

**BEFORE THE NATIONAL GREEN TRIBUNAL,
PRINCIPAL BENCH, NEW DELHI**

Original Application No. 425/2023

In the matter of: -

Deepika Khari

.... Applicant

Vs

State of Uttarakhand and Ors.

.... Respondents

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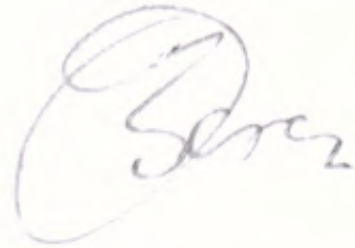
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New Delhi

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RESPONSE AFFIDAVIT BY PCCF (HoFF), UTTARAKHAND, IN COMPLIANCE OF DIRECTIONS PASSED BY THE HON'BLE NATIONAL GREEN TRIBUNAL VIDE ITS ORDERS DATED 05.05.2025 AND 17.02.2025.

I, Samir Sinha, aged about 59 years, s/o, Late Shri Rajendra Prasad as Principal Chief Conservator of Forests (HoFF), Uttarakhand, do hereby solemnly affirm on oath and state as under:

1. That in my above-mentioned official capacity, I am acquainted with the facts and circumstances of the present matter, and I am fully competent to file this Response Affidavit.
2. That the Hon'ble Tribunal vide paragraph number 7 of its order dated 17.02.2025, directed the PCCF, Uttarakhand, to file responses with reference to the substantial environmental questions therein. The relevant paragraphs of the order are as follows:

“7. The substantial environmental questions which arise in the present case may be noticed as under:-

- (i) Whether controlled fire is the only method of preventing/controlling fire in the forest or there is any other alternative method;*
- (ii) Whether the method of controlled fire adopted for preventing/controlling fire in the forest is supported by any scientific study regarding efficacy of the above said method; and*
- (iii) Whether the said method has been approved by MoEF&CC as a remedial measure for preventing/controlling forest fires.*

8. In view of the nature, magnitude and importance of substantial environmental questions involved in the present case, we consider it appropriate to widen the scope of the present proceedings so that the substantial environmental questions involved can be looked into by the concerned authorities and appropriate remedial measures can be taken.

9. Appropriate responses with reference to the substantial environmental questions noticed above may be filed by PCCF, Uttarakhand and also by MoEF&CC.”



3. That, in compliance with the above aspects raised by the Hon'ble Tribunal, the response submitted by the PCCF (HoFF) are as follows:

A. That in response to point (i) of paragraph 7, *whether controlled fire is the only method of preventing/controlling fire in the forest or there is any alternative method*, it is submitted that:

The control burning is a traditional method for reducing the fuel load in the forest areas thereby reducing the chances of large fires in the warmer months. This method has been prescribed as a management tool and finds place as prescriptions in the management/working plans for the forest divisions in the State of Uttarakhand. The control burning is carried out with an objective to reduce the leaf litter available in the forest areas and is normally carried out before the onset of the fire season. However, during the fire season also, in a strictly regulated manner, as necessitated by leaf fall period, its extent/spread, it is carried out as a fire drill especially along the roads, around the periphery of the plantations, etc. to prevent any chance of forest fire.

No, the control burning/controlled fire is not the only preventive method for controlling forest fires. Besides this, there are other methods also viz. clearing the fallen leaf litter manually along the roads and around the periphery of the raised plantations before the fire season. However, this requires much more resources owing to higher manual labour and time involved.



B. That in response to point (ii) of paragraph 7, whether the method of controlled fire adopted for preventing/controlling fire in the forest is supported by any scientific study regarding efficacy of the above said method, it is submitted that:

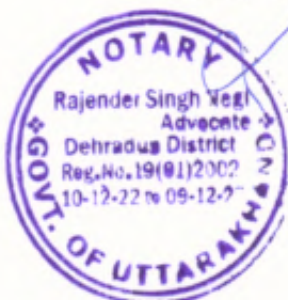
The method of controlled fire/control/prescribed burning adopted for controlling fire in the forest is supported by various scientific studies globally, many of which have been carried out to assess its efficacy.

The relevant and key parts of the few conducted scientific studies are provided as under: -

a) *Crystal A. Kolden, 2019, "We're Not Doing Enough Prescribed Fire in the Western United States to Mitigate Wildfire Risk" by Department of Forest, Rangeland, and Fire Sciences, University of Idaho Fire 2019, 2, 30; doi:10.3390/fire2020030 - Prescribed fire not only reduces the biomass available to burn in a subsequent uncontrolled wildfire, it also supports carbon sequestration, facilitates ecological resilience, and is critical in restoring ecological function in regions where decades of fire exclusion pushed fire-adapted ecosystems outside their historic range of variability and degraded such function.*

b) *Marcos Francos and Xavier Übeda, 2021. "Prescribed fire management" Environmental Science & Health 2021, 21:100250- Prescribed fire is often used for environmental and land management, and controlled burning has proved a good tool to manage large forest areas in cases where economic resources are limited, being economically beneficial and feasible for land management.*

c) *W. Lachlan McCaw, 2013. "Managing Forest fuels using prescribed fire - A perspective from southern Australia" Forest Ecology and Management 294 (2013) 217-224 Prescribed fire is increasingly recognized as also playing an*



important role in mitigating undesirable effects of high intensity fires on environmental values including soil, water and biodiversity.

d) *M. P. North, S. L. Stephens, B. M. Collins, J. K. Agee, G. Aplet, J. F. Franklin, P. Z. Fulé, 2015 "Reform Forest fire management" SCIENCE 18 September 2015 VOL 349 ISSUE 6254 - Fire can also be used to reduce fuels either intentionally (prescribed burning) or opportunistically (letting a natural ignition burn as "managed wildfire") under moderate weather conditions.*

e) *Paulo M. Fernandes and Herminio S. Botelho, 2003 "A review of prescribed burning effectiveness in fire hazard" International journal of Wildland Fire, 2003, 12. Wildfire hazard abatement is one of the major reasons to use prescribed burning. The best result of prescribed fire application is likely to be attained in heterogeneous landscapes.*

f) *S. Little, J. P. Allen and E. B. Moore "Controlled Burning as a Dual Purpose Tool of Forest Management in New Jersey's Pine Region"- Controlled burning does not eliminate the need for organized fire suppression, but supplements it. At the same time, this type of burning greatly favours reproduction of Pines instead of that of the less desirable hardwoods.*

g) *Susan J. Prichard, David L. Peterson, and Kyle Jacobson, 2010."Fuel treatments reduce the severity of wildfire effects in dry mixed conifer forest, Washington, USA". Can. J For. Res. 40:1615-1626.- This study provides strong quantitative evidence that thinning alone does not reduce wildfire severity but that thinning followed by prescribed burning is effective at mitigating wildfire severity in dry western forests.*

The complete research articles of the above scientific studies showing the positive aspects of control/prescribed burning are annexed as **Annexure No. 1 (1.1 to 1.7)**



Moreover, the control burning has been prescribed as a management tool in the working/management plans of the forest divisions that are prepared for 10-year period. The areas for control burning which are sensitive to forest fires are taken up in accordance with the working/management plans.

As an example, the prescriptions regarding control burning provided in the working plans of Dehradun and Garhwal Forest divisions are provided as an **Annexure No. 2 (2.1 to 2.2)**.

Moreover, the directions from the PCCF (HoFF), Uttarakhand for taking up control burning exercise as prescribed in the working/management plans for the forest divisions had been issued to all the Divisional Forest Officers (DFOs)/Deputy Directors (DDs). These directions in the form of letter issued is annexed as **Annexure No. 3**.

Also, for taking up other alternative measures apart from control burning, several initiatives have been taken up for collection of leaf litter from the forest areas. The State has formulated an effective strategy for livelihood generation for local villagers based on collection & commercial utilization of *Chir pirul* and development of social entrepreneurship for its consumption/ utilization. The State had issued a *Chir pirul* management Policy in the year 2018 for electricity generation from *Chir pirul* and other types of biomass. Also, the State Govt. had issued directions for payment of Rs. 3.00/- per kg to the collectors for collecting *Chir pirul* which was later amended to Rs. 10.00/- per kg so as to enhance its collection and also, to enhance the income generation of local villagers. The concerned Govt. order Number 382/G.2.2025.21;09) 2015 E-51081 dated 25.02.2025 is annexed as **Annexure No. 4**. Through these initiatives, the annual *Chir Pine Pirul* collection data is provided as under: -

- 2022: 1,260 tons



- 2023: 2,381.50 tons
- 2024: 3,829.95 tons
- 2025: In the current forest fire season of 2025, a quantity of 1891.37 tons (till 11th June 2025) has been collected from the forest areas by the local self-help groups (SHGs), Van panchayats, Mahila mangal dal etc.

Moreover, suggestions had been issued to all the DFOs/DDs for taking up collection of the fallen leaves and converting it into manure, use of *chir-pirul* (fallen pine needles)/other leaf litter in constructing vegetative check dams and use of collected *chir-pirul* in making pellets/briquettes and also as fuel for industries. The directions in the form of letter issued is annexed as **Annexure No. 5.**



C. That in response to point (iii) of paragraph 7, *whether the method has been approved by MoEF&CC as a remedial measure for preventing/controlling Forest fires*, it is submitted that:

Control burning has been prescribed as a management tool in the working/management plans of the forest divisions that are prepared for 10-year period and are duly approved by MoEF&CC.

Moreover, the National Action Plan on forest fire issued by MoEF&CC in 2018 includes the provision of control burning and the concerned prescriptions provided there-in are mentioned as under:-

Para 6.4 Control Burning: -

Control burning may be necessary in some places for preventing spread of fire. The following actions are recommended to improve the consistent performance and effectiveness of control burning wherever necessary:

- I. *Prioritization of areas for control burning as part of fire risk zonation analysis.*
- II. *Monitoring of performance of control burning at the Circle level and integration of monitoring data into a database maintained by the SFDs;*
- III. *Timely release of funds for control burning prior to the onset of the peak fire season and the provision of advance/ad-hoc release as needed;*
- IV. *Development of state-specific guidelines for control and prescribe burns to be notified and revised as may be necessary.*

This National Action Plan on forest fire issued by MoEF&CC is annexed as Annexure No. 6.



4. That the Hon'ble Tribunal vide paragraph number 5 of its last order dated 05.05.2025, directed the Chief Conservator of Forests (HoFF), to file an additional response giving all relevant details and also mentioning the instructions issued to the field staff regarding control burning and also manual collection of dead leaves as stated in the response attached with his affidavit and also give other information sought by this Tribunal regarding preventive control measures and remedial measures with respect to the specified aspects. The relevant paragraphs of the order is as follows:

"5. In these facts and circumstances, PCCF (HoFF), Uttarakhand is directed to file additional response giving all relevant details and also mentioning the instructions issued to the field staff regarding control burning and also manual collection of dead leaves as stated in the response attached with his affidavit and also give other information sought by this Tribunal regarding preventive control measures and remedial measures with respect to the following aspects:-

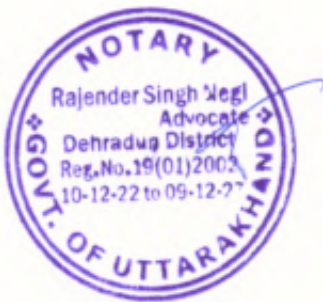
- (i) *Number of forest fire incidents which took place in the year 2024 in Uttarakhand;*
- (ii) *Causes for the forest fires specified separately under the categories of natural, man-made or any other reason (the reason may be specified);*
- (iii) *Measures taken to remedy the damage caused by the forest fires;*
- (iv) *Preventive measures proposed to be taken for preventing forest fires during the year 2025 and the following years;*
- (v) *Budget amount allocated for undertaking remedial measures for remedying the damage caused by forest fires during the*



year 2024 with details regarding adequacy of the amount and modes of utilization; and

- (vi) Budget amount to be allocated for taking of remedial measures for controlling forest fires during the year 2025.*

6. Additional response may be filed by PCCF (HoFF), Uttarakhand within two months.”

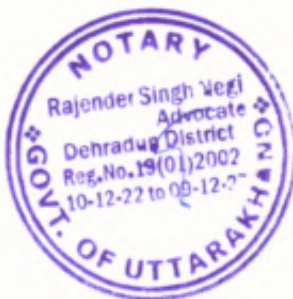


5. In compliance with the above aspects raised by the Hon'ble Tribunal, the response submitted by the PCCF (HoFF) are as follows:

A. That in response to point (i) of paragraph 5, it is submitted that, the *number of forest fire incidents which took place in the year 2024 in Uttarakhand:*

In the year 2024, total of 1276 forest fire incidents occurred during the fire season in which the affected forest area was 1771.665 Ha. The following table provides the detail of the fire incidences, affected area and the type of forests in which the forest fire incidences took place:-

Incidents No. in Reserve Forest (RF)	Incidents No. in Civil Soyam /Van Panchayat Forest	Total Fire Incidents	Affected RF Area (Ha)	Affected Soyam / Panchayat Forest Area (Ha)	Civil Van Forest	Total Affected Forest Area (Ha)
1	2	3	4	5		6
847	429	1276	1228.585	543.08		1771.665



B. That, in response to point (ii) of paragraph 5, *the causes for the forest fires specified separately under the categories of natural, man-made or any other reason*, it is submitted that:

During the forest fire season 2024, the forest fire incidents that took place were majorly surface fire and only the leaf litter, grass etc. were affected.

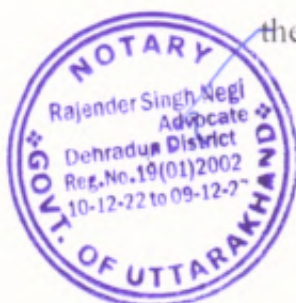
Generally, following are the causes of fire incidences in the forest areas:

-

(a) **Stubble burning related to Farming:** - In the period March-May, the local people after harvesting of their agriculture crops, carry out the burning of the crop residues. Due to the summer season, rising temperature and long dry spell associated with winds, this stubble burning fire escapes from the agriculture fields to the nearby civil/panchayat/reserve forest. Therefore, many fire incidences are attributed to this cause.

(b) **Traditional practices :-** As a traditional annual practice, people living in forest fringe villages burn the forest floor near their villages and pasture lands to get rid of the dry leaf litter particularly the *Chir-Pirul* and also to ensure the fresh grass growth for their livestock. This practice also contributes to the forest fires in the State. However, various sensitization and awareness generation programs are being organised in order to mobilize the community not to take up these activities during the fire season.

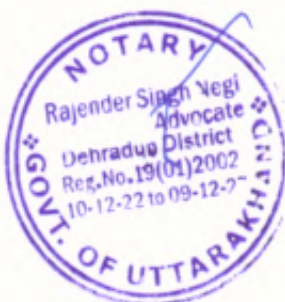
(c) **Intentional setting of fire:-** To obtain new grass, for theft and illegal hunting, to hide illegal felling, to make felling and transportation easy, to keep the footpath clean, to save personal property and feeling of revenge against any person, government employee or department. For their solution, it is necessary to awaken public consciousness and to



warn the people going, working and passing through the forests and to keep a constant watch on them.

(d) Negligence: - Leaving fire lit or throwing burning cigarettes and matchsticks by tourist, workers, shepherds, pedestrians etc. In order to prevent the occurrence of fire due to negligence, various awareness generation programs have been conducted for the community institutions.

Therefore, most of the forest fire incidence are man-made which are either intentional or due to negligence.



C. That, in response to point (iii) of paragraph 5, *the measures taken to remedy the damage caused by the forest fires* are submitted herein:

Based on the long experience of managing forest fires, which forms an integral part of forest management in the state of Uttarakhand and the National Action Plan for Forest Fire (NAPFF), the measures taken for mitigating the forest fires involved the following key components:

1. Prevention of forest fires and increasing the resilience of forests to fires
2. Detection of Forest fires
3. Fire suppression and control

These measures are detailed below:

Prevention of forest fires and increasing the resilience of forests to fires:

i. Use of fire risk zones in forest-fire planning

Historic forest fire occurrence and patterns were used to identify areas that are most prone to fires. Forest Fire incidences records and the fire alerts received from FSI of past years were geo-referenced and mapped. This historical data along with information on forest types and their inherent vulnerability was used to classify administrative units such as forest divisions and ranges according to fire sensitivity which helped in assigning priority of effort (human and financial) for forest-fire control and management. The divisional sensitivity map for Uttarakhand is annexed as **Annexure No 7**.



ii. Forest fire prevention

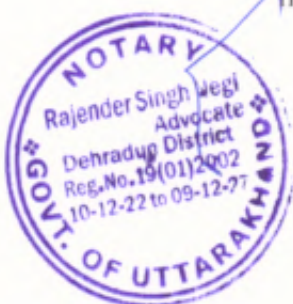
Most forest fires are man-made and are often linked to socio-economic and livelihood issues of the forest fringe communities. Therefore, for reducing the forest fire incidences by making these communities aware of the many tangible and intangible benefits lost to them, both individually and collectively, various activities towards sensitizing the communities are taken up to mobilise their support for forest fire prevention.

Following actions are being taken in this regard:

- Awareness generation & Sensitisation

Starting from 1st of November 2024, massive awareness generation/sensitization activities have been undertaken to ensure active community participation in Forest Fire Management

- Regular awareness activities at large scale had been organized all over the State which include rallies, discussions, meetings, and seminars targeting various stakeholders including schools and colleges. This awareness drive culminates in Forest-Fire Awareness Week which is conducted annually in the first/second week of February when the efforts reach their zenith a little before the official start of the forest -fire season (15th February to 15th June or onset of monsoon whichever is later). A total of 5550 awareness generation activities were organized through-out the State some of which continued through the forest fire season 2025. A detailed division-wise account of the number of such activities is annexed as **Annexure No 8**. Few coverages of the awareness activities in print media are also annexed as a sample **Annexure No 9**.



- In addition, forest-fire prevention campaigns on print and electronic media, Radio, TV, social media etc. has also been done. Signages have been erected at multiple places displaying slogans to prevent forest fires and toll-free numbers for public to report forest fire incidences.
- Before the onset of the forest fire season, the importance of forests and wildlife and the harmful effects of forest fire are widely publicized in the divisions and ranges through a sufficient number of handbills, warning posters, slogans etc. These are pasted on information boards, sign boards, buses and departmental vehicles. Along with this, the telephone numbers of the state and district level control rooms are also widely publicized.
- Effective publicity is done in various areas through seminars, audio-visuals and loudspeakers on vehicles. In this public relations campaign, the local villagers, Yuva Mangal Dal, Mahila Mangal Dal, school students, teachers etc. are also included and their participation and goodwill is earned.

iii. Increasing the resilience of forests to fires

- Soil and Water/Moisture conservation (SMC) works

Much of India's rainfall is concentrated over three months of monsoon, leaving the rest of the year predominantly dry. The dry spells lead to forests becoming short of moisture increasing the fire hazard. Over the last few years, one of the aims of forest management has been moisture retention for longer time after monsoon rains.

Several existing programs for eco-rehabilitation, stream rejuvenation and catchment area treatment plans provide scope for this kind of work.

- River rejuvenation, Water Regime and SMC works



Currently, many streams are being treated through various soil and moisture conservation works in their catchment areas, which include, vegetative and rubble check-dams, contour trenches, gully plugging, percolation tanks etc. The efforts made by the Forest Department to enhance water regime in the forests are given as under: -

Soil and water conservation work is an important priority of the state. Under funds from CAMPA and state sector schemes, work is being done to treat the catchment areas of water streams flowing in the forests of the State. For ensuring scientific and effective treatment of the critical streams in the forest areas sensitive to Forest fire, a detailed technical report (DTR) had been prepared with the following objectives for each stream/spring treatment: -

- To enhance rainfall infiltration into the ground thus increasing recharge capabilities of spring/stream aquifers to sustain the local ecosystem.
- Science based planning, designing and Monitoring & Evaluation.
- To strengthen the capacity of communities, sensitization and awareness of different stakeholders .
- Sustain water security through community participation.
- To control damaging runoff and degradation and thereby conservation of soil and water. To manage and utilize the runoff water for useful purpose.
- To protect, conserve and improve the land of stream catchment for more efficient and sustained production.



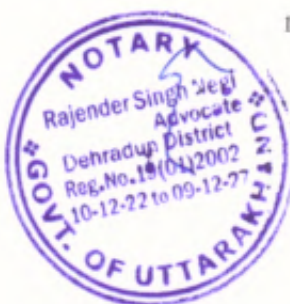
- To check soil erosion and to reduce the effect of sediment yield on the stream shed.
- To enhance the ground water recharge, wherever applicable.

For this, extensive field visit of the catchment area and along the stream/spring have been conducted and drainage line and information gathered from the source maps. Accordingly, the detailed treatment plans have been made in order to reduce the soil erosion, recharge of groundwater and for increasing the availability for potable and irrigational water for the use of villagers. In these detailed plans, the GIS based information has led to the type of structures to be constructed at particular positions of the stream catchments.

Under this activity in **CAMPA scheme**, in the last three years (2022-23, 2023-2024 and 2024-2025), a total of 12987 check dams, 7.7 lakh contour trenches, 811 water-ponds, 376698 percolation pits etc. have been constructed. In addition, 7708 *Chal-khals*, the traditional water harvesting structures were also constructed.

From the year 2023-24, the soil conservation works have been taken up in a project mode and detailed technical reports (DTRs) have been prepared for selected streams/springs. Under CAMPA scheme, for these works, a total of 245 water streams have been selected by various forest divisions in the years 2023-2024 and 2024-2025.

While these efforts will increase the duration of flow of selected water streams through enhanced percolation on one hand, moisture will be maintained in the surrounding forest areas, it will help in increasing the prevalent natural regeneration, will help in reducing forest fires and many benefits are expected including availability of water for local residents and wildlife.



With these efforts made under CAMPA for soil and water conservation in the past 3 years, it is estimated that 14.30 crore liters of rain water storage capacity has been developed in the year 2022-23 and 15.24 crore liters in the year 2023-24 and 18.52 crore liters of rain water storage capacity has been developed in the year 2024-25.

The details of structures constructed during different years in each division for SMC Works in CAMPA is annexed as **Annexure No 10**.

Thus, there is a consistent effort to increase the number of streams treated thereby increasing the area brought under soil and moisture conservation in the forest areas of the state.

Under the State sector scheme, for carrying out the SMC works, emphasis is given to the forest areas which are sensitive to forest fire and also, the critical water streams have been taken up.

Under State sector (Forest protection & management scheme), CAMPA & Centrally sponsored scheme, the construction of structures as part of the soil and moisture works carried out in the last three years (financial year 2022-23 to 2024-25) in the forest areas is summarized as below: -

A total number of 9,10,179 different structures (soil & moisture conservation works) have been constructed. A total of 19631 check dams (vegetative /RR/ crate wire), 13285 chal-khal, 650610 contour trenches, 2828 water-ponds, 8296 percolation pits and 215529 water holes have been constructed. Additionally, 235 Amrit Sarovars have been rejuvenated in this scheme.

While these efforts will increase the flow of selected water streams on one hand, moisture will be maintained in the surrounding forest areas, it will help in increasing the prevalent natural regeneration, will help in

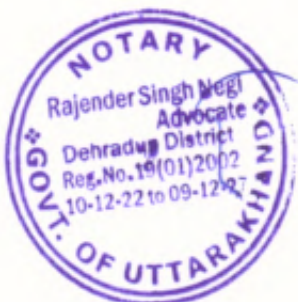


reducing forest fires and many benefits are expected including availability of water for local residents and wildlife.

- Role of Spring and River Rejuvenation Authority (SARRA) and the Forest Department:

- SARRA was set up by the State Government for better coordination of all agencies involved in soil and water conservation activities. It identified 42 critical water sources within forest areas (19 streams and 23 springs).
- In the financial year 2024-25, the Forest Department selected 16 out of 19 streams, of which 15 were revived under the State Sector Scheme and 01 under the CAMPA scheme.

Thus, as detailed above, the Forest Department in coordination with other agencies are taking significant steps to remedy the damage caused by the forest fire which is assisting the water conservation and rejuvenation of water sources, which is expected to further enhance water storage capacity in the coming years.



D. That, in response to point (iv) of paragraph 5, *the preventive measures that have been taken up for preventing forest fires during the year 2025 and the following years*, are herein summarised:

D.I Shitlakhet Model :-

- As a novel measure, in this fire season 2025, to increase community participation, the department is replicating the 'Shitlakhet Model' which is operational in parts of Almora district in all other sensitive forest divisions of the state.
- The *Shitlakhet* movement, triggered by the 2003-04 drought and drying of the Kosi River drying, began with the slogan "Jungle Bachao, Pani Bachao" in 30 villages around Syahi Devi – Shitlakhet ridge, Almora.
- Community engagement included constituting Mahila Mangal Dals, rewarding women's groups, and in later years creating "*Jungle ke Dost*" Facebook and WhatsApp groups for communication/dissemination of the awareness/sensitization.
- Key actions included restricting firewood collection, introducing metal ploughs with Vivekanand Agriculture Research Institute, and supporting the Forest Department in fire prevention.
- This year, exposure visits were conducted for forest officials, Van Panchayat Sarpanches, Self Help Groups, forest fire management committees and other villagers to learn best practices at *Shitlakhet* and replicate in their respective areas. For a period of approximately two months from 15th December 2024 to 15th February 2025, 1170 personnel in multiple teams from 19 forest divisions, have participated in these visits.

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- In addition, teams comprising of 319 members from Soil Conservation Forest Division, Lansdowne went on an exposure visit to Jardargaon village, Tehri district to see initiatives similar to *Shitlakhet*.

D.II Aun Diwas Celebrations: -

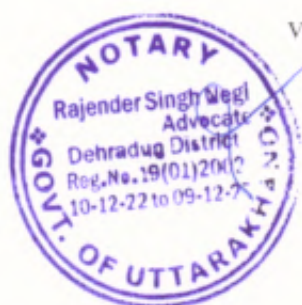
It is an activity carried out by the local communities for preventing the stubble burning activity during the peak forest fire season. The local villagers /community institutions participate in an event to with a resolve not to carry out the stubble burning in the period of fire season thereafter. This concept started from the *Shitlakhet* where in the local communities celebrates this event on 1st April of every year, implying that all the stubble burning is completed prior to this date.

After carrying out the extensive exposure visits of community institutions and local field officials, ground efforts were continued to replicate the *Shitlakhet* model at other locations.

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As per the report received from DFO Garhwal Forest Division, Pauri, the forest fire sensitive Adwani forest block was selected as a model for forest fire prevention in which 27 villages and 18 Van panchayats have constituted *Adwani Vanbandhu Samiti* on 05.03.2025. *Adwani Vanbandhu Samiti* had organized forest fire prevention and safety seminar in the Block premises Kaljikhil in the presence of all stakeholders.

On March 25, 2025, local communities in Adwani celebrated Aun Diwas by actively engaging in forest conservation activities, including cleaning dry leaves and maintaining cleanliness around homes and fire-prone areas, while over 400 villagers pledged not to set forest fires and committed to cooperating with the Forest Department. The joint campaign, involving various government departments and NGOs, provided villagers with



information on forest conservation and fire prevention, highlighted the consequences of forest fires, and encouraged proactive environmental practices. A follow-up awareness event was held on April 7, 2025, in the sensitive Srinagar forest area to further strengthen community involvement, making the campaign a success through active participation and raising awareness about forest fire prevention and positive behavioral change.

D.III Incentives and Awards for Active Community Institutions and Individuals

To further enhance peoples' participation in forest fire mitigation, incentives and awards are also being instituted.

- Awards and recognition are being given to community institutions and individuals by the forest department on special occasions, who have rendered outstanding services in forest fire mitigation, like Independence Day and Republic Day.
- The State Government of Uttarakhand has issued the Government order to provide incentives for selected community-based forest fire protection committees as an incentive towards their performance in forest fire prevention/mitigation in fire-prone divisions. In this year, 390 forest fire protection committees/ Van Panchayats have been selected in the most sensitive *Chir* pine dominated forest divisions for providing incentives of ₹ 30,000.00 per committee. This Govt. order is annexed as **Annexure No. 11**.
- Moreover, a proposal has also been submitted to the State Government for providing cash awards/commendation certificates to the community institutions & forest crew personnel involved in active forest fire management, which is under active consideration.



D.IV The other forest fire prevention measures that have been taken up during the forest fire season 2025 provided as below: -

- **FOREST FIRE-LINES**

Forest fire-lines were created in the forests of Uttarakhand as a part of scientific management of the forests which was initiated one and a half century ago. Depending on the requirement, fire-lines of appropriate width were created by clearing the vegetation therein. These were then annually maintained to check growth of vegetation which also included trees. In early 1980s with the increased realization of ecological conservation role of forests particularly those growing in Himalayan Mountain chain of present-day Uttarakhand, the Govt. of Uttar Pradesh put a moratorium on felling of green trees in the hills of Garhwal and Kumaon. In the judgement dated 12.12.1996 in the matter T.N. Godavarman Thirumulkpad vs Union of India & Ors, the Hon'ble Supreme Court directed:

FOR THE STATE OF HIMACHAL PRADESH AND THE HILL REGIONS OF THE STATES OF UTTAR PRADESH AND WEST BENGAL:

There will be no felling of trees permitted in any forest, public or private. This ban will not affect felling in any private plantation comprising of trees planted in any area which is not a 'forest'; and which has not been converted from an earlier "forest".

Thus, there was a complete ban on felling of trees. As a result, vegetation on the forest fire-lines was not cleared and trees grew rapidly on them. The state of Uttarakhand approached the Hon'ble Supreme Court for relief on the matter and on 17.05.2023, the Hon'ble Supreme Court lifted the ban through an order.



As per existing records of the forest divisions as given in the working plans the State of Uttarakhand has large number of fire-lines in the reserved forest areas the details of which are given in **Annexure No 12**.

In compliance to the Hon'ble Supreme Court order dated 17.05.2023, the forest department has started working on clearing of forest-fire lines and presently nearly 1089 km of fire-lines are being cleared in four forest divisions.

The details of the above-mentioned clearing are provided as under: -

- Length of forest fire-lines 1089.35 kms has been cleared as per the provisions of the Divisional working plans: -

Name of Forest Division	Length of fire line cleared in Km.
Ramnagar	80.33
Soil Kalsi	530.75
Dehradun	33.72
Nainital	444.55
Total	1089.35

In many forest divisions, the working plan approvals from Govt. of India have prescribed a condition of separate permission from them in cases of green felling of trees, and efforts are going on to seek this permission.

In addition to the regular forest-fire-lines, many other linear clearings serve as fire-lines and the Forest Department has been maintaining them



regularly as it does not involve green felling. Primary among them are the roads, which along with the cleared and controlled burnt dry litter and vegetation on either side, serve the purpose of fire-breaks. Nearly 18000 km of such roads are being maintained as fire-lines annually.

Control on Agricultural Stubble Burning

- Instructions have been issued to District Magistrates to ensure the completing of agricultural stubble burning before March 31, 2025 except in exceptional cases and directions have been provided for sensitization of the local villages towards this measure and for acting against unauthorized stubble burning after March 31, 2025. The order issued by the District Magistrate, Almora in this regard is annexed as **Annexure No. 13.**
- Directions have been issued by the Principal Secretary, Forest, Govt. of Uttarakhand & the PCCF (HoFF), Uttarakhand to the District Magistrates (DMs) for sensitization of the local villagers for not resorting to stubble burning in the fire season and also providing restrictions for the same. The said directions are enclosed as **Annexure No. 14 & 15.**
- In the State, *Chir Pirul* Units owners/ Entrepreneurs who are operating the pellets/ briquettes plants are also using the mechanized Bailer/Compactor and shredding machine (Hammer mill) for compaction and utilization of *Chir-pirul*.



Forest Floor Biomass Management

- Majority of forests in Uttarakhand are deciduous in nature and starting from winter months through spring and summer, majority of tree species shed leaves. These shed leaves make a mat of dry litter which is highly inflammable and is a forest-fire hazard. The problem is particularly extreme in *Chir* Pine forest in middle Himalayas as the dry needle like leaves (locally called *Pirul*) are slow in decomposition and make a highly inflammable mat on the forest floor when dry. These forests make about 15% of the forests of the State and are one of the most fire sensitive areas.

Forest department has taken special steps to deal with the forest floor biomass management particularly in the *Chir* Pine forests.

Chir Pine *Pirul* (leaves) collection

- There is an emphasis on collection of *Chir* Pine *Pirul* (leaves) - for reducing the fuel load on the forest floor and for livelihood generation for the locals who are involved in its collection.

Annual *Chir* Pine *Pirul* collection data

- 2022: 1,260 tons
- 2023: 2,381.50 tons
- 2024: 3,829.95 tons
- 2025: In the current forest fire season of 2025, a quantity of 1891.37 tons (till 11th June 2025) has been collected from the forest areas by the local self-help groups (SHGs), Van panchayats, Mahila mangal dal etc.



- Presently, there are 9 pellets/briquettes making plants operational in the State. Efforts are being made to motivate the entrepreneurs for the establishment of more pellet/briquette plants. Moreover, the forward linkages are being established to transport and utilize the collected *Chir-pirul* in these plants as well as other biomass-based industries/units.
- A MoU is in place between Forest Department, Nainital and Century Paper & Pulp Ltd. for collection of *Chir-pirul*.
- Efforts are being made to engage with NTPC and also with IOCL for *Chir-pirul* collection.
- Moreover, to enhance the *Chir-pirul* collection by the villagers and also livelihood generation to them, the rate of collection has been enhanced from Rs 3/kg to Rs 10/kg by the State Government vide its order dated 25.02.2025. This will further enhance *Chir Pirul* collection in the state which will reduce the fuel loads.
- Now, the *Chir-pirul* collection activity has picked up considerably which is helping on one hand in reducing the fuel load from the forest areas and on the other hand, it is providing income generation to the local community institutions especially Women SHGs, Van panchayats, Mahila mangal dal etc. Besides this it also providing raw material for many biomass-based industries/units.
- The MoEF&CC, Govt. of India has appreciated the innovative efforts of the State Government/Forest Department, Uttarakhand regarding the Biomass Utilization (*Chir Pine* needles, *pirul* collection and utilization). The MoEF&CC, Govt. of India has




issued an appreciation letter for all States/UTs to take note of the strategy of Uttarakhand and to draw relevant learning and best practices for possible adoption in their respective jurisdictions. The copy of letter is annexed as **Annexure No 16**.

Designation of Nodal Officers for High-Risk Districts

- For better monitoring and guidance from experienced senior officers posted at forest headquarters in Dehradun, they have been assigned districts as nodal officer. As per the letter No. 549/27-1 dated 20-01-2025, issued by the Principal Chief Conservator of Forests (PCCF) HoFF, Uttarakhand, they have been designated as district-level nodal officers for effective fire management in high-risk areas along with their broad responsibilities. At present, the Nodal officers are regularly inspecting their jurisdictional Districts for monitoring of the Forest fire management activities and submitting their reports to the Forest Department and the Govt. of Uttarakhand.

Involvement of other Departments



- District forest-fire plans have been finalized under the overall guidance of District Magistrates to ensure comprehensive forest fire control with participation of all line-departments. These are utilized to compile a state level forest fire mitigation plan. The Chief secretary, Principal Secretary and PCCF (HoFF), Govt. of Uttarakhand also take meeting of field officers including District Magistrates and Divisional Forest Officers as and when required during the forest fire season. Hon'ble Forest Minister also took a meeting of the officers to review the preparedness on 24th Dec, 2024 and 01st April, 2025.



- **Incident Response Systems (IRS)** have been set up at the district level involving various line departments for quick coordinated response during fire seasons. The District Magistrates (DMs) of the district Pithoragarh, Bageshwar, Champawat and Pauri Garhwal Districts have set up IRS in their Districts. The IRS notification of the District Pithoragarh is annexed as **Annexure No 17**.
- Help of NDRF and SDRF is sought in extreme forest fire events. Helicopters are also pressed into service at such times.
- To assess the prepared and for having an effective coordinated response in the Districts and State level for Forest fire prevention/mitigation, state level mock exercise was conducted on 13th February, 2025 involving Uttarakhand State Disaster Management Authority (USDMA) and all concerned departments at 16 sites in the state with the support of National Disaster Management Authority (NDMA).

Weather Forecasting for Fire-Prone Areas



- The Uttarakhand Forest Department, has signed an MoU in February 2025 with the India Meteorological Department (IMD), New Delhi, for providing customized Weather Forecasts for early warning of fire-prone conditions besides the normal weather update including providing the forest fire danger ratings of the sensitive forest areas an example of one such forecast (dated 02.06.2025) is given in **Annexure No 18**.
- Other open access mobile applications on weather are also being used regularly by officers at the headquarters and field for early warning of fire-prone conditions.



Forest fire detection

- Early detection of forest fires is the key to its efficient and quick control. Traditionally it was being done by maintaining a round the clock vigil using watch towers and other prominent high spots and information communicated through wireless. With the advent of technology, in the year 2016, satellite-based alerts were initiated, wherein the specialized cameras on the satellites detect thermal anomaly and interpret it as a potential forest fire alert. These are communicated to the ground receiving stations and then communicated to the field formations with latitude and longitude immediately.

Forest Survey of India's Fire Alert System (Version 3.0)

- The MODIS & SNPP-VIIRS satellite sensors provide near real-time and large forest fire alerts. These are communicated to those registered on the FSI portal through SMS along with locational details. The letter No. 102927/2024 dated 05-08-2024 issued by APCCF, Forest Fire & Disaster Management directed each forest division to register as many subscribers as possible (forest officials, Van Panchayat Sarpanches, Self Help Groups, etc.) under the Forest Fire Alerts System (3.0) of FSI. As of now, 13,921 subscribers have registered from the state of Uttarakhand.
- These alerts are immediately made available to the concerned field officials for rapid response.

Forest Fire Reporting and Management Mobile App

- The Department has developed a new mobile application for reporting forest fire incidents (Uttarakhand Forest Fire app) for



the 2025 forest fire season, moving from manual to digital platform for the first time.

Key Points:

- **Usage:** Timely detection, reporting, and response to forest fire incidents in Uttarakhand.
- **Features Demonstrated:**
 - Real-time fire alerts with satellite data integration.
 - GPS-tagged fire incident reporting.
 - Photo upload and fire intensity input features.
 - Centralized dashboard for monitoring and analytics.

The forest officials can monitor and manage forest fires through this app. Public can also report fires through it. The app also has the capability to track the movement of vehicles engaged in firefighting activities.

- When an alert is received from Forest Survey of India (FSI), field officials are notified through this app who address the alert through forest fire-fighting teams from crew station, and fire incidents are monitored via a centralized dashboard at divisional level and state headquarters. The app is providing a tactical advantage over the existing FSI system as the SMS from FSI system are often received 10-12 hours after the satellite passage while the app using the same information from the csv files and displays it on a geographical domain in 2-3 hours, thus reducing the response time substantially.




- All assets of the Uttarakhand Forest Department for forest fire prevention and control, such as crew stations, range & divisional offices, and forest check-posts/chowkies, are mapped to ensure quick action in minimum response time.
- As of now, 9125 subscribers have registered in Uttarakhand Forest fire app since its launch earlier this year. Also, 20 GPS enabled vehicles have also been integrated in this app for monitoring of the forest fire alerts.
- Seeing the implementation of the Uttarakhand Forest Fire Mobile App, the Forest Survey of India (FSI), MoEF&CC has asked for the demonstration of this app for incorporating the useful features that can be included in the Mobile Application being developed at their end.

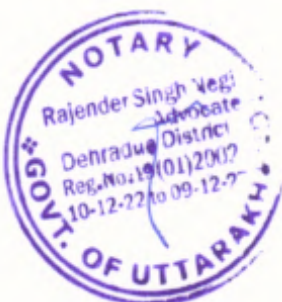
State-Level Integrated Command & Control Centre for Forest Fire Management

- 
- A State-Level Integrated Command & Control Centre has been established at the Forest Headquarters for real-time information exchange and management on forest fires and human-wildlife conflict. This centre is operational since February 15, 2025.
 - The forest fire information obtained through the mobile app is reflected at the command centre dashboard. This desktop version has the capabilities to analyse data and directions can be passed to field officers quickly based on the analysis. Thus, it will act as a decision support system.

Fire suppression and control



- Despite taking all preventive steps including mass awareness drives, forests fires get initiated at various locations when there are long dry spells. The forest staff in the field is continuously on a look out for such incidences so that they can be attended to and controlled in shortest possible time. Information on the same is also shared through modern methods like satellite-based alerts which are received on Uttarakhand Forest fire app and shared with the entire team of forest staff in the state. Information about forest fires also reaches through toll-free helpline number of the Forest Department from public.
- The Forest Department immediately takes remedial steps and teams from the nearest crew stations rush to the spot of fire and make best efforts to douse the fire in shortest possible time. Most fires are doused by the team of forest personnel and often help of local people is also taken. In rare cases, where the fires are too large and in very difficult terrain, help from other agencies of the Govt. like SDRF and NDRF is taken. In very rare cases, army helicopters have also been pressed into action.

E. That, in response to point (v) of paragraph 5, *the budget amount allocated for undertaking remedial measures for remedying the damage caused by forest fire during the year 2024* is herein submitted:

Sl. No.	Name of the scheme	Budget released (₹ in Lakh)
1	Forest Protection and management (state sector)	2835.87
2	Forest Fire Prevention and Management Scheme (Centrally funded)	202.34
3	CAMPA Scheme	1069.06
Total		4107.27



F. That, in response to point (vi) of paragraph 6, *the budget amount to be allocated for taking of remedial measures for controlling forest fires during the year 2025* is herein submitted:

In financial year 2025-26, the proposed and released budget (till now) in different schemes is provided as under: -

Name of scheme	Proposed budget (₹ in Lakh)	Released Amount (₹ in Lakh)
Forest Fire Protection of Reserve Forests (State Sector)	2920.00	2000.00
Forest Fire Prevention & Management Scheme (Centrally Sponsored Scheme)	1000.00	116.67(in process of release)
CAMPA	1200.00	In process of release
Total	5120.00	

- Apart from this, National Disaster Management Authority (NDMA) has also approved Preliminary Project Report (PPR) for financial year 2025-26 (one year) based on the study/assessment done for identification of most fire prone Districts of strengthening forest fire management in India. In this project, NDMA has in- principle approved ₹16.73 Crore (Central share-₹ 15.21 Cr. + State share- ₹ 1.52 Cr.) for the State of Uttarakhand to mitigation of forest fire in 6 districts (Almora, Champawat, Nainital, Dehradun, Pauri & Tehri). This will also augment the Forest fire management in the State of Uttarakhand.
- While the State Govt. of Uttarakhand is providing resources for efficient management and control of forests fires in the state, there



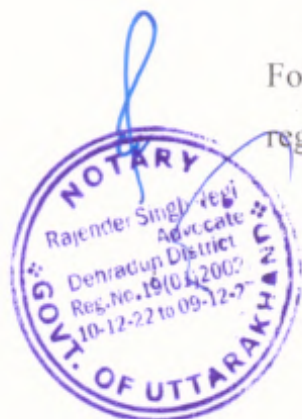
is always scope for improvement in our capability in dealing with forest fires. Consequently, the forest department analysed the present strength and weaknesses and identified gaps where additional resources will go a long way in dealing with forest fires in a further improved manner. Since the budgetary requirements for the same were large, a five-year project was prepared and sent to MoEF&CC. The key points in the project are elucidated below: -

- Five-Year Fire Management Plan (2024-25 to 2028-29)

A ₹404.01 crore proposal for a five-year forest fire management plan for addressing the present gaps/challenges in Management has been submitted to the Ministry of Environment, Forest & Climate Change, Government of India on October 8, 2024 after comprehensive gap-analysis for forest fire management. This project has provisioned for the strengthening the department on the following aspects: -

- Strengthening of Human Resources.
- Capacity Building and Awareness Programs
- Pre-Fire Season Mock Drill
- Procurement/Strengthening of Equipment for Fire Mitigation
- Procurement /hiring Mobility Vehicles (for QRTs)
- Infrastructure Development
- Water Regime and SMC works
- Post Fire Restoration of fire burnt Area
- Controlled Cool Burning & Fire line maintenance
- Floor Bio-mass Utilization from Forest: -Pine Needle (*Chir*) Utilization
- Fire Fighting Tools

For this project, a meeting had been carried out by MoEF&CC in this regard. It is being pursued by the State Govt. and the Forest Department.



6. That the present response affidavit in compliance with the direction passed by this Hon'ble Tribunal is being filed for the kind perusal of this Hon'ble Tribunal.



VERIFICATION

I, the deponent above named, do hereby verify and say that the contents of my above submissions, from paragraphs 2-5, by way of the affidavit are true and correct to my knowledge based on the record, and as per the information received which all I believe to be true.

That no part of this affidavit is false and nothing material has been concealed therefrom.

Verified by me at D.Du, Uttarakhand, on this 26 day of June 2025.



3738/25
This affidavit is sworn before me by
Shri. Rajender Singh Negi
who is identified by Shri
at Dehradun on.....

(Rajender Singh Negi)
Advocate & Notary, Dehradun

[Signature]
DEPONENT

Filed By

[Signature]

DEEPAK BORA

Counsel for the State of Uttarakhand

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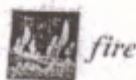
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Article

We're Not Doing Enough Prescribed Fire in the Western United States to Mitigate Wildfire Risk

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Received: 28 April 2019; Accepted: 21 May 2019; Published: 29 May 2019



Abstract: Prescribed fire is one of the most widely advocated management practices for reducing wildfire hazard and has a long and rich tradition rooted in indigenous and local ecological knowledge. The scientific literature has repeatedly reported that prescribed fire is often the most effective means of achieving such goals by reducing fuels and wildfire hazard and restoring ecological function to fire-adapted ecosystems in the United States (US) following a century of fire exclusion. This has translated into calls from scientists and policy experts for more prescribed fire, particularly in the Western US, where fire activity has escalated in recent decades. The annual extent of prescribed burning in the Western US remained stable or decreased from 1998 to 2018, while 70% of all prescribed fire was completed primarily by non-federal entities in the Southeastern US. The Bureau of Indian Affairs (BIA) was the only federal agency to substantially increase prescribed fire use; potentially associated with increased tribal self-governance. This suggests that the best available science is not being adopted into management practices, thereby further compounding the fire deficit in the Western US and the potential for more wildfire disasters.

Keywords: indigenous burning; traditional ecological knowledge; wildland fire; controlled burning; prescribed burning; Cerro Grande

1. Introduction

Recent disastrous and fatal wildfires across the United States (US) have yielded renewed calls to reduce the wildfire hazard [1–4]. One of the primary hazard reduction strategies identified in the scientific literature is prescribed burning—the intentional ignition of controlled fire, which is also referred to as prescribed fire or controlled burning in the US [5]. Prescribed fire not only reduces the biomass available to burn in a subsequent uncontrolled wildfire [5–7], it also supports carbon sequestration [8,9], facilitates ecological resilience [10–12], and is critical in restoring ecological function in regions where decades of fire exclusion pushed fire-adapted ecosystems outside their historic range of variability and degraded such function [12–14]. As anthropogenic ignitions and climate change have enabled the expansion of the fire season and larger and more disastrous wildfires [15–18], many of the recent high-profile scientific syntheses and perspectives have specifically advocated for increased use of prescribed fire [1–4,19,20]. Similarly, the US National Cohesive Wildland Fire Management Strategy (hereafter, Cohesive Strategy)—a planning effort stemming from the 2009 FLAME Act—specifically identified prescribed fire as the most cost-effective solution over the largest potential area of the US, as compared to managed wildfire and non-fire vegetation treatment [21]. Both the best available science and guiding policy documents in the US support more prescribed fire, but there has been limited assessment of whether this is translating to practice.

The intentional use of fire across landscapes has a long history in the US that is rooted in both the widespread indigenous burning practices of many North American tribes and the use of fire as a land-clearing tool by settlers prior to the 20th century [22]. At the onset of the 20th century,

perceptions about intentional burning underwent a fundamental shift, particularly in the Western US, where large wildfires threatened lives and timber resources and cultivated modern US wildfire policies [23]. Science-based efforts to restore fire to Southeastern forests were underway by the 1930s, while prescribed fires and natural wildfire were reintroduced into Western national parks and wilderness areas in the 1960s [22]. In parallel, American Indian tribes have sought to reintroduce fire, both to reclaim sovereignty through self-governance of tribal lands and to maintain important tribal cultural components [24–26]. There is also recognition that considerable extant traditional ecological knowledge (TEK) surrounding fire and indigenous controlled burning practices persists in native communities throughout the US [25]. This indigenous knowledge is a rich potential source of information and strategies for implementing more prescribed fire through collaborative partnerships with tribes, but remains underutilized [25–27].

As has been widely documented, prescribed fire is not without drawbacks. Prescribed fires produce smoke, which can violate air quality regulations and has negative impacts to human health [28–30]. Prescribed fires infrequently escape to become wildfires. Perhaps the most notable of such incidents was the 2000 Cerro Grande Fire, which began in early May as a prescribed fire at Bandelier National Monument in New Mexico but escaped to become a 19,000 ha wildfire. The Cerro Grande Fire consumed 235 homes [29] and subsequently shut down nearly all federal prescribed burning in the US for several months. These potential negative effects translate to social perceptions that provide considerable barriers to the widespread use of prescribed fire [30]. A considerable challenge for science has been to accurately assess the trade-offs of prescribed fire versus wildfire, particularly as wildfires occur relatively infrequently for a given location and indirect or secondary wildfire effects are difficult to quantify.

A Web of Science search of refereed literature of the terms “prescribed fire”, “controlled burning”, and “prescribed burning” demonstrates that over the past century, 4275 total refereed indexed papers were published that addressed prescribed fire in the US (Figure 1), with only one prior to 1972. There is a significant positive trend during this period as the literature expands around prescribed fire and controlled burning. It covers a broad range of topics, but the literature is overwhelmingly associated with Environmental Sciences and Ecology (85%), with only a small proportion affiliated with relevant disciplines such as Business/Economics (6%), Public Health (5%), Water Resources (4%), Engineering (3%), and Social Sciences (1%). Notably, while earlier literature focused on prescribed fire as a tool to restore fire excluded from so-called “fire-prone” forests (i.e., historically high-frequency and low-severity fire forests), more recent literature has investigated the use of controlled burning across a range of ecosystems to reduce hazardous fuels, not just forests considered prone to fire.

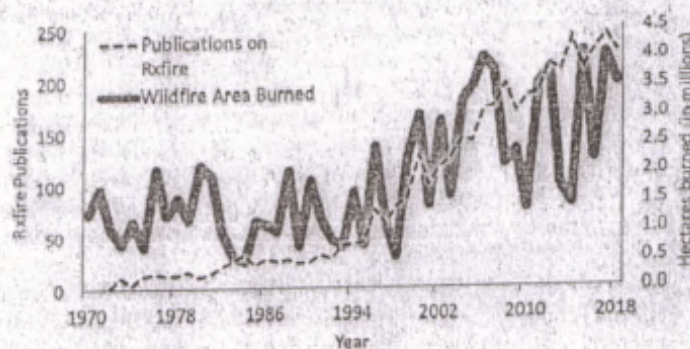


Figure 1. Annual publications on prescribed fire (dashed black line) and annual area burned (red solid line) for the United States (US), 1970 to 2018.

This trend towards increased understanding of prescribed fire should theoretically support its increased application, and such application is sorely needed. In the US Pacific Northwest, Haugo et al. [31] reported that for the 31-year period between 1984 and 2015, wildfire burned just 1.6 mill ha across a subset of forests in Washington and Oregon. This total was an order of magnitude less than the 15–21 mill ha expected under historical fire regimes and in the absence of fire suppression and exclusion. This deficit included 7–10 mill ha of the type of low-severity fire that prescribed burning can replace or be used to restore ecological function [31]. Other more general studies have similarly reported widespread wildfire deficits across western US forests [32]. To date, however, there has been little assessment of changes in US prescribed fire use in response to increased understanding of both its effects and the broader fire deficit.

My primary objective was to assess whether the US federal land management agencies are translating the best available science and current national fire policies into the increased use of prescribed fire. I also sought to assess regional and agency differences in order to understand which regions and agencies are increasing their prescribed fire accomplishments, as would be expected given the increased emphasis in both the scientific literature and policy. The adoption of increased prescribed fire use may be a key indicator of sociocultural acceptance of fire, which is a critical first step in effectively reducing wildfire vulnerability [20].

2. Methods

I evaluated trends in the application of prescribed fire in the US from the National Interagency Fire Center (NIFC) Situation Report (SIT Report) Archives and Historical Wildland Fire Summaries (available at www.nifc.gov). The annual Historical Wildland Fire Summary reports published by NIFC list both wildfire and prescribed fire accomplishments for each state stratified by federal agency (or non-federal entities), and date back to 2002 (but do not include prescribed fire in 2018). The SIT Report Archive includes the daily (during peak US fire activity) to weekly (during low fire activity) reports of large fires, cumulative wildland fires and area burned, and cumulative prescribed fires and area burned from 1998 to present. I utilized the cumulative prescribed fire data included in the last published SIT Report for each calendar year for the temporal analysis, and the Historical Wildland Fire Summaries to explore state-level trends.

For each Geographic Area (as defined by NIFC), more commonly referred to as a Geographic Area Coordination Center (GACC) region, I calculated a Spearman's Rho (years versus area) to assess trends, the annual mean accomplishment for a given GACC (ha/year), the trend or slope (mean change in ha/year from 1998 to 2018), the relative trend as a percent based on the mean accomplishment of a GACC (slope/mean accomplishment * 100), the percent of the US total 1998–2018, and the percent of the US trend 1998–2018. As GACCs vary widely by size and the amount of land managed by various agencies (Table S1), I also calculated an area weighting for the annual mean accomplishment by GACC and agency to normalize by area. Similarly, I calculated these metrics for each agency class. The five primary federal land management agencies that manage wildfire are each an individual class (i.e., the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), the Fish and Wildlife Service (FWS), the National Park Service (NPS), and the US Forest Service (USFS)), while a sixth class denoted as "State/Other" (SI/OT) includes any entity reporting that does not fall under the five primary federal agencies. This includes both other federal agencies that accomplish substantial prescribed fire, such as the Department of Defense (DOD) on military installations, the Department of Energy (DOE), the Bureau of Reclamation (BOR), as well as both state and even some private/non-profit entities where state agencies complete and report accomplishments (Table S1). I did not limit the analysis to any one ecosystem or fire regime type (e.g., historically fire-prone forests). As noted previously, more recent literature and management policies such as the Cohesive Strategy do not limit prescribed fire as a hazard reduction tool to any ecosystem.

The SIT Report Archive is not perfectly equivalent to the annual Historical Summaries because the data were not yet assessed for quality control, and also because the last report of the year was often published prior to December 31 (so additional accomplishments may have been reported in the last few days of the year). However, because the Archive dates back to 1998, it provides four additional years of data in a relatively short time series. The annual prescribed fire totals for the SIT Report final report of the year and the official totals provided in the Historical Wildland Fire Summaries are nearly equivalent for the 2002–2017 overlap period ($r^2 = 0.9992$). It should be noted that while these data can include prescribed burns conducted by private entities working with agency partners, they largely exclude the type of broad-scale private lands burning that occurs in grasslands and rangelands (e.g., the annual pasture burns across the Flint Hills region of Eastern Kansas).

3. Results

As recorded in the National Interagency Fire Center Daily Situation Reports, fire agencies completed a reported 23 million hectares of prescribed fire (averaging just over 1 mill ha per year) over the period 1998 to 2018, and annual totals increased by an average of 61,678 ha (mean 5% annual increase) per year (Table 1, Figure 2). However, 70% of all prescribed fire and 98% of the increase over time was observed in the Southeastern US Geographic Area (Figure 2a,c). Of the remaining nine Geographic Areas of the US (as delineated by the National Interagency Fire Center), only three reported an increase in prescribed fire over the period of record (Figure 2b,d), while the remainder reported a decrease. Excepting a strong increase in prescribed fire in the Eastern GACC and a strong decrease in the Great Basin, however, the slopes for all other units were so small that they were essentially rendered flat, even when the GACCs were normalized by area. This is particularly reflected in rank correlation coefficients, where only the Southern, Eastern, and Great Basin GACCs demonstrated a strong trend (i.e., a Spearman's Rho value greater than 0.5) (Table 1).

Table 1. Trends in prescribed fire accomplishments in the United States (US) by Geographic Area Coordination Center region (GACC) from 1998 to 2018, including raw trend (mean ha/year), relative trend (normalized by mean accomplishment for a given GACC), percent of the total US accomplishment, percent of the total US trend, and Spearman's Rho to indicate the strength of the trend.

GACC	Trend (ha/yr)	Rel. Trend (%)	% of US Total	% of US Trend	Spearman's Rho ¹
Alaska	253	3.1	0.7	0.4	0.29
Northwest	−861	−1.9	4.2	−1.4	−0.47
N. California	−404	−2.0	1.8	−0.7	−0.48
S. California	−160	−2.3	0.6	−0.3	−0.29
No. Rockies	−501	−1.7	2.8	−0.8	−0.45
Great Basin	−1228	−4.5	2.5	−2.0	−0.64
Southwest	−170	−0.3	6.1	−0.3	−0.07
Rocky Mtns	246	0.7	3.4	0.4	0.10
Eastern	4023	4.8	7.6	6.5	0.74
Southern	60,480	7.9	70.1	98.1	0.67
TOTAL	61,678	5.7	100.0	100.0	0.61

¹ Correlation coefficients below −0.5 or above 0.5 are considered strong trends and are more meaningful than p-values in such a small dataset.

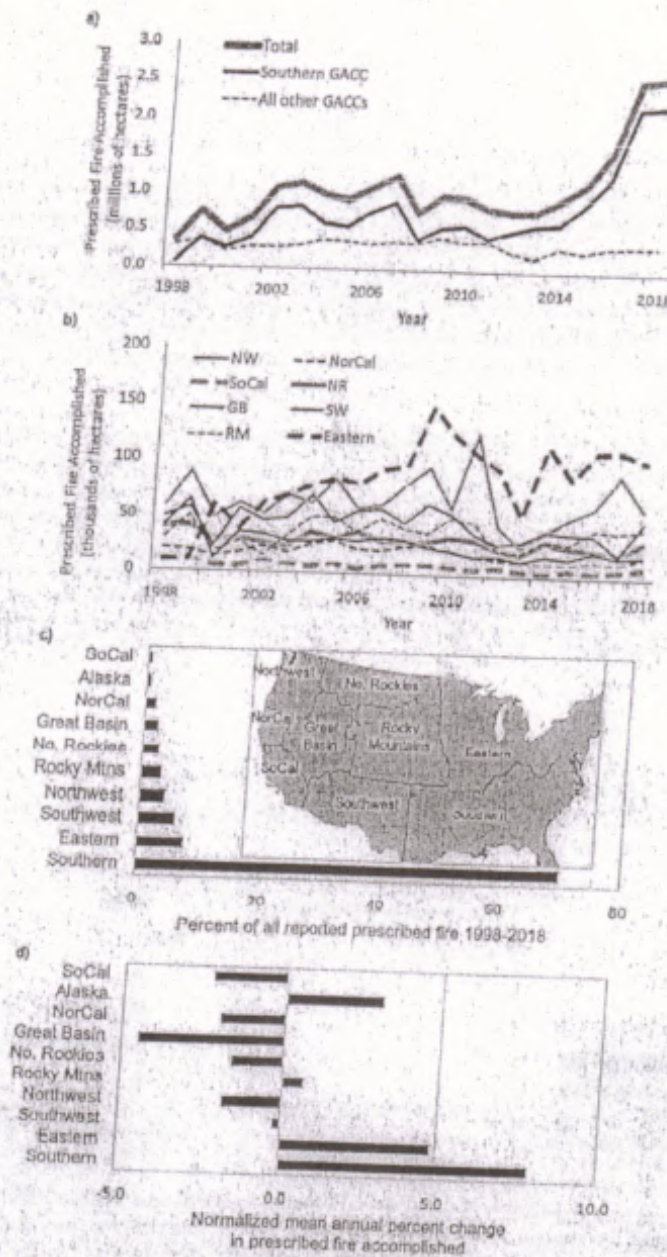


Figure 2. Prescribed fire accomplished in the United States (US) from 1998 to 2018 across Geographic Area Coordination Center (GACC) regions, including (a) total area burned (in millions of hectares), area burned in the Southern Geographic Area (GACC), and area burned in all nine other GACCs; (b) area burned (in thousands of hectares) in the eight other contiguous US GACCs (excludes Alaska and Southern); (c) proportion of all reported prescribed fire over the 21-year period by GACC; and (d) the normalized (by mean annual total accomplishment per GACC) mean annual change in prescribed fire completed, ranked by (c).

Similarly, when stratified by agency, 39% of the 21-year total and 93% of the increase in prescribed fire was accomplished by State/Other entities (Table 2, Figure 3). Of the primary federal land management agencies, only the BIA (relative trend = 3.7%; $r_s = 0.68$) accomplished substantially more prescribed fire over the study period. Overall, the proportion of total prescribed fire completed by US federal agencies has diminished from over 90% annually to less than 30% annually across the past two decades as the State/Other totals have steadily increased. This is unsurprising given regional trends, as less than 7% of the Southeastern US is managed by the five primary federal land management agencies (Table S1).

Table 2. Trends in prescribed fire accomplishments in the United States (US) by agency from 1998 to 2018, including raw trend (mean ha/yr), relative trend (normalized by mean accomplishment for a given agency), percent of the total US accomplishment, percent of the total US trend, and Spearman's Rho to indicate the strength of the trend. Agencies are Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), Fish and Wildlife Service (FWS), National Park Service (NPS), US Forest Service (USFS), and other federal (e.g., Defense, Energy, and Reclamation), non-federal, state, and municipal agencies that report to the National Interagency Fire Center (NIFC) (State/Other, ST/OT).

Agency	Trend (ha/yr)	Rel. Trend (%)	% of US Total	% of US Trend	Spearman's Rho ¹
BIA	1164	3.7	2.9	1.9	0.69
BLM	−1335	−3.0	4.1	−2.2	−0.47
FWS	518	0.6	8.6	0.8	0.05
NPS	397	1.0	3.6	0.6	0.06
USFS	3053	0.7	41.3	5.4	0.09
ST/OT	57,582	13.4	39.5	93.4	0.74

¹ Correlation coefficients below −0.5 or above 0.5 are considered strong trends and are more meaningful than p-values in such a small dataset.

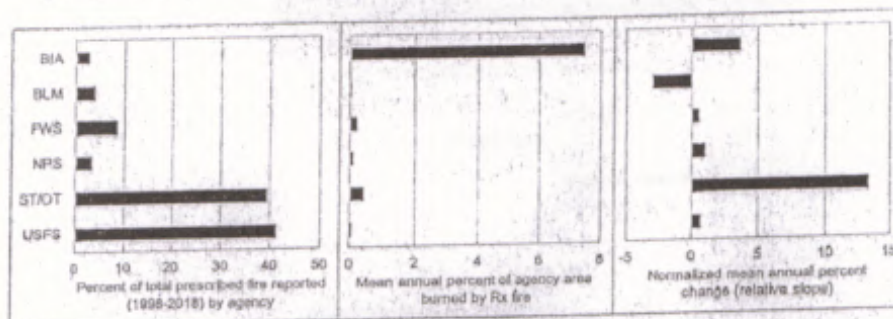


Figure 3. Percent of all reported prescribed fire nationally over the 21-year period (1998–2018) stratified by agency (left panel), mean annual percent of agency area burned by prescribed fire (i.e., area-normalized mean accomplished; center panel), and normalized (by mean annual total accomplishment per agency) mean annual change in prescribed fire completed (i.e., relative slope per agency; right panel).

4. Discussion

The Southeastern US accomplished over twice the amount of prescribed fire as the entire rest of the US combined between 1998 and 2018. This may be one of many reasons why the Southeastern states have experienced far fewer wildfire disasters relative to the Western US in recent years [17,33]. The amount of prescribed fire reported in the Southeastern US is also likely underreported, as the Southeastern states have purportedly accomplished millions of hectares of prescribed fire annually for decades [34–37]. However, until 1998 there was no central prescribed fire reporting in the US. Even after 1998, non-federal entities did not necessarily report the full scope of their accomplishments in the federal reporting system.

The dramatic difference in prescribed fire completed between east and west reflects both a broad socio-cultural divide over fire [29] and a problematic dichotomy between federal and non-federal fire management. Biophysical conditions have often been highlighted as a challenge to prescribed burning in the Western US; the topography is more complex and inaccessible, burn windows are narrow, and fuels have built up throughout decades of fire exclusion [23,38]. By contrast, the Southeastern states have both the most extensive Wildland–Urban Interface in the US [39] and some of the worst air quality challenges associated with prescribed fire due to higher humidity (e.g., increased smog formation). That agencies are able to accomplish so much prescribed fire in such a populated region likely also reflects social acceptance in addition to more conducive conditions. It is also telling that no single Southern state is driving the regional trend. State summaries in the Historical Wildland Fire Summary reports indicate that Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas all completed an average of over 40,000 ha per year each from 2002 to 2017.

Prescribed fire is widely accepted as a tool in the Southeastern states, where residents are more accustomed to using controlled fire to enhance timber production, control the rapidly growing vegetation, and enhance game species habitat [29,34]. Some states, such as Florida, even have laws that recognize prescribed fire as being in the public interest and protect landowner rights to utilize it [40]. Although studies throughout the US have shown that residents in all regions broadly support the concept of prescribed fire, they fear the potential for escaped fires and they are also highly concerned about smoke impacts [41]. However, Engbreton et al. [42] found significantly higher tolerance of prescribed fire smoke from Southern-state residents than those in Western states, which suggests that this tolerance may translate into less opposition to using prescribed fire in the Southern GACC. This is true for either federal or non-federal agencies in the region: the Historical Summaries indicate that much of the USFS annual prescribed fire accomplishment occurs in the Southern GACC states (particularly along the Gulf Coast) rather than in the Western states where the greatest proportion of USFS land lies.

By contrast, fire managers in the Western US face considerable social barriers to using prescribed fire, including negative public perceptions of risk of escapes and smoke [29,42]. This high perception of risk has been cemented by the occasional escaped prescribed fire, but it has likely also become entrenched due to the absence of prescribed fire demonstrated here. Fire managers, particularly federal fire managers, receive insufficient incentive to use prescribed fire under current agency policies that incentivize fire suppression (e.g., with overtime pay and promotion) but penalize risk-taking, particularly when escaped prescribed fires occur [29,43]. Additionally, federal funding for prescribed fire and other fuel reduction activities has been drastically depleted over the past two decades as large wildfires force federal agencies to expend allocated funds on suppression rather than prevention [35–37].

Of the federal agencies reporting individually (i.e., separate from the ST/OT class), only the BIA has been able to substantially increase the relative use of prescribed fire. This increase is particularly striking because a higher proportion of tribal lands managed by BIA have been subject to prescribed fire than for any other agency, with a mean of 7.5% of tribal lands burned each year (Figure 3). This may reflect the more recent efforts of tribes seeking to reclaim sovereignty on their ancestral lands through increased self-governance and drawing upon TEK to re-introduce extensive intentional fire in these landscapes [25], particularly following the 2004 Tribal Forest Protection Act [26]. The push for more prescribed fire among tribes is also reflected in the BIA budget for prescribed fire, particularly compared with the fire suppression budget. BIA devotes the second-highest budget of the five primary land management agencies to prescribed fire (behind USFS), but the prescribed fire budget is between 50% and 80% of its fire suppression budget, while no other agency's prescribed fire budget has exceeded 25% of its fire suppression budget in the last five years [44]. It is also worth noting that the more detailed Historical Wildland Fire Summary reports suggest that the strong positive trend in the Eastern GACC region is potentially partially a function of increased tribal burning in that region.

Despite changes in federal fire management policy meant to increase prescribed fire use, only one region of the US has considerably increased the amount of prescribed fire completed, and credit

for much of this increase goes to non-federal agencies. Given the evidence that federal agencies have not accomplished more prescribed fire across the US over the past two decades, this suggests that while the Cohesive Strategy incorporates the best available science in a top-level holistic management framework, federal agencies have not made sufficient policy changes or budgetary allocations to carry out the Strategy.

There is considerable evidence in the scientific literature that prescribed fire is the most effective means of reducing the risk of wildfire disasters and increasing ecosystem resilience across much of the US. However, only one primary federal land management agency has substantially increased prescribed fire use, and the only widespread use and acceptance of prescribed fire is in the Southeastern states. Federal and non-federal entities have used the prescribed fire expertise of the Southeastern region as a training ground for fire and fuel managers across the US, but this has not translated to increased prescribed fire use. This suggests that a larger cultural shift in public sociocultural perceptions of prescribed fire is needed to truly capitalize upon the utility of prescribed fire and more aggressively reduce wildfire risk. Without such a shift, more catastrophic wildfire disasters are inevitable.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2571-6255/2/2/30/s1>. Table S1: Hectares under each primary land management agency by Geographic Area Coordination Center (GACC) region.

Funding: This research was partially supported by the National Science Foundation through award DMS-1520873.

Acknowledgments: The author is grateful for input from John Abatzoglou and four anonymous reviewers that strengthened this paper, and for agency budget data from Maya Miller at Climate Central that improved the Discussion.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Calkin, D.E.; Cohen, J.D.; Hirney, M.A.; Thompson, M.P. How risk management can prevent future wildfire disasters in the wildland-urban interface. *Proc. Natl. Acad. Sci. USA* **2014**, *111*, 746–751. [CrossRef] [PubMed]
2. Moritz, M.A.; Batillori, E.; Bradstock, R.A.; Gill, A.M.; Handmer, J.; Hessburg, P.P.; Leonard, J.; McCaffrey, S.; Odion, D.C.; Schoennagel, T.; et al. Learning to co-exist with wildfire. *Nature* **2014**, *515*, 58–66. [CrossRef] [PubMed]
3. North, M.P.; Stephens, S.L.; Collins, B.M.; Agee, J.K.; Aplet, G.; Franklin, J.F.; Fule, P.Z. Reform forest fire management. *Science* **2015**, *349*, 1280–1281. [CrossRef] [PubMed]
4. Schoennagel, T.; Balch, J.K.; Brinkerhoff, H.; Dennison, P.E.; Harvey, B.J.; Krawchuk, M.A.; Mietkiewicz, N.; Morgan, P.; Moritz, M.A.; Rasker, R.; et al. Adapt to more wildfire in western North American forests as climate changes. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 4582–4590. [CrossRef]
5. Fernandes, P.M.; Botelho, H.S. A review of prescribed burning effectiveness in fire hazard reduction. *Int. J. Wildland Fire* **2003**, *12*, 117–128. [CrossRef]
6. Pollet, J.; Omi, P.N. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. *Int. J. Wildland Fire* **2002**, *11*, 1–10. [CrossRef]
7. Vaillant, N.M.; Pites Kaufman, J.A.; Stephens, S.L. Effectiveness of prescribed fire as a fuel treatment in Californian coniferous forests. *Int. J. Wildland Fire* **2009**, *18*, 165–175. [CrossRef]
8. Wiedinmyer, C.; Hurteau, M.D. Prescribed fire as a means of reducing forest carbon emissions in the western United States. *Environ. Sci. Technol.* **2010**, *44*, 1926–1932. [CrossRef]
9. Hurteau, M.; North, M. Fuel treatment effects on tree-based forest carbon storage and emissions under modeled wildfire scenarios. *Front. Ecol. Environ.* **2009**, *7*, 409–414. [CrossRef]
10. Collins, B.M.; Das, A.J.; Battles, J.J.; Fry, D.L.; Krasnow, K.D.; Stephens, S.L. Beyond reducing fire hazard: Fuel treatment impacts on overstory tree survival. *Ecol. Appl.* **2014**, *24*, 1879–1886. [CrossRef]
11. Smith, A.M.S.; Kolden, C.A.; Bowman, D.M. Biomimicry can help humans to coexist sustainably with fire. *Nature Ecol. Evol.* **2018**, *2*, 1827. [CrossRef]
12. Larson, A.J.; Delic, R.T.; Canoler, C.A.; Parks, S.A.; Dietz, M.S. Latent resilience in ponderosa pine forest: Effects of resumed frequent fire. *Ecol. Appl.* **2013**, *23*, 1243–1249. [CrossRef]

13. Fule, P.Z.; Cocke, A.E.; Heinlein, T.A.; Covington, W.W. Effects of an intense prescribed forest fire: Is it ecological restoration? *Restor. Ecol.* **2004**, *12*, 220–230. [CrossRef]
14. Moore, M.M.; Covington, W.W.; Fule, P.Z. Reference conditions and ecological restoration: A southwestern ponderosa pine perspective. *Ecol. Appl.* **1999**, *9*, 1266–1277. [CrossRef]
15. Abatzoglou, J.T.; Williams, A.P. Impact of anthropogenic climate change on wildfire across western US forests. *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 11770–11775. [CrossRef] [PubMed]
16. Balch, J.K.; Bradley, B.A.; Abatzoglou, J.T.; Nagy, R.C.; Fusco, E.J.; Mahood, A.L. Human-started wildfires expand the fire niche across the United States. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 2946–2951. [CrossRef]
17. Bowman, D.M.; Williamson, G.J.; Abatzoglou, J.T.; Kolden, C.A.; Cochrane, M.A.; Smith, A.M.S. Human exposure and sensitivity to globally extreme wildfire events. *Nat. Ecol. Evol.* **2017**, *1*, 0058. [CrossRef]
18. Bowman, D.M.; Moreira-Muñoz, A.; Kolden, C.A.; Chávez, R.O.; Muñoz, A.A.; Salinas, E.; González-Reyes, A.; Rocco, R.; de la Barrera, R.; Williamson, G.J.; et al. Human-environmental drivers and impacts of the globally extreme 2017 Chilean fires. *Ambio* **2019**, *48*, 350–362. [CrossRef] [PubMed]
19. Stephens, S.L.; Agee, J.K.; Fule, P.Z.; North, M.P.; Romine, W.H.; Swetnam, T.W.; Turner, M.G. Managing forests and fire in changing climates. *Science* **2013**, *342*, 41–42. [CrossRef]
20. Smith, A.M.S.; Kolden, C.A.; Paveglio, T.B.; Cochrane, M.A.; Bowman, D.M.; Moritz, M.A.; Kliskey, A.D.; Alessa, J.; Hudak, A.T.; Hoffman, C.M.; et al. The science of fire ecology: Achieving fire resilient communities. *Bioscience* **2016**, *66*, 130–146. [CrossRef]
21. Wildland Fire Leadership Council. *The National Strategy: The Final Phase in the Development of the National Cohesive Wildland Fire Management Strategy*; Washington, DC, USA, 2014. Available online: <https://www.forestsandrangelands.gov/strategy/thestrategy.shtml> (accessed on 25 April 2019).
22. Ryan, K.C.; Knapp, E.B.; Varner, J.M. Prescribed fire in North American forests and woodlands: History, current practice, and challenges. *Front. Ecol. Environ.* **2013**, *11*, e15–e24. [CrossRef]
23. Stephens, S.L.; Ruth, L.W. Federal forest-fire policy in the United States. *Ecol. Appl.* **2005**, *15*, 532–542. [CrossRef]
24. Kinnerer, R.W.; Lake, F.K. The role of indigenous burning in land management. *J. For.* **2001**, *99*, 36–41.
25. Lake, F.K.; Wright, V.; Morgan, P.; McFadden, M.; McWally, D.; Steyer-Rumann, C. Returning fire to the land: Celebrating traditional knowledge and fire. *J. For.* **2017**, *115*, 343–353. [CrossRef]
26. Rasmussen, K.; Hubbard, M.; Lytt, K. Wildland fire management as conservation based development: An opportunity for reservation communities? *Soc. Nat. Resour.* **2007**, *20*, 497–510. [CrossRef]
27. Ray, L.; Kolden, C.A.; Chapin, F., III. A case for developing place-based fire management strategies from traditional ecological knowledge. *Ecol. Soc.* **2012**, *17*, 37. [CrossRef]
28. Broome, R.A.; Johnston, F.H.; Horsley, J.; Morgan, G.G. A rapid assessment of the impact of hazard reduction burning around Sydney, May 2016. *Med. J. Aust.* **2016**, *205*, 407–408. [CrossRef]
29. Kolden, C.A.; Brown, T.J. Beyond wildfire: Perspectives of climate, managed fire and policy in the USA. *Int. J. Wildland Fire* **2010**, *19*, 364–373. [CrossRef]
30. Quinn-Davidson, L.N.; Varner, J.M. Impediments to prescribed fire across agency, landscape and manager: An example from northern California. *Int. J. Wildland Fire* **2012**, *21*, 210–218. [CrossRef]
31. Haugo, B.; Kellogg, B.S.; Canaler, C.A.; Kolden, C.A.; Kemp, K.B.; Robertson, J.; Mellen, K.L.; Vaillant, N.M.; Restaino, G.M. The Missing Fire: Quantifying human exclusion of wildfire in Pacific Northwest forests, USA. *Ecosphere* **2019**, *10*, e02702. [CrossRef]
32. Parks, S.A.; Miller, C.; Parisien, M.A.; Holsinger, L.M.; Dobrowski, S.Z.; Abatzoglou, J. Wildland fire deficit and surplus in the western United States, 1984–2012. *Ecosphere* **2015**, *6*, 1–13. [CrossRef]
33. Williams, J. Exploring the onset of high-impact mega-fires through a forest land management prism. *For. Ecol. Manag.* **2013**, *294*, 4–10. [CrossRef]
34. Haines, T.K.; Bushy, R.J.; Cleaves, D.A. Prescribed burning in the South: Trends, purpose, and barriers. *South. J. Appl. For.* **2001**, *25*, 149–153.
35. Melvin, M.A. *2012 National Prescribed Fire Use Survey Report*; Coalition of Prescribed Fire Councils, Inc.: Newton, GA, USA, 2012; p. 22. Available online: <http://www.prescribedfire.net/resources-links> (accessed on 5 April 2019).
36. Melvin, M.A. *2015 National Prescribed Fire Use Survey Report*; Coalition of Prescribed Fire Councils, Inc.: Newton, GA, USA, 2015; p. 22. Available online: <http://www.prescribedfire.net/resources-links> (accessed on 5 April 2019).

