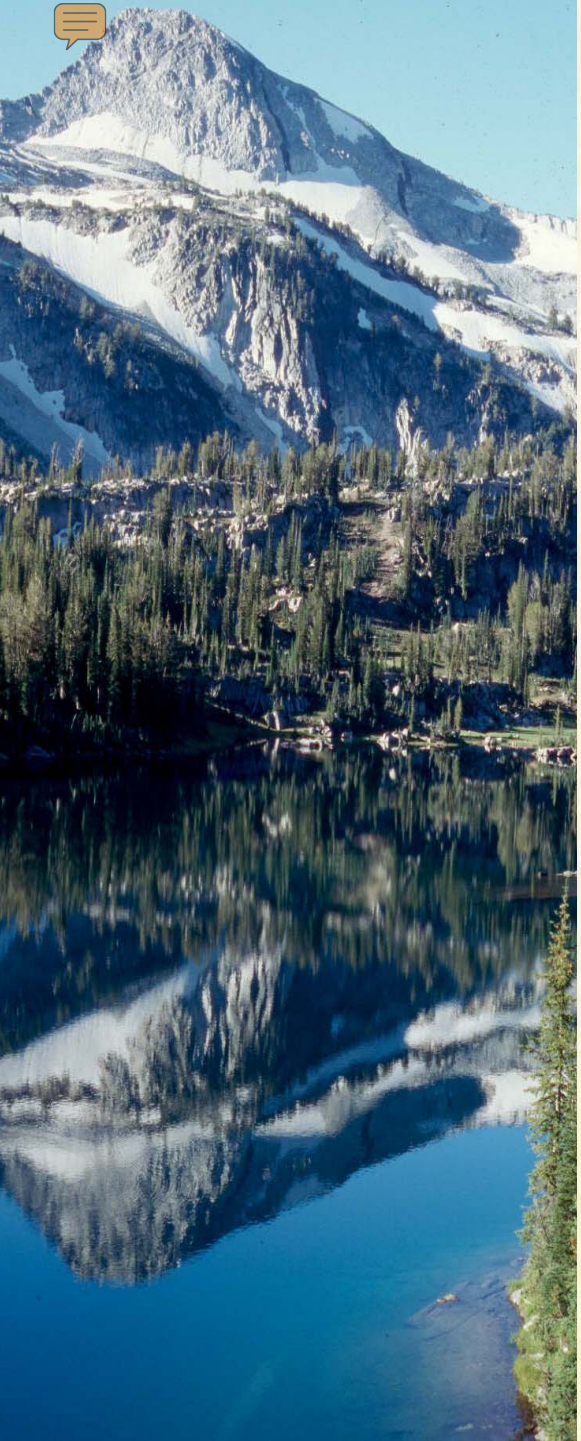
Tools and Approaches to Help Plan for WFU

- Describe two tools
- Identify uses for WFU/Fire planning

Carol Miller and Anne Black
Aldo Leopold Wilderness Research Institute
Rocky Mountain Research Station
Missoula, MT

Wildland Fire Use For Resource Benefits
Northern Rockies Training Center
February 17,2005



Research to improve fire stewardship

Fire Effects Planning Framework (FEPF)

Where and under what conditions will fire create *benefits* and pose *risks* to management objectives?

BurnPro (Probability of Burning)

Where is fire most likely to burn on the landscape, given the *spatial arrangement* of ignitions, fuels & topography?

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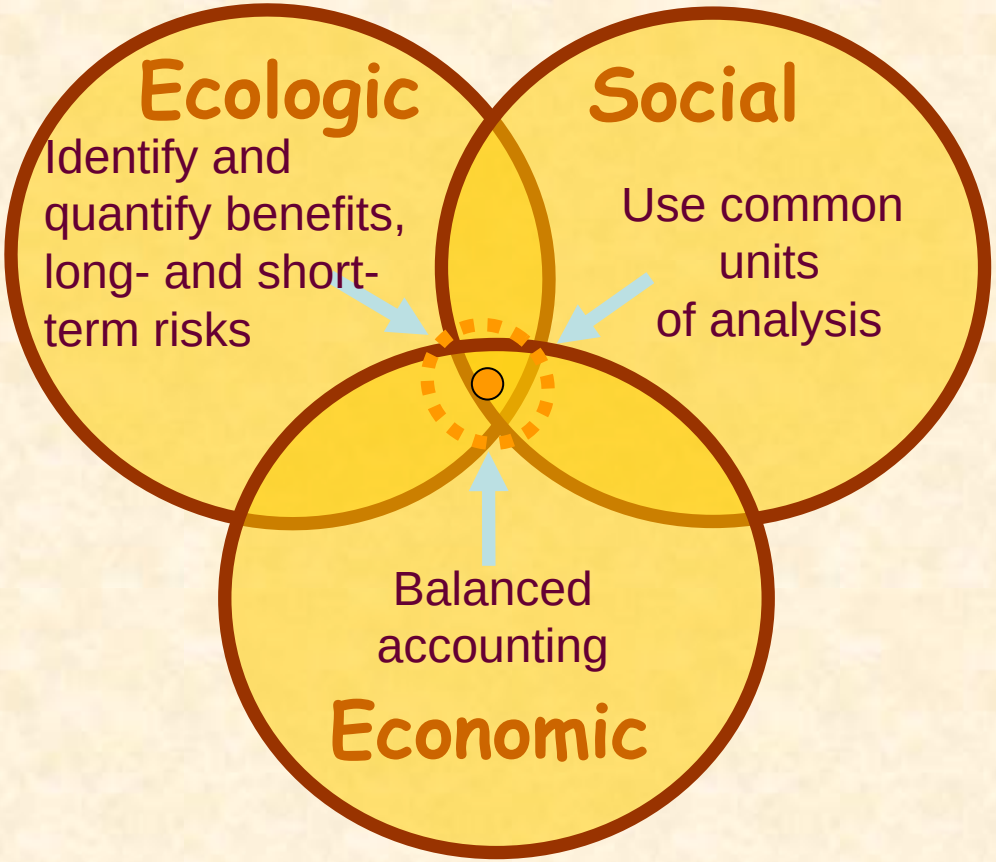

Where is information on resources or benefits used in the fire planning process?

Broad-scale:

Land/Resource Management Plan
Fire Management Plan
WFU Guidebook

Site-specfic:

Wildland Fire Implementation Procedures

Stage I

- **Decision Criteria Checklist**
  - **effects acceptable?**
  - **Relative risk acceptable?**

Stage II

- **Objectives used to establish desired outcomes**
- **Tied to land management plans**

SAM - specific, achievable, measurable, relevant, trackable

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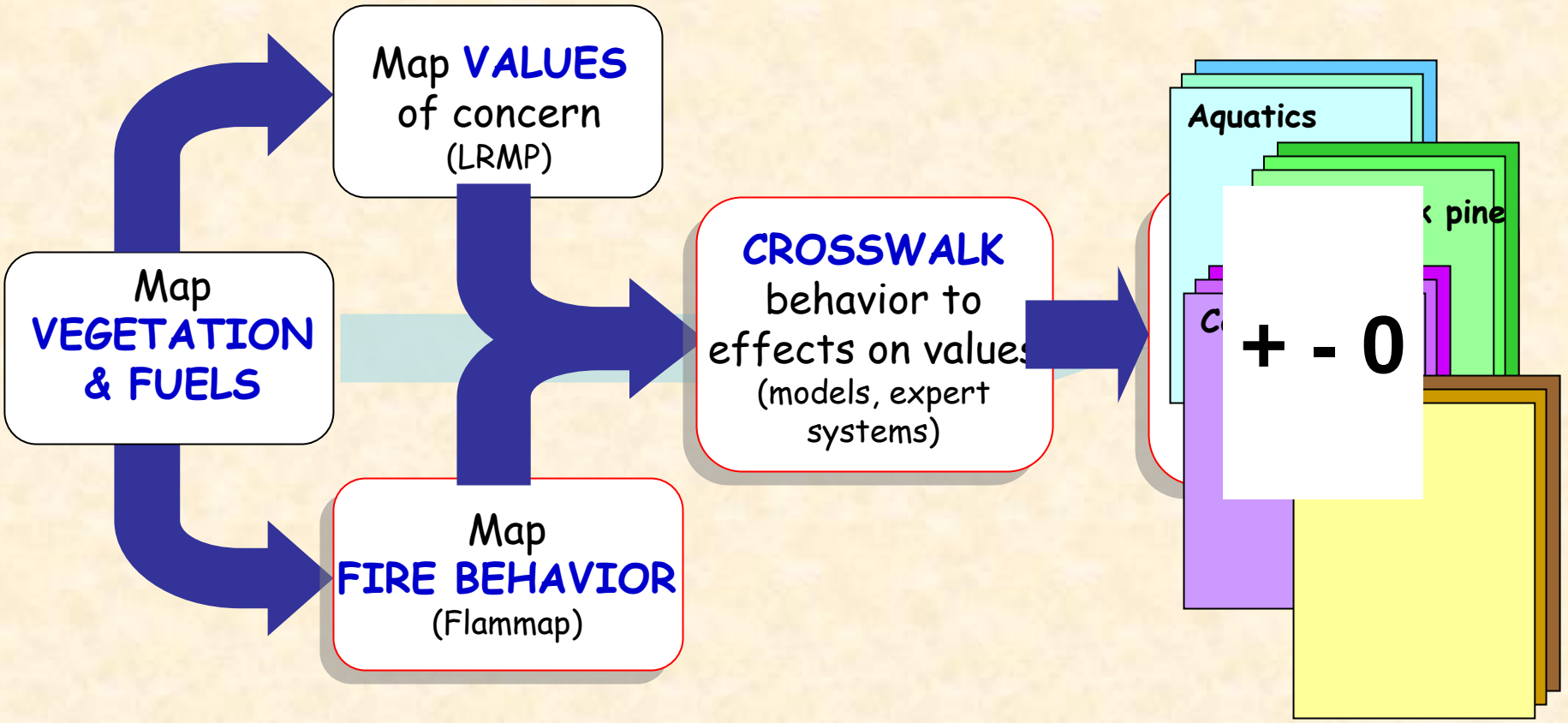

