Appendices

Fact sheets posted on the Website

Wildland Fuels Management: evaluating risks and benefits

ALDO LEOPOLD WILDERNESS RESEARCH INSTITUTE

Frequently Asked Questions…

1. What types of information does this process generate?

Inputs…

Information on historic fire weather, existing vegetation and fuels condition is used by a series of existing computer tools (FireFamily+, FARSITE, and FLAMMAP)…

Outputs…

…to build a GIS library of maps that display the expected fire behavior under critical fire weather conditions and resulting effects on different social and ecological values. Specific information includes:

- annual probability of fire from natural and/or human starts (using the BurnPro model)
- likely fire behavior under a spectrum of weather parameters (using FLAMMAP),
- likely secondary fire effects on vegetation,
- likely effect of fire on wildlife targets and information for ES consultations
- areas of uncharacteristic fire severity,
- areas where fire is desirable - move systems towards desired conditions
- priority stands for treatment, and
- areas of ecological feasibility for wildfire use, prescribed fire or mechanical treatment.

Uses …

The map library can be used to:

1. Identify areas where opportunities exist for achieving resource benefits on a wildfire or prescribed fire incident. With better-informed decisions, managers can focus suppression resources where fires pose clear risks, and avoid costly expenditures where fires confer resource benefits.
2. Assist in planning fuels reduction projects by identifying where fire effects are uncharacteristic or undesirable as well as where fire effects are characteristic or desirable.
3. Provide critical information for Land/Resource Management Plans by quantifying and mapping areas of risk and benefit under various fire weather situations in the present and in the future.
4. Monitor and report progress towards land management goals.

For more information contact: Anne Black, 406-329.2126, aeblack@fs.fed.us
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Project overview...

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Featured Projects

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Frequently Asked Questions…

2. How can this information be used?

Overview… From the Map Libraries* numerous decision-support products can be developed. Here, we describe three –

1. Planning (Long-term, Broad-scale): simulation of future landscape conditions under alternative management scenarios.
2. Fire Management Plan (Mid-term, Broad-scale): WFU fire management units derived from generalized benefits maps.
3. Incident Support (Short-term, Fine-scale): map of maximum fire perimeter and indicating areas of opportunity, benefit and values at risk.

*Map Libraries contain fire behavior and associated fire effects maps for a suite of fire management weather conditions.

1. Future landscapes…

Landscape Dynamic Simulation Models are used to generate information on the effect of various long term fire and land management strategies on: wildlife, aquatic resources, vegetation, future fire risk and behavior, and other parameters within the map libraries. Here we show treatment areas, resulting fire behavior and resulting fire behavior as a function of the 'natural fire behavior' for a single decade.

These analyses help managers and the public understand the opportunities, consequences, and feasibility of various land, fuel and fire management strategies.

2. Fire Management Plan…

The map libraries can also be used to support development of Fire Management Plans. In this example, we calculated the percentage of each subwatershed (6^{th} HUC) in a) low severity fire under moderate fire weather conditions and b) active crown fire under severe fire weather conditions. Subwatersheds with a high percentage of lands in a) and low percentage in b) we classed as candidates for Wildfire Use zones. These subwatersheds could be used to summarize benefits and risks from the map library; with the resulting maps and analysis included in the Fire Management Plan. This identification of fire management strategies sensitive to both social and ecological values.

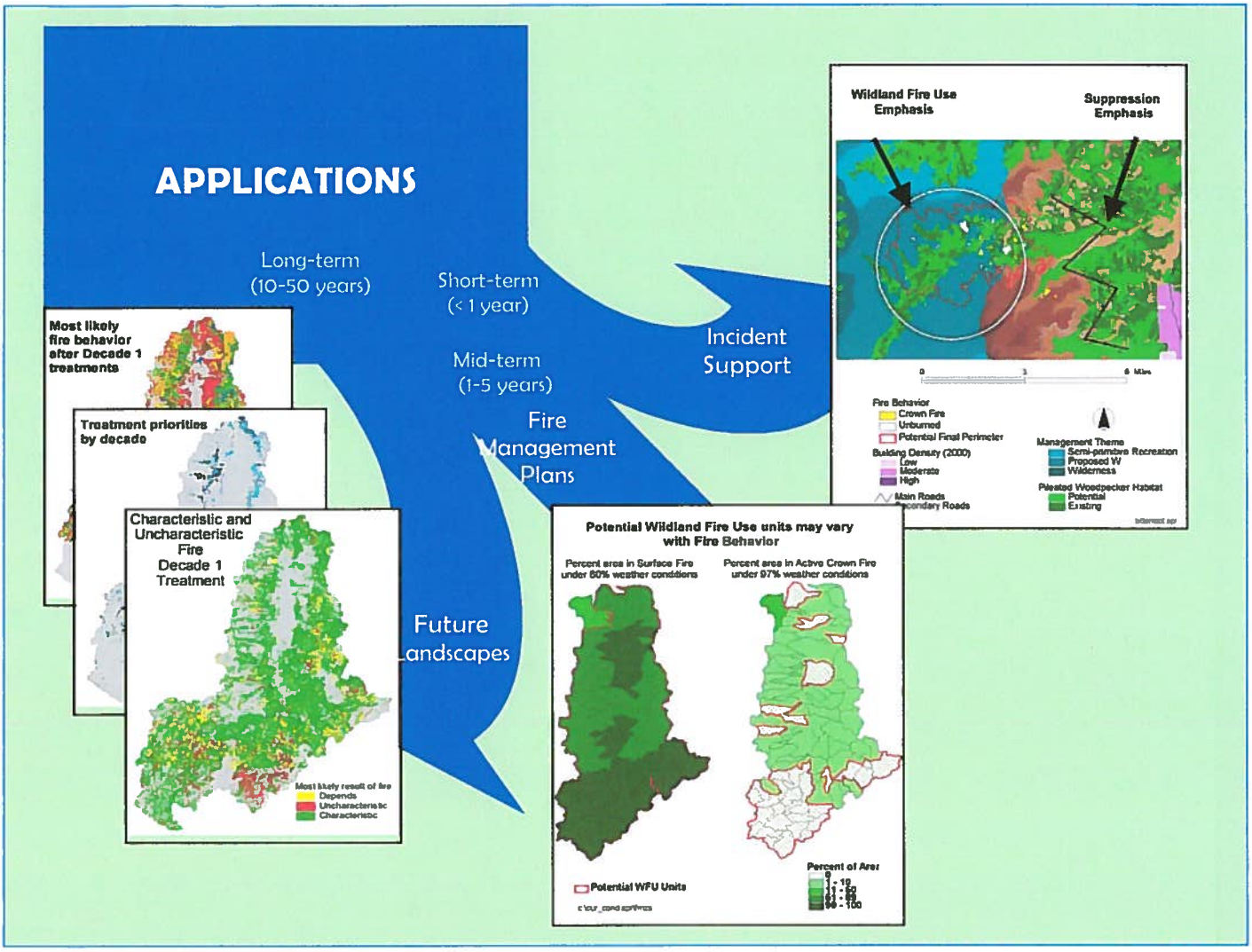
A similar type of analysis, in conjunction with fuels and social data could be used to help prioritize stands and areas for prescribed fire.