37. Melvin, M.A. *2018 National Prescribed Fire Use Survey Report*; Coalition of Prescribed Fire Councils, Inc.: Newton, GA, USA, 2018; p. 22. Available online: <http://www.prescribedfire.net/resources-links> (accessed on 5 April 2019).
38. Vaillant, N.M.; Reinhardt, E.D. An evaluation of the Forest Service Hazardous Fuels Treatment Program—Are we treating enough to promote resiliency or reduce hazard? *J. For.* **2017**, *115*, 300–308. [CrossRef]
39. Radeloff, V.C.; Helmers, D.P.; Kramer, H.A.; Mockrin, M.H.; Alexandre, P.M.; Bar-Massada, A.; Butsic, V.; Hawbaker, T.J.; Martinuzzi, S.; Syphard, A.D.; et al. Rapid growth of the US wildland-urban interface raises wildfire risk. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 3314–3319. [CrossRef] [PubMed]
40. Brenner, J.; Wade, D. Florida's revised prescribed fire law: Protection for responsible burners. In *Proceedings of Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management*; Miscellaneous Publication No. 13; Galley, K.E.M., Klinger, R.C., Sugihara, N.G., Eds.; Tall Timbers Research Station: Tallahassee, FL, USA, 2003; pp. 132–136.
41. McCaffrey, S.M. Prescribed fire: What influences public approval? In *Fire in Eastern Oak Forests: Delivering Science to Land Managers, Conference Proceedings*; Gen. Tech. Rep. NRS-P-1; Dickinson, M.B., Ed.; US Department of Agriculture, Forest Service, Northern Research Station: Newtown Square, PA, USA, 2006; pp. 192–198.
42. Engebretson, J.M.; Hall, T.E.; Blades, J.J.; Olsen, C.S.; Toman, E.; Frederick, S.S. Characterizing public tolerance of smoke from wildland fires in communities across the United States. *J. For.* **2016**, *114*, 601–609. [CrossRef]
43. Lueck, D.; Yoder, J. The economic foundations of firefighting organizations and institutions. *J. For.* **2015**, *113*, 291–297. [CrossRef]
44. Miller, M. (ClimateCentral.org, New York, NY, USA). Personal Communication, 2019.



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Prescribed fire management

Marcos Francos¹ and Xavier Úbeda²

Abstract

Fire plays a role in the vast majority of terrestrial ecosystems. Researchers have discovered that the negative effects of prescribed fire on soil, water and vegetation are transitory, and that benefits are much greater. This paper presents a synthesis of the most important recent work on the effects of prescribed fire on soil, water and vegetation and assesses the validity of the use of fire as a management tool. The impact of fire is low and temporary, whereas the benefits are greater both directly (e.g. reduction in vegetative fuel and the risk of fire, noncontamination of water) and indirectly (e.g. improvement in forest health). Thus, prescribed burning is a good management tool and should be incorporated into land management and regional planning. Researchers, managers, stakeholders and landowners must be taken into account to increase knowledge of this management tool and implement it in the most optimal way possible.

Addresses

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Current Opinion in Environmental Science & Health 2021, 21:100230

This review comes from a themed issue on Environmental Impact assessment: Fire, Prevention, management and challenges

Edited by Paulo Pereira and Edivaldo L. Thomas

For a complete overview see the Article Collection

<https://doi.org/10.1016/j.coes.2021.100230>

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Keywords

Soil degradation, Forest management, Fire ecology, Water quality, Vegetation recovery, Fuel load

Introduction

Fires are a key ecological factor in the earth system [1]. However, as many cultures have used fire for management purposes considering people safety and hazard-ousness, even though it was previously known to have a low impact on soil, water and vegetation. Soil is one of the most valuable non-renewable resources [2]. In forest areas, soil can be degraded by high-severity fires [3], but

low-severity fires, as is commonly the case of prescribed fires, minimise the adverse effects of fire on soil and are often beneficial [4]. They have thus proved to be a good forest management tool, and even more so in areas of high fire recurrence [5**]. Depending on its intensity, fire can affect water quality, furthermore following wildfires. However, marked changes in water quality have not been found after prescribed fire compared with prefire water quality [6]. A prescribed fire will immediately eliminate grasses and some shrubs but the fire will quickly be followed by an increase in herbaceous species and a decrease in the percentage of certain occupied by woody species [7]. The vegetation response after a prescribed fire mainly depends on fire intensity and frequency, the two factors that influence cover dynamics over time [8]. Prescribed fire is often used for environmental and land management, and controlled burning has proved a good tool to manage large forest areas in cases where economic resources are limited, being economically beneficial and feasible for land management [9]. This type of management can be an extremely effective mean to prevent shrub invasions [10*] and facilitate the colonisation or recovery of keystone species of flora [11] and fauna [12,13]. Given the body of scientific, theoretical and practical evidence, fire exclusion has been reconsidered and abandoned in almost all ecosystems across the world to instead incorporate this type of management in regional and territorial planning [14,15]. Furthermore, some decades ago, fire used to be employed for forest management, but developments in modern forestry erroneously excluded fire from the reproduction of natural processes and focused instead on fire suppression [16]. The use of prescribed fire reduces wildfire risk and creates habitats for grazing and wildlife [17]. It is therefore essential to educate stakeholder groups who influence prescribed fire policies to change policy regulations that in many cases present legal barriers to implementing effective ecosystem management strategies such as prescribed fire [18]. A prescribed fire is a use of low-intensity fire under planning to achieve different goals in different weather, fuel and topographic conditions therefore, it is essential to analyse how they influence the environment to take them into account in territorial management [5**,17].

This review is organised as follows. First, we examine the impact of prescribed fire on soil, vegetation and water and the implications for its use as a management

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tool. Then, we summarise the benefits and drawbacks of this tool, which is used worldwide for environmental and territorial management. To perform this review, we conducted a literature search for scientific articles published mainly in English over the last two decades in the Scopus Database. In some cases, earlier studies were consulted for the explanation and discussion of certain dynamics. The search terms used were: "prescribed fire" or "prescribed burning" or "controlled fire" and "soil properties" or "vegetation" or "plant" or "water" or "management tool" or "planning", and this search was combined with another in Google Scholar.

The effects of prescribed fire on soil, water and vegetation

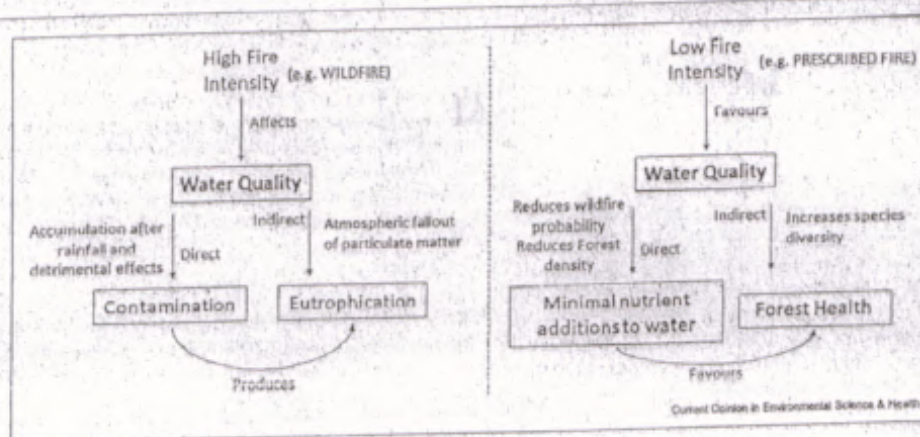
Prescribed fire can have long-term benefits such as increased soil sorption capability [19], optimisation of soil quality to improve forage for livestock [20] and enhanced proliferation of microbial communities [21*]. In other cases, although the post-fire levels of some chemical elements do not reach prefire values, especially in the short-term [22], prescribed fire can still achieve the proposed management objectives [23]. Prescribed fire exerts positive, neutral or negative effects on soil depending on the soil properties studied, but its impact is always lower than in the case of a wildfire, indicating that this tool is a good alternative in fire-prone areas and extensive highland areas, offering reduced costs compared with other forest management practices [5**].

Groundwater chemistry is not directly affected by prescribed fire because such fires do not burn with sufficient intensity to change the chemical elements in

water [24,25]. Indeed, fire intensity is the most important factor to consider when studying the impact of prescribed fire on water quality (Figure 1). Only in some cases have slight increments on water nutrient loading been detected after a prescribed fire [26,27], but such post-fire increments are unlikely to impact watershed resources [28*,29*] sometimes being beneficial for water quality and human health decreasing the amount of contaminants as benzene and ethylbenzene both known carcinogens [30,31]. As regards water content, prescribed fire may increase soil water content immediately after fire but can be detrimental to the germination process in the second and third growing seasons [32]. Prescribed fire not only increases the amount of water available but also increases the efficiency with which some species use that water, which is of great importance in water-limited ecosystems [33].

Fire reduces the vegetative fuel load, and this effect persists for about 15 years in Mediterranean ecosystem. There are regions where this period of time is much shorter because climate conditions promote fast vegetation growth and rapid fuel load recovery/increment and therefore reaching the long-term needs more or less years depending on one ecosystem or another. After that, the area will be dominated by shrubs, decreasing herbaceous, and plant diversity and requiring a new prescribed fire [43]. As regards short-term effects, in the first year after a prescribed fire, there is a reduction in shrub cover, an increase in herbaceous cover and a reduction in plant diversity. Despite these changes, the overall amount of forage two years after a prescribed fire remains unchanged compared to unburned areas, but the quality of forage for grazing cattle increases [44]. In the medium- to long-term, prescribed fire does not change vegetation

Figure 1



Influence of fire intensity on water quality. This figure is based on references [6,24–26,28*,29*,34–42].

communities, confirming its beneficial effects and indicating that it could be repeated after a few years [45]. In many cases, prescribed fire promotes pine and oak regeneration [46], enhances understory vegetation communities, increases species richness, diversity and cover in oak woodlands [47] and can establish a successional trajectory towards a sagebrush steppe vegetation structure as against pinyon and juniper species on single-leaf pinyon – Utah juniper woodland (*P. monophylla* Torr. & Griseb. – *J. osteosperma* [Torr.] Little) (Marking Corral) and a Utah juniper woodland (Onaqui) [48*].

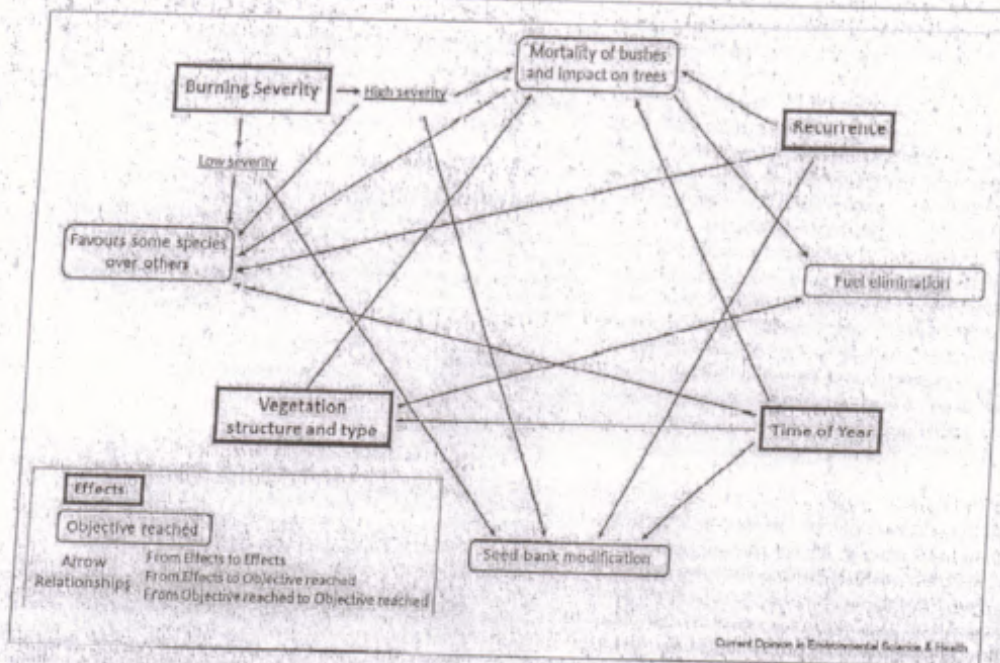
The effects of burning on vegetation can be direct or indirect and can occur from the level of seed banks to the herbaceous, shrub and arboreal strata. The mortality in each stratum is given by the burning objectives, which are summarised in the figure given in the following context, together with the four most important variables to consider: burning intensity, type and structure of vegetation, time of the year when burning takes place and recurrence of burning (Figure 2).

Prescribed fire as a management tool

Prescribed burning is not yet fully accepted worldwide as a management tool. Many countries see fire as a risk rather than a resource. In fact, until technical and scientific evidence supported the use of fire as a

management tool for forests and other land uses, nearly all governments held this view. In Australia, however, prescribed burning has been carried out on a recurring basis since the 1960s for the purposes of wildfire mitigation, agricultural practices such as stubble reduction and grazing land management, property protection, the maintenance of ecological processes and biodiversity conservation [53**]. These same authors describe the areas in Australia where prescribed burning is implemented, which coincide with those where the most intense fires have occurred due to the type of vegetation and climate [54]. Although the authorities' use of prescribed fire has increased since the 1960s, growing environmental awareness since the mid-1980s has prompted questions about whether prescribed burning has negative environmental effects, triggering a reduction in its use [53**]. Aware of social concern about the possible environmental effects of prescribed fires, researchers and scientists began to publish many more articles and technical reports, with publications rising from 70 in the 1970s to 205 in the 1980s [55]. These authors also highlight an increase in the 1990s in articles focussing exclusively on the ecological effects. Interestingly, in an exhaustive review of studies published in Australia, Oliveras and Bell [54] did not find a single publication that completely ruled out the use of fire as a management tool.

Figure 2



Prescribed burning and vegetation: objectives, effects and relationships. This figure is based on references [4, 49–52].

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A recurrent question in many countries regarding the use or not of prescribed fire for management is whether fire is a natural phenomenon, or more accurately, if a significant proportion of forest fires are started by natural causes. In southeast Australia, large fires have been recurrent throughout history, and many of them have had a natural cause such as lightning strikes in dry storms, according to Stryger et al. [56], whereas in Tasmania they have increased since the 2000s as a consequence of longer, more intense dry spells. Perceiving the causes as natural renders the use of fire for land management more acceptable. Recent technological advances such as the use of satellite images to verify burning intensities, the application of different fire use models depending on the type of vegetation [57] to be managed and the use of fire propagation simulators [58] have all increased perceptions of the use of prescribed fire as acceptable and even necessary [53**] because of climate change and evidence that the climate in southeast Australia is becoming warmer and drier [59].

According to Spencer et al. [60], the use of prescribed fire is fully accepted in the United States, but there are barriers to its increased use, perhaps the most important being a lack of qualified, available personnel to carry out prescribed burning at ecologically meaningful scales and in sufficiently large landscapes to affect fire behaviour and restore key components of ecosystems. According to Walker and Salt [61], socio-ecological relationships are becoming increasingly complex and all actors must be involved to strengthen prescribed fire training exchanges. Furthermore, according to Chaffin et al. [62], this can only be achieved if administrations have the capacity to adapt more rapidly to forest management needs in the USA. Fire suppression policies produced catastrophic effects in *Pondosa* pine forests of Western US [63]. In Europe, the situation of professionals trained to carry out prescribed fires varies widely, even within the same States, because regional authorities may apply different policies. Nevertheless, training exchanges are gradually being rolled out in many areas of Europe.

There is also debate, for example in Europe, on whether those carrying out prescribed burns should be professionals who work for companies specialising in this practice. In Spain, all prescribed fires are carried out by government personnel. As regards the level of use of prescribed burns, this cannot be generalised for Europe as a whole or even within States because restricted or even prohibited land management practices vary depending on local authorities [64]. In some European countries, laws are often based on 19th century ordinances on the use of fire, although these may now seem obsolete. Nevertheless, prescribed fire is used for forest management in many European countries, including Sweden, the United Kingdom and Germany in the

northern Europe, France and Spain in southern Europe. In none of these cases is this practice governed by a single regulation, and in some cases it is restricted to highly specific territories [65].

Final remarks and conclusions

Prescribed fire is a good tool for forest management, especially in fire-dependent ecosystems. The harmful effects of these low-intensity fires on soil, water and vegetation are few and transitory, whereas the benefits are long-term and much greater than the damage. Therefore, the use of prescribed fire should be implemented formally through regional planning and should seek stakeholders' engagement, knowledge and experience to ensure community inclusion [66]. Involving the community is essential to the success of this type of management, as is changing perceptions of controlled fire to see it as it is: a good environmental and territorial management tool. It is therefore also necessary to educate the public about controlled fire and promote its use in order to gain public support. In sum, prescribed fire represents an unparalleled forest management tool that provides maximum ecological benefit with minimum effort.

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.

Acknowledgements

This study was supported by the POSTFIRE CARE Project (CGL2016-75178-C2-2-R [AEI/FEDER, UE]) funded by the Spanish Research Agency (AEI) and the European Union through European Funding for Regional Development (FEDER), and 2017SGR1344 of the Generalitat de Catalunya. The authors also wish to thank the Language Services at the University of Barcelona for the English revision of the manuscript.

References

Papers of particular interest, published within the period of review, have been highlighted as:

- * of special interest
- ** of outstanding interest

1. Bowman DM, Balch JK, Artaxo P, Bond WJ, Carlson JM, Cochrane MA, Pyne SJ: *Fire in the earth system*. *Science* 2009, 324:481–484.
 2. Lal R: *Restoring soil quality to mitigate soil degradation*. *Sustainability* 2015, 7:5875–5895.
 3. Úbeda X, Lorca M, Outeiro LR, Bernia S, Castellnou M: *Effects of prescribed fire on soil quality in Mediterranean grassland (Prades Mountains, north-east Spain)*. *Int J Wildland Fire* 2005, 14:379–384.
 4. Soehrenbroch BC, Nix B, Jacobs KA, Bowles ML: *Two decades of low-severity prescribed fire increases soil nutrient availability in a Midwestern, USA oak (Quercus) forest*. *Geoderma* 2012, 182:90–91.
 5. Alcañiz M, Outeiro L, Franco M, Úbeda X: *Effects of prescribed fires on soil properties: a review*. *Sci Total Environ* 2018, 613: 944–957.
- This work makes an outstanding synthesis of the impacts of prescribed fire on soil physical, chemical and biological properties.

6. Lange RW: *Methodology for estimating detectable change in water quality due to prescribed fire in northern Colorado*. Colorado State University; 2001. MS Thesis, 73 pp.
7. Moore WH, Swindel BF, Terry WS: Vegetative response to prescribed fire in a north Florida flatwoods forest. *J Range Manage* 1992, 35:386–389.
8. Pierce L, Harlan I, Irman J, Casanova M: *The parker flats prescribed burn: 10th year post-fire vegetation recovery in 2015*. Final report division of science & environmental policy. California State University Monterey Bay; 2016. 100 Campus Center, Seaside, CA 93955, 17 pp.
9. Hmielewski TL, Carter SK, Spaul H, Helmers D, Radeloff VC, Zedler P: Prioritizing land management efforts at a landscape scale: a case study using prescribed fire in Wisconsin. *Ecol Appl* 2016, 26:1018–1029.
10. Polissoli N, Ploce P, Gómez-Villate IE: Is prescribed fire a suitable management tool to reduce shrub encroachment in palm savannas? *Restor Ecol* 2019, 27:109–119.
- In this study the authors carry out an excellent analysis of the use of prescribed fires to manage forest stands and plant populations.
11. Zachmann LJ, Shaw DW, Dickson BG: Prescribed fire and natural recovery produce similar long-term patterns of change in forest structure in the Lake Tahoe basin, California. *For Ecol Manage* 2018, 409:276–287.
12. Archuleta FO, Ford PL: Prescribed fire: a proposed management tool to facilitate black-tailed prairie dog (*Cynomys ludovicianus*) colony expansion. In *The 22nd International grassland congress (revitalising grasslands to sustain our communities)* took place in Sydney, vol. 19. Australia from September 15th September through September, 2013.
13. Roe JH, Kieh AL, Nacy JP: Variation and repeatability of home range in a forest-dwelling terrestrial turtle: implications for prescribed fire in forest management. *J Zool* 2020, 310:71–82.
14. Goldammer J: Use of prescribed fire in land management, nature conservation and forestry in temperate-boreal Eurasia. *BioGrass* 2010:6–26.
15. Alcaraz M, Oulaino L, Francos M, Esqueu J, Úbeda X: Long-term dynamics of soil chemical properties after a prescribed fire in a Mediterranean forest (Montgrí Massif, Catalonia, Spain). *Sci Total Environ* 2016, 572:1329–1335.
16. Cogou S, Roturier S, Ostlund L: The origins of prescribed burning in Scandinavian forestry: the seminal role of Joel Wretling in the management of fire-dependent forests. *Eur J For Res* 2020, 130:303–406.
17. Fernandes RM, Davies GM, Ascoli D, Fernández C, Moreira F, Rigolot E, Molina D: Prescribed burning in southern Europe: developing fire management in a dynamic landscape. *Front Ecol Environ* 2013, 11:14–14.
18. Wenka CL, Rogers WE, Kreuter UP: Legal barriers to effective ecosystem management: exploring linkages between liability, regulations, and prescribed fire. *Ecol Appl* 2015, 25: 2382–2393.
19. Neundorff M: *Prescribed fire-induced changes in soil properties of the southeastern forests of the United States: sorption behavior of polar and nonpolar compounds*. Master dissertation. Clemson University; 2020. 105 pp. https://tigerprints.clemson.edu/all_theses/3425.
20. Úbeda X, Alcaraz M, Borges G, Oulaino L, Francos M: Soil Quality of abandoned agricultural terraces managed with prescribed fires and livestock in the municipality of Capafonts, Catalonia, Spain (2000–2017). *Agronomy* 2019, 9:340.
21. Freidenreich A, Harris B, Dattamudi S, Betancourt E, Reis MS, Jayachandran K: Effects of prescribed fire on soil properties in a pine rockland ecosystem. *Agr Environ Lett* 2020, 5: e20026.
- The paper provides very sound results how prescribed fire affects key soil properties from short- to long-term.
22. Glora-García A, Badía-Villas D, Mari-Dalmau C, Ortiz-Pepona D, Mora JL, Amias-Herrera GM: Effects of prescribed fire for pasture management on soil organic matter and biological properties: a 1-year study case in the Central Pyrenees. *Sci Total Environ* 2018, 618:1079–1087.
23. Francos M, Stefanuto EB, Úbeda X, Pereira P: Long-term impact of prescribed fire on soil chemical properties in a wildland-urban interface. Northeastern Iberian Peninsula. *Sci Total Environ* 2019, 689:305–311.
24. Richter DD, Ralston CW, Harris WR: Prescribed fire: effects on water quality and forest nutrient cycling. *Science* 1982, 215: 651–653.
25. Stephens SL, Melisier T, Poth M, McGurk B, Payne D: Prescribed fire, soils, and stream water chemistry in a watershed in the Lake Tahoe Basin, California. *Int J Wildland Fire* 2004, 13:27–35.
26. Loupe TM, Miller WW, Johnson DW, Sedinger JS, Carroll EM, Walker RF, Saini CM: Effects of mechanical harvest plus chipping and prescribed fire on Sierran runoff water quality. *J Environ Qual* 2009, 38:537–547.
27. Zhang W: *Effects of prescribed forest fire on water quality and aquatic biota in the southeastern United States*. Master dissertation. Clemson University; 2017. 91 pp. https://tigerprints.clemson.edu/all_theses/2763.
28. Hahn GE, Coates TA, Lallam BE, Majidzadeh H: Prescribed fire effects on water quality and freshwater ecosystems in moist-temperate eastern North America. *Wat Area J* 2019, 39:40–57.
- This work makes an outstanding analysis about how prescribed fire management influences the quality of freshwater.
29. Klimas K, Hiesl P, Hagan D, Park D: Immediate effects of prescribed fire on sub-surface water quality in a managed yellow pine forest. *Fire* 2020, 3:14.
- In this work the authors did a very good study about the effects of prescribed fire immediately after fire on sub-surface water quality.
30. Coates TA: *Forest management in coastal pine forests: an investigation of prescribed fire behavior, detrital chemical composition, and potential water quality impacts*. Doctoral Thesis. Dissertation. Clemson University; 2017. 125 pp. https://tigerprints.clemson.edu/all_dissertations/18381.
31. Klimas KB: *Prescribed fire effects on water quality variables in the southern Appalachian region*. Master dissertation. Clemson University; 2020. 127 pp. https://tigerprints.clemson.edu/all_theses/3294.
32. Mullen RM, Springer AE, Kolb TE: Complex effects of prescribed fire on restoring the soil water content in a high-elevation riparian meadow, Arizona. *Restor Ecol* 2006, 14: 242–250.
33. Renninger HJ, Clark KL, Skowronski N, Schäfer KV: Effects of a prescribed fire on water use and photosynthetic capacity of pitch pines. *Trees (Berl)* 2013, 27:1115–1127.
34. Gottfried GJ, DeBano LF: *Streamflow and water quality responses to preharvest prescribed burning in an undisturbed ponderosa pine watershed. Effects of fire management on southwestern natural resources*. RMRS-GTR-191. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station; 1990:222–231.
35. Sackett SS, Haase SM, Hunnington MG: *Prescribed burning in Southwestern ponderosa pine*. United States department of agriculture forest service general technical report RM-1996: 170–186.
36. McKelvey KS, Skinner CN, Chang CB, Emman DO, Husan SJ, Parsons DJ, Weatherpoon CP: *An overview of fire in the Sierra Nevada. In Sierra Nevada ecosystem Project, final report to congress, vol. II*. Davis, CA: Assessments and Scientific Basis for Management Options; 1996:1033–1040. University of California. Centers for Water and Wildland Resources.
37. Rinne JN, Naary DG: *Fire effects on aquatic habitats and biota in Madroño-type ecosystems: southwestern United States*. United States department of agriculture forest service general technical report RM-1996:135–144.
38. Hauer FH, Spencer GN: Phosphorus and nitrogen dynamics in streams associated with wildfire: a study of immediate and long-term effects. *Int J Wildland Fire* 1998, 8:183–198.

6 Environmental impact assessment: Fire. Prevention, management and challenges

39. Payne DY: *Prescribed fire effects on water quality in the Lake Tahoe Basin, California*. Master Dissertation no 1935. San Jose State University; 1999, <https://doi.org/10.31979/etd.qv6c-uzc5>.
40. Yu CH, McCarl BA: The water implications of greenhouse gas mitigation: effects on land use, land use change, and forestry. *Sustainability* 2018, 10:2367.
41. Brooks KN, Floliot PF, Magner JA: *Hydrology and the management of watersheds*. John Wiley & Sons; 2012. 5-15 pp.
42. Waldrop TA, Goodrick SL: *Introduction to prescribed fires in Southern ecosystems*. Science update SRS-054, n°54. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station; 2012. 80 pp.
43. North M, Zald H, Collins D, Hurteau M: *Changes in forest vegetation and fuel conditions 15 years after prescribed fire*. Final Report JFSP PROJECT ID: 15-1-07-6; 2019. 22 pp.
44. Sittler KL, Parker KL, Gillingham MP: Vegetation and prescribed fire: implications for Stone's sheep and elk. *J Wildlife Manage* 2019, 83:393-409.
45. Boensch DM: *Long-term overstory vegetation responses to prescribed fire management for longleaf pine at Big Thicket National Preserve*. Master Dissertation. Stephen F. Austin State University 2016. 67 pp.
46. Schwartz NJ, Urban DL, White HS, Moody A, Klein RN: Vegetation dynamics vary across topographic and fire severity gradients following prescribed burning in Great Smoky Mountains National Park. *For Ecol Manag* 2016, 365:1-11.
47. Livingston AC, Varner JM, Jules ES, Kane JM, Arquello LA: Prescribed fire and conifer removal promote positive understory vegetation responses in oak woodlands. *J Appl Ecol* 2016, 53:1604-1612.
48. Williams CJ, Pierson FB, Nouwakpo SK, Al-Hamdan OZ, Komos PR, Woltz MA: Effectiveness of prescribed fire to re-establish sagebrush steppe vegetation and ecohydrologic function on woodland-encroached sagebrush rangelands, Great Basin, USA: Part I: vegetation, hydrology, and erosion responses. *Catena* 2020, 185:103477.
- In this study the authors provides key information about the use of prescribed fire to ecosystem restoration, avoid invasive species and post-fire vegetal dynamics.
49. Blason PA, Rieman BE, Luce C, Hessburg PF, Lee DC, Kershner JL, Reeves GH, Gresswell RE: Fire and aquatic ecosystems of the western USA: current knowledge and key questions. *For Ecol Manag* 2003, 178:213-229, [https://doi.org/10.1016/S0378-1127\(03\)00063-X](https://doi.org/10.1016/S0378-1127(03)00063-X).
50. Hutchinson TF, Sutherland EK, Yussay DA: Effects of repeated prescribed fires on the structure, composition, and regeneration of mixed-oak forests in Ohio. *For Ecol Manag* 2005, 218:210-228, <https://doi.org/10.1016/j.foreco.2005.07.011>.
51. Arkle RS, Rillid DS: Prescribed fires as ecological surrogates for wildfires: a stream and riparian perspective. *For Ecol Manag* 2010, 259:893-903, <https://doi.org/10.1016/j.foreco.2009.11.029>.
52. Fan Z, Ma Z, Dey DC, Roberts SD: Response of advance reproduction of oaks and associated species to repeated prescribed fires in upland oak-hickory forests, Missouri. *For Ecol Manag* 2012, 266:160-169, <https://doi.org/10.1016/j.foreco.2011.08.034>.
53. Morgan GW, Tolhurst KG, Poynter MW, Cooper N, McGulloch T, Ryan R, Wouters MA, Stephens N, Black P, Sheehan D, Leeson P, Whight S, Davey SM: Prescribed burning in south-eastern Australia: history and future directions. *Aust For* 2020, 83:4-28, <https://doi.org/10.1080/00049158.2020.1739883>.
- In this work the authors lay down the retrospective basis for the beginning of the prescribed fires in Australia and the chronological evolution that this management tool has had over the years in that country.
54. Tolhurst K: Prescribed burning in victoria: policy and practice. In *Bushfire prevention: are we doing enough?* Melbourne: Institute of Public Affairs; 2003. 19 pp.
55. Oliveras I, Bell T: An analysis of the Australian literature on prescribed burning. *J For* 2008, 106:31-37, <https://doi.org/10.1093/jof/106.1.31>.
56. Styger J, Marsden-Smedley J, Kirkpatrick JB: Changes in lightning fire incidence in the tasmanian wilderness world heritage area, 1980-2016. *Fire* 2018, 1:1-10, <https://doi.org/10.3390/fire1030038>.
57. Cruz MG, Gould JS, Alexander ME, Sullivan AL, McCaw WL, Matthews S: Empirical-based models for predicting head-fire rate of spread in Australian fuel types. *Aust For* 2015, 78:118-158, <https://doi.org/10.1080/00049158.2015.1030003>.
58. Tolhurst KG, Shierle R, Cheng DMO, Phoenix: Development and application of a bushfire risk management tool. *Aust J Emerg Manag* 2008, 23:47-54, doi=60949643850011.res=IELHSS.
59. Hughes L, Steffen W: *Be prepared: climate change and the ACT bushfire threat*. Sydney (Australia): Climate Council of Australia; 2019. 70 pp, <https://research-management.mq.edu.au/files/portafiles/portal/15457207/mq-29845-Publisher+version.pdf>.
60. Spencer AG, Schultz CA, Hoffman CM: Enhancing adaptive capacity for restoring fire-dependent ecosystems: the fire learning network's prescribed fire training exchanges. *Ecol Soc* 2015, 20:35, <https://doi.org/10.5751/ES-07847-200338>.
61. Walker R, Salt D: *Resilience praction: building capacity to absorb disturbance and maintain function*. Washington, D.C.: Island; 2012. <https://doi.org/10.5822/978-1-61091-231-0>. USA.
62. Chaffin BC, Gosnell H, Cosens BA: A decade of adaptive governance scholarship: synthesis and future directions. *Ecol Soc* 2014, 19:56, <https://doi.org/10.5751/es-06824-190356>.
63. Steel ZL, Safford HD, Viers JH: The fire frequency-severity relationship and the legacy of fire suppression in California forests. *Ecosphere* 2015, 6:1-23.
64. Lázaro A: Development of prescribed burning and suppression fire in Europe. In *Best practice of fire-use - prescribed burning and suppression fire programmes in selected case study regions in Europe*. Edited by Montiel C, Kraus DT, European Forest Institute; 2010:17-31.
65. Goldammer J, Montiel C: Identifying good practices and programme examples for prescribed burning and suppression fire. In *Best practice of fire-use - prescribed burning and suppression fire programmes in selected case study regions in Europe*. Edited by Montiel C, Kraus DT, European Forest Institute; 2010:35-44.
66. Russell-Smith J, Edwards AC, Sangha KK, Yates CP, Gardener MR: Challenges for prescribed fire management in Australia's fire-prone rangelands—the example of the Northern Territory. *Int J Wildland Fire* 2020, 29:332-353.



Managing forest fuels using prescribed fire – A perspective from southern Australia

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ARTICLE INFO

Article history:
Available online 12 October 2013

Keywords:
Forest fires
Bushfires
Prescribed burning
Eucalypt forest

ABSTRACT

Prescribed fire has been used in a coordinated manner to manage fuels in eucalypt forests of southern Australia since the 1950s. The impetus for planned use of fire arose from the need to reduce the impact of extensive, high intensity fires on life, property and commercial forest values. Prescribed fire is increasingly recognised as also playing an important role in mitigating undesirable effects of high intensity fires on environmental values including soil, water and biodiversity. Critical elements for an effective prescribed fire program include a sound understanding of fire behaviour, an experienced and flexible workforce, and organisational commitment to adaptive management involving planning, monitoring and applied research. Implementation of prescribed fire programs has been closely linked with, and dependent upon, the development of burning guides for particular forest types through empirical field research. The contribution of prescribed fire to mitigating the effects of extensive, high intensity fires can be quantified in a variety of ways using basic combustion science, well-documented case studies, analysis of fire statistics, and simulation. Fuel reduction can improve the safety, efficiency and effectiveness of fire suppression, although these effects may be subtle and difficult to measure. Social and political factors can significantly influence the conduct and effectiveness of prescribed fire programs, and effective engagement with the community during planning, implementation and post-fire monitoring phases is essential to ensure that the role of prescribed fire in land management is properly recognised and understood.

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1. Introduction

Prescribed fire has been used in a coordinated manner to manage fuels in eucalypt forests of southern Australia since the 1950s. The impetus for planned use of fire arose from the need to reduce the impact of extensive, high intensity fires on life, property and commercial forest values. These fires followed in the wake of disruption of traditional aboriginal burning patterns, broadscale clearing of land for agricultural development, and commercial exploitation of forests that generated large amounts of logging debris and introduced new sources of ignition from settlements, steam locomotives and machinery. Major bushfires such as Black Sunday (February 1926) and Black Friday (January 1939) in Victoria, and the 1961 bushfires that destroyed the towns of Dwellingup, Nanga Brook and Karridale in south west Western Australia have come to be regarded as defining moments in Australian history (Pyne, 1991). The Australian experience is not unique and a similar pattern of events can be traced in the fire histories of the United States, Canada and other countries undergoing rapid settlement and economic development of the land during the 19th and first half of the 20th centuries (Pyne, 1995). Cessation of land clearing and the transfer of extensive tracts of public land into reserves

managed primarily for recreation and nature conservation has not, however, been accompanied by a reduction in the extent and impact of destructive fires. During the first decade of the current century unplanned fires burnt more than 3 million ha of public land in south-eastern Australia, culminating in the destructive fires of Black Saturday 7 February, 2009 when 173 lives were lost and more than 2000 buildings destroyed in the state of Victoria (Ellis et al., 2004; Teague et al., 2010). The size and impact of unplanned fires also increased in south-west Western Australia during this period, although the scale of losses has been considerably less than in south-eastern Australia.

The economic, social and environmental impacts of unplanned fire at a global scale have increased substantially during the past decade (Williams et al., 2011). Fires having unprecedented consequences in terms of loss of human life, suppression cost, economic loss and natural resources impacts have occurred in Australia, Mediterranean Europe, Russia, the United States and parts of south-east Asia and South America. Many factors contribute to the increasing impact of fire including population growth in peri-urban communities (Stephens et al., 2009; Syphard et al., 2009), altered patterns of land use in rural areas (Pausas et al., 2008), persistent drought at regional scales (Cook et al., 2004; van Ommen and Morgan, 2010; Gergis et al., 2012), and changes in forest structure and fuel dynamics linked to climatic stress (Allen et al., 2010) and land management practices (Stephens

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and Ruth, 2005). The term 'mega-fires' has emerged to characterise fires that simultaneously exhibit extreme values of economic and social impact, environmental consequence and resistance to suppression (Williams et al., 2011; Williams, 2013). Reaching broad international agreement on a formal definition of mega-fire may prove difficult because of differing perspectives amongst policy makers, managers, practitioners and scientists working in the fire arena, and because of profound differences between societies in the way that fire is managed. Nevertheless, rigorous evaluation of the concept of mega-fires is useful because it may help to identify common trends in the scale and impact of fire emerging across biomes and jurisdictional boundaries.

Eminent fire historian Stephen J. Pyne observed that Australia, far more than any other industrialised nation, has held to a tradition of prescribed burning, attributing this to the fact that no single institution has been sufficiently powerful to impose its will on the land, and that eradication of fires is unachievable in a land characterised by flammable vegetation, drought and dry winds (Pyne, 2003). In the Australian context prescribed fire refers to the application of fire under specified environmental conditions to a predetermined area and at a time, intensity and rate of spread required to attain planned resource management objectives (AFAC, 2012). Prescribed burning originated as a tool for fire protection in forests (McArthur, 1962; Peet, 1965; McCaw et al., 2003), but its use has broadened in recent decades to include regenerating areas following timber harvesting, and managing habitat for biodiversity conservation (Burrows, 2008). Prescribed burning also plays an important role in mitigating undesirable effects of unplanned high intensity fires on soil and water values (Certiří, 2005). These aims need not be mutually exclusive and in practice all burning achieves some level of fuel reduction. Fires used to reduce fuels in eucalypt forests are typically of low to moderate intensity with fireline intensities (Byram, 1959) in the range 500–2500 kW m⁻¹, and are implemented at scales ranging from tens of hectares ignited by ground crews through to thousands of hectares ignited using aerial ignition.

An Australian perspective on the use of prescribed fire for managing forest fuels should be of interest to the global fire community which is facing the challenge of escalating socio-economic and environmental impacts from unplanned fires. This paper examines (1) the scientific knowledge base underpinning the use of prescribed fire for fuel reduction in eucalypt forests, (2) approaches to evaluate the effectiveness of prescribed fire in mitigating the impacts of high intensity unplanned fires, and (3) contemporary influences on the implementation of prescribed fire programs in southern Australia, particularly in the states of Western Australia and Victoria.

2. Forest fuels and fire behaviour in southern Australia

This paper is concerned primarily with open eucalypt forests, also commonly known as dry sclerophyll forests, which at maturity can attain a height of 30 m and overstorey foliage cover of 30–70% (Specht, 1970). Open eucalypt forests are widespread in southern Australia in areas with a temperate or Mediterranean-type climate receiving mean annual rainfall >500 mm, and occur on a broad range of soils and landforms including plateaus, ranges and plains (Boland et al., 2006; Gill, 2012). Prescribed burning is also undertaken in some tall open forests with eucalypts up to 80 m in height, particularly forests dominated by *Eucalyptus diversicolor* in south-west Western Australia.

The fuels in a eucalypt forest can be categorised into a series of strata according to particle size, arrangement and potential contribution to fire behaviour (Gould et al., 2011, Fig. 1). Fuel strata include those which:

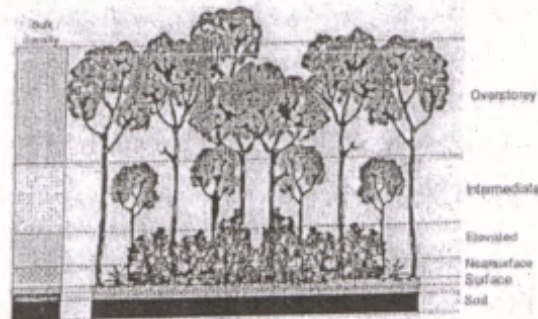


Fig. 1. Visually distinct fuel layers within an open eucalypt forest in southern Australia (Source: Gould et al., 2011). Grey scale on the left side indicates the relative bulk density of each layer.

- contribute to the flame height: primarily the loosely compacted layer of leaf litter, twigs and low shrubs on or near the forest floor;
- contribute to the depth of flame behind the fire front: mostly the upper part of the leaf litter layer and the larger twig components (6–25 mm diameter) embedded in it;
- contribute to smouldering combustion: the lower compacted part of the leaf litter layer, sometimes referred to as duff, and dead fuels >25 mm diameter, decorticated bark of stringybark types, which may contribute up to 10 t ha⁻¹ and burn for hours;
- burn only when supported by the combustion of fine dead fuels: these are generally sparse elevated dead fuels, live fuels (including canopy) and some dead fuels;
- do not burn because of their location, moisture content or size (e.g. live trunks, moist logs).

Important characteristics of fire behaviour in eucalypt forests identified by Luke and McArthur (1978) and in a recent review by Sullivan et al. (2012) include the potential for rapid rates of forward spread (up to 10 km h⁻¹), crowning and massive spotting with firebrands transported up to 30 km downwind under extreme fire danger conditions (Ellis, 2011; Cruz et al., 2012).

Until recently, fuel load (mass per unit area) was the only fuel characteristic used in Australian forest fire danger rating systems to predict fire behaviour. Studies by McArthur (1967, 1962) and Peet (1965) suggested that the amount of fine fuel (<6 mm diameter) available on the forest floor (i.e. fuel consumed by the fire) was the most significant fuel variable affecting the spread of fires in eucalypt forests. These authors claimed that, for fixed temperature, humidity, drought factor and wind speed, the rate of spread of the headfire (R) is directly proportional to the load of fine fuel (W) consumed and is expressed as a simple linear relationship:

$$R = aW \quad (1)$$

where a is a constant derived from field experiments in a specific fuel type. Fireline intensity (Byram, 1959) is usefully correlated with flame dimensions, difficulty of fire suppression, and a broad range of effects of fire on the environment (Cheney, 1990). Intensity (I) is calculated as the product of fuel load consumed in the flaming zone (W) and rate of spread (R) according to the formula:

$$I = HW \quad (2)$$

where H is the heat yield of the fuel in units of kJ kg⁻¹. If the rate of spread is directly proportional to fuel load, it follows that reducing the fuel load by half, halves the rate of spread and reduces the intensity of the fire fourfold. This relationship between fuel load, rate of spread and fire intensity has provided a simple but powerful

argument to support fuel reduction burning in eucalypt forests for more than 50 years. However, McArthur (1967, 1962) and Peet (1965) provided no detailed description of analytical methods or confidence limits on the correlation between rate of spread and fuel load. Their relationships were generally based on data from low to moderate intensity fires ($<2500 \text{ kW m}^{-1}$) lit at a point and allowed to develop for periods of up to 1 h in fuel composed predominantly of leaf litter and low shrubs.

The relationship between age-related fuel characteristics and fire behaviour in open eucalypt forest was investigated during a comprehensive series of field experiments known as Project Vesta (Gould et al., 2007; McCaw et al., 2012). Simultaneous experimental fires were conducted under dry summer conditions at two locations with contrasting understorey and fuel structures that had developed over periods of 2–22 years after prescribed burning. Most fuel characteristics including bark, understorey shrubs, near-surface and surface fuels increased with increasing time since last fire, and visual hazard scores described patterns of fuel dynamics over time in a similar fashion to models based on fuel load accumulation (Gould et al., 2011). Fuel hazard scores that reflect the quantity and arrangement of surface and near-surface fuel were more strongly correlated with most fire behaviour variables than were corresponding fuel load variables. The near-surface fuel layer of suspended leaves, bark, twigs and low shrubs was found to be the dominant stratum affecting headfire rate of spread during these experiments. Visual ratings of fuel structure have been included in new algorithms to predict fire behaviour and fire threat in open eucalypt forests (Cheney et al., 2012). Fine fuel load remains an important consideration in fire behaviour prediction because of its contribution to fireline intensity. By providing a better understanding of how different fuel strata contribute to fire behaviour, findings from the Project Vesta experiments also provide a sound basis to assess the effectiveness of fuel reduction treatments in modifying the behaviour of high intensity fires burning under dry conditions.

3. Quantifying the effectiveness of prescribed fire

Fire behaviour is influenced by fuel quantity and arrangement, fuel dryness, wind speed, and slope. Fires burn more intensely when fuels are continuous, well aerated and dry, when winds are strong enough to deflect flames forward and pre-heat fuels in advance of the flame front, and for the same reason when a fire is advancing up a slope (Sullivan et al., 2012). In the simplest case, the reduction of fire behaviour immediately following fuel removal by prescribed burning is obvious as there is no surface fuel to burn, and even crown fires may collapse within a short distance after encountering a recently fuel reduced area. As fuel re-accumulates in subsequent years the benefits of prescribed burning for fire suppression will be evident in the form of reduced rate of spread and fire intensity, and reduced fire propagation by spotting. Thermal impact on vegetation and soils will also be lessened, commensurate with the reduced fire intensity. Eventually, at some time after burning, fire behaviour in the treated area becomes indistinguishable from that in adjoining forest that has not been subject to fuel reduction treatment. The challenge, therefore, is to quantify in some practical way:

- how the effects of fuel reduction vary with weather conditions and fuel dryness;
- how long the effects of fuel reduction persist; and
- how fuel reduction contributes to an overall reduction in damage from unplanned fire.

Fernandes and Botelho (2003) comprehensively reviewed the effectiveness of prescribed burning for fuel hazard reduction draw-

ing on information from North America, Australia and Europe. Their paper represents an important milestone in the fire management literature and has been widely cited. They concluded that the hazard reduction benefits of prescribed fire are easily demonstrated by fire behaviour theory, through observation and measurement of post-treatment fuel changes in experimental or operational burns, and by computer simulation at the plot, stand and landscape levels. Analysis of modifications in fire regimes induced by prescribed burning was identified as the best approach currently available to evaluate the effectiveness of fuel management programs, despite the fact that separating the effects of treatment from the overall fire management effort may be difficult. Fernandes and Botelho (2003) also stressed the need for replicated studies of high intensity fire behaviour in field experiments. Each of these approaches can be informative but as with many areas of scientific inquiry, no single line of evidence is likely to be sufficiently robust or free from bias to adequately quantify the effectiveness of fuel reduction burning. Bias may be introduced by imperfect knowledge of fire behaviour, and by the opinions of the investigators themselves. An integrated approach that draws on a broad range of indicators offers the best way forward.

The extent of fuel reduction achieved by burning is critical because it determines how much fuel remains to support a subsequent bushfire. To significantly reduce potential bushfire behaviour it is necessary to:

- reduce the depth, quantity and continuity of surface and near-surface fuel which contribute directly to fire spread and flame depth;
- reduce the height of the elevated fuel layer of understorey shrubs which contribute to flame height;
- remove flammable and loose outer bark on tree stems that contributes to spotting.

The extent of fuel reduction achieved by prescribed burning depends on the amount of fuel present, the environmental conditions under which an area is burnt, and the way in which an area is ignited. Fine fuels ($<6 \text{ mm}$ diameter) in eucalypt forest respond rapidly over periods of one to several hours to changing environmental conditions including precipitation, relative humidity, air temperature and insulation (Matthews et al., 2010). Coarse fuels respond more slowly to environmental conditions over periods ranging from days to months depending on their size, initial moisture content, surface condition and state of decay (Burrows, 1987). Fuel consumption increases with more severe burning conditions and higher fireline intensities, and is maximised when both fine and coarse fuels are dry (Hollis et al., 2011a,b). More intense fires will have larger flames that consume greater quantities of live and dead foliage on understorey shrubs, and bark on standing trees (Burrows, 1997; Gould et al., 2007; Wotton et al., 2012). Fire intensity can be strongly influenced by the way that a planned burn area is ignited, in particular whether the fire is set to burn with the wind or against the wind, upslope or downslope, and whether fire is ignited as individual points or in lines (Tolhurst and Cheney, 1999). The pattern of ignition can be manipulated to increase or decrease the proportion of area burnt, particularly where there are natural barriers to fire spread in the landscape, for example rock outcrops and scree slopes, moist gullies or sand dunes. A widely spaced ignition pattern will increase the likelihood of patches remaining unburnt, even if they do support flammable fuels. Closely spaced ignition will increase the proportion of area subject to increased fire behaviour as fires originating from separate ignition points interact and coalesce.

Time elapsed since fuel reduction treatment is important because fuels re-accumulate from annual litter fall and regrowth of understorey shrubs (Gould et al., 2011). The relationship between

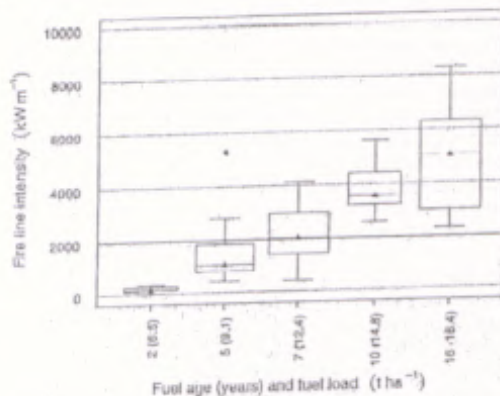


Fig. 2. Fireline intensity of experimental fires burning under dry summer conditions of moderate to high fire danger in eucalypt fuels of different age. The combined load of surface and near-surface fuel for each age class is shown in brackets. Box-and-whisker plot shows the median value (•), 25th and 75th quartiles (i.e. 50% of cases have values within the box) and dots (•) represent outliers more than 1.5 box-length from the 25th and 75th percentiles. Horizontal bold line indicates an intensity 2000 kW m⁻¹ above which the effectiveness of fire suppression using tankers and bulldozers declines markedly. Data for the tall shrub site from Project Vesta experiments (McCaw et al., 2012).

fuel age and fire intensity, hence suppression difficulty, is illustrated by comparing the median intensity of Project Vesta experimental fires ignited in fuels of different age under dry summer conditions of moderate to high fire danger (Fig. 2). Fires were conducted simultaneously in each fuel age so that the mean fire danger conditions for the experiments are constant. Intensities are calculated from surface and near-surface fuel loads and represent a fire that has been burning for long enough to establish a head fire at least 100 m wide. Mean fire intensity increased with increasing fuel age, and exceeded 2000 kW m⁻¹ for the 10 and 16 year-old fuels. The effectiveness of fire suppression using tankers and bulldozers declines markedly once fire intensity exceeds 2000 kW m⁻¹ (Loane and Gould, 1986), and these data indicate that fires in fuels older than about 7 years will be difficult to control under average summer conditions of moderate to high fire danger in open eucalypt forest. Bark continues to accumulate on the trunks of rough-barked eucalypts for many decades, adding to the difficulty of fire suppression in long unburnt forest (Gould et al., 2007).

The persistence of a measurable effect from reduced fuels has been examined in a number of studies. The effects of previous burning persisted for up to 5 years in open eucalypt forest in the Blue Mountains west of Sydney (Price and Bradstock, 2010), although this study did not explicitly account for the contribution of fire suppression in limiting fire spread. House loss resulting from the devastating Victorian fires of 7 February 2009 was significantly reduced where prescribed burning had been undertaken upwind of the property during the previous 5 years (Gibbons et al., 2012). A study of initial attack success on Victorian bushfires reported that fuel reduced areas older than about 10 years, with an overall fuel hazard of high or greater, had a low probability of assisting with suppression (McCarthy and Toffhurst, 2001). Fuel dynamics in open eucalypt forests with a shrubby understorey and fibrous barked trees indicate that some effect of fuel reduction from prescribed burning could in fact persist for up to 15 years (McCaw et al., 2012), although this effect would be difficult to quantify and probably impossible to demonstrate with statistical certainty in the circumstances of high intensity unplanned fires.

The effectiveness of fuel reduced areas in modifying the behaviour of unplanned fires will depend on their size and location

within a landscape. In eucalypt forests prone to massive spotting, fuel reduced areas several kilometres deep are required to reduce the density of new ignitions started by spotting that suppression forces must contend with (McArthur, 1967; Ellis, 2011; McCaw et al., 2012). In southern Australia the most severe fire weather conditions are associated with winds from the north and north-west, although fires spreading on a wide front with southerly winds following the passage of a cold front have caused substantial loss of life and property (Rawson et al., 1983; Teague et al., 2009). Small fuel reduced areas will be ineffective if they are readily outflanked by a bushfire burning through heavy fuel in adjacent areas. This was illustrated clearly during the early evening of 7 February 2009 when a southerly wind change turned the northern flank of the Kilmore East fire into a 55 km long headfire that encountered a number of areas fuel reduced with prescribed fire in the previous autumn of 2008 (McCaw, 2009; Cruz et al., 2012). Fuel reduced areas were small in size (<2 km²) relative to the scale of Kilmore East fire and had little impact on its overall spread following the wind change. Despite extreme fuel dryness, adverse fire weather conditions and the small scale of fuel reduction burns the pattern of burn severity mapped from satellite imagery clearly indicates that fire intensity was reduced within prescribed burnt areas, and for a distance of up to several kilometres downwind of them (refer to Fig. 8 in Cruz et al., 2012). A more extensive area of 3 year-old fuel north of Kinglake that resulted from a bushfire in January 2006 remained largely unaffected by the Kilmore East bushfire, despite adjacent forest being heavily crown scorched or defoliated by crown fire.

Weather conditions play a critical role in determining the extent to which fire behaviour is modified by fuel reduction, although this remains an area of considerable uncertainty. Experimental fire behaviour studies in eucalypt forest have generally been limited to conditions of high, or at most very high fire danger, for obvious reasons of safety and risk management (McCaw et al., 2012). The case study approach has been widely used in Australia to examine the behaviour of unplanned fires (Fernandes and Botelho, 2003; McCaw et al., 2008; Sneeuwjagt, 2008). Probably the earliest case study in eucalypt forest is that of McArthur (1962) who reconstructed the spread of the 1961 Dwellingup bushfires in south-west Western Australia and documented examples where fuels less than 3 years old prevented fires from crowning, even when weather conditions were extreme. Understandably, case studies of the effectiveness of prescribed burning have tended to focus on extreme weather conditions when fires pose the greatest risk to human life, property and infrastructure (Blanchi et al., 2010). The advent of remote sensing and spatial analysis techniques has assisted in quantifying the relationship between fire weather, fuel, terrain and fire severity (Keeley, 2009) at the landscape scale. Studies of this type have demonstrated that, under extreme weather conditions, the probability of crown fire in eucalypt forest is significantly reduced for up to 5 years after previous fire, in environments as diverse as the Blue Mountains of New South Wales (Bradstock et al., 2010), the Central Highlands of Victoria (Bradstock and Price, 2010), and south-west Western Australia (Fig. 3).

The contribution of fuel reduced areas to the effectiveness and safety of fire suppression under less extreme weather conditions is also important, as these are the conditions during which the majority of fire suppression work is done. Unplanned fires can grow to large size if they escape initial attack because the terrain is inaccessible to firefighters, the intensity of the fire exceeds the capacity of the resources available, or the time between detection and initial attack is protracted. All of these factors may be invoked in the circumstance of multiple lightning ignitions in remote areas, as experienced in the highlands of south-eastern Australia in January 2003 (McLeod, 2003) and December 2006 (McCarthy et al., 2012). Analysis of suppression efforts on 66 fires ignited by



Fig. 3. Fire severity in open forest of Jarrah (*Eucalyptus marginata*) near Dwellingup, Western Australia arising from a bushfire on 4 February 2007 when the McArthur (1967) Forest Fire Danger Index was 75 (Severe). Air temperature was 41 °C, relative humidity 12% and winds 35 km h⁻¹ from the north-west. Inset photographs illustrate the severity of fire at three locations identified by letters: (A) defoliation in forest unburnt for >20 years; (B) full crown scorch of forest at the boundary between the fuel >20 years-old and forest burnt 2 years previously by prescribed fire; and (C) a patch of 2 year-old fuel within the fuel reduced forest that only burnt at very low intensity during the 2007 bushfire because the surface fuel was sparse and discontinuous.

lightning on 1 December 2006 showed that resources were allocated to fires on shallower slopes and with lower fuel hazard ratings, and that the success of containment was affected by slope, fuel hazard and weather during the subsequent week (McCarthy et al., 2012). Aerial suppression operations have been shown to be more effective where the hazard ratings of surface and near-surface fuels are lower (Plucinski et al., 2012), and backburning operations can be undertaken more rapidly and with lower risk of escape when the adjoining fuels are low. The existence of substantial areas of recently burnt forest gives fire managers the flexibility to delay initial attack in these areas while suppression resources are directed to more immediate priorities, as documented in case studies by Underwood et al. (1985) and Cheney (2010).

Analysis of the occurrence and extent of planned and unplanned fires can provide useful insight into the effectiveness of prescribed burning in managing fire regimes at the landscape scale over decadal time periods. Boer et al. (2009) demonstrated a strong inverse relationship between the extent of prescribed burning and unplanned fire in the Warren region of south-west Western Australia over 45 years, during which the fraction of the study area burnt annually by planned fire ranged from 4% to 11%. Landscape scale studies of fire occurrence in the Sydney region have shown that fuel reduction by previous fire and prescribed burning has a measurable, but limited, effect on fire spread and on the extent of unplanned fire (Price and Bradstock, 2010, 2011). The overall extent of prescribed burning in the Sydney region was small (<1% per annum). Loehle (2004) proposed the concept of leverage to quantify the extent of reduction in unplanned fire achieved for each unit of planned fire undertaken. Leverage provides a useful framework within which to analyse the effectiveness of prescribed fire for a range of management objectives including reducing the extent of unplanned fires; however, such an analysis also needs to account for the relative impacts of different levels of fire severity on natural

resource values, biodiversity and atmospheric emissions. Price and Bradstock (2011) suggested that in open eucalypt forests of southern Australia approximately three units of planned fire are required to reduce the unplanned fire area by one unit. For the Sydney region this implies an annual prescribed burning program of around 5% of the landscape would be required to halve the current extent of unplanned fire. This represents a tenfold increase on recent levels, and would bring the scale of prescribed burning up to a level similar to that undertaken in the forests of south-west Western Australia which has been effective in minimising the impacts of high intensity bushfires over a multi-decadal period (Adams and Attiwill, 2011).

4. Prescribed fire and the management of public lands

A high proportion of the forest land in southern Australia is publicly owned and managed by state agencies that have a broad charter for biodiversity conservation and other aspects of natural resource management. Agencies operate under legislation that provides them with responsibilities and powers for both biodiversity conservation and fire management. Finding an appropriate balance is not an easy task, and is made more challenging by rapid growth in peri-urban communities adjacent to public lands, changing demographics in rural communities, and the changing social and political environment in which fire management decisions are made (Bradstock et al., 2012a). Australia is a highly urbanised society and much of the population has become detached from the reality of living in a fire-prone environment, viewing fire simply as a threat to life, property and the environment.

Use of prescribed fire to achieve fuel reduction and other land management objectives has declined in southern Australia over recent decades (Sneeuwjagt, 2008; Parliament of Victoria, 2008; Boer et al., 2009; Adams and Attiwill, 2011). This decline can be attributed to a range of factors including: increased complexity of integrating fire management with land uses of public forests (e.g. timber harvesting, mining, recreation infrastructure, biodiversity conservation); changes in the timing and duration of weather patterns suitable for prescribed burning; greater awareness of and sensitivity to smoke from planned burns; and a general increase in aversion to risk arising from management activities. In Western Australia, the policy basis for the prescribed burning program on public lands has been challenged during litigation to recover commercial losses attributed to the impacts of smoke from prescribed fires on neighbouring vineyards. The court concluded that it would be unreasonable to impose a duty of care to avoid smoke damage to wine grapes on a public authority with fire management responsibilities and biodiversity conservation functions where it is not always possible to avoid some smoke during the sensitive stages of grape production (Murphy, 2010). The decision of the court was upheld following appeal (McLure et al., 2012).

Australia has a rich tradition of post-fire inquiries at State and federal level following major fire events; in the past decade these have included inquiries by independent experts (e.g. Esplin et al., 2003; Ellis et al., 2004; Keelty, 2011, 2012), parliamentary committees (House of Representatives, 2003; Parliament of Victoria, 2008; Senate Select Committee, 2010), coronial inquests (Doogan, 2005), and a Royal Commission (Teague et al., 2010). Most, if not all, of these inquiries have considered the issues associated with management of fuel on public land, and have called for the use of planned fire for fuel reduction to be maintained or increased. Prescribed burning was a major focus of the Royal Commission into the 2009 Victoria fires, and generated more public submissions than any other single topic. The Commission heard evidence on prescribed burning from a range of Australian and overseas expert witnesses, and convened an expert panel to consider the

establishment of a formal target for an annual burning program on public lands; a target of 5% was subsequently set by the Victorian Government (2010). Western Australia is the only state to have consistently maintained a program of prescribed burning exceeding 5% of its public forest estate (Sneeuwjagt, 2008; Adams and Attiwill, 2011), and evidence from empirical and simulation studies in other states suggests that to significantly reduce the extent of unplanned fires requires a program of this scale (Price and Bradstock, 2011; Bradstock et al., 2012b).

Implementing an ongoing program of prescribed burning places additional demands on land management agencies beyond those traditionally associated with fire suppression response. Prescribed burning requires detailed planning and lead times of up to 5 years may be required to integrate burning with other land management activities. Effective engagement with local communities is also essential during the planning, implementation and post-fire monitoring phases. The workforce required for prescribed burning may differ somewhat to that required for fire suppression alone. Prescribed burning requires personnel to be available during the milder spring and autumn months either side of the core summer fire season, and to have the flexibility to wait for a suitable window of burning conditions to arise. Experience, continuity of service and a sound practical understanding of fire behaviour are also attributes of particular importance in prescribed burning, and are vital in maintaining corporate knowledge and practical skills.

Prescribed burning brings with it the risk of escape and unintended consequences including damage to property and infrastructure, increased area burnt under conditions that may be outside the prescribed range, and loss of confidence by government and the community in the agency responsible for undertaking the burn. These consequences were highlighted in November 2011 by the escape of a prescribed burn at Margaret River in south-west Western Australia (Keelty, 2012), and internationally in March 2012 by the escaped North Fork prescribed burn in Colorado (State of Colorado, 2012). Serious as the consequences of these escapes have been, they must in the end be balanced against the risk of not intervening to manage fuels. Risks associated with prescribed burning can be minimised by good planning and operational practice, and there is considerable scope to further minimise risk by utilising emerging capabilities for weather forecasting and modelling dynamic interactions between fires and the atmosphere (Mills and McCaw, 2010; Peace et al., in press).

5. Conclusion

Prescribed fire is a valuable tool for managing fuels in eucalypt forests in southern Australia to mitigate the behaviour of high intensity bushfires. Evidence from a variety of sources including replicated field experiments, case studies of significant bushfires, and analyses of fire occurrence at the landscape scale demonstrates that prescribed burning can reduce fire behaviour and difficulty of suppression, and reduce the likelihood of crown fire for a period of at least 5 years following burning. Studies of the effectiveness of fuel reduction in mitigating fire behaviour and the impacts of bushfire on the community have tended to focus on relatively brief periods of extreme fire weather conditions (<10 h), which is understandable given the strong association between extreme conditions and loss of life and property. However, fuel reduced areas also contribute significantly to early containment of multiple fires, provide safe anchor points for fire containment, and increase the effectiveness of suppression operations. Prescribed burning reduces the severity of bushfire impacts on soil, vegetation and other environmental values, and is an important tool for achieving biodiversity conservation and environmental management objectives in eucalypt forests.

Acknowledgements

I wish to thank Rick Sneeuwjagt, Neil Burrows, Peter Keppel, Jim Gould, Phil Cheney and Kevin Tolhurst for sharing their insights into fire behaviour and prescribed burning in eucalypt forests over many years. I also thank the many people from CSIRO, the Department of Environment and Conservation (formerly Department of Conservation and Land Management) and other agencies who contributed to Project Vesta.

References

- Adams, M., Attiwill, P., 2011. *Burning Issues: Sustainability and Management of Australia's Forests*. CSIRO Publishing, Collingwood, Victoria.
- Australian Fire and Emergency Services Authorities Council, 2012. *Bushfire glossary*. <http://knowledgeweb.afac.com.au/data/bushfire_glossary/> (accessed 01.07.12).
- Allen, C.D., Macalady, A.K., Chenhouli, H., Bachelet, D., McDowell, N., Vennetier, M., Kitzberger, T., Rigling, A., Breshears, D., Hogg, E.H., Gonzalez, P., Fensham, R., Zhang, Z., Castro, J., Demigova, N., Lim, J.H., Allard, G., Running, S.W., Senock, S.W., Cobb, N., 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management* 259, 660–684. <http://dx.doi.org/10.1016/j.foreco.2008.09.001>.
- Blanchi, K., Lucas, C., Leonard, J., Finkel, K., 2010. Meteorological conditions and wildfire-related house loss in Australia. *International Journal of Wildland Fire* 19, 914–926. <http://dx.doi.org/10.1071/WF08175>.
- Boer, M.M., Sadler, R.J., Winkler, R.S., McCaw, W.J., Grierson, P.F., 2009. Long-term impacts of prescribed burning on regional extent and incidence of wildfires – evidence from 50 years of active fire management in SW Australian forests. *Forest Ecology and Management* 259, 132–142. <http://dx.doi.org/10.1016/j.foreco.2009.10.005>.
- Boland, D.J., Brooker, M.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A., McDonald, M.W., Turner, J.L., 2009. *Forest Types of Australia*, fifth ed. CSIRO Publishing, Collingwood, Australia.
- Bradstock, R.A., Price, O., 2010. Fire severity patterns in the Victorian bushfires of February 7th 2009: influences of weather, terrain and land use history. Report Prepared for the 2009 Victorian Bushfires Royal Commission (Exhibit 0723, document Identification EXP.025.001.0001).
- Bradstock, R.A., Hammit, K.A., Collins, L., Price, O., 2010. Effects of fire weather, fuel and terrain on fire severity in topographically diverse landscapes of south-eastern Australia. *Landscape Ecology* 25, 607–619.
- Bradstock, R.A., Cary, G.J., Davies, L., Lindenmayer, D.B., Price, O.F., Williams, R.J., 2012a. Wildfires, fuel treatment and risk mitigation in Australian eucalypt forests: insights from landscape-scale simulation. *Journal of Environmental Management* 105, 66–75. <http://dx.doi.org/10.1016/j.jenvman.2012.03.050>.
- Bradstock, R.A., Williams, R.J., Gill, A.M., 2012b. Future fire regimes of Australian ecosystems: new perspective on enduring questions of management. In: Bradstock, R., Gill, A.M., Williams, R. (Eds.), *Flammable Australia: Fire Regimes, Biodiversity and Ecosystems in a Changing World*. CSIRO Publishing, Collingwood, Victoria, pp. 307–324.
- Burrows, N.D., 1987. The soil dryness index for use in fire control in Western Australia. Department of Conservation and Land Management Technical Report No. 17.
- Burrows, N.D., 1997. Predicting canopy scorch height in Jarrah forests. *CALMScience* 2, 267–274.
- Burrows, N.D., 2008. Linking fire ecology and fire management in south-west Australian forest landscapes. *Forest Ecology and Management* 255, 2394–2406. <http://dx.doi.org/10.1016/j.foreco.2008.01.009>.
- Byram, G.M., 1959. *Forest fire behaviour*. In: Davis, K.P. (Ed.), *Forest Fire Control and Use*. McGraw-Hill, New York, pp. 61–89.
- Cesini, G., 2005. Effects of fire on properties of forest soils: a review. *Oecologia* 143, 1–10. <http://dx.doi.org/10.1007/s00442-004-1738-8>.
- Cheney, N.P., 1990. Quantifying bushfires. *Mathematical and Computer Modelling* 13, 9–15.
- Cheney, N.P., 2010. Fire behaviour during the Pickering Brook wildfire, January 2005 (Perth Hills Fires 71–80). *Conservation Science Western Australia* 7, 451–468.
- Cheney, N.P., Gould, J.S., McCaw, W.J., Anderson, W.R., 2012. Predicting fire behavior in dry eucalypt forest in southern Australia. *Forest Ecology and Management* 280, 126–131. <http://dx.doi.org/10.1016/j.foreco.2012.06.012>.
- Cook, E.R., Woodhouse, C.A., Eakin, C.M., Meko, D.M., Cleaveland, M.K., 2004. Long-term and dry changes in the western United States. *Science* 306, 1015–1018.
- Cruz, M.G., Sullivan, A.J., Gould, J.S., Sims, P.C., Bonner, A.J., Hollis, J.J., Hurley, B.J., 2012. Anatomy of a catastrophic wildfire: the Black Saturday Kilmore East fire in Victoria, Australia. *Forest Ecology and Management*. <http://dx.doi.org/10.1016/j.foreco.2012.02.035>.
- Doogan, M., 2008. The Canberra firestorm: inquests and inquiry into four deaths and four fires between 8 and 18 January 2003. Office of the Coroner, Canberra, Australian Capital Territory.
- Ellis, P.F., 2011. Fuelbed ignition potential and bark morphology explain the notoriety of the eucalypt messmate 'stringybark' for intense spotting. *International Journal of Wildland Fire* 20, 897–907. <http://dx.doi.org/10.1071/WF10052>.

- Ellis, S., Kanowski, P., Whelan, R., 2004. National Inquiry on bushfire mitigation and management. Commonwealth of Australia, Canberra.
- Esplin, B., Gill, A.M., Enright, N., 2003. Report of the Inquiry into the 2003–03 Victorian bushfires. State Government of Victoria, Melbourne.
- Fernandes, P.M., Botelho, H.S., 2003. A review of prescribed burning effectiveness in fire hazard reduction. *International Journal of Wildland Fire* 12, 117–128.
- Gergis, J., Gallant, A.J.E., Braganza, K., Karoly, D.J., Allen, K., Cullen, L., D'Arrigo, R., Goodwin, I., Grierson, P., McGregor, S., 2012. On the long-term context of the 1987–2009 'Big Dry' in South-Eastern Australia: insights from a 206-year multiproxy rainfall reconstruction. *Climatic Change* 111, 923–944. <http://dx.doi.org/10.1007/s10584-011-0263-x>.
- Gibbins, P., van Bommel, L., Gill, A.M., Cary, G.J., Driscoll, D.A., Bradstock, R.A., Knight, E., Moritz, M., Stephens, S.L., Lindennayer, D.B., 2012. Land management practices associated with house loss in wildfires. *PLoS One*, e29212. <http://dx.doi.org/10.1371/journal.pone.0029212>.
- Gill, A.M., 2012. Bushfires and biodiversity in southern Australian forests. In: Bradstock, R., Gill, A.M., Williams, R. (Eds.), *Flammable Australia – Fire Regimes, Biodiversity and Ecosystems in a Changing World*. CSIRO Publishing, Collingwood, Victoria, pp. 235–252.
- Gould, J.S., McCaw, W.L., Cheney, N.P., Ellis, P.F., Knight, L.K., Sullivan, A.L., 2007. Project Vesta. Fire in Dry Eucalypt Forest: fuel structure, fuel dynamics, and fire behaviour. Ensis-CSIRO, Canberra, ACT and Department of Environment and Conservation, Perth, WA, Australia.
- Gould, J.S., McCaw, W.L., Cheney, N.P., 2011. Quantifying fine fuel dynamics and structure in dry eucalypt forest (*Eucalyptus marginata*) in Western Australia for fire management. *Forest Ecology and Management* 252, 531–546. <http://dx.doi.org/10.1016/j.foreco.2011.04.022>.
- Victorian Government 2010. Making Victoria fire-ready: Implementing the Government's Response to the 2009 Victorian Bushfires Royal Commission. Department of Justice, Melbourne, Victoria.
- Hollis, J.J., Anderson, W.R., McCaw, W.L., Cruz, M.G., Burrows, N.D., Ward, R., Tolhurst, K.G., Gould, J.S., 2011a. The effects of fireline intensity on woody fuel consumption in southern Australian eucalypt forest fires. *Australian Forestry* 74, 81–90.
- Hollis, J.J., Matthiessen, S., Anderson, W.R., Cruz, M.G., Burrows, N.D., 2011b. Behind the flaming zone: predicting woody fuel consumption in eucalypt forest fires in southern Australia. *Forest Ecology and Management* 261, 2049–2067. <http://dx.doi.org/10.1016/j.foreco.2011.02.031>.
- House of Representatives, 2003. A Nation Charred: Report on the inquiry into bushfires. Parliament of Australia, Select Committee into the recent Australian bushfires, Canberra.
- Keeley, J.E., 2009. Fire intensity, fire severity and burn severity: a brief review and suggested usage. *International Journal of Wildland Fire* 18, 116–126. <http://dx.doi.org/10.1071/WF07049>.
- Keeley, M.J., 2011. A Shared Responsibility: The Report of the Perth Hills Bushfire February 2011 Review. Government of Western Australia, Perth.
- Keeley, M.J., 2012. Appraising the risk: Report of the Special Inquiry into the November 2011 Margaret River Bushfire. Government of Western Australia, Perth.
- Lomic, L.T., Gould, J.S., 1996. Aerial suppression of bushfires: cost-benefit study in Victoria. Division of Forest Research, National Bushfire Research Unit, CSIRO, Canberra, ACT.
- Lovich, C., 2004. Applying landscape principles to fire hazard reduction. *Forest Ecology and Management* 198, 261–267.
- Luke, R.H., McArthur, A.G., 1978. Bushfires in Australia. Australian Government Publishing Service, Canberra.
- Matthews, S., Gould, J., McCaw, W.L., 2010. Simple models for predicting dead fuel moisture in eucalyptus forest. *International Journal of Wildland Fire* 19, 459–467. <http://dx.doi.org/10.1071/WF09005>.
- McArthur, A.G., 1962. Control burning in eucalypt forest. Commonwealth of Australia Forestry and Timber Bureau, Canberra, ACT, Leaflet No. 80, Canberra.
- McArthur, A.G., 1967. Fire behaviour in eucalypt forest. Commonwealth of Australia Forestry and Timber Bureau, Canberra, ACT, Leaflet No. 107, Canberra.
- McCarthy, G.J., Tolhurst, K.G., 2001. Effectiveness of broadcast fuel reduction burning in assisting with wildfire control in parks and forests in Victoria. Department of Natural Resources and Environment Victoria, Research Report, No. 51, Melbourne.
- McCarthy, G.J., Flückiger, M.P., Gould, J.S., 2012. Analysis of the resourcing and containment of multiple remote fires: the Great Divide complex of fires, Victoria, December 2006. *Australian Forestry* 75, 54–63.
- McCaw, W.L., 2009. Report on the effect of fuel reduction burning on the behaviour and severity of the Victorian bushfires on 7 February 2009. Prepared for the 2009 Victorian Bushfires Royal Commission (Exhibit D/22, document Identification EXP/026.001.00011).
- McCaw, W.L., Cheney, N.P., Sneeijagt, R., 2003. Development of a scientific understanding of fire behaviour and use in south-west Western Australia. In: Abbott, I., Burrows, N. (Eds.), *Fire in ecosystems of south-west Western Australia: impacts and management*. Backhuys Publishers, Leiden, The Netherlands, pp. 171–187.
- McCaw, W.L., Gould, J.S., Cheney, N.P., 2008. Quantifying the effectiveness of fuel management in modifying wildfire behaviour. In: Fire, environment and society – from research to practice. 15th Conference of the Australasian Fire and Emergency Services Authorities Council, Adelaide.
- McCaw, W.L., Gould, J.S., Cheney, N.P., Ellis, P.F., Anderson, W.R., 2012. Changes in behaviour of fire in dry eucalypt forest as fuel increases with age. *Forest Ecology and Management* 271, 170–181. <http://dx.doi.org/10.1016/j.foreco.2012.02.003>.
- McLeod, R., 2003. Inquiry into the Operational Response to the January 2003 Bushfires in the ACT. ACT Government, Canberra.
- McLure, P., Bass, J.A., Pullin, J.A., 2012. Southern Properties (WA) Pty Ltd v Executive Director of the Department of Conservation and Land Management Western Australia Court of Appeal 79.
- Mills, G.A., McCaw, W.L., 2010. Atmospheric stability environments and fire weather in Australia – extending the Haines Index. Centre for Australian Weather and Climate Research, Technical Report No. 20.
- Murphy, J., 2010. Southern Properties (WA) Pty Ltd v Executive Director of the Department of Conservation and Land Management [No. 2] [2010]. Western Australian Supreme Court 45.
- Parliament of Victoria, 2008. Inquiry into the Impact of Public Land Management on Bushfires in Victoria. Report of the Victorian Parliament, Environment and Natural Resources Committee, Melbourne.
- Pausas, J.G., Ullrich, J., Rodrigo, A., Vallejo, R., 2008. Are wildfires a disaster in the Mediterranean basin? *International Journal of Wildland Fire* 17, 713–723. <http://dx.doi.org/10.1071/WF07151>.
- Peace, M., McCaw, W.L., Mills, G., in press. Meteorological dynamics in a fire environment: a case study of the Layman prescribed burn in Western Australia. *Australian Meteorological and Oceanographic Journal*.
- Peet, G.B., 1965. A fire danger rating and controlled burning guide for northern Jarrah forest of Western Australia. Forest Department Western Australia Bulletin No. 74, Perth.
- Plucinski, M.P., McCarthy, G.J., Hollis, J.J., Gould, J.S., 2012. The effect of aerial suppression on the containment times of Australian wildfires estimated by management personnel. *International Journal of Wildland Fire* 21, 219–229. <http://dx.doi.org/10.1071/WF11063>.
- Price, O.F., Bradstock, R.A., 2010. The effect of fuel age on the spread of fire in sclerophyll forest in the Sydney region of Australia. *International Journal of Wildland Fire* 19, 35–45. <http://dx.doi.org/10.1071/WF08167>.
- Price, O.F., Bradstock, R.A., 2011. The influence of weather and fuel management on the annual extent of unplanned fires in the Sydney region of Australia. *International Journal of Wildland Fire* 20, 142–153. <http://dx.doi.org/10.1071/WF10016>.
- Pyne, S.J., 1991. *Burning Bush. A Fire History of Australia*. Hecoy Holt and Company Inc., New York.
- Pyne, S.J., 1995. *World Fire – The Culture of Fire on Earth*. University of Washington Press.
- Pyne, S.J., 2003. Fire's lucky country. In: Abbott, I., Burrows, N. (Eds.), *Fire in ecosystems of south-west Western Australia: impacts and management*. Backhuys Publishers, Leiden, The Netherlands, pp. 1–8.
- Rawson, K., Billing, P., Duncan, S., 1983. The 1982–83 forest fires in Victoria. *Australian Forestry* 46, 163–172.
- Senate Select Committee on Agricultural and Related Industries, 2010. The incidence and severity of bushfires across Australia. Commonwealth of Australia, Canberra.
- Sneeijagt, R.J., 2008. Prescribed burning: how effective is it in the control of large bushfires? In: Fire, environment and society – from research to practice. 15th Conference of the Australasian Fire and Emergency Services Authorities Council, Adelaide, pp. 419–435.
- Specht, R.L., 1970. Vegetation. In: Leeper, G.W. (Ed.), *The Australian Environment*. CSIRO and Melbourne University Press, Melbourne, pp. 49–67.
- State of Colorado, 2012. Lower North Fork Prescribed Fire: Prescribed Fire Review. Office of the Executive Director, Department of Natural Resources, Denver, Colorado.
- Stephens, S.L., Ruth, L.W., 2005. Federal forest-fire policy in the United States. *Ecological Applications* 15, 532–542.
- Stephens, S.L., Adams, M.A., Handmer, J., Kearns, F.R., Lecker, L., Leonard, J., Moritz, M.A., 2009. Urban-wildland fires: how California and other regions of the US can learn from Australia. *Environmental Research Letter* 4, 014010.
- Sullivan, A.L., McCaw, W.L., Cruz, M.G., Matthews, S., Ellis, P.F., 2012. Fuel weather and fire behaviour in Australian ecosystems. In: Bradstock, R., Gill, A.M., Williams, R. (Eds.), *Flammable Australia – Fire Regimes, Biodiversity and Ecosystems in a Changing World*. CSIRO Publishing, Collingwood, Victoria, pp. 51–77.
- Syphard, A.D., Radeloff, V.C., Hansen, E.J., Stewart, S.I., 2009. Conversion threats due to human-caused increases in fire frequency in Mediterranean-climate ecosystems. *Conservation Biology* 23, 758–769.
- Teague, B., McLeod, R., Pascoe, S., 2009. Interim Report 2009, Victorian Bushfires Royal Commission. Parliament of Victoria, Australia.
- Teague, B., McLeod, R., Pascoe, S., 2010. Final Report 2009, Victorian Bushfires Royal Commission. Parliament of Victoria, Australia.
- Tolhurst, K.G., Cheney, N.P., 1999. Synopsis of the knowledge used in prescribed burning in Victoria. Department of Natural Resources and Environment, Victoria.
- Underwood, R.J., Sneeijagt, R.J., Styles, H.G., 1985. The contribution of prescribed fire to forest fire control in Western Australian eucalypt forests. In: Ford, J.R. (Ed.), *Symposium on Fire Ecology and Management in Western Australian Ecosystems*. WAT Environmental Studies Group, Report No. 14.
- van Ommen, T.D., Morgan, V., 2010. Showfall increases in coastal East Antarctica linked with southwest Western Australian drought. *Nature Geoscience* 3, 267–272. <http://dx.doi.org/10.1038/NGEO761>.
- Williams, J.T., 2013. Exploring the onset of high-impact mega-fires through a forest land management prism. *Forest Ecology and Management* 294, 4–10.