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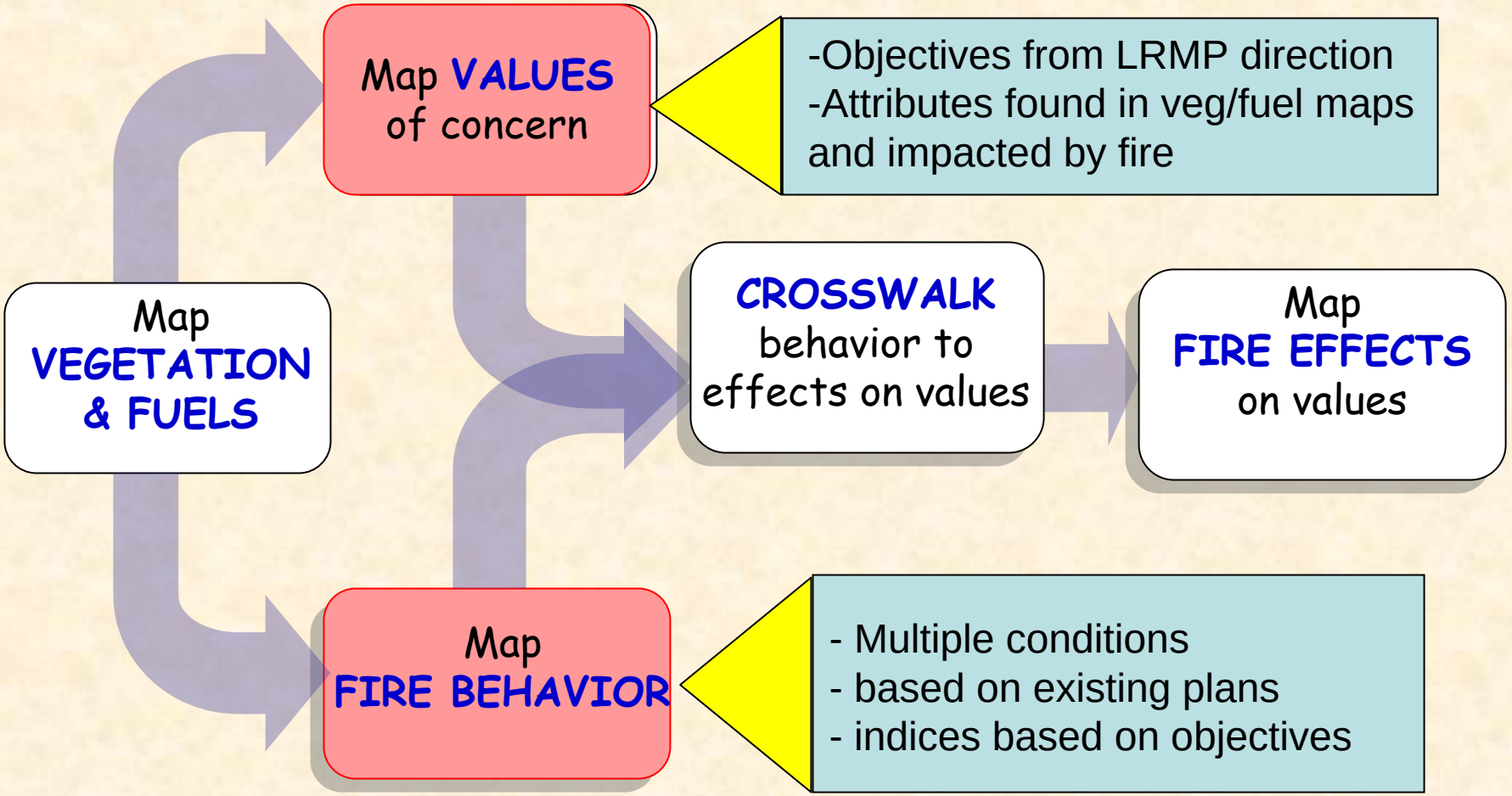
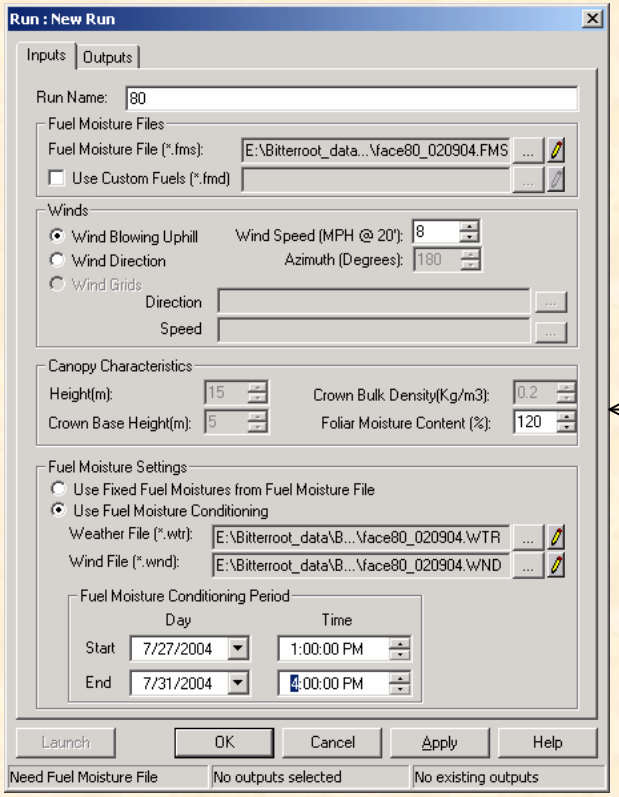
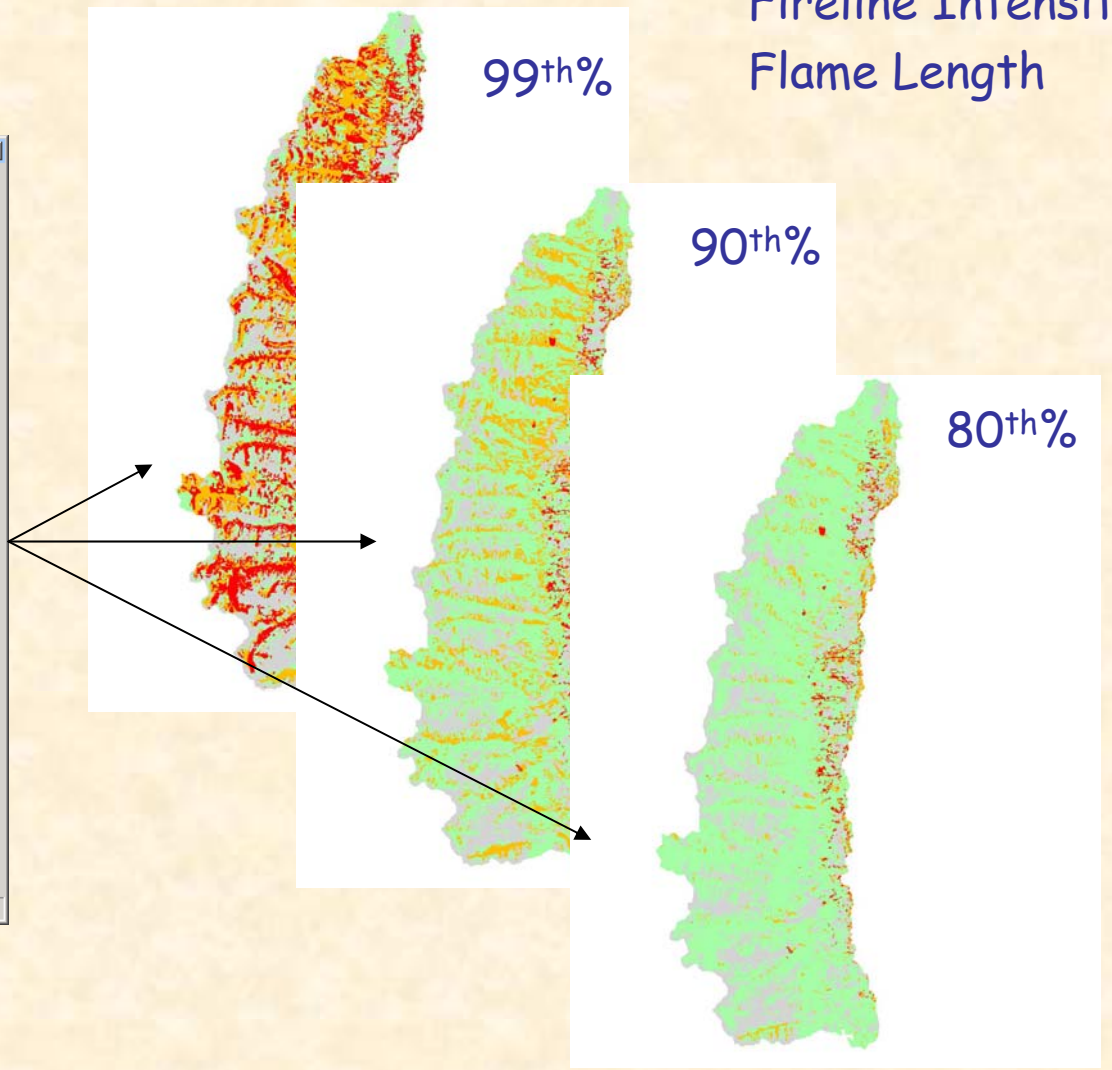