3. Incident Support…

Map libraries of fire effects provide important information for incident support.

a. Cost containment may be assisted by overlaying predicted fire perimeters on predicted effects maps for the extant fire weather conditions.

b. Identification and quantification of non-monetary benefits, such as changes in Condition Class or habitat restoration, is quick and easy making integration into a Go/No-Go, WFIP, or WFSA practical.



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FEATURED PROJECTS
Leopold Institute

Wildland Fuels Management: evaluating risks *and* benefits

http:leopold.wilderness.net/research/fprojects/F001.htm

Wildland Fuels Management: evaluating risks and benefits

Frequently Asked Questions…

3. How can I quantify benefits from fire?

The Process…

To answer this question, you first need to define 'benefit'. Benefits may be monetary or non-monetary. Monetary benefits are most likely to result from reduced future management or fire suppression efforts and costs than from the sale of a commodity. Quantification of monetary costs is outside the scope of this project, but several methods in development may assist. One of these uses the SIMPPLLE landscape dynamic simulation model. If you provide SIMPPLLE with realistic costs of treatment and fire suppression, you can compare 'life-time costs' associated with different fire and fuels treatment strategies.

We define nonmonetary benefits as the number of acres that will be moved towards or into a more desirable condition based on reference to the area's targets found in long-range plans, Fire Management Plans, monitoring plans and other targets, such as management indicator species. Undesirable effects are those resulting in movement away from target conditions.

Remember to quantify and summarize desirable and undesirable effects over the same areas as identified and used in planning and monitoring docuements. For instance, on the Bitterroot National Forest, old growth targets are set for 3rd order watersheds, thus, when calculating benefits, summary must occur by 3rd order watershed and compare potential effects to existing and desired future conditions.

Benefits may be quantified for any scale of interest. Here, we illustrate nonmonetary benefits –

1. at a landscape scale under existing conditions,
2. at an incident level under existing conditions, and
3. at a landscape scale in the future.

The following illustrations are subset from posters which appear in full on the project website: http://leopold.wilderness.net/research/fprojects/F001.htm.

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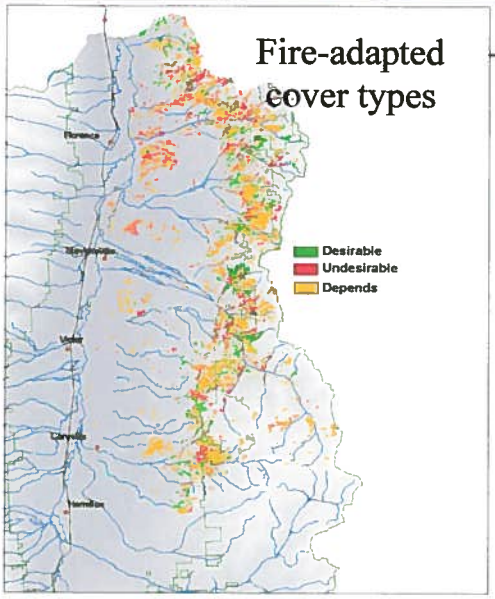
1. Illustration of benefits at a landscape scale under existing conditions.

Potential Fire Effects Library — Effects Quantification

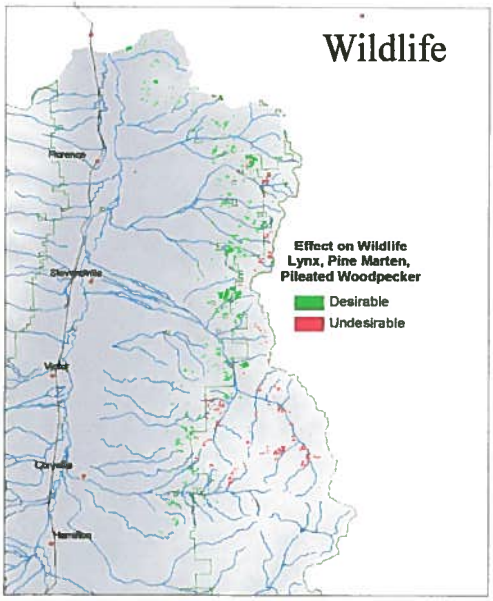


CELLS	EFFECT	HECTARES
18,544.00	Depends	15,020.64
2,531.00	Desirable	2,050.11
2,594.00	Undesirable	2,101.14

This layer indicates where fire under typical 'High' fire weather conditions moves stands of early-seral forest species toward or away from Desired Future Conditions or Processes. Probable fire severity was compared to the fire tolerance of cover type and structural class. Because surface fires in these systems are expected to maintain valued attributes of the overall system, they are coded as '*Desirable*'. Stands were coded '*Depends*' if the probable fire type was passive crown fire, and *Undesirable* if the probable fire type was active crown fire.

Users may also determine 'Characteristic' vs.Uncharacteristic' fire behavior/fire effects.