- Williams, J., Albright, U., Hoffman, A.A., Eritsov, A., Moore, P.F., De Mucals, J.C.M., Leonard, M., San Miguel-Ayanz, J., Xanthopoulos, G., Liervo, P., 2011. Findings and implications from a coarse-scale global assessment of recent selected mega-fires. Food and Agriculture Organisation, United Nations, Rome. 14p.
- Wotton, B.M., Gould, J.S., McCaw, W.L., Cheney, N.P., Taylor, S.W., 2012. Flame temperature and residence time of fires in dry eucalypt forest. *International Journal of Wildland Fire* 21, 270–281. <http://dx.doi.org/10.1071/WF10127>.

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PERSPECTIVES



ENVIRONMENTAL SCIENCE

Reform forest fire management

Agency incentives undermine policy effectiveness

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Globally, wildfire size, severity, and frequency have been increasing, as have related fatalities and taxpayer-funded firefighting costs (1). In most accessible forests, wildfire response prioritizes suppression because fires are easier and cheaper to contain when small (2). In the United States, for example, 98% of wildfires are suppressed before reaching 120 ha in size (3). But the 2% of wildfires that escape containment often burn under extreme weather conditions in fuel-loaded forests and account for 97% of fire-fighting costs and total area burned (3). Changing climate and decades of fuel accumulation make efforts to suppress every fire dangerous, expensive, and ill advised (4). These trends are attracting congressional scrutiny for a new approach to wildfire management (5). The recent release of the National Cohesive Wildland Fire Management Strategy

(NCWEMS) (6) and the U.S. Forest Service's (USFS's) current effort to revise national forest (NF) plans provide openings to incentivize change. Although we largely focus on the USFS, which incurs 70% of national firefighting costs (7), similar wildfire policies and needed management reforms are relevant throughout the United States and fire-prone areas worldwide.

Accumulated fuels in dry forests need to be reduced so that when fire occurs, rather than "crowning out" and killing most trees, it is more likely to burn along the surface at low-moderate intensity, consuming many small trees and restoring forest resilience to future drought and fire. Mechanical thinning can reduce tree density and some fuels but is often limited by legal (wilderness and park areas), operational (steep or remote ground), and cost constraints (8). Fire can also be used to reduce fuels either intentionally (prescribed burning) or opportunistically (letting a natural ignition burn as "managed wildfire") under moderate weather conditions. Although these burns are much less precise than

Many severe wildfires are due to past fire suppression. Firelighters during the Rim Fire near Yosemite National Park, California, 25 August 2013.

mechanical thinning, in remote locations, fire is usually more efficient, cost-effective, and ecologically beneficial than mechanical treatments (9).

ENTRENCHED DISINCENTIVES

Management reform in the United States has failed, not because of policy, but owing to lack of coordinated pressure sufficient to overcome entrenched agency disincentives to working with fire. Responding to established research, official agency policy now supports a more flexible response to fire than ever before (6). Actual wildfire response, however, has changed little because of substantial management impediments. Suppression generally begets larger, more intense wildfires, which in turn intensifies agencies' suppression response (10). The alternative, working with fire, is rarely used because of liability and casualty risks and little tolerance for management errors.

For example, during the most recent decade when data were collected (ending in 2008), only 0.4% of ignitions were allowed to burn as managed wildfires (7). For individual NFs, there is little economic incentive to change because fire suppression is steadfastly financed through dedicated congressional appropriations, which are augmented with emergency funding, whereas fuels reduction and prescribed burning costs come out of a limited budget allotted to each NF and is often borrowed to cover wildfire suppression costs. With these deterrents, "battling" fire and "only you can prevent wildfire" campaigns have more traction than recognizing that many severe fires result from accrued management decisions. This skewing of agency motivation also distorts economic, insurance, and local regulatory incentives that influence development in fire-prone regions (11).

Although agencies are slow to reform internally, they may more rapidly respond to local stakeholder pressure. The core problem has been the lack of a public constituency that advocates for reform of fire-use practices (11). The benefits of greater fire use have been a difficult sell because of public objections to smoke and a negative perception of forest fires. This has begun to change as communities increasingly threatened by large fires are urging land-management agencies to accelerate fuel reduction efforts, including the use of managed fire (e.g., yosemite Stanislaus Solutions.com and 4FRL.org). Timber companies would also benefit from more fire-resilient landscapes in which their private lands are embedded. There is growing awareness that large, severe fires are inevitable in many dry forests, especially in a warming climate. Smoke, safety threats, fire intensity, and human health risks can be better managed for public benefit with proactive fire use under favorable weather and wind dispersal conditions (12).

EFFECTING CHANGE. Public support for expanded fire use could thus be directed toward revision of each NF plan, which provides standards and guidelines for daily management decisions. Plans can divide the landscape into zones for different fire management strategies, an approach used by Parks Canada. U.S. forest plans could zone areas close to homes (wildland-urban interface) as an area where most fuels re-

duction relies on mechanical thinning and fires are suppressed. Beyond this could be an intermediate area where prescribed fire and mechanical treatment are used to optimize fuels reduction. More remote forests could be intentionally burned with prescribed fire, or lightning ignitions allowed to burn as managed wildfires under moderate weather conditions.

Three of the first eight NFAs to develop new plans have proposed that more than half of their area in the southern Sierra Nevada be zoned for prescribed and managed fire use. Over the next decade, most of the 155 NFs will begin writing new plans and holding public forums. Engaged local stakeholders will need to look beyond short-term impacts of fire use (e.g., smoke, limited access, and risk of escape) to support managers working with fire and challenge suppression in remote forest zones.

Public support of NCWFMS may help overcome reform disincentives by stressing national interagency collaboration. In response to decades of problem wildfires, the U.S. Congress passed the FLAME Act in 2009 requesting development of NCWFMS, a coordinated strategy to support landscape restoration and fire-adapted communities. Coordination is essential as large, intense wildfires often cross ownership boundaries. For example, in California's 2013 Rim Fire, large patches of old-growth trees in Yosemite National Park were killed when fuel-loaded forests on nearby NF land generated extreme fire behavior that crossed into the park (13). NCWFMS can exert peer pressure between agencies and provide support for tough decisions. To accomplish these changes, some policy and resource-deployment decisions supporting fire use could be made at the national level. In the United States, federal land agencies each fund their own fire crews but the National Interagency Fire Center (NIFC) coordinates resource deployment between agencies and nationally across geographic areas. Dedicated crews could be hired and trained for managed fire use, and NIFC could be charged with deploying them for beneficial burning (14). Some local and regional agencies have briefly created such crews, but they were often pulled into fire suppression when wildfire activity increased. By giving NIFC deployment authority, it could ensure that these crews are only used for working with fire and are available to burn when weather conditions are favorable. Optimal weather and smoke dispersal conditions occur even in heavily populated and regulated areas such as California, but many burn windows are missed because crews are at or being held for wildfire deployment (9). Air-quality regulations limit prescribed fires, although they have

much lower emissions than the inevitable wildfire. The Environmental Protection Agency could consider treating prescribed fire smoke like wildfire, as an unregulated "exceptional event."

National government also has an incentive to reduce wildfire expenses and forest agencies' emergency fire borrowing. In many years, suppression costs consume 50% of agency annual budgets, which, after operating expenses, leaves little money for proactive fuels treatment or forest restoration (11). Costs and injuries, however, are much lower on managed fires than on escaped wildfires (7, 15). The estimated cost savings for using managed fire compared with wildfire suppression over the same area (15) could be reported to Congress to highlight the economy of using proactive restoration rather than reactive triage.

Increased fire use will necessitate management changes (16). Mechanical fuels reduction could also be used not only for fire containment but also to establish safe-zone anchors to facilitate greater fire re-introduction (8). Large prescribed burns commonly used in Western Australia are possible because a network of these anchors allows 0 to 8% of the forest to be burned annually (16). Australian foresters make substantial efforts to educate the public about the inevitability of fire and its ecological benefits and to build support for fire use and smoke tolerance.

We will not eliminate wildfire, but public support for proactive use of managed fires can help restore millions of hectares of forest ecosystems. ■

REFERENCES

1. S. L. Stephens et al., *Front. Ecol. Environ.* 12, 115 (2014).
2. M. A. Finney, *For. Ecol. Manage.* 211, 97 (2005).
3. D. C. Calkin et al., *J. For.* 103, 179 (2005).
4. M. A. Moritz et al., *Nature* 515, 58 (2014).
5. Staff of Sen. M. Cantwell, "The Wildfire Management Act of 2015: A white paper" (Office of Sen. M. Cantwell, Washington, DC, 2015) (<http://lisa.gov/31du20>).
6. Forests and Rangelands, National Cohesive Wildland Fire Management Strategy (2014); <http://lisa.gov/IEDC/CCL>.
7. National Interagency Fire Center, Statistics (NIFC, Boise, ID, 2015); <http://lisa.gov/IN28024>.
8. M. North et al., *J. For.* 113, 40 (2015).
9. L. N. Quisenberry, J. M. Varner, *Int. J. Wildland Fire* 21, 210 (2012).
10. D. E. Calkin et al., *For. Ecol. Manage.* 29, 9 (2015).
11. K. Bradshaw, D. Lueck, *Wildfire Policy: Law and Economics Perspectives* (Routledge, London, 2012).
12. D. Schweitzer, R. Cisneros, *J. Environ. Manage.* 144, 265 (2014).
13. J. M. Lydersen, M. P. North, B. M. Collins, *For. Ecol. Manage.* 328, 326 (2014).
14. M. P. Dornbeck, J. E. Williams, *Can. J. Wood Conserv. Biol.* 13, 867 (2004).
15. G. Snider, P. J. Dougherty, *Can. J. For.* 104, 431 (2005).
16. R. J. Sheehy et al., *J. For. Ecol.* 9, 14 (2013).

ACKNOWLEDGMENTS

The content is solely the responsibility of the authors and does not necessarily represent the official views of the USFS.

10.1126/science.aab2136

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A review of prescribed burning effectiveness in fire hazard reduction

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Abstract. Wildfire hazard abatement is one of the major reasons to use prescribed burning. Computer simulation, case studies, and analysis of the fire regime in the presence of active prescribed burning programs in forest and shrubland generally indicate that this fuel management tool facilitates fire suppression efforts by reducing the intensity, size and damage of wildfires. However, the conclusions that can be drawn from the above approaches are limited, highlighting the need for more properly designed experiments addressing this question. Fuel accumulation rate frequently limits prescribed fire effectiveness to a short post-treatment period (2–4 years). Optimisation of the spatial pattern of fire application is critical but has been poorly addressed by research, and practical management guidelines are lacking to initiate this. Furthermore, adequate treatment efforts in terms of fire protection are constrained by operational, social and ecological issues. The best results of prescribed fire application are likely to be attained in heterogeneous landscapes and in climates where the likelihood of extreme weather conditions is low. Conclusive statements concerning the hazard-reduction potential of prescribed fire are not easily generalised, and will ultimately depend on the overall efficiency of the entire fire management process.

Additional keywords: fuel management; fire management; forest protection.

Introduction

Prescribed burning is the deliberate application of fire to forest fuels under specified conditions such that well-defined management goals are attained (Wade and Lunsford 1989). A wide spectrum of objectives can be accomplished by prescribed fire, including site preparation for tree regeneration, silvicultural improvements, range and wildlife habitat management, control of weeds, insects and diseases, and biodiversity maintenance (Kilgore and Curtis 1987; Wade and Lunsford 1989). It is the reduction of wildfire hazard in protecting forests, wildland resources and infrastructures at the urban interface, which ultimately affects human safety, that remains the main motivation for prescribed burning, in spite of its growing importance as an ecosystem management tool (Haines *et al.* 1998).

The rationale for hazard-reduction burning is clear-cut. Once a fire is ignited, its behaviour is determined by weather, topography and fuels, but management actions to mitigate its negative consequences are restricted to fuels. Current fire fighting technology fails when faced with multiple-fire events, and is not able to cope with wildfires burning under severe weather conditions. According to the review of Hirsch and Martell (1996), it is generally accepted that the suppression capability of ground forces has an upper fireline intensity limit of 3000–4000 kW m⁻¹, and that fire fighting actions are futile beyond 10 000 kW m⁻¹.

Fire intensity is essentially a function of rate of fire spread and the amount of available fuel for combustion (Byram 1959). Prescribed fire decreases the intensity of a subsequent wildfire primarily by reducing fuel loads, especially of the finer elements in the more aerated fuel layers that govern fire spread (Rothermel 1972), but also by disrupting the horizontal and vertical continuity of the fuel complex. Fuel modification from a prescribed-burning treatment is expected to improve directly the probability of successful fire control by reducing fire intensity. In ecosystems where high-intensity fire is not acceptable, the routine use of prescribed fire should change the wildfire regime such that it will be characterised by smaller and less severe fires from both the ecological and economic perspective.

Relationships between fuel accumulation and wildfire activity have been reported in Europe, for both the Mediterranean basin (Rego 1991) and the boreal forest (Schimmel and Granström 1997). Logical reasoning, model simulation and observation all indicate that fire exclusion from the conifer ecosystems of the western USA has led to unnatural fuel accumulations conducive to uncontrollable and highly-damaging wildfires (Van Wagtendonk 1985; Arno and Brown 1989; Keane *et al.* 1990; Brown *et al.* 1994). The so-called fuel/age paradigm (Zedler and Seiger 2000) states that previous fire history controls the spatial pattern of fires in vegetation types with a time-dependent, fuel-driven,

non-random fire regime. For example, fire size in California chaparral is limited by fuel age patchiness (Minnich 1983; Minnich and Chou 1997), and fuel contiguity influences the spatial distribution of fire (Chou *et al.* 1990). Natural prescribed fire programs in conifer forests of the Yellowstone (Sweeney 1985) and Yosemite (van Wageningen 1995) National Parks have generated fuel mosaics where previous fires act as effective containment lines. Similar patterns occur naturally in the boreal forest of Canada (Amiro *et al.* 2001).

The efficiency of prescribed fire in reducing wildfire hazard is frequently mentioned as a matter of fact, but the basic premise is seldom questioned. However, uncertainty about the protective advantages brought by prescribed burning has been identified by fire managers as an obstacle, albeit minor, to expansion of its use (Haines *et al.* 2001). The meaningful quantification of the impact of fuels on fire regimes is regarded by Schimoldt *et al.* (1999) as a major research priority. Even though fuel effects are accounted for by current fire behaviour models used in fire management applications, proper quantification of such effects has not been attempted for high-intensity fires burning under extreme weather conditions (Cheney 1996).

Fuel breaks, whose efficiency has been discussed by Agos *et al.* (2000), and prescribed fire are part of complementary strategies, aiming respectively at wildfire containment by fuel isolation and fire behaviour modification by fuel reduction (Pyne *et al.* 1996). It is the purpose of this paper to analyse, as objectively as possible, the premise that prescribed fire is a valuable tool for forest protection and wildfire mitigation, on the basis of a literature review covering different vegetation types and fire environments from North America, Australia and Europe. The economic aspects of prescribed burning have been reviewed by Hesselin (2000) and will not be addressed here.

Fuel reduction assessment at the management level

The effectiveness of prescribed burning at the management level can be determined by effective monitoring, where a systematic process of data collection is used to establish a basis to evaluate and adjust the practice (Van Wageningen *et al.* 1982). Evaluation by fire management agencies of the effectiveness of prescribed fire in hazard reduction generally concentrates on its effect on fuels. Burning plans usually specify how much and what categories of fuels should be removed, which requires pre- and post-burn assessments.

Several alternative methods can be used to determine pre-burn fuel quantities, including the assignment of standard (Anderson 1982) or custom (e.g. Fernandes and Pereira 1993) fuel models, photo series illustrating known fuel loads (e.g. Weise *et al.* 1997) or fuel hazard classifications (McCarthy *et al.* 1998) that are compared with the current fuel situation being monitored in the field. Indirect procedures to estimate fuel loads resort to descriptors such as vegetation height,

cover and litter depth (e.g. Sneeuwjagt 1973; Armand *et al.* 1993; Finney and Martin 1993), which are frequently measured using line intercept sampling techniques (Van Wagner 1968; Brown 1974). Direct evaluation by destructive sampling methods (e.g. Brown *et al.* 1982) is seldom used by fire managers.

Fuel consumption achievement by hazard-reduction burning can be described or quantified by destructive sampling of the remaining fuel, visual estimates (usually expressed as a percentage of the pre-burn loading), specific photos series for fuel reduction (Scholl and Waldrop 1999), or measurement of post-burn variables such as charred surface percentage, depth of burn, diameter reduction of large woody fuels, and diameter of the remaining shrubs and twigs. Depth of burn, widely used in Canada (e.g. McRae *et al.* 1979), is especially relevant when the forest floor is predominant in the fuel complex. Ryan and Noste (1985) conceived a practical and broadly applicable method using flame length and char depth classes to assess prescribed fire severity that can be used to qualify forest floor consumption. Prescribed fire users in France and Portugal are simultaneously asked for quantitative and qualitative evaluations of fuel consumption during the monitoring process of the practice (Rigolot and Gaulier 2000).

Few examples exist where quantitative information on fuel reduction is translated into classifications of effectiveness, probably because of the natural variability in fuel conditions. In *Eucalyptus* woodland in the Blue Mountains of south-eastern Australia, James (1999) considers that a burn is effective when fine fuel reduction surpasses 50% of the pre-burn quantity and proposes a methodology based on visual estimates of both reduced and created fuel to verify if fuel management objectives are met. Buckley and Corkish (1991) also propose a visual method of rating fuel reduction in thinning slash of *Eucalyptus sieberi* (Table 1). More objective classifications of fuel reduction effectiveness based on post-burn fuel information are feasible and can be developed with the aid of fire behaviour simulators (see next section).

Fuel consumption by prescribed fire is weather dependent, introducing an additional element of variability into the outcomes of fuel management (Omi and Kalabokidis 1998). For example, even though the average surface fuels reduction during an experimental burning program in *Pinus pinaster*

Table 1. Classification of prescribed fire effectiveness based on visual estimates of fine fuel reduction percentages. Adapted from Buckley and Corkish (1991)

Effectiveness class	Reduction (%)		
	Litter	Slash	Shrub
Very good	>50	>75	>75
Good	25-50	>75	25-75
Fair	<25	25-75	<25
Poor	Unburned	<25	Unburned

stands was 90%, a variation of 9–100% was observed between fires (Fernandes *et al.* 2000a). Proper prescribed burning planning can optimise fuel reduction through the use of predictive models that use fuel moisture content and pre-burn fuel loading as inputs (e.g. McRae 1980; Sandberg 1980; Harrington 1987; Brown *et al.* 1991). However, variability in fuel consumption within a site is unavoidable and can be large (e.g. Robichaud and Miller 1999), which means the burn goal may not be achieved in some areas of the overall burn.

Fire managers should also appraise fuel reduction based on area treated, especially when aerial ignition is used to apply fire across a large landscape. According to Wade and Lunsford (1989), it is sufficient to have fuels reduced on 75–80% of a given area, while Wilson (1992) indicates a range from 50% to 90%, depending on fire protection priorities. The target for hazard reduction in Tasmanian moorland is a 70% fuel consumption over 70% of the area being treated (Marsden-Smedley *et al.* 1999).

Computer simulation of prescribed fire effectiveness

The changes induced on the fuel complex structure by a fuel treatment are measurable, and can be quantified in terms of changes in fire behaviour by computer simulation. The BEHAVE fire behaviour prediction system (Andrews 1986) based upon the spread model of Rothermel (1972) is frequently used to predict and compare fuel treatment effects on potential fire hazard, using customised fuel modelling (Burgan and Rothermel 1984) to emulate the modifications undergone by the fuel complex. Users of this approach should be aware of the subjectivity in quantifying post-burn shrub and downed woody fuels depths for the purpose of building a fuel model.

Anderson and Brown (1987) characterise fire behaviour in managed (not specifying the method of treatment) and untreated fuels of common western United States vegetation types. Their BEHAVE simulations for extreme fire weather show post-treatment reductions in fireline intensity between 80% and 96%. Similar figures in the range 80–98% were obtained for southern European pine stands after experimental prescribed fires (Rego *et al.* 1987; Vega *et al.* 1994; Fernandes *et al.* 2000b). When evaluating an actual prescribed fire management program, Fernandes *et al.* (1999) found an average fireline intensity reduction of 98% of the pre-treatment values, allowing wildfire suppression to be undertaken by direct attack with hand tools (Andrews and Rothermel 1982). However, the estimated decrease in fire behaviour can be as low as 10% (Omi and Kalabokidis 1998) due to insufficient impact on the fuel complex because of excessive fuel moisture. These previous results concern the immediate effects of prescribed fire. However, the effect of time since burning can be simulated by dynamic fuel models. For example, in the pine forests found on Florida's coastal plain, difficulty of wildfire control would be moderate to high 5 years after treatment (Brose and Wade 2002).

Empirical Australian models and guides for fire spread in eucalypt forest, derived from experimental fires under relatively mild weather, use a directly proportional relationship between rate of fire spread and fuel load (McArthur 1962, 1967; Sneeuwjagi and Peet 1985). Consequently, they predict that a 50% reduction in fuel load will halve the rate of spread but reduce fireline intensity fourfold.

The benefits of extending the simulations from the plot/stand scale to a landscape scale are obvious. Outputs from the BEHAVE system, combined with crown-fire initiation thresholds, indicate significant decreases in fire hazard at both the stand and landscape levels from the joint application of prescribed fire and thinning in late-successional forests of the north-western United States (Wilson and Baker 1998).

The association of GIS technology with fire behaviour models makes detailed predictions possible at the landscape level. FARSITE (Finney 1998) is a spatial fire growth model that integrates spatial (fuels and topography) and temporal (weather, fuel moisture) data, allowing analysis of the implications of fuel changes under specified ignition and weather scenarios.

Van Wageningen (1996) used FARSITE to examine fire behaviour modifications due to fuel-breaks and alternative management practices of surface fuels and crown-fuels in the Sierra Nevada of California. Prescribed fire was the most effective technique, and under severe weather conditions reduced the average fireline intensity of a wildfire by 76% and its burned area by 37%, avoiding manifestations of severe fire behaviour. Stephens (1998) compared the effects of 12 different fuel and silvicultural treatments using FARSITE where prescribed burning alone, or in combination with thinning, was the most effective method to reduce fireline intensity.

The most complete example of FARSITE capabilities comes from Finney *et al.* (in press). Two scenarios were tested: no-treatment, and a combination of prescribed burning with tree pruning and thinning. Fire fighting effectiveness was simulated for both cases, and their fire suppression, fuel management, property damage and post-burn rehabilitation costs were estimated. According to the simulation, fuel management did slow fire growth and allowed for quicker fire containment. Estimated costs and net value change of the no-treatment option were estimated to be seven times higher.

Any fire behaviour simulation should consider the effect of prescribed fire that leads to a decrease in wildfire intensity, and consequently to easier suppression and less damage. The passive effect of prescribed burning on wildfire propagation, which assumes that the fuel complex becomes non-flammable, thus preventing fire ignition and spread, can also be explored. After formulation by Gill and Bradstock (1998), this approach has been attempted by Bradstock *et al.* (1998a) on a simulated landscape, relying on a simple spatial model based on percolation theory. The authors conclude that prescribed burning diminishes the average size of wildfires burning during extreme weather conditions only when the

rates of wildfire occurrence are low, and stress the importance of preventing ignitions.

Observed effects of prescribed burning on wildfire behaviour, severity and suppression

Well-documented case studies concerning the fate of wildfires that run into fuel managed areas are useful to fulfil the objectives of this review. A number of examples are available and testify to both the virtues and limitations of hazard-reduction burning.

Tree damage resulting from wildfire occurrence is one of the most used descriptors of the prescribed fire effect. Reductions in tree mortality and crown scorch have been found for *Pinus ponderosa* stands that were treated by prescribed burning 1 year (Wagle and Eakle 1979), 5 years (Pollet and Omi 2002) and 6 years (Martin *et al.* 1988) before the wildfire, when compared with adjacent untreated stands. Weatherapoon and Skinner (1995) showed the importance of previous stand conditions, and indirectly, fuel management activities in the reduction of tree crown injury after extensive wildfires in California conifer forests: all stands with untreated fuels were severely damaged.

Wildfires burning under extreme drought conditions swept across 10 000 ha of the Osceola National Forest in Florida, despite the existence of a regular prescribed fire program (Outcalt and Wade 2000). Nevertheless, pine mortality in recently burned areas (up to 1.5 years) was restricted to 15% in natural stands and 5% in plantations, while it reached 44% and 52% in the same stands, respectively with a fuel age of 2 years or more.

California chaparral burned sites of 12–20 ha in size were successful in containing 11 wildfires at temperatures above 32°C, relative humidities below 20%, and wind speeds higher than 30 km h⁻¹ (Franklin 1988). Regelbrugge (2000) also described how a prescribed burned area in chaparral contributed in protecting a community from wildfire in a wildland–urban interface.

The south-east of Australia provides several examples of the prescribed burning effects on wildfires. McArthur *et al.* (1966) describe how a scrub area burned 1 year before hindered a fire from entering a pine plantation. Four case studies of wildfires burning under conditions of very high fire danger in *Eucalyptus* forest and heathland show that fuel reduction burns up to 10 years old can still influence fire behaviour, even if the best results occurred within 2 years after the treatment (Grant and Wouters 1993). Five case studies are reported by Billing (1981) where property losses were avoided or fire-line intensity was diminished, thus making direct fire fighting attack possible. Rawson *et al.* (1985) found evidence of wildfires stopped or slowed by previous prescribed fires, improved fire control operations due to the existence of fuel-reduced areas, effective protection of assets, and less overall demand for fire fighting resources. These benefits extended through 5 years after the treatments.

McCarthy and Tolhurst (2001) present an in-depth assessment of the effectiveness of fuel reduction burning in public land across the state of Victoria in Australia. Suppression of 11% of the wildfires occurring in 1990–1997 was positively affected by the practice, with fuel hazard level (or time since last burn) and fire danger index being critical regarding the probability of a previous prescribed burn slowing a head-fire. Obvious effects in wildfire propagation were observed in areas treated no more than 2–4 years before, but the assistance to fire suppression generally ceased after 10 years. Fire spread delays for a given fuel hazard level are also increasingly less likely as fire weather becomes more severe.

Valuable assistance to fire control is attributed to prescribed fire during the less severe phases (estimated fireline intensity in the 1000–7000 kW m⁻¹ range) of the extensive Dwellingup fire of 1961 in the *Eucalyptus marginata* forest of south-western Australia (Peet and Williamson 1968). During the major run of the same fire, with a fireline intensity in excess of 15 000 kW m⁻¹ (Peet and Williamson 1968), the fire dramatically changed its behaviour and did not affect the tree crowns as it crossed an area that was burned 2 years before (McArthur 1962). Underwood *et al.* (1985) describe nine selected wildfires in south western Australia whose direct attack was not possible or failed, but that were only controlled after entering areas treated up to 4 years before. Previous prescribed fires affected the outcomes of a wildfire in a *Pinus pinaster* plantation in the same region (Burrows *et al.* 2000): intensity, difficulty of control, and tree damage were higher where fuel loading was greater. McCaw *et al.* (1992) report extensive fire propagation in 5-year-old shrubland in south-western Australia under conditions of extreme fire weather that generated fire intensities estimated at 20 000–40 000 kW m⁻¹; a delay in fire spread and actual vegetation patches remaining unburned were observed in 5-year-old fuels, but not in fuels older than 8 years.

In Europe, where prescribed fire programs are more recent and localised, available information is scarce. In *Pinus pinaster* stands in Portugal, Silva (1997) describes how three wildfires were affected by burned buffer zones established in the previous winter. Fire behaviour was visibly reduced by the treatments, allowing easy containment in one of the cases. Observations by the authors in *Pinus pinaster* stands in Portugal where prescribed fire had been carried out 4 years before include a stand-replacement fire that was turned into a non-lethal surface fire, and a crown fire that went through a pole-sized stand without any noticeable reduction of intensity.

Some well-documented case studies are available for southern France. Rigolot (1997) provides six examples of wildfires in the eastern Pyrenees that ran into shrubland areas that were prescribed burned between 1 month and 7 years before; the efficiency of the treatment was variable and seemed to be affected by wind speed, size of the wildfire, and available suppression forces. Lambert *et al.* (1999) assessed the efficiency of fuel-breaks, including those maintained by

periodic burning in combination with grazing or mechanical treatments. The authors reported 10–100-fold reductions in fireline intensity for a wildfire crossing a fuel-break, and indicated a fuel loading of 1 t ha^{-1} as the upper threshold where a wildfire under extreme weather conditions (including wind speeds up to 90 km h^{-1}) will not be stopped by a fuel-break in the absence of suppression.

Effects of fuel reduction on the wildfire regime

Fire regime can be defined as the nature and severity of fire occurring over long periods (Brown 2000). The available examples relate essentially to the effects of prescribed fire on the size component of the fire regime, and come from parts of the United States and Australia with extended prescribed burning programs. Wright and Bailey (1982) refer to studies by several authors indicating reductions in the area burned by wildfires in the *Pinus ponderosa* forests of the western United States as a result of prescribed burning programs. Fires occurring in fuel-reduced areas also tend to be smaller, less damaging to trees, and lower in fire suppression expenditures.

Davis and Cooper (1963) found that the number, but especially the size, of wildfires in the coastal plains of the south-eastern United States increased with time since the last hazard-reduction burn: 7% of the total forested area with fuels older than 5 years burned each year, in contrast to a figure of 0.1% where fuel accumulation time had not reached 5 years. The effect of prescribed burning within the same region has been analysed by comparing wildfire activity in treated and non-treated areas (Martin 1988, cited by Koehler 1993). 91.3% of the area burned by wildfires larger than 40 ha occurred where prescribed fire had not been used during the previous 3 years, while the average size of a wildfire was 8.5 ha in areas treated within the last 3 years and increased to 25.2 ha in untreated areas. An estimate was made that prescribed burning saved more than 4500 ha of forest and decreased fireline intensity on 2385 ha.

Koehler (1993) analysed fire statistics in a portion of central Florida from 1981 to 1990. He concluded that prescribed fire programs that have been active for a sufficient time are reflected in less and smaller wildfires on average. Data also showed minor fluctuations in wildfire acreage from year to year, suggesting that prescribed fire attenuates the behaviour of subsequent fires that might occur under severe fire weather.

Mercer *et al.* (2000) examined the relationship between wildfire activity in counties of Florida during the particularly severe year of 1998 and the number of burn permits, a surrogate for prescribed fire activity. In contradiction with the above-mentioned studies, little statistical evidence was obtained that prescribed fire reduces wildfire area. Smaller and less numerous burn operations were associated to the occurrence of larger wildfires, but the authors have considered such result not conclusive, since a lower number of prescribed fire permits may be issued in severe wildfire years.

The results were even less demonstrative of a prescribed fire effect when the approach was extended to the 1995–1999 period by Prestemon *et al.* (2002), who question the adequacy of the permits to describe the amount of prescribed burning and suggest a finer spatial scale of analysis.

According to Cheney (1996), prescribed fire has been so effective in reducing the wildfire threat to some regions of Australia that local inhabitants have developed a false sense of security. More than 90% of the wildfires in south-western Australia remain below 10 ha and large fires occur only under extreme weather situations. As a consequence of the emphasis that has been put in the prescribed burning practice since the early 1960s, most large wildfires occurred where the use of prescribed fire is less substantial (Sneeuwagt 1994). A valid counter argument is that the two first-mentioned effects can be affected by efficient fire suppression resources, since early detection and rapid initial attack are common features of the fire management strategy in western Australia (Underwood *et al.* 1985).

In the opinion of Meredith (1996), prescribed fire is more effective in south-western than in south-eastern Australia. Nevertheless, the statistics for southern New South Wales in the period 1980–1992 are also favourable (Good 1996): the average size of a wildfire burning in treated areas with less than 3 years was 302 ha, against 584 ha outside treated areas, and only 15% of the wildfires occurring on prescribed fire areas had grown to more than 50 ha.

Limitations and constraints to prescribed fire effectiveness

Weather and fuel considerations

The previously mentioned study by McCarthy and Tolhurst (2001) is expressive of the limitations that extreme fire weather and fuel re-accumulation impose on the effectiveness of a prescribed burn program. A very small percentage of the total number of all wildfires accounts for the majority of the burned area (Strauss *et al.* 1989) and those fires are driven by synoptic-scale weather patterns (Schimoldt *et al.* 1999). Jasper (1999) states that 95% of the fires that destroyed property occurred on days when the fire danger was very high or extreme. Prescribed fire impacts the behaviour and effects of large wildfires, but it is unlikely that the fuel effect will override extreme weather conditions to the extent of actually inhibiting fire spread. However, the critical importance of weather can be easily underestimated when the emphasis of management is placed on fuel modification (Bradstock *et al.* 1998a).

Simulations of surface fireline intensity and crown fire initiation in western Canadian subalpine forests have attributed a relatively minor role to fuel in comparison to weather (Bessie and Johnson 1995). On the contrary, simulations for boreal mixedwood forest of eastern Canada, where weather is generally more moist and vegetation variability among stands is

high, show that fuels are the driving force in fire behaviour (Hély *et al.* 2001). In opposition to a well-established belief (e.g. Rothermel and Philpot 1973; Sapsis and Martin 1994), it has been shown that large chaparral fires in southern California do not depend on the availability of old fuels for their propagation (Dunn 1989; Keeley *et al.* 1999) nor are they stopped by a landscape mosaic of different fuel ages (Zedler and Seiger 2000; Keeley and Fotheringham 2001). Similarly to chaparral, most subalpine (Bessie and Johnson 1995) and boreal forests (Johnson *et al.* 2001) in Canada are closed-canopied vegetation types characterised by a fire regime of large and inevitable stand-replacing crown fires induced by the vertical and horizontal fuel continuity and triggered by dry periods.

The previous paragraph leads to the conclusion that the fuel/age paradigm is a simplification, and that the hazard-reduction effectiveness of prescription burning will vary by ecosystem (or fuel type) and according to the relative impacts of fuels and weather on fire behaviour. Because fire behaviour increases in a non-linear fashion with the decrease of fuel moisture and the increase of wind speed, which additionally vary in a much wider range than fuel properties, the influence of these factors on fire behaviour will increasingly prevail over the effect of fuel characteristics in more severe weather scenarios. Prescribed burning will be less effective in regions that have higher likelihood of experiencing strong winds during drought periods, because such combination is conducive to extreme fire events in intensity and extension (Schmoldt *et al.* 1999).

Longevity of the prescribed fire effect is conditioned by the intrinsic nature of vegetation, sooner or later, regaining its former fuel loading and structure. Fuel dynamics knowledge is used to define the prescribed fire return interval and the burning effort required to reach a management objective (e.g. to maintain fuel loads below a given hazard threshold). However, post-treatment recovery can be so fast that fuel management may be futile or even counter-productive in some vegetation types (e.g. Fensham 1992). Fuel dynamics can be exacerbated by a number of factors, namely the amount of remaining fuel and newly created fuel (i.e. conversion of live vegetation to dead fuel, post-burn litter fall), changes in vegetation composition such that it becomes more flammable (e.g. invasion by grass or weed species), and post-burn reduction of the decomposition rate.

Litter hazard is commonly re-established within 2–5 years after prescribed fire (Sackett 1975; Van Wageningen and Sydoriak 1987; Fensham 1992). Nevertheless, the overall benefits of prescribed burning, namely in avoiding crown fire or substantially reducing the potential for its occurrence, should persist for longer periods, since the understory vegetation layer build-ups at a lower rate. Reduction in the amount of fibrous loose bark is important in some *Eucalyptus* species to preclude the development of crown fires and reduce airborne firebrands lofted ahead of the fire front (McArthur 1967);

the effects of prescribed fire on this fuel component can be of long duration (Tolhurst *et al.* 1992).

Fireline intensity will undoubtedly be decreased by prescribed burning compared to a no-treatment scenario so long as fuel loads remain below the pre-treatment values. However, early claims that rate of spread increases with fuel load (e.g. McArthur 1962), are not supported by more recent studies (Gould 1991; Cheney *et al.* 1993; McAlpine 1995; Burrows 1999), which points to a short-lived effect of prescribed burning on this fire parameter, probably disappearing as soon as the fuel complex regains its pre-burn structure. Experimental studies (Cheney *et al.* 1998) designed to clarify the effect of time since last fire and fuel loading on fire behaviour under an extended range of burning conditions are being undertaken in dry eucalypt forest in south-western Australia.

Spatial considerations

The size, shape and spatial arrangement of the treatment units, including their location in relation to fuel breaks (Agee *et al.* 2000), can strongly affect the efficiency of the prescribed fire treatment at the landscape scale. The hazard reduction effect brought by discrete fuel treatments to specific stands may be too small and/or too fragmented to have any impact on large fires (Omi and Kalabokidis 1998).

The spatial pattern of hazard reduction burning can be quite varied, comprising treatments dispersed in the landscape, extensive application to large areas, or strategic and more intensive use in order to link or expand discontinuities such as fuel breaks and non-flammable areas. In the western United States (Finney 2002) and in Canada (McRae and Flannigan 1990), prescribed fire is commonly applied in units of 100s to 1000s of hectares. Maximum size of the burn units can reach 8000 ha in Australian eucalypt forest (Grant and Wouters 1993), 300 ha in southern France shrubland (Rigolot 1997), or 30 ha in pine stands of Portugal (Fernandes *et al.* 1999).

The hazard-reduction advantages of large-scale prescribed burning are not proven and some authors are of the opinion that burning in strategic small areas creates more effective barriers because the percentage of area burned is higher and the amount of residual fuel is lower (Grant and Wouters 1993; Rawson *et al.* 1985). For vegetation types dominated by crown-fire regimes, Keeley (2002) suggests intensively managed buffer zones (including prescribed burned areas) in strategic locations, especially in the wildland-urban interface. However, in fuel types prone to long-distance spotting, the benefits of prescribed fire on a broad area basis are apparent: sufficiently large treatment units will provide landing spots for most firebrands, reducing their ignition potential and the likelihood of developing into intense fire fronts, as well as reducing production and lofting of firebrands when the main fire front actually propagates in the treated area. Simulations with FARSITE suggest that disperse and small treated areas are preferable to network-type treatments,

because shorter distances will result between individual fuel-reduced areas thus limiting wildfire growth more effectively (Finney *et al.* 1997). According to Loureiro *et al.* (2000), maximum landscape fragmentation (a surrogate for fuel discontinuity) is achieved by a compromise between the number and the size of prescribed fire units.

Selection of treatment areas currently relies on combined functions of several factors, such as values at risk, ignition potential, suppression capability and fire behaviour potential (Sneeuwjagt 1998). Other constraints are listed in the next section. According to Finney (2001), such approaches will likely originate arbitrary or random spatial patterns with a poor influence on wildfire growth. Based on fire shape and relative fire spread in treated and untreated areas, Finney (2001) gives a set of equations to optimise the width and length of a rectangular treatment unit such that it maximises the delay in the propagation of a wildfire. After extending the same reasoning to a landscape level, the author concludes that feasible and effective spatial arrangements of prescribed burning should result in treatment units that partially overlap in the direction of fire spread. A promising automated method to optimise fuel treatment patterns in real landscapes is under development (Finney 2002).

Operational, social and ecological constraints

Prescribed burning programs are strongly constrained by a number of factors, including inadequate funding. Bradstock *et al.* (1998b) mentions other constraints such as suitable weather for burning, and favourable landscape in terms of topography and vegetation continuity. Meredith (1996) stresses the importance of environmental heterogeneity and gives the example of western versus eastern Australia: drier and more predictable weather, milder topography, and relatively uniform forests in south-western Australia allow larger, safer, and more effective burns that can be conducted more times per year. Liability risks and the necessity to comply with environmental protection, smoke management and air quality regulations are nowadays an important restriction to prescribed fire activity in both the United States (Haines *et al.* 1998, 2001) and Australia (Underwood and Sneeuwjagt 1993).

The opportunities to carry out prescribed burning operations are greatly reduced by the above-mentioned restrictions, and thus can compromise hazard minimisation in fire-prone regions. For example, in the urban-wildland interface of Sydney, Australia, 27% of the area would require annual treatment if probability levels of uncontrollable fire were to be reduced to 10 days per year (Bradstock *et al.* 1998b). The number of available days for burning is quite variable from year to year (e.g. Gill *et al.* 1987); it can be increased by broadening the prescription to hotter and drier conditions, but several problems may arise, including higher probabilities of escaped fires and property damage. According to

a survey conducted in western United States, weather is by far (39% of the respondents) the most important reason for cancelling prescribed fires, followed by smoke management and air pollution concerns (18%) (Barrett *et al.* 2000).

Prescribed fire planning often gives ecological considerations a secondary role, and the consequence is that fire managers can assume a successful fuel reduction operation as a burn that fulfills ecosystem management goals (Bennett and Kunzmann 1992). Conflicts between hazard-reduction burning and conservation values should be negligible in ecosystems with a recurrent history of low-intensity surface fires (e.g. Haase and Sackett 1998; Sackett and Haase 1998; Ward 1998; Barnett 1999), but not where a natural fire regime characterised by high-intensity fire is replaced by more frequent, smaller and less severe fires (Whelan and Muston 1991). Given the absence or scarcity of results from long-term studies on the ecological effects of prescribed fire regimes, methodologies based on biological indicators have been proposed to reconcile protection and conservation objectives (Gill and Bradstock 1994; Burrows and Friend 1998; Gill and McCarthy 1998), but such compromise is not always possible (e.g. Morrison *et al.* 1996; Bradstock *et al.* 1998c).

Conclusion

The hazard reduction benefits of prescribed fire are easily demonstrated by fire behaviour theory, through observation and measurement of post-treatment fuel changes in experimental or operational burns, and by computer simulation at the plot, stand, and landscape levels. Despite their limitations, the existing fire behaviour models, linked with fire effects and fuel dynamics models, provide a useful framework to predict and evaluate the outcomes of fuel management strategies, select alternative treatment methods, and plan the fuel treatments in time and space.

The operational effectiveness of prescribed fire inferred from case studies is largely anecdotal, and most of the examples of success that are available refer to recently (up to 4 years) treated areas. A wildfire is an unplanned event, which implies uncertainties regarding fuel characteristics, weather and fire behaviour, as well as the existence of interactive effects. Analysis of hazard reduction effectiveness based on well-documented case studies of wildfire behaviour, severity and suppression difficulty as modified by burned areas is thus limited in the conclusions that can be drawn. This stresses the need for replicated studies of high-intensity fire behaviour in field experiments.

Analysis of modifications in the fire regime induced by prescribed burning are currently the best way to evaluate the practice, even if they do not allow direct statistical confirmation. Positive changes brought by long-term prescribed fire programs are undeniable, but it is quite difficult, if not impossible, to isolate the protective effect of the treatment from the whole fire management process.

The amount of land that can be subjected to prescribed fire is greatly restricted by several operational and ecological issues, thus making a fire management approach difficult based solely or predominantly on prescribed burning. The higher incidences of unwanted ignitions are associated with areas where human pressure and residential development are also high, posing additional social constraints and operational difficulties on the use of fire. Nevertheless, rather than burning as much as possible, it is more important to carefully select the treatment locations. Simulations of fire growth or percolation in landscapes containing different fuel treatment configurations in terms of size, shape and spatial arrangement can give valuable insights into the delineation of more effective prescribed burning programs. Sound, well-established methods to design the spatial patterns of treatment application are still missing, and optimisation of the spatial arrangement of prescribed fire clearly requires further research.

Quantification of the influence of prescribed fire on large wildfires remains elusive, but the existing evidence supports the conclusion that recently treated areas do limit the spread of a fire and will result in a less homogeneous post-burn landscape. It is clear that prescribed fire moderates wildfire severity and can benefit wildfire control operations in various ways, by increasing the safety of the personnel involved in suppression, decreasing the quantity and type of fire fighting resources (e.g. ground crews instead of aircraft), changing the overall suppression strategy (e.g. direct attack instead of indirect attack), reducing the risk inherent to the burning-out operations that are used in indirect attack, lessening the amount of mopping-up, or simply providing better access and anchor points for suppression actions.

The best results of prescribed fire application (and indeed of other fuel management options) are likely to be achieved in regions less prone to experiencing extreme weather conditions, and where wildfire propagation is *a priori* constrained by landscape and land use diversity, and by natural or artificial obstacles. The spatial pattern of fuel treatment is also less critical in those situations. Since prescribed burning reduces but does not eliminate the threat posed by wildfires, mitigation of their undesired effects should rely on an integrated approach that combines prevention of human caused fires, efficient fire detection and suppression, and adequate stand and fuel management practices.

Acknowledgements

This paper evolved from a deliverable of the research project FIRE TORCH Prescribed Burning as a Tool for the Mediterranean Region: a Management Approach (ENV4-CT98-0715), funded by the DG XII of the European Commission, in the framework of the Environment and Climate Program. The authors acknowledge the comments and suggestions made by two anonymous reviewers. Lachie McCaw (Western Australia Department of Conservation and

Land Management) reviewed an early version of the paper and supplied additional literature.

References

- Agee JK, Rahm R, Finney MA, Omi PN, Sapsis DB, Skinner CN, Van Wageningen JW, Weatherspoon CP (2000) The use of shaded fuelbreaks in landscape fire management. *Forest Ecology and Management* 127, 55–66.
- Amiro BD, Stocks BJ, Alexander ME, Flannigan MD, Wotton BM (2001) Fire, climate change, carbon and fuel management in the Canadian boreal forest. *International Journal of Wildland Fire* 10, 405–413.
- Anderson HE (1982) Aids to determining fuel models for estimating fire behaviour. USDA Forest Service, Intermountain Forest and Range Experiment Station General Technical Report INT-122, Ogden, UT, 22 pp.
- Anderson HE, Brown JK (1987) Fuel characteristics and fire behavior considerations in the wildlands. In 'Symposium and workshop on protecting people and homes from wildfire in the Interior West', pp. 124–130. USDA Forest Service, Intermountain Forest and Range Experiment Station General Technical Report INT-GTR 251, Ogden, UT.
- Andrews PL (1986) BEHAVE: fire behavior prediction and fuel modeling system—BURN subsystem, Part I. USDA Forest Service, Intermountain Research Station General Technical Report INT-194, Ogden, UT, 130 pp.
- Andrews PL, Rothermel RC (1982) Charts for interpreting wildland fire behavior characteristics. USDA Forest Service, Intermountain Forest and Range Experiment Station General Technical Report INT-131, Ogden, UT, 21 pp.
- Armand D, Etienne M, Legrand C, Marechal J, Valette JC (1993) Phytovolume, phytomasse et relations structurales chez quelques arbustes méditerranéens. *Annales Sciences Forestières* 50, 75–89.
- Arno SF, Brown JK (1989) Managing fire in our forests—time for a new initiative. *Journal of Forestry* 87, 44–46.
- Barnett JP (1999) Longleaf pine ecosystem restoration: the role of fire. *Journal of Sustainable Forestry* 9, 89–96.
- Barrett TM, Jones JG, Wakimoto RH (2000) Forest Service spatial information use for planning prescribed fires. *Western Journal of Applied Forestry* 15, 200–207.
- Bennett PS, Kunzmann MR (1997) The applicability of generalized fire prescriptions to burning of Madroan evergreen forest and woodland. *Journal of the Arizona-Nevada Academy of Science* 24–25, 79–84.
- Boggs WC, Johnson EA (1995) The relative importance of fuels and weather on fire behavior in subalpine forests. *Ecology* 76, 747–762.
- Billing P (1981) The effectiveness of fuel-reduction burning: five case histories. Department of Conservation and Environment, Fire Management Branch, Research Report No. 10, Victoria.
- Bradstock RA, Bedward M, Cohn JS (1998a) Weather, ignition and fuel as determinants of fire regimes: investigation of limits to management using a simple, spatial modelling approach. In 'Proceedings of the 3rd international conference on forest fire research & 14th conference on fire and forest meteorology' (Ed. DX Viegas) pp. 2365–2378. (ADAI: Coimbra).
- Bradstock RA, Gill AM, Kenny BJ, Scott J (1998b) Bushfire risk at the urban interface estimated from historical weather records: consequences for the use of prescribed fire in the Sydney region of south-eastern Australia. *Journal of Environmental Management* 52, 259–271.
- Bradstock RA, Bedward M, Kenny BJ, Scott J (1998c) Spatially-explicit simulation of the effect of prescribed burning on fire regimes and plant extinctions in shrublands typical of south-eastern Australia. *Biological Conservation* 86, 83–95.

- Bruse P, Wade D (2002) Potential fire behavior in pine flatwood forests following three different fuel reduction techniques. *Forest Ecology and Management* 163, 71–84.
- Brown JK (1974) Handbook for inventorying downed woody material. USDA Forest Service, Intermountain Forest and Range Experiment Station General Technical Report INT-16, Ogden, UT, 24 pp.
- Brown JK (2000) Introduction and fire regimes. In 'Wildland fire in ecosystems, effects of fire on flora'. (Eds JK Brown and JK Smith) pp. 1–7. USDA Forest Service General Technical Report RMRS-GTR-42-Vol. 2, Ogden, UT.
- Brown JK, Arno SF, Barrett SW, Menakis JP (1994) Comparing the prescribed natural fire program with presettlement fires in the Selway-Bitterroot wilderness. *International Journal of Wildland Fire* 4, 157–168.
- Brown JK, Oberthur RD, Johnston CM (1982) Handbook for inventorying surface fuels and biomass in fire interior west. USDA Forest Service General Technical Report INT-129, Ogden, UT.
- Brown JK, Reinhardt ED, Fischer WC (1991) Predicting duff and woody fuel consumption in northern Idaho prescribed fires. *Forest Science* 37, 1550–1566.
- Buckley AJ, Corkish NJ (1991) Fire hazard and prescribed burning of thinning slash in eucalypt regrowth forest. Department of Conservation and Environment, Fire Management Branch, Research Report No. 29, Victoria.
- Burgin R, Rothermel R (1984) BEHAVE: fire behavior prediction and fuel modeling system—FUEL subsystem. USDA Forest Service General Technical Report INT-167, Ogden, UT.
- Burrows ND (1999) Fire behaviour in Jarrah forest fuels: 2. Field experiments. *CALM Science* 3, 57–84.
- Burrows ND, Friend G (1998) Biological indicators of appropriate fire regimes in southwest Australian ecosystems. In 'Fire in ecosystem management: shifting the paradigm from suppression to prescription'. Tall Timbers Fire Ecology Conference Proceedings No. 20. (Eds TL Pruden and LA Brennan) pp. 413–421. (Tall Timbers Research Station, Tallahassee)
- Burrows ND, Ward B, Robinson AD (2000) Behaviour and acoustic impacts of a large wildfire in the Quagga mallee pine (*Pinus pinaster*) plantation, Western Australia. *CALM Science* 3, 251–269.
- Byram GM (1959) Combustion of forest fuels. In 'Forest fire control and use'. (Ed. KP Davis) pp. 61–89 (McGraw-Hill: New York).
- Cheaney P (1996) The effectiveness of fuel reduction burning for fire management. In 'Fire and biodiversity: the effects and effectiveness of fire management'. Paper No. 8, pp. 7–16 (Department of the Environment, Sport and Territories: Canberra).
- Cheaney NP, Gould JS, Catchpole WR (1993) The influence of fuel, weather and fire shape variables on fire spread in grasslands. *International Journal of Wildland Fire* 3, 31–44.
- Cheaney NP, Gould JS, McCaw L (1998) Project Vesta: research initiative into the effects of fuel structure and fuel load on behaviour of wildfires in dry eucalypt forest. In 'Proceedings of the 13th fire and forest meteorology conference', pp. 375–378 (International Association of Wildland Fire).
- Chou V, Mirreth R, Salazar I, Power J, Dezzani R (1990) Spatial autocorrelation of wildfire distribution in the Idyllwild Quadrangle, San Jacinto Mountain, California. *Photogrammetric Engineering and Remote Sensing* 56, 1507–1513.
- Davis LS, Conner RW (1963) How prescribed fire affects wildfire occurrence. *Journal of Forestry* 61, 915–917.
- Duen AT (1989) The effects of prescribed burning on fire hazard in the chaparral: toward a new conceptual synthesis. In 'Proceedings of the symposium on fire and watershed management', pp. 23–29. USDA Forest Service General Technical Report PSW-109.
- Fensham RJ (1992) The management implications of fine fuel dynamics in bushlands surrounding Hobart, Tasmania. *Journal of Environmental Management* 36, 301–320.
- Fernandes P, Botelho H, Bento J (1999) Prescribed fire to reduce wildfire hazard: an analysis of management burns in Portuguese pine stands. In 'Proceedings of the DELFI international symposium on forest fires: needs and innovations', pp. 360–364 (CDAR: Athens).
- Fernandes P, Botelho H, Loureiro C (2000a) Modelling the links between environmental conditions, fire behaviour and fire effects important for prescribed burning operational purposes. Fire Torch Project Contract No. ENV4-CT98-0715, Deliverable F1.
- Fernandes P, Botelho H, Loureiro C (2000b) Fire hazard implications of alternative fuel management techniques—case studies from northern Portugal. In 'Proceedings from the joint fire science conference and workshop'. (Eds LF Neuenchwander and KC Ryan). Vol. II, pp. 268–270 (University of Idaho: Moscow, ID).
- Fernandes PM, Pereira JP (1993) Caracterização de combustíveis na serra da Arrábida. *Silva Lusitana* 1, 237–260.
- Finney MA (1998) FARSITE: Fire Area Simulator—model development and evaluation. USDA Forest Service Research Paper RMRS-RP-4, Ogden, UT.
- Finney MA (2001) Design of regular landscape fuel treatment patterns for modifying fire growth and behaviour. *Forest Science* 47, 219–228.
- Finney MA (2002) Use of graph theory and a genetic algorithm for finding optimal fuel treatment locations. In 'Forest fire research and wildland fire safety'. (Ed. DX Viegas). (Miltipress: Rotterdam).
- Finney MA, Martin KB (1993) Fuel loading, bulk density and depth of forest floor in coast redwood stands. *Forest Science* 39, 617–622.
- Finney MA, Sapsis DB, Bahro B (in press) Use of FARSITE for simulating fire suppression and analyzing fuel treatment economics. In 'Proceedings of the symposium on fire in California ecosystems: integrating ecology, prevention, and management'.
- Franklin SR (1988) LACFD weeds out dangerous fuels with vegetation management program. *American Fire Journal*, January, 24–25.
- Gill AM, Bradstock RA (1994) The prescribed burning debate in temperate Australian forests: towards a synthesis. In 'Proceedings of the 2nd international conference on forest fire research'. (Ed. DX Viegas) pp. 703–712 (ADAI: Coimbra).
- Gill AM, Bradstock RA (1998) Prescribed burning: patterns and strategies. In 'Proceedings of the 13th fire and forest meteorology conference', pp. 3–6 (International Association of Wildland Fire).
- Gill AM, Christian KR, Moore PH (1987) Bushfire incidence, fire hazard and fuel reduction burning. *Australian Journal of Ecology* 12, 299–306.
- Gill AM, McCarthy MA (1998) Intervals between prescribed fires in Australia: what intrinsic variation should apply? *Biological Conservation* 85, 161–169.
- Good RB (1996) Fuel dynamics, PrePlan and future research needs. In 'Fire and biodiversity: the effects and effectiveness of fire management'. Paper No. 8, pp. 7–16. (Department of the Environment, Sport and Territories: Canberra).
- Gould JS (1991) Validation of the Rothermel fire spread model and related fuel parameters in grassland fuels. In 'Proceedings of the conference on bushfire modelling and fire danger rating systems'. (Eds NP Cheaney and AM Gill) pp. 51–64. (CSIRO: Canberra).
- Grant SR, Wouters MA (1993) The effect of fuel reduction burning on the suppression of four wildfires in Western Victoria. Department of Conservation and Environment, Fire Management Branch, Research Report No. 41, Victoria.
- Hase SM, Sackett SM (1998) Effects of prescribed fire in giant sequoia-mixed conifer stands in Sequoia and Kings Canyon National Parks. In 'Fire in ecosystem management: shifting the paradigm from suppression to prescription'. Tall Timbers fire ecology conference

- proceedings No. 20'. (Eds TL Pruden and LA Brennan) pp. 236–243. (Tall Timbers Research Station: Tallahassee)
- Haines TK, Martinez J, Cleaves DA (1998) Influences on prescribed burning activity in the United States national forest system. *International Forest Fire News* 19, 43–46.
- Haines TK, Bushy RL, Cleaves DA (2001) Prescribed burning in the South: trends, purpose, and barriers. *Southern Journal of Applied Forestry* 25, 149–153.
- Harrington MG (1987) 'Predicting reduction of natural fuels by prescribed burning under ponderosa pine in southeastern Arizona.' USDA Forest Service Research Note RM-472. Fort Collins, CO.
- Hély C, Flannigan M, Bergeron Y, McRae D (2001) Role of vegetation and weather on fire behavior in the Canadian mixedwood boreal forest using two fire behavior prediction systems. *Canadian Journal of Forest Research* 31, 430–441.
- Heisler H (2000) The economics of prescribed burning: a research review. *Forest Science* 46, 322–334.
- Hirsch KG, Martell DL (1996) A review of initial attack fire crew productivity and effectiveness. *International Journal of Wildland Fire* 6, 199–215.
- James SG (1999) Evaluation of the effectiveness of prescribed burning: a simple methodology for post-burn assessment of the achievement of fire management objectives. In 'Proceedings of the Australian Bushfire Conference'. (Eds I. Lunt and D.G. Green) [http://life.csu.edu.au/bushfire99/papers]
- Jasper RG (1999) The changing direction of land managers in reducing the threat from major bushfires on the urban interface of Sydney. In 'Proceedings of the Australian Bushfire Conference'. (Eds I. Lunt and D.G. Green) [http://life.csu.edu.au/bushfire99/papers]
- Johnson EA, Miyasaka H, Stridge SK (2001) Wildfire regime in the boreal forest and the idea of suppression and fuel buildup. *Conservation Biology* 15, 1554–1557.
- Kearse RE, Arno SE, Brown JK (1990) Simulating cumulative fire effects in ponderosa pine/Douglas-fir forests. *Ecology* 71, 189–203.
- Keeley JE (2002) Fire management of California shrubland landscapes. *Environmental Management* 29, 395–408.
- Keeley JE, Fotheringham CJ (2001) Historic fire regime in Southern California shrublands. *Conservation Biology* 15, 1536–1548.
- Keeley JE, Fotheringham CJ, Morais M (1999) Reexamining fire suppression impacts on brushland fire regimes. *Science* 284, 1829–1832.
- Kilgore BJM, Curtis GA (1987) Guide to understory burning in ponderosa pine-larch-fir forests in the Intermountain West. USDA Forest Service General Technical Report INT-233. Ogden, UT.
- Koehler JT (1993) Prescribed burning: a wildfire prevention tool? *Fire Management Notes* 53–54, 9–13.
- Lambert B, Castelnau D, Costa M, Etienne M, Guillon J, Rigolot E (1999) 'Analyse après incendie de six coupures de combustible.' (Editions Cardère: Montfavet)
- Loureiro C, Fernandes P, Rego F, Botelho H (2000) Optimização do fogo controlado na dinâmica do potencial de propagação de incêndios à escala da paisagem. In 'Atas do congresso ibérico de fogos florestais'. pp. 167–176 (ESAC: Casco Branco)
- Marsden-Smedley JB, Ruhnau T, Pyke A, Catchpole WR (1999) Buttongrass moorland fire-behaviour prediction and management. *The Forester* 11, 87–107.
- Martin RE, Landsberg JD, Kauffman JR (1988) Effectiveness of prescribed burning as a fire prevention measure. In 'Proceedings of the international workshop on prescribed burning'. pp. 31–44 (INRA: Avignon)
- McAlpine RS (1995) Testing the effect of fuel consumption on fire spread rate. *International Journal of Wildland Fire* 5, 134–152.
- McArthur AG (1962) 'Control burning in eucalypt forest.' Australian Forestry and Timber Bureau, Leaflet No. 80, Canberra.
- McArthur AG (1967) 'Fire behaviour in eucalypt forest.' Australian Forestry and Timber Bureau, Leaflet No. 107, Canberra.
- McArthur AG, Douglas DR, Mitchell LR (1966) 'The Wandilloo fire, 5 April 1958: fire behaviour and associated meteorological and fuel conditions.' Forest and Timber Bureau, Forest Research Institute, Leaflet No. 98, Canberra.
- McCarthy GJ, Tolhurst KG (2001) 'Effectiveness of broadscale fuel reduction burning in assisting with wildfire control in parks and forests in Victoria.' Natural Resources and Environment, Fire Management Research Report No. 51, Victoria.
- McCarthy GJ, Tolhurst KG, Chaito K (1998) 'Overall fuel hazard guide.' Department of Conservation and Environment, Fire Management Branch Research Report No. 47, Victoria.
- McCaw T, Maher T, Gillen K (1992) 'Wildfires in the Fitzgerald River National Park, Western Australia, December 1989.' Western Australia Department of Conservation and Land Management, Technical Report No. 26, Perth.
- McRae DJ (1980) 'Preliminary fuel consumption guidelines for prescribed burning in Ontario slash fuel complexes.' Department of the environment, Canadian Forest Service, Report O-X-310, Sault Ste. Marie.
- McRae DJ, Alexander MH, Stocks BJ (1979) 'Measurement and description of fuels and fire behavior on prescribed burns: a handbook.' Department of the Environment, Canadian Forest Service, Report O-X-287, Sault Ste. Marie.
- McRae DJ, Flannigan MD (1990) Development of large vortices on prescribed fires. *Canadian Journal of Forest Research* 20, 1878–1887.
- Mercer DE, Fye JM, Pritchett JP, Butry DT, Holmes TP (2000) Economic effects of catastrophic wildfires: assessing the effectiveness of fuel reduction programs for reducing the economic impacts of catastrophic forest fire events. Southern Research Station, Research Triangle Park, Final Report Topic 8 of the Research Grant Ecological and Economical Consequences of the 1998 Florida wildfires, Joint Fire Science Program, SRS4851.
- Meredith CW (1996) Is fire management effective? In 'Fire and Biodiversity: the effects and effectiveness of fire management'. Paper No. 8, pp. 227–231. (Department of the Environment, Sport and Territories: Canberra)
- Minnich RA (1983) Fire mosaics in southern California and northern Baja California. *Science* 219, 1287–1294.
- Minnich RA, Chou YH (1997) Wildland fire patch dynamics in the chaparral of southern California and northern Baja California. *International Journal of Wildland Fire* 7, 221–248.
- Morrison DA, Buckney RT, Bewick BJ (1996) Conservation conflicts over burning bush in south-eastern Australia. *Biological Conservation* 76, 167–175.
- Omi PN, Kalabokidis KD (1998) Fuels modification to reduce large fire probability. In 'Proceedings of the 3rd international conference on forest fire research & 14th conference on fire and forest meteorology'. (Ed. JIX Viegas) pp. 2073–2088. (ADAI: Coimbra)
- Outcalt KW, Wado DD (2000) The value of fuel management in reducing wildfire damage. In 'Crossing the millennium: integrating spatial technologies and ecological principles for a new age in fire management'. pp. 271–275 (University of Idaho/IAWF: Moscow, ID)
- Peet GB, Williamson AJ (1968) An assessment of forest damage from the Dwellingup fires in Western Australia. In '5th conference of the institute of foresters of Australia' (Perth)
- Pollet J, Omi PL (2002) Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. *International Journal of Wildland Fire* 11, 1–10.

- Prestemon JP, Pye JM, Butry DT, Holmes TR, Mercer DE (2002) Understanding broadscale wildfire risks in a human-dominated landscape. *Forest Science* 48, 685–693.
- Pyne SJ, Andrews PL, Laveni RD (1996) 'Introduction to wildland fire (2nd edn)'. (John Wiley and Sons: New York)
- Rawson R, Billington P, Rees B (1985) Effectiveness of fuel-reduction burning. Department of Conservation and Environment, Fire Management Branch, Research Report No. 25, Victoria.
- Regelbrugge JC (2000) Role of prescribed burning in the management of chaparral ecosystems in southern California. In '2nd interface between ecology and land development in California' (Eds JR Keeley, M Bazz-Keeley, and CJ Fotheringham) pp. 19–26. U.S. Geological Survey Open-File Report 00–62.
- Rego FC (1991) Fuel management. In 'EC/E/TAO/IO seminar on forest fire prevention, land use and people', pp. 209–221. (Ministry of Agriculture: Athens, Greece)
- Rego FC, Silva JM, Botelho H (1987) Prescribed burning in the reduction of wildfire hazard in Northern Portugal. In 'Proceedings of the world congress on wildfire prevention', (Athens)
- Rigolot B (1997) 'Etude sur la caractérisation des effets écologiques aux écosystèmes forestiers méditerranéens par les brûlages dirigés et répétés, exercice 1996, Rapport final.' Ministère de l'Environnement, Direction de la prévention et des risques, sous-direction de la prévention des risques majeurs.
- Rigolot B, Ouellet A (2000) 'Prescribed burning field forum', Fire Torch Project Contract No. ENV4-CT98-0715, Deliverable B1.
- Robichaud PR, Miller SM (1999) Spatial interpolation and simulation of post-burn duff thickness after prescribed fire. *International Journal of Wildland Fire* 9, 137–143.
- Rothermel RC (1972) A mathematical model for predicting fire spread in wildland fuels. USDA Forest Service, Intermountain Forest and Range Experiment Station Research Paper INT-115. Ogden, UT. 40 pp.
- Rothermel RC, Philpot CW (1973) Predicting changes in chaparral flammability. *Journal of Forestry* 71, 640–643.
- Ryan KC, Noss NV (1985) Evaluating prescribed fires. In 'Proceedings of the symposium and workshop on wilderness fire', pp. 230–238. USDA Forest Service General Technical Report INT-182. Ogden, UT.
- Sackett SS (1975) Scheduling prescribed burns for hazard reduction in the southeast. *Journal of Forestry* 73, 143–147.
- Sackett SS, Haase SM (1998) Two case histories for using prescribed fire to restore ponderosa pine ecosystems in northern Arizona. In 'Fire in ecosystem management: shifting the paradigm from suppression to prescription'. Tall Timbers Fire Ecology Conference Proceedings No. 20. (Eds TL Pruden and LA Brennan) pp. 380–389 (Tall Timbers Research Station: Tallahassee)
- Sandberg D (1980) Duff reduction by prescribed underburning in Douglas-fir. USDA Forest Service Research Paper PNW-272. Portland, OR.
- Sansis DB, Martin RE (1994) Fire, the landscape, and diversity: a theoretical framework for managing wildlands. In 'Proceedings of the 12th conference on fire and forest meteorology', pp. 270–278 (Society of American Foresters)
- Schimmel J, Granström A (1997) Fuel succession and fire behaviour in the Swedish boreal forest. *Canadian Journal of Forest Research* 27, 1207–1216.
- Schmidt DL, Peterson DL, Kenne RE, Lettman JM, McKenzie D, Weise DR, Sandberg DV (1999) Assessing the effects of fire disturbance on ecosystems: a scientific agenda for research and management. USDA Forest Service General Technical Report PNW-GTR-455. Portland, OR.
- Schoff ER, Waldrop TA (1999) Photos for estimating fuel loadings before and after prescribed burning in the upper coastal plain of the southeast. USDA Forest Service General Technical Report SRS-26. Asheville, NC.
- Silva JM (1997) Historique des feux contrôlés au Portugal. *Forêt Méditerranéenne* 18, 299–310.
- Sneeuwjagt R (1973) 'Measuring forest fuels'. Research Paper No. 9. (Forests Department of Western Australia: Perth)
- Sneeuwjagt R (1994) Fighting fire with fire. *Landscape* 9, 23–27.
- Sneeuwjagt R (1998) Application of wildfire threat analysis in south-western forest of western Australia. In 'Proceedings of the 3rd international conference on forest fire research & 14th conference on fire and forest meteorology'. (Ed. DX Viegas) pp. 2155–2176. (ADAI: Coimbra)
- Sneeuwjagt RJ, Peet GB (1985) 'Forest fire behaviour tables for Western Australia (3rd edn)' (Department of Conservation and Land Management: Perth)
- Stephens SL (1998) Evaluation of the effects of silvicultural and fuels treatments on potential fire behaviour in Sierra Nevada mixed-conifer forests. *Forest Ecology and Management* 105, 21–35.
- Strauss D, Bednar L, Mees R (1989) Do one percent of forest fires cause ninety-nine percent of the damage? *Forest Science* 35, 319–328.
- Sweeney JN (1985) Old burn limit size of fires. In 'Proceedings of the symposium and workshop on wilderness fire'. USDA Forest Service General Technical Report INT-182, p. 389. Ogden, UT.
- Tolhurst KG, Pynn DW, Loyn RJ, Wilson AG, Follett J (1992) Ecological effects of fuel reduction burning in a dry sclerophyll forest. Forest Research Centre, Department of Conservation and Environment, Melbourne.
- Underwood RJ, Sneeuwjagt RJ (1993) Where there's fire, there's smoke. *Landscape* 8, 10–16.
- Underwood RJ, Sneeuwjagt RJ, Styles HG (1985) The contribution of prescribed burning to forest fire control in western Australia: case studies. In 'Fire ecology and management in western Australian ecosystems'. (Ed. JR Ford) pp. 153–170. WAT Environmental Studies Group Report No. 34.
- Van Wagner CE (1968) The line intersect method in forest fuel sampling. *Forest Science* 14, 20–26.
- Van Wageningen JW (1985) Fire suppression effects on fuels and succession in short-fire-interval wilderness ecosystems. In 'Proceedings-symposium and workshop on wilderness fire', pp. 119–126. USDA Forest Service General Technical Report INT-182. Ogden, UT.
- Van Wageningen JW (1995) Large fires in wilderness areas. In 'Proceedings of a symposium on fire in wilderness and park management', pp. 113–116. USDA Forest Service General Technical Report INT-182. Ogden, UT.
- Van Wageningen JW (1996) Use of a deterministic fire growth model to test fuel treatments. In 'Sierra Nevada ecosystem project: final report to Congress. Assessment and scientific basis for management options', pp. 1155–1165 (University of California: Davis)
- Van Wageningen JW, Hancock L, Ferry O, French D, Hance J, Hickman J, McCleese W, Mutch R, Zontek F, Butts D (1982) 'Prescribed fire monitoring and evaluation guide'. (NWC/G, Prescribed Fire and Fire Effects Working Team: Washington, D.C.)
- Van Wageningen JW, Sydorick CA (1987) Fuel accumulation rates after prescribed fires in Yosemite National Park. In 'Preprint volume 9th conference on fire and forest meteorology', pp. 101–105. (American Meteorological Society: Boston)
- Vega JA, Valette JC, Rego F, Lara C, Gillon D, Ventura J, Barn S, Gómendi V, Botelho H, Gujarró M, Hussard C, Ruiz L, Cuiñas P, Murechal J, Mendes-Lopes J, Díez R, Fernandes P, Fontúrbel M, Santos J, Róza dos M, Beloso M (1994) Forest fire prevention through prescribed burning: an international cooperative project carried out in the European STEP program. In 'Proceedings of the 2nd international conference on forest fire research'. (Ed. DX Viegas) pp. 75–84 (ADAI: Coimbra)

- Wade D, Lunsford JD (1989) 'A guide for prescribed fire in Southern forests.' USDA Forest Service Technical Publication R8-TP 11, Atlanta, GA.
- Wagle RF, Easkie TW (1979) A controlled burn reduces the impact of a subsequent wildfire in a ponderosa pine vegetation type. *Forest Science* 25, 123-129.
- Ward D (1998) Reconstructing the fire history of the jarrah forest of south-western Australia. In 'Proceedings of the 13th conference on fire and forest meteorology', pp. 245-249 (International Association of Wildland Fire).
- Weatherspoon CP, Skinner CN (1995) An assessment of factors associated with damage to tree crowns from the 1987 wildfires in Northern California. *Forest Science* 41, 430-451.
- Wciac, DR, Gelobter A, Haase SM, Sackett SS (1997) Photo series for quantifying fuels and assessing fire risk in giant sequoia groves. USDA Forest Service General Technical Report (SW-GTR-163). Albany, NY.
- Whelan KJ, Myster RM (1991) Fire regimes and management in south-eastern Australia. In 'Proceedings of the 17th Tall Timbers fire ecology conference. High intensity fire in woodlands: management challenges and options', pp. 235-258 (Tall Timbers Research Station, Tallahassee).
- Wilson AG (1992) 'Assessing fire hazard on public lands in Victoria: fire management needs, and practical research objectives.' Department of Conservation and Environment, Fire Management Branch, Research Report No. 31, Victoria.
- Wilson JS, Baker PJ (1998) Mitigating fire risk to late-successional forest reserves on the east slope of the Washington Cascade Range, USA. *Forest Ecology and Management* 110, 59-75.
- Wright HA, Bailey AW (1982) 'Fire Ecology, United States and Southern Canada.' (John Wiley and Sons: New York).
- Zedler PH, Seiger LA (2000) Age mosaics and fire size in chaparral: a simulation study. In '2nd interface between ecology and land development in California'. (Eds JE Keeley, M. Baer-Keeley and CJ Pothorringham), pp. 9-18, U.S. Geological Survey Open-File Report 00-62.

Controlled Burning as a Dual-Purpose Tool of Forest Management in New Jersey's Pine Region

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Subject to frequent and devastating fires the New Jersey pine region is one of the "hot spots" of the Northeast. Scrub forest with tall resinous-leaved shrubs and heavy accumulations of duff present dangerous fuel conditions. Long fire seasons, few obstructions to wind and soils that dry readily add to the hazard. Disastrous fires as a consequence are all too common. Furthermore, favored by protection, oaks and other low-value hardwoods have encroached on pine land where they seldom attain sawlog size. Controlled burning properly applied and safeguarded offers an effective tool both for reducing fuel and for favoring pine over oak.

CONTROLLED burning, sometimes called prescribed burning, is not a new practice in southern New Jersey. It has been used for protection purposes on some areas, particularly on the Lebanon State Forest, for 20 years. Studies of its use as a silvicultural tool were started on the Lebanon State Forest in 1936. Results of this latter work were published in 1945 (3). The practice lends itself so effectively to an integration of the uses of fire for silvicultural and protection purposes that in recent years as much as 1,000 acres have been burned annually under prescribed methods on the Lebanon State Forest.