Create Fire Behavior Library

FlamMap



Crown Fire Potential
Fireline Intensity
Flame Length

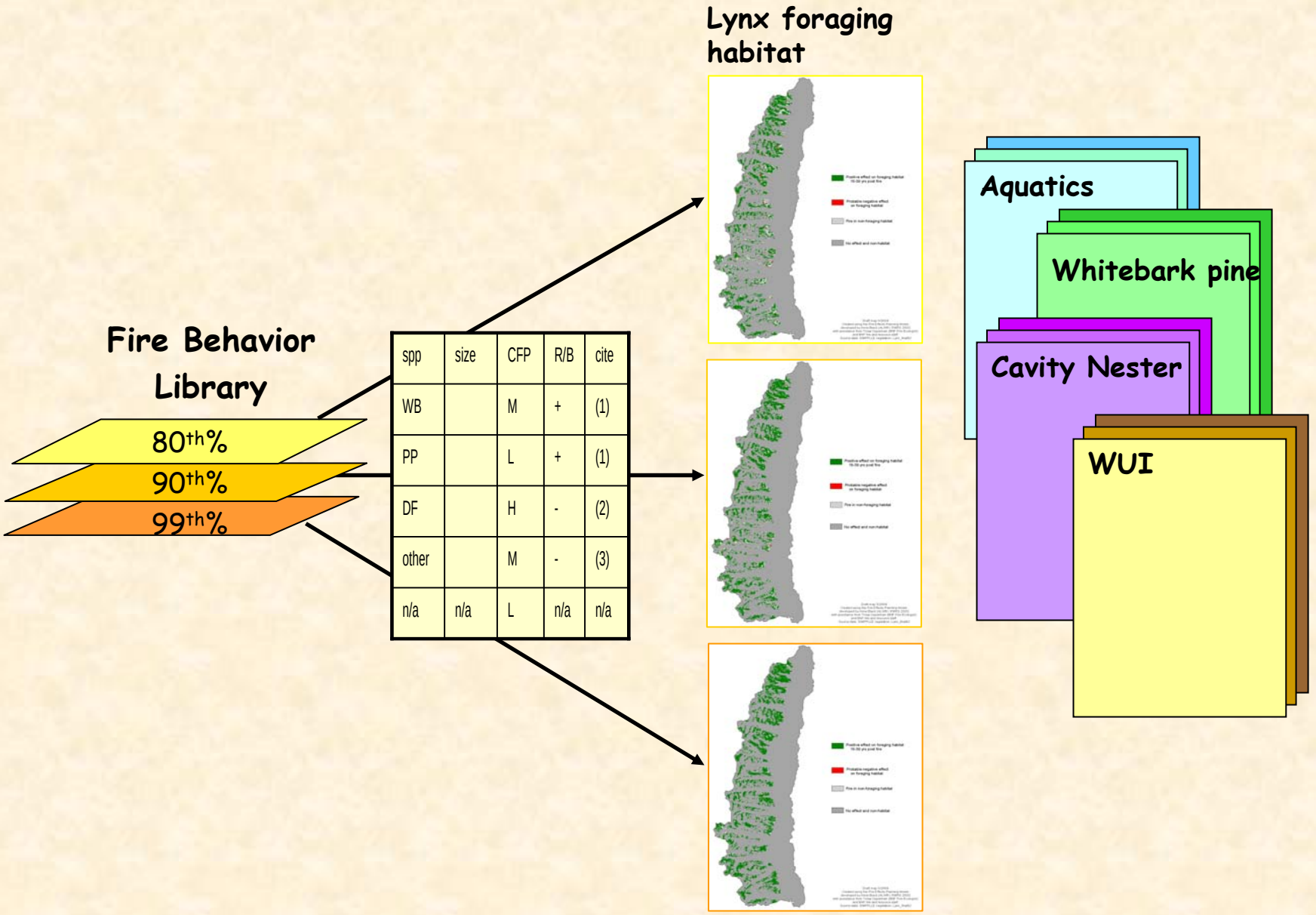


Create Fire Effects Crosswalks

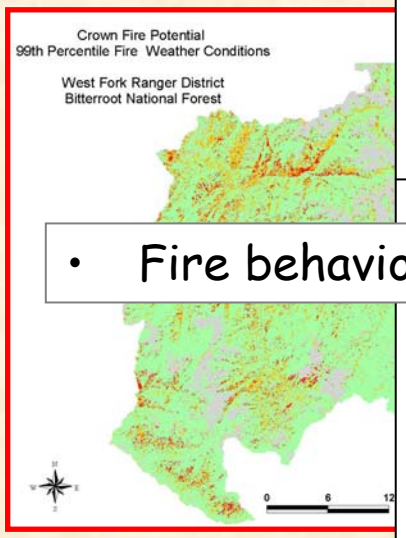
Physical Habitat Characteristics → Fire Behavior → Fire Effects

Species	Size/ Structure	Crown fire potential	Benefits/Risks to whitebark pine	Mapping Multiplier	Information Source
WB-AL-AF mix, and WB-ES-AF mix	All	High	**Desirable Effects** WB to outcompete other conifers	+1	Tomback et al. 2001
		Low or Moderate	**Highly Desirable Effects** favor late successional WB	+100	Tomback et al. 2001
WB-only	Seed/sap	All fires	**Undesirable Effects** WB established but not reproducing yet	-100	Tomback et al. 2001; FOFEM
	All except seed/sap		**Desirable Effects** restore native fire regime	+1	Tomback et al. 2001; FOFEM
All other species mixes	All	High	**Highly Desirable Effects** provide potential WB habitat	+100	Keane, Arno, pers.comm.
		Low or Moderate	**Desirable Effects**	+1	Keane, Arno, pers.comm
No Burn	All	None	**Not Habitat** rock above 6500'	0	N/A