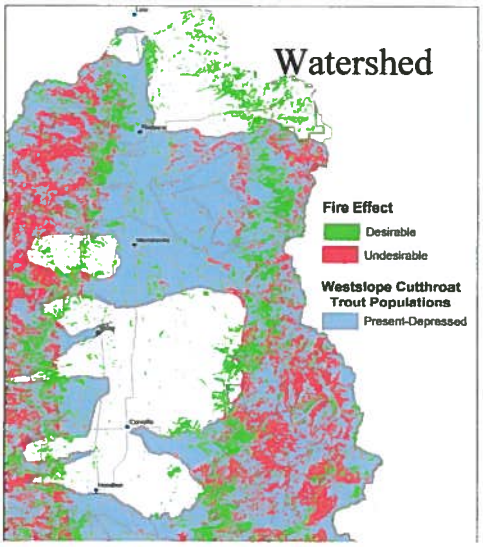
A complete map library will include similar maps for the full suite of fire weather conditions.



CELLS	EFFECT	HECTARES
1,713.00	Desirable	1,387.53
466.00	Undesirable	377.46

In this step, effects on wildlife under 'High' fire weather conditions are mapped. In most cases effects will flow from changes in habitat quantity, arrangement, and quality. Effects determinations may be made using a either a rule-based crosswalk or a quantitative model based on species-habitat relationships. Again, a full map library will include similar maps for all species of interest and fire weather conditions.

Colored areas at left indicate desirability of fire effects under high fire weather conditions on Lynx, Pine Marten or Pileated Woodpecker.

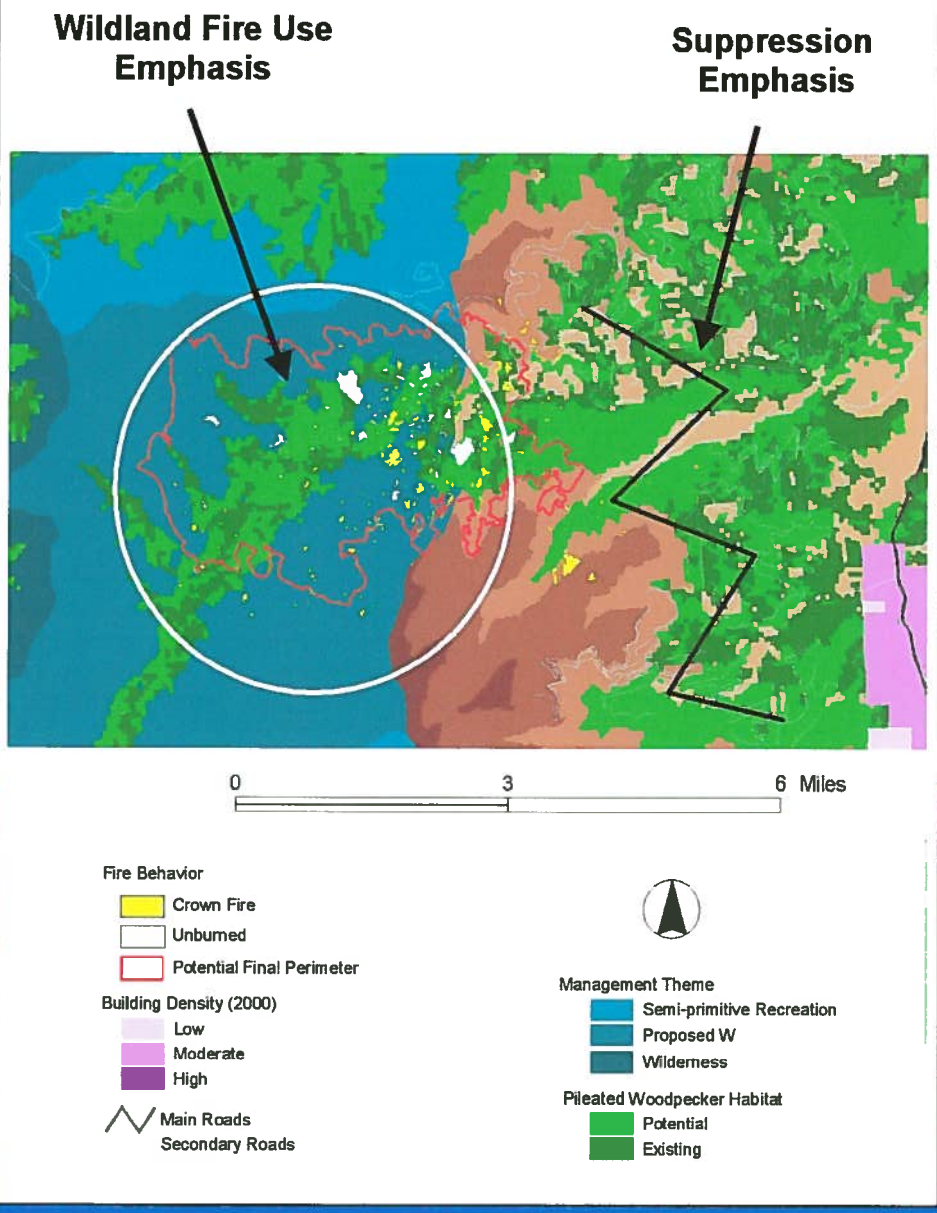


CELLS	EFFECT	HECTARES
399,239.51	Desirable	323,384.00
48,419.75	Undesirable	39,220.00

In a similar fashion, effects on aquatic systems are determined – either through identifying physical changes in the system and tying this to the Desired Future Conditions, or by determining the ultimate effect on species of interest.

In this example, *Desirable* effects occur on areas that will most probably have minimal effect on vegetation and in areas of low erosion potential. *Undesirable* effects are identified for areas that will most probably burn with a severe effect on vegetation and in areas of moderate erosion potential. These are overlain on a map indicating population status of Westslope Cutthroat Trout

2. Illustration at an incident level under existing conditions.



At the incident level, many types of benefits may be calculated, including:

* benefits to resources
* reduction in fuels hazard
* increased future fire fighter safety
* cost containment
* changes in Condition Class

Incident Support

Here, we've overlain a probable final fire perimeter (MMA may also be used) generated in FARSITE onto crown fire potential under similar conditions generated in FLAMMAP, land use, structure density, and habitat for a Management Indicator Species.