This prescribed use of fire has aroused considerable interest among private timberland owners in southern New Jersey with the result that the State Conservation Department is now supervising controlled burning on some private lands. Accordingly, after 12 years' testing of the use of fire as a silvicultural tool, and some 20 years of its gradually increasing use for protection purposes, the authors believe it is time to report on controlled burning as a dual-purpose tool of forest management in the Pine Region of New Jersey.

The original upland forests in the Pine Region consisted of open stands of large pitch and shortleaf pines. Years of heavy cutting and hot wild fires have greatly favored sprout oaks to the detriment of pine, many of which are now deformed by fire. Thousands of acres now produce nothing of value; the estimated timber cut in 1946 was equivalent to only 1 cord from every 14 acres of woodland. The problem is to convert these deteriorated forests to pine stands of seedling origin.

The more rapidly growing pines do grow to

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sawtimber and piling size; the oaks rarely produce more than cordwood (3, 5). Several methods of conversion have been tried. Planting pine seedlings followed by cleanings to insure dominance over oak sprouts was tried (5) but it was soon realized that this was costly; that natural reproduction methods might be cheaper and at the same time result in more desirable stands. Accordingly, studies were made on the use of machinery and on the use of controlled burning in preparing seedbeds for natural regeneration of pine. Supplemental studies were made on methods of cutting, slash disposal, and control of advance hardwood growth.

The total results show that pine seedlings can be established by planting or by preparing a seedbed either with machines or by controlled burning. Planting costs at least \$15 to \$20 per acre. No reduction in fire hazard is obtained by this method, however, and at least two cleanings are probably needed to insure a good stand of pine. The same approximate cost applies to the use of machinery; the same number of future cleanings would be needed.

The use of controlled fires greatly favors the establishment of pine reproduction and the control of less valuable hardwoods. Although earlier results were previously published in detail (3), a summary of recent data is given here to provide perspective on the silvicultural phases of controlled burning. Table 1 summarizes the mortality and basal scarring resulting from several prescribed burns. These data illustrate the fact that oak is much more susceptible to controlled fire than pine. They thus indicate that controlled burning can be used to increase the ratio of pine to oak in this type.

The effect of controlled fires on pine seedlings and their establishment is shown in Table 2. The data substantiate the obvious fact that burns are extremely destructive to the small seedlings already present. Of more significance, however,

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is the fact that seedbed preparation through controlled burns results in the establishment of much new pine reproduction.

The increased pine reproduction, established as the result of controlled burns, will need a period of protection to allow the pines to reach 2 inches d.b.h. After that period, further use of controlled fire will aid in the maintenance of high proportions of pine through selective killing and damage to competing oaks. The spacing of periodic burns should then be close enough so that oak reproduction remains susceptible to killing by fire throughout the pine rotation. Because the susceptibility of the hardwoods decreases rapidly as their height increases beyond 4 feet, fire should be used as often as necessary to prevent any appreciable number from growing to greater size.

The sequence of operations over a rotation, but beginning in reproduction stands of oak and pine, should be approximately as follows for silvicultural purposes:

1. Heavy cuttings of oak sprouts until pines

TABLE 1.—MORTALITY AND BASAL SCARRING OF PINES AND OAKS RESULTING FROM SEVERAL CONTROLLED BURNS^a

D.b.h. (Inches)	Mortality		Basal scarring	
	Pine (From 10 annual burns)	Oaks (From 6 annual burns)	Pine (After 10 annual burns)	Oaks (After 6 annual burns)
	Percent	Percent	Percent	Percent
Ingrowth	16	100	19	—
1	3	12	8	49
2	0	2	6	32
3	0	1	0	16
4-5	0	0	0	9
Over 6	0	0	0	0

^aData are from the experimental areas described in the earlier publication (3). Mortality shown is the difference between that on the burned areas and that on the controls. Pines are pitch and shortleaf. Initial d.b.h. is used for mortality, and final d.b.h. of surviving trees for basal scarring. Ingrowth includes those trees reaching 0.6 inches in diameter during the study.

are 2 inches d.b.h.

2. Periodic burns after pines are 2 inches in diameter and until harvest cuttings are made. These burns will help keep the oaks under control and keep a crop of pine seedlings on the ground. Thinnings and improvement cuttings might also be undertaken during this period as markets permit, particularly in stands where the oaks, because of insufficient cleanings, have grown to sizes where mortality by controlled fire cannot be expected. In case there is no market for these products, girdling or poisoning of the hardwoods is a desirable practice.

3. Harvest cutting using a method resulting in an even-aged stand.

4. Complete protection from fire until the new stand is 2 inches d.b.h.

Partly because of the silvicultural effects, controlled burns are recommended at 4- to 5-year intervals in oak-pine stands 20-60 years old. Under proper conditions, these would cost no more than \$1 to \$1.50 per acre over a rotation except for small areas that are more costly to burn. One cleaning may be sufficient. Total cost including this one cleaning should not exceed \$4 per acre over a rotation, excluding taxes, interest, and other administrative costs that would be no more than under other silvicultural systems. The results so far obtained from studies indicate that the stands would have a much higher percentage of pines where controlled burning is used than under the other systems. In addition fuel accumulations are periodically reduced under prescribed burning so that loss by chance fires is improbable.

Silvicultural measures are of little use if fire protection is ineffective. Fires in southern New Jersey have frequently burned 1 to 2 percent of the area, and in the worst years much more. A major advantage of controlled burning is that it is not only an effective tool for use in converting rundown stands to seedling pine

TABLE 2.—THE EFFECT OF VARIOUS SCHEDULES OF CONTROLLED BURNING ON PINE SEEDLINGS AND THEIR ESTABLISHMENT

Number of burns 1937-46	Number of growing seasons since last burn	Percent change in number of seedlings, 1937-46, by height classes of—			
		0.0-1.5 feet	1.6-3.5 feet	3.6 feet or more	All
3 to 10	1 or 2	+95 to +393	-93 to -100	-33 to -80	+50 to +188
2	5	+516	-75	-60	+362
0	43	+9	+11	+114	+19
(Control)					

stands, but is an aid to fire protection as well. This is self-evident; for if the litter of the forest floor is consumed by these light winter fires at periodic intervals, there will be less danger of chance fires gaining headway in the intervals between controlled burns. Controlled burning, however, should be considered only as a supplementary measure in forest fire control. In no wise is it a substitute for organized fire protection. Its effectiveness as a supplement is illustrated by the following case history.

On April 20, 1946, at 11:30 a.m., a spark from a freight engine started a fire near New Lisbon, New Jersey. The fire danger that day was class 5 on the Appalachian meter (model 5-B). The local towerman detected the fire at 11:48 a.m. and at 11:58 a.m. the first warden and two men arrived. These first three men backfired a sand road within 500 feet of the starting point of the fire, were unable to check the head fire, and had to fall back. Three wardens and 14 men tried to hold a two-lane hard-surface road, 950 feet from the first sand road, by backfiring. As the head fire approached, spot fires were set as much as 300 feet beyond the road, and the line was lost. At 1:15 p.m. the head, 150 feet wide, hit another hard-surface road 1,500 feet beyond the second road. The third road was also backfired and 115 men with three fire trucks were stationed along it. Thirty spot fires were, however, set beyond the road in thick undergrowth unburned for 20 years; although within 100 feet of the road, not all of these were suppressed. Some built up and the fire passed on to jump a swamp and creek 350 feet away.

The next chance to stop the main head was on a sand road more than a mile beyond the point where the fire had hit the creek. In driving toward this road, the head again crossed a creek. Two wardens, 35 men, and one fire truck tried to hold this road by backfiring and extinguishing the "carry-overs." Although about 100 spot fires were suppressed, 15 to 20 fires, starting 150 to 250 feet beyond the sand road, built up new heads and this line was lost. Over 9,000 feet beyond this point was the boundary of the Lebanon State Forest. Along the boundary was a forested firebreak on which the surface fuels had been reduced in past years, largely through controlled burning. The head fire struck this line on a $\frac{3}{4}$ -mile front between 5 and 5:30 p.m., setting spot fires as much as

1,200 feet ahead. Twenty-four men and two fire trucks were stationed there. The head fire was stopped; the spot fires, occurring mostly on control-burned ground, were extinguished; and this line was held.

Killing damage was confined on the state forest to less than half an acre. The contrast between the damage on the two sides of the boundary line was very striking; it illustrated the great difference between the results of controlled fire and wild fire (Fig. 1). This difference lies essentially in the fact that light winter fires, when properly used, reduce the fuel continuity on the ground and favor a closed overwood. Periodic severe fires, on the other hand, promote a continuation of hazardous conditions by keeping the overwood open, while the stems killed by the last fire and the resulting sprouts of trees and shrubs accumulate. These in a few years build up a good vertical continuity of fuel leading to the tops of the tallest surviving pines. Part of the total area covered by the 1946 fire had suffered from severe fires twice before since January 1938 and the fuel conditions were exactly as described above. Partly because of the periodic recurrence of such fires with their production and maintenance of hazardous conditions, the authors believe that controlled burning should become a fundamental part of the management of the South Jersey Pine Region.

The New Lisbon fire provided an excellent example of the value of controlled burns in aiding the suppression of severe fires that occur on days of high danger. It aroused new interest in using controlled burning as a management tool for both protection and silvicultural purposes.

WHY CONTROLLED BURNING IS RECOMMENDED

For fire protection.—Controlled burns reduce the thick mats of duff and the dense shrubby understory. Thus much of the fuel is removed, and protection from severe fires is made easier. It should be clearly understood, however, that the protection offered is relative and not absolute. The need for fire suppression forces is not eliminated, but their work is made more effective.

For silvicultural purposes.—Light winter fires may be used to improve the forests by favoring the pines. The burning prepares a suitable seed-bed for the natural reproduction of pine and checks the development of hardwoods (3).

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Ecological succession provides another argument for controlled burning. If all fires were excluded for a long enough period, the pines would be eliminated for all practical purposes. The forest would then be formed of the climax type of less valuable hardwoods which, incidentally, would have a far greater fire hazard than well stocked stands of pine.

WHERE CONTROLLED BURNING MAY BE USED

The Region.—Controlled burning in New Jersey should be limited to the Pine Region in the southeastern part of the state. It should not, in the light of present knowledge, be used in the Delaware Valley or in northern New Jersey (3) where the soils are of good quality and support stands of yellow-poplar, sweetgum, pin oak, red oak, and similar species. These good sites usually have a high population of earthworms and other soil fauna that are responsible for the rapid disintegration of dead leaves and the formation of a mull type of humus. Thus the organic debris usually does not accumulate there in amounts sufficient to create a severe fire hazard.

The upland sites in the Pine Region are quite different. Their dry, sandy, acid soils grow pitch and shortleaf pines in mixture with oaks (scarlet, black, chestnut, and white) of low quality. In these soils earthworms and other soil fauna characteristic of mull humus are seldom found, even in areas long unburned. Earthworms must have abundant moisture (10), which the upland soils in the Pine Region do not provide. Soil acidity may be another limiting factor. Lutz (4) shows that the pH of some of these soils ranges from 3.46 to 5.14. These values are well below the 5.6 to 8.3 at which earthworms may occur or the 7.0 to 7.8 at which they are most abundant (9, p. 337).

Because of the absence of these life forms and the low bacterial population, fungi are chiefly responsible for the disintegration of forest litter, and the disintegration is very slow. Litter accumulates on the surface, often to a depth of 4 inches on areas unburned for several years. Such blankets of duff materially increase the fire hazard.

The applicable sites.—Past studies indicate that controlled burning can be used successfully on all upland sites within the region. The treatment is apparently beneficial also in the pine swamps, but under no circumstances should controlled burning be attempted on the true

swamp sites that support stands of white-cedar and swamp hardwoods (2).

The applicable stands.—The use of controlled burns will often be limited by the predominance of small stems in the stands. On upland sites stands where most of the trees are under 2 inches in diameter at breast height should not be burned. Pines over 2 inches are not injured by light fires. Oaks larger than 2 inches are easily scarred, but such damage is considered of little importance in this region because of the limited potentialities of the hardwoods.

Lowland sites have a denser understory of "harder-burning" shrubs (sheep-laurel, leather-leaf, bayberry) than upland areas (blueberry, huckleberry), so that fires generally burn with greater intensity and may injure pines up to 4 inches in diameter. For this reason lowland sites should not be burned unless the dominant pines have diameters of at least 4 inches at breast height.

It is important that all areas be carefully examined before burning. In appraising the probable effects of controlled fire, it is generally unnecessary to consider suppressed stems of either hardwoods or pines.

METHODS OF BURNING

Controlled burning should be attempted only under the direct supervision of an experienced forester or fire warden.^{*} The objective should be a light fire with flames so low that a man can readily walk through them, that is, with flames mounting on the average not more than a foot or two above the ground. Such a fire will not consume all the debris on many areas, but will materially reduce its depth. Whether the fire is set with or against the wind depends on the fuel moisture conditions and the wind velocity.

Frequency.—The frequency of burning depends on the degree of protection desired. For maximum protection of improved property, burns at 1- or 2-year intervals are recommended. For developing a wide firebreak, burning at 4- or 5-year intervals may be sufficient on upland sites. However, it should be noted that where large fuel accumulations have developed several controlled fires may be needed to reduce the duff gradually to desirable proportions. In such places the first few controlled fires may have to be at 1- to 3-year intervals.

^{*}State law requires that all burning be done under permit from the New Jersey Forest Fire Service.

When to burn.—Controlled burning should be limited to the winter months. The period between Christmas and March 1 usually offers the best conditions, because changes in fuel moisture are then relatively slow. At other times fuels dry too quickly, and a light fire may rapidly build up into a severe one.

Even during the recommended period there are occasional days when the danger will be too high, particularly for burning areas that have thick layers of oak leaves. On such areas burns

should be limited to days that rate a high class 1 or low class 2 on the Appalachian danger meter (model 5-B). Areas that have been long unburned, and on which the fuel accumulation is heavy, should be control-burned when much of the debris is too wet to burn readily; but since litter dries from the surface downward, the proper time can be chosen by experienced personnel.

Present information indicates that the proper conditions for winter burning are as follows:

Average depth of duff	Oak-pine and pine-serub oak areas where oak leaves predominate in the duff	Upland pine stands with duff composed chiefly of pine needles
<i>Inches</i>	<i>Danger class</i>	<i>Danger class</i>
3 or more	High class 1	Low class 2
1 to 2	Low class 2	High class 2
Less than 1	High class 2	Low class 3



FIG. 1.—Adjoining stands on the boundary of the 1946 New Lisbon fire: A, this stand, control-burned at 2- or 3-year intervals as part of the firebreak on the Lebanon State Forest, helped to stop the forest fire; B, a stand on private land burned by the fire.

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The proper conditions for controlled burning occur on 30 to 40 days during the usual winter. During the winter of 1946-47, for example, there were 38 days when controlled burns could have been made. Of these, 31 were working days.

Speed of firing.—How large an area should be fired at one time depends on two main factors: (1) the burning conditions and (2) the boundaries of the area. On blocks bounded by roads or swamps more fire can be set with safety than where the boundaries are narrow raked or plowed lines. For example, in burning one 90-acre tract bounded by roads and swamps, over a mile of fire was set at one time by three men; whereas the same men in burning narrow fire-breaks (or safety strips) would frequently have only 100 to 200 feet of fire burning at one time. On areas with good boundaries and under favorable conditions fire may be set almost as fast as a man can walk.

COST OF CONTROLLED FIRES

The cost of controlled burns varies with several factors: continuity of fuel; size and shape

of area; type of boundaries; burning conditions; and the experience, judgment, and availability of personnel. The cheapest controlled burns are obtained when (1) there is a continuity of fuel on the forest floor, so that a fire will spread across the area; (2) the area is of such size and shape that a minimum amount of firing per acre is necessary; (3) the area is bounded by wet swamps or roads free from litter, so that no line preparation and a minimum of patrol are necessary; (4) the firing can be made with the wind; and (5) personnel with adequate experience and good judgment are available.

The costs vary considerably (Table 3). For example, the burning of safety strips (8), which adjoin some roads on the South Jersey state forests, is an expensive form of protection, often costing up to \$1 per acre burned. There are several reasons for this high cost.

1. Lack of natural boundaries. The road serves as one boundary, but on the woods side a narrow line about a foot wide is raked. The preparation of this line often accounts for half



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the total cost, and the firing work is slowed by the need for seeing that the fire does not cross the raked line.

2. Limited width of the strips. Narrow strips, 25 to 200 feet wide, are expensive to burn because the fire makes a short run, and more firing is needed per unit area.

3. Lack of fuel continuity. The safety strips have been burned at 1- to 3-year intervals, usually for over 10 years, and present fuels are scattered. The dead leaves are blown into piles against some obstruction such as a clump of shrubs, and so fires do not spread readily across the area.

On the other hand, the controlled burning of large blocks of woodland is much less expensive, although the costs are affected by the same factors previously mentioned. Each prescribed burn of tracts fired so frequently that fuels are scattered is twice as expensive as that of tracts less frequently burned and on which fuels are continuous (Table 3). The lack of good boundaries also greatly increases the cost of controlled burning wooded blocks. For example, in 1945 two tracts were control-burned on the same day. One contained 59 acres, the other 90. Neither had been burned for 21 years and fuel accumulations were comparable. Both tracts were bounded by roads or swamps. However, on the 59-acre tract, 19 acres were excluded because of other ownership or the presence of reproduction. Raking the necessary lines and burning the remaining 40 acres required 11 man-hours. The 90-acre tract was burned as a unit in less than 3 man-hours. At \$1 per man-hour, the burn on the first tract cost 27.5 cents per acre, and on the second, 3.3 cents an acre. Over 70 percent of the difference in cost is attributed to the poor boundaries used in burning the smaller tract.

Size and shape of tracts are important factors also because of their effect on the amount of

firing necessary per unit area. For example, two adjoining tracts on the Lebanon State Forest have each had two controlled burns. One area of 22 acres is bound by roads; the other, of 110 acres, by roads and swamps. In each case the perimeter that has to be fired is 1.1 miles long. The costs of the burns have been 27 and 20 cents per acre for the smaller tract, and 3 and 4 cents per acre for the larger area. The differences have been chiefly due to the proportionally greater amount of firing and patrol necessary on the smaller area because of its small size and poor shape.

Burning conditions are also an important factor. When fuels are rather dry and the desired fire intensity can be obtained only by firing against the wind, labor costs may be twice those necessary when firing with the wind gives satisfactory results. The judgment and experience of personnel are likewise important. In control-burning one tract in the winter of 1946-47, an attempt was made to include an area with heavier fuel accumulations than prevailed on the remainder. This mistake quadrupled the man-hours required because of the additional work necessary in suppression and patrol. Personnel should be available for burning work when conditions are suitable. In this respect controlled burning is analogous to the haying job of a farmer. The most satisfactory work, as well as the cheapest, is usually obtained from crews regularly employed on the area, and least from crews hired several days in advance for a specific period.

The costs presented in Table 3 are higher than need be expected on managed areas where controlled burns of tracts are made at 4- to 10-year intervals by experienced personnel. In the first place, the initial burns made after 20 years of fire exclusion are more expensive than subsequent ones. Secondly, the costs shown in Table

TABLE 3.—COST OF CONTROLLED BURNS AS AFFECTED BY TYPE AREA AND PAST TREATMENT^a

Type of area	When control-burned	Total area	Area burned per man-hour	Cost per acre	Range in cost per acre
Small areas around buildings	Annually for 10 years or more	<i>Acres</i>	<i>Acres</i>	<i>Dollars</i>	<i>Dollars</i>
Safety strips 25-200 feet wide	Annually or biennially, usually for 10 years or more	10	0.74	1.35	1.30-1.40
Tracts of 23-71 acres	Annually for 6-10 years	138	1.1	.94	.70-1.33
Tracts of 52-133 acres	Biennially for 6 years	262	2.9	.34	.21-.78
Tracts of 22-80 acres	For the first time	185	6.6	.15	.12-.17
		220	5.2	.19	.14-.27

^aCost figures are on the basis of \$1 per man-hour. All burns were made in the winter of 1946-47.

3 include line preparation and the additional firing necessary on old safety strips that border some of the tracts. Consequently, the present evidence is that, in the case of tracts having the proper size, shape, and boundaries, a periodic burn can be made at the rate of 10 or more acres per man-hour, or no more than 10 cents an acre.

IDEAL ARRANGEMENT OF AREAS FOR PRACTICAL MANAGEMENT

Studies and experience indicate that the solution to the fire problem in the South Jersey Pine Region might be greatly aided by (1) breaking up large forested areas into units bounded by roads or swamps, and (2) treating a certain proportion of these units by controlled burning. The ideal arrangement would be units in a checkerboard pattern or similar system. In the case of large holdings, units should be about 100 acres in size as these are more economically treated than smaller ones. Protection and silvicultural needs would be coordinated in the burning treatments. Stands having an average diameter less than 3 inches would thus alternate with ones having larger trees. The latter units would be control-burned at appropriate intervals. Fire would be excluded from the younger stands until the trees had reached the size when controlled burning could be safely undertaken.

The protection of such an ideal area from a severe, wild fire would be relatively simple, for there would be a 50-50 chance that it would strike one of the control-burned units. There the fire either would die out or could be easily suppressed. If it should strike one of the unburned units, it would be bounded on all sides by control-burned areas so that probably only the one unit would suffer. While a fire might pass from one unburned unit to another on the diagonal, the chances for holding it at the relatively small points of contact would be good.

APPLICATION OF CONTROLLED BURNS IN PRACTICAL MANAGEMENT

Hindrances.—The forest areas of the Pine Region do not, of course, have an ideal arrangement at the present time. The road system is inadequate for such a pattern, and occasionally there are unbroken units as large as 5,000 acres.

Property lines seldom coincide with the roads. Tracts that are bounded by roads and swamps are often irregular in shape. Moreover, within many units there is much intermixing of both

types and age classes. Many of the upland stands and a still higher proportion of the pine swamps are composed largely of stems whose size renders them susceptible to damage from even light fires (2).

Immediate program.—The problem of introducing controlled burning on a larger scale in the Pine Region obviously presents many difficulties. The conditions for a control-burning program are far from ideal. However, careful surveys will usually show that patterns resembling the ideal arrangement can be developed, although the initial use of controlled burns may be limited to the preparation of barrier zones. For the immediate future, the following program is suggested:

1. Limit the control-burning program to areas that can be properly supervised.

2. After the preparation of suitable plans, extend the control-burning program to all appropriate state lands.

3. As an aid to fire protection on both state and private lands prepare barrier zones to break up large forest areas. This would prevent the development of large wild fires. These barrier zones would consist of control-burned belts supplementing swamps, or other natural barriers.

4. When private owners of forest land request control burning either for fire protection or as a dual-purpose tool in the management of their lands, detailed plans based on careful surveys should be made by competent foresters. It may be necessary for the owner to construct roads or plowed fire lines before controlled-burning can be started. The burning should be done by crews especially trained by the state but paid by the private owner.

Plans have been made for the controlled burning of some private holdings, following the procedure described above, and some burns have been made. Each plan includes a map of the holding showing the location of individual tracts and of recommended improvements. One sheet of a standard form is usually sufficient for describing the suggested improvements, but separate sheets of a second standard form are prepared for each tract or block (Fig. 2).

Silvicultural practices.—If controlled burning is to be used successfully in the Pine Region of southern New Jersey, certain silvicultural practices should probably be followed.

Species more susceptible to fire damage than the native hard pines should not be introduced

except on restricted areas for experimental purposes. White and red pines have been planted here, but neither does well in this region (6, 7). Loblolly pine, while relatively resistant to fire injury (1), is still of questionable value in this forest region.

Cutting practice should be directed toward the development and maintenance of even-aged stands occupying units adequately bounded (i.e., by roads and swamps) to permit the most economical use of controlled burns.

Thinning from below is desirable where conditions are appropriate, but should be done only in conjunction with controlled burning. Thinning alone accelerates the invasion by hardwoods and shrubs, and without controlled burning favors undesirable hardwoods over the pine.

Thinning should be made uniformly over a

unit, for otherwise fuels tend to vary in moisture content. Such variation increases the difficulty of obtaining a uniform, light burn over the unit.

Slash from thinnings should be so disposed that it will not constitute a hazard in subsequent controlled burns. This can be done either by piling and burning or lopping and scattering. In either case it should be kept well away from the boles of remaining trees.

On the areas periodically control-burned, seed-bed conditions will be favorable and many pine seedlings will start. These will be killed by shade or the subsequent fire, but new ones will replace them. Thus there should be a nucleus of advance reproduction when the burns are discontinued and harvest cuttings initiated. The amount and distribution of advance reproduction should

S A M P L E	
New Jersey Department of Conservation	
PRESCRIBED BURNING PLAN - Sheet No. 2	
Owner <u>John Doe</u>	Date <u>August 1947</u>
Location of area <u>Near Pasadena, Ocean County</u>	
Block No. <u>3</u>	Area of Block <u>60 acres</u>
1. Forest type: <u>Upland</u>	
2. Overwood: <u>Oak-pine, well stocked</u>	
Average diameter trees <u>6"</u> Average height <u>40'</u>	
3. Understory: <u>Medium; blueberry and huckleberry</u>	
4. Litter: <u>Medium; oak leaves and pine needles</u>	
5. Number of annual burns needed to reduce present fuel accumulation: <u>2</u>	
6. Frequency of burns thereafter: <u>at 4 to 5-year intervals</u>	
7. First burn recommended in winter of: <u>1947-48</u>	
8. Estimated degree of danger first burn: <u>Low</u>	
FORESTER <u>G. Smith</u>	

FIG. 2.—Sample sheet prepared for a 60-acre tract in a 2,000-acre holding.

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determine whether the single seed tree or two-cut shelterwood method is followed in these cuttings.

SUMMARY AND CONCLUSIONS

This paper summarizes the experience and research in using controlled burns in the Pine Region of southeastern New Jersey. The primary object of the use of fire as a tool is to provide protection of large blocks of forest land from the devastating fires that periodically sweep the area. Controlled burning does not eliminate the need for organized fire suppression, but supplements it.

At the same time this type of burning greatly favors reproduction of pines instead of that of the less desirable hardwoods.

The central principle of the recommended practice consists in the interspersal of burned with unburned units to provide favorable patterns of defense against the advance of wild fires. The controlled burning of the selected units should be done at favorable seasons of the year, mostly during the period between Christmas and March 1. On the basis of present data controlled burning at intervals of 4 to 5 years is indicated for upland stands in which the diameter of the average dominant is 3 inches or more.

In this region protection and silviculture are phases of the same problem. Controlled burning

can be used as a dual-purpose tool. On the basis of experience and study extending over 20 years, the authors are convinced that controlled burns are the key to management of upland sites in the Pine Region of southeastern New Jersey.

LITERATURE CITED

1. Chapman, H. H. 1942. Management of loblolly pine in the pine-hardwood region in Arkansas and in Louisiana west of the Mississippi River. Yale Univ. School Forestry Bul. 49. 150 pp., illus.
2. Little, S. 1946. The effects of forest fires on the stand history of New Jersey's Pine Region. Northeast. Forest Expt. Sta. Forest Management Paper 2. 43 pp., illus.
3. ——— and E. B. Moore. 1945. Controlled burning in South Jersey's oak-pine stands. Jour. Forestry 43:499-506, illus.
4. Lutz, H. J. 1934. Ecological relations in the pitch pine plains of southern New Jersey. Yale Univ. School Forestry Bul. 38. 80 pp., illus.
5. Moore, E. B. 1939. Forest management in New Jersey. N. J. Dept. Conserv. and Devel. 55 pp., illus.
6. New Jersey Department of Conservation and Development. 1938. The Bass River white pine plantation. N. J. Dept. Conserv. and Devel. Div. Forests and Parks Tech. Note 1. 2 pp.
7. ———. 1938. The growth of red pine plantations in North and South Jersey. N. J. Dept. Conserv. and Devel. Div. Forests and Parks Tech. Note 5. 3 pp.
8. Ostrom, C. E. 1938. Servant fires. Amer. Forests 44:118-19, illus.
9. Waksman, S. A. 1932. Principles of soil microbiology. The Williams and Wilkins Co., Baltimore, Md. 894 pp., illus.
10. Walton, W. R. 1928. Earthworms as pests and otherwise. U. S. Dept. Agric. Farmers Bul. 1569. 14 pp., illus.

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Fuel treatments reduce the severity of wildfire effects in dry mixed conifer forest, Washington, USA

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Abstract: To address hazardous fuel accumulations, many fuel treatments are being implemented in dry forests, but there have been few opportunities to evaluate treatment efficacy in wildfires. We documented the effectiveness of thinning and prescribed burning in the 2006 Tripod Complex fires. Recent fuel treatments burned in the wildfires and offered an opportunity to evaluate if two treatments (thin only and thin and prescribed burn) mitigated fire severity. Fire severity was markedly different between the two treatments. Over 57% of trees survived in thin and prescribed burn (thinRx) units versus 19% in thin only (thin) and 14% in control units. Considering only large-diameter trees (>20 cm diameter at breast height), 73% survived in thinRx units versus 36% and 29% in thin and control units, respectively. Logistic regression modeling demonstrates significant reductions in the log-odds probability of tree death under both treatments with a much greater reduction in thinRx units. Other severity measures, including percent crown, scorch and burn severity index, are significantly lower in thinRx units than in thin and control units. This study provides strong quantitative evidence that thinning alone does not reduce wildfire severity but that thinning followed by prescribed burning is effective at mitigating wildfire severity in dry western forests.

Résumé : Pour s'attaquer au danger que représente l'accumulation des combustibles, plusieurs traitements des combustibles ont été appliqués dans les forêts sèches, mais il y a eu peu d'occasions d'évaluer l'efficacité de ces traitements lors d'incendies de forêt. Nous avons documenté l'efficacité de l'éclaircie et du brûlage dirigé dans le cas des incendies du Tripod Complex de 2006. Les aires où les combustibles avaient été traités récemment ont brûlé lors de ces incendies, ce qui a fourni l'occasion d'évaluer si deux traitements (une éclaircie seule ou combinée à un brûlage dirigé) ont diminué la sévérité du feu. La sévérité du feu a été très différente selon le traitement. Plus de 57 % des arbres ont survécu dans les aires traitées par une éclaircie suivie d'un brûlage dirigé (ECLBRUL) comparativement à 19 % dans les aires qui avaient seulement été éclaircies (ECL) et 14 % dans les aires témoins. En ne considérant que les arbres de gros diamètre (>20 cm de diamètre à hauteur de poitrine), 73 % des arbres ont survécu dans les aires ECLBRUL comparativement à respectivement 36 % et 29 % dans les aires ECL et témoins. Un modèle de régression logistique a mis en évidence une réduction significative de la probabilité de mortalité des arbres dans le cas des deux traitements, mais la réduction était beaucoup plus forte dans les aires ECLBRUL. D'autres mesures de sévérité du feu, dont le pourcentage de roussissement des cimes et l'indice de sévérité du feu, avaient des valeurs significativement plus faibles dans les aires ECLBRUL que dans les aires ECL et témoins. Cette étude démontre clairement de façon quantitative que l'éclaircie appliquée seule ne réduit pas la sévérité des incendies de forêt, mais qu'une éclaircie suivie d'un brûlage dirigé est une mesure efficace pour diminuer la sévérité d'un incendie de forêt dans les forêts sèches de l'Ouest américain.

[Traduit par la Rédaction]

Introduction

With a legacy of fire suppression and exclusion, millions of hectares of dry forests in western North America have fuel accumulations that are considerably higher than prior to the 20th century (Covington 2003; Hessburg et al. 2005). Wildfire frequency and area burned have increased over the past 50 years, and this trend is expected to continue under global warming scenarios (Gillett et al. 2004; McKenzie et al. 2004; Westerling et al. 2006). A variety of fuel treatments are being applied to dry forests throughout the interior

West (see Agee and Skinner 2005 and Peterson et al. 2005 for reviews). Because regular prescribed burning generally reduces surface fuels, it is one of the more promising approaches to fire hazard reduction (Agee and Skinner 2005; Finney et al. 2005; Johnson et al. 2007). However, prescribed burn windows generally are short due to potential smoke impacts and fire hazard (Riebau and Fox 2001; Stephens and Ruth 2005). In most western forests, the area treated with fire remains low compared with the millions of hectares that might benefit from treatment (Stephens and Ruth 2005). Surrogate treatments involving forest thinning

Received 8 January 2010. Accepted 5 May 2010. Published on the NRC Research Press Web site at cjfr.nrc.ca on 24 July 2010.

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and biomass removal are being implemented in many dry forests (Graham et al. 1999; Peterson et al. 2005).

A central principle underlying most fuel reduction programs is that they will mitigate the occurrence of high-severity fire events in areas with historic high-frequency, low- and mixed-severity fire regimes (Agee and Skinner 2005). Although many fuel treatment programs are being implemented, there have been few opportunities to quantitatively evaluate treatment efficacy in wildfires. Existing studies generally agree that mechanical thinning followed by prescribed burning is the most effective at mitigating wildfire severity (Finney et al. 2005; Ritchie et al. 2007). The effectiveness of fuel reduction programs, particularly that of prescribed burning, is also supported by fire behavior and effects modeling (Stephens and Moghaddas 2005; Johnson et al. 2007). Better representation of forest types and climatic regimes is needed to assist managers in planning and prioritizing fuel treatments. More definitive evidence and guidelines on the relative effectiveness of different types of fuel treatments are also needed to provide the scientific basis for fuel treatment planning in the West.

We conducted an opportunistic study to determine the relative success of recent fuel treatments in mitigating wildland fire severity, as represented by tree mortality and damage (i.e., bole char and crown scorch). The 2006 Tripod complex fires burned over 70000 ha of mixed conifer forests and involved numerous fuel treatments, including units that had been thinned and prescribed burned within 10 years prior to the wildfire event. Our main objective was to evaluate differences in wildfire severity in stands with thin treatments (thin), thin and prescribed burning treatments (thinRx), and no treatment (control) within the Tripod Complex fires.

Methods

Study area

Treatment units are located within the southwestern section of the Tripod Complex fires approximately 10 km north of Winthrop, Washington (Fig. 1). The study area is located in the Methow Valley Ranger District of the Okanogan-Wenatchee National Forest. Climate is characterized by cold winters and warm dry summers with a prolonged summer drought. Mean annual temperature is 15.1 °C, ranging from -11.6 °C (January annual average minimum) to 30.1 °C (July annual average maximum) (Western Regional Climate Center, Winthrop, Washington, www.wrcc.dri.edu). Mean annual precipitation is 3600 mm with 70% of precipitation falling between October and March, predominantly as snow. Topography is highly dissected with steep slopes and numerous subdrainages (Barksdale 1975). Soils are generally coarse textured Andisols with high gravel content (Natural Resources Conservation Service 2008).

Study units are located in low- to midelevation forests (Table 1). These forests are primarily composed of multi-aged stands of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), ponderosa pine (*Pinus ponderosa* P.A.C. Lawson), and lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.). Western larch (*Larix occidentalis* Nutt.), Engelmann spruce (*Picea engelmannii* Parry ex Engelm.), grand fir (*Abies grandis* (Dougl. ex D. Don) Lindl.), and subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) are occa-

sional stand associates. Understory plant assemblages are sparse in these dry forests. Common shrubs include antelope bitterbrush (*Purshia tridentata* (Pursh) DC) and snowbrush (*Ceanothus velutinus* Dougl. ex Hook.). Common herbaceous species include beardless bluebunch wheatgrass (*Agropyron apicatum* var. *interme* (Scribn. & J.G. Sm.) Heller), pinegrass (*Calamagrostis rubescens* Buckl.), Idaho fescue (*Festuca idahoensis* Elmer), and raceme pussytoes (*Antennaria racemosa* Hook.) (Ohlson 1996).

Fires were historically common, with an estimated 2- to 18-year fire return interval between 1700 and 1900 from fire scar records at low elevations (Ohlson 1996). Over the past 50-100 years, fire intervals have lengthened due to fire exclusion, and forest assemblages have shifted from ponderosa pine dominance to higher densities of Douglas-fir (Lehmkühn et al. 1993). Prior to the Tripod Complex fires, wildfires had not occurred throughout much of the study area in over 80 years.

The 2006 Tripod Complex fire was one of the largest fire events for Washington State in the past 50 years. It was preceded by hot dry weather and an ongoing mountain pine beetle (*Dendroctonus ponderosae* Hopkins, 1902) outbreak in mid- to high-elevation lodgepole pine forests. The fires initiated as two lightning strikes and converged under extreme fire weather conditions, spreading as a mixture of crown fires and variable intensity surface fires. The fires initiated on 3 July and 23 July and were finally extinguished in early November from snow and rainfall events. Over 60% of the area burned was classified as moderate to high severity (US Forest Service 2008).

Sampling design and treatment description

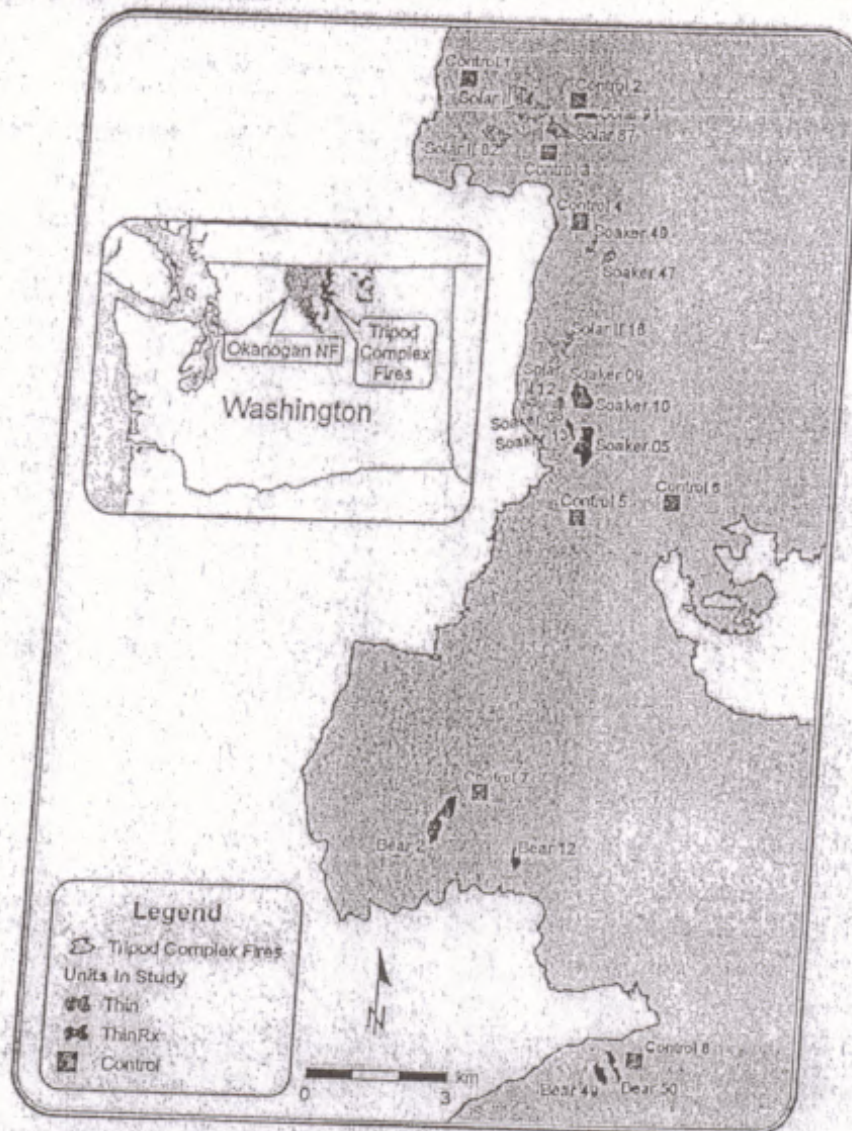
Of the treatment units available for this study, several were excluded because they were located along the wildfire perimeter or were surrounded by unburned forest. We also limited treatment units to those that had been harvested or prescribed burned within the past 15 years. Units adjacent to known burnout operations were also excluded from the study, but with increasing distance from where burnouts initiated, it was unclear whether units burned as a result of the wildfire or fires ignited in burnout operations. For a balanced study design, sample size was constrained by the availability of thinRx units that met selection requirements. Eight thinned units and eight thinRx units were selected for this study (Table 1).

Eight control units with no record of harvesting or burning were randomly selected within the matrix of treatment units. Control unit selection was buffered 0.4 km from the Tripod perimeter and within 0.8 km of road access. A standard area of 8 ha was delineated for each control unit. A 2006 Burned Area Reflectance Classification image (Forest Service Remote Sensing Applications Center) was used to confirm that selected controls were not surrounded by unburned forest and were burned by the wildfire.

Mechanical thinning prescriptions included both thin-from-below harvests that targeted small-diameter and understory trees and shelterwood harvests that removed both understory and overstory trees. All timber harvests were completed 8-15 years prior to the wildfire event and were mostly whole-tree harvested by tractor. The four Solar II thin units were helicopter logged, and tree crowns were left

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Fig. 1. Study area. Thin, recently thinned units; thinRx, recently thinned followed by prescribed burn units; control, unmanaged areas randomly selected throughout the burned area.



on site (Table 1). Recent (2006) burn plans are available for all Solar II units and estimated fuel loads include 9–13 Mg ha^{-1} of fine fuels (<7.6 cm diameter), 9–22.4 Mg ha^{-1} of large woody fuels (>7.6 cm diameter), 0.7–2 Mg ha^{-1} of litter, and 9–13 Mg ha^{-1} of duff. Burn plans (2003) also are available for three of the tractor-logged thin units (excluding Soaker 8) and include the following estimated fuel loads: 11–24 Mg ha^{-1} of fine woody fuels, 22–54 Mg ha^{-1} of large woody fuels, 5–7 Mg ha^{-1} of litter, and 6–11 Mg ha^{-1} of duff.

Prescribed burns were conducted on thinRx units between 0 and 6 years prior to the wildfire event. Hand lines were

constructed around each unit, and units were hand- or helicopter-ignited. Burning took place either in the spring or in the fall, and all burns were recorded as successful, with fuel coverage and accomplishing fuel reduction objectives of reducing fine fuels by 90%–100% and large fuels by up to 70%.

An additional paired sampling design was used to evaluate differences in fire severity between treated units and adjacent untreated control stands that had similar topography and likely experienced similar fire weather at the time of the wildfire. Adjacent areas were excluded if they were upslope of the treated unit, across a major road or perennial

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Table 1. Treatment unit names, area, estimated burn date(s), coordinates, aspect, slope gradient, and elevation.

Treatment	Unit(s)	Area (ha)	Estimated burn date(s)	UTM_E	UTM_N	Aspect (°)	Slope (%)	Elevation (m)
Control	C1	8.2	20 Aug.	712257	5397643	260	44	855
	C2	8.2	15 and 16 Aug.	714629	5397311	313	52	1409
	C3	8.2	18 and 19 Aug.	714114	5396203	323	45	1303
	C4	8.2	10 Aug.	714915	5394812	228	30	1731
	C5	8.2	20 Aug.	715484	5388596	157	31	1150
	C6	8.2	17 and 18 Aug.	717466	5389005	53	54	1266
	C7	8.2	10 Aug.	713983	5382667	97	21	1422
	C8	8.2	29 and 31 July	717795	5377142	236	36	1499
Thin	Soaker 8	4.9	16 Aug.	714860	5390967	177	46	1437
	Soaker 47	11.4	10 Aug.	715619	5394106	228	36	1747
	Soaker 49	3.3	10 Aug.	715227	5394285	162	27	1787
	Solar 87	12.2	18 Aug.	714260	5396683	210	31	1362
	Solar II 12	28.5	16 Aug.	714420	5391410	222	44	1399
	Solar II 16	11.0	14 Aug.	714821	5392234	257	31	1603
	Solar II 82	14.7	18 and 19 Aug.	712940	5396481	237	28	1165
	Solar II 84	41.9	16 and 17 Aug.	713540	5397157	237	23	1294
ThinRx	Bear 2	22.4	20 Aug.	713227	5382066	117	30	1430
	Bear 12	5.7	18 and 19 Aug.	714898	5381307	86	21	1495
	Bear 49	7.3	10 Aug.	717113	5376841	329	52	1450
	Bear 50	6.5	1 and 10 Aug.	717370	5377041	286	47	1437
	Soaker 5	8.1	16 Aug.	715509	5390125	134	27	1390
	Soaker 9 and 10	19.1	15 and 16 Aug.	715330	5391140	107	18	1432
	Soaker 13	4.5	16 Aug.	715175	5390480	226	26	1346
	Solar 91	5.3	16 Aug.	714816	5397017	211	26	1523
C_thin	Soaker 8 C	—	16 Aug.	714900	5390712	178	46	1394
	Soaker 47 C	—	10 Aug.	715546	5394260	219	33	1754
	Soaker 49 C	—	10 Aug.	715205	5394210	162	22	1768
	Solar 87 C	—	18 and 19 Aug.	714088	5396708	179	33	1313
	Solar II 82 C	—	18 and 19 Aug.	712844	5396575	239	35	1098
	Solar II 84 C	—	16 and 17 Aug.	713451	5431010	237	33	1247
	Bear 2 C	—	20 Aug.	713468	5381954	81	42	1077
	Bear 12 C	—	19 and 20 Aug.	714807	5381261	154	19	1501
C_thinRx	Bear 49 C	—	10 Aug.	717435	5377162	332	45	1428
	Bear 50 C	—	31 July, 1 Aug.	716919	5376747	296	52	1484
	Soaker 9 and 10 C	—	15 Aug.	715534	5391189	80	35	1385
	Soaker 13 C	—	16 Aug.	715115	5390397	234	46	1308

Note: Sampling area was not determined for adjacent controls. Control, control unit; Thin, thin unit; ThinRx, thinned followed by prescribed burn unit; C_thin, adjacent control to thin unit; C_ThinRx, adjacent control to thin and prescribed burn unit.

streams from the treatment, and (or) had distinctly different topography (i.e., >30% slope gradient and (or) >90° difference in aspect). Not all thin and thinRx units had suitable adjacent controls. A total of six thin and six thinRx units were paired with adjacent controls (Table 1).

Due to the geographic span of treatment units, sample plots burned over a range of days in late July and August. Approximate burn dates were estimated from a fire progression map and are listed in Table 1. Fire behavior between 29 July and 1 August was recorded as low with some localized fire spread and crown fire activity. Predicted maximum temperatures were 17–27 °C and minimum relative humidities were 20%–50% with midflame windspeeds of 3–6 km·h⁻¹. Fire activity increased substantially on 10 August with extreme fire behavior noted in many areas. Predicted maximum temperatures were 18–23 °C and minimum relative humidity was 45%–55% with strong winds between 16 and

24 km·h⁻¹ with gusts up to 40 km·h⁻¹. Most of our study units burned between 15 and 20 August, and extreme fire behavior was noted during this period, including active crowning and rapid fire spread. Predicted maximum temperatures were 21–29 °C and minimum relative humidity was 14%–27%. Predicted midflame windspeeds were between 14 and 27 km·h⁻¹. Fire danger ratings reached a 10-year high between 17 and 20 August.

Field sampling methods

Units were sampled with circular plots along systematic grids. We used a nested plot sampling design to accommodate variable tree densities. Treated units (e.g., thin and thinRx) were sampled using 0.2 ha plots. Control units were sampled using 0.08 ha plots to account for generally much higher tree densities in all size classes. In stands with tree densities <30 trees per plot irrespective of size class, an

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trees were tallied within the largest radius plot. In denser stands, smaller tree size classes were sampled in subplots: trees between 10 and 20 cm diameter at breast height (DBH) were sampled in 25.4 m radius subplots and trees <10 cm DBH were sampled in 5.1 m radius subplots. Trees with heights <1.4 m were not sampled. A minimum of 10% of each unit was surveyed.

Plots were marked with a permanent center stake and numbered metal tag. At each plot, we collected general plot information including site description, aspect, slope gradient, slope position (i.e., lower slope, midslope, upper slope, ridgetop), and site severity for the entire plot (US Department of the Interior National Park Service 2003). The following measurements were collected for each sampled tree: DBH (centimetres), crown base height (metres), height to live crown (metres), tree height (metres), maximum height of crown scorch (metres), minimum and maximum bole char (metres), percentage of the crown volume that was scorched, and tree severity index (US Department of the Interior National Park Service 2003). Tree burn severity classes were defined as follows: 1 = unburned, 2 = scorched foliage, 3 = lightly burned (some foliage and small twigs burned), 4 = moderately burned (foliage and small stems consumed), and 5 = severely burned (only charred stems remain). Recent downed trees that fell after the wildfire (e.g., logs with uncharred wood at severed stems) were tallied as trees. For consistency in observations, field personnel regularly compared and calibrated estimates of percent crown scorch, site severity index, and tree severity index.

Live trees were tagged at tree bases facing plot center for sampling of tree status in subsequent years. During the summers of 2008 and 2009, plots that had live trees in 2007 were revisited to record subsequent tree mortality. Plots with 100% mortality were marked in the center but were not revisited in subsequent years.

Data analysis

Individual stand variables and fire severity measures were summarized by unit (Table 2). To test for differences in tree mortality following wildfire between thin, thinRx, and controls, we conducted a one-factor ANOVA on measures of tree fire severity for thin units, thinRx units, and controls (Sail et al. 2007). Where ANOVA indicated statistical differences between treatments (including treatments and adjacent controls), pairwise comparisons were made using Tukey honestly significant differences tests. In cases where data were not normally distributed, equivalent nonparametric tests were used.

Because tree mortality data are binary (i.e., either live or dead), we used binomial generalized linear modeling to evaluate effectiveness of treatments on tree mortality (R programming language). A logistic model was constructed to predict the proportion of dead trees by treatment type ($p < 0.05$).

With greater crown heights and thicker bark, large-diameter trees have a better likelihood of survival than small trees (Agee 1993). Small trees were more numerous in thin and control units than in thinRx units. To remove this potential bias, we performed an additional set of analyses on trees >20 cm DBH.

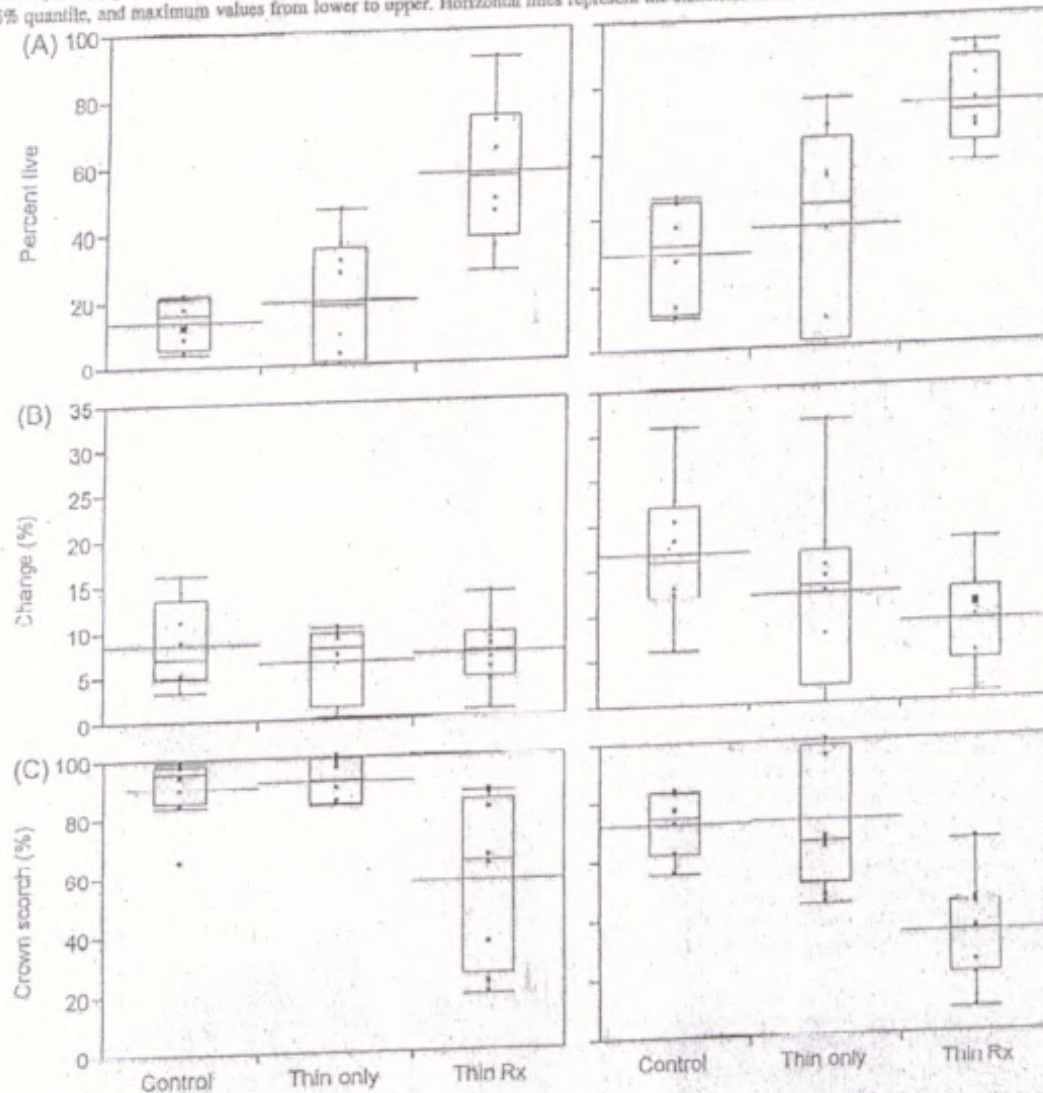
Table 2. Mean and SD (in parentheses) of stand variables and fire severity measures.

Stand variables			Fire severity measures						
Diameter (cm)	Density (trees·ha ⁻¹)	Crown base height (m)	Height (m)	Height to live crown (m)	Crown scorch maximum height (m)	Minimum bole char (m)	Maximum bole char (m)	% crown scorch	Burn severity index (1–5)
All trees									
Control	11.8 (2.7) ^a	1403 (463) ^a	9.0 (1.8)	8.8 (2.4) ^a	8.4 (1.5)	2.2 (1.5)	3.7 (1.6)	90.1 (11.6) ^a	2.7 (0.3) ^a
Thin	15.7 (7.1) ^a	475 (360) ^b	10.6 (3.1)	8.1 (2.4) ^a	9.8 (3.2)	2.5 (2.1)	5.3 (3.2)	91.8 (7.4) ^a	2.8 (0.2) ^a
ThinRx	22.1 (8.3) ^b	172 (131) ^b	12.4 (4.0)	5.9 (1.3) ^b	7.3 (1.6)	0.9 (1.1)	2.4 (1.2)	57.3 (28.0) ^b	2.3 (0.5) ^b
Large-diameter trees (>20 cm DBH)									
Control	35.1 (5.9)	166 (58) ^a	20.1 (2.3)	10.3 (1.8) ^a	17.3 (2.2) ^a	4.7 (2.9) ^a	8.0 (2.3) ^a	72.3 (10.9) ^a	2.4 (0.3) ^a
Thin	38.0 (4.4)	78 (18) ^b	18.6 (1.4)	7.4 (4.7) ^b	16.0 (2.5) ^a	4.1 (3.6) ^a	7.9 (3.9) ^a	72.5 (22.7) ^a	2.5 (0.4) ^a
ThinRx	37.3 (3.1)	53 (30) ^b	9.5 (2.0)	7.4 (1.7) ^b	11.2 (3.2) ^b	0.7 (0.3) ^b	3.2 (1.1) ^b	34.9 (17.5) ^b	1.9 (0.3) ^b

Note: Significant differences ($p < 0.05$, *t*-test) between control units, thin plots, and thinned and prescribed burn up to six indicated by different letters.

Note: Significant differences ($p < 0.05$, bold text) between control units, thin units, and thinRx and prescribed burn units are indicated by different letters.

Fig. 2. (a) Percent live trees by treatment for all trees and large-diameter trees (>20 cm DBH), (b) percent change in mortality 1 and 2 years postfire, and (c) percent crown scorch by treatment for all trees and large-diameter trees. Box plots represent minimum, 25% quantile, median, 75% quantile, and maximum values from lower to upper. Horizontal lines represent the statistical mean of all units within each treatment.



Results

Stand characteristics vary by treatment type (Table 2). As expected, tree density is significantly lower in thinRx and thin units than in control units. Thin units tend to be denser than thinRx units, but this difference is not significant. Tree diameter is significantly higher in thinRx units than in thin and control units. There are no significant differences in tree height or height to crown base between treatments.

Most fire severity measures in thinRx units significantly differ from those in thin and control units. As of 2009, over 57% of all trees survived in thinRx units versus 19% in thin

and 14% in control units (Fig. 2). Other tree severity measures, including percent crown scorch and burn severity index, are significantly lower in thinRx units than in thin and control units (Table 2). Mean percent crown scorch is over 90% in thin and control units compared with 57% in thinRx units. In contrast, there are no significant differences in fire severity measures between thin and control units.

Differences in tree severity are more evident when only large-diameter trees (>20 cm DBH) are considered. Over 73% of large-diameter trees survived in thinRx units versus 36% in thin and 29% in control units (Fig. 2). All measures of large-diameter tree severity in thinRx units are signifi-

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cantly different from those in thin and control units (Table 2). Maximum bole char is over 7.9 m in thin and control units versus 3.2 m in thinRx units. Percent crown scorch is 72% in thin and control units versus 34% in thinRx units. Considering only large trees, there still are no significant differences in fire severity measures between thin and control units.

The paired analysis of treated units versus adjacent controls resulted in similar findings (Table 3). Compared with adjacent controls, tree diameter is significantly higher in thinRx units. Tree density is significantly lower in both thin and thinRx units compared with adjacent controls. Considering all tree diameters, tree mortality and other measures of fire severity (i.e., minimum/maximum bole char, percent crown scorch, and burn severity) are significantly lower in thinRx units than in adjacent controls. There are no significant differences in fire severity measures between thin units and adjacent controls. When only large-diameter (>20 cm DBH) trees are considered, results are again very similar. Mean height and diameter of large trees are significantly higher in both thin and thinRx units than in adjacent controls. Although differences in fire severity measures are highly significant between thinRx and adjacent controls, there are no significant differences between thin units and adjacent controls.

Logistic regression models reveal significant reductions of the log-odds probability of tree death under both thin and thinRx treatments (Table 4). Both thin and thinRx treatments reduced the log-odds probability of tree mortality relative to adjacent controls, but thinRx treatments had much greater reductions than thin treatments (Table 4). Results are similar when only large-diameter trees are considered.

Tree mortality was surveyed for 3 years following the wildfire event. Following the initial survey in 2007, an additional 18% of trees died in 2008, and 7% of trees subsequently died in 2009. Percent change in tree mortality between 2007 and 2009 does not significantly differ by treatment (Fig. 2). Tree mortality markedly differs by species (Fig. 3) with the lowest mortality for western larch (21%) and ponderosa pine (39%) and highest mortality for lodgepole pine (91%) and Engelmann spruce (88%). Overall mortality for Douglas-fir is 66%.

Discussion

This study provides strong quantitative evidence that without treatment of surface fuels, thinning does not reduce tree mortality during a large wildfire. With lower tree densities and fewer understory trees than unmanaged controls, thin units likely were effective at reducing crown fire potential but not tree mortality. We did not observe evidence of crown fire in thin stands. In the first 2 years following the wildfire, red needles were retained on most dead trees (Fig. 4). In contrast, control units comprise a mixture of scorched patches of trees and areas where needle and branchwood in tree crowns were consumed by fire. High tree mortality in thin units likely was associated with cambial healing and crown scorch from intense surface fires. Maximum bole char and crown scorch height both were highest in thin units, suggesting long flame lengths and particularly high-intensity surface fires in those units.

Table 3. Mean differences and SE of the mean difference (in parentheses) between adjacent controls and treated units.

		Stand variables				Fire severity measures					
		Diameter (cm)	Density (trees/ha)	Crown base height (m)	Height (m)	Height to live crown (m)	Crown scorch maximum height (m)	Minimum bole char (m)	Maximum bole char (m)	% crown scorch	Burn severity index (1-5)
All trees											
Thin vs. control		4.4% (3.291)	-430 (191)	-0.031 (0.709)	2.024 (1.457)	0.917 (2.318)	1.776 (1.618)	-1.968 (2.051)	0.175 (2.078)	0.658 (6.126)	-0.142 (0.189)
ThinRx vs. control		8.755 (4.377)	-714 (208)	0.688 (1.111)	3.995 (2.415)	-2.083 (1.167)	-1.696 (1.779)	-1.975 (0.579)	-2.004 (0.746)	-37.610 (12.243)	-0.462 (0.194)
Large-diameter trees (>20 cm DBH)											
Thin vs. control		5.166 (3.050)	-717 (128)	0.295 (0.685)	0.894 (0.724)	1.047 (2.692)	0.454 (1.468)	-4.092 (3.092)	-2.524 (2.844)	-6.770 (12.506)	-0.205 (0.225)
ThinRx vs. control		6.028 (1.844)	-115.6 (29.0)	0.9296 (1.2858)	2.814 (1.159)	-1.4228 (0.9590)	-4.5809 (1.9237)	-4.1761 (1.5230)	-4.2645 (1.4822)	-42.610 (7.785)	-0.5233 (0.1294)
Note: Positive differences indicate that treated values are greater than controls. Significant differences ($p \leq 0.05$) are indicated by bold text.											

Note: Positive differences indicate that treated values are greater than control. Significant differences ($p < 0.05$) are indicated by bold text.

Table 4. Mean percentage of live trees and SE and binary generalized linear regression models of tree mortality in 2009.

Treatment	Mean % live (SE)	Equation coefficient (SE)
Standard control, all trees		
Null variance reduction 30%		
Control (β_0)	13.91 (2.63)	1.8283 (0.0125)
Thin (β_1)	19.43 (6.52)	-0.5002 (0.0222)
ThinRx (β_2)	57.39 (7.70)	-1.7037 (0.0303)
Standard control, large trees		
Null variance reduction 41%		
Control (β_0)	29.24 (5.70)	0.9382 (0.0278)
Thin (β_1)	36.47 (10.68)	-0.6664 (0.0476)
ThinRx (β_2)	73.11 (4.69)	-1.8721 (0.0593)
Adjacent thin control, all trees		
Null variance reduction 3%		
Adjacent control (β_0)	17.08 (7.85)	1.6229 (0.0169)
Thin (β_1)	25.90 (6.76)	-0.4251 (0.0252)
Adjacent thin control, large trees		
Null variance reduction 13%		
Adjacent control (β_0)	27.63 (11.80)	-0.9494 (0.0343)
Thin (β_1)	48.63 (9.73)	-0.9514 (0.0535)
Adjacent thinRx control, all trees		
Null variance reduction 20%		
Adjacent control (β_0)	29.44 (6.50)	1.2810 (0.0173)
ThinRx (β_2)	63.13 (7.10)	-1.4534 (0.0407)
Adjacent thinRx control, large trees		
Null variance reduction 56%		
Adjacent control (β_0)	40.02 (6.95)	0.5754 (0.0365)
ThinRx (β_2)	77.34 (5.01)	-1.7349 (0.0731)

Note: Regression models reflect the change in log odds of mortality relative to control units. The equation form is $\log\text{-odds}(\text{mortality}) = \log[p/(1-p)] = \beta_0 + \beta_1 X_{1j} + \beta_2 X_{2j}$, where p is the probability of mortality, β is each equation coefficient, $X_{1j} = 0$ for control and thinRx units and 1 for thin units, and $X_{2j} = 0$ for control and thin units and 1 for thinRx units. The equation intercept is the log odds of mortality for control units. Negative coefficient values indicate a reduction in log odds of mortality in treated units relative to the control. All equation coefficients are significant at $p < 0.05$.

Dispersed logging slash combined with extreme fire weather likely contributed to intense surface fire behavior and high tree mortality in thin units. Piled and burning of logging slash might have mitigated wildfire severity (Strom and Pule 2007) but was not conducted on any thin units. Because this was an opportunistic study, we have limited information about prefire surface fuel conditions. In all thin units, logging slash was characterized by forest managers as light using fuel model 11 with $<12 \text{ Mg}\cdot\text{ha}^{-1}$ of fine woody fuels $<20.3 \text{ cm}$ in diameter (Anderson 1982). Litter accumulations were low, with depths $<2 \text{ cm}$. Prefire shrub cover was not recorded, but shrub cover is low in these dry forests and probably did not contribute substantially to surface fire behavior. Prefire surface fuel data are not available on thinRx units, but prescribed burns were reported as successful in all units, with a reduction of $>90\%$ of fine surface fuels. Treatment of fine, downed woody debris and litter as accumulations likely reduced surface fire intensity, flame lengths, and convective and radiative heating in thinRx units and contributed to lower postfire severity measures as compared with thin and control units.

Although tree density is not significantly different between thin and thinRx units, thin units generally have higher tree densities associated with a higher proportion of small-diameter trees and saplings than thinRx units. When considering only large-diameter trees, overall tree mortality is still much higher in thin than in thinRx units and is not significantly different from that in control units. Differences in fire severity measures between treatments (i.e., maximum height of crown scorch, minimum/maximum bole char, percent crown scorch, and tree burn severity index) were all higher in our analysis of large-diameter trees. In both thin and thinRx units, large-diameter trees are almost exclusively Douglas-fir, ponderosa pine, and western larch, all species that are resistant to fire at larger diameters and therefore have a better chance of survival (Agee 1993). Two thin units (Solar II 82 and 84) are exceptions, with mortality comparable with that in thinRx units. Both units were helicopter-logged and recorded fine woody fuel accumulations similar to those in other thinned units. Adjacent controls sustained high tree mortality, indicating that the units had severe wildfire around them. However, large-diameter ponderosa pines

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Fig. 3. Percent live trees by major tree species in 2007, 2008, and 2009.

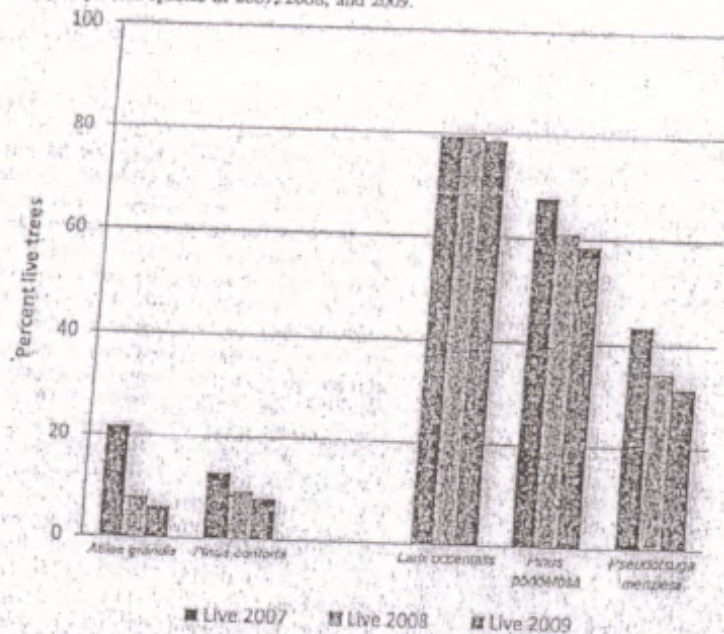
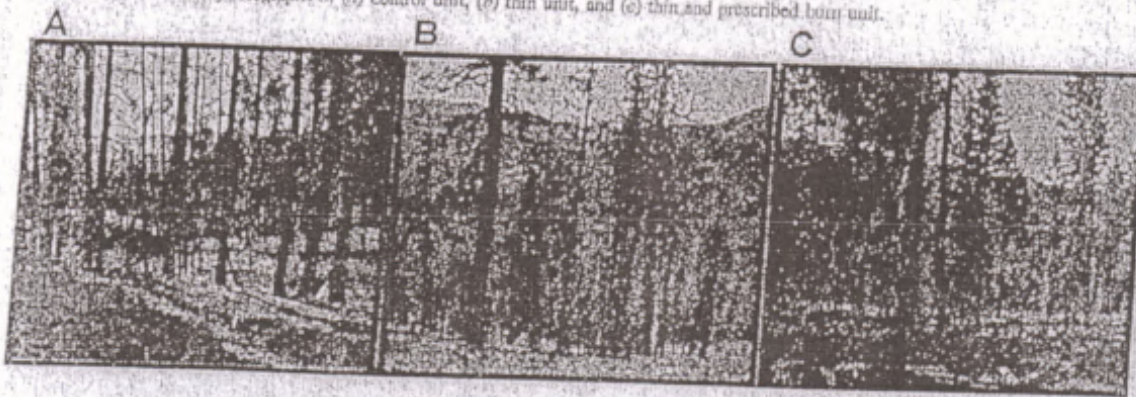


Fig. 4. Representative photographs of (a) control unit, (b) thin unit, and (c) thin and prescribed burn unit.



were common in both stands and may have contributed to lower mortality on these units. Our results strongly suggest that thinning alone does not mitigate wildfire severity, even when considering large-diameter trees.

When all tree sizes are considered, two thinRx units (Soaker 5 and Bear 50) have relatively high mortality. Both units were mechanically thinned, but clusters of small-diameter trees were retained. Mortality of these small-diameter trees may have been associated with the prescribed burn of the units and preceded the wildfire event.

Unit size does not appear to be a factor in treatment effectiveness. Even small thinRx units (4–5 ha in size) had low fire severity, indicating that size may not be as important as treatment type in predicting fire severity. Our results suggest that small units with low tree density and low surface fuels can alter fire behavior and reduce fire severity

within a larger matrix of high-intensity wildfire (Agee et al. 2000). Small units may not affect landscape fire spread (Finney et al. 2005) but could provide protection buffers of local resources such as structures, municipal water sources, and rare species habitat (Johnson 2008).

Location-specific records of burnout operations are not available for the Tripoli Complex fires. However, based on known ignition points, it is likely that some thin and thinRx units (specifically Soaker 5, 8, and 13 and Solar II 12) were impacted by burnout operations rather than the actual wildfire. At lower elevations, burnouts tended to be of higher intensity than the actual wildfire (Rick Lind, Tensas Ranger Station, personal communication). The two thinRx units (Soaker 5 and 13) effectively mitigated fire severity, whereas the two thin units (Soaker 8 and Solar II 12) had high mortality. However, it is possible that fire severity

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may have been lower in these thin units had they not been involved in burnout operations.

Wildfires can be extremely variable in fire spread and intensity due to changeable environmental conditions such as fire weather and topography. When we designed this study, we added an additional analysis of adjacent controls to test for differences between treatments in areas that presumably experienced similar fire weather and behavior as the wildfire burned into the control and treated units. Our analysis of adjacent controls demonstrated very similar results to those of our balanced ANOVA design and corroborates our findings.

Management implications

Results from this study closely agree with published field research and fire behavior and effects modeling. In a field-based, retrospective study of five wildfires in the interior West, Omi et al. (2006) found that thinning followed by slash treatment was the most effective at reducing fire severity, whereas thin treatments failed to reduce fire severity and in some cases increased it. Finney et al. (2005) evaluated the efficacy of prescribed burning in the 2002 Rodeo-Chediski fire in Arizona and reported significant relationships between the age, size, and frequency of past prescribed burns and lower fire severity. Strom and Fule (2007) studied thinned stands where slash had been piled and burned in the Rodeo-Chediski fire and found significant reductions in fire severity compared with untreated stands. Safford et al. (2009) also reported significant differences in tree mortality in thinned units where slash had been piled and burned relative to untreated areas in the Angora fire, California. In a study of fire severity following a wildfire in northern California, Ritchie et al. (2007) reported the highest tree survivorship in units that were thinned and prescribed burned. The effectiveness of fuel reduction programs, prescribed burning in particular, is also supported by fire behavior and effects modeling (Raymond and Peterson 2005; Stephens and Moghaddas 2005; Johnson et al. 2007). The national Fire and Fire Surrogates study also demonstrated that prescribed burns treatments were more effective than mechanical treatments at reducing surface fuels (Schwilk et al. 2009).

Given the similar findings to other studies, our results should be applicable to many dry forests with low- to mixed-severity fire regimes in the western United States. However, they may not apply to forests with flammable shrub and (or) grassland understories. Both thinning and prescribed burning can increase shrub dominance by creating gaps in the forest canopy (Bailey and Tappeiner 1998). For forest types in which flammable understory shrubs could be released by fuel treatments, the efficacy and longevity of treatments could be reduced compared with the dry forests of our study area. For example, in a landscape analysis of fire severity in the 2002 Biscuit fire in southwestern Oregon, Thompson and Spies (2009) reported that shrub cover was one of the most important predictors of fire severity. Plantations and other clearings involved in the Biscuit fire experienced the highest incidence of fire severity and were associated with a flammable shrub stratum.

Although individual fuel treatments may be effective at reducing fire severity, they may do little to alter fire spread across landscapes unless they are strategically placed (Agee

et al. 2000; Agee and Skinner 2005; Finney et al. 2005). Strategic placement of fuel treatments can be difficult to implement under complex terrain and management units (e.g., wildlife reserves, riparian corridors) (Peterson and Johnson 2007) but may be necessary to suppress and/or alter the course of fire spread (Finney 2007). Our study concentrated on fuel treatment effectiveness within specific treatment units and not on landscape patterns of fire spread. However, landscape fire spread did appear to be influenced by previous wildfires and fuel treatments. The most striking example of this was the approximately 1000 ha 1974 Forks fire located in the center of the Tripod perimeter. The Tripod Complex fires originated to the south and north of the old fire and wrapped around either side of the young lodgepole pine forest, burning only the edges of the regenerating trees. Similarly, a network of fuel treatments is located along the southwestern fire perimeter and was used as defensible space for back-burning to prevent fire spread toward nearby communities.

Conclusions

From fire behavior and effects modeling and available field-based studies, it appears that fuel treatments that reduce surface fuels can reduce fire severity. However, little is known about the effectiveness of fuel treatments in steep terrain and under extreme fire weather (Peterson et al. 2005). Although fuel treatments in this study appear to have had an impact even under extreme fire weather and steep terrain, weather and topography may supersede the importance of fuel treatments in other situations (Bessie and Johnson 1995; Cary et al. 2009). Validation of the effects of silvicultural and fuels management techniques for additional wildfires using real-time fire weather and behavior records would increase confidence in using these treatments more broadly to reduce fire hazard in fire-prone landscapes.

Increasing evidence shows that mechanical thinning followed by surface fuel removal is the most effective management approach to mitigate wildfire severity in dry forests. However, fire and fuel managers face numerous challenges in developing strategies for fuel reduction treatments. Prescribed fire is less expensive than mechanical or manual fuel removal but is often difficult to implement due to smoke management concerns and narrow windows of safe burning conditions. Targeting critical areas such as wildland-urban interfaces and appropriate forest types (e.g., those that historically supported high-frequency, low-intensity fire regimes) may help optimize resources (Agee et al. 2000; Agee and Skinner 2005; Peterson et al. 2007). Strategic placement of these fuel treatments may also be effective at limiting fire spread across critical landscapes (Finney 2007).

Acknowledgments

This study was funded by the Joint Fire Sciences Program and the USDA Forest Service Pacific Northwest Research Station. We thank Cameron Balog, Jon Dvorak, Travis Fiedel, Amy Jirka, Phil Monsonio, Joe Restaino, Shawn Smith, and Aaron Sengsirikul for conducting fieldwork. We thank John Daily, Gary Reed, Tom Ketchum, Meg Trebon, and Rick Lind for information on the Tripod Complex fires and logistical support. We thank Bob Vihnanek for field

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crew supervision, Paige Eagle for database analysis, Robert Nierheim and Travis Freed for GIS analysis, and Maureen Kennedy for statistical assistance. We also thank Donald McKenzie, Clint Wright, Maureen Kennedy, Roger Ottmar, and three anonymous reviewers for invaluable comments on the manuscript.