Create Fire Effects Library



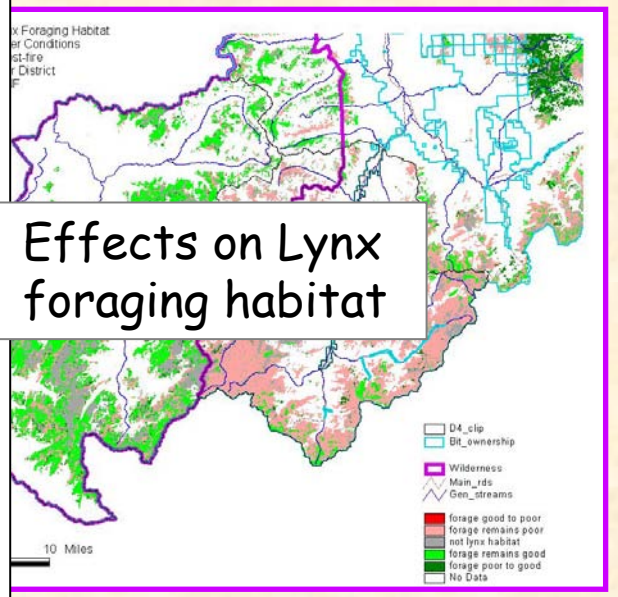
Map Library for Fire Planning



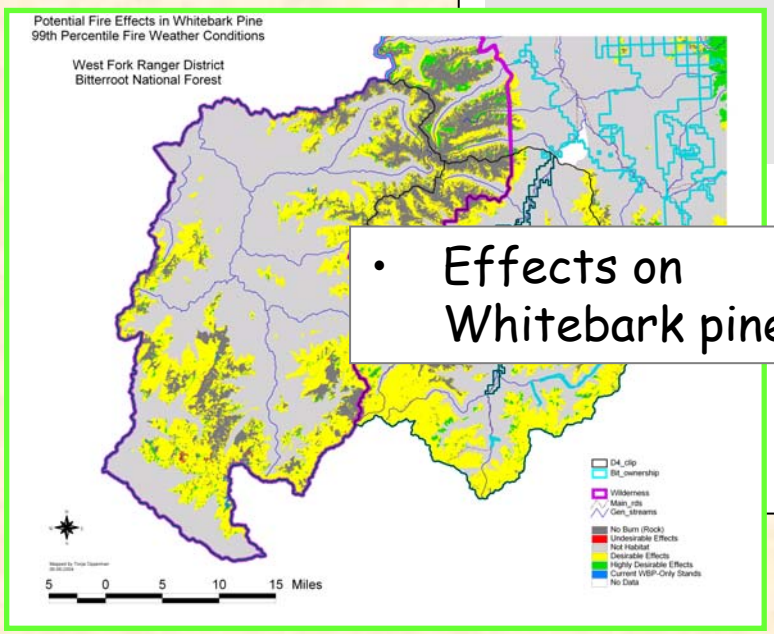
- Fire behavior

BITTERROOT NATIONAL FOREST

2004 Fire Effects Map Library



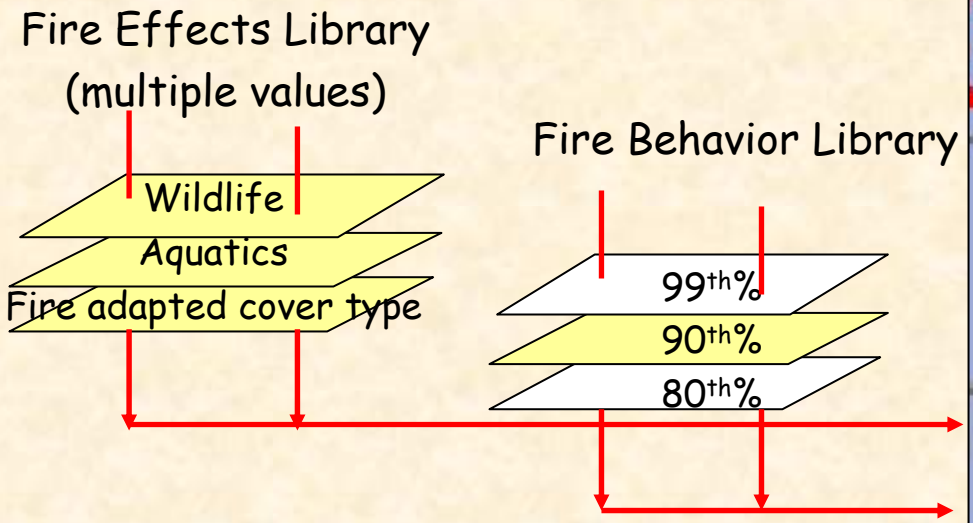
- Effects on Lynx foraging habitat



- Effects on Whitebark pine

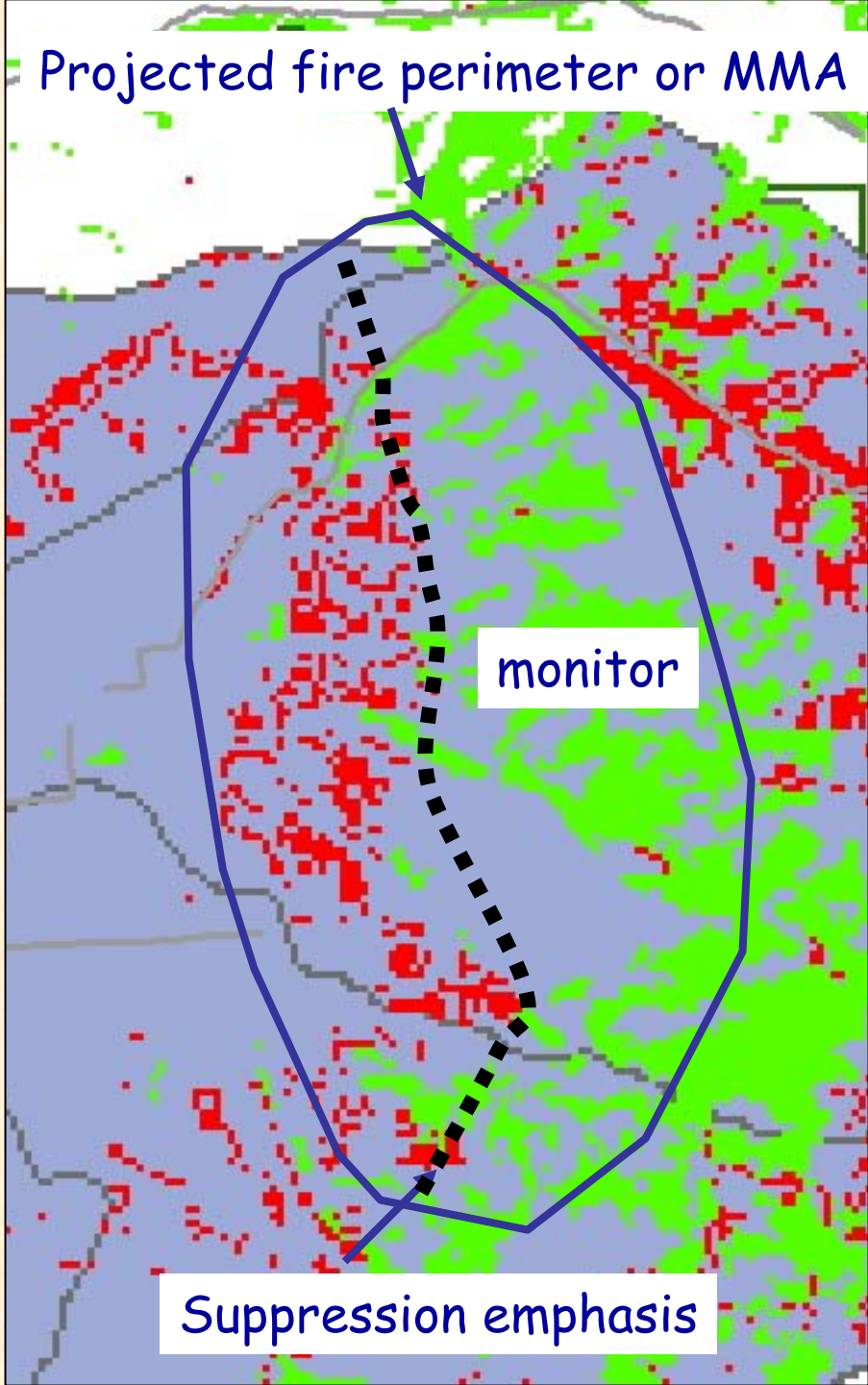
Go/NoGo Support:
WFIP analyses & documentation

Incident Planning:
focus suppression??