Quantification of non-monetary benefits is quick and easy when the map libraries are created during the off season and available in digital and paper form. These may be integrated into a Go/No-Go, WFIP, or WFSA practical. Outputs include maps and tables of acreages.

Life-of-fire fiscal benefits derive from targeting suppression efforts to areas ecologically and/or socially 'at risk'. Longer-term fiscal benefits derive from reducing risk from future fires.

3. Illustration at a landscape scale in the future.

Future benefits and risks of fire are determined by using a Landscape Dynamic Simulation Model to simulate future conditions under different management scenarios.

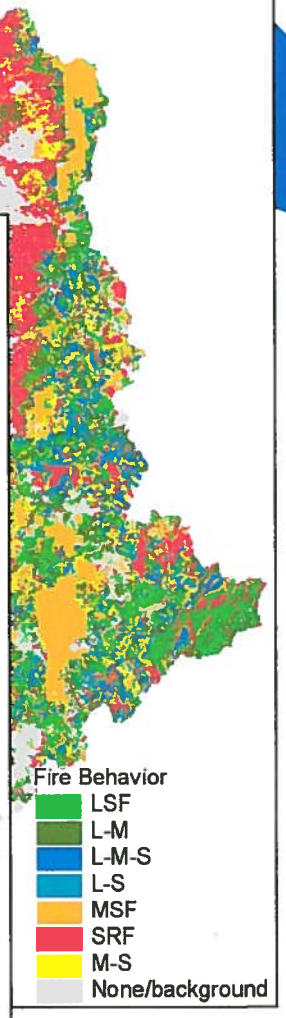
Here, we scheduled fuel treatment in dense stands of Ponderosa Pine and Douglas-fir. We calculated the most likely fire behavior (L, LSF = light severity fire; M, MSF = Mixed severity fire; S, SRF = Stand Replacing Fire; and mixes of these. Mixes occur because our landscape model determines behavior based on the type of fire in the upwind stand). 'Characteristic' and 'Uncharacteristic' fire behavior was determined by comparing stand composition with fire behavior. Stand replacing fires in grasslands and shrublands are characteristic in this system. 'Depends' refers to stands for which finer scale information is necessary for classification.

Alternatives Analysis

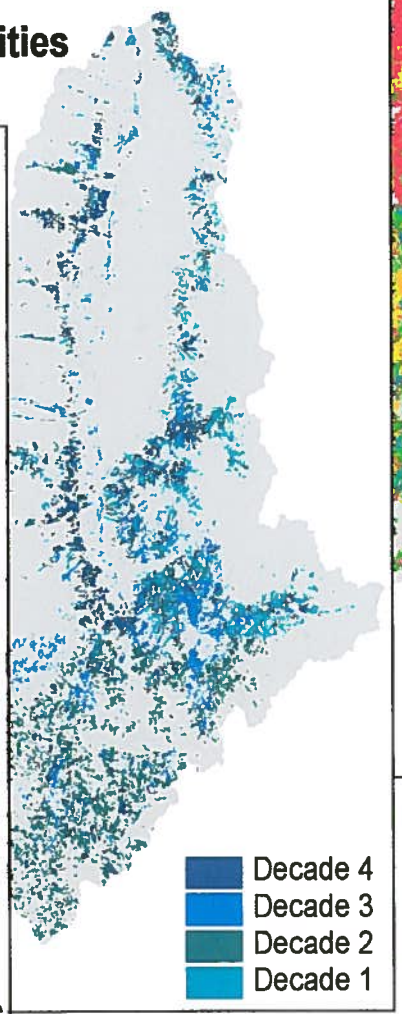
Similar maps are generated for wildlife, aquatic resources, future fire risk and behavior, and other parameters within the map libraries. Benefits and risks are quantified by comparing output maps with Desired Future Conditions.

Analyses help managers and the public understand the opportunities, consequences, and feasibility of various land, fuel and fire management strategies.

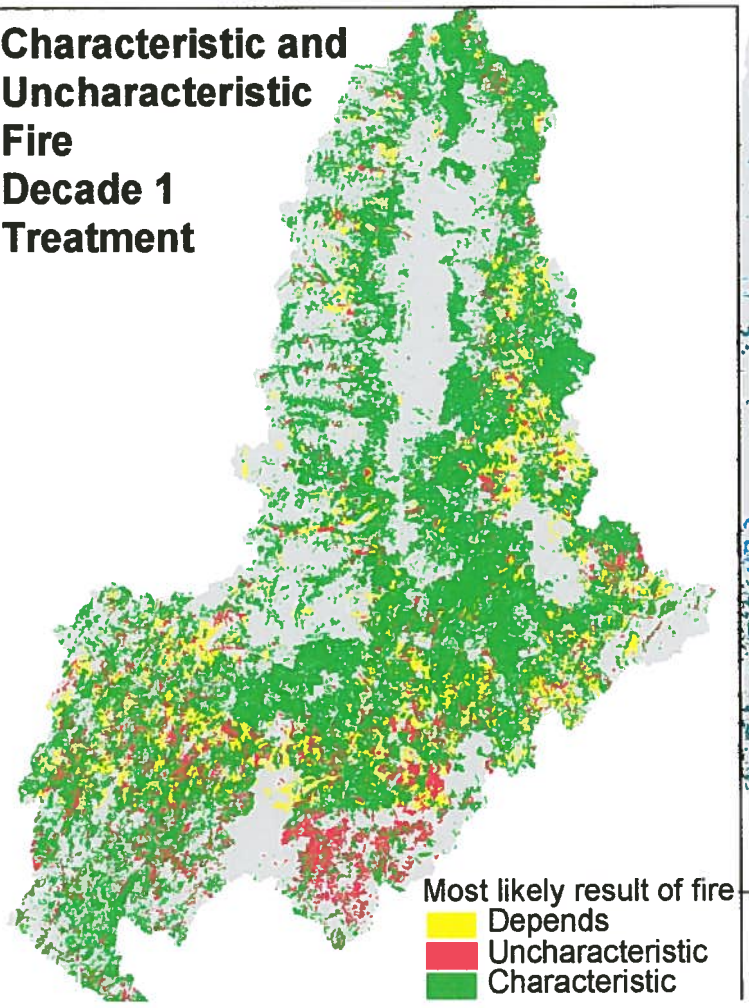
Most likely fire behavior after Decade 1 treatments



Treatment priorities by decade



Characteristic and Uncharacteristic Fire Decade 1 Treatment



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Frequently Asked Questions...

