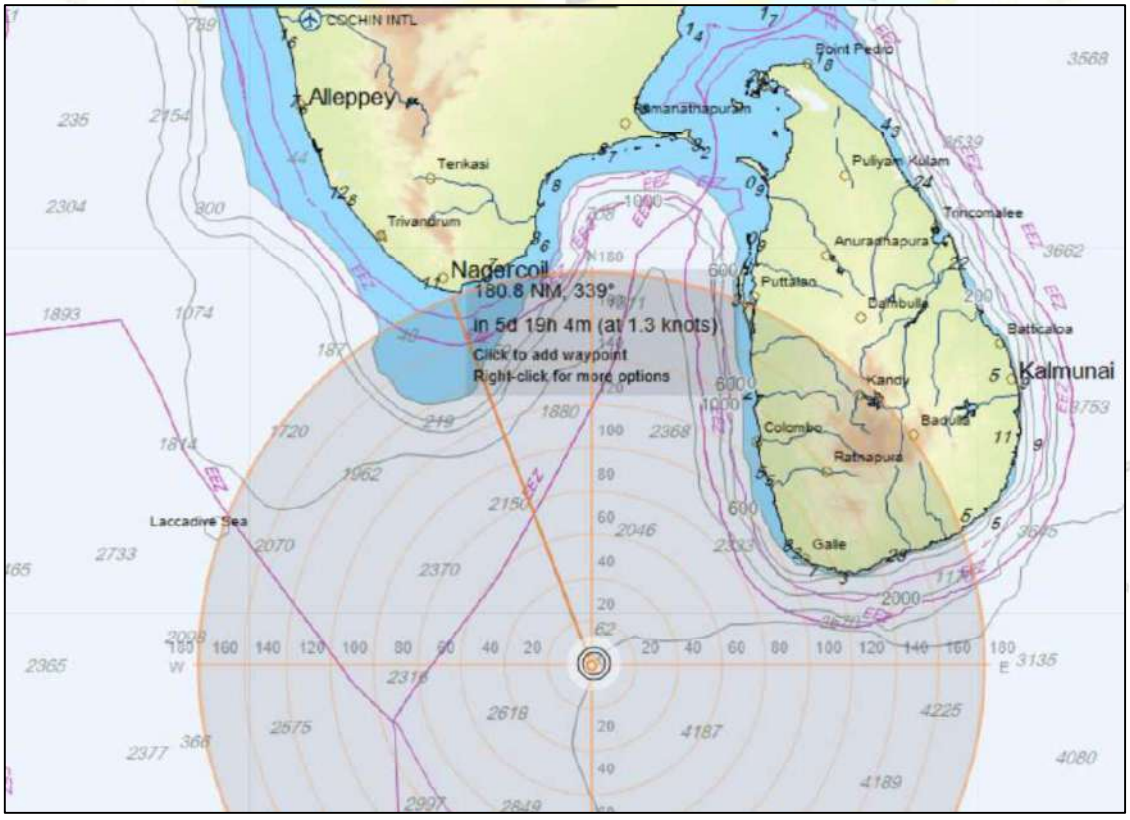

Figure 1: Position of the vessel

As of 24 July 2025, the *Wan Hai 503* remains under tow outside the Indian EEZ, being managed by the tug *Offshore Warrior*. The casualty is currently located approximately **90 nautical miles from the Indian EEZ boundary** and continues to be held in stable tow as preparations are made for further movement under a forward towing connection.

Onboard fire conditions have stabilized considerably. Light smoke continues to emanate from **Bay 29 to Bay 35**, but there is **no evidence of flame** or heat escalation. Temperature measurements across affected cargo holds remain stable and in control, averaging **around 40–41°C**. A complement of approximately **20 salvage personnel**, including the Salvage Master, is currently present onboard *Wan Hai 503*.

Dewatering efforts are ongoing and yielding consistent results. **Cargo Hold Nos. 5 and 6** are being pumped continuously to maintain manageable water levels. The **engine room** level is also stable and is being monitored round-the-clock. This level of dewatering is critical not only for operational access but also for any required inspection or shifting of equipment.

4. Additional Support:

Support vessel operations are being coordinated in tandem with ongoing salvage tasks. The ETV *Water Lily* continues to support **personnel and material transfer** between support tugs and the casualty vessel. The *Virgo*, which temporarily docked at **Galle Harbour** for maintenance, is scheduled to **rejoin operations by the morning of 25 July**. The Virgo's re-engagement is particularly important as it is designated to execute the **forward towing line connection**, a critical requirement for entry into a Port of Refuge.

Other deployed vessels, including *Saksham* and *Nand Saarthi*, remain on standby to support equipment and crew transfers as needed. The **Advantis Libra** has also been confirmed to **join operations by 29 July**, further reinforcing support capability. The vessel is being sent to replace Virgo after the forward towing line is connected.