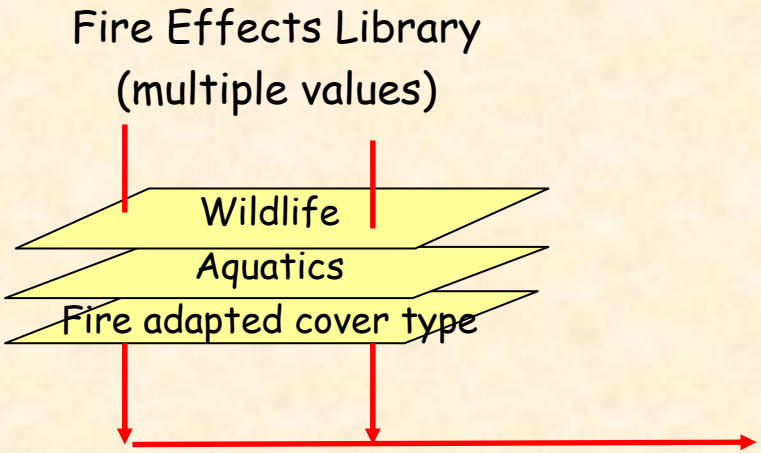


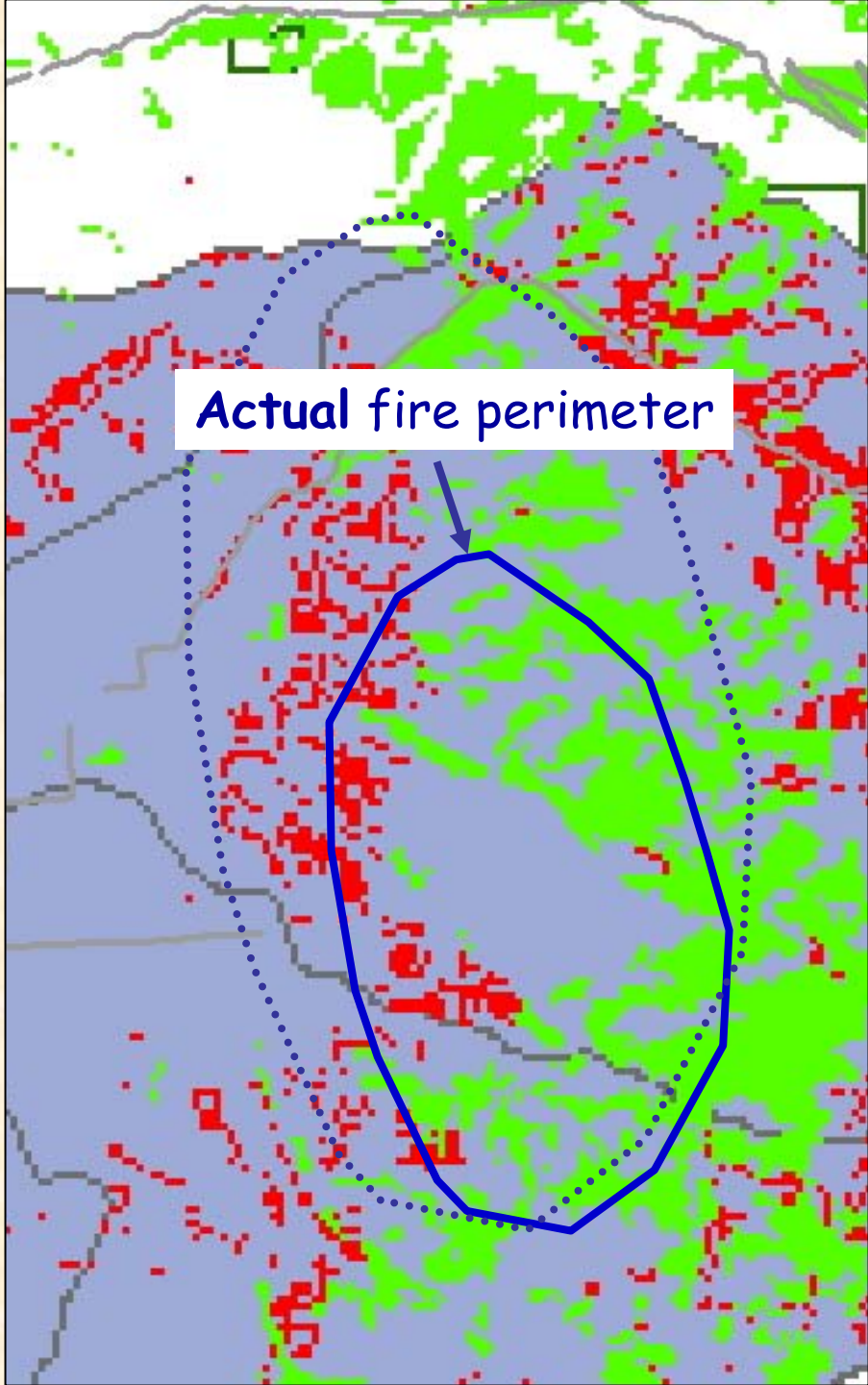
Quantify benefits or reductions in risk within MMA

Consider potential benefits when determining suppression strategy by flank



Post season:
Quantify effects and progress toward LRMP objectives

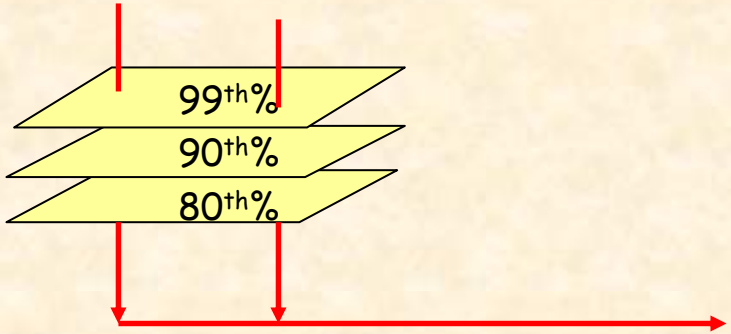




Adjust vegetation map for next season

Long-range - Activity Planning:
fuel treatment priorities

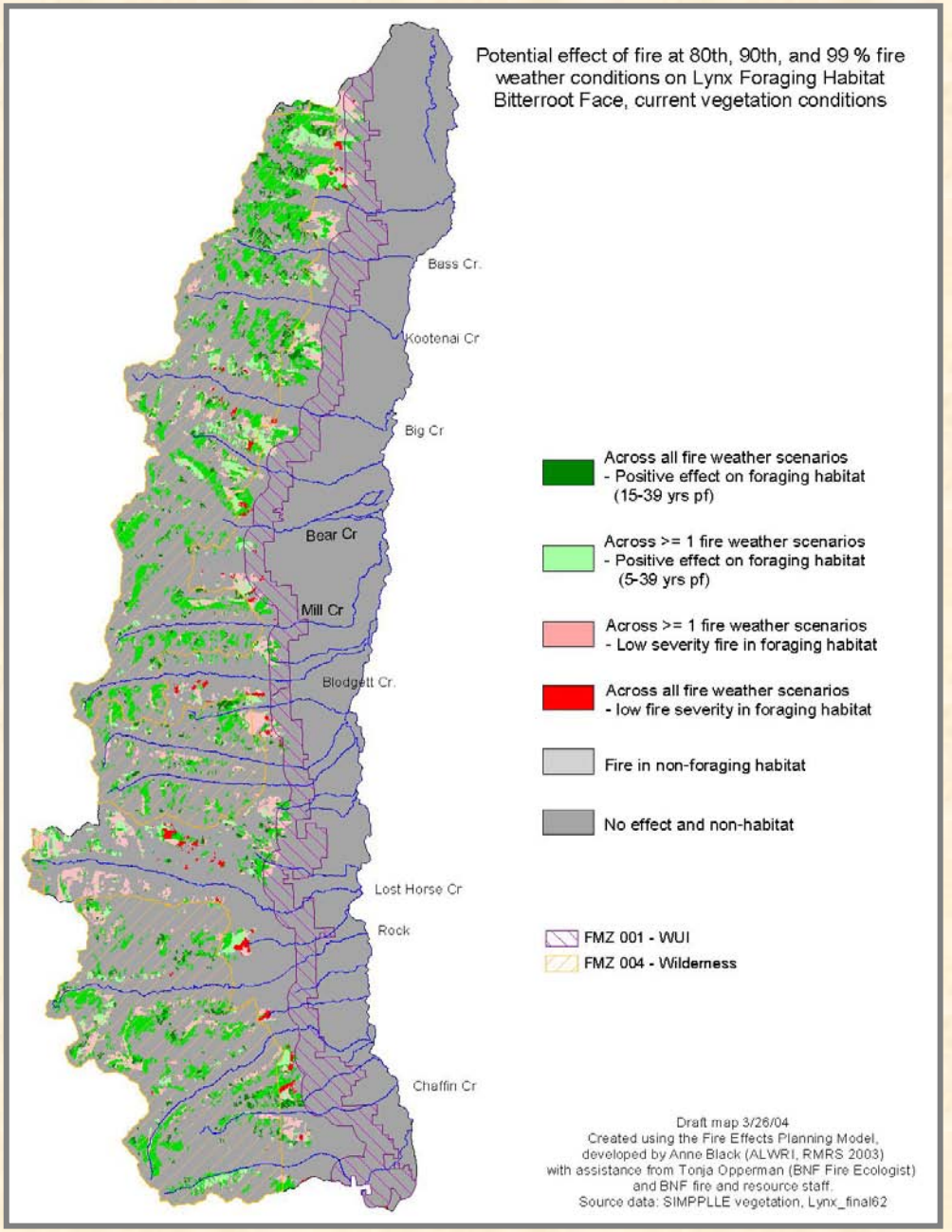
Fire Effects Library
(multiple conditions)