4. How can I identify opportunities to burn?

Overview...

To answer this question you first need to define 'opportunity'. In this example, we define 'opportunity' to mean areas and conditions in which the predicted effects of fire are 'characteristic' - within the natural range of variability for that stand structure, composition, and site condition. Our target condition is restoration of fire to fire-adapted ecosystems; thus, a 'beneficial' effect, defined as movement into or towards a desired condition, is synonymous with 'characteristic'.

The resulting maps indicating areas and conditions for beneficial effects will provide useful information for defining appropriate management responses, codifying these in Land/Resource Management Plans and in Fire Management Plans.

Required inputs...

You will need 3 types of inputs: a) fire behavior maps for a suite of weather conditions (generated previously in the protocol); b) a crosswalk that remaps fire behavior in terms of 'characteristic' or 'uncharacteristic' effects on your species or process of interest; and c) a map of locations of the target species or process.

General process...

To find where fire will most likely always be of benefit to the resource of interest, query through all fire behavior maps (low, moderate, high, very high, extreme). Most probably, you will be most concerned about realistic WFU or Rx conditions (such as under moderate to high conditions). For either case, apply the crosswalk to the fire behavior maps then query for the polygons or grid cells that are coded as 'characteristic'.

In this illustration (click on map), in addition to a positive/negative declaration, there is also a 'depends' category. This arises from the polygons modeled as supporting a passive crown fire. We classed them as 'depends' because the level of stand detail in the base datasets did not provide us sufficient information to confidently determine whether there would be crowing and if so, if the crowing would be sustained or patchy. More site-specific information - from plot data or experience - are needed to refine the prediction.

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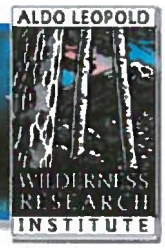
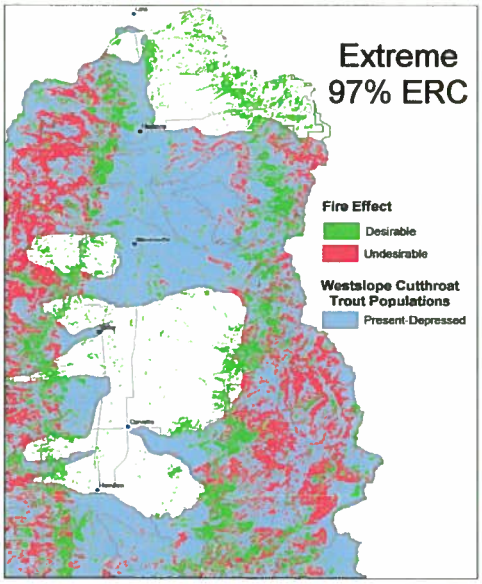


Frequently Asked Questions…

5. How can I identify areas of potential ecological damage?

Overview…. Potential ecological damage is determined in the same step as determination of potential opportunities. For both, you will need to define 'damage' (and benefit) for your system of interest. In our work, we equate 'damage' with 'risk', and define both 'damage' and 'benefit' in terms of the land management goals for that area. For the Bitterroot National Forest, our demonstration site, the goal is to manage stands within their normal range of variability. Thus, damage occurs mainly from 'uncharacteristic' fire, defined as a fire that is outside the normal range of behavior for a given stand structure and composition. Whatever set of conditions you choose, the key is in the creation of the crosswalk table that defines (remaps) each fire behavior class in terms of your criteria - desirable/undesirable, characteristic /uncharacteristic, acceptable/unacceptable.



Inputs… Producing a map (or map library) of potential ecological damage requires 3 inputs:

1. fire behavior map(s) based on threshold fire weather conditions,
2. a crosswalk that remaps fire behavior in terms of effects on your species or process of interest, and
3. a map of locations of the target species or process.

Process… Once you have the inputs, you can identify areas of potential ecological damage for a specific fire weather condition or across multiple fire weather conditions. To find where fire will likely cause ecological damage, use GIS to apply your crosswalk to the appropriate fire behavior-fire weather maps then query for the polygons coded for 'damage'. To identify where fire under any conditions will pose risks, query through all fire behavior maps (low, moderate, high, very high,extreme) at once.

Illustration… Here, we show probable fire effects on Westslope Cutthroat Trout under a single fire weather condition (Extreme, defined as 97th percentile Energy Release Component). Fire effects were determined by identifying physical changes from fire then evaluating this in light of Desired Future Conditions. 'Desirable' effects occur in areas that will most probably have minimal effect on vegetation and in areas of low erosion potential. 'Undesirable' effects are areas that will most probably burn with a severe vegetation effect and in areas of moderate erosion potential. In this example, These are overlain on a map indicating population status of Westslope Cutthroat Trout.

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6. How can I aggregate or balance conflicting management goals?

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Decision Support …

Undoubtedly, during the planning or implementation process, conflicts between opportunities, risks and constraints will arise. There are a variety of well-documented strategies available that can be used to rationalize and document these difficult balances. In addition, there are existing tools that might be adaptable for your uses. Check to see if internal procedures might already be in place that you can plug into. The Nature Conservancy's program SITES is one such possibility. This is an optimization tool for biodiversity planning, so finds the set of areas that offers the best solution given a set of user-defined criteria on targets and constraints (such as cost) and the relative importance of those targets and constraints. Another program, Asset Analyzer, was originally developed by the California Department of Forestry for use in fire planning. The tool was adapted for use across the southern Sierra's by the Southern Sierra Geographic Information Center and can be found on their web site.

In general, one must assign weights to each input layer (ecological targets and constraints) that reflect the preferences of the decision-makers – be they the public for long-range planning alternatives, the management team charged with developing the Fire Management Plan, the line officer responsible for making the go/no go decision, or the incident commander in charge of tactics and strategies. One can then use economic theory or sum the weighted values to arrive at a determination of overall priority. Interpretation of the resulting maps can be challenging.