Currently, the **primary coordination responsibility** for managing the incident is being **handed over to the Flag State, Singapore**, and the salvors. The Directorate General

of Shipping (India) has confirmed that India's operational coordination responsibilities will conclude once the vessel re-enters international waters beyond its EEZ, barring any renewed emergency and expects MPA Singapore to coordinate with the owners as well as the salvers for all further actions.

India will, however, continue to provide logistical assistance if requested, and has made arrangements to stand by in the event of any renewed crisis, especially in light of ongoing Southwest Monsoon conditions.

5. Situation Assessment

The situation onboard *Wan Hai 503* is being managed effectively by the salvage team. The fire outbreak has been controlled, and residual smoke is under observation but not currently escalating. Dewatering across multiple compartments has been successful, and structural assessments, confirm the vessel remains afloat and maneuverable under tow.

A key operational milestone is the **establishment of a forward towing connection**, which is essential for the vessel to be accepted into a Port of Refuge. The **Maritime and Port Authority of Singapore (MPA)** has clearly communicated that entry to a port will not be permitted until this forward tow connection is in place. To this end, the salvors have planned to complete the forward towing arrangement by 27–28 July 2025 using *Virgo*.

The MPA has also requested detailed photographic and structural reports, particularly of the port side's damaged sections, to evaluate the vessel's seaworthiness for coastal entry. Once the forward towing connection is confirmed, the salvors will submit updated documentation to the MPA for final review and port clearance.

Meanwhile, the Directorate General of Shipping (India) reiterated its position that any entry into an Indian Port of Refuge remains off the table till all bunkers are removed and till monsoon conditions prevail. DGS also emphasized that if the Port of Refuge clearance is delayed further, the vessel should **continue to be held outside all EEZs**, including in proximity to the India-Sri Lanka-Maldives tri-junction, if safety allows.

In conclusion, while the situation remains weather-sensitive, significant progress has been made in stabilizing the vessel. With towage secure, fire risk reduced, and personnel safely onboard, operations are now entering a decisive phase focused on relocation, compliance, and final port entry clearance.

This is the final SITREP being issued by the Directorate General of Shipping. The organization extends its sincere gratitude to all authorities who have actively participated in the salvage operations thus far. Their efforts were instrumental not only in keeping the vessel away from the Indian coast but also in critically contributing to the successful preservation of the vessel and the marine environment.

6. Navigational Hazards:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

7. Coordination Measures:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

8. Cargo Assessment:

Refer to SITREP – 3, 2200 hrs on 10/06/2025

Directorate General of Shipping

SITREP – 42, 1800 hrs on 21/07/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

Preparations for the next phase of salvage operations on the sunken MSC ELSA 3 have intensified with final mobilisation activities underway in Singapore. The DP2 Diving Support Vessel (DSV), equipped with a saturation diving system, is scheduled to depart on 24 July 2025 and will proceed directly to the wreck site. The project team intends to operate the vessel entirely offshore, without entering port, and will begin diving operations immediately upon arrival.

In the meantime, Canara Megh continues caretaking duties at the wreck site but had returned to Kollam over the weekend due to rough weather offshore. Redeployment is contingent on weather improvement. Kollam Port has emerged as the preferred logistical hub for the upcoming diving operation owing to its proximity, adequate draft (7 meters), and historical support to the salvage team. Immigration clearance is being arranged through the FRRO at Trivandrum, with full backing from the port and state maritime authorities.

Onshore, MERC continues daily cleanup and logistics operations. As of 18 July, 557 metric tons of nurdles have been collected from the affected shoreline areas, of which 266 MT have been transferred to the Kollam warehouse. Segregation of the remaining quantity is ongoing.

4. Situation Assessment:

The mobilisation of *Southern Nova* signals a critical transition into deep-sea fuel extraction and high-risk underwater operations requiring uninterrupted logistical and regulatory coordination. The strategy to operate directly offshore has been planned for this phase. However, immigration protocols and project crew access require clearances that are being actively pursued with the FRRO in Trivandrum and support from DG Shipping. A formal request has been raised for DG Shipping to issue a letter facilitating immigration and port pass arrangements through Kollam.

Kollam has been reaffirmed as the optimal base for project coordination, offering efficient turnaround times (approximately 4.5 hours to the site) and administrative ease compared to Kochi. Previous similar operations from Kollam reinforce its suitability, especially with robust institutional support from Kerala Maritime Board and Kollam Port Authority. The involvement of Pollution Control Boards and district administrations in Kanyakumari and Kollam continues to ensure regular oversight.

Additionally, MERC has reiterated the need for updated guidance from Tamil Nadu authorities concerning the disposal of stored nurdles in Kanyakumari, as no final directive has yet been received.