Fire effects always negative (red): Mechanical treatment

Fire effects always positive or neutral (green): Rx or WFU

Fire effects vary (light red, light green): various



Website

-background

-demonstrations

-fact sheets

FIRE EFFECTS PLANNING FRAMEWORK

A framework for fire planning

to assist in determining where and under what conditions fire may create benefits or pose threats to identified ecological conditions or management targets.

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

leopold.wilderness.net/research/fprojects/F005.htm

DRAFT

VERSION 0.0.03

2004

Anne E. Black

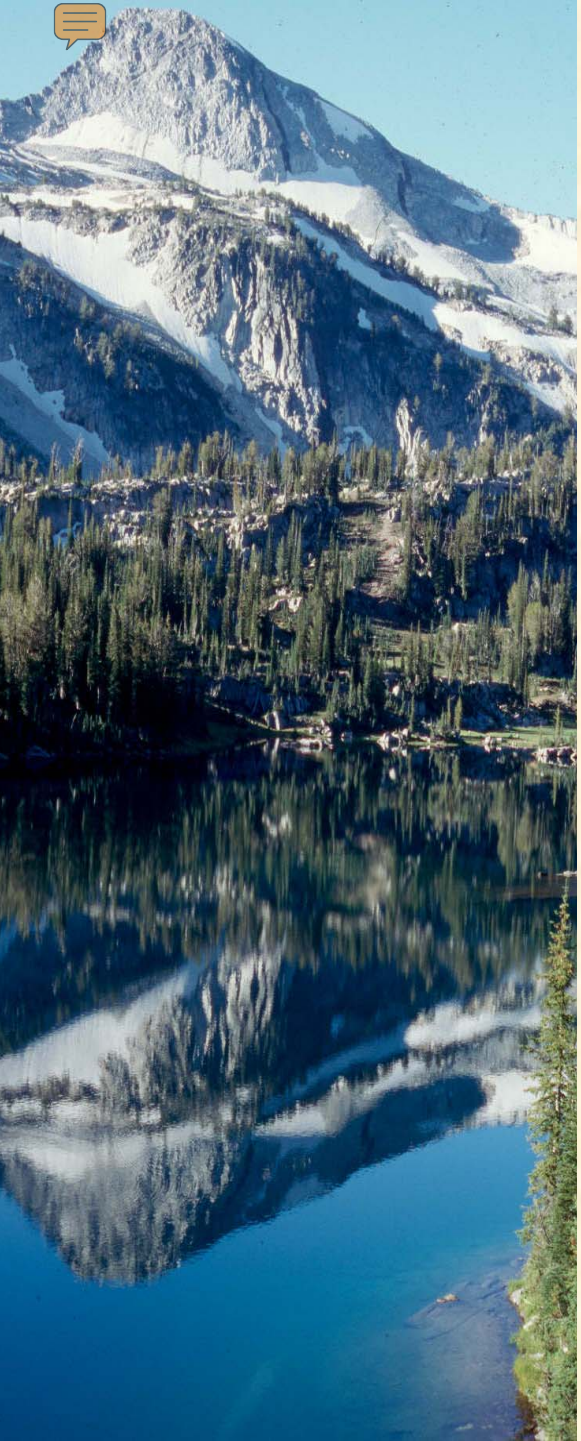
Aldo Leopold Wilderness Research Institute

Tonja Opperman

Bitterroot National Forest

Produced for a Joint Fire Science Project:

"Wildland Fuels: planning and evaluating benefits and risks"



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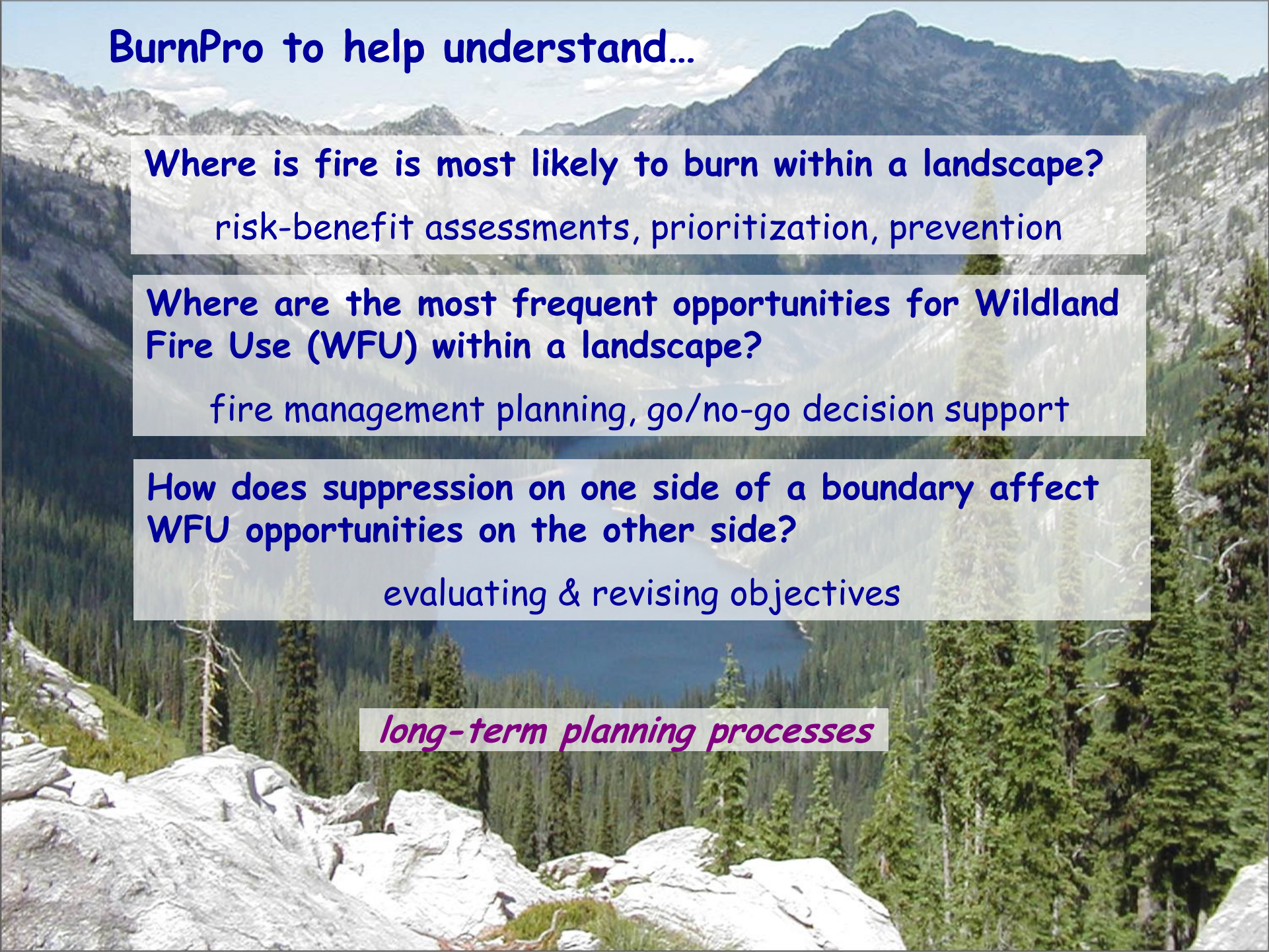