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7. How can I use this process to prioritize treatments?

Overview...

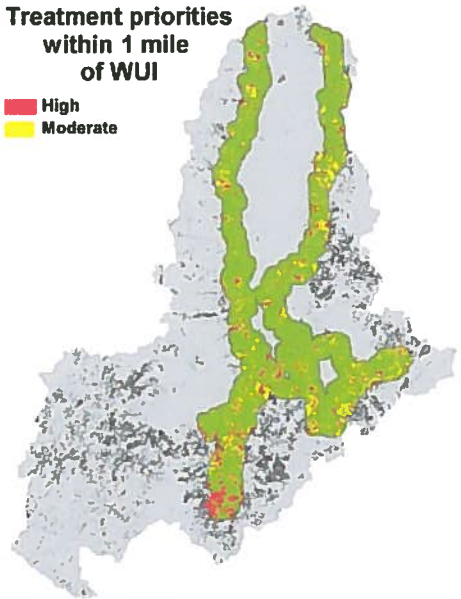
Data used to address prioritization is the output from the effects determination (see sheets 4 and 5). Criteria for determining priority must be established locally. Here we identify priority areas using three criteria,

1) forests at risk of uncharacteristic fire - Ponderosa Pine, Douglas-fir, and Western Larch in danger of crown fire,
2) WUI areas - areas within 1 mile of the residential zone; and
3) critical wildlife habitat -areas of high erosion hazard within watersheds currently containing westslope cutthroat trout.

Our illustrations show the convergence of high crown fire danger and WUI in one map, and high crown fire danger and wildlife in another. Most likely, you will apply several criteria then use a weighting or ranking system to combine the criteria maps to arrive at a final solution.

Treatment options vary by fire effects. Where fire is likely to result in characteristic effects under low to normal weather conditions, prescribed fire or even Wildland Fire Use may be an option. Mechanical treatment is necessary prior to reintroduction of fire in areas where fire effects are likely to be uncharacteristic effects under any weather conditions.

There are several approaches to prioritization. Identify existing stand conditions where fire effects are likely to be undesirable, then overlay other criteria onto these to find convergence (Figure 1). Use a simulation model to test the results of treating stands identified and determining the future conditions – fire behavior, cost, etc.



Simulation model...

We began by identifying stand structure conditions meeting our cover type criteria (dense, multi-story stands), then selecting and exporting these records from our GIS vegetation cover. We used this list to create an input file for SIMPPLLE.

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Project overview...

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Wildland Fuels Management: evaluating risks and benefits

ALDO LEOPOLD WILDERNESS RESEARCH INSTITUTE

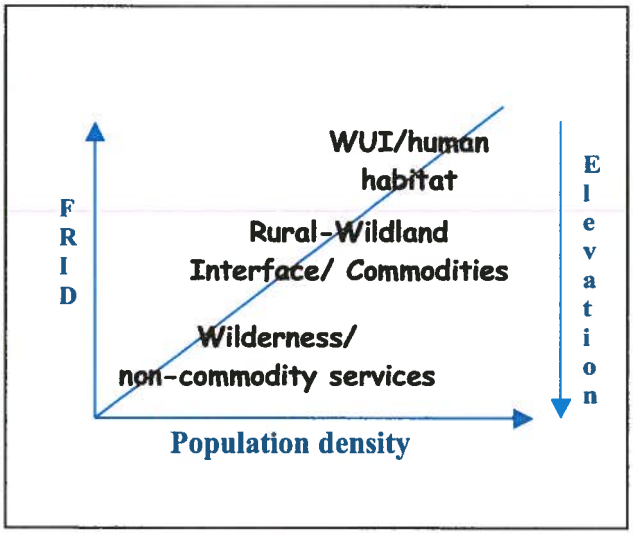
Frequently Asked Questions…

8. Where is fire a realistic management tool for meeting National Fire Plan and federal fire policy goals?

Three hundred ninety-seven million acres of land in the US have been identified as in need of treatment to reduce hazardous fuel loads. Key methods include mechanical treatments and/or fire (prescribed or Wildland Fire Use, respectively management- or naturally-ignited). Mechanical treatments are generally more expensive than fire treatments, but will be the only acceptable treatment in a number of areas. Understanding where fire may be the most effective and efficient treatment can help managers and the public develop a financially sound and ecologically sustainable fuels plan. Fire is a social as well as a biophysical process. In order to understand where fire may be a realistic management tool one must consider the complex relationships, and restraints imposed by those relationships, between current land uses, fire regimes and fire protection goals. The following suite of graphics illustrates one such characterization of these relationships and the resulting conditions and general areas under which fire is realistic.

For this thought experiment, we made the simplifying observations that 1) fire frequency generally decreases with elevation (fire return intervals increase); and 2) fire suppression - as a function of ignitions, access, priority and effort - has had greatest success at lower elevations as well. Departures from the natural fire return interval (FRID), then, are generally highest at lower elevations. Urban areas and agricultural lands are not discussed because they are longer subject to a fire regime characterized by a particular frequency and playing a predicable and significant role in ecosystem structure and function.

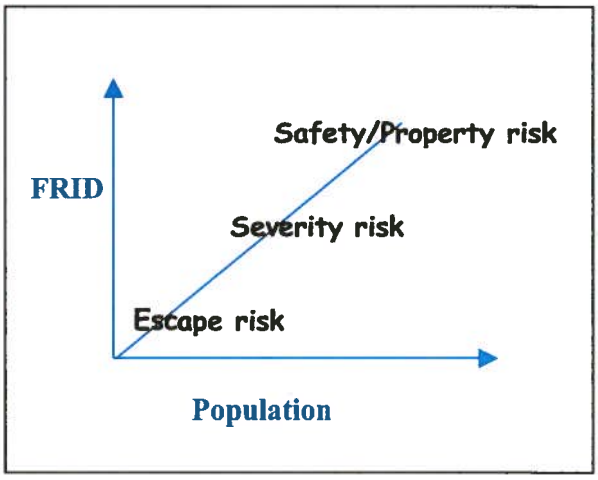
How are humans and land uses arrayed on the landscape?