As the response transitions into technically intensive salvage and waste management phases, institutional coordination, regulatory facilitation, and state-level cooperation will be crucial in maintaining momentum and achieving operational closure.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 43, 1800 hrs on 04/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DSV Southern Nova, a DP2 vessel, with a saturation diving system, has arrived at the wreck site of MSC ELSA 3 and is currently positioned approximately 14 nautical miles off the coast of Kerala. Preparatory work for the underwater fuel extraction phase is underway. Personnel transfer to the Southern Nova began on 03 August using PSV Offshore Monarch, after initial difficulties with Canara Megh due to persistent swell conditions. The transfer operations are being planned for execution in controlled batches during daylight hours, ensuring compliance with safety and immigration protocols. Coordination with FRRO, Trivandrum and port authorities has facilitated smooth documentation and logistical support.

Further, pollution prevention and control measures remain in place with booms placed onboard support vessels and pollution response teams on standby. Dive operations are expected to commence once final on-site safety checks are completed and sea conditions allow for stable deployment of divers and recovery systems. The Canara Megh, having provided offshore standby support, has returned to Kollam Port due to adverse weather and will be redeployed based on operational requirements.

Onshore, the marine environmental response continues with focused efforts on cleanup and transport of spilled nurdles. As of 04 August 2025, a total of approximately 625 metric tons of nurdles have been collected and transported to the Kollam

warehouse from affected coastal areas in Kerala and Tamil Nadu. Collection and segregation activities remain ongoing, supported by over 900 deployed personnel, including volunteers and MERC teams. However, formal responses from the Tamil Nadu State Government regarding disposal arrangements remain pending.

4. Situation Assessment:

With the arrival of the DSV *Southern Nova*, the operation has moved into a critical phase focused on submerged fuel extraction from the wreck. The requirement for close coordination between the Salvage Master and vessel Master remains essential for safe initiation of saturation diving. Weather remains a limiting factor, especially with rough sea conditions affecting crew mobility and limiting equipment deployment particularly the placement of marker buoys at the site.

Given the continued observation of nurdle recharges along the coastline and the confirmed number of 65 containers carrying plastic pellets, it is anticipated that shoreline wash-ups will persist intermittently. The current deployment model for volunteers is being adjusted based on localised recharge patterns. Furthermore, oil spill contingency preparedness has become more crucial with the onset of underwater works, prompting the need for meticulous coordination with the Indian Coast Guard.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

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Directorate General of Shipping

SITREP – 44, 1800 hrs on 05/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The salvage operation for the sunken MSC *Elsa 3* has entered a critical preparatory phase, following the observation of an oil sheen extending approximately 1.5 nautical miles from the wreck site. The Indian Coast Guard has been closely monitoring the situation, and aerial surveillance is underway using a Dornier aircraft. While no major spill has been confirmed, the possibility of a leak due to engine room disturbance has necessitated heightened vigilance.

The *Southern Nova* (DSV), mobilized for the next phase of fuel extraction, is currently stationed offshore and ready to commence operations. However, due to prevailing sea conditions, safe personnel and equipment transfer has not been feasible via the Offshore Monarch. Consequently, a formal request has been made for port clearance at Kollam to allow boarding of personnel and loading of gear from a safer location. The customs and immigration processes are being coordinated with the relevant authorities, and documentation (IGM/EGM, crew lists, etc.) is being compiled by MERC and MSC.

In light of the risk indicators observed, salvors have been clearly advised to keep oil spill containment and recovery gear ready for immediate deployment. This preparedness is critical to ensure swift response in the event of a discharge during operations.

4. Situation Assessment:

While the sheen remains limited in scope, this development highlights the need for the salvage team to transition swiftly into operational mode.

To facilitate this, it is imperative that the owners and salvors obtain necessary clearances from the Customs authorities expeditiously, allowing the DSV *Southern Nova* to berth at Kollam Port and begin loading of equipment and personnel.

Furthermore, Owners and salvors have been instructed to formally write to the Indian Coast Guard for any assistance in pollution response near the wreck site. The strategic deployment of such a support vessel will significantly enhance the response readiness for oil containment and recovery during fuel extraction and dive operations. It was also conveyed that the propeller wash is being done by Canara Megh to disperse the sheen which is also being further aided by the weather which is aiding natural weathering.

The Directorate General of Shipping has committed to issuing formal communications to support this inter-agency coordination, while Kollam Port continues to provide active facilitation. Ensuring synchronized action across all stakeholders is vital at this juncture to maintain momentum and minimize environmental risks.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 45, 1800 hrs on 06/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DSV *Southern Nova*, a DP2-classed dive support vessel, successfully berthed at Kollam Port at 0930 hrs on 06 August 2025. Following coordination with relevant port and government authorities, including FRRO (Immigration), Customs, and the Port Authority of Kollam, a team of 60 salvage experts completed the required immigration and health formalities. The onboarding process was completed by 1425 hrs.