BurnPro to help understand…

Where is fire is most likely to burn within a landscape?

risk-benefit assessments, prioritization, prevention

Where are the most frequent opportunities for Wildland Fire Use (WFU) within a landscape?

fire management planning, go/no-go decision support

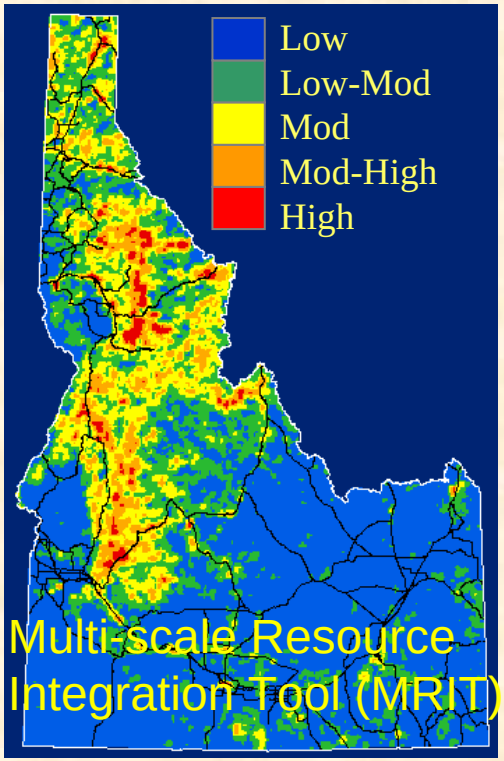
How does suppression on one side of a boundary affect WFU opportunities on the other side?

evaluating & revising objectives

long-term planning processes

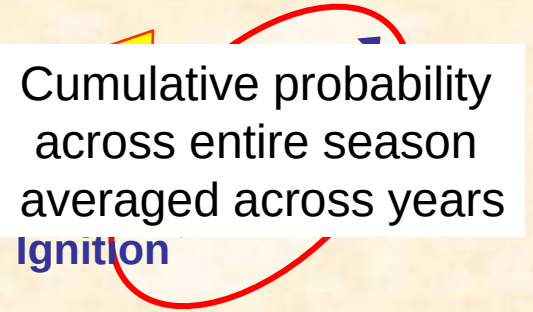
Probability of Ignition vs. Probability of Burning

ignitions / area / time period



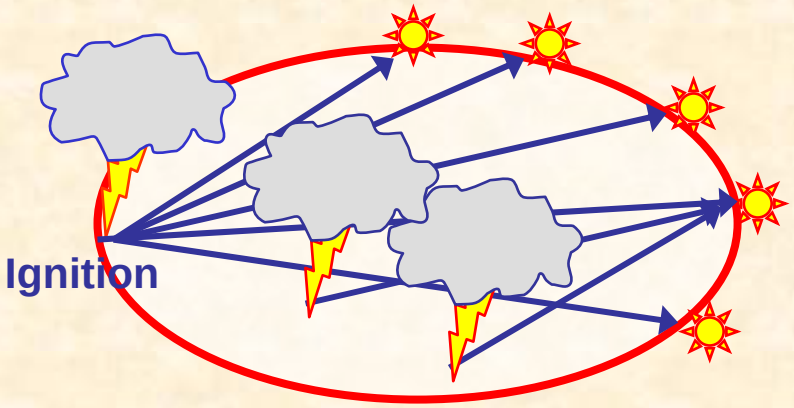
coarse scale assessment and planning

ignitions * spread *in a spatial context*



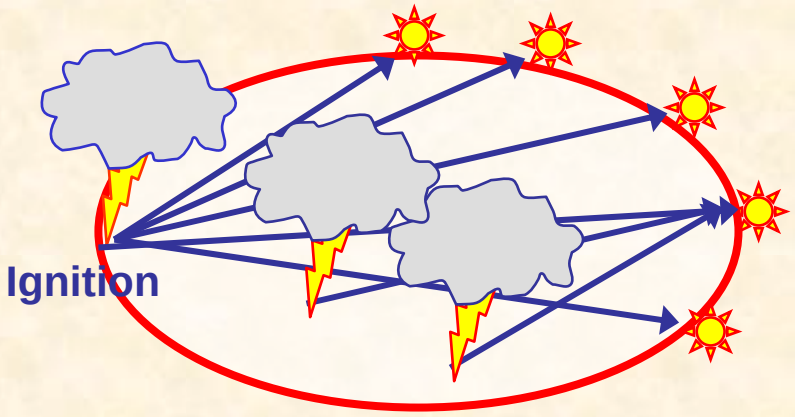
vs.

RERAP (single event)



BurnPro to Estimate Probability of Burning

Considers ignitions, rate of fire spread, and time available for fire spread, all in a spatial context



BurnPro provides:

- **Average annual value (many events, many years)**
- **Value for every location on a raster map**
- **Continuous values, not categorical—*relative* values**
- **Support for long-term planning (not incident management)**

BurnPro Overview

Probability of burning (P*Burn*) a location

=

Probability of fire reaching the location before the end of the fire season (P*End*)

X

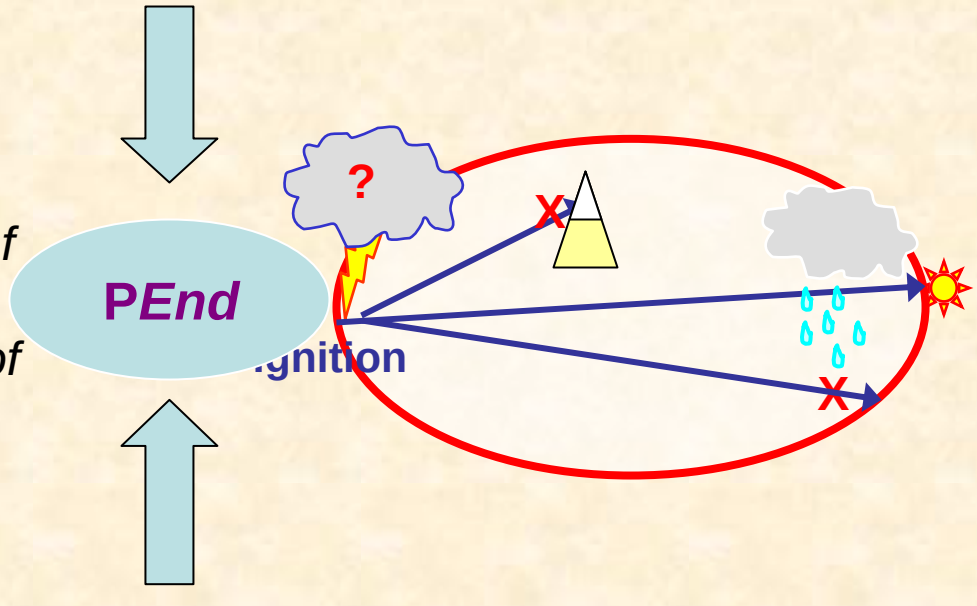
Probability of a fire stopping precipitation event *NOT* occurring before fire reaches the location (P*NoRain*)

The BurnPro Approach

How long does it tend to take a fire to spread to each point (days of cumulative spread time)?

Where and when do ignitions tend to be?
How fast does fire tend to spread?