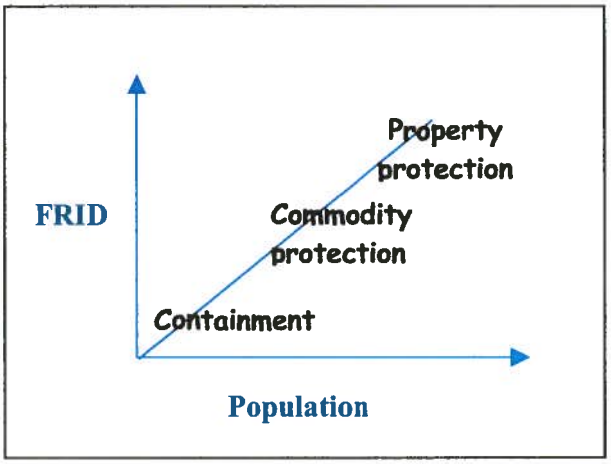
When you array human land uses along the FRID/Elevation axis you notice a stratification along population density spectrum as well. Population density is generally highest in the Wildland-Urban Interface as urban areas expand into adjacent forests, farm and rangelands. The primary use of these lands is as human habitat. Rural areas, with less population density, are characterized by commodity production – timber, forage, cattle, etc. Wilderness areas, where residential human development is prohibited, produce non-commodity resources such as water and recreation. FRID tends to be highest where human density is greatest.

How are fire risks arrayed on the landscape?

Risk from fire differs along a similar trajectory: Property and lives are at risk in the most densely populated areas and where FRID is greatest. The connection to FRID is due to increased fuel loads which can thwart fire control efforts, while producing much more severe effects. Where departures from natural fire regimes are less and where there are fewer people, the main risk are from damage to resources due to fire severity. In Wilderness and other remote areas, there is little risk to property and lives, and since fire regimes may well still be within the natural cycle, the main risks are of the fire escaping onto other lands.



How are fire management goals arrayed on the landscape?

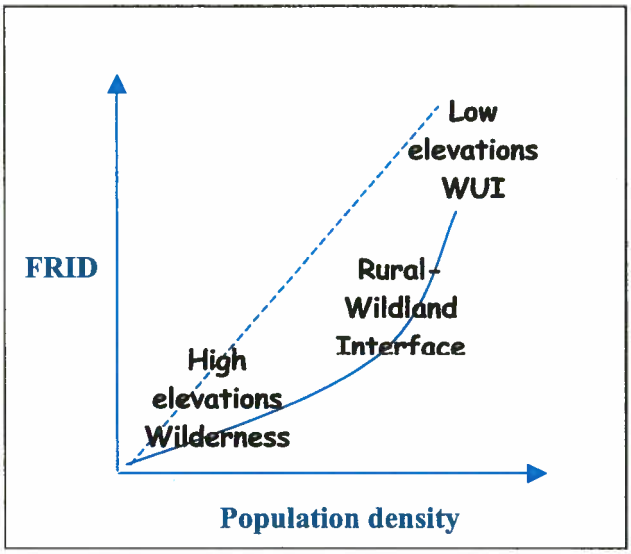


Goals for fire management follow closely on landuses and risks: protection of lives and property in the WUI, protection of commodities and future capacity in the RWI, and containment of fire within areas with few people or commodities of value.

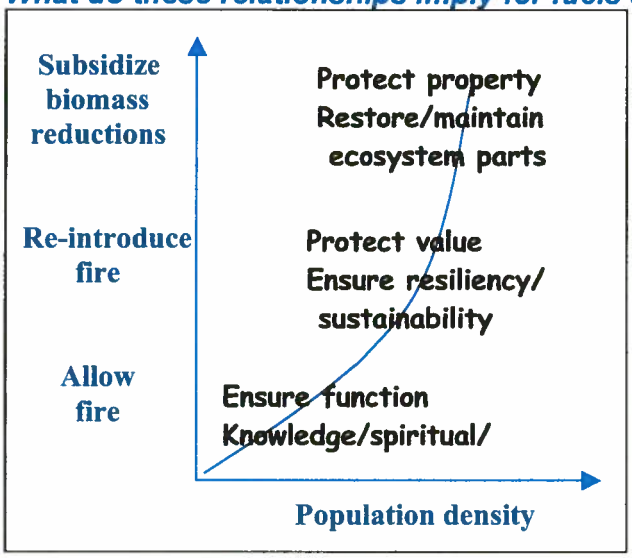
Where are the most realistic opportunities for using fire to meet NFP goals?

Given these constraints, where might the use of fire - the least expensive way to treat fuels accumulations over large areas – be most appropriately used to meet national policy goals?

There is an intuitive conversion of social, economic, and ecologic factors in the rural-wildland interface, particularly where existing fuel loads do not place the economic and ecologic systems at risk. This area has a relatively low population density but a generally a significant access infrastructure. Holdings are often large making coordination easier.



What do these relationships imply for fuels and fire management?



Accepting such a conclusion leads to several implications about the priority and type of fire management strategy.

Where population densities are high, where risks to life and property occur, or fuel loads are unnaturally high, fire management must subsidize fuels and biomass reductions.

Where fuel loads are within reach of natural variability and where risks from severe fire may be mitigated, new fire management priorities should focus on re-introducing fire and re-establishing a natural fire regime.

Where fuels are within the range of natural variation and the risks to life are low, pursue policies that allow fire to play its natural role, ensuring sustainable ecosystem function and the suite of human values and services these areas provide.

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Wildland Fuels Management: evaluating risks and benefits

Frequently Asked Questions…

9. What information do I need in order to use this process?

Project overview…

We have developed a process that allows managers to systematically determine where and under what conditions fire may create benefits or pose threats to identified ecological conditions or management targets. An important feature of this protocol is that fire effects are expressed in terms meaningful to both fire and resource staff. The process is spatially explicit (ArcView and/or ArcMap); uses existing, local datasets; incorporates the latest fire and vegetation research; provides model defaults to facilitate adaptation to local conditions; and generates information for a variety of planning scales from long-range to site-specific.