References

- Agee, J.K. 1993. Fire ecology of Pacific Northwest forests. Island Press, Washington, D.C.
- Agee, J.K., and Skinner, C.N. 2005. Basic principles of forest fuel reduction treatments. *For. Ecol. Manag.* 211(1-2): 83-96. doi:10.1016/j.foreco.2005.01.034.
- Agee, J.K., Balro, B., Finney, M.A., Omi, P.N., Sapsis, D.D., Skinner, C.N., van Wageningen, J.W., and Weatherspoon, C.P. 2000. The use of shaded fuelbreaks in landscape fire management. *For. Ecol. Manag.* 127(1-3): 55-66. doi:10.1016/S0378-1127(99)00116-4.
- Anderson, H.E. 1982. Aids to determining fuel models for estimating fire behavior. U.S. For. Serv. Gen. Tech. Rep. INT-GTR-122.
- Bailey, J.D., and Taper, J.C. 1998. Effects of thinning on structural development in 40- to 100-year-old Douglas-fir stands in western Oregon. *For. Ecol. Manag.* 108(1-2): 99-113. doi:10.1016/S0378-1127(98)00216-3.
- Backdale, J.D. 1975. Geology of the Methow Valley. Bull. 68. Washington State Division of Geology and Earth Resources. Seattle, Wash.
- Bessie, W.C., and Johnson, H.A. 1995. The relative importance of fuels and weather on fire behavior in subalpine forests. *Ecology*, 76(3): 747-762. doi:10.2307/1939341.
- Cary, G.J., Flannigan, M.D., Keano, R.D., Dryden, R.A., Davies, I.D., Lenihan, J.M., Li, C., Logan, K.A., and Parsons, R.A. 2009. Relative importance of fuel management, ignition management, and weather for area burned: evidence from five landscape-fire-incubation models. *Int. J. Wildland Fire*, 18(2): 147-58. doi:10.1071/WF07085.
- Covington, W.W. 2003. Restoring ecosystem health in frequent-fire forests of the American West. *Ecol. Res.* 21(1): 7-11. doi:10.3368/er.21.1.7.
- Finney, M.A. 2007. A computational method for optimizing fuel treatment locations. *Int. J. Wildland Fire*, 16(6): 702-711. doi:10.1071/WF06062.
- Finney, M.A., McHugh, C.W., and Grenfell, I.C. 2005. Stand- and landscape-level effects of prescribed burning on two Arizona wildfires. *Can. J. For. Res.* 35(7): 1714-1722. doi:10.1139/x05-090.
- Gillett, N.P., Wehner, A.J., Zwiers, F.W., and Flannigan, M.D. 2004. Detecting the effect of climate change on Canadian forest fires. *Geophys. Res. Lett.* 31(L18211): 1-4. doi:10.1029/2004GL020876.
- Graham, R.L., Harvey, A., Jain, T., and Tonn, J.R. 1999. The effects of thinning and similar stand treatments on fire behavior in western forests. U.S. For. Serv. Gen. Tech. Rep. PNW-GTR-463.
- Hessburg, P.F., Agee, J.K., and Franklin, J.F. 2005. Dry forests and wildland fires of the inland Northwest USA: contrasting the landscape ecology of pre-settlement and modern eras. *For. Ecol. Manag.* 211(1-2): 117-139. doi:10.1016/j.foreco.2005.02.016.
- Johnson, M.C. 2008. Analyzing fuel treatments and fire hazard in the Pacific Northwest. Ph.D. thesis, College of Forest Resources, University of Washington, Seattle, Wash.
- Johnson, M.C., Peterson, D.L., and Raymond, C.L. 2007. Guide to fuel treatments in dry forests of the western United States: assessing forest structure and fire hazard. U.S. For. Serv. Gen. Tech. Rep. PNW-GTR-636.
- Lehmkuhl, J.F., Hessburg, P.F., Ottmar, R.D., Everett, R.L., Alvarado, E., and Vihnanek, R.H. 1993. Historic and current vegetation pattern and associated changes in insect and disease hazard, and fire and smoke conditions in eastern Oregon and Washington. In *Eastside forest ecosystem health assessment. Vol. III. Edited by Paul F. Hessburg. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station*, pp. 589-718.
- McKenzie, D., Gotsdolf, Z., Peterson, D.L., and Mote, P. 2004. Climate change, wildfire, and conservation. *Conserv. Biol.* 18(4): 890-902. doi:10.1111/j.1523-1739.2004.00492.x.
- Natural Resources Conservation Service. 2008. Soil survey geographic (SSURGO) database for Okanogan - Methow Highlands Area, WA. WA 749. USDA Natural Resources Conservation Service, Fort Worth, Tex.
- Ohlson, T.H. 1996. Fire regimes of the ponderosa-pine-Douglas-fir-beardless bluebunch wheatgrass plant association in the Methow Valley of North Central Washington. M.S. thesis, Washington State University, Pullman, Wash.
- Omi, P.N., Martinson, E.J., and Chong, G.W. 2006. Effectiveness of pre-fire fuel treatments. Joint Fire Sciences Program. Final Rep. 03-2-1-07. Joint Fire Sciences Program, Boise, Idaho.
- Peterson, D.L., and Johnson, M.C. 2007. Science-based strategic planning for hazardous fuel treatment. *Fire Manag. Today*, 67: 13-18.
- Peterson, D.L., Johnson, M.C., Agee, J.K., Jain, T.B., McKenzie, D., and Reinhardt, R.R. 2005. Forest structure and fire hazard in dry forests of the western United States. U.S. For. Serv. Gen. Tech. Rep. PNW-GTR-628.
- Peterson, D.L., Everts, L., Gravenmier, B., and Eberhardt, E. 2007. A consumer guide: tools to manage vegetation and fuels. U.S. For. Serv. Gen. Tech. Rep. PNW-GTR-690.
- Raymond, C.L., and Peterson, D.L. 2005. Fuel treatments alter the effects of wildfire in a mixed-evergreen forest, Oregon, USA. *Can. J. For. Res.* 35(12): 2961-2965. doi:10.1139/x05-206.
- Riebau, A.R., and Fox, D. 2001. The new smoke management. *Int. J. Wildland Fire*, 10(4): 415-427. doi:10.1071/WF01039.
- Ritchie, M.W., Skinner, C.N., and Hamilton, T.A. 2007. Probability of tree survival after wildfire in an interior pine forest of northern California: effects of thinning and prescribed fire. *For. Ecol. Manag.* 247(1-3): 200-208. doi:10.1016/j.foreco.2007.04.044.
- Safford, H.D., Schmidt, D.A., and Carlson, C.H. 2009. Effects of fuel treatments on fire severity in an area of wildland-urban interface, Angora Fire, Lake Tahoe Basin, California. *For. Ecol. Manag.* 258(5): 773-787. doi:10.1016/j.foreco.2009.05.024.
- Sall, J., Creighton, L., and Lehman, A. 2007. JMP start statistics: a guide to statistics and data analysis using JMP. 4th ed. SAS Press Series. SAS Institute Inc., Cary, N.C.
- Schwilk, D.W., Keeley, J.E., Knapp, E.E., McIver, J., Bailey, J.D., Fettig, C.J., Fiedler, C.E., Harrod, R.J., Moghaddas, J.J., Outcall, K.W., Skinner, C.N., Stephens, S.L., Waldrop, T.A., Vasey, D.A., and Youngblood, A. 2009. The National Fire and Fire Surrogate study: effects of fuel reduction methods on forest vegetation structure and fuels. *Ecol. Appl.* 19(2): 285-304. doi:10.1890/07-1747.1. PMID: 19323191.
- Stephens, S.L., and Moghaddas, J.J. 2005. Experimental fuel treatment impacts on forest structure, potential fire behavior, and predicted tree mortality in a California mixed conifer forest. *For. Ecol. Manag.* 215(1-3): 21-36. doi:10.1016/j.foreco.2005.03.070.
- Stephens, S.L., and Ruth, L.W. 2005. Federal forest-fire policy in

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- the United States. *Ecol. Appl.* 15(2): 532-542. doi:10.1890/1051-0761(2004)15[532:U.S.]2.0.CO;2
- Strom, B.A., and Fule, P.Z. 2007. Pre-wildfire treatments affect long-term postcross pine forest dynamics. *Int. J. Wildland Fire*, 16(1): 128-135. doi:10.1071/WF06031.
- Thompson, J.R., and Spies, T.A. 2009. Vegetation and weather explain variation in crown damage within a large mixed-severity wildfire. *For. Ecol. Manag.* 258(7): 1684-1694. doi:10.1016/j.foreco.2009.07.031.
- US Department of the Interior National Park Service. 2003. Fire monitoring handbook. Fire Management Program Center, National Interagency Fire Center, Boise, Idaho.
- US Forest Service. 2005. Final environmental impact statement, Methow Valley Ranger District, Winthrop, Wash.
- Westerling, A.L., Hidalgo, H.G., Cayan, D.R., and Swetnam, T.W. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science*, 313(5789): 940-943. doi:10.1126/science.1128834. PMID: 16825536.

ANNEXURE 2

WORKING PLAN
OF
DEHRADUN FOREST DIVISION
SHIWALIK CIRCLE
VOLUME - I
PART-II
(FUTURE MANAGEMENT)
PERIOD
(2020-21 TO 2029-30)



Revised under the supervision of
Sanjeev Chaturvedi, I.F.S.

C.C.F. Working Plan,
Uttarakhand

Compiled & Submitted by
P.K. Patro, I.F.S.
C.F/ Working Plan Officer

2010 10 10

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- iv. Use of modern technologies such as use of Drone and satellite-based alert system are very useful for timely detection of forest fire.
- v. Provision of enough communication and transport system.
- vi. Public participation by making them aware that it is their moral & legal responsibility to report & to help in controlling fire.
- vii. Making all the telephone numbers (of forest officials) public to facilitate people to report.

19.22.2.2 Control Measures:

- i. Counter-firing and beating the fire with trained firefighting crew.
- ii. Adequate number of firefighting crew at crew stations to be ready to control fire on 24-hour basis.
- iii. Provision of transportation (Jeep/Tractor with trolley & water tankers) for each range for fast response & to minimize damage.
- iv. Adequate hand tools for firefighting to be made available at crew stations.
- v. Modern equipment like Leaf blower, pressurized water sprinkler, fire extinguishing balls etc. are very useful.

19.22.2.3 Firefighting methods: The different methods of fire fighting in the forest are as follows:

- i. **Extinguishing with water:** Small forest fire can be extinguished by throwing water on it. But there is limitation to this method in the sense that water may not be available in the areas. On the other hand, fire does not occur in areas near water source or moist areas.
- ii. **Extinguishing with soil (earth):** Soil or earth can be used for extinguishing forest fire because it is always available at sites. The soil can be dug out and thrown to the fire to put out. If fire occurs in hard and rocky areas it is not feasible to use this method. Most of the areas of the division are of such nature.
- iii. **Extinguishing with beating:** Surface fires are generally controlled by beating them out. For this purpose, 'jhapa' are made of branches of the nearby shrubs and small trees. Then, men standing on the periphery of the fire beat it out. This is the best way to extinguish creeping, ground and surface fires.
- iv. **Extinguishing with counter-fire:** Crown fire and infernos are controlled by counter-fire. People move ahead of the fire and start burning the areas in the opposite direction after clearing line. In such case, the two fires from the opposite direction meet somewhere and got extinguished. This is usually the best method to fight big fire and the safest.

19.22.2.4 Mopping up: This is very important for the success of firefighting works done on the ground. In places where smoke is coming out from burnt debris; burning material should be opened so that unburnt fuel can also burn. Mopping up should be done in such a way that the fire does not spread to adjoining areas. Following precautions are necessary in mopping up operation:

- i. Smouldering blocks, bushes and trees should be checked properly and any trace of fire should be extinguished with soil or water before leaving the area.
- ii. Sufficient manpower should be employed for extinguishing the remaining fire. The tools like Pulaski and others should be used for this purpose.

- iii. The big heaps of ash should be spread to find out any fire that maybe present in it and the same should be extinguished.

19.22.2.5 Hand tools: The following hand tools are of great utility during control of forest fire effectively:

- i. Double edge axe: This is utilized for cutting shrubs, branches of trees.
- ii. Brush hook: This is utilized for cutting shrubs, and branches of trees.
- iii. Pulaski: This is used for removing roots of trees and shrubs and also utilized for cutting shrubs.
- iv. Macloid: It is used for making and cleaning fire lines and for throwing Soil.
- v. Shovel: This is used for throwing earth and can also be used for cutting branches up to 2 cm diameter.
- vi. Rake: This is used for clearing leaves twigs etc.
- vii. Naif Sake pump: This is used for mopping up works.

19.22.2.6 Other Control Measures: Effective fire management requires three steps, i.e. prevention, detection & control. Following are some of other important activities: -

- i. Preparation of annual fire plan
- ii. preparation of annual fire risk map.
- iii. Creation of Public awareness.
- iv. Annual assessment of infrastructure and equipment.

19.23 Fire reporting & assessment of damage: This is also an important aspect of fire management & for preparation of future strategy. The check list is as follows:

- i. Number of fire incidents, mapping and measuring the area.
- ii. Investigation- causes, lapses in fire prevention and reporting, responsibility of personnel.
- iii. Assessment of fire damage.
- iv. Fire effects on top canopy, middle, lower and ground vegetation & forest floor
- v. Fire effects on ground & soil conditions.
- vi. Injuries to trees and effects on growth due to damage to leaves, stems & barks.
- vii. Damage to young seedlings and regeneration.
- viii. Effect on micro-climate and vegetation tending towards xerophytic succession.
- ix. Damage to animals, birds, Insects and micro-organisms.
- x. Effect on ecology and environment.

19.23.1 Assessment of the Loss Caused by Fire: Fire causes both tangible and intangible damages to the forests and wild life. Loss of regeneration, timber, NTFP and wildlife are tangible while loss of soil fertility, soil constituent and wild life habitat etc. are intangible. Fire damages lead to increase in rate of soil erosion and causes drying up of water sources. Fire causes adverse effect on regeneration and destroys under growth leading to invasion by weeds. Natural succession goes into retrogression. Wild animals and birds are killed.

19.23.2 The valuation of loss caused by forest fire is generally calculated on the basis of direction issued vide Chief W.P letter no. 638/27-2, dated, 22.1.2020. Detail is given below: -



ANNEXURE 3
**कार्यालय प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।**

दूरसं० 0135-2746934, 2741461, फैक्स-2741630, 2741462 ईमेल -pccfuk@gmail.com

सेवा में,

समस्त प्रभागीय वनाधिकारी/उप निदेशक,
उत्तराखण्ड।

विषय :- वनों की अग्नि सुरक्षा व्यवस्था वर्ष 2025 के सम्बन्ध में दिशा-निर्देश।

महोदया/महोदय,

उत्तराखण्ड वनाग्नि घटनाओं की दृष्टि से अत्यन्त ही संवेदनशील प्रदेश है। प्रतिवर्ष ग्रीष्मकाल में प्रदेश के अन्तर्गत वनाग्नि घटनाएँ घटित होती हैं। अधिकांश वनाग्नि घटनाएँ चीड़ बाहुल्य वन क्षेत्रों के अन्तर्गत होती हैं। वनाग्नि की घटनाओं के कारण प्राकृतिक वन सम्पदा एवं वन्यजीवों को क्षति के साथ ही यहां की जैव-विविधता पर भी अत्यन्त ही प्रतिकूल प्रभाव पड़ता है। वनाग्नि की रोकथाम हेतु वनाग्नि सत्र प्रारम्भ होने से पूर्व ही वनाग्नि सुरक्षा के सभी समुचित उपाय कठोरता से लागू किये जाने अत्यन्त ही आवश्यक हैं। अतः वनाग्नि सत्र-2025 में वनाग्नि की रोकथाम एवं प्रभावी नियंत्रण हेतु निम्नलिखित दिशा-निर्देश निर्गत किये जाते हैं :-

- 1- **National Action Plan on Forest Fire (NAPFF)** – पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार के पत्रांक F.No. 8-4/2016-FPD, दिनांक 24.04.2018 जो कि इस कार्यालय के पत्रांक 144/27-1, दिनांक 14.05.2018 द्वारा पूर्व ही आपको प्रेषित किया गया है, द्वारा तैयार किये गये National Action Plan on Forest Fire (NAPFF) के अनुसार प्रदेश में वनाग्नि सुरक्षा एवं आपदा प्रबन्धन हेतु आवश्यक कार्यवाही सुनिश्चित की जाये।
- 2- **नियंत्रित दाहन** – वन क्षेत्रों में कार्ययोजना के अनुसार प्रस्तावित वार्षिक एवं द्विवार्षिक नियंत्रित दाहन का कार्य 15 फरवरी, 2025 तक अवश्य पूर्ण कर लिया जाये। ऐसे वन क्षेत्र जो अधिक ऊँचाई (1600 मी० से ऊपर) पर स्थित हैं तथा जहां पर अधिक नमी के कारण नियंत्रित दाहन एवं फुकान कार्य 15 फरवरी तक सम्पन्न नहीं हो सकता है, वहां नियंत्रित दाहन माह मार्च के प्रथम पक्ष तक अनिवार्य रूप से पूर्ण किया जाये अथवा इन क्षेत्रों से ज्वलनशील पदार्थ एकत्र कर उसका निस्तारण किया जाये। प्रभागों के अन्तर्गत की जाने वाली कन्ट्रोल बर्निंग के सम्बन्ध में स्थानीय मीडिया/समाचार पत्रों एवं अन्य सोशल मिडिया में भी समय-समय पर जानकारी उपलब्ध करायी जाये।
- 3- **फायर लाईन** – फायर लाईनों के कटान/फुकान की व्यवस्था फायर सीजन प्रारम्भ होने से पूर्व पूर्ण कर ली जाये। प्रभागों द्वारा यह सुनिश्चित किया जाये कि फायर लाईनों को प्रयोग की स्थिति में रखें, जिसका एक निश्चित अन्तराल में प्रभावी सुपरविजन किया जाये। वे वन मार्ग जो फायर लाईनों का कार्य करते हैं, उन्हें चिन्हित कर ज्वलनशील तत्वों से मुक्त रखा जाये। फायर लाईनों के अनुरक्षण/सफाई हेतु मा० उच्चतम न्यायालय द्वारा दिनांक 18.05.2023 को पारित निर्णय के अनुसार कार्यवाही हेतु पूर्व ही निर्देश निर्गत किये हैं। निर्गत निर्देशों के अनुसार समयान्तर्गत कार्यवाही सुनिश्चित की जाये।
- 4- **मास्टर कन्ट्रोल रूम** – समस्त प्रभागीय वनाधिकारी (अक्षेत्रीय वन प्रभागों तथा भूमि संरक्षण, सिविल व सोयम तथा डैम प्रभागों को सम्मिलित करते हुए) अपने-अपने प्रभागों में स्थापित मास्टर कन्ट्रोल रूम को 24 घन्टे सक्रिय रखेंगे। इस हेतु प्रभागों में स्थापित मास्टर कन्ट्रोल रूम में

वनाग्नि शमन सम्बन्धी समस्त उपकरण/संसाधनों को अध्यावधिक करते हुए तदनुसार कार्यवाही सुनिश्चित की जाये।

- 5- **जिला स्तरीय फायर प्लान** – जिला स्तरीय वनाग्नि प्रबन्धन समिति की बैठक आयोजित कर दिनांक 10 नवम्बर, 2024 तक जिला स्तरीय फायर प्लान का अनुमोदन करा लिया जाये तथा समस्त विभागों के जिला स्तरीय अधिकारियों को जिलाधिकारियों के स्तर से निर्देश निर्गत कराने का कार्य किया जाये। जिला स्तरीय फायर प्लान की अनुमोदित प्रति दिनांक 15 नवम्बर, 2024 तक सम्बन्धित वन संरक्षकों के साथ ही मुख्य वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड को अनिवार्य रूप से उपलब्ध करा दी जाये।
- 6- **राजस्व भूमि तथा सिविल एवं सोयम वनों में अग्नि सुरक्षा** – राजस्व भूमि तथा सिविल एवं सोयम वनों में वनाग्नि प्रबन्धन एवं अग्नि शमन व्यवस्था स्थापित करने हेतु जिलाधिकारियों को सम्बन्धित जिला संयोजकों के स्तर से पत्र प्रेषित किया जाये। ऐसे वनों की वनाग्नि सुरक्षा हेतु संबंधित उप जिलाधिकारियों का उत्तरदायित्व जिलाधिकारियों के स्तर से निर्धारित कराया जाना आवश्यक है। इसके अतिरिक्त सिविल सोयम एवं भूमि संरक्षण वन प्रभागों द्वारा समीपवर्ती क्षेत्रीय वन प्रभागों के अन्तर्गत घटित वनाग्नि घटनाओं के नियंत्रण में पूर्ण सहयोग किया जायेगा, इसका विशेष ध्यान रखा जाये।
- 7- **फायर डेंजर रेटिंग** – प्रत्येक रेंज मुख्यालय पर मौसम मापन यंत्र स्थापित कर प्रतिदिन मापन, विश्लेषण और चेतावनी (तापमान, आर्द्र-शुष्क वायु दबाव और बेग, फ्यूल मॉडल, फायर डेंजर रेटिंग) को प्रस्तारित कराया जाये। इसके साथ ही एफ0एस0आई0 की वैबसाइट पर उपलब्ध फायर प्रोन एरिया मैपिंग का भी नियमित संज्ञान लिया जाये।
- 8- **वायरलैस संचार व्यवस्था** – वायरलैस संचार व्यवस्था को हर समय हर स्तर पर सुचारु रखा जाये, किसी भी वायरलैस सैट में कोई खराबी आये तो तत्काल इसकी मरम्मत करायी जाये। आवश्यकतानुसार पुलिस वायरलैस सिस्टम तथा स्थानीय पुलिस वायरलैस की भी मदद ली जा सकती है।
- 9- **क्रू-स्टेशन** – प्रभागों में स्थापित फायर क्रू-स्टेशनों में टीम लीडर व कार्मिकों की शीघ्र तैनाती कर दी जाये। प्रत्येक क्रू-स्टेशन में वनाग्नि शमन सम्बन्धी समस्त उपकरण/संसाधनों को अध्यावधिक करते हुए तदनुसार कार्यवाही सुनिश्चित की जाये।
- 10- **मॉकड्रिल** – यह सुनिश्चित किया जाये कि रेंजों में वनाग्नि सत्र से पूर्व एवं वनाग्नि सत्र के मध्य एक निश्चित अवधि के अन्तराल में क्रू-स्टेशनवार अधिक से अधिक मॉकड्रिल का आयोजन किया जाये। मॉकड्रिल के सम्बन्ध में विस्तृत सूचना मुख्य वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड को ई-मेल (nodalforestfire.uk@gmail.com) के माध्यम से उपलब्ध कराना सुनिश्चित किया जाये। मॉकड्रिल की कार्यवाही में सम्बन्धित विभागों, वन पंचायत सरपंचों, महिला/युवा मंगल दलों के साथ ही अन्य स्वयं सेवी संस्थाओं को भी सम्मिलित किया जाये।
- 11- **प्रचार-प्रसार** – वनाग्नि की रोकथाम हेतु वृहद् स्तर पर प्रचार-प्रसार हेतु यथा आवश्यक कार्यवाही की जाये, इस व्यवस्था के अन्तर्गत विभिन्न समाचार पत्रों/मीडिया के माध्यम से स्थानीय जनता को जागरूक किया जाये। इसके साथ ही वन क्षेत्रों के समीपवर्ती गांवों में वन विभाग के प्रति सद्भावना उत्पन्न कर वनाग्नि की रोकथाम हेतु उन्हें प्रोत्साहित करने के उपाय किये जायें। जनपद अल्मोड़ा के अन्तर्गत ग्राम शीतलाखेत, टिहरी में जड़धार गाँव व बालगंगा रेंज के अन्तर्गत स्थानीय ग्रामीण महिलाओं द्वारा वन क्षेत्रों का स्वयं संरक्षण करते हुए वनाग्नि से बचाव हेतु कार्यवाही की गयी है। अन्य क्षेत्रों से भी ग्रामीणों/महिला मंगल दल/वन पंचायतों के सदस्यों को उक्त क्षेत्रों का Exposure visit करवाने की भी कार्यवाही सुनिश्चित की जाये ताकि अन्य क्षेत्रों में भी इसी प्रकार की कार्यवाही को बढ़ावा दिया जा सके। अग्निकाल के दौरान प्रत्येक सप्ताह प्रचार-प्रसार का विवरण ई-मेल के माध्यम से मुख्य वन संरक्षक, ईकोटूरिज्म एवं

- 12- **जन-सहयोग** — उत्तराखण्ड शासन, वन एवं पर्यावरण अनुभाग-2 के शासनादेश संख्या-454/1(2)व0ग्रा0वि0/2004-9(22)/2001, दिनांक 27 मार्च, 2004 द्वारा वनाग्नि सुरक्षा हेतु जिलास्तरीय, विकासखण्ड एवं वन पंचायत स्तर पर समितियों के गठन हेतु निर्देश जारी किये गये हैं। विकासखण्ड एवं वन पंचायत स्तर पर समितियों का गठन नहीं किया गया है और न ही इस स्तर पर क्षेत्र में बैठकें की जाती हैं। शासनादेश के अनुसार इन समितियों का गठन तथा इनके स्तर से वनाग्नि सुरक्षा के उपाय सुनिश्चित कराये जायें। समय-समय पर गोष्ठियां आयोजित कर वनाग्नि सुरक्षा हेतु रणनीति तैयार करायी जाये तथा अधिक से अधिक जन सहयोग प्राप्त किया जाये। वन पंचायतों को भी वनाग्नि सुरक्षा कार्यक्रम में जोड़ा जाये। समस्त वन क्षेत्राधिकारियों को आपात स्थिति के लिए स्वयं सेवक दलों, युवक मंगलदल, महिला मंगलदल आदि से सहयोग प्राप्त करने हेतु प्रेरित किया जाये। इस हेतु वन पंचायत/ग्रामसभा स्तर पर जागरूकता बैठकों/प्रशिक्षणों का आयोजन सुनिश्चित किया जाये।
- 13- **अन्तर्विभागीय समन्वय** —राजस्व विभाग, पुलिस विभाग, चिकित्सा, लोक निर्माण विभाग, वन पंचायत आदि अन्य विभागों से समन्वय स्थापित किया जाये। आवश्यकता पड़ने पर सेना व अर्द्धसैनिक बलों का वनाग्नि नियंत्रण हेतु सहयोग प्राप्त किया जाये। सिविल सोयम एवं पंचायती वनों में वनाग्नि की रोकथाम/नियंत्रण एवं शमन में राजस्व एवं पुलिस विभाग के कर्मचारियों का दायित्व सम्बन्धित जिलाधिकारी द्वारा निर्धारित किया जाता है। प्रभागीय वनाधिकारियों का यह दायित्व होगा कि वनाग्नि की दैनिक व साप्ताहिक सूचना हेतु निर्धारित प्रारूप में सिविल सोयम एवं पंचायती वनों में होने वाली वनाग्नि दुर्घटनाओं का विवरण सम्मिलित किया जाये।
- 14- **पैट्रोलिंग/दौरे (क्षेत्र भ्रमण)** —वनाग्निकाल में प्रभागीय वनाधिकारी व उप प्रभागीय वनाधिकारी अपने क्षेत्रों में इस प्रकार पर्याप्त निरीक्षण/भ्रमण तथा संवेदनशील क्षेत्रों में रात्रि विराम करेंगे ताकि प्रभावी अनुश्रवण के साथ ही समस्त क्रू-स्टेशनों, समीपवर्ती ग्रामों/वन पंचायतों को वनाग्नि रोकथाम हेतु जागरूक किया जा सके। प्रभागीय वनाधिकारी कम से कम 20 दिन मुख्यालय से बाहर अपने कार्यक्षेत्र में क्षेत्र भ्रमण पर रहें, उप प्रभागीय वनाधिकारी 3-4 दिनों में रेंजों के फायर क्रू-स्टेशनों का निरीक्षण कर आवश्यक व्यस्थाएँ सुनिश्चित करेंगे।
- 15- **संसाधन प्रबन्धन** —प्रभागों एवं रेंजों में उपलब्ध वाहनों जैसे-जीप, ट्रक एवं टैक्टर ट्रॉली आदि को अच्छी दशा में रखा जाये। जो वाहन किराये पर लिए जायेंगे उनकी विस्तृत सूचना वन संरक्षक व एफ0एफ0आर0एम0एस0 पर प्रेषित की जायेगी। वनाग्नि रोकथाम हेतु उपकरणों को क्रू-स्टेशनों में आवश्यकतानुसार निर्धारण कर आवंटित किया जाये। समस्त वाचटावरों का निरीक्षण कर उन्हें प्रयोग की स्थिति में लाया जाये।
- 16- **FFMIS का उपयोग** — वनाग्नि सत्र के दौरान प्रभागों के अन्तर्गत घटित प्रत्येक वनाग्नि दुर्घटना को प्रतिदिन विभाग की वैबसाईट पर बने Forest Fire Management Information System (FFMIS) पर इन्द्राज किया जाये।
- 17- **सतर्कता व्यवस्था** —प्रभागों द्वारा चिन्हित संवेदनशील एवं अतिसंवेदनशील स्थानों को वरीयता देते हुए सतर्कता व्यवस्था सुनिश्चित की जाये ताकि सरारती तत्वों से वनों को आग से बचाया जा सके।
- 18- **सूचना का आदान-प्रदान** —वनाग्नि दुर्घटना की प्रथम सूचना और जाँच की अन्तिम सूचना संबंधित वन संरक्षक व मुख्य वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड को तत्परता से प्रेषित की जाये।
- 19- **लीसा कूपों एवं वृक्षारोपण स्थलों की सुरक्षा** — रागरत वृक्षारोपण क्षेत्रों, लीसा कूपों तथा रूखे-गिरे वृक्षों को वनाग्नि से सुरक्षित रखने हेतु विशेष व्यवस्था की जाये।

- 20- **बनाग्नि घटना की रिपोर्ट** —प्रभागवार/जनपदवार बनाग्नि की दैनिक रिपोर्ट निर्धारित प्रारूप में संकलित कर सम्बन्धित वन संरक्षक/निदेशक को प्रतिदिन अपराह्न 1:00 बजे तक उपलब्ध करायी जाये। सभी वन संरक्षक/निदेशक अपने-अपने वृत्तों की सूचना संकलित कर सम्बन्धित मुख्य वन संरक्षकों को अपराह्न 1:30 बजे तक तथा समस्त क्षेत्रीय मुख्य वन संरक्षक अपने मण्डलों की संकलित सूचना अपराह्न 2:00 बजे तक मुख्यालय को उपलब्ध करायेंगे। इसी प्रकार साप्ताहिक एवं मासिक रिपोर्ट निर्धारित प्रपत्र में संकलित कर प्रेषित की जायेगी। बनाग्नि सम्बन्धी सूचनाओं के लिए 85-87, राजपुर रोड, देहरादून स्थिति राज्य एवं बनाग्नि आपदा प्रबन्धन कक्ष के टोल फ्री नं० 18001804141, लेन्डलाईन 0135-2744558 एवं व्हाट्सएप नं० 9389337488 का अधिकाधिक प्रयोग एवं प्रचार-प्रसार किया जाये तथा प्रदेश स्तर पर इनके माध्यम से सूचनाओं का आदान-प्रदान किया जाये।
- 21- **लोक निर्माण विभाग व सीमा सड़क संगठन (डी0जी0बी0आर0) द्वारा मोटर मार्गों के पक्कीकरण** कार्यों के दौरान बनाग्नि व सावधानीपूर्वक एवं सतर्कता के साथ उपयोग करने हेतु यथोचित निर्देश निर्गत करते हुए इन विभागों की अधिकारियों/कर्मचारियों/श्रमिकों का बनाग्नि नियंत्रण/प्रबन्धन में अपेक्षित सहयोग भी प्राप्त किया जाये। यह सुनिश्चित किया जाये की लोक निर्माण विभाग व सीमा सड़क संगठन (डी0जी0बी0आर0) द्वारा मोटर मार्गों के पक्कीकरण कार्यों पर क्षेत्रीय वन कर्मियों द्वारा पूर्ण निगरानी रखी जाये।
- 22- **FSI के फायर अलर्ट सिस्टम (3.0 Version) को लागू किया जाना** — FSI द्वारा विकसित किये गये फायर अलर्ट सिस्टम (3.0 Version) से विभागीय कार्मिकों के साथ ही प्रदेश के अन्तर्गत समस्त वन पंचायत सरपंचों, ग्राम प्रधानों, महिला/युवा मंगल दलों के सदस्यों, स्थानीय ग्रामवासियों के साथ ही स्थानीय प्रशासन, राजस्व विभाग के कार्मिकों को भी अनिवार्य रूप से जोड़ा जाना है। क्योंकि बनाग्नि नियंत्रण में इनके भी महत्वपूर्ण भूमिका होती है। वर्तमान तक इस सिस्टम में 9479 subscriber जोड़े गये हैं, इन्हें और अधिक बढ़ाये जाने की आवश्यकता है। इस सम्बन्ध में पूर्व में ही समुचित निर्देश निर्गत किये गये हैं तथा प्रभागवार लक्ष्य भी आवंटित किये गये हैं। अतः निर्देशानुसार कार्यवाही सम्पादित करते हुए इसकी सूचना मुख्य वन संरक्षक, बनाग्नि एवं आपदा प्रबन्धन व इस कार्यालय को भी प्रेषित की जाये।
- 23- **Forest Fire Alerts and Feedback** — प्रभागीय वनाधिकारी यह सुनिश्चित करेंगे कि उनके द्वारा एफ0एस0आई0 से प्राप्त प्रत्येक फायर अलर्ट पर ऑनलाईन फीडबैक अंकित किये जाये। यह सुनिश्चित किया जाये कि शत-प्रतिशत ऑनलाईन फीडबैक दिया जाये। एफ0एस0आई0 की वेबसाइट पर फायर अलर्ट प्राप्त करने हेतु ऑनलाइन पंजीकरण के लिए मुख्य वन संरक्षक, अनुश्रवण, मूल्यांकन, आई0टी0 एवं आधुनिकीकरण, उत्तराखण्ड के पत्रांक 448/27-1, दिनांक 21.09.2019 तथा मुख्य वन संरक्षक, बनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड के पृष्ठांकन पत्रांक 154/27-1, दिनांक 03.12.2019 द्वारा सभी प्रभागीय वनाधिकारियों को User ID एवं Password प्रदान किये गये हैं। अतः दिये गये निर्देशानुसार कार्यवाही सुनिश्चित की जाये।
- 24- **Forest Fire Uttarakhand Mobile App :-** प्रदेश के अन्तर्गत विगत वर्षों की बनाग्नि प्रबन्धन के अनुभवों के आधार पर बनाग्नि सूचना प्रबन्धन प्रणाली को आई0टी0 आधुनिकीकरण का उपयोग कर digitization किया जायेगा, जिससे बनाग्नि की रोकथाम में लगने वाले response time में अत्यधिक कमी लाई जा सकती है। वर्तमान में Forest Fire Uttarakhand Mobile App को विकसित किया गया है, जो कि android phone के लिए ही develop की गयी है। सभी फील्ड अधिकारियों/कर्मचारियों द्वारा Forest Fire Uttarakhand Mobile App को अनिवार्य रूप से install करना आवश्यक है। इस ऐप के संचालन हेतु प्रत्येक वन प्रभाग से 02 मास्टर ट्रेनर, 01 कम्प्यूटर ऑपरेटर एवं 01 मास्टर कंट्रोल रूम कार्मिक को प्रशिक्षण हेतु नामित किया जायेगा। प्रशिक्षण प्रभागीय वनाधिकारी, हरिद्वार वन प्रभाग, हरिद्वार द्वारा प्रदान किया जायेगा। प्रशिक्षण प्राप्त करने के उपरान्त मास्टर ट्रेनरों द्वारा प्रभागीय स्तर पर अन्य समस्त कार्मिकों को प्रशिक्षित किया जायेगा। Forest Fire Uttarakhand Mobile App में GIS mapping हेतु beat boundary,

sal, oak & pine forest layer एवं रें 822 नियों की GPS location I.T.Cell द्वारा उपलब्ध करायी जायेगी। माह अक्टूबर में इस ऐप की प्रदेश स्तर पर mock drill (Trial) कराते हुए माह नवम्बर, 2024 तक प्रत्येक क्र-स्टेशन पर उक्त मोबाईल ऐप का शत प्रतिशत mock drill (Trial) कर लिया जाये।

25- Moisture Regime :- वनाग्नि सत्र 2025 से पूर्व वनाग्नि के दृष्टिकोण से अतिसंवेदनशील/संवेदनशील वन क्षेत्रों के अन्तर्गत (विशेष रूप से जिन क्षेत्रों में गतवर्ष वनाग्नि की अधिक घटनायें प्रकाश में आयी हैं) Moisture Regime बढ़ाने हेतु मृदा एवं जल संरक्षण कार्य जैसे – चाल-खाल, जलकुण्डों आदि का निर्माण कार्य बजट की उपलब्धता के आधार पर करवाये जाने आवश्यक हैं जो कि वनाग्नि नियंत्रण/प्रबन्धन हेतु सहायक सिद्ध होगा। अतः प्रभागों में उपलब्ध बजट के आधार पर मृदा एवं जल संरक्षण कार्य सम्पादित किये जाये।

26- वन पंचायतों की भागीदारी :- वनाग्नि सत्र-2025 में वनाग्नि घटनाओं के प्रभावी नियंत्रण/रोकथाम हेतु वन पंचायतों का भी पूर्ण सहयोग प्राप्त किया जाये। इस हेतु अभी से प्रभागों के अन्तर्गत स्थित वन पंचायतों के सरपंचों/सदस्यों के साथ ही स्थानीय ग्रामीणों के साथ समय-समय पर बैठकों का आयोजन करते हुए अपेक्षित सहयोग हेतु अनुरोध किया जाये ताकि वनाग्नि सत्र में वनाग्नि घटनाओं के प्रभावी नियंत्रण हेतु सामाजिक सहभागिता सुनिश्चित की जा सके।

27- Forest Fire Risk Zonation/ Sensitivity Mapping :-

❖ वर्ष 2011 से 2021 तक Incidences की Frequency एवं विभिन्न अन्य घटकों क्रमशः वन सस्य का प्रकार, वन सस्य का घनत्व, ऊँचाई, आस्पेक्ट, स्लोप, मार्गों से दूरी, बस्तियों से समीपता आदि को दृष्टिगत रखते हुए Forest Fire Risk Zonation Maps तैयार कर प्रभागों को पूर्व ही उपलब्ध करा दिये गये हैं। उक्त स्थानों में वनाग्नि दुर्घटनाओं को Risk classes के अनुसार कार्यवाही सुनिश्चित की जाये।

❖ विगत वर्षों में वनाग्नि घटनाओं के स्थलीय बीट वार analysis कर sensitivity ज्ञात की गयी। उक्त मानचित्रों में दर्शायी गयी बीटों की संवेदनशीलता के आधार पर वनाग्नि आधार-भूत संरचना (Infrastructure), क्रू-स्टेशनों में कार्मिकों की तैनाती एवं रेंजों में बजट आवंटन की कार्यवाही सुनिश्चित की जाये।

❖ वनाग्नि नियंत्रण/प्रबन्धन हेतु गतिमान राज्य सैक्टर की योजनाओं, केन्द्र पोषित योजना (फारेस्ट फायर प्रिवेन्शन एन्ड मैनेजमेन्ट स्कीम) एवं कैम्पा-एन0पी0वी0 के अन्तर्गत बजट के आवंटन की कार्यवाही Forest Fire Risk Zonation तथा उक्तानुसार की गयी sensitivity mapping के आधार पर ही की जाये।

❖ राज्य स्तर/जिला स्तर/प्रभाग स्तर पर तैयार की जा रही वनाग्नि प्रबन्ध योजना-2025 के निरूपण में भी Fire Risk Zones का उपयोग करते हुए वनाग्नि प्रबन्धन कार्यों को क्षेत्र विशेष की आवश्यकता के अनुसार सूचित किया जाये।

28- Action taken Report — प्रभागवार एफ0एस0आई0 से एक दिन पूर्व प्राप्त active fire alerts एवं large fire alerts की Action Taken Report निर्धारित प्रारूप में प्रतिदिन अपराह्न 12:00 बजे कार्यालय मुख्य वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड को उपलब्ध करायी जाये।

29- उच्च हिमालीय क्षेत्रों हेतु विशेष रूप से निम्न बिन्दुओं पर ध्यान देते हुए कार्यवाही सुनिश्चित की जाये:-

- उच्च हिमालयी क्षेत्रों में आने-जाने वाले व्यक्तियों पर निगरानी रखी जाये तथा इस बारे में खूफिया जानकारी ली जाये।
- शिकारियों के प्रवेश के मध्यनजर वन्यजन्तु वाहुल्य क्षेत्रों में अधिकाधिक गश्त/पैट्रोलिंग की जाये तथा क्षेत्र के चरवाहों से शिकारियों के बारे में जानकारी प्राप्त की जाये।

- क्षेत्र में अस्त्र लाइसेंसधारी/गैर लाइसेंसधारी व्यक्तियों की जानकारी प्राप्त करने हेतु जिला अधिकारी एवं ग्रामवासियों से सम्पर्क स्थापित कर उनके अस्त्रों तथा विगत में प्रयोग किये गये कारतूसों आदि के बारे में जानकारी प्राप्त कर ली जाये।
- ग्रीष्मकाल में बुग्याली क्षेत्रों में प्रवास कर रहे घरवाहों पर नियंत्रण रखा जाये तथा उन्हें वनाग्नि के बारे में जानकारी देते हुए वनाग्नि नियंत्रण में उनका सहयोग प्राप्त किया जाये।
- जनपद में तैनात सैन्य व अर्द्धसैनिक बलों (आई.टी.बी.पी., एस.एस.बी. आदि) से निरन्तर सम्पर्क स्थापित करते हुए आवश्यकता पड़ने पर वनाग्नि की रोकथाम हेतु इनका सहयोग प्राप्त किया जाये।

उपरोक्त के अतिरिक्त पूर्व में समय-समय पर वनों की अग्नि सुरक्षा हेतु शासन/इस कार्यालय तथा मुख्य वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन द्वारा जारी निर्देशों का भी अनुपालन सुनिश्चित किया जाये। अक्षेत्रीय वन प्रभागों यथा- भूमि संरक्षण, सिविल एवं सोयम तथा डैम वन प्रभागों के समस्त अधिकारी एवं कर्मचारी भी उपरोक्तानुसार वनों की सुरक्षा में अपना योगदान देंगे।

भवदीय,

Signed by

Dhananjai Mohan

Date: 04/05/2024 मोहन

प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।

प्रतिलिपि :- प्रमुख सचिव, वन एवं पर्यावरण, उत्तराखण्ड शासन को सादर सूचनार्थ प्रेषित।

प्रतिलिपि :- निम्नलिखित को इस आशय से प्रेषित कि उपरोक्त निर्देशों के अनुपालन हेतु अपने स्तर से अनुश्रवण कर प्रभावी कार्यवाही सुनिश्चित करें :-

1. प्रमुख वन संरक्षक, वन पंचायत, उत्तराखण्ड।
2. प्रमुख वन संरक्षक, वन्यजीव/मुख्य वन्यजीव प्रतिपालक, उत्तराखण्ड।
3. समस्त अपर प्रमुख वन संरक्षक, उत्तराखण्ड।
4. समस्त मुख्य वन संरक्षक, उत्तराखण्ड।
5. समस्त वन संरक्षक/निदेशक, उत्तराखण्ड।

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प्रेषक,
विक्रम सिंह यादव,
संयुक्त सचिव,
उत्तराखण्ड शासन।

सेवा में,
प्रमुख वन संरक्षक (हॉफ),
उत्तराखण्ड, देहरादून।

वन अनुभाग-2

देहरादून दिनांक 25 फरवरी, 2025

विषय:-राज्य में वनाग्नि नियंत्रण हेतु चीड़ पीरुल एकत्रीकरण कार्यों से स्थानीय जनता को सीधे जोड़ने के सम्बन्ध में।

महोदय,

उपरोक्त विषयक शासनादेश संख्या-981/X-2-2023-21(19)2015 दिनांक 16.05.2023 के द्वारा चीड़ के पीरुल से घटित होने वाली वनाग्नि के रोकथाम हेतु पीरुल एकत्रित करने के लिए क्षेत्रवासियों को रोजगार उपलब्ध कराने के उद्देश्य से किसी व्यक्ति विशेष द्वारा मान्यता प्राप्त संस्था यथा वन पंचायत, स्वयं सहायता समूह एवं युवक मंगल दल आदि के माध्यम से वन क्षेत्र में पीरुल को एकत्रित कर स्थाई रूप से निष्कासन करने पर वन विभाग द्वारा उस व्यक्ति को संस्था के माध्यम से राज्य सैक्टर की संगत योजना अथवा कम्पा के अन्तर्गत उपलब्ध धनराशि से ₹0 3 00 प्रति किलोग्राम की दर से भुगतान किए जाने की स्वीकृति प्रदान की गयी है।

2. राज्य में वनाग्नि नियंत्रण हेतु चीड़ पीरुल एकत्रीकरण कार्यों से स्थानीय जनता को सीधे जोड़ने तथा अजीविका में वृद्धि किये जाने के दृष्टिगत शासन द्वारा सम्यक् विचारोपरान्त लिये गये निर्णय के क्रम में मुझे यह कहने का निदेश हुआ है कि इस संबंध में पूर्व निर्गत शासनादेश दिनांक 16.05.2023 में संशोधन करते हुए चीड़ पीरुल एकत्रीकरण हेतु ₹0 3.00 प्रति किलोग्राम के स्थान पर ₹0 10.00 (दस रुपये मात्र) प्रति किलोग्राम की दर से भुगतान किए जाने की श्री राज्यपाल इस शर्त के अधीन स्वीकृति प्रदान करते हैं कि वन क्षेत्रान्तर्गत चीड़ पीरुल की क्रय की सीमा ₹0 50.00 करोड़ निर्धारित रहेगी।

3. उक्त शासनादेश दिनांक 16.05.2023 को इस सीमा तक संशोधित समझा जाय।

4. यह आदेश वित्त विभाग के अशासकीय संख्या-1/276657/2025, दिनांक 18 फरवरी, 2025 में प्राप्त वित्त विभाग की सहमति से निर्गत किये जा रहे हैं।

Signed by
Vikram Singh Yadav

Date: 25-02-2025 18:46:31

भवदीय,

(विक्रम सिंह यादव)
संयुक्त सचिव

संख्या- /X-2-2025-21(09)2015 तददिनांक

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित :-

1. सचिव पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार।
2. स्टाफ आफिसर, मुख्य सचिव, उत्तराखण्ड शासन।
3. समस्त अपर मुख्य सचिव/प्रमुख सचिव/सचिव, उत्तराखण्ड शासन।
4. आयुक्त गढ़वाल/कुमाऊँ मण्डल।
5. समस्त जिलाधिकारी, उत्तराखण्ड।
6. समस्त प्रभागीय वनाधिकारी, वन विभाग, उत्तराखण्ड।
7. महानिदेशक, सूचना एवं लोक सम्पर्क विभाग, उत्तराखण्ड।
8. निदेशक, एन0आई0सी0 सचिवालय परिसर, देहरादून।
9. गार्ड फाईल।

(विक्रम सिंह यादव)
संयुक्त सचिव

Government Order on Pine Needle Collection for Forest Fire Prevention

File no- 382/X-2-2025-21(09) 2015 E-51081

From:

Vikram Singh Yadav,
Joint Secretary,
Government of Uttarakhand

To:

Principal Chief Conservator of Forests (HoFF),
Uttarakhand, Dehradun

Forest Section-2

Date: 25 February 2025

Subject: Involvement of Local Communities in Pine Needle Collection (Pirul) for Forest Fire Prevention

Respected Sir,

With reference to the above-mentioned subject, the Government order No. 981/X-2-2023-21(19)/2015, dated 16.05.2023, sanctioned payment of ₹3.00 per kilogram for collecting and permanently removing pine needles (Chir Pirul) from forest areas. This initiative aimed to prevent forest fires and provide employment to local residents through recognized entities like Van Panchayats, Self-Help Groups, and Yuvak Mangal Dals. The payment was made under the State Sector Schemes or CAMPA Funds through the respective institutions.

To further strengthen forest fire control measures and enhance livelihood opportunities, the government has reconsidered the existing provisions and decided to revise the collection rate from ₹3.00 per kg to ₹10.00 per kg.

However, the total budget for pine needle procurement will be capped at ₹50.00 crores.

Accordingly, the previous Government order dated 16.05.2023 shall be deemed amended to this extent.

This order is issued with the approval of the Finance Department, as per their approval No. 1/276657/2025, dated 18 February 2025.

Signed by
Vikram Singh Yadav
Joint Secretary
Date: 25-02-2025 18:46:31

Copy forwarded for information and necessary action to:

1. Secretary, Ministry of Environment, Forest & Climate Change, Government of India.
2. Staff Officer, Chief Secretary, Government of Uttarakhand.
3. All Additional Chief Secretaries/Principal Secretaries/Secretaries, Government of Uttarakhand.
4. Commissioner, Garhwal/Kumaon Division.
5. All District Magistrates of Uttarakhand.
6. All Divisional Forest Officers (DFOs), Forest Department, Uttarakhand.
7. Director General, Information & Public Relations Department, Uttarakhand.
8. Director, NIC, Secretariat Premises, Dehradun.

9. Guard File.

ANNEXURE 3

गढ़वाल वन प्रभाग
(गढ़वाल वृत्त, उत्तराखण्ड)
की

प्रबन्ध योजना

(अवधि नियंत्रण वर्ष 2024-25 से 2033-34)

संजीव चतुर्वेदी, भा०व०से०

मुख्य वन संरक्षक, कार्य योजना
उत्तराखण्ड, हल्द्वानी के निर्देशन में

एन०एन०पाण्डेय, भा०व०से०

वन संरक्षक, गढ़वाल वृत्त

पंकज कुमार, भा०व०से०

कार्य योजना अधिकारी द्वारा संकलित

खण्ड-1 (भाग-1)



उत्तराखण्ड शासन

मुख्य वन संरक्षक, कार्य योजना
उत्तराखण्ड, हल्द्वानी

12-14-19-1000

फायर लाईनों का रख-रखाव :- प्रभाग के आरक्षित वनों में पूर्व में आवश्यकतानुसार विभिन्न लम्बाई व चौड़ाई की अग्नि रक्षा पट्टियों का निर्माण किया गया था, जिनका मुख्य उद्देश्य संवेदनशील वन खण्डों में वनाग्नि के प्रसार को रोकने व प्रभावित स्थल पर सीधे से पहुँचने तथा आवश्यक सामग्री व संसाधन पहुँचाना था। वर्तमान में इन फायर लाईन्स में लम्बे समय से रख-रखाव न होने के कारण विभिन्न प्रकार के वन उगकर स्थापित हो गये हैं। वर्तमान में फायर लाईनों पर उगे हरे वृक्षों के पतन पर प्रतिबन्ध हट जाने के कारण इनका नियमित रख-रखाव किया जाना अतिआवश्यक है। क्षेत्र भ्रमण में चिह्नित फायर लाईनों में से कुछ का निरीक्षण किया गया तथा यह पाया गया कि वर्तमान में चिह्नित स्थलों पर फायर लाईन होने का प्रमाण नहीं है। यह हो सकता है कि इनकी स्थिति अत्यन्त ही अथवा वर्तमान में ये वन स्वरूप में परिवर्तित हो गई हों। वर्तमान में प्रभाग के इन फायर लाईनों की कुल लम्बाई लगभग 140 किमी० के 10 गुनी लम्बाई में पक्की सड़कों का निर्माण हो चुका है, जिनसे फायर लाईन के उद्देश्यों की पूर्ति हो रही है। इनके उपयोग से नियंत्रक दल बाहन से शीघ्र घटना स्थल पर पहुँचता है तथा अन्य दुर्घटना नियंत्रक कार्य करता है। ये सड़कें वनाग्नि को रोकने के लिए भी प्रभावी हैं। इनका निर्माण भी आबादी बाहुल्य क्षेत्रों में हुआ है जिनमें अधिकांश घीछ वगैरे हैं तथा अग्नि अन्य दुर्घटना के लिए संवेदनशील है। वर्तमान में फायर लाईन में उगे वनों को काटकर पुनः सभी फायर लाईन का रख-रखाव किया जाना सार्थक प्रतीत नहीं होता है। जिन अग्नि दुर्घटना के लिए संवेदनशील क्षेत्रों में मोटर मार्गों का निर्माण नहीं हुआ है, वहाँ कम घनत्व के वनों में न्यूनतम वृक्ष पतन को ध्यान में रखते हुए पुरानी फायर लाईनों की सफाई अथवा नई फायर लाईनों के निर्माण के सम्बन्ध में प्रभागीय वनाधिकारी द्वारा निर्णय लिया जायेगा।

21.13.2 अन्य अग्निरोधी पट्टिकाएँ :- उपरोक्त के अतिरिक्त प्रभाग में बड़े पैमाने पर अरब मार्ग, पैदल मार्ग, लीसा बटिया भी हैं जिनमें आवागमन के सुधार हेतु विशेष रूप से घीछ, पिरुल गिरने के उपरान्त सफाई करने से अग्नि दुर्घटनाओं में कमी पाई गयी है। 05 वर्ष से कम अवधि के रोपण क्षेत्रों में एक फायर बायर तथा अधिक के रोपण क्षेत्र के चारों तरफ 10 फीट की अग्नि रक्षा पट्टी बनाये जाने से भी अग्नि दुर्घटनाओं में कमी देखी गई है। सड़क, अरब मार्ग, पैदल बटिया, लीसा बटिया, रोपण बटिया का विस्तृत विवरण वार्षिक वन अग्नि नियंत्रण योजना में दिया जाता है, के अनुसार प्राप्त बनराशि से प्राप्यिकता पर कार्य कराये जायेंगे।

21.13.3 नियन्त्रित दाहन :- वन विभाग द्वारा वनाग्नि के कारक जलीनी पिरुल व अन्य पदार्थ को कम करने के उद्देश्य से नियंत्रित दाहन किया जाता है। यह कार्य वनाग्निकाल प्रारम्भ होने से पहले किया जाता है तथा पहाड़ी दोरों में ऊपर से नीचे लगाया जाता है। नियंत्रित दाहन कठोर अग्नि रक्षित क्षेत्रों में 15 दिसम्बर से 15 फरवरी के मध्य नियन्त्रित दाहन किया जायेगा। वार्षिक नियन्त्रण दाहन के क्षेत्रों का विवरण सारणी-21.9 में दिया गया है। घीछ वनों में सबसे अधिक आग वर्तमान वर्ष में गिरते पिरुल के कारण होता है, जो अप्रैल से जून के बीच गिरता है। अतः वनाग्निकाल से पूर्व लगाए जा रहे आग से गुजरने गिरे पिरुल नष्ट होता है। पिरुल की मात्रा कम करने हेतु इनको जलाने के अतिरिक्त इनका उपयोग वन क्षेत्रों में चैकडेम बनाने या अन्य उपयोगों तथा जैविक खाद, ब्रिकेट्स, बिजली उत्पादन, पेपर इत्यादि हेतु वन क्षेत्रों से बाहर निकाले जाने के उपाय किये जाने चाहिए।

वार्षिक नियंत्रण दाहन के क्षेत्र

निवार्षिक नियंत्रित दाहन वाले क्षेत्र

नियंत्रित दाहन की प्रक्रिया :- नियन्त्रित दाहन करते समय निम्नलिखित नियमों/निर्देशों का पालन किया जाएगा:-

- (1) सामान्यतः नियंत्रित दाहन 15 फरवरी तक पूर्ण हो जाना चाहिए। दाहन का समय मौसम की शुष्कता, अग्निमुख, ऊँचाई तथा वनों में विद्यमान ज्वलनशील पदार्थों की मात्रा के ऊपर निर्भर करता है। नियंत्रित दाहन करते समय न्यूनतम सम्भावित क्षति के उद्देश्यों को सर्वोपरि रखना चाहिए। ऐसा न करने पर अग्नि के नीचे से ऊपर तेजी से फैलने की प्रवृत्ति के कारण सस्य को क्षति पहुँच सकती है।
- (2) दाहन का कार्य रादिव सूर्यास्त के पश्चात् अथवा रात्रि में किया जाना चाहिए।
- (3) लीसा टिपान वाले क्षेत्रों में नियंत्रित दाहन से पूर्व वृक्षों के चारों ओर नली-गांठि सफाई (जरु सफाई) कर देना चाहिए। अग्नि दाहन से पहले घीछ वन क्षेत्रों से लीसा टिन, गमले आदि अवश्य हटा लेने चाहिए।
- (4) हक-उकूक, लपु भांग छपाग के अवशेष प्रकाश मलबे की नियंत्रित फुकान से पूर्व हटाया जाना चाहिए।
- (5) वनों से जाने वाली मोटर मार्गों के दोनों ओर 5 मीटर तक सफाई कर ज्वलनशील पदार्थ जला देना चाहिए।
- (6) आरक्षित वनों में नियंत्रित दाहन करने से पूर्व इसकी सूचना समीपवर्ती सिविल सोयम, पंचायती वनों से सम्बन्धित पटवारियों, ग्रामवासियों, सारपंचों को अवश्य दी जानी चाहिए। इनकी संकलित सूची रेन्ज स्तर से क्षेत्र समिति प्रमुख तथा वन पंचायत अधिकारी को भी उपलब्ध करा दी जानी चाहिए।
- (7) तरुण सस्य क्षेत्रों में अग्नि दाहन का कार्य गनकर्मियों के दल के देख-रेख में कराया जाना चाहिए।

21.13.4 कठोर अग्नि रक्षा वाले क्षेत्र :- इसमें घीछ के युवा सस्य वाले क्षेत्र (पुनरुत्पादन की ऊँचाई 1.5 मीटर से कम), पुनरुत्पादन के अन्तर्गत घीछ के क्षेत्र, अपुनरुत्पादित घीछ क्षेत्र, समस्त घीछी परितियों वाली प्रजातियों के क्षेत्र, बाँज कार्ययुक्त, फर, सूस, देवदार रक्षित क्षेत्रों का विवरण प्रतिवर्ष के सिल्वीकल्चर प्लान ऑफ ऑपरेशन में दिया जाए तथा समस्त क्षेत्र को कठोर अग्नि सुरक्षा प्रदान करने हेतु निम्न कार्यवाही की जाए।

1. अग्नि रक्षित क्षेत्रों को बीट मानचित्रों में दर्शाया जाए। नये क्षेत्र इस श्रेणी में आने पर उनको भी मानचित्र में अंकित किया जाए।
2. प्रति वर्ष ग्रीष्म काल से पूर्व (सामान्यतया जनवरी) में अग्नि रक्षित क्षेत्रों की सूची राजि अधिकारी, अनुभाग अधिकारी, लीसा चौकीदार दी जानी चाहिए तथा जो कार्यवाही उनसे अपेक्षित है, उसका विवरण दिया जाना चाहिए।
3. इन क्षेत्रों के लिये पुष्क से अग्नि रक्षकों की नियुक्ति की जानी चाहिए।
4. इन क्षेत्रों के चारों ओर विद्यमान अग्नि रक्षा पट्टियों की नियमित रूप से वार्षिक सफाई तथा फुकान किया जाना चाहिए। अग्नि रक्षा पट्टी न होने पर इन क्षेत्रों के चारों ओर 30 मीटर चौड़ी पट्टी का नियमित रूप से वार्षिक फुकान किया जाना चाहिए, जिससे यह अस्थायी अग्नि रक्षा पट्टी का कार्य कर सके।
5. अग्नि रक्षित क्षेत्रों के समीप के क्षेत्रों में नियंत्रित फुकान किया जाना चाहिए।

6.11

6. अग्नि रक्षित क्षेत्रों से गुजरने वाले मार्ग तथा बटियाओं को और उनके दोनों ओर 10 मीटर दूरी तक के क्षेत्रों को साफ रखा जाए।
उनमें ज्वलनशील पदार्थ (पिरुल, सूखी पत्तियाँ आदि) एकत्र न होने दिये जायें।
7. अग्नि रक्षित क्षेत्रों में विभागीय कर्मचारियों की देख-रेख में अग्नि काल से पूर्व घास कटवा दी जाए।
8. कक्षाओं/उपकक्षाओं के चीड़ युक्त क्षेत्रों में ही नियंत्रित फुलान किया जायेगा। जंगली क्षेत्रों में तथा रिक्तियों में कदापि आग नहीं जाने दी जायेगी।
9. कक्षाओं/उपकक्षाओं में स्थित रोपण क्षेत्रों को कठोर रूप से अग्नि से बचाया जायेगा।

सारणी-21.11

कठोर अग्नि संरक्षित क्षेत्रों की सूची

कार्यवृत्त	अव्यक्ति
चीड़ कार्यवृत्त	इसमें चीड़ के युवा सस्य वाले क्षेत्र (पुनरुत्पादन की ऊँचाई 1.5 मी० से कम), पुनरुत्पादन के अन्तर्गत चीड़ के क्षेत्र, अपुनरुत्पादित चीड़ के क्षेत्र सम्मिलित हैं।
बाँस कार्यवृत्त	सम्पूर्ण कार्यवृत्त की कठोर अग्नि सुरक्षा आवश्यक है।
फर, स्प्रूस, देवदार कार्यवृत्त	सम्पूर्ण कार्यवृत्त की कठोर अग्नि सुरक्षा आवश्यक है।

21.13.5 चीड़ के वनों से पिरुल/टीटें हटाना :- चीड़ वन वनाग्नि हेतु अत्यधिक संवेदनशील होती है। यद्यपि यह वृक्ष वनाग्नि सहनशील है, बार बार हो रही वनाग्नि तथा कम व्यासवर्ग के वृक्ष में आग लगने से तथा लीसा घावों में आग लगने से भारी मात्रा में नुकसान होती है। इसके अतिरिक्त भूदा व जल स्तर पर भी दुष्प्रभाव होता है। अतः चीड़ वनों में वनाग्नि का प्रभावी नियंत्रण आवश्यक है। इसके लिए सर्वप्रथम चीड़ वनों से पिरुल की मात्रा घटाना होगा। इसके लिए पिरुल की एकत्रीकरण कर अन्य उपयोगों हेतु प्रयुक्त किया जाना चाहिए। वर्तमान में कतिपय वन प्रभाग द्वारा स्थानीय संस्था की मदद से पिरुल से लट्टे बनाने की दिशा में महत्वपूर्ण पहल किया गया है। मढ़वाल वन प्रभाग द्वारा भी इस तरह का पहल स्थानीय संस्थाओं की मदद से किया जा सकता है। पिरुल एकत्र करने में ग्रामीणों की मदद ली जाती है तथा कुछ धनराशि उन्हें प्रति कुन्तल के हिसाब से भुगतान किया जाता है। पिरुल का बुरादा बनाने में गुड़ चीटर मशीन की सहायता ली जाती है, तत्पश्चात् गोबर इत्यादि मिश्रकर लट्टे बनाये जाते हैं। इस तरह की योजना बनाने से पूर्व ऐसे लट्टों की बिक्री हेतु प्रदेश के अन्दर अथवा बाहर बाजार चिन्हित अवश्य कर लिया जाना चाहिए, जिससे ऐसी योजना वीर्य कात्तीन जबकि तक बिना फिस्ती अवरोध के चलता रहे। पायलेट स्तर पर अग्नि संवेदनशील क्षेत्रों का चयन कर पिरुल हटाने की कार्यवाही की जायेगी। पिरुल का उसी वन क्षेत्र में चैकडेम बनाने हेतु भी प्रयुक्त किया जा सकता है, जिसकी तकनीक जल संसाधन प्रबन्ध एवं भूमि संरक्षण (अतिच्छादी) कार्यवृत्त में दिया गया है। इसके अतिरिक्त फायरपोर्ट बनाने, कोयले के टिबिकिया बनाने, बिजली उत्पादन तथा घरेलू उपयोग हेतु पिरुल का निस्तारण किया जा सकता है। चीड़ वनों में व्यापक रूप में उनके टीटें जमीन पर गिरे होते हैं जो वनाग्नि के फैलाव का मुख्य कारण है। आग लगे टीटें लुढ़कते हुए व उछलते हुए नासों को भी पार करते हुए अन्य वन क्षेत्रों में भी गिर सकते हैं, जिससे वहाँ भी वनाग्नि प्रारम्भ होती है। अतः वनाग्नि काल से पूर्व इन टीटों का भी निस्तारण किया जाना चाहिए तथा इसे ईंधन या अन्य प्रयोगों में इस्तेमाल किया जा सकता है। प्रत्यक्ष शोध संस्था यथा सीएएसआईआर से पिरुल के उपयोग के सम्बन्ध में शोध कराया जाना चाहिए। वनों से पिरुल निस्तारण को बढ़ावा देने के सम्बन्ध में शासनादेश संख्या-1072 X-2-2016-21(09)/2015, देहरादून दिनांक 06 अक्टूबर, 2016 (परिशिष्ट-18.1) से पिरुल अभिवहन को उत्तराखण्ड इमारती लकड़ी और अन्य वन उपज का अभिवहन नियमावली, 2012 के अन्तर्गत छूट प्रदान की गई है। प्रभाग को उत्तराखण्ड सरकार की पिरुल (चीड़ की पत्तियाँ) तथा अन्य प्रकार के बायोमास से विद्युत उत्पादन हेतु नीति-2018 के अन्तर्गत इच्छुक उद्योगियों से सम्पर्क हेतु कार्यक्रम आयोजित करते हुए अतिसंवेदनशील वन क्षेत्रों से रक्षाई रूप से पिरुल निष्कासन करने के सम्बन्ध में प्रयास किया जाना आवश्यक है इससे वन क्षेत्रों से न केवल फायल लोड कम होगा अपितु निकटवर्ती ग्रामीणों को प्रभाग में वनाग्नि नियंत्रण हेतु पिरुल एकत्रीकरण कार्यों से सीधे जोड़ा जा सकेगा तथा ग्रामीणों की आजीविका में वृद्धि भी होगी। उत्तराखण्ड शासन के पत्र सं० 981/X-2-2023-21(0)2015, दिनांक 16-05-2023 द्वारा राज्य में वनाग्नि नियंत्रण हेतु चीड़ पिरुल एकत्रीकरण कार्यों से स्थानीय जनता को सीधे जोड़ने तथा आजीविका में वृद्धि के उद्देश्य के दृष्टिगत पूर्व निर्गत शासनादेश 2198/X-2-2018-21(0)2015, दिनांक 05-11-2020 में निर्धारित धनराशि ₹० 2.00 को पुनरीक्षित करते हुए चीड़ पिरुल एकत्रीकरण हेतु 2.00 प्रति किलोग्राम के स्थान पर ₹० 3.00 प्रति किलोग्राम की दर से भुगतान किए जाने की स्वीकृति प्रदान की गई है।

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11

NATIONAL ACTION PLAN ON FOREST FIRE

FOREST PROTECTION DIVISION

MINISTRY OF ENVIRONMENT, FORESTS AND CLIMATE CHANGE

GOVERNMENT OF INDIA

NATIONAL ACTION PLAN ON FOREST FIRE

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List of Abbreviations

1. NAPFF: National Action Plan on Forest Fire
2. MoEF&CC: Ministry of Environment, Forest and Climate Change
3. SFD: State Forest Department
4. DFO: Divisional/District Forest Officer
5. FSI: Forest Survey of India, Dehradun
6. ICFRE: Indian Council for Forestry Research and Education, Dehradun
7. NDMA: National Disaster Management Authority
8. SDMA: State Disaster Management Authority
9. DDMA: District Disaster Management Authority
10. NDRF: National Disaster Response Force
11. SDRF: State Disaster Response Force
12. DFE: Directorate of Forest Education, Dehradun
13. CAMPA: Compensatory Afforestation Fund Management and Planning Authority
14. JFMC: Joint Forest Management Committee
15. SOP: Standard Operating Procedure
16. ICT: Information and Communication Technology
17. NTFP: Non-Timber Forest Produce
18. EDC: Eco-development Committee
19. FRA: Forest Rights Act (Scheduled Tribes and other Traditional Forest Dwellers {Recognition of Forest Right Act, 2006})
20. WPO: Working Plan Officer
21. IT Cell: Information Technology Cell
22. SHG: Self Help Group
23. MNREGA: Mahatma Gandhi National Rural Employment Guarantee Act

National Action Plan on Forest Fires

1. Statement of Purpose

Fires, both accidental and deliberate, have always played a very important role in shaping forests since ancient times. In India most of the forest fires are attributable to anthropogenic reasons. Communities use it to prepare lands for shifting cultivation, clear forest floor for NTFP collection, promote grass growth for grazing. Criminal gangs of poachers use it to force wild animals come out of safe hiding places, while unintentional fires caused by careless throwing of burning matchsticks and escape of cooking fire from temporary shelters for road workers also account for many forest fires. Forest Survey of India has reported that 54.40% of forests in India are exposed to occasional fires, 7.49% to moderately frequent fires and 2.40% to high incidence levels while 35.71% of India's forests have not yet been exposed to fires of any real significance. Major affected areas lie in the North East India and in the forests on the Deccan plateau. Prolonged droughts make forests vulnerable to fires and the changing climate further aggravates their vulnerability. The fragmentation of most of Indian forests, interspersed with habitations of all sizes, results in high human presence in most forested areas which adds to their vulnerability to fires.

The objective of this National Action Plan on Forest Fires, hereinafter referred to by its abbreviations NAPFF, is to minimize forest fires from taking place by informing, enabling and empowering forest fringe communities and may be incentivizing them to work in tandem with the forest departments. This will substantially reduce the vulnerabilities of forests across the diverse forest ecosystems in the Indian subcontinent against fire hazards, enhancing the capabilities of forest and other personnel and institutions in fighting fires, and speed up recovery after a fire event.

2. General Principles

- i. The prescribed actions in this NAPFF are intended to guide and assist the policy makers, administrators, forest officers, frontline staff, forest user agencies, forest fringe communities, visitors to forests, and civil society, for a holistic management of fires in forests.
- ii. Preventing fires from taking place and improving resilience of the forests against fire hazards shall form priority in forest management policies, strategies and programs with well-defined aims of conservation of biodiversity, wildlife and forest wealth.
- iii. The safety of the people, both resident and transient, firefighters, and fire managers shall always be accorded the highest priority during fire events.
- iv. There shall be a clear line of command for assuming the lead role and duties in the event of a forest fire.
- v. Districts shall form the units for Forest Fire Management planning and implementation for ease in coordination with the Disaster Management Authorities at the national, state and district levels.

3. Fire Risk Zonation and mapping

Forest fire risk zonation provides a scientific basis for identifying areas of priority for management interventions, allocating resources to priority areas, and monitoring the effectiveness of measures to reduce or control fire risk. These risk zones shall be reviewed and updated at least once every five years to respond to any changes in the abovementioned factors.

3.1 Risk factors

The following factors, among other locally relevant, may be considered for identifying and quantifying fire risks:

- i. *Fuels*, including forest cover and type as a broad indicator of fuel type. Optionally, states may perform field-based studies to measure fuel load and type;
- ii. *Proximity to infrastructure, property, and other assets*, including roads, habitations and other buildings, agricultural lands, transmission lines, and railways; *Topography*, including slope, aspect, elevation, terrain ruggedness and other characteristics;
- iii. *Social indicators*, including local dependence on forests for livelihoods, poverty, and traditional land use practices;
- iv. *Historic fire occurrence and patterns* may be used to identify areas that are most prone to fires. Fire records prior to 2003 may be geo-referenced and mapped. This historical data can be used to validate the results of analysis.;
- v. *Areas of special ecological or cultural importance*, including protected areas, historic sites, designated heritage sites, temples, pilgrimage routes, etc.; and
- vi. *Special ecological conditions*, for example, bamboo flowering, may be considered and provided weights.

3.2 Use of fire risk zones in forest planning

The results of the forest fire risk zonation shall be translated into concrete management actions under the forest working plans. The Working Plan Officers (DFOs in the case of Plans already in operation) shall identify activities or interventions to mitigate fire risks or reduce impact of the fire hazards in high-risk areas. These may include creation of additional fire lines, watch towers and other infrastructure in vulnerable areas. The same shall be examined speedily by the appropriate authorities for approval and making provisions for financing the approved activities. The Annual Plan of Operations for all forest divisions and circles, and protected areas, shall include the approved activities and interventions mentioned above. The state planning and finance departments shall prioritize resource allocation for forest fire management.

(Action by SFDs) (Monitoring by SFDs
and MoEFCC)

4. Preventing forest fires

Most forest fires are manmade and are linked to socio-economic and livelihood issues of the forest fringe communities. It should, therefore, be possible to greatly reduce the forest fire incidences by making these communities aware of the many tangible and intangible benefits lost to them, both individually and collectively, due to forest fires. Following actions are proposed to be taken in this regard:

4.1 Effective communication strategy for awareness generation

A mass communication strategy with adequate financial provisions for five years shall be framed by each SFD within two months for vigorous publicity and sensitization of the state in general and local communities in particular. It should be specifically targeted at students, farmers, women groups, cattle herders, NTFP collectors, infrastructure related professionals, urban dwellers, tourists and pilgrims, among others. Information on forest fire and its adverse effects should also be included in the school curriculum at several levels. The strategy would identify most effective means for reaching out to different target groups like school campaigns, campaigns on Radio, TV, and social media, mobile campaigns during festival season, organization of music festivals, and setting up information portals, among others.

(Action by SFDs) (Monitoring by SFDs and MoEFCC)

4.2 Empowering Communities to deliver on their responsibilities

The existing forest laws mandate the forest officials to seek participation of local communities in fire management. Under the FRA the forest areas recognized under community rights are mandated to be sustainably used by the right holding forest dweller community which places on them the responsibility of conservation of these areas. Similar responsibilities rest on the communities practicing shifting cultivation for protection of forests against damage by fires under their respective state laws. Similar expectations are also placed on the JFMCs and Van Panchayats in relation to the forest lands under their jurisdictions. These communities would be better placed to shoulder these responsibilities if they are adequately empowered with delegated authority and funds. The communities could also be incentivized for their cooperation in fire prevention and control measures in the form of money, rewards, social recognition, preference in Government schemes, etc. The SFDs may evolve state specific mechanisms for this purpose in tune with relevant laws and traditional practices.

(Action by SFDs) (Monitoring by SFDs and MoEFCC)

4.3 Capacity building of communities

The capacity of community organizations in prevention and control of forest fires should be enhanced by periodical training and capacity building programmes. Forest fire alerts information should also be provided to JFMC/EDC/Van Panchayat members and they should also be provided with firefighting equipment including leaf litter

blowers, other tools and protective clothing. The community members should be duly involved during the mock drills on forest fire before fire season. In the Micro plan of the JFMCs, there should be a separate chapter for forest fire management which should contain the details of vulnerable areas, location of natural & man-made water sources, other infrastructure available for fire prevention and management etc.

(Action by SFDs) (Monitoring by SFDs and MoEFCC)

5. Increasing the resilience of forests to fires

Management interventions for increasing resilience to forest fires may be planned according to the vulnerability to forest fires as reflected in the risk zonation maps. Following are some of the measures which could be adopted in this context.

5.1 Moisture and water conservation

As fire hazard is more in drier and deciduous habitats and areas with predominance of grasses, management action would need to aim at moisture retention for longer time after rains and appropriate preventive measures to ensure that minor fire incidences do not escalate into major fire events. A long-term plan for improving the water regime of the forest areas based on opportunities and feasibility will be useful in reducing vulnerability to fires. Several existing programs for eco-rehabilitation and catchment area treatment plans provide scope for this kind of work.

(Action by SFDs)
(Policy support by MoEFCC)

5.2 Forest floor biomass management

When necessary management interventions may be planned aiming at minimizing accumulation of dry fuel material on forest floor in the fire season. The litter and other biomass on the forest floor leading to fire danger could be gainfully utilised for the benefit of the society in identified areas. A framework for biomass management is suggested below and SFDs are encouraged to experiment with appropriate caution.

- a. Collection of forest floor biomass such as fallen pine needles for use in briquets may be encouraged by the waiver of royalty and transit fee for such collections.
- b. Policies for promoting biomass based off-grid micro power plants in remote areas may be put in place. Space heating in high altitude areas could be tried using excess biomass from forest floors vulnerable to fires.
- c. Guidelincs may to be framed for sustainable removal of dead bamboo in the

event of mass flowering to reduce risk of fire and also to conserve biodiversity.

- d. Policies for permitting women SHG to use forest floor biomass with appropriate safeguards for micro entrepreneurship may be put in place by the SFDs.

(Action by SFDs)

(Policy support by MoEFCC)

5.3 Weed Management

Invasive weeds such as Lantana need to be controlled as they contribute significantly to the fire danger and pose a threat to native biodiversity. The following actions are recommended:

- i. A baseline study to quantify the extent and spread of invasive weeds may be initiated by SFDs in consultation with scientific institutions such as ICFRE.
- ii. Lantana removal strategies adopted should ensure it does not regrow on treated lands. Removal should be organized as an attractive economic opportunity for the local communities.
- iii. Rehabilitation of treated areas with appropriate species and soil and moisture conservation measures should form part of the weed removal plan.

(Action SFDs and ICFRE)

(Monitoring by MoEFCC)

6. Forest Fire Preparedness

Preparedness in forest fire management leads to effective response to fire disasters resulting in reduced impact and quicker recovery. The following steps may form the basis of preparedness against forest fires:

6.1 Forest fire detection and alert

Satellite based Forest Fire Alerts are already operational across the country led by FSI. The following steps may be taken to improve the efficacy of the FSI fire alert system:

- i. **Digitization of forest boundaries:** In the absence of digitized boundaries in many forests across the country, the FSI screens fire detections using approximations leading to reduced efficacy of the alert system. The states may, therefore, complete the digitization of forest boundaries at the earliest.
- ii. **Promoting greater adoption of the Forest Fire Alert System:** FSI has put in place a robust forest fire alert system. The States shall encourage the involvement of all field functionaries in the same, so that the forest fire alert system can percolate down to beat level in least possible time. This may be institutionalized through a protocol.
- iii. **Improving Ground based Detection:** Even with the advances in new

remote sensing technologies for fire detection, ground-based detection continues to be essential and should be sufficiently resourced. The SFDs shall perform an assessment of the efficacy of the existing network of watchtowers by a review of the level of functionality and operational use of the existing towers. The WPOs (DFOs in the case of divisions where approved working plans are already in existence) may propose new locations for fire watchtowers based on coverage, visibility, ignition sources, and other relevant factors.

- iv. **Strengthening engagement with local communities:** Local communities are often the first to spot fires and alert the forest department. Locally suitable mechanisms should be developed by the SFDs for sourcing reliable and quick information from local communities.
- v. **Dedicated phone line:** A toll-free telephone number for fire detections and other required support needs to be established at state level to obtain information on forest fires from tourists, passersby and local people.
- vi. **Monitoring and Evaluation:** FSI has put in place a system to review all fire alert detections, and their ground verification. This is a critical step and may be monitored by MoEFCC in the month of December every year. SFDs must ensure that feedbacks on fire alerts are sent to FSI for validation.
- vii. **Wireless network:** In most remote forest areas mobile telephony is not well developed and frontline staff are unable to get the information coming on the Forest Fire Alert Alarms. In such cases, forests communication system may be supplemented by a dedicated wireless network.

(Action: SFDs)
(Monitoring by FSI and MoEFCC)

6.2 Digitize the location of critical resources and assets

The IT Cells of the state forest departments shall conduct inventory mapping of critical resources for forest fire prevention and management and make relevant

information available to the forest divisions. Resources and assets to be inventoried may include forest department resources, such as watchtowers, ground crew stations, controls rooms and fire lines as well as non-department resources, such as the locations of fire stations, fire tenderers and National and State Disaster Response Forces, and army and paramilitary camps. They may also include important infrastructure such as roads, railways, and telecommunications networks and natural resources such as water bodies and natural fire breaks that could assist in preparedness and planning for response to forest fires.

(Action by SFDs)
(Monitoring by MoEFCC)

6.3 Forest Fire Lines

SFDs may undertake the mapping and digitizing of the location of existing fire lines and other infrastructure such as roads, transmission lines, and rail lines that may function as fire breaks. A review of the maintenance status, functionality, and adequacy of these fire lines, and an assessment of the need for new fire lines, may be undertaken considering past fire data, forest types, habitations, and other relevant factors. Proposals for new fire lines should be made on a scientific basis considering their potential efficacy in reducing fire risk and their proximity to people, property, and areas of special concern (e.g., protected areas). Plantations should not be raised on existing or proposed fire lines.