All bunkering and provisioning requirements have been met, with the vessel now equipped to sustain continuous operations offshore for more than 45 days. Seven trucks carrying oxygen cylinders (for divers) arrived from Cochin and were safely transferred onboard, in addition to essential salvage personnel and equipment arriving via *Offshore Monarch*. *Southern Nova* is now in a state of full operational readiness.

Visual documentation of the vessel's deck layout, onboard systems, and diving and tank-cleaning equipment is to be prepared and submitted. Meanwhile, the shore clean-up and back-end waste management efforts remain ongoing. As of now, a cumulative total of 629 metric tons of plastic nurdles have been transported and stored in the Kollam warehouse. However, document verification for recent transfers is still pending due to the diversion of field teams to support offshore mobilization.

4. Situation Assessment:

With the onboarding phase complete and equipment mobilized, *Southern Nova* is prepared to commence offshore operations at the earliest, weather-permitting. The Salvage Master, in consultation with the vessel's command and meteorological advisors, is expected to make the departure call within the next 24 to 48 hours, based on updated weather models and on-site reconnaissance inputs.

The Indian Coast Guard (ICG) has been engaged in aerial surveillance of the wreck site. Video footage from these sorties is crucial in validating sea and wreck conditions prior to the vessel's offshore deployment. DGS has specifically advised the salvors to keep oil spill response equipment on immediate standby for deployment, given the risk of fuel leakage during extraction activities. The DSV is expected to be deployed on 09th August at the wreck site.

Further, the Directorate has reiterated the urgency for expeditious clearance from the Customs Department, particularly for specialized equipment and support materials being shipped into the country for this phase. The salvors have also been advised to formally approach the Indian Coast Guard for the possible deployment of a ICG asset should there arise a requirement of assistance in pollution response. This will ensure rapid response capability in case of any marine pollution incident during underwater tank extraction and transfer.

With all preparatory elements in place and institutional support extended, the salvage operation is expected to transition into active fieldwork imminently. Coordination among all stakeholders will continue to be critical to the success and safety of the ongoing intervention.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

Directorate General of Shipping

SITREP – 46, 1800 hrs on 08/08/2025

Sinking of MSC ELSA 3 (IMO no. 9123221, Flag Liberia) South West of Kochi

The contents of this SITREP are based on both written and verbal inputs received from the stakeholders

1. Incident Overview:

Refer to SITREP – 6

2. Response Actions Initiated:

Refer to SITREP – 6

3. Present Status:

The DP2 DSV *Southern Nova*, carrying salvage equipment and personnel, is scheduled to sail out from Kollam Port on the morning of 9 August 2025 at 1000 hrs. On-board preparations, including deck rearrangement and ballasting using 40 tonnes of fresh water, are being undertaken to optimize vessel stability and readiness for immediate offshore deployment. Upon reaching the wreck site, ROV calibration and wet testing will be initiated, followed by diver saturation and subsea surveys. Six tanks are confirmed to be loaded onto *Southern Nova*, with two remaining on *Offshore Monarch*, which will continue to operate as a supporting PSV throughout the salvage operations.

A container recently recovered from the sea was secured by *Canara Megha* and brought to Kollam Port. Initial inspection confirmed it to be empty. The container has been temporarily stored at port premises, with rigging work in progress for its formal unloading and assessment. *Canara Megha* will resume her offshore caretaking duties following this task. Customs and immigration formalities for all 65 onboard salvage personnel have been completed smoothly with full cooperation from authorities, enabling operational timelines to be maintained.

4. Situation Assessment:

The salvage operations are advancing into a critical phase involving saturation diving and subsea inspection, including assessment of potential obstacles around the wreck. This is expected to commence within the next 48 hours following ROV validations. Divers will also begin work on checking and securing all fuel vents to prevent leaks and initiate recovery operations. Continuous deployment of the *Offshore Monarch* alongside *Southern Nova* ensures operational flexibility and standby support at the site.

From the shoreline, clean-up efforts remain active, with 600 volunteers currently engaged. However, the daily collection of nurdles has plateaued, with the cumulative recovery estimated to be in the range of 629–639 metric tons. Coastal monitoring continues due to intermittent reports of nurdle washups, which are being responded to promptly. The OSR equipment has been confirmed to be on board *Canara Megha*, ensuring preparedness for any eventualities offshore. The coordinated engagement between MERC, SMIT, and all involved agencies has ensured the operation remains on schedule and in compliance with all regulatory protocols.

5. Environmental Risks:

Refer to SITREP – 6, 1800 hrs on 28/05/2024

6. Coordination Measures

Refer to SITREP – 6 for the overall coordination measures being undertaken

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