Required Data Inputs…

To develop a map library of **fire behavior**, you will need all the data requirements necessary for FLAMMAP and/or FARSITE. This includes:

- Daily fire weather data. This is processed through FireFamilyPlus to generate values for threshold fire weather conditions (80^{th}%, 90^{th}%, 97^{th}%, 99^{th}%) for Energy Release Component or the parameter local fire officials use to determine safe tactics. This information is then used to produce wind and weather files for running FLAMMAP.
- Digital DEM and fuels data. These include a fuel model - using Anderson Fire Behavior Fuel Models or other system capable of integrating into FARSITE; canopy fuels data (including stand height, crown closure, crown base height, crown bulk density); and digital elevation models for calculating separate grids of aspect, slope, elevation.

To develop a map library of **fire effects**, you will need

- Digital vegetation data. We used satellite imagery classified at 30m, supplemented by stand data to create datasets indicating both stand structure and composition.
- Additional digital data. Additional data may be necessary to predict probable locations of management indicators or resource targets. Examples might be aspect, elevation, precipitation, soils, or aquatic data.
- Maps for each management indicator or resource target of interest. Rules are used where other maps do not exist to create an initial map of each process or species of management interest. These datasets become 'baseline conditions' against which progress towards or away from targets is measured.
- Fire effects rules. Rules are used to determine and map fire effects for each management indicator or resource target. The rules, which can include mathematical equations, integrate and summarize fire behavior (flame length, crown fire activity, heat/area) into effects on the species of interest and its habitat requirements. This is often on existing vegetation, but should include any parameters directly impacting the process or species of interest.

Required Software...Specialized software is required to develop map libraries of fire behavior. These are available for free download on the Internet. These include:

- FireFamilyPlus which is used to generate weather information;
- FARSITE which is used to create .lcp file input for FlamMap2;
- FlamMap2 which is used to generate fire behavior; and
- ARCMAP or ARCVIEW with Spatial Analyst.

To generate information on potential future landscapes, you will also need a landscape simulation model. We used SIMPPLLE, but also tested FVS-FFE. Other systems include LANDSUM or RMLANDS.

To generate other fire effects, we used two additional existing models:

- FOFEM for emissions and first order fire effects such as mineral soil exposed; and
- Disturbed-WEPP for sedimentation and run-off.

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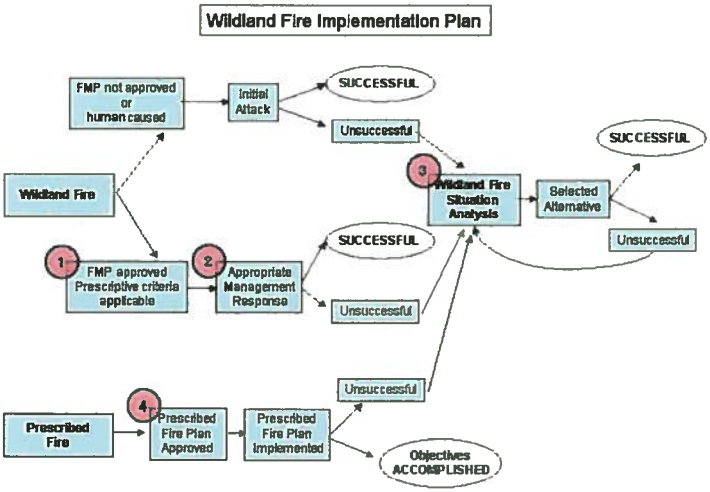
Frequently Asked Questions…

10. How can this process assist in developing WFIP's and WFSA's?

Overview…

Since options for fire management tactics are initially set at the broad-scale in the Land/Resource management plans and tier down, we developed our process to generate information appropriate to each of the planning scales: broad-scale, 10-15 year time frames; annual plans for Fire Management, prescribed burn and fuels treatment; and daily to monthly planning at the incident level. The key is to develop this information in the off-season and have it available in ditigal and/or hard copy form readily accessible to decision-makers.

This fact sheet identifies how information generated through our process may be used at each planning step mandated in the federal Wildland and Prescribed Fire Management Policy – Implementation Procedures Reference Guide, published by the NIFC (National Interagency Fire Center) in August 1998. Numbers on the graphic are explained in the text of the same number.



Adapted from the Wildland and Prescribed Fire Management Policy – Implementation Procedures Reference Guide, August 1998.

1. FMP approved prescriptive criteria applicable…

a. Long-range planning… The protocol can facilitate fire management by assisting in establishing the range of acceptable appropriate management responses codified in the Land/Resource Management Plan. At the broad-scale, the protocol generates maps and criteria for identifying fire use opportunities – an important input into establishment of long range objectives, conditions/standards and guidelines for fire use and desired future conditions for each management area

b. Fire Management Planning… The protocol can also be used in development and revision of Fire Management Plans by generating information at the mid-scale to:

- identify resources values, objectives/desired conditions/standards and guides, and constraints for each management/response unit; and
- set Fire Management or Maximum Manageable Areas.

2. Appropriate Management Response… Appropriate Management Response includes development of WFIP Stage I, II and III reports. Pre-planning can assist in developing these reports by providing spatial and tabular summaries of opportunities to achieve resource benefits under a variety of

fire weather threshold conditions. This information is critical to developing and selecting effective and appropriate alternatives.

3. Wildland Fire Situation Analysis... Even under a suppression strategy, use of pre-developed map layers identifying areas of ecological benefit and risk may still be useful in developing and prioritizing fire management activities. Spatial identification of potential benefits can help management teams target areas for contain or confine strategies instead of the generally more resource intensive control tactics. Map layers may also be indispensable for teams unfamiliar with the fire area or ecology.

4. Prescribed Fire Plan Approved... Map layers identifying ecological benefits also identify areas of ecological risk. These are areas and conditions under which a natural ignition is likely to produce unwanted consequences. Such areas should be prime targets for prescribed or mechanical treatments. Analysis of smoke profiles (production at the landscape level over time) can be instrumental in prioritizing prescribed burning opportunities.

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