(Action by SFDs)

6.4 Control Burning

Control burning may be necessary in some places for preventing spread of fire. The following actions are recommended to improve the consistent performance and effectiveness of control burning wherever necessary:

- i. Prioritization of areas for control burning as part of the fire risk zonation analysis;
- ii. Monitoring of the performance of control burning at the Circle level, and integration of monitoring data into a database maintained by the SFDs;
- iii. Timely release of funds for control burning prior to the onset of the peak fire season and the provision of advance/ad hoc release as needed;
- iv. Development of state-specific guidelines for control and prescribed burns to be notified and revised as may be necessary.

(Action by SFDs)

(Monitoring by SFDs)

7. Fire Suppression

Immediate response to forest fires after receipt of information is of utmost importance.

The SFDs must develop a culture of emergent response to fire alerts under which all available resources are used to douse the fire. This needs intense training at all levels, strengthening of infrastructure, and coordination with other relevant agencies.

7.1 Training for field staff, firewatchers, and community firefighters

The principal need for forest fire suppression is to have adequate competent, trained, and equipped workforce on the ground, ready to respond and take immediate action. Training should be provided to field officers, seasonal firewatchers, and community volunteers involved in firefighting. All these firefighters should understand basic principles of forest fire management for using the most effective suppression technique at their

disposal and know when retreat is necessary. The type of training provided to firefighters should be tailored according to the landscape, nature of terrain, their level of responsibility and role in the command structure in responding to fires.

- i. A modern and standardized training curriculum should be developed by the SFDs with the guidance of Directorate of Forest Education (DFE) of the MoEFCC. Other agencies involved in fire response, including National Disaster Management Authority (NDMA), NDRF, and the State Disaster Management Authorities may be involved in a consultative role.
- ii. Mock drills should be organized before fire season at various fire prone areas involving all the stakeholders such as District Administration, Police, Fire Department, NDRF, SDRF personnel, community organizations etc. for identification of gaps in the existing mechanism and better preparedness during crisis time.
- iii. Provision of training, equipment, and coordination should extend beyond state-managed forests to community institutions in regions such as the Northeast, where communities are responsible for managing most of the forest estate.

(Action by SFDs and DFE)
(Monitoring by the MoEFCC)

7.2 Equipping the firefighters

- i. The firefighting squad including field staff, seasonal firewatchers, and community firefighters should be provided with adequate firefighting equipment including leaf litter blowers, and protective clothing.
- ii. The SFDs should take the lead in this process of identifying and providing firefighting equipment suitable to local needs in consultation with the Indian Council of Forestry, Research & Education (ICFRE), Dehradun.
- iii. The ICFRE should focus on development of user-friendly fire fighting equipments, tools and protective clothing suitable for various regions of the country.
- iv. There should be sufficient practice sessions for the fire fighting personnel in the use of the fire fighting equipments including leaf litter blowers, and protective clothing so as to enhance their efficiency in actual fire fighting.

(Action: SFDs, ICFRE)
(Monitoring by the MoEFCC)

7.3 Development of adequate infrastructure for fire suppression

- i. An effective communication network should be ensured in all fire prone forest areas using wireless where necessary.
- ii. SFDs should develop, and enforce, a protocol for ensuring prompt access to field vehicles from nearby forest divisions for movement of firefighting personnel to the fire spots at the earliest.
- iii. Advance technologies such as use of drones should be explored in identification of exact location, intensity & direction of fire to facilitate fire extinguishment at the earliest.
- iv. Forest road network should be properly maintained for quick movement of firefighting forces to the fire site.

(Action: SFDs)

(Monitoring by MoEFCC)

7.4 Arrangements for adequate manpower in fire prone areas

- i. The SFDs should fill all vacancies especially at the level of frontline forest officials in the fire prone areas on priority basis.
- ii. Trained manpower may also be mobilized from other agencies such as Police, District Fire services, NDRE, SDRF etc.
- iii. The Communities living near the fire prone areas should also be sensitized and may be incentivized towards fire suppression activities.
- iv. There should be a mechanism for mobilization of forest fire fighting volunteers and providing them with adequate training on an urgent basis. A database of the firefighting volunteers should be maintained at district level.

(Action: SFDs)

8. Post Fire management

8.1 Assessment of loss due to forest fires

- i. FSI may develop a national level database for burnt area assessment on a yearly basis. Standardized protocols and procedures are needed to facilitate

the reporting of the area affected and losses due to forest fire which may be developed by the ICFRE in association with FSI and other institutions.

- ii. MoEFCC may assign ICFRE the responsibility of developing and standardizing methodologies for assessing losses due to forest fire including loss of intangibles such as ecosystem services.
- iii. Based on standardized methodologies, the ICFRE may further standardize protocols for estimating area affected and losses due to forest fire and reporting the same at successive levels.

- iv. The ICFRE may assist the DFE in designing and organizing adequate training programs for forest officials at various levels for this purpose.

(Action: SFDs, ICFRE and FSI)
(Monitoring by MoEFCC)

8.2 Proper investigation of the causes

The SFD shall ensure that the causes for every fire incident are properly investigated and adequate measures taken immediately including legal actions where necessary.

8.3 Restoration of fire affected areas

- i. A proper restoration plan should be prepared at once for the fire affected areas with the objective of restoring to its natural profile. Appropriate silviculture practices should be prescribed taking into account the ecological successional dynamics.
- ii. Adequate soil moisture conservation measures may be taken up in the fire affected areas for enhancing the moisture retention capacity of the land.
- iii. Indigenous vegetative barriers may be identified and planted around the fire affected areas.

(Action: SFDs)

9. Coordination with Other Agencies:

Forest fire management is a multifarious activity in which a frictionless interface with a range of institutions and social groups becomes very important for effective functioning. The SFDs are already working in coordination with the FSI for past many years. Forest fires of disastrous proportions already come under the purview of the National Disaster Management Authority (NDMA) and the Disaster Management Authorities at the state and district levels and institutional mechanisms for combating forest fires at disaster scale has already been formalized for incorporation in the National, State, and District level disaster management plans. Institutionalization of close coordination with relevant institutions is thus already a reality but it needs to be strengthened further. For this purpose there are existing procedures developed by the DMAs at all levels and the SFDs may take urgent steps to update, upgrade and integrate their systems with those of the DMAs. In addition the following steps may be taken by the SFDs.

- i. Functioning of the Crisis Management Groups for Forest Fires at all levels may be reviewed to ensure that Standard Operating Procedures (SOPs) are in place related to command and control, compilation of availability of extent and location of resources required in case of occurrence of fires and for monitoring its spread.
- ii. Organizing mock drills is a very efficient way of ensuring preparedness. MoEFCC and NDMA may provide guidance for action at the state level. Joint trainings and

mock exercises with all relevant agencies may be organized to facilitate coordination during a fire event.

- iii. Assistance of Defense agencies located in the vicinity becomes critical in certain situations where quick and concerted action can make a difference. MoEFCC may need to coordinate at the Ministerial level with the the Ministry of Defense to obtain suitable directions for their field formations so that such extension of assistance becomes a routine matter.
- iv. An escalation matrix may be developed at the state level by the SFDs in consultation with the SDMA to decide at what stage of aggravation of fire crisis the help from SDRF and NDRF should be sought.

(Action: MoEFCC, SFDs, NDMA, SDMA, DDMA)
(Monitoring by MoEFCC)

10. Centre of Excellence for Forest Fires

A Centre of Excellence is needed to be established to undertake data collection and analysis, frontline research in all aspects of forest fires, and development of firefighting equipment and tools. For the past two decades the FSI has been providing excellent leadership in forest fires and it would be most appropriate to set up this institute under the control of the FSI with strong linkages with ICFRE and leading universities across the country. Sufficient additional personnel and financial allocations would be required to enable FSI to undertake this task.

(Action by FSI and MoEFCC)

11. Mobilization of Financial resources

Forest fires pose the foremost threat to India's forests and the threat is projected to become more serious with the changing climate. Therefore, emphasis on the adequate protection of existing forest resources from fire hazards should become high priority attracting adequate funding. Specifically,

- i. The SFDs should make sufficient financial resources available at district, range and local level well in advance of fire season with enough imprest money for ensuring that lack of money does not hamper emergent fire management works.
- ii. While budgetary allocations for fire protection must be earmarked it should be possible to make fire protection integral to many other programs of forest protection. Community development works and entry point activities in forest enclosures and fringes could develop fire protection arrangements on the borders of habitations.

- iii. Climate funds under existing global bilateral or multilateral mechanisms for activities leading to adaptation to the changing climate can be a good source for money and must be accessed.
- iv. For promotion of use of Information and Communication Technology (ICT) standing instructions are already in place for mandatory use of a minimum proportion of total sectoral allocation in ICT in the respective sector. This should be made use of for ICT part of the forest fire detection and protection activities.
- v. MNREGA and community development/welfare programs aimed at generating employment through creation of assets with labour intensive activities are a good source of funding for some aspects of forest fire protection and should be made use of.
- vi. Community Forest Rights have been recognized in forests under The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. The Act also empowers the right holders to sustainably use the resources under the community forest rights thus recognized. Activities related to sustainable use of community right forests must also include protection of such areas from overuse and destruction by disasters like fire also. For this purpose, Forest Administration needs to come to assist the stakeholder communities in planning and managing the community rights areas on priority. As the areas under community rights are expected to experience regular human presence, vulnerability to fire hazard is high and is needed to be minimized.
- vii. India has technical cooperation arrangements with several countries where technical and financial assistance can be tapped for augmenting forest fire management capabilities. External financial aid should be accessed for investment on infrastructure for this purpose.
- viii. In the large infrastructure projects particularly river valley projects, Environmental Management Plans and Catchment Area Treatment Plans are mandatorily prepared and implemented at the cost of the user agencies. Such activities can be very useful in augmenting moisture retention capacity of the catchments thus minimizing fire hazards.
- ix. Crowd funding is a popular means of financial resource mobilization for any common cause where interested people can contribute. Environmental causes like forest fire protection can garner enormous support from public. Local community organizations working in vicinity of vulnerable forests can thus be encouraged to organize crowd funding for work at community level. This could be particularly effective in and around areas of tourist, cultural or religious significance located near or within forests etc. MoEFCC could explore the possibility of encouraging this as a policy for people's participation in forest fire protection and management.

Action: SFDs, State governments and MoEFCC

Public Awareness Programmes organised by Forest Department
Division wise report from 01.11.2024 to 31.05.2025 as below

S.No.	Circle Name	Division Name	No. of programmes organised	No. of participants
1	2	3	4	5
1	North Kumaon Circle	Almora Forest Division	8	
2		Bageshwar Forest Division	204	10887
3		Champawat Forest Division	260	6663
4		Pithoragarh Forest Division	117	2740
5		Civil & Soyam Forest Division Almora	239	5964
6	South Kumaon Circle	Nainital Forest Division	49	1486
7		SC Nainital Forest Division	114	2332
8		SC Ramikhet Forest Division	231	4573
9		SC Ramnagar Forest Division	243	5303
10	Western Circle	Haldwani Forest Division	122	2243
11		Ramnagar Forest Division	161	4105
12		Tarai East Forest Division	61	3549
13		Tarai West Forest Division	192	5386
14		Tarai Central Division	30	1230
15	Garhwal Circle	Alaknanda Soil Conservation Forest Division, Gopeshwar	60	1169
16			124	4967
17		Badrinath Forest Division, Gopeshwar	58	1473
18		Garhwal Forest Division, Pauri	155	6281
19		Rudraprayag Forest Division, Rudraprayag	84	2046
20	Bhagirathi Circle	Civil & Soyam Forest Division, Pauri		
21		Narendranagar Forest Division	154	3096
22		Soil Conservation Forest Division, Uttarkashi	96	1614
23			66	1497
24		Tehri Dam Forest Div-ist New Tehri	123	3417
25	Yamuna Circle	Tehri Dam-II, Forest Division, Uttarkashi	60	1800
26		Tehri Forest Division, New Tehri	206	6133
27		Uttarkashi Forest Division	160	5369
28		Chakrata Forest Division	96	2154
29		Mussoorie Forest Division	247	6800
30	Shivalik Circle	Tons Forest Division, Purnia	65	3151
31		Upper Yamuna Barkot Forest Division	263	6158
32		Hardwar Forest Division	60	2065
33		Dehradun Forest Division	170	4219
34		Lansdowne Forest Division	14	496
35	Nanda Devi Biosphere Reserve, Gopeshwar	Soil Conservation Forest division Kalsi	105	2946
36		SC Lansdowne Forest Division Lansdowne	122	3384
37	Rajaji Tiger Reserve	Nanda Devi National Park, Joshimath	132	3134
38		Kedarnath Wildlife Division, Gopeshwar	403	9278
39	Corbett Tiger Reserve	Rajaji TR	93	3939
40		Govind WLS	55	1381
41		Gangotri National Park	11	553
		Corbett Tiger Reserve, Ramnagar	91	3836
		Kalagarh Tiger Reserve	108	1233
		Total	5550	152075

SHEETLAKHET MODEL

To spread awareness about Sheetalakhhet model for forest fire management, following activities are undertaken:

- 1- Villagers, especially women, should be organized and registered as Mahila Mangal Dal, Mahila Group.
- 2- Forest department should maintain continuous communication with Mahila Mangal Dals and groups.
- 3- Village *Forest Fire Committee* should be formed by including Forest Beat Officer, Revenue Sub Inspector/ Police Station, Village Development Officer, Village Head, Forest Sarpanch, Village Head, Village Prahari and members of Mahila Mangal Dal and villagers. * A WhatsApp group of the committee should also be formed. * Every Forest Fire Committee should be given necessary equipment like rack, water bottle etc. for cleaning Pirul.
- 3- With the help of forest fire committee, in fire prone areas (sensitive to forest fire), before 15th February, with the help of controlled burning, 20-30 feet wide and as long as required area should be burnt to create *fire strips*. These fire strips will help in preventing uncontrolled spread of forest fire in summer and preventing it from getting out of control.
- 4- Under the supervision of village forest fire committee, the process of burning on/aada/keda (*thorny bushes, weeds, crop residues of the fields)* should be completed safely by 28th February in low altitude districts and by 31st March in high altitude districts.

To complete this process in a time bound manner, the village forest fire committee should inform every villager in writing through the village guard to complete the process of burning of aada/stubble on time.

5- Before 28th February in low altitude districts and before 31st March in high altitude districts Every forest fire committee should declare in writing that the process of burning on, aada/keda has been completed safely in their village. If cases of burning of aada/stubble are found after *28 February in low altitude districts* and *31 March in high altitude districts*, a fine should be imposed.

6-- *Oun Day* - Every forest fire committee should organize On Day by holding a group meeting on 1 April. On this day, discussions should be held on the damage caused to water sources, biodiversity and environment due to forest fire.

7- In case of fire in any forest area, starting efforts to extinguish the fire in the first half an hour makes it easier to stop the fire in less time and with less damage, so the village forest fire committee should be trained to extinguish and stop the fire until the forest department team arrives.

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Today, dated 01.04.2025, at Rajkiya Inter College Rangel under the Sheetlakhait section of Almora Range, the forth औषण दिवस ceremony was organized in which U-Cost's Director Shri Durgesh Pant Ji and former retired PCCF Shri Kapil Joshi Ji, Forest Range Officer Almora, Deputy Ro / Sheetlakhait, Forest Daroga / Kathpuria Section, Forest Beat Officer / Northern Syahi Devi, Forest Beat Officer / Southern Syahi Devi, and two departmental workers were present And "Considering this forest fire season, important points were discussed on how we can control forest fires. The program emphasized the importance of forests and raised awareness about not setting fire in forests. In case of fire, an appeal was made to cooperate by informing the forest department."



Teams from different forest division of uttarakhand were also given training under the Sheetalakhet model

1. Civil Soyam forest division, Pauri
Team 1
50 people
Team 2 = 50 people
2. Garhwal forest division, garhwal
Team 1 = 50 people
Team 2 = 50 people
3. Rudraprayag forest division, garhwal
Team 1 = 40 people
Team 2 = 40 people
Team 3 = 40 people
4. Badrinath forest division, Badrinath
Team 1 = 50
Team 2 = 50
5. Alaknanda Bhumi sanrakshan forest division
Team = 50
6. Pithoragarh forest division
Team 1 = 50
7. Nainital forest division
Team = 50
8. Ramnagar forest division, Ramnagar
Team = 50
9. Atirikt bhumi van sanrakshan, Ramnagar
Team = 50
10. Bhumi Sanrakshan, Ranikhet
Team = 50
11. Bhumi Sanrakshan, Nainital
Team = 50
12. Tarai west, Ramnagar
Team = 50
13. Tarai East, haldwani
Team = 50
14. Haldwani forest division, Haldwani
Team = 50
15. Civil Soyam , Almora Team = 50
16. Almora forest division

Team =50

17 Champawat forest division
Team =50

18 Tarai Center Rudrapur
Team =50

19. Bageshwar forest division
Team =50

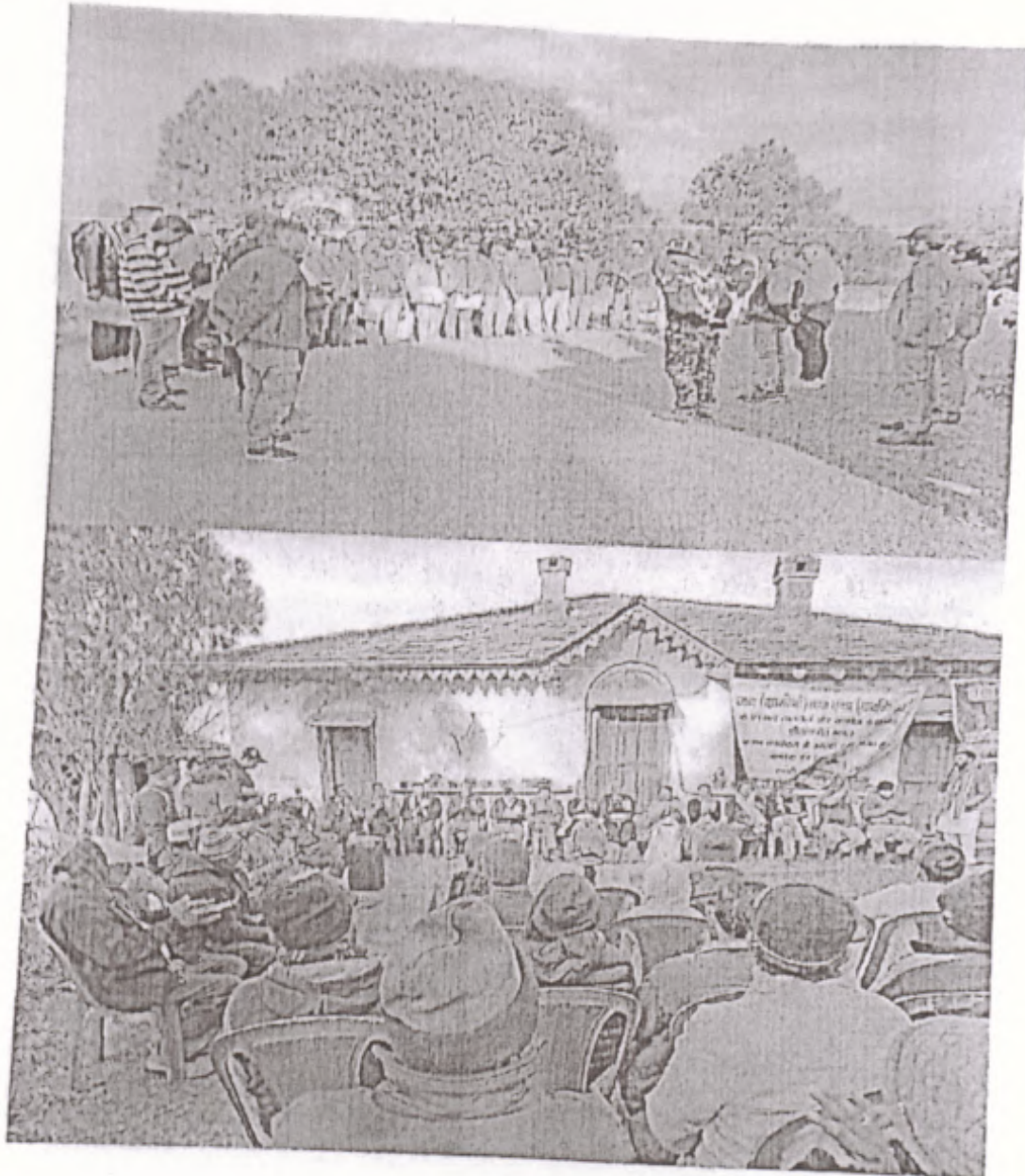
Summary

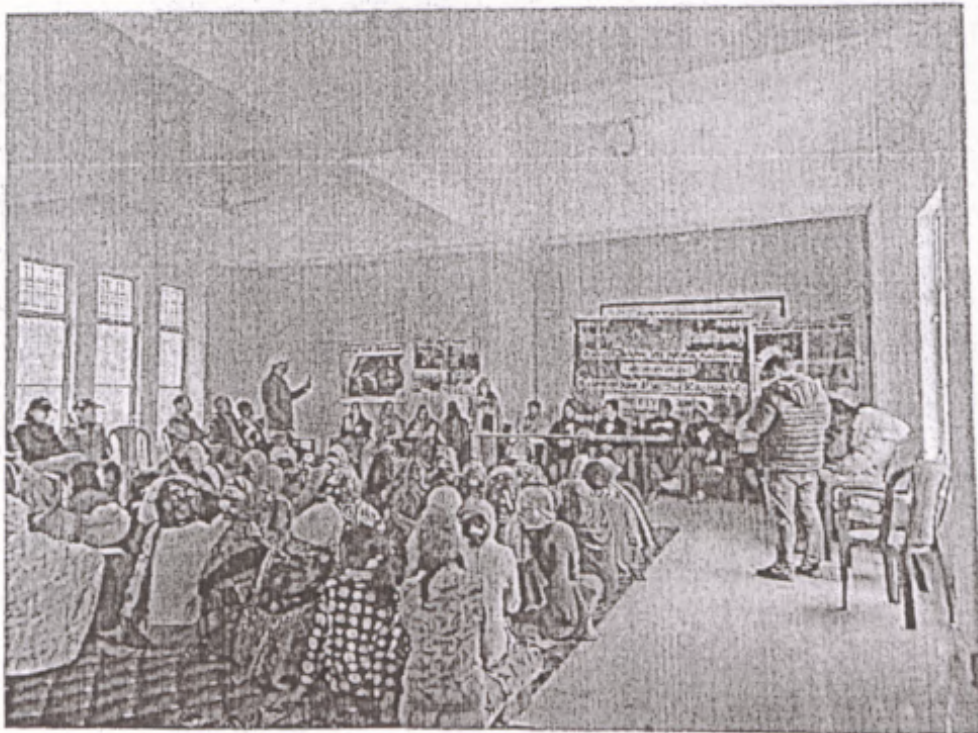
Total forest division =19

Total Team =24

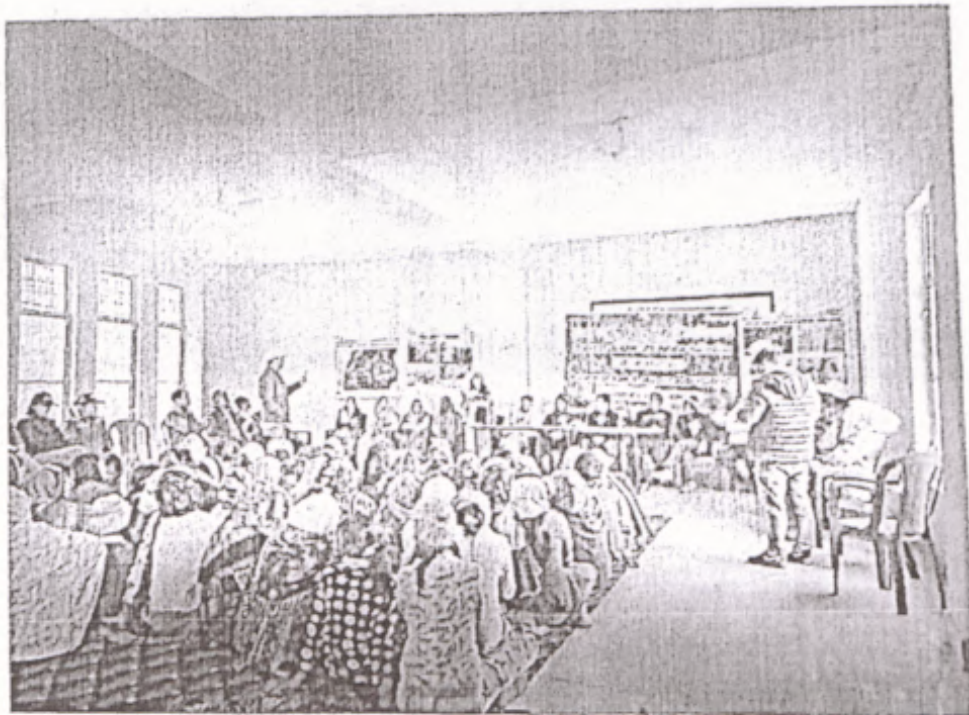
Total people trained= 1170

Glimpses of activities done under sheetlakhet model











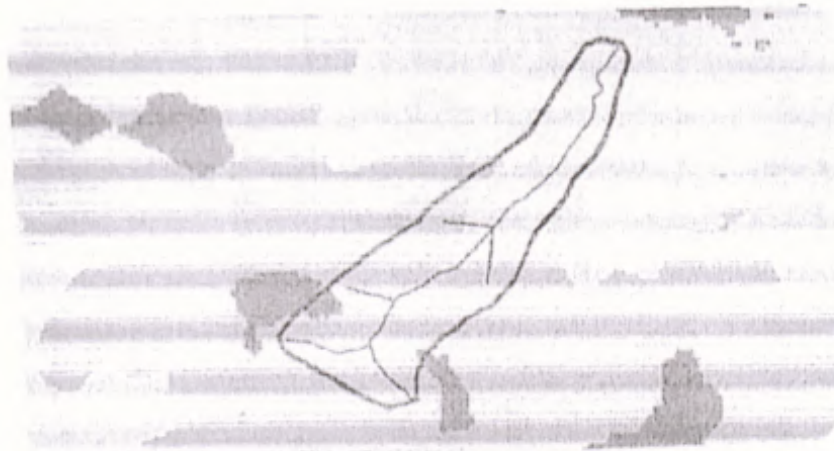






*Detailed Technical Report of Sugar Cane
Springshed.*

Forest Division : NAINITAL FOREST DIVISION
Range : BADHON
Source : SINAD
GPS Coordinate : N 29.05926 E 79.85899



Division Forest Officer
Nainital Forest Division

Forest Department
Uttarakhand Dehradun 248001

Prepared by : Shri Ulka Foundation, Haldwani, Nainital

Summary Of Cost										
सिनाङ्ग नाले में प्रस्तावित कार्य के व्यय का आकलन										
बढ़ौन वन क्षेत्र वर्ष 2023-2024 से 2025-2026 तक, नैनीताल वन प्रभाग नैनीताल										
क्र०सं०	कार्य का विवरण	दर	2023-2024		2024-2025		2025-2026		योग	
			भौतिक	वित्तीय	भौतिक	वित्तीय	भौतिक	वित्तीय	भौतिक	वित्तीय
1	2	3	4	5	6	7	8	9	10	11
1	गली प्लम्ब	17300	40	692000	20	346000	20	346000	80	1384000
2	आरआर ड्राई चौकडेम (3.00मी०)	26900	15	403500	5	134500	5	134500	25	672500
3	क्रेट बायर चौकडेम	53500	20	1070000	10	535000	10	535000	40	2140000
4	बालखाल (50000 से० हाफ्ट)	33100	10	331000	5	165500	5	165500	20	662000
5	वाटरपिक / विरल चौकडेम	6400	40	256000	25	160000	25	160000	90	576000
6	जलकुण्ड	250000	1	250000	1	250000	1	250000	3	750000
7	अनुभव एव मूल्यांकन	40000	1	40000	1	40000	1	40000	3	120000
8	डी०पी०आर० डिपेसन	140000	1	140000	0	0	0	0	1	140000
9	कन्दूर टेच (20मी०)	40	4000	160000	2000	80000	2000	80000	8000	320000
10	एम०आई०एस०सी०	40000	1	40000	1	40000	1	40000	3	120000
	योग :-			3382500		1751000		1751000		6884500

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2	CHAPTER : II Drainage Line Treatment Work Selection	22
3	CHAPTER : III Detailed design, drawing and estimates of all the Intervention	29
4	CHAPTER : IV Detailed Budget, Expected Outcomes	42

Chapter -1

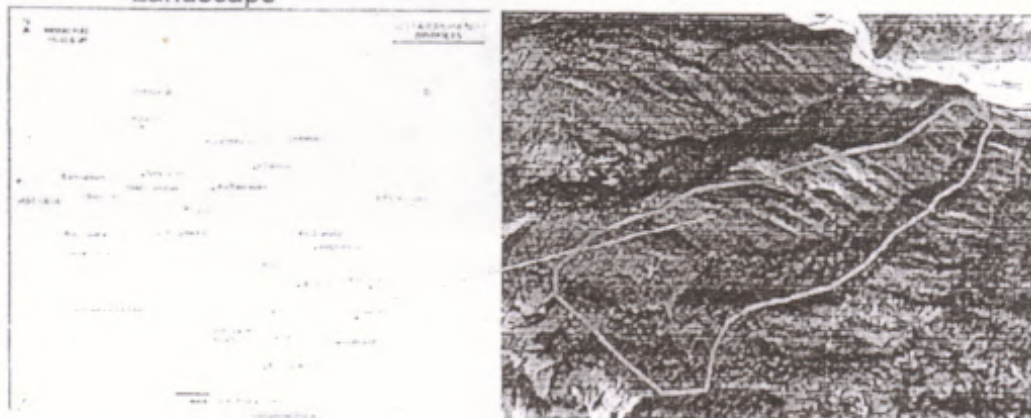
Basic Profile of Drainage Line		
1	Name of the drainage line to be treated	Simud - Nala
2	Watershed ID	2B7D4
3	Stream Order to be treated	First, Second, third, Fourth order
4	Name or No of supporting drainage lines if any	-
5	(A) Overall catchment area in Ha.	70
6	(B) Catchment area falling in Forest in Ha	
7	Name of Villages	Okhaldhunga, Barath, Siroli
8	Proposed Forest area in ha for treatment	
9	Major issues identified in the catchment area	Catchment is High soil erosion ranking Siltation at the bed profile Low ground water
10	Name of existing structures along with GPS coordinates in the drainage line (mention functional or non functional) (in the proposed forest area like tanks, stop dams, check dams, gabion, contour trenches, etc.)	NIL
11	Average width of drainage line in mt. (in the proposed forest area)	At Starting point - 1 M Middle point-5.0M End point-9.0 M
12	Treatment length of drainage line in Km (in the proposed forest area)	6.19 km
13	Average slope of drainage line in degree (in the proposed forest area)	20-40 degree
14	Benchmark points of drainage line (with location name L. (C.N., Coupe, local name of the plant, etc.) and GPS coordinates)	Okhaldhunga, Barath, Siroli
15	Average duration of water flow (in months, Also write the months name)	Seasonal flow of water upto order III & perennial flow in the order IV.
16	Maximum depth of flow in mt.	Upto 1.4m.
17	Availability of boulders in the catchment area (high, medium, low)	Meduim
18	Current use of drainage line (Irrigation, livestock drinking, plantation, wildlife, eco-tourism)	Drinking water for human, cattles & wildlife.
19	Number of Household benefiting from drainage line (SC/ST/OBC/Others)/ (Wildlife and forest growing stock)	175

Source :Data collected from forest survey

Objectives:

- To enhance rainfall infiltration into the ground thus increasing recharge capabilities of spring aquifers to sustain the local ecosystem.
- Science based planning, designing and Monitoring & Evaluation
- To strengthen the capacity of communities
- Sensitisation and awareness of different stakeholders
- Sustain water security through community participation.
- To control damaging runoff and degradation and thereby conservation of soil and water.
- To manage and utilize the runoff water for useful purpose.
- To protect, conserve and improve the land of springshed for more efficient and sustained production.
- To protect and enhance the water resource originating in the springshed.
- To check soil erosion and to reduce the effect of sediment yield on the springshed.
- To rehabilitate the deteriorating lands.
- To moderate the floods peaks at downstream areas.
- To improve and increase the production of timbers, fodder and wild life resource.
- To enhance the ground water recharge, wherever applicable.

Setting of Forest watershed boundary of the proposed area in the Landscape -



Drainage and Water Body Map of Sinad



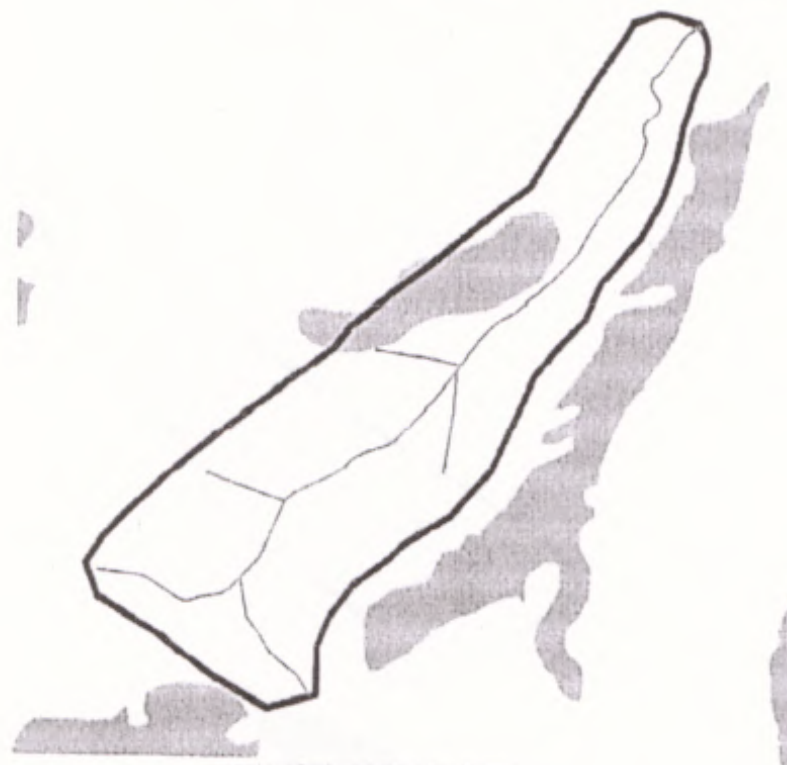
Source: Google Earth Pro, Bhuvan and Q GIS

Waste Land Map



- ✓ ☐ Catchment area
- ✓ ☐ Drainage
- ✓ ☒ UK_WL50K_1516
 - ☒ Gullied and Ravinous land
 - ☒ Scrub land
 - ☒ Waterlogged Area
 - ☒ Salt Affected Area
 - ☒ Shifting Cultivation
 - ☒ Degraded Forest
 - ☒ Degraded Pastures/ Grazing land
 - ☒ Degraded land under Plantation
 - ☒ Sandy Area
 - ☒ Mining/ Industrial Waste
 - ☒ Barren Rocky Area
 - ☒ Snow covered/Glacier Area
 - ☒ Non-Wasteland Area

Source: Google Earth Pro, Bhuvan and Q GIS



Sheet Erosion

Sheet Erosion

Full Edition

● **Quality Engineering**

☐ $\mathbb{P}^1 \times \mathbb{P}^1 \rightarrow \mathbb{P}^1$

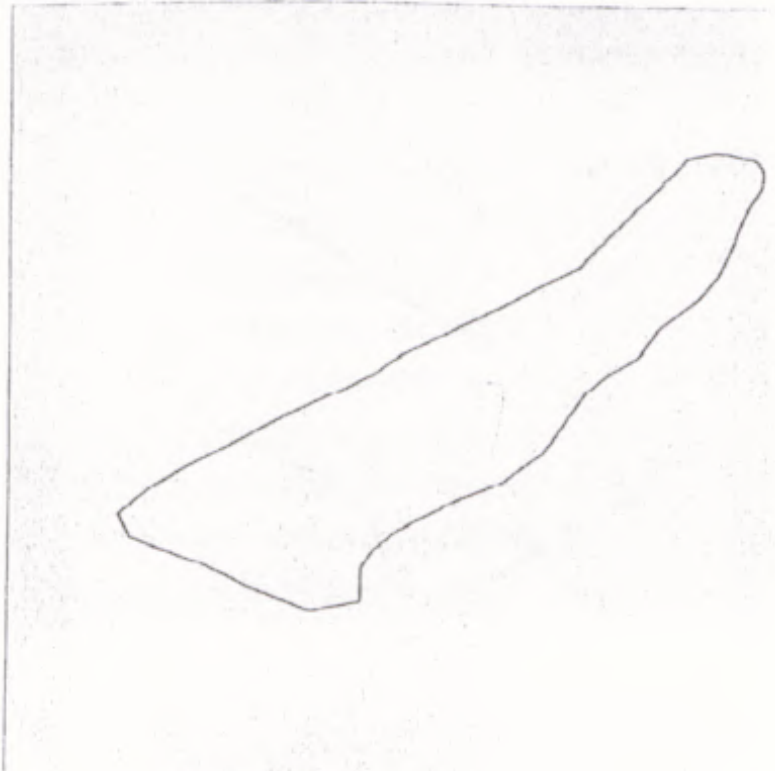
Sheet erosion: at top of dune:

and because:

f (fold), *l* (labeled case),

☐ Mr. Richard G. ...

Soil Texture Map



Legend

Drainage

SOIL TYPE

Bd- Dystric Cambisols

Be- Eutric Cambisols

I- Lithosols

Jc- Calcaric Fluvisols

Re- Eutric Regosols

Glaciers (GL)

Source: Google Earth Pro, Bhuvan and Q GIS

Lithology Map



Legend

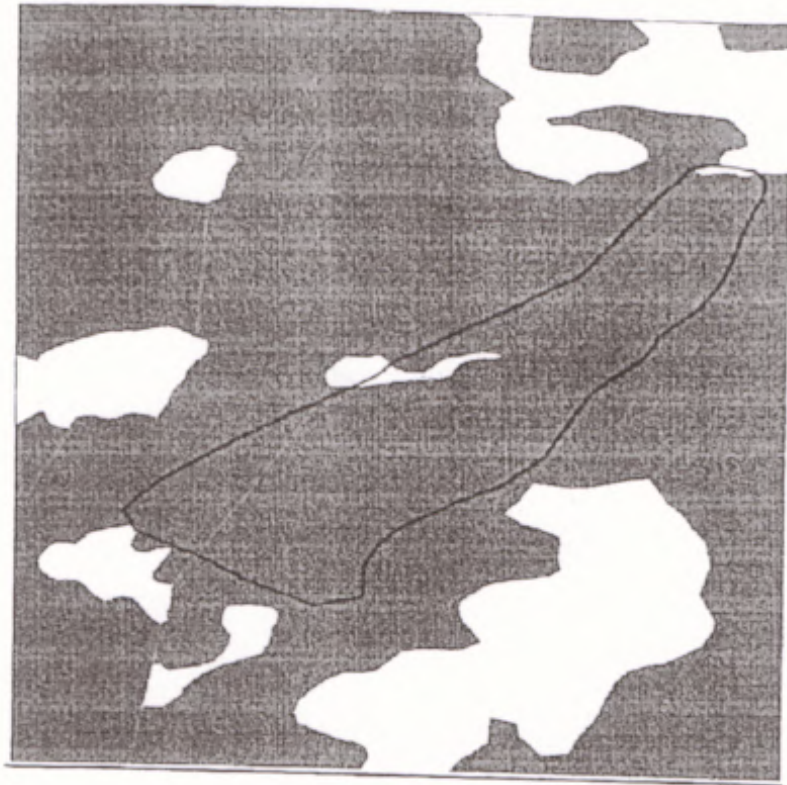
- Drainage
- ☐ UK_Wholog_Map

Legends

- ☐ Mesozoic
- ☐ Quaternary Sediments Rocks
- ☐ Cretaceous Sedimentary Rocks
- ☐ Triassic metamorphic and sedimentary rocks
- ☐ Tertiary and cretaceous igneous and metamorphic rocks
- ☐ Jurassic metamorphic and sedimentary rocks
- ☐ Undivided precambrian rocks
- ☐ Treatment area

Source: Google Earth Pro, Bhuvan and Q GIS

Forest Cover Map



Legend

- Drainage
-  Treatment Area
-  Other
-  Forest

Source: Google Earth Pro, Bhuvan and Q GIS

Lineament Map



- ✓ ☐ Treatment Area
- ✓ ☐ Drainage
- ✓ ☐ Legend
- Geomorphic lineaments
- Geomorphic Lineaments, Scarp parallel
- Geomorphic Lineaments, Drainage parallel
- Geomorphic Lineaments, Ridge parallel
- Geomorphic Lineaments, Parallel to shoreline
- Geomorphic Lineaments, Gorge/trench parallel
- Geomorphic Lineaments, Break in slope
- Structural lineaments
- Structural lineaments, Fault
- Structural lineaments, Joint/Fracture
- Structural lineaments, Shear zone
- Structural lineaments, Axial trace of fold
- Structural lineaments, Dyle
- Geomorphic lineaments
- Geomorphic Lineaments, Scarp parallel
- Geomorphic Lineaments, Drainage parallel
- Geomorphic Lineaments, Ridge parallel
- Geomorphic Lineaments, Parallel to shoreline
- Geomorphic Lineaments, Gorge/trench parallel
- Geomorphic Lineaments, Break in slope
- Structural lineaments
- Structural lineaments, Fault
- Structural lineaments, Joint/Fracture
- Structural lineaments, Shear zone
- Structural lineaments, Axial trace of fold
- Structural lineaments, Dyle

Source: Google Earth Pro, Bhuvan and Q GIS

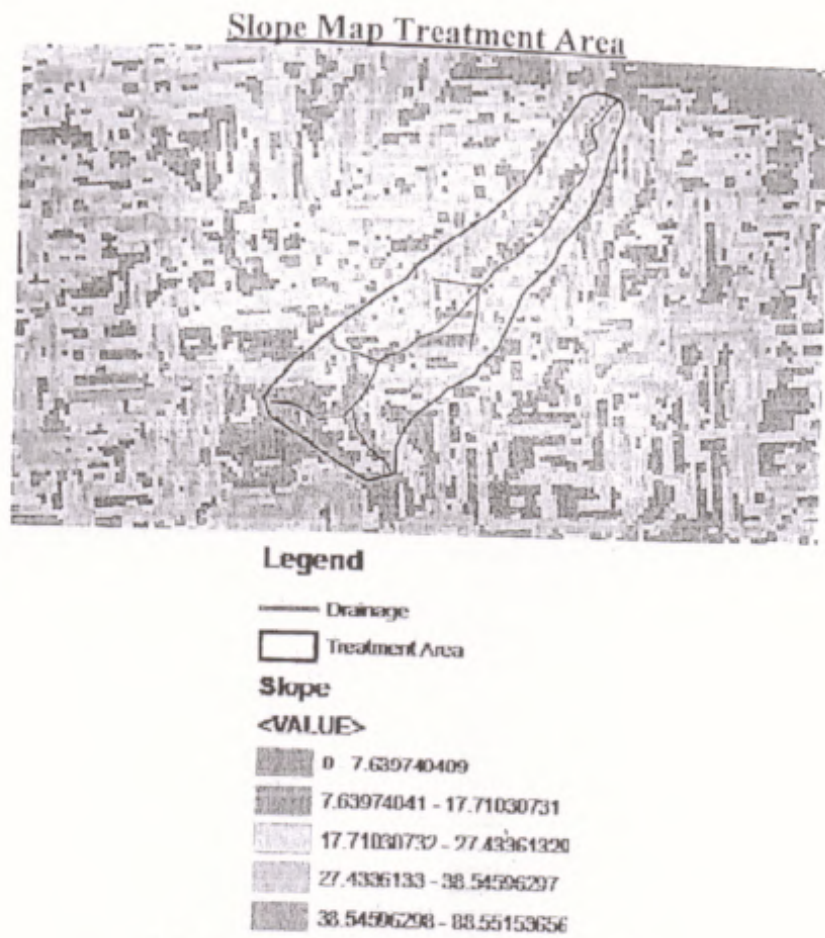
Groundwater Prospects Map



Groundwater Prospects Map

Legend
1. Deep aquifer (100 to 150 m)
2. Deep aquifer (150 to 200 m)
3. Deep aquifer (200 to 250 m)
4. Deep aquifer (250 to 300 m)
5. Deep aquifer (300 to 350 m)
6. Deep aquifer (350 to 400 m)
7. Deep aquifer (400 to 450 m)
8. Deep aquifer (450 to 500 m)
9. Deep aquifer (500 to 550 m)
10. Deep aquifer (550 to 600 m)
11. Deep aquifer (600 to 650 m)
12. Deep aquifer (650 to 700 m)
13. Deep aquifer (700 to 750 m)
14. Deep aquifer (750 to 800 m)
15. Deep aquifer (800 to 850 m)
16. Deep aquifer (850 to 900 m)
17. Deep aquifer (900 to 950 m)
18. Deep aquifer (950 to 1000 m)
19. Deep aquifer (1000 to 1050 m)
20. Deep aquifer (1050 to 1100 m)
21. Deep aquifer (1100 to 1150 m)
22. Deep aquifer (1150 to 1200 m)
23. Deep aquifer (1200 to 1250 m)
24. Deep aquifer (1250 to 1300 m)
25. Deep aquifer (1300 to 1350 m)
26. Deep aquifer (1350 to 1400 m)
27. Deep aquifer (1400 to 1450 m)
28. Deep aquifer (1450 to 1500 m)
29. Deep aquifer (1500 to 1550 m)
30. Deep aquifer (1550 to 1600 m)
31. Deep aquifer (1600 to 1650 m)
32. Deep aquifer (1650 to 1700 m)
33. Deep aquifer (1700 to 1750 m)
34. Deep aquifer (1750 to 1800 m)
35. Deep aquifer (1800 to 1850 m)
36. Deep aquifer (1850 to 1900 m)
37. Deep aquifer (1900 to 1950 m)
38. Deep aquifer (1950 to 2000 m)
39. Deep aquifer (2000 to 2050 m)
40. Deep aquifer (2050 to 2100 m)
41. Deep aquifer (2100 to 2150 m)
42. Deep aquifer (2150 to 2200 m)
43. Deep aquifer (2200 to 2250 m)
44. Deep aquifer (2250 to 2300 m)
45. Deep aquifer (2300 to 2350 m)
46. Deep aquifer (2350 to 2400 m)
47. Deep aquifer (2400 to 2450 m)
48. Deep aquifer (2450 to 2500 m)
49. Deep aquifer (2500 to 2550 m)
50. Deep aquifer (2550 to 2600 m)
51. Deep aquifer (2600 to 2650 m)
52. Deep aquifer (2650 to 2700 m)
53. Deep aquifer (2700 to 2750 m)
54. Deep aquifer (2750 to 2800 m)
55. Deep aquifer (2800 to 2850 m)
56. Deep aquifer (2850 to 2900 m)
57. Deep aquifer (2900 to 2950 m)
58. Deep aquifer (2950 to 3000 m)
59. Deep aquifer (3000 to 3050 m)
60. Deep aquifer (3050 to 3100 m)
61. Deep aquifer (3100 to 3150 m)
62. Deep aquifer (3150 to 3200 m)
63. Deep aquifer (3200 to 3250 m)
64. Deep aquifer (3250 to 3300 m)
65. Deep aquifer (3300 to 3350 m)
66. Deep aquifer (3350 to 3400 m)
67. Deep aquifer (3400 to 3450 m)
68. Deep aquifer (3450 to 3500 m)
69. Deep aquifer (3500 to 3550 m)
70. Deep aquifer (3550 to 3600 m)
71. Deep aquifer (3600 to 3650 m)
72. Deep aquifer (3650 to 3700 m)
73. Deep aquifer (3700 to 3750 m)
74. Deep aquifer (3750 to 3800 m)
75. Deep aquifer (3800 to 3850 m)
76. Deep aquifer (3850 to 3900 m)
77. Deep aquifer (3900 to 3950 m)
78. Deep aquifer (3950 to 4000 m)
79. Deep aquifer (4000 to 4050 m)
80. Deep aquifer (4050 to 4100 m)
81. Deep aquifer (4100 to 4150 m)
82. Deep aquifer (4150 to 4200 m)
83. Deep aquifer (4200 to 4250 m)
84. Deep aquifer (4250 to 4300 m)
85. Deep aquifer (4300 to 4350 m)
86. Deep aquifer (4350 to 4400 m)
87. Deep aquifer (4400 to 4450 m)
88. Deep aquifer (4450 to 4500 m)
89. Deep aquifer (4500 to 4550 m)
90. Deep aquifer (4550 to 4600 m)
91. Deep aquifer (4600 to 4650 m)
92. Deep aquifer (4650 to 4700 m)
93. Deep aquifer (4700 to 4750 m)
94. Deep aquifer (4750 to 4800 m)
95. Deep aquifer (4800 to 4850 m)
96. Deep aquifer (4850 to 4900 m)
97. Deep aquifer (4900 to 4950 m)
98. Deep aquifer (4950 to 5000 m)
99. Deep aquifer (5000 to 5050 m)
100. Deep aquifer (5050 to 5100 m)

Source: Google Earth Pro, Bhuvan and Q GIS



Source: Google Earth Pro, Bhuvan and Q GIS

Contour Map Treatment Area



Legend

Contour

— all other values —

Contour

0

100

200

300

400

500

600

700

800

900

1000

1100

1200

1300

1400

1500

1600

1700

1800

1900

2000

2100

2200

2300

2400

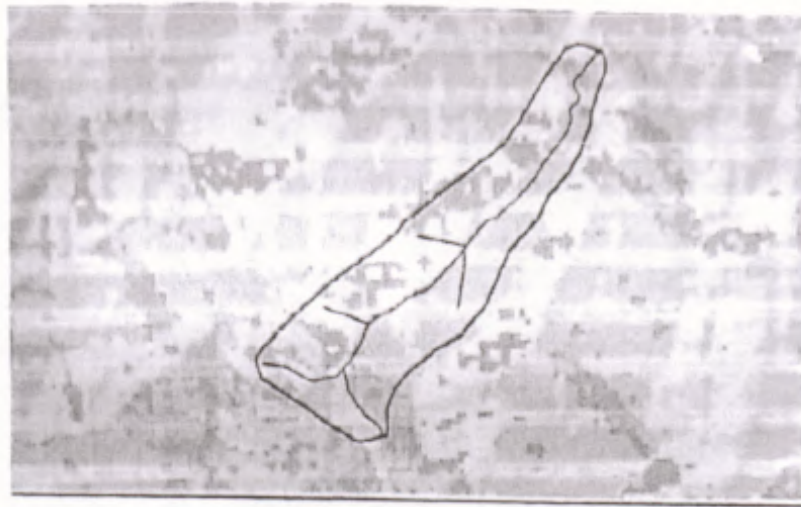
2500

2600

 catchment

Source: Google Earth Pro, Bhuvan and Q GIS

Aspect Map Treatment Area



Legend

	Drainage
	Treatment Area
	Flat (-)
	North (0-22.5)
	Northwest (22.5-67.5)
	East (67.5-112.5)
	Southeast (112.5-157.5)
	South (157.5-202.5)
	Southwest (202.5-247.5)
	West (247.5-292.5)
	Northwest (292.5-337.5)
	North (337.5-360)

Source: Google Earth Pro, Bhuvan and Q GIS

Hillshade Map Treatment Area



Legend

 catchment

HillShade

Value

0 - 70

 70.00000001 - 121

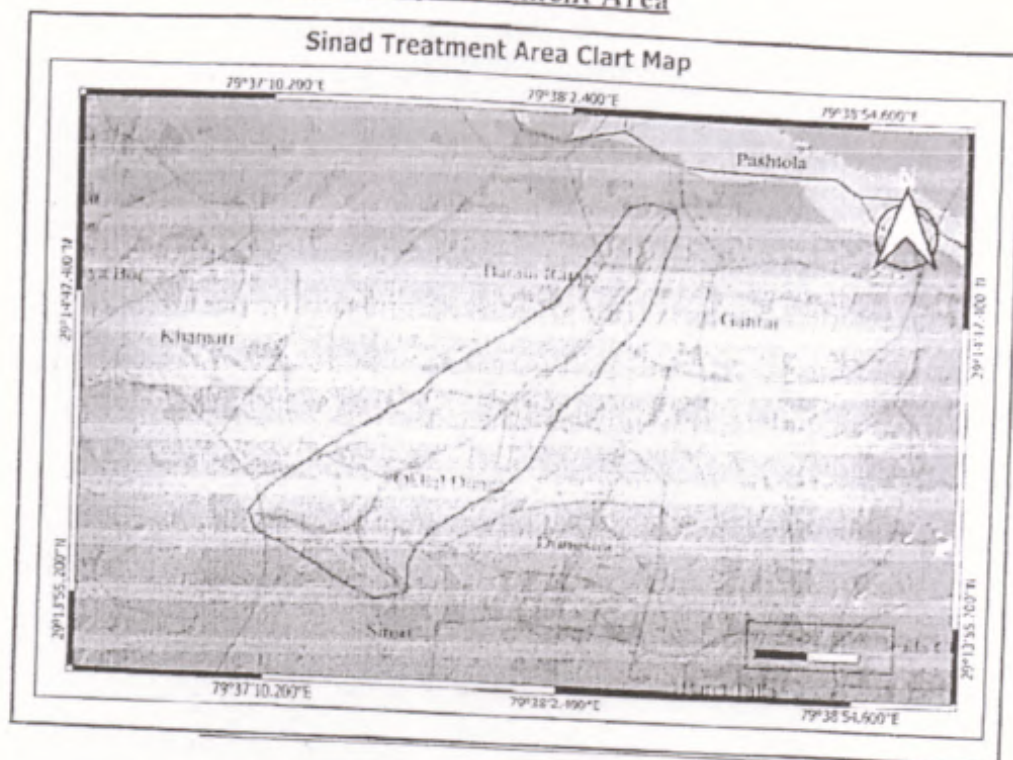
 121.00000001 - 162

 162.00000001 - 201

 201.00000001 - 254

Source: Google Earth Pro, Bhuvan and Q GIS

Clart Map Treatment Area



-  Good Recharge (Percolation Tank, Water Harvesting Structure, Trenches for Recharge)
-  Moderate Recharge (Loose Boulder Check Dam, Gully Plug, Water Arresting Trench)
-  Surface Storage (Farm Pond, Farm Bund and Well Deepening)
-  Area of Protection and Regeneration (Grass Seeding, Stone Bunding, Bench Terracing, etc.)

Source: Google Earth Pro, Bhuvan and Q GIS

-2

Sinad NALA

Extensive field visit of the Catchment area and tracking along in the Stream, Drainage Line and information gathered from the source maps treatment plan of Spring shed has been made in order to reduce the soil erosion. The treatment plan will result in recharge of groundwater and the availability for potable and irrigational water for the use of villagers will increase. Detailed treatment plan has been made for this purpose and GIS based information has led to the type of structures to be constructed at particular position of the stream. GPS Locations of all the interventions/structures have been shown below :-

SNO	Divison	Reng	Code	Structure	Lattitute	Longitute	Budget(Rs)
1	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3716	17300
2	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
3	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.372	17300
4	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3718	17300
5	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.372	17300
6	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3727	17300
7	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.3726	17300
8	Nainital	Badon Renge	Gpl	Gully Plugs	29.1427	79.3723	17300
9	Nainital	Badon Renge	Gpl	Gully Plugs	29.1419	79.3717	17300
10	Nainital	Badon Renge	Gpl	Gully Plugs	29.1418	79.3721	17300
11	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
12	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.372	17300
13	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
14	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3719	17300
15	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.372	17300
16	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
17	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3725	17300
18	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3722	17300
19	Nainital	Badon Renge	Gpl	Gully Plugs	29.1427	79.3712	17300
20	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
21	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.3723	17300
22	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3721	17300
23	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
24	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
25	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
26	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3721	17300
27	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
28	Nainital	Badon Renge	Gpl	Gully Plugs	29.1424	79.372	17300
29	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3719	17300
30	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
31	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3723	17300
32	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3723	17300
33	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
34	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
35	Nainital	Badon Renge	Gpl	Gully Plugs	29.1419	79.372	17300

36	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
37	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3723	17300
38	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3719	17300
39	Nainital	Badon Renge	Gpl	Gully Plugs	29.1424	79.3719	17300
40	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.372	17300
41	Nainital	Badon Renge	Gpl	Gully Plugs	29.1426	79.3719	17300
42	Nainital	Badon Renge	Gpl	Gully Plugs	29.1427	79.3723	17300
43	Nainital	Badon Renge	Gpl	Gully Plugs	29.1428	79.3724	17300
44	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3725	17300
45	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3726	17300
46	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3721	17300
47	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3719	17300
48	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
49	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3723	17300
50	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3719	17300
51	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.372	17300
52	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3721	17300
53	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3719	17300
54	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
55	Nainital	Badon Renge	Gpl	Gully Plugs	29.1424	79.3719	17300
56	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3721	17300
57	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.372	17300
58	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3719	17300
59	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.3723	17300
60	Nainital	Badon Renge	Gpl	Gully Plugs	29.1426	79.3718	17300
61	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3717	17300
62	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3715	17300
63	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3719	17300
64	Nainital	Badon Renge	Gpl	Gully Plugs	29.1419	79.3721	17300
65	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
66	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3717	17300
67	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3718	17300
68	Nainital	Badon Renge	Gpl	Gully Plugs	29.1425	79.3721	17300
69	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3722	17300
70	Nainital	Badon Renge	Gpl	Gully Plugs	29.1424	79.3723	17300
71	Nainital	Badon Renge	Gpl	Gully Plugs	29.1426	79.3724	17300
72	Nainital	Badon Renge	Gpl	Gully Plugs	29.1418	79.3725	17300
73	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3719	17300
74	Nainital	Badon Renge	Gpl	Gully Plugs	29.1423	79.3724	17300
75	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3721	17300
76	Nainital	Badon Renge	Gpl	Gully Plugs	29.1422	79.3717	17300
77	Nainital	Badon Renge	Gpl	Gully Plugs	29.1419	79.3721	17300
78	Nainital	Badon Renge	Gpl	Gully Plugs	29.142	79.3719	17300
79	Nainital	Badon Renge	Gpl	Gully Plugs	29.1421	79.3722	17300
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81	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3711	6400
82	Nainital	Badon Renge	PR1	Pirul Check	29.1427	79.3718	6400

				daim			
83	Nainital	Badon Renge	PR1	Pirul Check daim	29.142	79.3719	6400
84	Nainital	Badon Renge	PR1	Pirul Check daim	29.1419	79.372	6400
85	Nainital	Badon Renge	PR1	Pirul Check daim	29.142	79.3719	6400
86	Nainital	Badon Renge	PR1	Pirul Check daim	29.1422	79.3724	6400
87	Nainital	Badon Renge	PR1	Pirul Check daim	29.1425	79.3726	6400
88	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3715	6400
89	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3717	6400
90	Nainital	Badon Renge	PR1	Pirul Check daim	29.1422	79.3718	6400
91	Nainital	Badon Renge	PR1	Pirul Check daim	29.1423	79.3719	6400
92	Nainital	Badon Renge	PR1	Pirul Check daim	29.1424	79.372	6400
93	Nainital	Badon Renge	PR1	Pirul Check daim	29.1419	79.3721	6400
94	Nainital	Badon Renge	PR1	Pirul Check daim	29.1418	79.3722	6400
95	Nainital	Badon Renge	PR1	Pirul Check daim	29.1417	79.3725	6400
96	Nainital	Badon Renge	PR1	Pirul Check daim	29.1418	79.3726	6400
97	Nainital	Badon Renge	PR1	Pirul Check daim	29.1422	79.3717	6400
98	Nainital	Badon Renge	PR1	Pirul Check daim	29.1423	79.372	6400
99	Nainital	Badon Renge	PR1	Pirul Check daim	29.1425	79.3727	6400
100	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3719	6400
101	Nainital	Badon Renge	PR1	Pirul Check daim	29.1423	79.3717	6400
102	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3715	6400
103	Nainital	Badon Renge	PR1	Pirul Check daim	29.1423	79.3714	6400
104	Nainital	Badon Renge	PR1	Pirul Check daim	29.1425	79.3717	6400
105	Nainital	Badon Renge	PR1	Pirul Check daim	29.1427	79.3718	6400
106	Nainital	Badon Renge	PR1	Pirul Check daim	29.1429	79.3723	6400
107	Nainital	Badon Renge	PR1	Pirul Check daim	29.1421	79.3725	6400
108	Nainital	Badon Renge	PR1	Pirul Check daim	29.1423	79.3727	6400
109	Nainital	Badon Renge	PR1	Pirul Check daim	29.1427	79.3729	6400
110	Nainital	Badon Renge	PR1	Pirul Check daim	29.1424	79.373	6400
111	Nainital	Badon Renge	PR1	Pirul Check daim	29.1425	79.3733	6400
112	Nainital	Badon Renge	PR1	Pirul Check daim	29.1417	79.3734	6400
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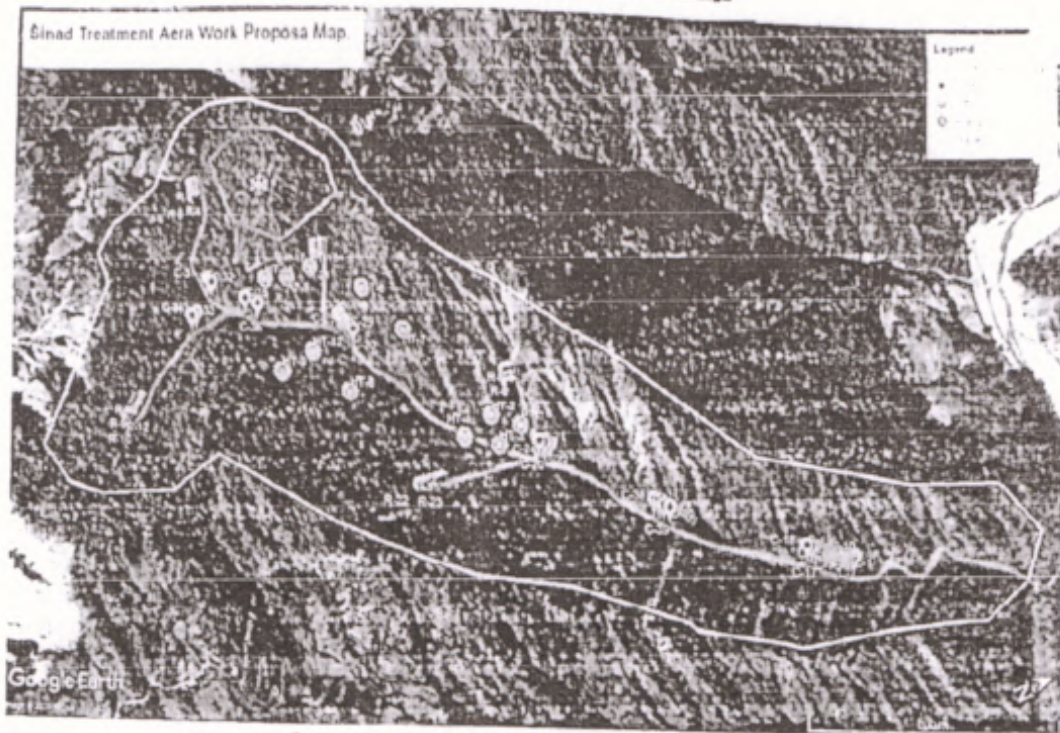
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115	Nainital	Badon Renge	PR I	Pirul Check daim	29.1415	79.3718	6400
116	Nainital	Badon Renge	PR I	Pirul Check daim	29.1427	79.3712	6400
117	Nainital	Badon Renge	PR I	Pirul Check daim	29.1428	79.3714	6400
118	Nainital	Badon Renge	PR I	Pirul Check daim	29.1419	79.3715	6400
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120	Nainital	Badon Renge	PR I	Pirul Check daim	29.1426	79.3713	6400
121	Nainital	Badon Renge	PR I	Pirul Check daim	29.1422	79.3711	6400
122	Nainital	Badon Renge	PR I	Pirul Check daim	29.1423	79.3719	6400
123	Nainital	Badon Renge	PR I	Pirul Check daim	29.1428	79.372	6400
124	Nainital	Badon Renge	PR I	Pirul Check daim	29.1429	79.3722	6400
125	Nainital	Badon Renge	PR I	Pirul Check daim	29.1433	79.3723	6400
126	Nainital	Badon Renge	PR I	Pirul Check daim	29.1425	79.3725	6400
127	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3727	6400
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129	Nainital	Badon Renge	PR I	Pirul Check daim	29.1422	79.3719	6400
130	Nainital	Badon Renge	PR I	Pirul Check daim	29.1423	79.371	6400
131	Nainital	Badon Renge	PR I	Pirul Check daim	29.1422	79.3719	6400
132	Nainital	Badon Renge	PR I	Pirul Check daim	29.1424	79.3719	6400
133	Nainital	Badon Renge	PR I	Pirul Check daim	29.1425	79.3717	6400
134	Nainital	Badon Renge	PR I	Pirul Check daim	29.1428	79.3715	6400
135	Nainital	Badon Renge	PR I	Pirul Check daim	29.1417	79.3714	6400
136	Nainital	Badon Renge	PR I	Pirul Check daim	29.1418	79.3717	6400
137	Nainital	Badon Renge	PR I	Pirul Check daim	29.1416	79.3719	6400
138	Nainital	Badon Renge	PR I	Pirul Check daim	29.1415	79.372	6400
139	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3721	6400
140	Nainital	Badon Renge	PR I	Pirul Check daim	29.1419	79.3722	6400
141	Nainital	Badon Renge	PR I	Pirul Check daim	29.1425	79.3725	6400
142	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3727	6400
143	Nainital	Badon Renge	PR I	Pirul Check daim	29.1416	79.3719	6400
144	Nainital	Badon Renge	PR I	Pirul Check	29.1415	79.3729	6400

				daim			
145	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3726	6400
146	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3711	6400
147	Nainital	Badon Renge	PR I	Pirul Check daim	29.1419	79.3713	6400
148	Nainital	Badon Renge	PR I	Pirul Check daim	29.1415	79.3719	6400
149	Nainital	Badon Renge	PR I	Pirul Check daim	29.1427	79.372	6400
150	Nainital	Badon Renge	PR I	Pirul Check daim	29.1428	79.3725	6400
151	Nainital	Badon Renge	PR I	Pirul Check daim	29.1429	79.3717	6400
152	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3719	6400
153	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3718	6400
154	Nainital	Badon Renge	PR I	Pirul Check daim	29.1425	79.3719	6400
155	Nainital	Badon Renge	PR I	Pirul Check daim	29.1423	79.3715	6400
156	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3717	6400
157	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3719	6400
158	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3715	6400
159	Nainital	Badon Renge	PR I	Pirul Check daim	29.1423	79.3717	6400
160	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3719	6400
161	Nainital	Badon Renge	PR I	Pirul Check daim	29.1425	79.3713	6400
162	Nainital	Badon Renge	PR I	Pirul Check daim	29.1422	79.3729	6400
163	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3719	6400
164	Nainital	Badon Renge	PR I	Pirul Check daim	29.1423	79.3716	6400
165	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3719	6400
166	Nainital	Badon Renge	PR I	Pirul Check daim	29.142	79.3717	6400
167	Nainital	Badon Renge	PR I	Pirul Check daim	29.1424	79.3714	6400
168	Nainital	Badon Renge	PR I	Pirul Check daim	29.1427	79.3718	6400
169	Nainital	Badon Renge	PR I	Pirul Check daim	29.1429	79.3721	6400
170	Nainital	Badon Renge	PR I	Pirul Check daim	29.1421	79.3719	6400
171	Nainital	Badon Renge	RR I	R R Dry	29.23607	79.61946	26900
172	Nainital	Badon Renge	RR I	R R Dry	29.23607	79.6196	26900
173	Nainital	Badon Renge	RR I	R R Dry	29.23605	79.61974	26900
174	Nainital	Badon Renge	RR I	R R Dry	29.23603	79.61988	26900
175	Nainital	Badon Renge	RR I	R R Dry	29.23602	79.62	26900
176	Nainital	Badon Renge	RR I	R R Dry	29.24222	79.62916	26900
177	Nainital	Badon Renge	RR I	R R Dry	29.24224	79.629	26900

178	Nailnut	Badon Renge	RR1	R R Dry	29.24227	79.62876	26900
179	Nailnut	Badon Renge	RR1	R R Dry	29.23312	79.62892	26900
180	Nailnut	Badon Renge	RR1	R R Dry	29.23318	79.62888	26900
181	Nailnut	Badon Renge	RR1	R R Dry	29.23324	79.62882	26900
182	Nailnut	Badon Renge	RR1	R R Dry	29.2333	79.62877	26900
183	Nailnut	Badon Renge	RR1	R R Dry	29.23333	79.6287	26900
184	Nailnut	Badon Renge	RR1	R R Dry	29.23337	79.62865	26900
185	Nailnut	Badon Renge	RR1	R R Dry	29.2334	79.62859	26900
186	Nailnut	Badon Renge	RR1	R R Dry	29.23345	79.62853	26900
187	Nailnut	Badon Renge	RR1	R R Dry	29.23876	79.62302	26900
188	Nailnut	Badon Renge	RR1	R R Dry	29.23871	79.62314	26900
189	Nailnut	Badon Renge	RR1	R R Dry	29.23869	79.62325	26900
190	Nailnut	Badon Renge	RR1	R R Dry	29.23866	79.62336	26900
191	Nailnut	Badon Renge	RR1	R R Dry	29.23863	79.62346	26900
192	Nailnut	Badon Renge	RR1	R R Dry	29.23931	79.63085	26900
193	Nailnut	Badon Renge	RR1	R R Dry	29.23943	79.63086	26900
194	Nailnut	Badon Renge	RR1	R R Dry	29.23962	79.63089	26900
195	Nailnut	Badon Renge	RR1	R R Dry	29.23975	79.63089	26900
196	Nailnut	Badon Renge	CW1	Crate Wire	29.24774	79.63721	53500
197	Nailnut	Badon Renge	CW1	Crate Wire	29.24768	79.63716	53500
198	Nailnut	Badon Renge	CW1	Crate Wire	29.24762	79.63712	53500
199	Nailnut	Badon Renge	CW1	Crate Wire	29.24758	79.63709	53500
200	Nailnut	Badon Renge	CW1	Crate Wire	29.24753	79.63706	53500
201	Nailnut	Badon Renge	CW1	Crate Wire	29.24747	79.63703	53500
202	Nailnut	Badon Renge	CW1	Crate Wire	29.24742	79.63699	53500
203	Nailnut	Badon Renge	CW1	Crate Wire	29.24737	79.63695	53500
204	Nailnut	Badon Renge	CW1	Crate Wire	29.24732	79.63689	53500
205	Nailnut	Badon Renge	CW1	Crate Wire	29.24727	79.63686	53500
206	Nailnut	Badon Renge	CW1	Crate Wire	29.24722	79.63681	53500
207	Nailnut	Badon Renge	CW1	Crate Wire	29.24718	79.63677	53500
208	Nailnut	Badon Renge	CW1	Crate Wire	29.24713	79.63672	53500
209	Nailnut	Badon Renge	CW1	Crate Wire	29.24708	79.63668	53500
210	Nailnut	Badon Renge	CW1	Crate Wire	29.24704	79.63664	53500
211	Nailnut	Badon Renge	CW1	Crate Wire	29.247	79.63662	53500
212	Nailnut	Badon Renge	CW1	Crate Wire	29.24693	79.63657	53500
213	Nailnut	Badon Renge	CW1	Crate Wire	29.2469	79.63653	53500
214	Nailnut	Badon Renge	CW1	Crate Wire	29.24685	79.63649	53500
215	Nailnut	Badon Renge	CW1	Crate Wire	29.24199	79.63131	53500
216	Nailnut	Badon Renge	CW1	Crate Wire	29.24205	79.63136	53500
217	Nailnut	Badon Renge	CW1	Crate Wire	29.24209	79.63141	53500
218	Nailnut	Badon Renge	CW1	Crate Wire	29.24214	79.63145	53500
219	Nailnut	Badon Renge	CW1	Crate Wire	29.24221	79.6315	53500
220	Nailnut	Badon Renge	CW1	Crate Wire	29.23837	79.62573	53500
221	Nailnut	Badon Renge	CW1	Crate Wire	29.23842	79.62585	53500
222	Nailnut	Badon Renge	CW1	Crate Wire	29.23848	79.626	53500
223	Nailnut	Badon Renge	CW1	Crate Wire	29.23853	79.62612	53500
224	Nailnut	Badon Renge	CW1	Crate Wire	29.23857	79.62623	53500

225	Nainital	Badon Renge	CWI	Crate Wire	29.23861	79.62632	53500
226	Nainital	Badon Renge	CWI	Crate Wire	29.23549	79.62319	53500
227	Nainital	Badon Renge	CWI	Crate Wire	29.23555	79.62333	53500
228	Nainital	Badon Renge	CWI	Crate Wire	29.23487	79.6241	53500
229	Nainital	Badon Renge	CWI	Crate Wire	29.23498	79.62408	53500
230	Nainital	Badon Renge	CWI	Crate Wire	29.23625	79.62419	53500
231	Nainital	Badon Renge	CWI	Crate Wire	29.23651	79.6245	53500
232	Nainital	Badon Renge	CWI	Crate Wire	29.24402	79.63392	53500
233	Nainital	Badon Renge	CWI	Crate Wire	29.24411	79.63401	53500
234	Nainital	Badon Renge	CWI	Crate Wire	29.24418	79.63414	53500
235	Nainital	Badon Renge	CWI	Crate Wire	29.24429	79.63425	53500
236	Nainital	Badon Renge	CKI	Chal-khal	29.24177	79.63058	33100
237	Nainital	Badon Renge	CKI	Chal-khal	29.24116	79.63002	33100
238	Nainital	Badon Renge	CKI	Chal-khal	29.2411	79.63085	33100
239	Nainital	Badon Renge	CKI	Chal-khal	29.24037	79.63028	33100
240	Nainital	Badon Renge	CKI	Chal-khal	29.23743	79.62392	33100
241	Nainital	Badon Renge	CKI	Chal-khal	29.23919	79.62508	33100
242	Nainital	Badon Renge	CKI	Chal-khal	29.23981	79.62673	33100
243	Nainital	Badon Renge	CKI	Chal-khal	29.23811	79.62784	33100
244	Nainital	Badon Renge	CKI	Chal-khal	29.23668	79.62654	33100
245	Nainital	Badon Renge	CKI	Chal-khal	29.23809	79.62387	33100
246	Nainital	Badon Renge	CKI	Chal-khal	29.2369	79.62369	33100
247	Nainital	Badon Renge	CKI	Chal-khal	29.23754	79.62635	33100
248	Nainital	Badon Renge	CKI	Chal-khal	29.23744	79.6207	33100
249	Nainital	Badon Renge	CKI	Chal-khal	29.24708	79.63668	33100
250	Nainital	Badon Renge	CKI	Chal-khal	29.23809	79.62387	33100
251	Nainital	Badon Renge	CKI	Chal-khal	29.1421	79.3716	33100
252	Nainital	Badon Renge	CKI	Chal-khal	29.142	79.3719	33100
253	Nainital	Badon Renge	CKI	Chal-khal	29.1422	79.372	33100
254	Nainital	Badon Renge	CKI	Chal-khal	29.1423	79.3718	33100
255	Nainital	Badon Renge	CKI	Chal-khal	29.1425	79.372	33100
256	Nainital	Badon Renge	CTI	Contour Trench	29.1423	79.3727	320000
257	Nainital	Badon Renge	JK	Jalkund	29.1425	79.3726	250000
258	Nainital	Badon Renge	JK	Jalkund	29.1427	79.3723	250000
259	Nainital	Badon Renge	JK	Jalkund	29.1419	79.3717	250000
260	Nainital	Badon Renge	CC	CANTEGENCE CHANGE	29.1418	79.3721	120000
261	Nainital	Badon Renge	D.P	D.P.R PRIPATION	29.142	79.3719	140000
262	Nainital	Badon Renge	C	Contigencies	29.142	79.3719	120000
	Nainital		Total				6884500

Treatment Area Proposal Work Map



Source: Google Earth Pro, Bhuvan and Q GIS

Chapter - 3

Detailed estimates of works :-

1 - गली प्लगिंग कार्य का प्राक्कलन

क्रम सं०	कार्य का विवरण	इकाई	संख्या	मपत भीतर में			मात्रा	दर	मनराशि	आवक
				ल०	पी०	व/म०				
1	2	3	4	5	6	7	8	9	10	11
1	गली प्लग निर्माण हेतु मुनियार्द खुदान		1	3	1.50	0.60	2.70			
	अगल-बगल खुदान		1*2	0.50	1.00	0.60	0.30		1	
	योग						3.00	378.30	1134.90	1-2
2	उक्त गली प्लग की आर०आर पत्थरों से कोरी घिनाई मुनियार्द में	Sqm	1	3.00	1.50	0.60	2.70			
	प्रथम पादुका में		1	4.00	1.00	1.00	4.00			
	योग						6.70	2263.60	15168.12	1-3
3	गली प्लग के आगे पीछे यानस्पतिक कटिंग लगाना		500					2.00	1000.00	
	कुल योग								17301.02	
	या								17300.00	

2 - झाई चैकडैम का प्राक्कलन

3

DETAILED ESTIMATE OF R.R.DRY STONE MASONRY CHECK DAM AT- SINAD NALA BAHON RANGE NAINITAL FOREST DIVISION NAINITAL										
3.00 MI. SPAN DRY CHECK DAM.										
Sl. No.	Name of Item	No	Measurement (Mt.)			Qty		Rate	Amount	S.O.R.N O.
			L.	W.	H/D					
1	2	3	4	5	6	7		8	9	10
1	Excavation in foundation for retaining, breast walls etc. in all types of soils and rocks including all lead, lift and disposal of surplus material as per direction of engineer - in - charge, as per drawing and technical specifications Clause 305.1 of MORD Specification									
	foundation	1	3.00	1.60	0.80	3.84				
	first step	2	0.50	1.30	0.80	1.04				
	second step	2	0.50	1.00	0.80	0.80				
	apran	1	3.00	1.00	0.30	0.90				
						8.58	cumt.	360.60	2372.09	SOR (misc.1.2)
2	Random Rubble Stone Masonry laid Dry, in breast walls, retaining walls, etc. including supply of all material, labour, T&P and royalties etc. complete as per drawing and technical specifications Clauses 702, 704, 1202 & 1203 of MORD Specification									
	foundation	1	3.00	1.60	0.80	3.84				
	First step	1	4.00	1.30	0.80	4.16				
		2X1	1.75+2.0 /2	1.00	0.80+0.50 /2	2.43				
	apran	1	3.00	1.00	0.30	0.90				
						11.33	cumt.	2129.50	24127.24	SOR (misc.1.3)
3	Agave plantation around the check dams / catchment area for strengthening of check dam.					120.00	no	3.47	416.40	Dep. SOR 2.0.8.4
								TOTAL	26915.73	
								say	26900.00	
	NOTE-									
1	RATES OF (FY 2022-2023) SOR ITEMS ARE TAKEN FOR BHIMTAL (BLOCK -78) FOR THE ESTIMATION PURPOSE (AS ON 3.10.2022)									

३-फोटोग्राफ

DETAILED ESTIMATE OF CRATE WIRE STONE MASONRY CHECK DAM AT- SINAD NAALA (BADON RANGE, NAINITAL)										
FOREST DIVISION NAINITAL										
5.00 ML SPAN CHECK DAM-										
Sl. No.	Name of Item	No	Measurement (ML.)			Qty		Rate	Amount	S.O.R. NO.
			L	W	H/D					
1	2	3	4	5	6	7	8	9	10	
1	Excavation in foundation for retaining, breast walls etc, in all types of soils and rocks including all lead, lift and disposal of surplus material as per direction of engineer - In - charge, as per drawing and technical specifications Clause 305.1 of MORD Specification									
	foundation	1	5.00	2.00	1.00	10.00				
	first step	2	0.50	1.50	1.00	1.50				
	second step	2	0.50	1.00	0.80	0.80				
	apran	1	3.00	1.20	0.45	1.62				
						13.92	cumt.	360.50	5018.16	SOR (misc. 1.2)
2	Providing and laying of wire crates 3.00x1.50x1.50 in size with GI wire conforming to IS: 280 & IS:4826 in 150mm x 150mm mesh laid with stone boulders. as per direction of Engineer-in- charge. (As per PWD Uttarakhand specifications) GI wire 8 gauge BWG									
	foundation	1	5.00	2.00	1.00	10.00				
	First step	1	6.00	1.50	1.00	9.00				
		2x1	2.75+2.50/2	1.00	0.80	4.20				
	apran	1	5.00	1.20	0.45	2.70				
						25.90	cumt.	1817.20	47065.48	SOR (misc.)

31

									1.7.2)
	Agave plantation around the check dams / catchment area for strengthening of check dam. (राग और एक गवना, गुलाब करण)					410.00	no.	3.47	1477.70
								TOTAL	53506.34
								say	53500.00

Sl. No	Name of Item	No	Measurement (M)			Qty		Rate (Katsbagh block)	Amount	S O R NO
			L	M	H D					
1	2	3	4	5	6	7	8	9	10	
1	Excavation in foundation for retaining, bored walls etc. in all types of soils and rocks including all load left and disposal of surplus material as per direction of engineer-in-charge, as per drawing and technical specifications, Clause 304.1 of MORD									
	Foundation	1	4.00	1.00	1.00	5.00				
	First step	1x5	0.50	1.20	1.00	2.25				
	Second step	1x5	0.50	1.00	0.50	2.00				
	up on	1	4.00	0.00	0.50	1.05				
						14.33	cu.m.	254.20	3677.12	SOR (under 1.7.2)
2	Overriding and laying of wire netting 500x150x150 mesh with 0.15m x 1.50m mesh laid with stone boulders as per direction of Engineer-in-charge (As per PWID Technical specifications of wire is given below)									
	Foundation	1	4.00	1.00	1.00	5.00				
	First step	1	6.00	1.20	1.00	8.50				
		1x5	2.50-2.5	1.00	0.50+0.50	0.10				
	up on	1	4.00	0.00	0.20	1.05				
						26.07	cu.m.	1823.00	4751.05	SOR (under 1.7.2)
3	Agave plantation around the check dam / catchment area for strengthening of check dam. (राग और एक गवना, गुलाब करण)					267	no.	3.47	925.33	Dep. SOR 2.0.8.4
								TOTAL	53523.50	
								say	53500.00	
	NOTE									
1. RATE OF 1% 10% 20% SOR THESE ARE TAKEN FOR ESTIMATING BLOCK, FOR THE ESTIMATING PURPOSE ONLY (10.00%)										

4- चालखाल का प्राकलन

DETAILED ESTIMATE OF CONSTRUCTION OF KHAL AT- SINNAD, BARHON GOLA RANGE, NAINITAL FOREST DIVISION NAINITAL										
Sl. No.	me of Item	Na	No	Measurement (ML)			Rate		Amount	SOR NO
1	2	3	4	W.	H/D	Qty	8	9	10	
1	नर्मो जल संस्थाप हेतु पीण्ड निर्माण के लिए समतलीकरण का कार्य मय सभी सामान एवं श्रम सहित	1	9.00	1.50	0+1.00/2	6.75 cum.	73.00	492.75	Dep.Sor1.1.2	
2	पीण्ड निर्माण हेतु खुदान कार्य मय सभी सामान एवं श्रम सहित	1	8.00+5.00/2X5.00+2.00/2X1.2 0			27.30				
						27.30 cum	360.60	9841.65	SOR (misc.1.2)	
3	पीण्ड के तले में हैण्ड पैवड स्टोन फीलिंग का कार्य	2	8.00+5.00/2X1.92X0.15			3.74				
		2	5.00+2.00/2X1.92X0.15			2.02				
		1	5.00	2.00	0.15	1.50				
						7.26 cumt	987.30	7167.00	SOR (misc.1.6)	
4	पीण्ड के बाहरी भाग में बण्डिंग हेतु आरडाआर0 पथरी की चिनाई का कार्य	2	6.90	0.45	0.30	2.40				
		2	5.00	0.45	0.30	1.35				
						3.75 cumt.	2129.50	7992.01	SOR (misc.1.3)	
5	वमो के घानी को पीण्ड में संचय हेतु समीपवर्ती क्षेत्र से नाली निर्माण कर पाण्ड में लाना।	2	40.00	0.30	0.30	7.20 cumt.	360.60	2595.60	SOR (misc.1.2)	
6	Excavation of contour trenches in catchment area 1.00x0.45x0.30 mt.					130 Rmt.	0.00	5200.00	Dep.rate (4.7.2)	
Total							33289.81			
or say							33100.00			
NOTE-										

BOR TAKEN FOR SOUTH KUMAON CIRCLE FOR THE ESTIMATION PURPOSE CHAPTER -4 (S.M.C. AS ON 01.02 2023)
 RATES OF (FY 2022-2023) BOR ITEMS ARE TAKEN FOR BHIMTAL (BLOCK -7B) FOR THE ESTIMATION PURPOSE (AS
 ON 3 10 2022)

5- वानस्पतिक का प्राक्कलन

प्राक्कलन बावत वानस्पतिक चैक डेम का निर्माण (01 NO.)

Sl. No.	Name of Item	No	Measurement (Mt.)				Rate	Amount	S.O.R. NO.	
			L.	W.	H/D	Qty				
1	2	3	4	5	6	7	8	9	10	
1	खम्बे गाढ़ने हेतु गड्ढे खोदना					26	no.	12.00	312.00	4.11.1
2	गड्ढों में खम्बे गाड़ना तथा वाटर्सिंग कार्य (6" x 8" ऊँच व 1" से 8" परिधि)					26	no.	23.00	598.00	4.11.2
3	बुरा जड़ गाढ़ने हेतु गड्ढा बनाना तथा लाइव बीज बनाना					90	no.	19.00	1710.00	4.11.3
4	कटिंग रोपण तथा घास रोपण हेतु फर्च खुदाय कार्य (1.00x0.45x0.30 mt.)					50	Rmt.	40.00	2000.00	4.7.2
5	फर्च में कटिंग/घास/ रोपण का कार्य						L.S.	L.S.	300.00	MR
10	पिरुल एकत्रित करना तथा लकड़े के रूप में बंधना						L.S.	L.S.	1500.00	MR
							योग-	6420.00		
							SAY	6400.00		

5	Random Rubble Stone Masonry laid in 1:6 cement and sand mortar, in breast walls, retaining walls, parapets, scuppers, etc. including supply of all material, labour, T&P and royalties etc. complete as per drawing and technical specifications Clauses 702, 704, 1202 & 1203 of MORD Specification								
		up to G.L.	1	6.00	1.00	0.70	4.20		
			1	6.00	0.40	0.70	1.68		
		apron	1	2.50	1.50	0.45	1.69		
						7.57	cum	4073.30	30824.70 SOR Misce. 1-4
6	Providing concrete for plain/ reinforced concrete in open foundations complete as per drawings and technical specifications Clause 802, 803, 1202 & 1203 Nominal mix (1:2:4)								
			1	6.00	1.00	0.10	0.60		
			1	6.00	0.40	0.10	0.24		
		top of apron	1	2.50	1.50	0.10	0.38		
						1.22	cum	7119.20	8649.83 SOR (MORD) 11.4.3.1
7	Random Rubble Stone Masonry laid in 1:6 cement and sand mortar, in breast walls, retaining walls, parapets, scuppers, etc. including supply of all material, labour, T&P and royalties etc. complete as per drawing and technical specifications Clauses 702, 704, 1202 & 1203 of MORD Specification								
		Above Ground Level	1	6.00	0.50+	1.10	1.65		
			1	6.00	0.40	1.10	2.64		
		Wing Wall	2X 1	2.00	1.00	0.60 +0.5 0/2	2.20		
						6.49	cum	4073.30	26435.72 SOR Misce. 1- 4

5- जलकुण्ड का प्राक्कलन

DETAILED ESTIMATE OF CONSTRUCTION OF JALKUND AT- SINAD NAALA Redon RANGE NAINITAL FOREST DIVISION NAINITAL										
Sl. No.	Name of Item	N O	Measurement (Mtr.)				Rate	Amount	DSR/SO R Item No.	
			L	W.	H/D	Qty				
1	2	3	4	5	6	7	8	10	11	
1	Clearing jungle including uprooting of rank vegetation, grass, brush wood, trees and saplings of girth up to 30 cm measured at a height of 1 m above ground level and removal of rubbish up to a distance of 50 m outside the periphery of the area cleared.	1	9.00	18.00		162.00 sqmt.	17.60	2851.20	DSR 2.31	
2	Excavation for Structures Earthwork in excavation for structures as per drawing and technical specifications Clause 305.1 including setting out, construction of shoring and bracing, removal of stumps and other deleterious material and upto a lead of 50 m, dressing of sides and bottom and backfilling in trenches with excavated suitable material									
	wall	1	6.00	2.00	1.15	13.80				
	apron	1	2.50	1.50	0.30	1.13				
						14.93 cum				
	Ordinary soil Upto 3 m depth					14.93 cum	425.30	6347.50	SOR Mord 11.1.1.1	
3	Providing concrete for plain/ reinforced concrete in open foundations complete as per drawings and technical specifications Clause 802, 803, 1202 & 1203 Nominal mix 1:3:6	1	6.00	2.00	0.30	2.60 cum	8378.00	22960.80	SOR (MORD) 11.4.1.1	
4	Providing concrete for plain/ reinforced concrete in open foundations complete as per drawings and technical specifications Clause 802, 803, 1202 & 1203 R.C.C grade M 25									
	Bottom	1	6.00	2.00	0.15	1.80				
	vertical	1	6.00	0.60	1.90	6.84				
						8.64 cum	8229.00	71098.56	SOR(M ORD) 11.4.5	

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							TOTAL	250058.79	
							Say	250000.00	
	NOTE-								
	RATES OF DSR 2023 ARE TAKEN FOR THE ESTIMATION PURPOSE								
	CONTRACTOR'S PROFIT IS INCLUSIVE IN SOR AND DSR ITEMS.								
	RATES OF (FY 2024-2025) SOR ITEMS ARE TAKEN FOR LANGARHA (BLOCK -69) FOR THE ESTIMATION PURPOSE (AS ON 24.08.2024)								

6 - कंदूर ट्रेच का प्राक्कलन :-

क्रमसं०	कार्य का विवरण	ईकाई	रिटिंग	गणत मीटर में			मात्रा	दर	अनराशि	आवृत्ति
				एक	दो	तीन				
1	2	3	4	5	6	7	8	9	10	11
1	कंदूर ट्रेच खुदान कार्य	R.M	1.00	1.00	0.45	0.30	1.00	40/र०मी०	40.00	
	योग								40.00	

नोट :- उपरोक्त सभी प्राक्कलन आदर्श रूप में तैयार किये गये हैं। पी.ओ.सी की दरों में विकासखण्डवार परिवर्तन हो सकता है। विभागीय दरों में परिवर्तन होने पर कार्य की अनराशि में परिवर्तन हो सकता है। स्थल चयन में जलसुख के प्राक्कलन में परिवर्तन हो सकता है।

Chapter- 44.1 परियोजना का परिणाम (Outcome of the Project):

- High seedling survival rate in villages of Spring shed area.
- Increase in biomass production in the villages of Spring shed area.
- Increase in the availability of fodder in the villages of Spring Said area.
- Household water security in villages of Spring shed area.
- Improvement in water quality in villages of Spring shed area.
- Enhanced life of downstream storage structures in villages of Spring shed area.

4.2 Total estimated budget for springshed works:

Summary Of Cost										
सिनाड़ नाले में प्रस्तावित कार्य के व्यय का आकलन										
बढ़ीन वन क्षेत्र वर्ष 2023-2024 से 2025-2026 तक, नैनीताल वन प्रभाग नैनीताल										
क्र.सं 0	कार्य का विवरण	दर	2023-2024		2024-2025		2025-2026		योग	
			भौतिक	वित्तीय	भौतिक	वित्तीय	भौतिक	वित्तीय	भौतिक	वित्तीय
1	2	3	4	5	6	7	8	9	10	11
1	गली प्लम्ब	17300	40	692000	20	346000	20	346000	80	1384000
2	आर.आर. ड्राई चैकडैम (3.00मी०)	26900	15	403500	5	134500	5	134500	25	672500
3	क्रेट वायर चैकडैम	53500	20	107000	10	535000	10	535000	40	2140000
4	चालखाल (50000 स्क्व. फुट)	33100	10	331000	5	165500	5	165500	20	662000
5	वानस्पतिक/पिरुल चैकडैम	6400	40	256000	25	160000	25	160000	90	576000
6	जलकुण्ड	25000	1	250000	1	250000	1	250000	3	750000
7	अनुश्रवण एवं मूल्यांकन	40000	1	40000	1	40000	1	40000	3	120000
8	डीपीओआर प्रिपेरेशन	140000	1	140000	0	0	0	0	1	140000
9	कन्दूर टैंक (50मी०)	40	4000	160000	2000	80000	2000	80000	8000	320000
10	एमओआईओएसओसीओ	40000	1	40000	1	40000	1	40000	3	120000
	योग :-			3382500		1751000		1751000		6884500

Signature

Signature

Forest Range officer

Division
Forest Officer

Agricultural & Livelihood Map (Livelihood activities in and around spring shed area)



Figure 19: Livelihood Map (Source: Bhuvan and Q GIS)

Annexure I - Base Line Survey
SINAD NALA WORKS BASELINE SURVEY

1. Project Area Details:

District	Division	Nala Name	Catchment Area of Nala (in ha)	Numbers of Villages in and Around Catchment area	Latitude & Longitude of Highest Ridge	Latitude & Longitude of Lowest valley (Nalla exit) point
1	2	3	4	5	6	7
Nainital	Nainital Forest Division, Nainital	Sinad Nala	70	Okhaldhunga, Barath, Siroli	29.23607	79.24429
					79.61946	79.63425

2. Record of Nala-Water flow

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1	2	3	4	5	6	7	8	9	10	11	12
L	L	L	L	L	L	M	H	H	M	L	L

***Key:**

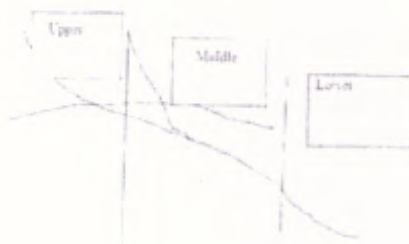
S.No	Categorory	Description
1.	High - H	Full height of water column
2.	Moderate - M	Continuous flow but very low water column
3.	Low - L	Water in some area (in patches)
4.	No - N	Dry

3. Soil Erosion Status of Catchment area of Nala:

S No.	Zone	Left side of main Nala		Right side of main Nala	
		No. of Gully	Category	No. of Gully	Category
1	2	3	4	5	6
	Upper Catchment zone	0	0	0	0
	Middle Catchment zone	3	L	14	H
	Lower Catchment zone	4	L	18	H

*Key:

Category	Gully formation
High - H	More than 10 Gullies
Moderate - M	5 - 10 Gullies
Low - L	0 to 5 Gullies



4. Ground water quality Pre and Post Monsoon:

Pre-Monsoon		Post- Monsoon	
YEAR	2014	YEAR	2015
DATA SOURCE	IMIS	DATA SOURCE	IMIS
QUALITY PARAMETERS		QUALITY PARAMETERS	
pH	8	FLUORIDE(mg/l)	0.12
TDS(mg/l)	248	CHLORIDE(mg/l)	12
FLUORIDE(mg/l)	0.28	IRON(mg/l)	2.02
CHLORIDE(mg/l)	81	NITRATE(mg/l)	15
IRON(mg/l)	0.12	SULPHATE(mg/l)	-
NITRATE(mg/l)	24	# 0 - Sample is not analyzed for that parameter	
SULPHATE(mg/l)	2	WATER QUALITY	Non Potable
# 0 - Sample is not analyzed for that parameter			
WATER QUALITY	Potable		

5. Details of survey team

Date of Survey :
 Signature of Surveyor :
 Name of Surveyors :
 Baseline Survey checked by:

Annexure II- Tools and Materials to be used

1. For Gabion Structure

S. No.	Tools and Materials	Specification	Quantity
1	GI wire	CSIDC Item Code- 700000105, Wire thickness- 3.15 mm Width of wire Bundle- 1m or 1.2 m, Opening of wiremesh- 50mm X50mm	As per size of Structure
2	Centring hooks	2 Sut rod	8-10 Nos
3	Binding Wire	14-16 gauge	2 Bundle
4	Players	Standard Size	2 Nos
5	Cutter	Medium Size	1 No
6	Hammer	Small size	1 No
7	Axe	Medium size	1 Nos
8	Measuring Tape	30m	1 No
9	Steel tape	5m	1 No
10	Level Tube	15 m	1 No

1. For Check Dam/Stop Dam/ Concrete Dyke/RR Dry Chek Dam/Creat Wire Chek Dam

S. No.	Tools and Materials	Specification	Quantity
1	Cement	CSIDC Supply	As per quantity
2	Sand	Fine and course sand	As per quantity
3	Gravel	20mm and 40 mm	As per quantity
4	Stone	0.25mx0.25mx0.25m	As per quantity for stone pitching
5	Vibrator	Niddle Vibrator type	1 Nos (on rent)
6	Mixture Machine		(on rent/Tendrers)
7	JCV		(on rent/Tendrers)
8	Tractor		(on rent/Tendrers)
9	Centing plate		As per quantity
10	Measuring Tape	30m	1 No
11	Steel tape	5m	1 No
12	Level Tube	15 m	1 No

10. Summary of Proposed Spring Rejuvenation Plan prepared by Departments/ Organizations

Name of Department/Organization -FOREST DIVISION NAINITAL
 Name of District - NAINITAL
 Name of Block -BHIMTAL
 Name of Gram Panchayat/Town -OKHALDHUNGA
 Name of Nodal officer/person for proposed plan -SH. CHANDRASHEKHAR JOSHI
 Designation - DIVISIONAL FOREST OFFICER, NAINITAL FD
 (Responsible for planning, implementation,
 monitoring and uploading information in
 SARRA Dashboard, SARRA Mobile App etc.).
 Contact No. 05942-2367900
 Email Id dfonainital@gmail.com

Table No. 10.1

Please fill the required information as per DPR-(INR)

S.N.	Budget Head & Allocation	Budget Proposed
1	DPR Preparation (1-2% of total project cost)	
2	Total cost of Interventions / Activities	140000.00
3	Monitoring & Evaluation (2% of total project cost)	6624500.00
	Total	120000.00
		6884500.00

Table No. 10.2

Please fill the information (Year wise) as mentioned in DPR- (INR)

S.N.	Name of Activity	Unit	Physical Target in identified recharge zone*			Total of physical targets	Financial Amount
			SINAAD NAALA				
			YEAR				
			2024-25	2025-26	2026-27		
1	DPR Preparation		140000	-	-	-	140000.00
2	Interventions/ Activities						
2.1	Identified recharge area of spring	70 Ha.				70	
2.2	Contour Trenches	No.	4000	2000	2000	8000 R.M	320000.00
2.3	Gully plugs	No.	40	20	20	80	1384000.00
2.4	Chal-Khal	No.	10	5	5	20	662000.00
2.5	Brushwood/Pirul check dam	No.	40	25	25	90	576000.00
2.6	RR Dry Check Dam	No.	15	5	5	25	672500.00
2.7	Gabion/ Cratewire check dam	No.	20	10	10	40	2140000.00
2.8	Cemented Jalkund	No.	1	1	1	3	750000.00
2.9	Misc.	Ls	40000	40000	40000		120000.00

2.10	Estimated Area of Catchment Treated by above Activities	70 Ha.				70	
3	Monitoring & Evaluation **	INR	40000	40000	40000	LS	120000.00
	Total						6884500.00

*Number of springs can be added by inserting additional columns for physical and financial targets of selected rejuvenation works.

**PIA will engage an independent M & E Agency or Dhara-Naula Sanrakshan Samiti for the purpose of monitoring the discharge and impact of spring rejuvenation activities.

Table No. 10.3

Financial Convergence detail of proposed spring rejuvenation activities-

Total Financial Amount	Fund from PIA/ Department	Fund from other sources	Fund from SARRA convergence	Total
	(A)	(B)	(C)	(A+B+C)
6884500.00				6884500.00

(INR)

List of Annexure-

- 1- Detail Project Report (DPR).
- 2- Detail of Dhara Naula Sanrakshan Samiti.
- 3- MOU for O&M of Spring Rejuvenation Works.
- 4- Any other relevant documents.

Date of Proposal Submission:-.....

Submitted By:-Range Forest Officer, Badhon

Signature with stamp:-

Note: The above format could be further

संख्या- 536/X-2-2025-21(04)/2023 ई-42348

प्रेषक,
आर०के०सुचांशु,
प्रमुख सचिव,
उत्तराखण्ड शासन।
सेवा में,
प्रमुख वन संरक्षक(हॉफ)
उत्तराखण्ड, देहरादून।

वन अनुभाग-2.

देहरादून, दिनांक 21 मार्च, 2025

विषय:- ग्राम पंचायत/ग्राम पंचायतों के कलस्टर स्तर पर वनाग्नि सुरक्षा प्रबन्धन समितियों के गठन एवं उन्हें प्रोत्साहित किये जाने हेतु प्रोत्साहन धनराशि (Incentive) दिये जाने के संबंध में।

महोदय,

उपर्युक्त विषयक अपने पत्र संख्या-698/27-1 दिनांक 23.02.2023, संख्या-861/27-1(4) दिनांक 07.06.2024 तथा मुख्य वन संरक्षक/अपर प्रमुख वन संरक्षक वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड, देहरादून के पत्र संख्या-140/27-1(4) दिनांक 18.08.2023, पत्र सं-1021/27-1(4), दिनांक 24.04.2023 एवं पत्र सं-132/27-1(4), दिनांक 20.08.2024 का संदर्भ ग्रहण करें, जिनके माध्यम से ग्राम पंचायत/ग्राम पंचायतों के कलस्टर स्तर पर वनाग्नि सुरक्षा प्रबन्धन समितियों के गठन एवं उन्हें प्रोत्साहित किये जाने हेतु प्रोत्साहन धनराशि (Incentive) दिये जाने का प्रस्ताव शासन को उपलब्ध कराया गया है।

2- उक्त के संबंध में मुझे यह कहने का निर्देश हुआ है कि शासन द्वारा सम्यक विचारोंपरान्त राज्य में वनाग्नि सत्र के दौरान वनाग्नि घटनाओं की रोकथाम के दृष्टिगत निम्नानुसार ग्राम पंचायत/ग्राम पंचायतों के कलस्टर स्तर पर वनाग्नि सुरक्षा प्रबन्धन समितियों के गठन एवं उन्हें प्रोत्साहित किये जाने हेतु प्रोत्साहन (Incentive) धनराशि रु० 30,000/- दिये जाने की श्री राज्यपाल निम्नांकित शर्तों के अधीन सहर्ष स्वीकृति प्रदान करते हैं:-

1. प्रथम चरण में अतिसंवेदनशील चीड़ बाहुल्य वन प्रभागों/रेंजों में गठित समितियों को प्रोत्साहन (Incentive) दिया जायेगा। ग्राम पंचायत स्तरीय वनाग्नि सुरक्षा प्रबन्धन समितियों का गठन मुख्यतः चीड़ बाहुल्य वन क्षेत्रों (वनाग्नि की दृष्टि से संवेदनशील/अतिसंवेदनशील) में किया जायेगा।
2. प्रत्येक समिति को वनाग्नि सत्र के दौरान वनाग्नि नियंत्रण/प्रबन्धन हेतु निकटवर्ती वन क्षेत्र आवंटित करते हुये सम्बन्धित क्षेत्रों में समितियों को आवंटन से पूर्व एवं क्षेत्र आवंटन के उपरान्त एफ०ए०एस०आई० से प्राप्त Forest Fire Alerts/Large Forest Fire Alerts की संख्या एवं कार्यवाही के मूल्यांकन के आधार पर किया जायेगा।
3. ग्राम पंचायत स्तरीय वनाग्नि सुरक्षा प्रबन्धन समितियों का गठन ग्राम पंचायतों/क्षेत्र की स्थिति के अनुसार यथा-छोटी-छोटी 3 से 4 ग्राम पंचायतों को सम्मिलित करते हुए कलस्टर के रूप में किया जायेगा।
4. वनाग्नि सत्र के दौरान प्रत्येक प्रबन्धन समितियों को 500-600 हे० वन क्षेत्र में वनाग्नि प्रबन्धन/नियंत्रण हेतु अस्थाई रूप से वनाग्नि नियंत्रण/प्रबन्धन हेतु जिम्मेदारी दी जायेगी।

5. प्रबन्धन समितियों द्वारा आवंटित वन क्षेत्र के अन्तर्गत किये जा रहे वनाग्नि प्रबन्धन/नियंत्रण कार्यों का सम्बन्धित प्रभागीय वनाधिकारियों द्वारा अनुश्रवण किया जायेगा।
6. वनाग्नि सुरक्षा प्रबन्धन समितियों को रू० 30,000/-की प्रोत्साहन राशि मानकानुसार दी जायेगी।
7. वनाग्नि सुरक्षा प्रबन्धन समितियों का गठन वनाग्नि सत्र से पूर्व किया जाय, ताकि वनाग्नि प्रबन्धन/नियंत्रण कार्यों में इनका समुचित सहयोग प्राप्त हो सके।
8. वन सुरक्षा प्रबन्धन समिति के गठन के उपरान्त प्रभाग स्तर पर समिति के साथ 03 वर्षों की अवधि के लिए संलग्नक-1 के अनुसार अनुबन्ध (MoU) किया जायेगा। समितियों के कार्यों का अनुश्रवण उपरान्त संतोषजनक स्थिति पर अनुबन्ध (MoU) को आगामी 1 वर्ष हेतु विस्तारित किया जा सकता है।
9. अनुबन्ध (MoU) की शर्तों का निर्धारण नोडल अधिकारी, वनाग्नि स्तर से किया जायेगा।
10. अनुबन्ध (MoU) की निर्धारित शर्तों का पूर्ण अनुपालन समितियों द्वारा सुनिश्चित किया जायेगा।

(1) वनाग्नि सुरक्षा प्रबन्धन समिति का स्वरूप:-

- | | |
|--|--------------|
| 1. ग्राम प्रधान/प्रशासक | - अध्यक्ष |
| 2. सरपंच, वन पंचायत (आच्छादित) | - सदस्य |
| 3. अध्यक्ष, महिला मंगल दल | - सदस्य |
| 4. अध्यक्ष, युवक मंगल दल | - सदस्य |
| 5. अध्यक्ष, स्वयं सहायता समूह (यदि हो) | - सदस्य |
| 6. राजस्व विभाग/विकास विभाग के नामित कार्मिक | - सदस्य |
| 7. वन दरोगा/वन आरक्षी | - सदस्य सचिव |

(2) समिति के उद्देश्य:-

1. वनाग्नि घटनाओं के नियंत्रण में स्थानीय ग्रामवासियों को सामुहिक रूप से जोड़ते हुए उनका सहयोग प्राप्त करना।
2. समिति के माध्यम से स्थानीय ग्रामीणों को वनाग्नि के प्रति संवेदनशील बनाना तथा इसके दुष्प्रभाव हेतु जागरूक करना।
3. प्रचार-प्रसार के माध्यम से वनाग्नि विभीषिका को कम करने में जन सहयोग प्राप्त करना।
4. जन-सहभागिता के मूलभूत सिद्धांत को आधार मानकर वनों के प्रबन्धन में स्थानीय ग्रामवासियों की भूमिका सुनिश्चित करने हेतु प्रोत्साहित करना।
5. वनाग्निकाल के दौरान एवं वनाग्निकाल के उपरान्त भी वनों के प्रबन्धन एवं संवर्धन हेतु ग्रामवासियों को प्रेरित करना।
6. ग्रामवासियों को वनों से जोड़कर उनकी आजीविका में वृद्धि करना।

(3) समिति के कार्य एवं दायित्व:-

1. वनाग्नि सुरक्षा प्रबन्ध समितियों द्वारा ग्राम पंचायत या ग्राम पंचायत कलस्टर के

- समीपस्थ वन क्षेत्रों (आरक्षित/पंचायती/सिविल सोयम वनों) में वनाग्नि नियंत्रण/प्रबन्धन की जिम्मेदारी सुनिश्चित की जायेगी।
- वन क्षेत्रों में जमा अवशिष्ट (सूखी घास, पिरुल, झाड़ी आदि) को वनाग्निकाल से पूर्व एवं वनाग्निकाल के दौरान नियमित अंतराल पर वन क्षेत्रों से हटाया जायेगा ताकि वनाग्नि की संभावना को कम किया जा सके। पिरुल के अन्य प्रयोग हेतु उक्त समिति संयुक्तित से MoU कर अतिरिक्त आय का साधन भी सृजित करने हेतु कार्यवाही करेगी।
 - ग्राम पंचायत स्तर पर समय-समय पर बैठकें/गोष्ठियों के माध्यम से जन-जागरूकता कार्यक्रमों का आयोजन।
 - वनाग्नि घटना होने पर वनाग्नि निवारण की कार्यवाही सुनिश्चित करना।
 - पंचायती वनों/सिविल सोयम वनों से लगे आरक्षित वन क्षेत्रों में वनाग्नि घटना घटित होने पर वनाग्नि रोकथाम/नियंत्रण हेतु कार्यवाही सुनिश्चित करना।
 - ग्राम पंचायतों के समीप स्थित पंचायती वनों/सिविल सोयम वनों के अन्तर्गत विभिन्न प्रकार के भागों के दोनों तरफ एकत्रित/जंगल में ज्वलनशील पदार्थों को सावधानीपूर्वक जलाकर समाप्त करना।
 - वन क्षेत्रों में जानबूझकर आग लगाने वाले असांमानाजिक तत्वों की सूचना निकवर्ती वन/पुलिस चौकी को देना।
 - वन क्षेत्रों में जैविक दबाव को कम करने में अपेक्षित सहयोग करना।
 - यह समिति वनाग्नि सत्र में ग्राम स्तर पर उपलब्ध सभी ग्रामीणों को वन क्षेत्र में वनाग्नि न लगाने हेतु जागरूक करेगी।
 - समिति को आवंटित वन क्षेत्रों में वनाग्नि घटना होने पर वनाग्नि नियंत्रण हेतु समिति द्वारा तत्परता से कार्यवाही सुनिश्चित की जायेगी।
 - वन क्षेत्रों के समीप स्थित निजी खेतों में वनाग्नि सत्र के दौरान आग न जलाने/सावधानी पूर्वक जलाने हेतु प्रेरित/जागरूक करना।

(4) प्रोत्साहन (Incentive):-

- वनाग्नि के प्रभाव को कम करने के लिए समिति के सफल प्रयासों हेतु उन्हें वन विभाग द्वारा Incentive दिया जायेगा।
- वनाग्नि नियंत्रण में उत्कृष्ट योगदान देने वाली प्रत्येक समिति को Incentive के रूप में धनराशि का प्रावधान प्रस्तावित किया जायेगा।
- धनराशि का प्रावधान वनाग्नि नियंत्रण हेतु केन्द्र पोषित योजना, राज्य सैंक्टर योजनाओं एवं कैम्पा योजना के अन्तर्गत किया जायेगा।
- समितियों को प्रोत्साहन धनराशि का आवंटन आवंटित वनों के प्रकार यथा-

चीड़, बांज, साल एवं अन्य मिश्रित वनों तथा वनाग्नि की संवेदनशीलता को दृष्टिगत रखते हुए क्षेत्रों के आधार पर किया जायेगा।

5. समितियों को निर्धारित धनराशि में से 50% की धनराशि वनाग्नि काल के प्रारम्भ में तथा 50% की धनराशि वनाग्नि काल के उपरान्त समिति के वनाग्नि नियंत्रण कार्यों के अनुश्रवण/मूल्यांकन उपरान्त आवंटित की जायेगी। यदि वनाग्नि सत्र के दौरान उपलब्ध किये गये क्षेत्रों में वनाग्नि घटना होती है तो वनाग्नि से प्रभावित क्षेत्र के आंकलन के अनुसार प्रोत्साहन राशि में कटौती की जायेगी।

6. वनाग्नि नियंत्रण/प्रबन्धन हेतु अग्निशमन उपकरण जैसे-फायर रैक, टार्व, दंडाली, पाटल, डांगरी आदि का आवंटन वन विभाग द्वारा किया जायेगा।

7. वनाग्नि काल में आवंटित क्षेत्रों के अन्तर्गत वनाग्नि घटना न होने पर समितियों के कुशल प्रशस्ति-पत्र/पुरुस्कार भी स्थानीय जन-प्रतिनिधियों के माध्यम से वनाग्नि सत्र के पश्चात प्रदान किया जायेगा।

(5) प्रोत्साहन (Incentive) धनराशि का रख-रखाव:-

1. प्रत्येक ग्राम स्तरीय वनाग्नि सुरक्षा प्रबन्धन समिति को विभाग द्वारा सम्बन्धित प्रभागीय वनाधिकारियों के माध्यम से निर्धारित धनराशि का भुगतान किया जायेगा।
2. प्रत्येक ग्राम स्तरीय वनाग्नि सुरक्षा प्रबन्धन समिति को वन विभाग द्वारा उपलब्ध प्रोत्साहन धनराशि हेतु निधि स्थापित की जायेगी। प्रोत्साहन धनराशि समिति के बैंक खाते में उपलब्ध कराई जायेगी।
3. समिति के निधि/खाते में उपलब्ध धनराशि का उपयोग ग्राम पंचायत स्तर पर जनहित में माइक्रोप्लान (सूक्ष्म योजना) के आधार पर वृत्त की अनुसूचित दरों के अनुसार किया जायेगा।
4. खाते से समस्त आहरण बैंक के नियमानुसार किया जायेगा।

(6) वन पंचायतों को वनाग्नि प्रबन्धन में रैंकिंग देने के लिए पैरामीटर:-

1. वनाग्नि मुक्त दिन (40 weight):-

1. पैरामीटर (मानक):- निर्दिष्ट अवधि (जैसे वनाग्नि सत्र) के दौरान वन पंचायत के अधिकार क्षेत्र में लगातार वनाग्नि मुक्त दिनों की कुल संख्या की गणना की जायेगी।

गणना:-

प्रति वनाग्नि मुक्त दिन 1 अंक
भारित स्कोर के लिए कुल अंको को 0.4 से गुणा करते हुए।
डेटा का स्रोत:- एफ0एस0आई0 से प्राप्त डेटा।

2. वनाग्नि से रक्षित क्षेत्र (हेक्टेयर) (30 %weight):-

1. पैरामीटर (मानक):- निर्दिष्ट अवधि के दौरान वन पंचायत के क्षेत्र में वन भूमि के कुल क्षेत्रफल की गणना के आधार पर जो क्षेत्र वनाग्नि अप्रभावित रहता है।

गणना:-

1. प्रति 10 हेक्टर संरक्षित क्षेत्र पर 1 अंक (कम से कम अधिकतम पुरस्कार के लिए समायोजित)
- भारित अंक के लिए कुल अंकों को 0.3 से गुणा करते हुए।
- डेटा स्रोत:- एफओएसआईओ से प्राप्त डेटा।
2. सामुदायिक सभागिता हेतु अंक (30% weight):-
1. पैरामीटर (मानक):-

- वनाग्नि सुरक्षा कार्यशालाओं में उपस्थिति (प्रति व्यक्ति 2 अंक)।
- वनाग्नि अभ्यास (Fire Drill) में भागीदारी (प्रति व्यक्ति 3 अंक)।
- वनाग्नि खतरों की रिपोर्टिंग (प्रति सत्याप्रति रिपोर्ट 5 अंक)।
- वनाग्नि शमन प्रयासों में स्वयंसेवा (प्रति दिन 10 अंक)।

गणना:-

- अर्जित सभी अंकों के योग के आधार पर।
- भारित अंक के लिए कुल अंकों को 0.3 से गुणा करते हुए।

कुल अंक:-

- 1) प्रत्येक श्रेणी से भारित अंकों को जोड़ें जायेगा ताकि प्रत्येक वन पंचायत के लिए अंतिम अंक प्राप्त हो सकें।
- 2) वन पंचायतों को उनके कुल अंकों की श्रेणी के आधार पर आंकलन किया जायेगा।

प्रोत्साहन धनराशि (Incentive) संरचना:-

1. प्रति समिति अधिकतम प्रोत्साहन (Incentive) 30,000/-
2. स्तरित प्रोत्साहन (Incentive):-
- स्तर 1 (शीर्ष 10%) - 30,000/-
- स्तर 2 (अगले 20%) - 22,500/-
- स्तर 3 (अगले 30%) - 15,000/-
- स्तर 4 (40 % से कम) - शून्य

7-अवार्ड/पुरस्कार:-

वनाग्नि सुरक्षा प्रबंधन समिति को उनके द्वारा दिये गये योगदान हेतु सामूहिक/व्यक्तिगत रूप से अवार्ड/पुरस्कार, प्रशस्ति-पत्र एवं अतिरिक्त Incentive दिये जाने का प्रावधान रखा गया है, जिसके मानक निम्नवत:-

1. समिति को अस्थाई रूप से वनाग्नि नियंत्रण की जिम्मेदारी हेतु दिये गये सम्वन्धित वन क्षेत्रों में वनाग्नि घटनाओं के कुशल नियंत्रण हेतु दिये गये उत्कृष्ट योगदान।
2. आवंटित वन क्षेत्रों में वनाग्नि घटना न होना।
3. वनाग्नि घटना होने पर कम से कम समय में एवं घटना के फैलाव को नियंत्रित करना है।
4. वनों के संरक्षण/संवर्द्धन हेतु जागरूकता।
5. जन समुदायों को वनाग्नि घटनाओं की रोकथाम हेतु प्रेरित करना।
6. वन क्षेत्रों से लगे समीपस्थ निजी खेतों में आढ़ा न जलाने हेतु प्रेरित करना।

- 3- कृपया उपरोक्तानुसार अपेक्षित आवश्यक कार्यवाही करने का कष्ट करें।

4- यह आदेश वित्त विभाग के आदेशांक 1/28223/2025 दिनांक 12.03.2025 में प्राप्त उनकी सहमति से जारी किये जा रहे हैं।

Signed by
 Ramesh Kumar Sudhanshu
 (अधीनस्थ, सहायक)
 Date: 21-03-2025 10:15:57

संख्या- 526 / X-2-2024-21(04)2023 तददिनांक

प्रतिलिपि:- निम्नांकित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित:-

1. आयुक्त गढ़वाल मण्डल/कुमाऊँ मण्डल।
2. प्रमुख वन संरक्षक, वन पंचायत, उत्तराखण्ड।
3. अपर प्रमुख वन संरक्षक, नियोजन एवं वित्तीय प्रबंधन, उत्तराखण्ड, देहरादून।
4. अपर प्रमुख वन संरक्षक, वनाग्नि एवं आपदा प्रबंधन/मंडल अधिकारी, उत्तराखण्ड, देहरादून।
5. समस्त जिलाधिकारी, उत्तराखण्ड।
6. मुख्य वन संरक्षक, गढ़वाल/कुमाऊँ।
7. समस्त वन संरक्षक, उत्तराखण्ड।
8. समस्त प्रभागीय वनाधिकारी, उत्तराखण्ड वन विभाग, उत्तराखण्ड।
9. गार्ड फ़ाइली।

Signed by
 Vikram Singh Yadav
 Date: 21-03-2025 10:48:34

(विक्रम सिंह यादव)
 संयुक्त राक्षि

सलग्नक-1

अनुवन्ध (MoU) का प्रारूप

प्रदेश के अन्तर्गत वनाग्नि के कुशल प्रबंधन हेतु जन-सहभागिता को सुनिश्चित करने के उद्देश्य से जनपद, _____ में _____ वन प्रभाग की _____ क्षेत्र के अन्तर्गत ग्राम पंचायत _____ में ग्राम पंचायत/ग्राम पंचायतों के कंसल्टर राष्ट्रीय वनाग्नि सुरक्षा प्रकल्प समिति (निरासे ग्राम प्रधान/वन पंचायत सरपंच/महिला व युवक मंगल दलों के प्रतिनिधि तथा वन विभाग/संजय विभाग के संबंधित कार्मिक भी सम्मिलित हों) का आज दिनांक _____ को निम्नलिखित कदम किया गया तथा समिति के अध्यक्ष के रूप में श्री/श्रीमती _____ को नामित किया गया।

यह समिति वनाग्नि क्षेत्र के दौरान वन विभाग द्वारा निर्धारित नियम वन क्षेत्र के अन्तर्गत पूर्ण सक्रियता से कार्य करेगी तथा वनाग्नि घटनाओं वनाग्नि नियंत्रण/प्रबंधन हेतु जिम्मेदार होगी तथा वनाग्नि नियंत्रण हेतु वन विभाग को पूर्ण सहयोग प्रदान करेगी। समिति द्वारा वन विभाग से निर्धारित दिशा-निर्देशों/दायित्वों के अनुरूप कार्यवाही सुनिश्चित की जायेगी।

समिति के कार्य :-

- वनाग्नि सुरक्षा समिति के अन्तर्गत महिलाओं के समूह को वनाग्नि से बचाव के लिए एक कमांडो गैंग या वन क्षेत्र निर्धारित किया जायेगा। यदि निर्धारित क्षेत्र में वनाग्नि की घटना होती है तो सम्बन्धित समिति

वनाग्नि नियंत्रण हेतु जिम्मेदार होगी।

- यह समिति क्षेत्रीय वन कर्मियों के मार्गदर्शन में कार्य करेगी।
- समिति द्वारा वनाग्नि को रोकने तथा वनों में आग न लगाने के सम्बन्ध में स्थानीय ग्रामवासियों को जागरूक किया जायेगा।
- समिति द्वारा वन क्षेत्रों में जागबूझ कर आग लगाने वाले असामाजिक तत्वों की पहचान कर सूचना वन विभाग को उपलब्ध करायी जायेगी।
- यह समिति वनाग्नि के साथ ही वन्यजीवों से सुरक्षा एवं संरक्षण कार्यों हेतु राज्य सरकार द्वारा सञ्चालित योजनाओं की जानकारी ग्रामीणों को उपलब्ध करायेगी।
- आबादी वाले क्षेत्रों में मानव-वन्यजीव-संघर्ष/वनाग्नि से कोई दुर्घटना घटित होने पर समिति तत्काल वन कर्मियों को सूचित करेगी तथा कर्मचारियों के पहुँचने तक स्थिति को संभालने का प्रयास करेगी।
- वन क्षेत्रों में जैविक दबाव कम करने हेतु यह समिति वन विभाग का सहयोग करेगी।

प्रोत्साहन :-

- समितियों को निर्धारित धनराशि में से 50% की धनराशि वनाग्निकाल के प्रारम्भ में तथा 50% की धनराशि वनाग्निकाल के उपरान्त समिति के वनाग्नि नियंत्रण कार्यों के अनुभवण/मूल्यांकन उपरान्त आवंटित की जायेगी।
- वनाग्निकाल में अग्नित्त क्षेत्रों के अन्तर्गत वनाग्नि घटना न होने पर समितियों के कुशल प्रयासों हेतु मानक से 10% अतिरिक्त Incentive दिया जायेगा एवं इसके साथ ही एक प्रशस्ति- पत्र/पुरस्कार भी स्थानीय जन-प्रतिनिधियों के माध्यम से वनाग्नि सत्र के पश्चात प्रदान किया जायेगा।
- वनाग्नि नियंत्रण कार्यों हेतु वन विभाग द्वारा यथासम्भव उपकरण जैसे-फायर रेक्स, टार्च, दटासी आदि उपलब्ध कराये जायेंगे।

यह अनुबन्ध निम्नलिखित साक्षियों के समक्ष दिनांक को हस्ताक्षरित किया गया।

साक्षीगण

1-

2-

हस्ताक्षर

(प्रथम पक्ष)

प्रभागीय वनाधिकारी/वन क्षेत्राधिकारी।
प्रमुख वन समिति।

हस्ताक्षर

(द्वितीय पक्ष)

अध्यक्ष-वनाग्नि सुरक्षा

ANNEXURE 10

Annexure-8

Category Wise & Division Wise Details of Soil & Water Conservation Works under CAMPA in Uttarakhand in 2022-2023

All Financial Figures are in Lakhs

Category	Water Bodies (Nos.)	Contour Trenches (Nos.)	Maintenance of water bodies (Nos.)	Percolation Pits/Tubes (Nos.)	Rejuvenation of water sources (Dhara/Nasla) (Nos.)	Rejuvenation of rivers (No. of Checkdams, percolation tanks, trenches etc.)	Chai-Khal (Nos.)	Check Dams (Nos.)	Total Expenditure
1	2	3	4	5	6	7	8	9	10
DFO ALMORA	110	2034	7		2		114	47	76.03
DFO CL ALMORA		24095					158		81.07
DFO PITHORAGARH		3000				25	97		42.00
DFO CHAMPAINAT	65	5195					348	86	86.04
DFO NAINITAL						20		60	29.48
DFO ADM SC RAMBAGARH		18000		50	8		37	78	46.85
DFO SC RAMBAGARH	183	22555		39	7	1	38	38	88.30
DFO SC NAINITAL	2	15000		49	8	4	204		104.30
DFO TARAI EAST							32		25.91
DFO TARAI WEST							8	10	25.00
DFO TARAI CENTRAL							5	89	56.73
DFO HALDWAR	32			8			14	31	41.75
DFO SAMBHALGARH	40							103	60.05
DFO SC UTTARAKASHI	18	15000			5		182		69.35
DFO UTTARAKASHI					8				60.00
DFO TEHRU GANJ							115	115	73.50
DFO TEHRU GANJ								4	56.20
DFO NARANDKA NAGAR			3	60	2		35		120.00
DFO TEHRU							540		156.18
DFO PAURI GVL SOYAM		20000			8		74	27	54.88
DFO BAKRINATH					4			405	92.25
DFO GABRIWAL		40000							58.50
DFO RUDRAPUR					4		137		57.50
DFO SC ALAKNANDA	5	78000		17				117	118.75
DFO SC LANSDOWNE		4400	1		7	4	158	89	73.45
DFO LANSDOWNE	23	23500			1		57	55	66.91
DFO SC KALSI		10000					47	190	57.60
DFO DEHRADUN	1			82	45			45	79.50
DFO HARIDWAR		400			2		7	10	67.00
DFO UPPER TAMUNA BARKOT									58.40
DFO CHAKRATA		60000					320		78.35
DFO MIZSOORIE					106		60	28	72.48
DFO TONS		14500			6		30	77	48.84
DFO BIRGO WILDLIFE SANCTUARY				7	2				4.70
RAJAJI BP	2	9000	8				20	51	46.75
DFO GOWIND WILDLIFE SANCTUARY	8	8500		10	7				43.64
DFO GANGOTRI NP		18500							74.18
DFO KALAGAN TIGER RESERVE	17	6042					13	13	52.50
DFO NANDADEV NATIONAL PARK	24	5000		28	3			70	54.83
DFO KEDARNATH	31	7000			3		25		47.23
Total	558	282121	21	306	226	54	3200	1900	2281.98

Category Wise & Division Wise Details of Soil & Water Conservation Works under CAMPA in Uttarakhand in 2023-2024

All Financial Figures are in Lakhs

Category	Water Bodies / Ponds (Nos.)	Contour Trenches (Nos.)	Maintenance of water bodies (Nos.)	Percolation Pits (Hrs)	Rejuvenation of water sources (Dhara, Nuala) (Nos.)	Rejuvenation of rivers (No. of Checkdams, percolation tanks, trenches etc.)	Chal-Khal (Nos.)	Check Dams (Nos.)	Total Financial Expenditure in Lakh Rs.
1	2	3	4	5	6	7	8	9	10
DFO ALMORA								23	43.36
DFO PITHORAGRAH		120000		52			37	155	64.7
DFO CHAMPAWAT								3	35.36
DFO BAGESHWAR	27	3000			1	2	121	71	227.13
DFO NAINITAL	3	24401					129	354	258.18
DFO Addl SC RAMNAGAR		24090					127	320	193.07
DFO SC RANIKHET		16200		8			140	183	48.77
DFO SC NAINITAL	6	29500					333	333	108.71
DFO HALDWARI		200		4			45	24	10.87
DFO NAININDRA							6	21	27.25
DFO SC UTTARAKASHI							168	328	350.53
DFO UTTARAKASHI							8	6	82.45
DFO TEHRJ DAM1						5		0	157.7
DFO TEHRJ DAM2								380	100.01
DFO NARENDRA NAGAR		1050					80	158	270.88
DFO TEHRJ								10	228.14
DFO PAUN CIVIL SOYAM								127	54.24
DFO BADRINATH	5	2672					176	711	232.47
DFO GARHWAL								6	132.09
DFO RUDRAPUR									5.98
DFO SC ALMORA	28	3015					123	473	247.58
DFO SC LANDOWNE	3	25000					3	12	20.78
DFO SC KALI									67.61
DFO LANDOWNE				55			120	879	205.06
DFO MUSCOORE								3	54.70
DFO GANGOTRI NP								74	34.14
DFO KALAGARI TIGER RESERVE	12	200					19		62.05
DFO KEDARNATH					6				
Total	83	251239	0	116	6	7	1692	5282	3279.85

Category Wise & Division Wise Details of Soil & Water Conservation Works under CAMPA in Uttarakhand in 2024-2025

All Financial Figures are in Lakhs

Category	Water Bodies / Funds (Nos.)	Catchment Trenches (Nos.)	Maintenance of water bodies (Nos.)	Percolation Pits / holes (Nos.)	Rejuvenation of water sources (Dhara, Naala) (Nos.)	Rejuvenation of rivers (No. of Checkdams, percolation tanks, trenches etc.)	Chai-Khal	Check Dams	Total Financial (Expenditure) in (Lakh Rs.)
1	2	3	4	5	6	7	8	9	10
DFO ALMORA		1230		990			557	2,124.00	103.40
DFO PITHORAGRAH			1		4				64.32
DFO CHAMPAINAT		1700		2	1			12	730.13
DFO BAGESHWAR		14071	26	20		61	108	322	80.69
DFO NAINITAL	2	17476		10			83	202	388.63
DFO AMS SC RAMNAGAR	16	12492		2			177	262	379.36
DFO SC PANDEHET	29	32131	30	375110			168	273.00	133.05
DFO SC NAINITAL	21	809		2			14	16	152.62
DFO HALDHWAN		100						51	37.84
DFO RAMNAGAR							75	456	300.30
DFO SC UTTARAKASHI					1			16	136.72
DFO UTTARAKASHI	52							1	187.24
DFO TEHRU DAMS	0	1408						40	202.36
DFO TEHRU DAMS								16	180.09
DFO NARENDRA NAGAR								8	213.87
DFO TEHRU								16	184.90
DFO PAURI CIVIL SOYAM								35	28.79
DFO BADINATH	4	12174			1		60	64	88.63
DFO GARIHWAL							568	406.00	485.35
DFO BUDHAPURAYAG							100	383	107.80
DFO SC ALAKHANDA	36						79	204	583.82
DFO SC LANSDOWNE	2	3559	6		1		115	134	589.58
DFO LANSDOWNE								1	6.39
DFO SC KALSI							112	68	532.50
DFO DEHRADUN		22342		102			96	172	775.74
DFO UPPER YAMUNA BARBOT			1					24	62.25
DFO MUSKOWRI		2680			21.00	31		7	282.13
DY. (BR. RAJUL) NP			2				430		301.84
DFO SOWIND WILDLIFE SANCTUARY		285		60			50	110	35.47
DFO GANGOTRI NP					3			1	33.00
DFO MALABARI RIVER RESTIVE	4				11		8	18	27.00
DFO KEDARNATH	4	4303					15	40	286.13
Total	169	128695	65	376276	43	120	2816	5805	4732.47

DIVISION WISE SMC -DTR under CAMPA (Rs in lakh)				
Sl. No.	Name of Division	Amount released in 2024-25		
		Name of Streams in Year 2023-24 (II nd year)	Name of Streams in Year 2024-25 (1st year)	
1	(a)	(b)	(c)	(d) (e)
1	ALMORA DIVISION	8	3	
		Khangad gadhera	8.86	Dharakot Gadhera 21.54
		Asuro	7.65	Kaugadla Gadhera 21.54
				Machidhar Gadhera 22.08
		Baiganiya	8.03	
		Bale gadhera	9.22	
		Mangro gada	7.16	
		Kanjebad	11.34	
		Noli gadhera	8.51	
		Khuresu gadhera	7.63	0.00
		8	68.44	65.16
2	PITHORAGARH DIVISIONS	5		
		Doligad	16.15	
		Kauli Nala	15.80	
		Gharudigad	16.11	
		Jadiyanala	16.28	
		Dug Nala	16.11	
	Total	5	80.45	
3	CHAMPAWAT DIVISION	3	9	
		Guteh nala	26.05	Bhodhakot Gadhera 21.48
		Jamanpod nala		Ligrana Gadhera 20.09
		Kothera nala		Galitadi Gadhera 19.80
				Babed nala 19.36
				Bansana nala 18.76
				Chipa nala 19.31
				Tadleshwar Nala 19.15
				Gmala shanicha khola 19.32
				Jhangda nala 18.59
	Total	3	26.05	173.86
4	BAGESHWAR DIVISION	8	0	
		Ganigaon Gadhera	38.45	
		Garpatal Gadhera		
		Kukadagad Gadhera		
		Thaklad	10.56	
		Karnedi	10.45	
		Upangad	11.25	
		Siminargol	9.97	
			0.00	
	Total	8	80.68	0
	TOTAL NORTH KUMAON CIRCLE	24.00	255.62	12 239.02
5	NAINITAL DIVISION	8	4	
		Burtoli Nala	153.21	Kaunta Gadhera 33.09
		Gharti Nala		Shinad Gadhera 34.52
		Jadpani Nala		Lemejar Gadhera 35.37
		Kalsa Nala		Kapilleshwar Gadhera 34.34
		Ratudi Nala		
		Saur Nala		
		Shipra Nala		
		Takura Nala		
	Total	8	153.21	4 137.32
6	RAMNAGAR SC DIVISION	8		
		Dangola Rolla	127.91	
		Dhungad Raula		
		Gadkot Malla		
		Jhukadi Rolla		
		Katera Rolla		
		Reegdi Rolla		
		Sadoni Rolla		

Sl. No.	Name of Division	Amount released in 2024-25			
		Name of Streams in Year 2023-24 (11 nd year)		Name of Streams in Year 2024-25 (1st year)	
1	(a)	(b)	(c)	(d)	(e)
		Tudi Rolli			
	Total	8	127.91		
7	RANIKHET SC DIVISION	3		3	
		Gaul Gadhera		Jam Gadhera	17.23
		Saregwad Gadhera	38.86	Harbagd Gadhera	18.88
		Selapani Gadhera		Bichauli Gadhera	18.67
				Shimoli Gadhera	21.73
			0.00		0.00
	Total	3	38.86	4	76.51
8	NAINITAL SC DIVISION	8		4	
		Chatini	71.46	Chyodi Gadhera	18.98
		Dadima		Aatawrth Gadhera (अतरथ)	21.26
		Dahra		Changaw Gadhera	20.43
		Dhanyakpot		Pinroo Gadhera (पिनरो)	20.49
		Letibunga			
		Pastola			
		Pasyu			
		Quaidel			0.00
	Total	8	71.46	4	81.16
	TOTAL SOUTH KUMAON CIRCLE	27	391.16	12	294.99
9	HALDWANI DIVISION	1			
		Ratighat Nala	17.93		
	Total	1	17.93		
10	RAMNAGAR DIVISION	1		1	
		Noonipani	13.17	Drehauri	87.59
			0.00		0.00
	Total	1	13.17	1	87.59
	TOTAL WESTERN CIRCLE	2	31.10	1	87.59
	TOTAL KUMAON ZONE	53	678.18	25	621.60
11	UTTARKASHI SC DIVISION	8		4	
		Asthal		Thain	14.36
		Gawana Nala		Naitala (Jaukanee)	13.56
		Kamar		Mando	15.26
		Koti Gad	138.33	Shagda	15.21
		Kumrada			
		Ouangad			
		Pipili Koti Nala			
		Silyana Nala			
			0.00		0.00
	Total	8	138.33	4	58.39
12	UTTARKASHI DIVISION	10	16.60		
		Banalsert Nala			
		Bareth Nala			
		Chamraoli Khad			
		Dandakhal Nala			
		Jainrani Khal	97.64		
		Kuldhar Nala			

Sl. No.	Name of Division	Amount released in 2024-25			
		Name of Streams in Year 2023-24 (II nd year)		Name of Streams in Year 2024-25 (Ist year)	
		(a)	(b)	(c)	(d)
1			Mulani Nala		
			Rahmatnati Nala		
			Ringatza Khad		
			Siyalana Khad		
	Total	10	97.64		
13	TEHRI DAM1 DIVISION	2		4	
			Jagothi Nala		
			Jakhholi	19.22	
				Manda Nala	24.77
				Bahedi Nala	29.83
				Bisan lamra Gadhera	24.61
				Odigad	45.77
	Total	2	19.22		0.00
14	TEHRI DAM2 DIVISION	6		4	124.98
			Bagikhala	51.31	
			Banda Dhara		
			Gair Nala		
			Idriyan Khad		
			Kundenaam Dhara		
			Yugoldam Dhara		
				3	
				Hareti Nala	43.08
				Jugaldi Kailath dhara	48.72
				Uprikot Nala	44.48
	Total	6	51.31		
15	NARENDRA NAGAR DIVISION	12		3	135.28
			Geerwadi Gadhera		
			Godi Gad		
			Gawani Gad		
			Khajra Pani Tok		
			Kulband Gadhera		
			Malli Channi Gadhera		
			Papdi Khala		
			Khureet Gad	6.92	
			Pujaldi Gad	5.69	
			Mathiyani gaon Gad	5.93	
			Udkhanda Gad	16.71	
			Naur-basoi	9.98	
	Total	12	213.35		
16	TEHRI DIVISION	10		6	
			Asgarh Khala		
			Chalgadna		
			Chamliyan		
			Chhamund		
			Chata Ki Gad		
			Dhudgate		
			Gair Gad		
			Shrikot Gad		
			Siwani		
			Nadichami Gad	23.87	
	Total	10	205.91		0.00
	TOTAL BHAGINATHI CIRCLE	48	725.76	6	128.73
17	PAURI CS DIVISION	1		17	447.38
			Chauda Gaad	20.79	

[illegible]

Sl. No.	Name of Division	Amount released in 2024-25			
		Name of Streams in Year 2023-24 (II nd year)		Name of Streams in Year 2024-25 (Ist year)	
		(b)	(c)	(d)	(e)
1	(a)				
	Total	Ragad			
24	DEHRADUN DIVISION	2	5.25	3	
				Sisarukhala	96.47
				Paniyalakhala चलिखला	88.53
				Naukhala नौखला	90.71
	Total				275.73
24	LANSDOWNE SOIL	7		7	
		Androl	70.94	Gunldiet Nala	50.25
		Bangya Saar		Pulyashu Androl gadera	7.50
		Bhaidgaon		Kenda Rauthaya Rola	7.50
		Dargwasi Tok		Sila Rola	7.50
		Diyul Gadhera		Jmelli (गमेली)	7.50
		Rothiya Rola		Bhaidgaw Gadera	9.50
		Sila Raula		Bubai diul gadera गुद	9.50
	Total	7	70.94	7	99.25
	TOTALSHIWALIK CIRCLE	12	128.32	10	374.98
25	MUSSOORIE DIVISION	13		10	
		Arel Gaon Khala		Kheri ka khalakhala	135.28
		Udriyan Khala		Chintola water spring	
		Dholani Khala		Ratnalgad Spring	
		Gadola Khala	65.99	Ghadiyal Spring	
		Joodowala Khala		Radwara Ghdhera	
		Luharkha Khala		Phediya khala	
		Guler khala-I	7.21	Bhawan khala	
		Guler khala-II	8.71	Maharaj ki Chauti	
		Radwar khala	8.46	Bhinsy	
		Naya danda tok	8.53	Bhilaru	
		Kathiyana tok	12.62		
		Ratnalgad tok	8.97		
		Bola khadad	8.47		
	Total	13	128.96	10	135.28
26	UPPER YAMUNA DIVISION			3	
				Pisau Khad	17.49
				Keshari Tunalka	22.49
				Morasala Khadd	22.52
	Total			3	62.50
	TOTALYAMUNA CIRCLE	13	128.96	13	197.78
27	TOTAL GARHWAL ZONE	99	1486.09	47	1229.75
	KALAGARH TR	2			
		Dhaniya	27.00		
		Kugadda			
	Total	2	27.00		
28	RAJAJI TIGER RESERVE			3	
				Churadigad Nala	44.63
				Luni purbi	28.71
				Kumbhi Chaudh Nala	29.83
	Total			3	103.17
29	KEDARNATH WL	9		2	
		Baargad	83.42	Chedapani gadera	31.51
		Banarsen		Banjyali Gadera	43.43
		Bhoran			
		Domgad			
		Hanjira			
		Hanz Nala			
		Karnprayag Nala			
		Sindrvani			
		Varidhar			
	Total	9	83.42	2	0.00
30	GOVIND W.L			2	74.94
				Esabragad -इसबरागद	18.61
				Giyagad गियागद	16.87
	Total			2	35.48

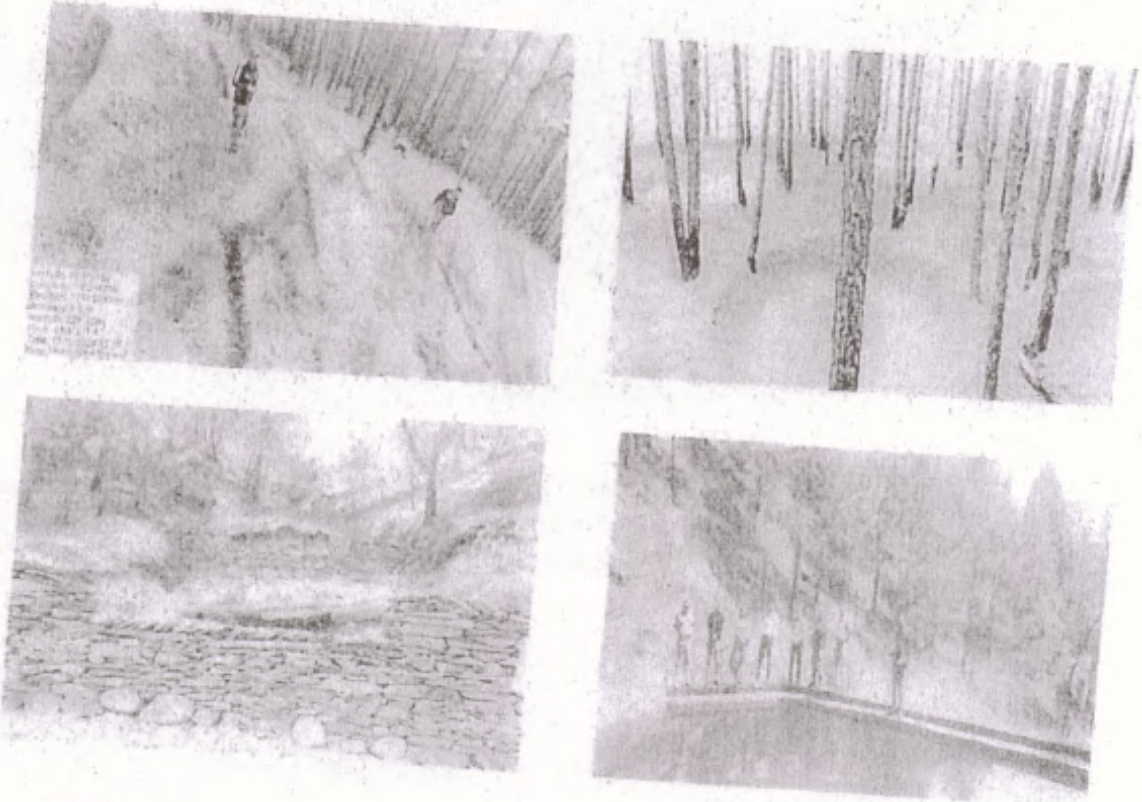
Sl. No.	Name of Division	Amount released in 2024-25			
		Name of Streams in Year 2023-24 (II nd year)		Name of Streams in Year 2024-25 (Ist year)	
1	(a)	(b)	(c)	(d)	(e)
31	GANGOTRI NP	3			
		Miyana Gad	33.00		
		Patangani			
		Rudragaira			
	Total	3	33.00		
	TOTAL WILDLIFE ZONE	14	143.42	7	213.59
	GRAND TOTAL	166	2307.69	79	2064.93





डी0टी0आर0 के माध्यम से सूख रहे जल स्रोतों में मृदा एवं जल संरक्षण कार्य

छमुण्ड गदेरा

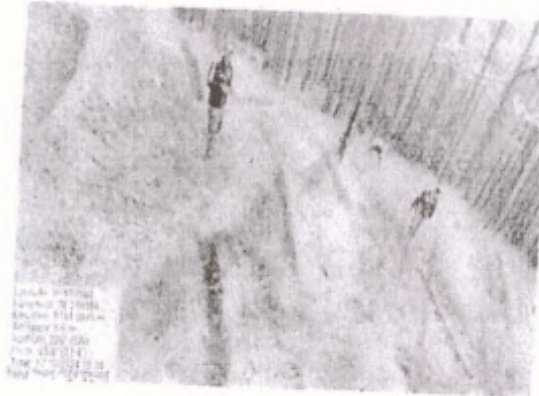


कार्यों का उद्देश्य- भू-सरण की रोकथाम, जल स्रोतों का पुनरोद्धार, मृदा में नमी बढ़ाने से वनान्नि रोकथाम, वनान्नि रोकथाम हेतु पानी की उपलब्धता, वन्य जीव हेतु पानी की उपलब्धता बढ़ाना।

कार्यों का विवरण-

क्र०सं०	कार्य का प्रकार	इकाई	प्रथम वर्ष	द्वितीय वर्ष
1	कन्टूर ट्रेन्च	हेक्टेयर		
2	चाल-खाल	संख्या	10	5
3	गली प्लग	संख्या	6	4
4	क्रेटवायर चैकडैम	संख्या	20	0
5	साईडवाल	संख्या	9	6
6	आर०आर०झाई चैकडैम	संख्या	20	0
7	पक्का पौण्ड	संख्या	30	0
		संख्या	1	1

डी0टी0आर0 के माध्यम से सूख रहे जल स्रोतों में मृदा एवं जल संरक्षण कार्य
सिवाणी गदेरा



कार्यों का उद्देश्य— भू-क्षरण की रोकथाम, जल स्रोतों का पुनरोद्धार, मृदा में नमी बढ़ाने से वनाग्नि रोकथाम, वनाग्नि रोकथाम हेतु पानी की उपलब्धता, वन्य जीव हेतु पानी की उपलब्धता बढ़ाना।



कार्यों का विवरण—

क्रमांक0	कार्य का प्रकार	इकाई	प्रथम वर्ष	द्वितीय वर्ष
1	कन्दूर ट्रेन्च	हेक्टेयर	5	5
2	चाल-खाल	संख्या	10	5
3	गली प्लग	संख्या	20	0
4	क्रेटवायर चैकडैम	संख्या	5	11
6	आर0आर0ड्राई चैकडैम	संख्या	25	0
7	पक्का पीण्ड	संख्या	1	1

कार्यालय वन क्षेत्राधिकारी, बढौन वन क्षेत्र, हैड़ाखान नैनीताल

पत्रांक:-417/7-1

दिनांक- 03/06/2025

सेवा में,

श्रीमान प्रभागीय वनाधिकारी,
नैनीताल वन प्रभाग नैनीताल

विषय-

सिनाड़ नाले अन्तर्गत (डी0टी0आर0) वर्ष 2024-25 में किये गये कार्यों के फोटोग्राफ उपलब्ध कराने के सम्बन्ध में।

महोदय,

उपरोक्त विषयक क्रम में बढौन वन क्षेत्र के अन्तर्गत वर्ष 2024-25 में किये गये कार्यों के सापेक्ष फोटोग्राफ की सूचना का विवरण निर्धारित प्रपत्र में बनाकर निम्नानुसार सेवा में प्रेषित है।

(1)

सिनाड़ नाला / 2024-25				
क्र0सं0	कार्य का नाम	कार्य की मात्रा (संख्या / हे0 / कि०मी०)	कार्य स्थल का नाम एवं जी0पी0एस0	कार्य की फोटोग्राफ
1	2	3	4	5
1	गलीप्लानि निर्माण कार्य	14	पश्चिमी ओखलढूंगा कक्ष संख्या 12, N29°14' 17.7" E079°37' 36.2"	
2	गलीप्लानि निर्माण कार्य	14	पश्चिमी ओखलढूंगा कक्ष संख्या 14, N29°14' 12.7" E079°37' 33.2"	
3	गलीप्लानि निर्माण कार्य	12	पश्चिमी ओखलढूंगा कक्ष संख्या 15, N29°14' 12.9" E079°37' 53.1"	
4	कोर अवरुधक निर्माण कार्य	8	पश्चिमी ओखलढूंगा कक्ष संख्या 12, N29°14' 18.0" E079°37' 37.2"	

5	कोरे अवरोधक निर्माण कार्य	7	पश्चिमी ओखलदुंगा संख्या ,14 N29°14' 18.0" E079°37' 37.2"	
6	केटवायर अवरोधक निर्माण कार्य	7	पश्चिमी ओखलदुंगा संख्या ,12 N29°14' 18.6" E079°37' 33.7"	
7	केटवायर अवरोधक निर्माण कार्य	10	पश्चिमी ओखलदुंगा संख्या ,14 N29°14' 12.8" E079°37' 32.2"	
8	केटवायर अवरोधक निर्माण कार्य	3	पश्चिमी ओखलदुंगा संख्या ,15 N29°14' 16.2" E079°37' 40.4"	
9	घास खाल	5	पश्चिमी ओखलदुंगा संख्या ,14 N29°14' 14.5" E079°43' 49.1"	
10	घास खाल	5	पश्चिमी ओखलदुंगा संख्या ,15 N29°14' 18.9" E079°37' 29.3"	
11	मानसपतिक अवरोधक	20	पश्चिमी ओखलदुंगा संख्या ,12 N29°14' 21.1" E079°37' 28.8"	

12	मानस्यतिक अवस्थित	20	पश्चिमी ओखलदुंगा संख्या ,15 N29°14' 07.8" E079°37' 46.3"	
13	कन्दूर फरो खुदान	4000 R.m.	पश्चिमी ओखलदुंगा संख्या ,14,15 N29°14' 13.5" E079°43' 21.1"	
14	जलकुण्ड	1	पश्चिमी ओखलदुंगा संख्या ,15 N29°14' 18.5" E079°37' 39.3"	
15	जलकुण्ड	1	पश्चिमी ओखलदुंगा संख्या ,14 N29°14' 18.9" E079°37' 38.6"	

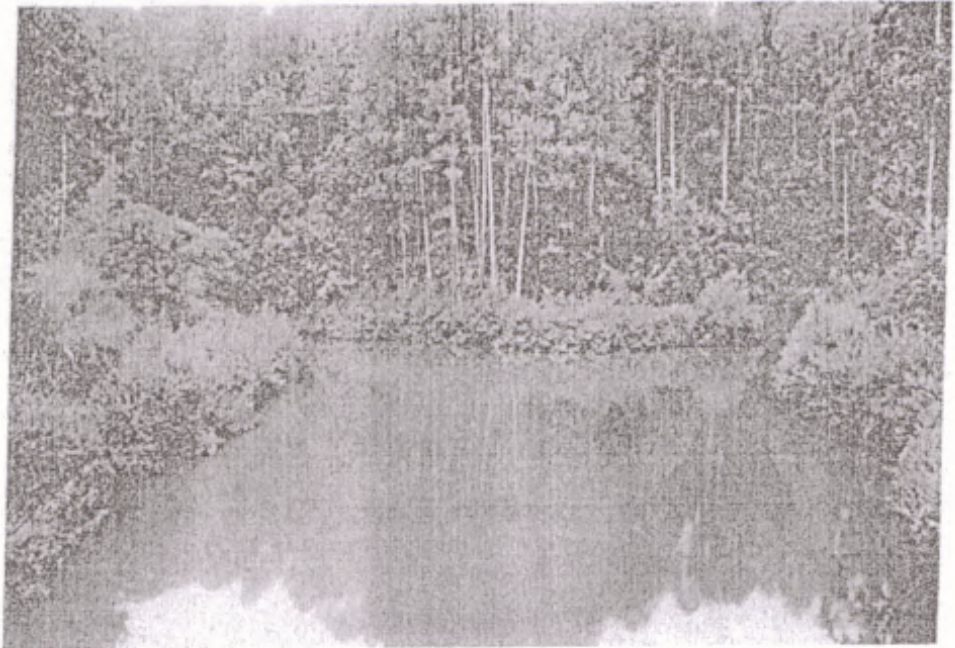
सिनाड़ जलाशय/अमृत सरोवर

स्थल विवरण— सिनाड़ जलाशय का काठगोदाम हैड़ाखान मोटर मार्ग पर काठगोदाम से 18 किलोमीटर की दूरी पर नैनीताल वन प्रभाग की बढौन रेंज के आरक्षित वन क्षेत्र पश्चिमी ओखलढूंगा कक्ष संख्या 14 तथा 15 के मिलान पर ओखलढूंगा ग्राम के समीप स्थित है। जिस क्षेत्रफल 0.09 है। यह जलाशय पूर्व से निर्मित है सिनाड़ जलाशय का जल गौला नदी में सम्मिलित होता है। इस क्षेत्र का एक मात्र जलाशय होने के कारण वन्य प्राणीयों हेतु वर्ष भर जल उपलब्ध हो गया है जिस कारण उक्त क्षेत्र वन्य प्राणीयों के आदर्श वास स्थल के रूप में विकसित रहा है।

1. स्थल की जी0पी0एस0 लोकेशन निम्न प्रकार है—

N 29° 14' 07"

E 79° 37' 24"



Height- 1100 Mtr.

स्थल का नाम, क्षेत्रफल, बीट, रेंज, प्रभाग

स्थल का विवरण निम्न प्रकार है—

1.	कक्ष संख्या	पश्चिमी ओखलढूंगा 14, 15
2.	स्थल का क्षेत्रफल	0.09 हेक्टेयर
3.	बीट का नाम	पश्चिमी ओखलढूंगा
4.	रेंज	बढौन रेंज
5.	प्रभाग	नैनीताल वन प्रभाग, नैनीताल

2.3- जिला मुख्यालय आदि

जिला नैनीताल, तहसील नैनीताल, ब्लॉक भीमताल, ग्राम ओखलढुंगा।

2.3- भूमि का विवरण- वन भूमि/राजस्व भूमि/गैर वन भूमि

पश्चिमी ओखलढुंगा कक्ष 14, 15 नैनीताल वन प्रभाग के बढौन रेंज के आरक्षित वन क्षेत्र अन्तर्गत है।

2.3- सड़क

प्रस्तावित स्थल काठगोदाम-हैड़ाखान-खनस्यू मोटर मार्ग पर काठगोदाम से लगभग 18 कि०मी० की दूरी पर है।

2. स्थल का प्राकृतिक विवरण-

3.1- फलोरा- क्षेत्र में मौजूद प्रमुख वनस्पति का विवरण निम्न प्रकार है

वनस्पति का प्रकार	वनस्पति का हिन्दी नाम	वैज्ञानिक नाम
वृक्ष	चीड़	<i>Pinus roxburghii</i>
	साल	<i>Shorea robusta</i>
	जामुन	<i>Syzygium cumini</i>
	काफल	<i>Myrica esculenta</i>
	रोहिणी	<i>Mallotus philippensis</i>
	बाँज	<i>Quercus leucotrichophora</i>
	मेहल	<i>Pyrus pashia</i>
झाड़ी	हिसालू	<i>Rubus ellipticus Sm.</i>
	कडू	<i>Clerodendrum infortunatum</i>
	कड़ीपत्ता	<i>Murraya koenigii</i>
वेल	मालू	<i>Bauhinia vahlii</i>
	गेठी	<i>Dioscorea bulbifera</i>
	तरुड	<i>dioscorea alata</i>
	विदारि कन्द	<i>Pueraria tuberosa</i>
घास	औंस	<i>Thysanolaena maxima</i>
	नरकुल	<i>Phragmites karka</i>
	नेपियर	<i>Pennisetum purpureum Schumach</i>

उपरोक्त वनस्पतियों के अतिरिक्त अन्य कई प्रकार की वनस्पतियां भी क्षेत्र में बहुतायत से पाई जाती हैं।



वन क्षेत्र का दृश्य

3.2- फौना- क्षेत्र में मौजूद वन्यप्राणियों का विवरण निम्न प्रकार है

वन्य प्राणी का हिन्दी नाम	वैज्ञानिक नाम
गुलदार / तेंदुआ	<i>Panthera pardus</i>
सांभर	<i>Rusa unicolor</i>
काकड	<i>Muntiacus muntjak</i>
सेही	<i>Hystrix indica</i>
जंगली सुअर	<i>Sus scrofa</i>
हिमालयन सिवेट	<i>Paguma larvata</i>
संराव	<i>Capricornis sumatraensis thar</i>
जंगल कैट	<i>Prionailurus bengalensis</i>
कलीज फीजेन्ट	<i>Lophura leucomelanos</i>
किंग कोबरा	<i>Ophiophagus hannah</i>
कोबरा	<i>Naja</i>
धागन	<i>Ptyas mucosa</i>

3.3 प्रस्तावित कार्य:-सिनाड़ नाले अन्तर्गत गलीप्लग संख्या-80, कोरे अवरोधक संख्या-25, केटवायर अवरोधक-40, चाल-खाल-20, वानस्पतिक अवरोधक-90, जलकुण्ड-03, कन्दूर ट्रेन्च-15000 र0मी0 बनाये जा रहे हैं।

3.4- जलाशय वृद्धि एवं लाभ- जलाशय के विस्तार हेतु अमृत सरोवर योजना के अन्तर्गत जलाशय की क्षमता वृद्धि हेतु जलाशय के पिछले संकरे भाग को वर्ष 2022-23 में खुदाई कर चौड़ा किया गया। जिसके पश्चात जलाशय में लगभग 13906750 लाख लीटर की वृद्धि हो गयी है। जलाशय के पूर्वी तथा पश्चिमी तट पर मिट्टी को पुनः वापस बह कर जलाशय में आने से रोकने हेतु पथरों की दिवाल निर्माण का कार्य भी किया गया है। जलाशय के कैचमेंट क्षेत्र में विविध प्रकार की घास एवं पौधों का रोपण किया गया है। जलाशय की वृद्धि से निम्न लाभ क्षेत्र में हो रहे हैं जो निम्नवत् है-

- ❖ वर्षाकाल में चोल-खाल, कन्टूर ड्रेनज से जल संग्रहण में वृद्धि ।
- ❖ अवरोधक निर्माण से सिल्ट/गाद रोक जा रहा है।
- ❖ जलाशय के निचले क्षेत्र में जो भी गांव है उनके पेयजल एवं सिंचाई हेतु स्थानीय जल स्रोतों में वृद्धि हो रही है। जिससे सूखे के समय फसलों को बचाने में मदद मिल रही है।
- ❖ स्थानीय जलवायु में परिवर्तन व हरित क्षेत्र में वृद्धि देखा गया एवं वातस्फटिक तंत्र में वृद्धि हो रही है। यह स्थान जलीय पारिस्थितिक तंत्र में परिवर्तित हो रहा है।
- ❖ इस जलाशय क्षेत्र में चारा व अन्य प्रजातियों में वृद्धि हो रही है। जलवायु परिवर्तन व आस-पास के क्षेत्रों में तापमान में कमी देखी गयी है।
- ❖ अतिरिक्त वर्षा जल को संग्रहित कर बाढ़ के जोखिम को कम किया गया है।
- ❖ जलाशय विकसित होने से वन्यजीवों व पक्षियों के प्राकृतिक वास स्थल में सुधार।
- ❖ घास रोपण से आवेछनीय खरपतवार में कमी देखी गयी है।

3.5- लाभार्थियों का विवरण- इस क्षेत्र में जलाशय के निर्माण तथा उसकी क्षमता वृद्धि से ग्राम बड़ेत, के लगभग 30-35 परिवारों एवं ओखलकूंगा क्षेत्र के लगभग 30 परिवारों को सिंचाई एवं पेयजल हेतु सुविधा उपलब्ध हो गयी है।

भवदीय,

वन क्षेत्राधिकारी
बढ़ौन वन क्षेत्र, हैड़ाखान

Length of forest fire-lines in Uttarakhand (in km)

Length of forest fire-lines in Uttarakhand (in km)				
Width-->	100 ft	50 ft	30 ft	Total
Kumaon zone	394.81	773.84	1085.7	2254.35
Garhwal zone	1382.94	1136.25	947.35	3466.54
Wildlife zone	352.07	613.71	193.46	1159.24
Total	2129.82	2523.8	2226.51	6880.13

Indian Council of Agricultural Research (ICAR)
Agricultural Engineering Division
 KAB-II, Pusa, ICAR, New Delhi-110022

F. No. A. Engg. 7/8/2025-AE

Date: 16.05.2025

विषय:- Stubble Burning (आड़, पराली तथा अवशेष जलाने) के संबंध में।

प्रिय श्री निशांत वर्मा,

हमें उपरोक्त उद्धृत विषय के संबंध में दिनांक 15 मई, 2025 का पत्र प्राप्त हुआ है। फसल अवशेष प्रबंधन के लिए विकसित प्रौद्योगिकियों को जानने के आपके प्रयास की हम सराहना करते हैं। फसल प्रबंधन के लिए विकसित प्रौद्योगिकियों का विवरण संलग्न अनुबंध (Annexure)-I में दिया गया है।

किसी भी अन्य प्रश्न के लिए, कृपया निदेशक, आईसीएआर- सेंट्रल इंस्टीट्यूट ऑफ एग्रीकल्चरल इंजीनियरिंग (सीआईएई), भोपाल से नीचे दिए गए पते पर संपर्क करें:

निदेशक,

आईसीएआर- केंद्रीय कृषि इंजीनियरिंग संस्थान (सीआईएई)

नबी बाग, बेरासिया रोड, भोपाल - 462038 (मध्य प्रदेश)

फोन नंबर: 91-755-2737191

ई-मेल: directorciae@gmail.com, director.ciae@icar.gov.in

सस्नेह।

आपका

P. L. Singh
 (पी. एल. सिंह) 20/5/2025

प्रधान वैज्ञानिक (इंजी.)

✓ सेवा में,

श्री निशांत वर्मा,

अपर प्रमुख वन संरक्षक,

वनाग्नि एवं आपदा प्रबंधन, उत्तराखण्ड, देहरादून

चौथी मंजिल 85, राजापुर रोड, देहरादून-248001(उत्तराखंड)

ईमेल: nodalforestfire.uk@gmail.com

ऑण दिवस

(अदवानी वन बन्धु समिति का गठन)

दिनांक 13.02.2025 को आयोजित वनाग्नि मॉकड्रिल सम्बन्धित बैठक में मा0 मुख्यमंत्री, उत्तराखण्ड सरकार द्वारा अल्मोड़ा जनपद में क्रियान्वित जनसहभागिता से वनाग्नि निवारण पर आधारित शीतलाखेत मॉडल को प्रदेश के अन्य जनपदों में भी क्रियान्वित करने हेतु आदेशित किया गया था।

1. उक्त के क्रम में जनपद गढ़वाल में स्थित वनाग्नि दृष्टिकोण से संवेदनशील अदवानी वन क्षेत्र का जनसहभागिता से वनाग्नि निवारण हेतु चयन किया गया है।
2. अदवानी वन क्षेत्र से कुल 27 ग्राम एवं 18 वन पंचायत सटी हैं।
3. वनाग्नि निवारण हेतु ग्राम प्रधान, वन पंचायत संरक्षक, महिला मंगल दल, युवक मंगल दल एवं अन्य ग्रामीणों की एवं वन विभाग के अतिरिक्त राजस्व विभाग, पुलिस विभाग, चिकित्सा विभाग, अग्नि शमन विभाग, ग्राम विकास विभाग, जल संरक्षण, पेयजल निगम एन0जी0ओ0 उन्नत गढ़वाल आदि की महत्वपूर्ण भागीदारी है।
4. इसी क्रम में दिनांक 05.03.2025 को प्रातः 11:00 बजे शीतलाखेत मॉडल के तर्ज पर अदवानी वनबन्धु समिति का गठन व समस्त हितधारकों (Stakeholders) की उपस्थिति में वनाग्नि सुरक्षा गोष्ठी का आयोजन ब्लॉक परिसर कल्जीखाल में किया गया।



(आड़ा दिवस आयोजन)

25 मार्च 2025 को आड़ा दिवस का आयोजन किया गया, जिसमें स्थानीय ग्रामीणों द्वारा अपने घरों के आस पास एवं नापखेतों में उपस्थित आड़े का वनाग्नि काल के दौरान लापरवाही से न जलाने की प्रतिज्ञा ली गयी एवं वनाग्नि की घटनाओं को कम करने हेतु वन विभाग का आश्वासन लेने की भी प्रतिज्ञा ली गयी।

समुदायों ने सूखी वनस्पतियों एवं घरों में की सफाई और आग रोकथाम उपायों में भाग लिया तथा प्रभागीय वनाधिकारी द्वारा 400 से अधिक स्थानीय नागरिकों को वनाग्नि रोकथाम की शपथ दिलायी गयी तथा वनाग्नि रोकथाम में सक्रिय भूमिका निभाने हेतु अपील की गयी। इस अभियान में वन विभाग के साथ-साथ ग्राम्य विकास विभाग, अग्निशमन विभाग, राजस्व विभाग एवं एन0जी0ओ0 उन्नत गढ़वाल ने सक्रिय भूमिका निभाई। ग्राम डुंगरा, गिदरासू, नगोली, बंगाउ मल्ला, गहड़, बलुड़ी, तमलाग, नहासैण, भीमली तल्ली आदि के ग्रामीणों ने इस अभियान में भाग लिया और वनाग्नि रोकथाम की शपथ ली। कार्यक्रम के दौरान ग्रामीणों को वनाग्नि नियंत्रण एवं पर्यावरण संरक्षण से जुड़ी महत्वपूर्ण जानकारियां प्रदान की गयी तथा वन संपदा की सुरक्षा में सक्रिय भागीदारी निभाने के लिए प्रेरित किया और वनाग्नि से होने वाले दुष्प्रभावों पर प्रकाश डाला गया।



बनाग्नि घटनाओं को कम करने हेतु जन सहभागिता के शीतलाखेत मॉडल को अपनाने के क्रम में पुनः 07 अप्रैल 2025 को बनाग्नि दृष्टिकोण से संवेदनशील श्रीनगर सिविल क्षेत्र में लगभग 15-20 ग्रामों में आड़ा दिवस कार्यक्रम आयोजित किया गया है, जिसमें लगभग 221 प्रतिभागियों ने प्रतिभाग किया।

ANNEXURE 13

Annexure-13

आदेश

उत्तराखण्ड शासन वन अनुभाग-02, देहरादून के पत्र संख्या-335/X-2, 2022.21(10)2020 दिनांक 11 मार्च 2022 एवं पत्र संख्या-711/X-2 2025.21(13)2022 टी0सी0-ई-83762 दिनांक 17 अप्रैल 2025 द्वारा वनाग्नि की रोकथाम के लिए प्रभावी कार्यवाही किये जाने के साथ ही जिलास्तरीय, विकास खण्ड एवं पंचायत स्तर पर समिति गठित किये जाने के निर्देश दिये गये हैं।

उक्त के क्रम में कार्यालय के आदेश संख्या-3839/छवीस-02/2022 दिनांक 30 मार्च 2022 के द्वारा वनाग्नि की रोकथाम के संबंध में दिये गये निर्देशों के अनुपालन में अगोहस्ताक्षरी की अध्यक्षता में एक विकास खण्ड स्तर पर संबंधित ब्लॉक प्रमुख की अध्यक्षता में तथा वन पंचायत पर संबंधित ग्राम प्रधान की अध्यक्षता में रणनीति तैयार किये जाने हेतु निम्नानुसार समिति गठित की गयी है:-

1. जिला स्तरीय समिति।

01	जिलाधिकारी	अध्यक्ष।
02	वरिष्ठ पुलिस अधीक्षक-	सदस्य।
03	मुख्य विकास अधिकारी	सदस्य।
04	अधिक्षात्री अगिगन्ता, प्रा0ख0 लो0नि0वि0, अल्मोड़ा।	सदस्य।
05	समस्त परगनाधिकारी	सदस्य।
06	1. श्री गजेन्द्र पतक, ऑडिनेटर, सौतलाखेत मॉडल (जिला अधिकारी द्वारा नामित)	सदस्य।
07	2. श्रीमती वसुधा पन्त, डीन, हिल्ट (जिला अधिकारी द्वारा नामित)	संयोजक।

2. खण्ड विकास स्तरीय समिति

01	ब्लॉक प्रमुख	अध्यक्ष।
02	खण्ड विकास अधिकारी	सदस्य।
03	मुख्यालय पर संबंधित थाने का थानाध्यक्ष	सदस्य।
04	परगनाधिकारी द्वारा नामित सज्जव अधिकारी जो नाएब सहसीलदार स्तर से कम न हो	सदस्य।
05	ब्लॉक प्रमुख द्वारा नामित 2 ग्राम प्रधान	सदस्य।
06	ब्लॉक प्रमुख द्वारा नामित 02 सामाजिक कार्यकर्ता जो पर्यावरण में रुचि रखते हों	सदस्य।
07	सहायक वन संरक्षक	संयोजक।

उक्तानुसार विकास खण्ड स्तरीय समिति जंगपद के सभी 11 विकास खण्डों हेतु प्रभावी रहेगी। उक्त समिति में नामित संयोजक अपने-अपने से संबंधित विकास खण्डों के ब्लॉक प्रमुख से सम्पर्क कर उक्त समिति के क्रमांक 05 एवं 06 में क्रमशः ग्राम प्रधान एवं 02 सामाजिक कार्यकर्ता के नाम प्राप्त कर समिति में सम्मिलित करेंगे। उक्तानुसार कार्यवाही किये जाने हेतु प्रभागीय वनाधिकारी अल्मोड़ा वन प्रभाग अल्मोड़ा द्वारा संबंधित संयोजकों को तदनुसार निर्देशित किया जायेगा।

3. वन पंचायत स्तरीय समिति।

01	ग्राम प्रधान	अध्यक्ष।
02	पटवारी/लेखपाल	सदस्य।
03	संबंधित क्षेत्र का वन दरोगा	संयोजक
04	ग्राम विकास अधिकारी	सदस्य।
05	वन रक्षक	सदस्य।
06	उप प्रधान	सदस्य।
07	ग्राम की महिलाएं	सदस्य।

उक्तानुसार वन पंचायत स्तरीय समिति जनपद के सभी वन पंचायतों/ग्रामों में प्रभावी रहेगी। उक्त समिति में नामित सयोजक अपने-अपने से संबंधित वन पंचायत/ग्राम समूह के ग्राम प्रधान से सम्पर्क कर उक्त समिति के क्रमांक 06 एवं 07 में क्रमशः उप प्रधान एवं ग्राम की महिला का नाम प्राप्त कर समिति में सम्मिलित करेंगे। उक्तानुसार कार्यवाही किये जाने हेतु प्रभागीय वनाधिकारी अल्मोड़ा वन प्रभाग अल्मोड़ा द्वारा संबंधित संयोजकों को तदनुसार अपने-अपने क्षेत्रान्तर्गत समिति गठित किये जाने हेतु निर्देशित किया जायेगा। उपजिलाधिकारी उक्तानुसार समिति में राजस्व उप निरीक्षकों को तदनुसार समिति के संबंध में अवगत कराते हुए निर्धारित किये गये दायित्वों के निर्वहन हेतु निर्देशित करेंगे।

शासन द्वारा उक्तानुसार गठित की गयी समितियों के कार्य एवं दायित्व निम्नवत निर्धारित किये गये हैं:-

- (1)- आरक्षित, सिविल व पंचायत वनों में अग्नि सुरक्षा हेतु जनपद में उपलब्ध संचार यातायात व अनुरूप उपकरणों को चिन्हित करके आवश्यकतानुसार उपयोग किया जाना।
 - (2)- सिविल वनों में सुरक्षा हेतु वन विभाग के अतिरिक्त राजस्व विभाग एवं ग्राम प्रधानों की भूमिका तय करने उनका सक्रिय सहयोग प्राप्त करना।
 - (3)- पंचायती वनों में अग्नि सुरक्षा हेतु पंचायती राज विभाग, वन विभाग, सरपंच एवं ग्रामीणों की भूमिका तय करना व उनका सहयोग प्राप्त करना।
 - (4)- लोक निर्माण विभाग, डी०जी०बी०आर० की सड़कों को पक्का कराये जाने आदि के कार्यों के समय वनों की आग से सुरक्षा हेतु सतर्कता बरतना एवं इस विभाग के कर्मचारियों व श्रमिकों का सहयोग प्राप्त करना।
 - (5)- वनों में अग्नि दुर्घटना से सुरक्षा कार्य का सहायलोकन व इनका अनुश्रवण किया जाना।
 - (6)- वनों की अग्नि सुरक्षा के लिए अन्य ऐसी कार्यवाही करना जिसे सामंति आवश्यक समझे, यथा एस०एस०बी०, वन पंचायत/ग्राम वन समिति, इको डेवलपमेंट समिति, स्वयंसेवी संस्थान आदि का सहयोग प्राप्त करना।
- 4- उक्तानुसार जिला स्तरीय समिति में नामित सभी सदस्यों से अपेक्षा की जाती है कि वे उक्तानुसार दिये गये दायित्वों के अनुरूप कार्यवाही करेंगे तथा वनाग्नि की रोकथाम हेतु प्रभावी कार्यवाही सुनिश्चित करेंगे। स्वयं तथा अपने अधीनस्थों के माध्यम से भी आम जनमानस को वनाग्नि के दुष्प्रभावों से अवगत कराये जाने के साथ ही जागरूक किया जाना भी सुनिश्चित करेंगे।
- 5- मुख्य विकास अधिकारी उक्तानुसार समितियों में नामित विकास खण्ड स्तर के अधिकारियों/कर्मचारियों को तदनुसार दायित्वों के निर्वहन हेतु निर्देशित करेंगे।
- 6- वरिष्ठ पुलिस अधीक्षक अल्मोड़ा उक्तानुसार विकास खण्ड स्तरीय समिति में नामित संबंधित थानाध्यक्षों को दिये गये दायित्वों का निर्वहन किये जाने हेतु निर्देशित करेंगे साथ ही सूचना तंत्र को सक्रिय किये जाने के साथ ही जंगलों में अराजक तत्वों द्वारा आग लगाये जाने पर संबंधितों की पहचान कर विधिसम्मत कार्यवाही अमल में लायेंगे।
- 7- संमत्ता उप जिलाधिकारियों द्वारा अपने-अपने क्षेत्रान्तर्गत राजस्व अधिकारियों तथा राजस्व निरीक्षक/राजस्व उपनिरीक्षकों को निर्देशित किया जाय कि वे अपने-अपने क्षेत्र में वनाग्नि के दुष्प्रभावों से आम जनमानस को अवगत कराते हुए वनाग्नि होने पर सूचना संबंधित कंट्रोल रूम को दिये जाने के साथ ही वनाग्नि को रोके जाने के संबंध में आम जनमानस से सहयोग लिये जाने हेतु प्रभावी कार्यवाही सुनिश्चित करेंगे साथ ही जंगलों में आग अराजक तत्वों द्वारा आग लगाये जाने पर संबंधितों की पहचान कर विधिसम्मत कार्यवाही अमल में लायेंगे।
- 8- मोटर मार्ग निर्माण इकाई के अधिकारियों को दायित्व होगा कि वे वनों की आग से सुरक्षा हेतु सतर्कता बरतना एवं विभाग के श्रमिकों को वनाग्नि को रोके जाने के संबंध में आवश्यक सहयोग दिये जाने हेतु निर्देशित करेंगे।

9- प्रभागीय वनाधिकारी अल्मोड़ा वन प्रभाग, अल्मोड़ा द्वारा वनाग्नि की सूचना दिये जाने हेतु निम्न दूरभाष नम्बर उपलब्ध कराये गये हैं। सर्वसम्बन्धित तत्त्वानुसार अपने-अपने अधीनस्थों/क्षेत्रान्तर्गत उक्त दूरभाष नम्बरों को आम जनमानस तक उपलब्ध करावेगे:-

प्रभागीय मास्टर कंट्रोल रूम-9456596850/51	आपदा प्रबन्धन कार्यालय अल्मोड़ा- 05962-237874/237875 मो0न0 7900433294
वन क्षेत्राधिकारी मंडान-9927375158	वन क्षेत्राधिकारी द्वाराहाट-7351585486
वन क्षेत्राधिकारी जीरासी-9917019493	वन क्षेत्राधिकारी सोमेश्वर-9412314937
वन क्षेत्राधिकारी अल्मोड़ा-9412977030	वन क्षेत्राधिकारी रानीखेत-7982181608

10- प्रभागीय वनाधिकारी द्वारा सूक्तानुसार सभी संबंधित विभागों के साथ समन्वय स्थापित कर वनाग्नि नियंत्रण हेतु प्रभावी कार्यवाही सुनिश्चिता की जायेगी तथा वनाग्नि की जानकारी दिये जाने हेतु कंट्रोल रूम तथा कू-स्टेशन के दूरभाष/मोबाईल नम्बर प्रत्येक विभाग/सरपंच/ग्राम प्रधानों तथा आम जनमानस को प्रचार-प्रसार कर उपलब्ध कराया जायेगा।

(आलोक कुमार पाण्डेय)
जिला अधिकारी, अल्मोड़ा

कार्यालय जिला अधिकारी, अल्मोड़ा।

संख्या 210C/आ0प्रव0प्राधि/वनाग्नि/2025, दिनांक 24 अप्रैल, 2025

प्रतिलिपि:-निम्नांकित को सादर सूचनार्थ प्रेषित:-

- 1- प्रमुख सचिव, वन अनुभाग-2, उत्तराखण्ड शासन, देहरादून।
- 2- आयुक्त कुमाऊँ मण्डल, नैनीताल।

प्रतिलिपि निम्नांकित को शासनादेश संख्या-454/1(2)व.पा.वि/2004-9(22)/2001 दिनांक 27 मार्च, 2004 की प्रति सहित उपरोक्तानुसार सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित:-

- 1- वरिष्ठ पुलिस अधीक्षक, अल्मोड़ा।
- 2- मुख्य विकास अधिकारी, अल्मोड़ा।
- 3- प्रभागीय वनाधिकारी, अल्मोड़ा वन प्रभाग, अल्मोड़ा/सिविल एवं सोयम वन प्रभाग, अल्मोड़ा/भूमि संरक्षण वन प्रभाग, रानीखेत।
- 5- संयुक्त मजिस्ट्रेट रानीखेत/समस्त उप जिलाधिकारी, जनपद अल्मोड़ा।
- 6- सूक्तानुसार नामित समितियों के सदस्यगण।

(आलोक कुमार पाण्डेय)
जिला अधिकारी, अल्मोड़ा

ANNEXURE 14

1/2/2025-2025

Annexure - 14

अनुस्मारक-पत्र

महत्वपूर्ण/समयबद्ध

संख्या-711/X-2-2025-21(13)2021 टी0सी0-ई-83762

प्रेषक,
आर0के0 सुधांशु
प्रमुख सचिव,
उत्तराखण्ड शासन।
सेवा में,
समस्त जिलाधिकारी,
उत्तराखण्ड।

वन अनुभाग-2,

देहरादून, दिनांक : 17 अप्रैल, 2025

विषय:- प्रदेश में वनाग्नि की रोकथाम एवं प्रभावी नियंत्रण किये जाने के सम्बन्ध में।

महोदया/महोदय,

उपरोक्त विषयक शासन के पत्रांक 2325/X-2-2023/2022, दिनांक 17.12.2024 का संदर्भ ग्रहण करें, जिसके माध्यम से वनाग्नि सत्र 2025 में वनाग्नि घटनाओं के नियंत्रण/रोकथाम हेतु राज्य के ग्रामीण क्षेत्रों में ओण/आड़ा/केड़ा जलाने की कार्यवाही को 01 अप्रैल के उपरान्त पूर्णतः प्रतिबन्धित करने तथा वनाग्नि सत्र के दौरान रेखीय विभागों का Incident Response System (IRS) गठित करने हेतु विस्तृत दिशा निर्देश निर्गत किये गये हैं। वर्तमान में जनपद पौड़ी एवं पिथौरागढ़ द्वारा ही IRS टीमों का गठन किया गया है।

अतः उक्त के सम्बन्ध में मुझे पुनः यह कहने का निर्देश हुआ है कि अपने-अपने जनपदों के अन्तर्गत वनाग्नि रोकथाम/नियंत्रण हेतु निम्न कार्यवाही अपने स्तर से यथाशीघ्र करना सुनिश्चित करें :-

1. समस्त जिलाधिकारी, रेखीय विभागों की तहसील अथवा ब्लॉक स्तर पर IRS टीम का गठन करते हुए रेखीय विभागों को वनाग्नि नियंत्रण/प्रबन्धन हेतु वन विभाग को पूर्ण सहयोग प्रदान करने हेतु प्रभावी कार्यवाही की जाये।
2. वर्तमान समय में वनाग्नि घटनाओं हेतु संवेदनशीलता के दृष्टिगत ओण/आड़ा/केड़ा जलाने की परम्परा को पूर्णतः प्रतिबन्धित किया जाये। अपरिहार्य परिस्थितियों में यदि नितांत आवश्यक हो तो अनिवार्य रूप से राजस्व उप निरीक्षक/ग्राम पंचायत विकास अधिकारी/ग्राम प्रधान/वन पंचायत सरपंच/ग्राम प्रहरी/आपदा मित्र/वन बीट अधिकारी की उपस्थिति में ही आड़ा फुकान की कार्यवाही पूर्व सूचना देते हुए की जाये।
3. आड़ा फुकान के कारण यदि वनाग्नि की घटना घटित होती है तो ऐसी स्थिति में सम्बन्धित के विरुद्ध वैधानिक कार्यवाही की जाए।
4. वनाग्नि नियंत्रण/रोकथाम हेतु पूर्व में निर्गत आदेशों का अक्षरक्षः पूर्णतः अनुपालन भी सुनिश्चित किया जाये।
5. साप्ताहिक रूप से आप जनपद में सभी सम्बन्धित प्रभागीय वनाधिकारियों के साथ वनाग्नि नियंत्रण/प्रबन्धन की कार्यवाही की समीक्षा अपने स्तर से करते हुए

- आवश्यकतानुसार वन विभाग का पूर्ण सहयोग प्रदान करना सुनिश्चित करें।
6. संकटकाल में वनाग्नि पर नियंत्रण पाने के लिए आपके द्वारा अन्य विभागों के वाहनों को अधिग्रहित कर इन्हें संबंधित प्रभागीय वनाधिकारियों के निर्देशन में वनाग्नि नियंत्रण की कार्यवाही हेतु आवंटित किया जाये।
 7. आपातकालीन स्थिति में एन0डी0आर0एफ0/एस0डी0आर0एफ0 की सेवायें ली जायें।
 8. चिंतित वर्षों में यह पाया गया है कि कुछ शरारती तत्वों द्वारा जानबूझकर या रंजिश में वनों में आग लगायी जाती है। ऐसे शरारती तत्वों को चिन्हित कर उनके विरुद्ध कड़ी वैधानिक कार्यवाही अमल में लायी जाये।

कृपया उपरोक्तानुसार कार्यवाही करते हुए अपेक्षित सहयोग प्रदान करने का कष्ट करें।

संलग्नक-उपरोक्तानुसार।

भवदीय,

Digitally signed by
Ramesh Kumar Sudhanshu
Oa(आर0के0 सुधांशु):54:25

प्रमुख सचिव

संख्या-711 /X-2-2025-21(13)2021 टी0सी0-ई-83762

प्रतिलिपि:- निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित :-

1. पुलिस महानिदेशक, उत्तराखण्ड।
2. प्रमुख वन संरक्षक (HoFF), उत्तराखण्ड।
3. प्रमुख वन संरक्षक, वन्यजीव, उत्तराखण्ड।
4. प्रमुख वन संरक्षक, वन पंचायत, उत्तराखण्ड।
5. अपर प्रमुख वन संरक्षक, वनाग्नि एवं आपदा प्रबन्धन, उत्तराखण्ड।
6. आयुक्त, कुमाऊँ/गढ़वाल उत्तराखण्ड।
7. अपर प्रमुख वन संरक्षक, गढ़वाल।
8. मुख्य वन संरक्षक- कुमाऊँ।
9. महानिरीक्षक, अग्निरामन एवं आपातकालीन सेवायें, पुलिस विभाग, देहरादून।
10. पुलिस उप महानिरीक्षक, एसडीआरएफ मुख्यालय, देहरादून।
11. समस्त वन संरक्षक/निदेशक, उत्तराखण्ड।
12. समस्त वरिष्ठ पुलिस अधीक्षक/पुलिस अधीक्षक, उत्तराखण्ड।
13. समस्त प्रभागीय वनाधिकारी/उप निदेशक, उत्तराखण्ड।
14. गार्ड फाईल।

(आर0के0 सुधांशु)
प्रमुख सचिव

प्रेषक,

संख्या 576/27-1(2)

प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।

सेवा में,

समस्त जिलाधिकारी,
उत्तराखण्ड।

देहरादून, दिनांक 24 जनवरी, 2025।

विषय :- सिविल एवं सोयम/राजस्व वनों के अन्तर्गत वनाग्नि नियंत्रण/प्रबन्धन की प्रभावी कार्यवाही के सम्बन्ध में।

सन्दर्भ:- प्रमुख सचिव, वन एवं पर्यावरण, उत्तराखण्ड शासन का पत्रांक सं० 2325/X-2-2023-21(13)/2022 ई-42348 दिनांक 17.12.2024।

महोदया/महोदय,

प्रमुख सचिव, वन एवं पर्यावरण, उत्तराखण्ड शासन के उपरोक्त सन्दर्भित पत्र द्वारा प्रदेश में वनाग्नि की रोकथाम एवं प्रभावी नियंत्रण किये जाने के सम्बन्ध में विस्तृत दिशा निर्देश निर्गत किये गये हैं। आप अवगत ही हैं कि ग्रीष्मकाल में प्रदेश के वन क्षेत्रों के अन्तर्गत वनाग्नि घटनाएँ घटित होती हैं। इसी कारण प्रति वर्ष 15 फरवरी से 15 जून तक वनाग्नि काल के रूप में घोषित होता है, जब वनाग्नि की घटनाएँ सर्वाधिक होती हैं। वनाग्नि को वर्ष 2003 में राज्य सरकार द्वारा प्राकृतिक आपदा घोषित किया गया है। इस काल में वनाग्नि के प्रभावी नियंत्रण हेतु आपके स्तर से अनेकों प्रशासकीय व वैधानिक कार्यवाही अपेक्षित हैं, जिनका उल्लेख उपरोक्त सन्दर्भित पत्र में किया गया है। इनमें से कुछ प्रमुख अपेक्षित कार्यवाही की में पुनरावृत्ति करना चाहूँगा ताकि आपके स्तर से इन्हें प्रभावी तौर से क्रियान्वित किया जा सके :-

1. पूर्व वर्षों की वनाग्नि घटनाओं के आँकड़ों से स्पष्ट है कि प्रदेश में होने वाली ऐसी घटनाओं का एक बड़ा भाग सिविल सोयम एवं पंचायती वनों में होता है व कई बार इन क्षेत्रों में वनाग्नि की प्रभावी रोकथाम न होने के कारण वनाग्नि आरक्षित वन क्षेत्रों में भी फैल कर बड़ा रूप धारण कर लेती है। उपरोक्त क्षेत्रों का नियंत्रण व प्रबन्धन राजस्व विभाग के अधीन होने के कारण इन क्षेत्रों को राजस्व/पुलिस विभाग के सम्बन्धित कार्मिकों का दायित्व स्पष्ट रूप से निर्धारित किया जाए व इन क्षेत्रों में प्रभावी वनाग्नि शमन व्यवस्था स्थापित की जाए। आवश्यकतानुसार इन क्षेत्रों हेतु राजस्व विभाग द्वारा फायर वाचर या अन्य अतिरिक्त मानव संसाधन वनाग्नि काल के दौरान योजित किये जाएं।
2. राज्य के ग्रामीण क्षेत्रों में ओण/आड़ा/केड़ा जलाने (stubble burning) में लापरवाही होने से वनों में वनाग्नि घटनाओं को रोकने हेतु ओण/आड़ा/केड़ा जलाने की परम्परा को समयबद्ध और व्यवस्थित किया जाना आवश्यक है। यह आवश्यक है कि कम ऊँचाई वाले जिलों में माह फरवरी के अंत तक तथा अधिक ऊँचाई वाले जिलों में यह मार्च के अंत तक ओण/आड़ा जलाने की कार्यवाही पूर्ण कर ली जाए। पुलिस थाना, राजस्व उप निरीक्षक, ग्राम पंचायत विकास अधिकारी, ग्राम प्रधान, वन पंचायत सरपंच, ग्राम प्रहरी, वन बीट अधिकारी के परस्पर तालमेल व सहयोग से ओण/आड़ा/केड़ा जलाने की कार्यवाही पूरी की जाये। 31 मार्च के बाद ओण/आड़ा/केड़ा जलाने की अनुमति विशेष परिस्थितियों में ही दी जाए। ओण/आड़ा/केड़ा जलाने के कारण वनाग्नि घटना होने की दशा में वैधानिक कार्यवाही की जाए। इस सम्बन्ध में आप अपने स्तर से सभी सम्बन्धितों को निर्देश निर्गत करें। वन विभाग द्वारा इस सम्बन्ध में की गई कार्यवाही निम्नानुसार है :-

ओण/आड़ा/केड़ा जलाने की कार्यवाही को समयबद्ध रूप से करने के प्रचार-प्रसार हेतु वन विभाग द्वारा प्रदेश के कई वन प्रभागों के ग्रामीणों/वनाग्नि प्रबन्धन समितियों/महिला मंगल समूहों/SHGS को स्याही देवी-शीतलाखेत क्षेत्र, अल्मोड़ा में भ्रमण हेतु भी माह दिसम्बर 2024 व

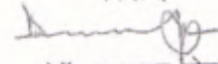
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जनवरी 2025 में ले जाया गया। इस क्षेत्र में वन विभाग के साथ मिलकर स्थानीय ग्रामीणों द्वारा गोण/आड़ा/केड़ा जलाने को 31 मार्च से पूर्व समाप्त करने व वनाग्नि के शमन हेतु सामुदायिक गहल से अपने क्षेत्र के चीड़ बाहुल्य वनों को गत एक दशक से अधिक समय से वनाग्नि से पूर्णतः बचाया है। अब तक प्रदेश के अनेक जनपदों से 700 से अधिक ग्रामीणों को इस क्षेत्र का भ्रमण (exposure visit) कराया गया है व यह कार्यवाही 15 फरवरी 2025 तक चलाते हुए लगभग 1000 ग्रामीणों को भ्रमण कराया जाएगा।

3. जिला स्तर पर आपदा के भांति भी वनाग्नि सत्र में रेखीय विभागों का IRS (Incident Response System) तैयार कर सम्बन्धित अधिकारियों का उत्तरदायित्व निर्धारित किया जाये।
4. प्रदेश स्तर पर चीड़ बाहुल्य क्षेत्रों में स्थानीय महिला मंगल दलों, स्वयं सहायता समूहों द्वारा किये जा रहे चीड़ पिरुल एकत्रीकरण की कार्यवाही को वृहद् पैमाने पर संचालित करते हुए इसका समय-समय पर अनुश्रवण किया जाए। इस कार्यवाही हेतु अपने स्तर से उद्यमियों को चिन्हित करते हुए चीड़ बाहुल्य वन क्षेत्रों में पैलेट्स/ब्रिकेट्स यूनिट स्थापना हेतु प्रयास किए जाएं।
5. आपसे यह अपेक्षा है कि वनाग्नि सत्र में समस्त संबंधित विभागों की साप्ताहिक अथवा पक्षिक बैठक आयोजित करें, जिसमें वनाग्नि घटनाओं की रोकथाम एवं नियंत्रण हेतु की गयी कार्यवाहियों की समीक्षा एवं सम्बन्धितों को आवश्यक निर्देश दिये जाये।
6. प्रदेश के अन्तर्गत प्रतिवर्ष ग्रीष्मकाल के दौरान वन विभाग के वृत्तों/प्रभागों में आवंटित फील्ड कार्यों के उपयोग हेतु उपलब्ध वाहनों का अधिग्रहण न किया जाये। वनाग्नि सत्र के दौरान आवश्यकता पड़ने पर अन्य विभागों के वाहनों को भी वनाग्नि नियंत्रण/प्रबन्धन की कार्यवाही हेतु वन विभाग को उपलब्ध कराये जाये।
7. विगत वर्षों में यह पाया गया है कि कुछ शरारती तत्वों द्वारा जानबूझकर या रंजिश में वनों में आग लगायी जाती है। ऐसे शरारती तत्वों को चिन्हित कर उनके विरुद्ध कड़ी वैधानिक कार्यवाही अमल में लाई जाये।
8. वनाग्नि सत्र से पूर्व आवश्यक वनाग्नि शमन उपकरणों की समूचित व्यवस्था हेतु (एस0डी0आर0एफ0 से वित्त पोषण कराते हुए) कार्यवाही की जाए।
9. वनाग्नि सत्र-2025 के दौरान प्रत्येक जिले में जिला आपदा परिचालन केन्द्र (DEOC) को सम्बन्धित प्रभागीय वनाधिकारियों के मास्टर कन्ट्रोल रूमों से अवश्य जोड़ा जाये एवं यह सुनिश्चित किया जाए कि सभी DEOC राज्य परिचालन केन्द्र (SEOC) तथा राज्य स्तरीय वनाग्नि कमान्ड सेंटर से वनाग्नि घटना की सूचना आदान-प्रदान हेतु सक्रिय रूप जुड़े रहें।

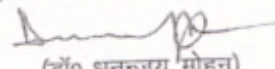
कृपया वनाग्नि नियंत्रण/प्रबन्धन हेतु उपरोक्तानुसार कार्यवाही करते हुए इस आपदा को नियंत्रित करने हेतु अपेक्षित सहयोग प्रदान करने का कष्ट करें।

भवदीय,


(श्री0 धनन्जय मोहन),
प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।

संख्या :- 576 / 27-1(2 / तददिनांकित।

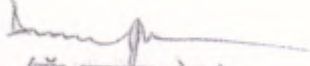
प्रतिलिपि :- वरिष्ठ निजी सचिव, मुख्य सचिव, उत्तराखण्ड शासन को मुख्य सचिव महोदय के संज्ञानार्थ।


(श्री0 धनन्जय मोहन),
प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।

संख्या :- 576 / 27-10) तददिनांकित।

प्रतिलिपि :- निम्नलिखित को सूचनार्थ एवं आपस्यक कार्यवाही हेतु प्रेषित :-

1. प्रमुख सचिव, वन एवं पर्यावरण, उत्तराखण्ड शासन।
2. पुलिस महानिदेशक, उत्तराखण्ड।
3. प्रमुख वन संरक्षक, बन्यजीव, उत्तराखण्ड।
4. प्रमुख वन संरक्षक, वन पंचायत, उत्तराखण्ड।
5. आयुक्त गढ़वाल/कुमाऊँ मण्डल।
6. पुलिस महानिरीक्षक, गढ़वाल/कुमाऊँ।
7. अपर प्रमुख वन संरक्षक, गढ़वाल।
8. मुख्य वन संरक्षक, कुमाऊँ।
9. समस्त वन संरक्षक/निदेशक, उत्तराखण्ड।
10. समस्त वरिष्ठ पुलिस अधीक्षक/पुलिस अधीक्षक, उत्तराखण्ड।
11. समस्त प्रभागीय वनाधिकारी/उप निदेशक, उत्तराखण्ड।


(डॉ० गनन्जय मोहन),
प्रमुख वन संरक्षक (HoFF),
उत्तराखण्ड।

File No. FPD-17/8/2025-FPD-Part (3)
Government of India
Ministry of Environment, Forest and Climate Change
(Forest Protection Division)

Indira Paryavaran Bhawan,
4th Floor, Agni Wing, Jor Bagh Road,
Ali Ganj, New Delhi-110003.

Dated the 14th May, 2025.

To,

The Principal Chief Conservator of Forests & HoFFs
All States/UTs

Subject: Circulation of Scheme on Biomass Utilization - Reg.

Sir/Madam,

Please find enclosed herewith the Scheme on Biomass Utilization as implemented by the State of Uttarakhand. The scheme outlines a structured approach for the collection, processing, and sustainable use of forest biomass with the twin objectives of reducing forest fire risk and promoting livelihood opportunities for forest-dependent communities.

In view of the above, all States/Union Territories & HoFF are requested to take note of the scheme for information and may consider drawing relevant learnings and best practices for possible adoption or contextual adaptation in their respective jurisdictions. Best practices in your state/UT, if any, may also be shared with the Ministry.

Yours sincerely,

Encl.As Above

(Sanjay Kumar Chauhan)
Assistant Inspector General of Forests (FPD)
Email: fpd-moefcc@gov.in

Copy to:

1. PS to DIGF (FPD), MoEF&CC, New Delhi.

$15 - 5 = 10$
 $10 - 5 = 5$
 $5 - 5 = 0$
 $15 - 5 = 10$
 $10 - 5 = 5$
 $5 - 5 = 0$

$$A \subseteq C \subseteq F, F \cdot F$$

प्रमुख वन संरक्षक (HoFF)
उत्तराखण्ड।

ANNEXURE 17

Annexure - 10 17

:: आदेश ::

जनपद पिथौरागढ़ अन्तर्गत वर्ष 2025 में वनाग्नि अवधि के दौरान वनाग्नि के प्रभावी नियंत्रण हेतु आपदा प्रबन्धन अधिनियम 2005 की सुरंगत धाराओं के अन्तर्गत तत्काल प्रभाव से Fire Season तक राजस्व विभाग, पुलिस विभाग, वन विभाग, ग्राम्य विकास विभाग, पंचायतीराज विभाग, अग्निशमन विभाग एवं स्वास्थ्य विभाग की तहसीलवार संयुक्त (Incident Response Team) IRT का गठन निम्नवत् किया जाता है।

S. N.	Tehsil wise IRT	IRT Commander	IRT Team	Area	Department
1	गंगोलीहाट	उप जिलाधिकारी	1 वन क्षेत्राधिकारी गंगोलीहाट	1-गंगोलीहाट से घाट पनार 2-दशाईथल से अग्रोन 3-दशाईथल से राईआगर	वन विभाग
			2 वन दरोगा		
			3 वन रक्षक		
			4 धानाध्यक्ष गंगोलीहाट		पुलिस विभाग
			5 खण्ड विकास अधिकारी		विकास विभाग
			6 ग्राम विकास अधिकारी		राजस्व विभाग
			7 राजस्व उपनिरीक्षक		पुलिस विभाग
			8 ग्राम प्रहरी		वन विभाग
			9 वन पंचायत सरपंच		शिक्षित विभाग
			10 शिक्षित अधिकारी गंगोलीहाट		पंचायतीराज विभाग
			11 ग्राम पंचायत विकास अधिकारी		
2	गण्डाई गंगोली	तहसीलदार	1 उप वन क्षेत्राधिकारी वनकोट / गण्डाई	1-राईआगर से सेराघाट 2-गण्डाई से वनकोट 3-सिमलता से वासीखेत	वन विभाग
			2 वन दरोगा		
			3 वन रक्षक		
			4 चौकी प्रहारी गण्डाई		पुलिस विभाग
			5 ग्राम विकास अधिकारी		विकास विभाग
			6 राजस्व उपनिरीक्षक		राजस्व विभाग
			7 ग्राम प्रहरी		पुलिस विभाग
			8 वन पंचायत सरपंच		वन विभाग
			9 शिक्षित अधिकारी गण्डाई		शिक्षित विभाग
			10 ग्राम पंचायत विकास अधिकारी		पंचायतीराज विभाग
3	धारधूला-1	उप जिलाधिकारी	1 वन क्षेत्राधिकारी धारधूला	1-धारधूला-तवाघाट 2-गलाती-धामीगांव 3-दोघाट-संथी	वन विभाग
			2 वन दरोगा		
			3 वन रक्षक		
			4 पुलिस निरीक्षक		पुलिस विभाग
			5 खण्ड विकास अधिकारी धारधूला		विकास विभाग
			6 ग्राम विकास अधिकारी		राजस्व विभाग
			7 राजस्व उपनिरीक्षक		पुलिस विभाग
			8 ग्राम प्रहरी		वन विभाग
			9 वन पंचायत सरपंच		शिक्षित विभाग
			10 शिक्षित अधिकारी धारधूला		पंचायतीराज विभाग
			11 ग्राम पंचायत विकास अधिकारी		
4	धारधूला-2	तहसीलदार	1 वन क्षेत्राधिकारी अरुणोद	1-जीलजीबी-विमखोला-बलुवाकोट-गलाती 2- बलुवाकोट से पय्यापीड़ी	वन विभाग
			2 वन रक्षक		
			3 धानाध्यक्ष जीलजीबी/बलुवाकोट		पुलिस विभाग
			4 खण्ड विकास अधिकारी धारधूला		विकास विभाग
			5 ग्राम विकास अधिकारी		
			6 राजस्व उपनिरीक्षक		राजस्व विभाग

			7	ग्राम प्रहरी		पुलिस विभाग
			8	वन पंचायत सरपंच		वन विभाग
			9	चिकित्सा अधिकारी, धारचूला		चिकित्सा विभाग
			10	ग्राम पंचायत विकास अधिकारी		पंचायतराज विभाग
5	डीडीहाट-1	उप जिलाधिकारी	1	वन क्षेत्राधिकारी डीडीहाट	1-डीडीहाट से थल 2-डीडीहाट से घर्मा 3-डीडीहाट से आदीचौर, रानीचौत	वन विभाग
			2	वन दरोगा		पुलिस विभाग
			3	वन रक्षक		विकास विभाग
			4	शान्ताध्यक्ष डीडीहाट		राजस्व विभाग
			5	खण्ड विकास अधिकारी, डीडीहाट		पुलिस विभाग
			6	ग्राम विकास अधिकारी		विकास विभाग
			7	राजस्व उपनिरीक्षक		राजस्व विभाग
			8	ग्राम प्रहरी		पुलिस विभाग
			9	वन पंचायत सरपंच		वन विभाग
			10	चिकित्सा अधिकारी, डीडीहाट		चिकित्सा विभाग
			11	ग्राम पंचायत विकास अधिकारी		पंचायतराज विभाग
6	डीडीहाट-2	तहसीलदार	1	वन दरोगा	1-अस्कोट से नारायण नगर 2-अस्कोट जौलजीबी 3-अस्कोट हेलिपद 4-डीडीहाट से कुणिया 5-देविराणा से काजार	वन विभाग
			2	वन रक्षक		पुलिस विभाग
			3	शान्ताध्यक्ष अस्कोट		विकास विभाग
			4	खण्ड विकास अधिकारी, डीडीहाट		राजस्व विभाग
			5	ग्राम विकास अधिकारी		पुलिस विभाग
			6	राजस्व उपनिरीक्षक		वन विभाग
			7	ग्राम प्रहरी		चिकित्सा विभाग
			8	वन पंचायत सरपंच		पंचायतराज विभाग
			9	चिकित्सा अधिकारी, डीडीहाट		
			10	ग्राम पंचायत विकास अधिकारी		
7	बंगामानी	तहसीलदार	1	वन दरोगा	1-तोली (वरग) 2-लुमती-बंगामानी-सेरा 3-वरग-मेतली-कनार-कुरछेत 4-वरग-तेजग 5-वल्ही, गेला से बोना तोगिक	वन विभाग
			2	वन रक्षक		विकास विभाग
			3	ग्राम विकास अधिकारी		राजस्व विभाग
			4	राजस्व उपनिरीक्षक		पुलिस विभाग
			5	ग्राम प्रहरी		वन विभाग
			6	वन पंचायत सरपंच		चिकित्सा विभाग
			7	चिकित्सा अधिकारी मदकोट		पंचायतराज विभाग
			8	ग्राम पंचायत विकास अधिकारी		
			9	पुलिस चौकी प्रहरी मदकोट		पुलिस विभाग
8	मुनस्यारी	उप जिलाधिकारी	1	वन क्षेत्राधिकारी मुनस्यारी	1-मदकोट, हरफांट से मुनस्यारी, 2-मुलाकोट से पाली, लीलम 3-कालामुनी से साईपोलू 4-जोरा दूधमानी	वन विभाग
			2	वन दरोगा		पुलिस विभाग
			3	वन रक्षक		विकास विभाग
			4	शान्ताध्यक्ष मुनस्यारी		राजस्व विभाग
			5	खण्ड विकास अधिकारी, मुनस्यारी		पुलिस विभाग
			6	ग्राम विकास अधिकारी		विकास विभाग
			7	राजस्व उपनिरीक्षक		राजस्व विभाग
			8	ग्राम प्रहरी		पुलिस विभाग
			9	वन पंचायत सरपंच		वन विभाग
			10	चिकित्सा अधिकारी, मुनस्यारी		चिकित्सा विभाग
			11	ग्राम पंचायत विकास अधिकारी		पंचायतराज विभाग
9	तेजग	तहसीलदार	1	वन क्षेत्राधिकारी मुनस्यारी	1- मोडम से सेलमाली	वन विभाग
			2	वन दरोगा		

			3 दन रक्षक	2- गिरीबेण्ड से ताराकोट, नागिक	पुलिस विभाग
			4 खानाभ्यक्ष नाचनी	3- तेजम-नाचनी बाराबमङ्ग	विकास विभाग
			5 चौकी प्रभारी कर्षीटी		राजस्व विभाग
			6 ग्राम विकास अधिकारी		पुलिस विभाग
			7 राजस्व उपनिरीक्षक		वन विभाग
			8 ग्राम प्रहरी		शिक्षित विभाग
			9 वन पंचायत सरपंच		पंचायतराज विभाग
			10 प्रभारी चिकित्सा अधिकारी, तेजम		
			11 ग्राम पंचायत विकास अधिकारी		
10	थल	तहसीलदार	1 वन क्षेत्राधिकारी बेरीनाग	1-हजेती, बरङ, थल	वन विभाग
			2 वन दरोगा	2-उडियासी कोटमन्वा, पाँखू, बरङ	पुलिस विभाग
			3 वन रक्षक		विकास विभाग
			4 खानाभ्यक्ष थल		राजस्व विभाग
			5 ग्राम विकास अधिकारी		पुलिस विभाग
			6 राजस्व उपनिरीक्षक		वन विभाग
			7 ग्राम प्रहरी		चिकित्सा विभाग
			8 वन पंचायत सरपंच		पंचायतराज विभाग
			9 चिकित्सा अधिकारी, थल		
			10 ग्राम पंचायत विकास अधिकारी		
11	बेरीनाग	तहसीलदार	1 वन क्षेत्राधिकारी बेरीनाग	1-बेरीनाग-पुरागाथल, कडैनाथल	वन विभाग
			2 वन दरोगा	2-बेरीनाग से सीटा	पुलिस विभाग
			3 वन रक्षक	3-कालिगिनाथक-जामुवथल-हजेती	विकास विभाग
			4 खानाभ्यक्ष बेरीनाग		राजस्व विभाग
			5 खण्ड विकास अधिकारी, बेरीनाग		पुलिस विभाग
			6 ग्राम विकास अधिकारी		वन विभाग
			7 राजस्व उपनिरीक्षक		शिक्षित विभाग
			8 ग्राम प्रहरी		पंचायतराज विभाग
			9 वन पंचायत सरपंच		
			10 चिकित्सा अधिकारी, बेरीनाग		
			11 ग्राम पंचायत विकास अधिकारी		
12	देवलथल	तहसीलदार	1 वन दरोगा	1-देवलथल से सुकालेख	वन विभाग
			2 वन रक्षक	2- देवलथल से कनालीछीना	पुलिस विभाग
			3 खानाभ्यक्ष थल		विकास विभाग
			4 ग्राम विकास अधिकारी		राजस्व विभाग
			5 राजस्व उपनिरीक्षक		पुलिस विभाग
			6 ग्राम प्रहरी		वन विभाग
			7 वन पंचायत सरपंच		चिकित्सा विभाग
			8 प्रभारी चिकित्सा अधिकारी, देवलथल		पंचायतराज विभाग
			9 ग्राम पंचायत विकास अधिकारी		
13	कनालीछीना	तहसीलदार	1 वन दरोगा	1-कनालीछीना से रातगङ्ग	वन विभाग
			2 वन रक्षक	2- कनालीछीना से बीपली	पुलिस विभाग
			3 खानाभ्यक्ष कनालीछीना	3- कनालीछीना से चर्पा	विकास विभाग
			4 खण्ड विकास अधिकारी, कनालीछीना		राजस्व विभाग
			5 ग्राम विकास अधिकारी		पुलिस विभाग
			6 राजस्व उपनिरीक्षक		वन विभाग
			7 ग्राम प्रहरी		
			8 वन पंचायत सरपंच		

			9	प्रभागी चिकित्सा अधिकारी, कनालीछीना		चिकित्सा विभाग
			10	ग्राम पंचायत विकास अधिकारी		पंचायतराज विभाग
14	पिथौरागढ़-1	उप जिलाधिकारी	1	वन क्षेत्राधिकारी पिथौरागढ़	1-पिथौरागढ़ से घाट	वन विभाग
			2	वन दरोगा	2-ऐचोली से मेलझुंगरी	
			3	वन रक्षक	3- पिथौरागढ़ से बारा	
			4	शानाध्यक्ष पिथौरागढ़	4- घण्डाक से दिगताली	
			5	खण्ड विकास अधिकारी, विम		पुलिस विभाग
			6	ग्राम विकास अधिकारी		विकास विभाग
			7	राजस्व उपनिरीक्षक		राजस्व विभाग
			8	ग्राम प्रहरी		पुलिस विभाग
			9	वन पंचायत सरपंच		वन विभाग
			10	प्रभागी चिकित्सा अधिकारी, इग्यारदेवी		चिकित्सा विभाग
			11	ग्राम पंचायत विकास अधिकारी		पंचायतराज विभाग
15	पिथौरागढ़-2	तहसीलदार	1	वन दरोगा	1-पिथौरागढ़ से नैनीताल	वन विभाग
			2	वन रक्षक	लऊँर	
			3	शानाध्यक्ष जाजरदेवल	2- पिथौरागढ़ से झुलाघाट	राजस्व विभाग
			4	खण्ड विकास अधिकारी, गुनाकोट	3- पिथौरागढ़ से बड़ावे	पुलिस विभाग
			5	ग्राम विकास अधिकारी	4- जाजरदेवल से सुगलेख	वन विभाग
			6	राजस्व उपनिरीक्षक	झुडी	चिकित्सा विभाग
			7	ग्राम प्रहरी		पंचायतराज विभाग
			8	वन पंचायत सरपंच		
			9	प्रभागी चिकित्सा अधिकारी, बडालु/मडमगलै		
			10	ग्राम पंचायत विकास अधिकारी		

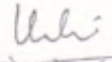
1. पुलिस अधीक्षक पिथौरागढ़ को इस आशय से प्रेषित कि सम्बन्धित क्षेत्रों में पुलिस कर्मों/फायर सर्विसेज कर्मियों को नामित करते हुए उनके नाम, पदनाम, मोबाईल नम्बर इस कार्यालय को 01 सप्ताह में उपलब्ध कराने का कष्ट करेंगे।
2. मुख्य चिकित्सा अधिकारी, पिथौरागढ़ को इस निर्देश के साथ प्रेषित कि अपने स्तर से सम्बन्धित क्षेत्रों में चिकित्सा अधिकारियों को नामित करते हुए उनके नाम, पदनाम, मोबाईल नम्बर इस कार्यालय में 01 सप्ताह में उपलब्ध करावेंगे।
3. प्रभागीय वनाधिकारी, वन प्रभाग पिथौरागढ़ को इस आशय से प्रेषित कि अपने स्तर से सम्बन्धित क्षेत्रों में वन क्षेत्राधिकारियों/वन दरोगा/वन रक्षक को नामित करते हुए उनके नाम, पदनाम, मोबाईल नम्बर इस कार्यालय में 01 सप्ताह में उपलब्ध करावेंगे।
4. सम्बन्धित उपजिलाधिकारी को इस निर्देश के साथ प्रेषित कि अपने स्तर से सम्बन्धित क्षेत्रों में राजस्व उपनिरीक्षक एवं वन पंचायत सरपंचों को नामित करते हुए उनके नाम, पदनाम, मोबाईल नम्बर इस कार्यालय में 01 सप्ताह में उपलब्ध करावेंगे।
5. जिला विकास अधिकारी, पिथौरागढ़ को इस निर्देश के साथ प्रेषित कि अपने स्तर से ग्राम विकास अधिकारियों को नामित करते हुए उनके नाम, पदनाम व मोबाईल नम्बर इस कार्यालय में 01 सप्ताह में उपलब्ध करावेंगे।
6. जिला पंचायत राज अधिकारी, पिथौरागढ़ को इस निर्देश के साथ प्रेषित कि अपने स्तर से ग्राम पंचायत विकास अधिकारियों को नामित करते हुए उनके नाम, पदनाम व मोबाईल नम्बर इस कार्यालय में 01 सप्ताह में उपलब्ध करावेंगे।

उपरोक्त IRT Commander/उप जिलाधिकारी तत्काल अपने परगना अन्तर्गत IRT की बैठक करते हुए वनाग्नि से सम्बन्धित आवश्यक कार्यवाही करना सुनिश्चित करेंगे तथा वनाग्नि से सम्बन्धित सूचनाएँ तहसील स्तरीय कन्ट्रोल रूम में रखे गये रजिस्टर में दर्ज करते हुए सायं 04:00 बजे प्रत्येक दिन जिला आपदाकालीन परिचालन केन्द्र पिथौरागढ़ को भी उपलब्ध करायेंगे।

प्रभागीय वनाधिकारी, वन प्रभाग पिथौरागढ़ समस्त IRT Commander/उप जिलाधिकारियों से समन्वय स्थापित कर साप्ताहिक रूप से वनाग्नि की घटनाओं की समीक्षा करते हुए क्षति एवं कृत कार्यवाही से अधोहस्ताक्षरी एवं शासन को अवगत करायेंगे।

IRT के समस्त सदस्य अपने-अपने क्षेत्रों के ग्राम प्रधान, महिला मंगल दल, युवक मंगल दल, आपदा मित्रों के सम्पर्क में रहेंगे तथा उनके मोबाईल नम्बर एकत्रित करते हुए अपने पास तथा जिला आपदाकालीन परिचालन केन्द्र, पिथौरागढ़ को भी उपलब्ध करायेंगे, जिससे कि सूचनाओं का त्वरित रूप से आदान-प्रदान हो सके।

दिनांक 20 फरवरी 2025


(विनोद गोस्वामी)

जिलाधिकारी/अध्यक्ष,

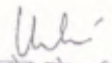
जिला आपदा प्रबन्धन प्राधिकरण,
पिथौरागढ़।

कार्यालय जिला आपदा प्रबन्धन प्राधिकरण, पिथौरागढ़।

पत्रांक 588/तेरह-आपदा/आईओआरटी/2024-25 दिनांक 20 फरवरी 2025

प्रतिलिपि निम्नांकित को सूचनार्थ एवं अनुपालनार्थ प्रेषित।

- 1- प्रमुख सचिव, वन एवं पर्यावरण, उत्तराखण्ड शासन, देहरादून।
- 2- सचिव, आपदा प्रबन्धन एवं पुनर्वास विभाग, उत्तराखण्ड शासन, देहरादून।
- 3- आयुक्त, कुमाऊँ मण्डल, नैनीताल।
- 4- पुलिस महानिरीक्षक, कुमाऊँ परिक्षेत्र, नैनीताल।
- 5- पुलिस अधीक्षक, पिथौरागढ़।
- 6- मुख्य विकास अधिकारी, पिथौरागढ़।
- 7- प्रभागीय वनाधिकारी, वन प्रभाग, पिथौरागढ़।
- 8- मुख्य चिकित्सा अधिकारी, पिथौरागढ़।
- 9- जिला विकास अधिकारी, पिथौरागढ़।
- 10- समस्त उप जिलाधिकारी, जनपद पिथौरागढ़।
- 11- जिला पंचायत राज अधिकारी, पिथौरागढ़।
- 12- समस्त तहसीलदार, जनपद पिथौरागढ़।


(विनोद गोस्वामी)

जिलाधिकारी/अध्यक्ष,

जिला आपदा प्रबन्धन प्राधिकरण,
पिथौरागढ़।

ANNEXURE 18

Annexure - 18

भारत सरकार
भारत मौसम विज्ञान विभाग
मौसम विज्ञान केंद्र
मोहकम्पुर,
हरिद्वार रोड, देहरादून, उत्तराखंड - 248005



GOVERNMENT OF INDIA
INDIA METEOROLOGICAL DEPARTMENT
Meteorological Centre
Mohkampur,
Haridwar Road, Dehradun, Uttarakhand - 248005

उत्तराखण्ड में वनाग्नि के लिए मौसम पूर्वानुमान
Weather forecast for Forest Fire in Uttarakhand

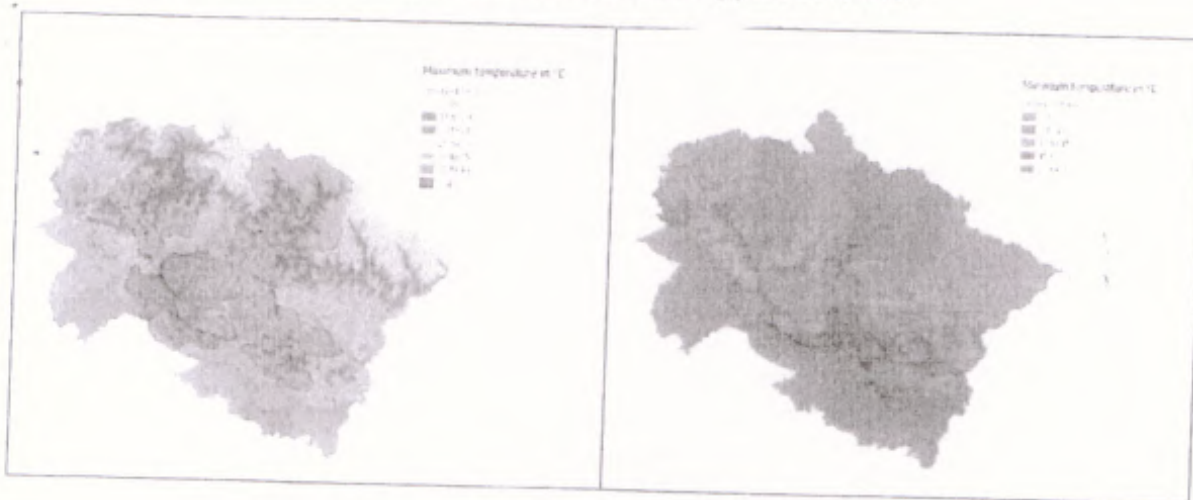
जारी करने की तिथि व समय/ Date & Time of issue:
27th May, 2025 at 14:00 Hours IST

तापमान सारांश/ Temperature Summary

- Maximum temperatures remained below normal to normal in plains and below normal in hills of Uttarakhand. Minimum temperatures remained above normal in plains and normal to below normal in hills of Uttarakhand. Highest maximum temperature 35.1°C was recorded at Pantnagar (U.S. Nagar) and lowest minimum temperature 13.1°C was recorded at Tehri.
- No large change in maximum temperatures during next 48 hours and slightly decrease thereafter.

पिछले 24-घंटों में दर्ज अधिकतम एवं न्यूनतम तापमान:

Maximum and Minimum Temperature observed during past 24-hours:

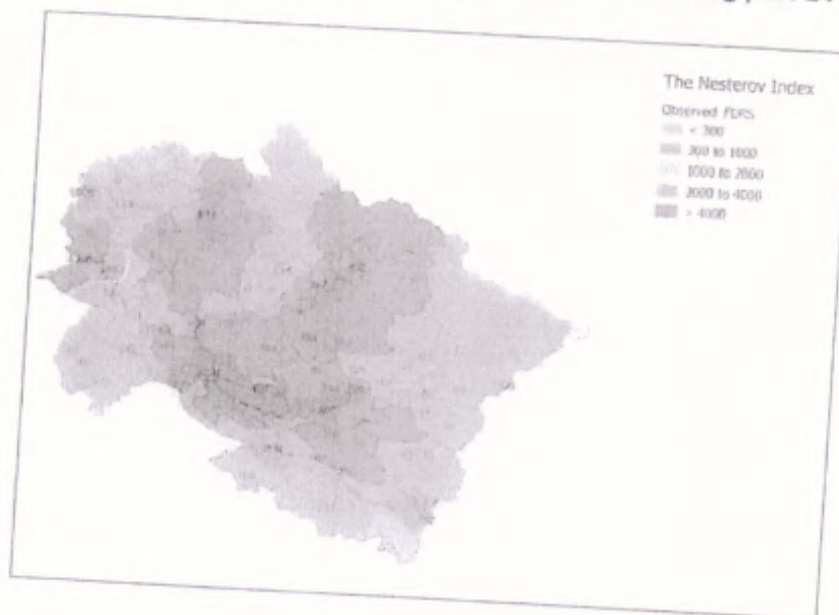


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पिछले 24-घंटो में दर्ज अधिकतम एवं न्यूनतम नमी:
Maximum and Minimum RH observed during past 24-hours:



नेस्टरोव सूचकांक (पिछले 24 घंटों में दर्ज) पर आधारित वनाग्निविभीषिका निर्धारण :
Forest Fire Danger Rating based on the Nesterov Index (observed during past 24-hours):



पिछले 24-घंटो में दर्ज कुल वर्षा:

24-hours accumulated Rainfall observed at 0830 IST (mm):

CHIEF AMOUNT OF RAINFALL (mm):

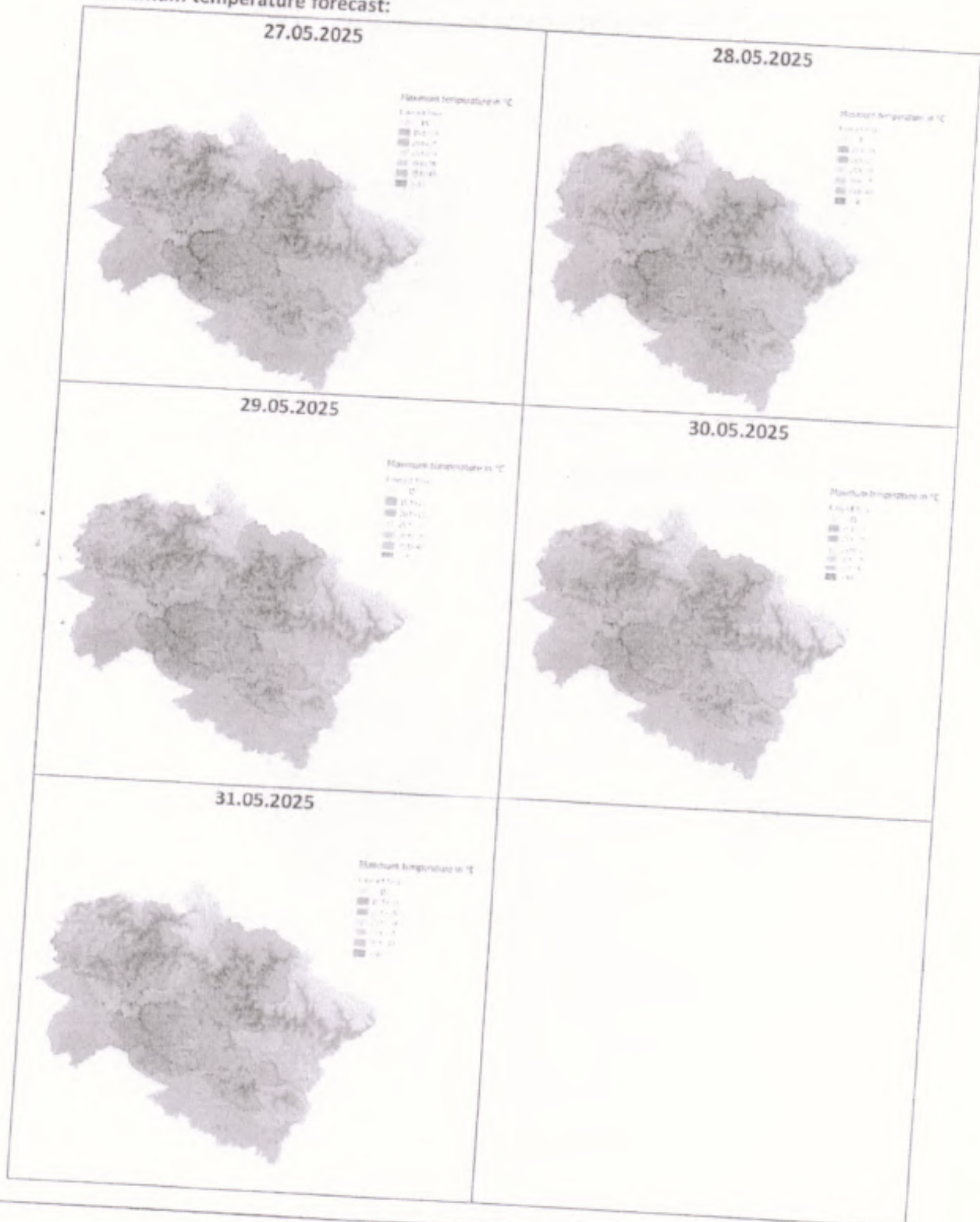
Manual: Tehri-65.8, Koteswar-55.0, Ghansali-45.0, Mori-35.0, Rudraprayag-24.0, Uttarkashi-23.0, Ganganagar-18.4, Maneri-13.0, Ranichauri-11.0, Jakholi-7.0, Dunda-6.0

AWS/ARG: Rudraprayag-16.5, Ranichauri-7.0, Maldevta-4.0



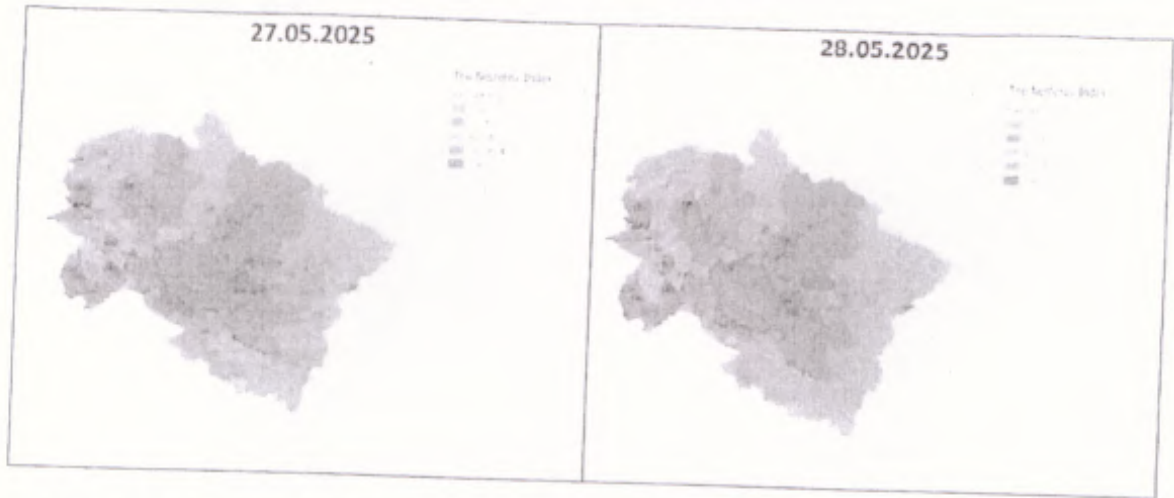
अधिकतम तापमान पूर्वानुमानः

Maximum temperature forecast:

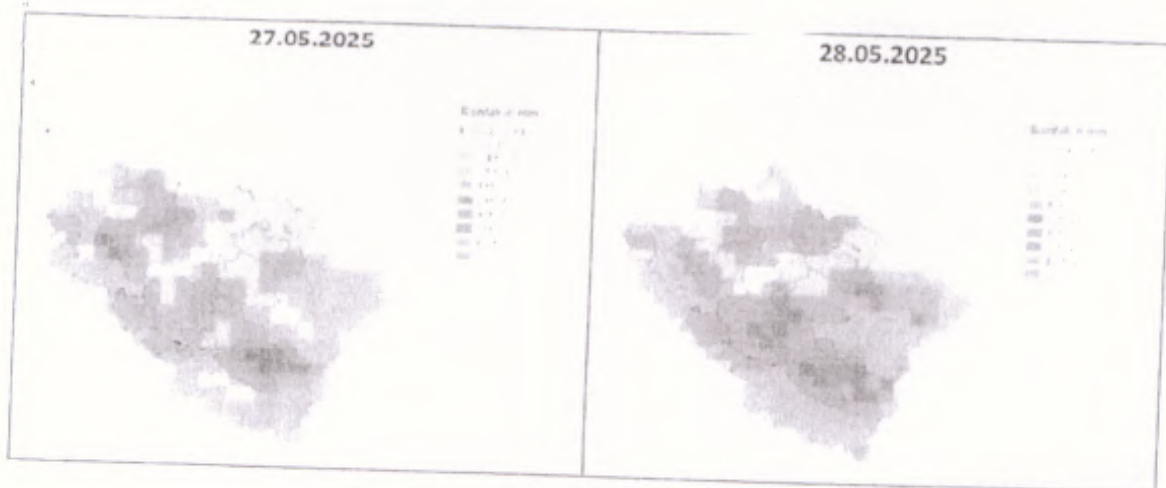


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नेस्टरोव सूचकांक पर आधारित वनाग्निविभीषिका निर्धारण पूर्वानुमान:
Forest Fire Danger Rating Forecast based on the Nesterov Index:



एन.डब्ल्यू.पी. मॉडल-आधारित वर्षा पूर्वानुमान:
NWP model-based Rainfall forecast:



तापमान चेतावनी/ Temperature Warnings: NIL

वर्षा का पूर्वानुमान/ Precipitation Forecast:

मध्यप्रदेश के लिए वर्षा का पूर्वानुमान (दिवस-1 से 7 तक)

आयी कपडो की तिथि: 27/05/2025



Rat-1 (Rat-1)



Rat-2



Rat-3



Rat-4



Rat-5



Rat-6



Rat-7

वर्षा का पूर्वानुमान (%)
कुल वर्षा (अप्रैल-मई)
वर्षा-अप्रैल + 1.25 (1.25)
वर्षा-मई + 1.25 (1.25)
वर्षा-अप्रैल + 1.25 (1.25)
वर्षा-मई + 1.25 (1.25)

वर्षा का पूर्वानुमान (%)
वर्षा-अप्रैल + 1.25 (1.25)
वर्षा-मई + 1.25 (1.25)
वर्षा-अप्रैल + 1.25 (1.25)
वर्षा-मई + 1.25 (1.25)

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Legends

Rainfall:

INTENSITY (mm)		DISTRIBUTION (DISTR)		PROBABILITY OF OCCURRENCE	
VERY LIGHT/बहुत हल्की	TRACE - 2.4 mm	ISOLATED/कहीं-कहीं	ISOLATED (UP TO 25% AREA)	UNLIKELY	Up to 25%
LIGHT/हल्की	2.5 - 15.5 mm	FEW/कुछ स्थान	SCATTERED (BETWEEN 25-50% AREA)	LIKELY	26 to 50%
MODERATE/मध्यम	15.6 - 64.4 mm	MANY/अनेक स्थान	FAIRLY WIDE SPREAD (BETWEEN 50-75% AREA)	VERY LIKELY	51 to 75%
HEAVY/गहरी	64.5 - 115.5 mm	MOST/अधिकांश स्थान	WIDE SPREAD (MORE THAN 75% AREA)	MOST LIKELY	Above 75%
VERY HEAVY/बहुत गहरी	115.6 - 204.4 mm				
EXTREMELY HEAVY/अत्यंत गहरी	> 204.4 mm				

Heavy snow: 64.5 - 115.5 cm (in depth) & Very heavy snow: 115.6 - 204.4 cm (in depth). (As per the new guidelines w.e.f January 1, 2016).
 ☞ Forecast and Warning for a particular day is valid from 0830 hours IST of day till 0830 hours IST of next day.

Distribution	Departure from mean
Markedly Below Normal	-5.0°C or less
Appreciably Below Normal	-3.1°C to -5.0°C
Below Normal	-1.6°C to -3.0°C
Normal	-1.5°C to 1.5°C
Above Normal	1.6°C to 3.0°C
Appreciably Above Normal	3.1°C to 5.0°C
Markedly Above Normal	5.0°C or more

When maximum temperature of a station reaches $\geq 40^{\circ}\text{C}$ for plains and $\geq 30^{\circ}\text{C}$ for hilly regions

(a) Based on Departure from normal

Heat Wave: Maximum Temperature Departure from normal: 4.5 - 6.4°C

Severe Heat Wave: Maximum Temperature Departure from normal: 6.5 - 12°C

(b) Based on Actual maximum temperature

Heat Wave: When actual maximum temperature $\geq 45^{\circ}\text{C}$

Severe Heat Wave: When actual maximum temperature $\geq 47^{\circ}\text{C}$

(c) Criteria for heat wave for coastal stations

When maximum temperature departure is $\geq 1.5^{\circ}\text{C}$ from normal. Heat Wave may be declared if predicted maximum temperature $\geq 12^{\circ}\text{C}$.

When maximum temperature remains $\geq 40^{\circ}\text{C}$

Warm Night: When maximum temperature departure is 4.5 - 6.4°C

Severe Warm Night: When maximum temperature departure is 6.5 - 12°C

1+
Heat Wave

1+
Warm Night