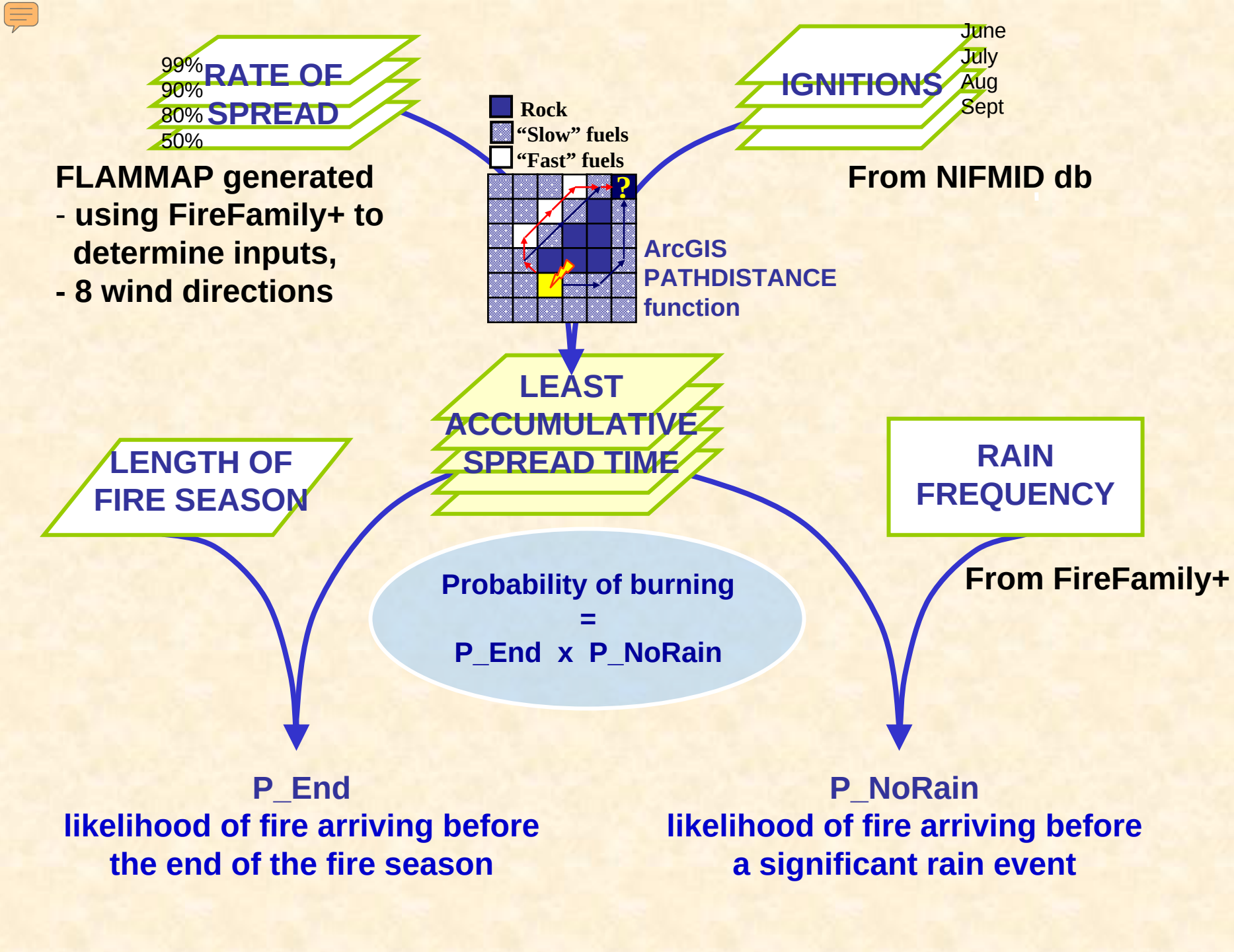
Probability of fire arriving before end of fire season



Probability of fire arriving before rain

How long is the fire season? (varies over elevation)

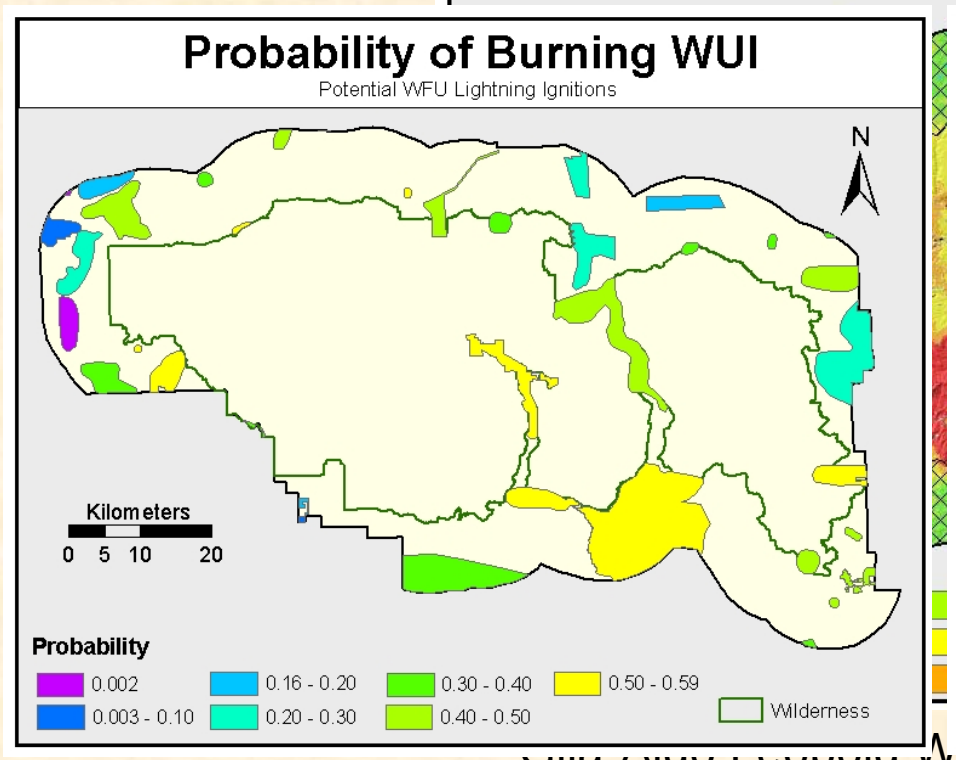
How frequent are fire-stopping events (rain)?

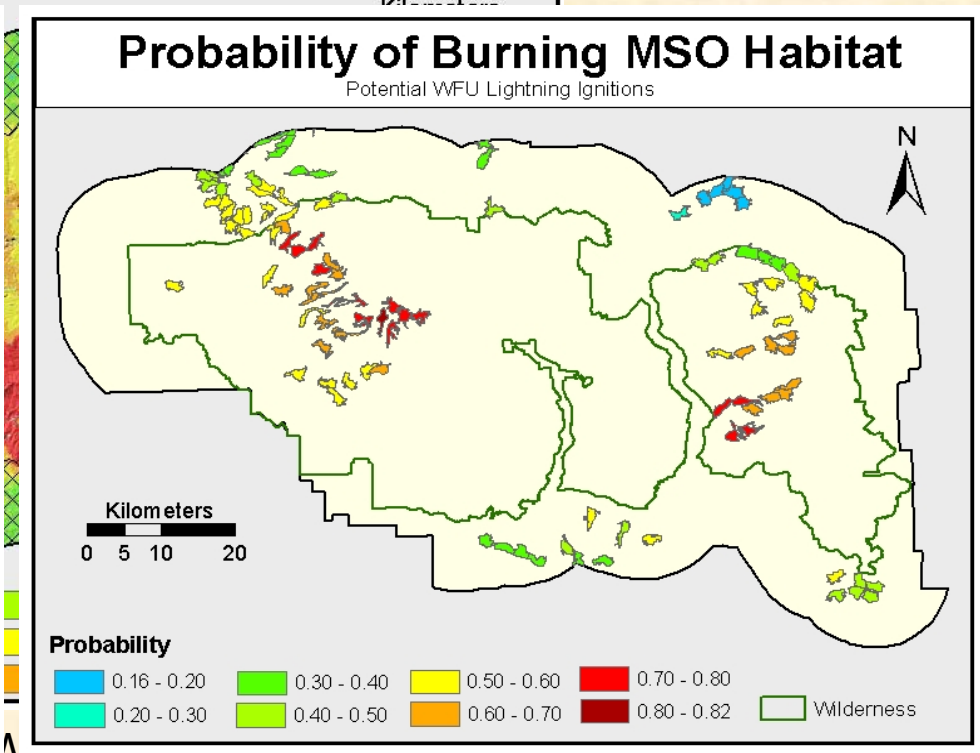

99%
90%
80%
50%
RATE OF SPREAD
FLAMMAP generated
- using FireFamily+ to determine inputs,
- 8 wind directions
Rock
"Slow" fuels
"Fast" fuels
?
ArcGIS PATHDISTANCE function
IGNITIONS
June
July
Aug
Sept
From NIFMID db
LEAST ACCUMULATIVE SPREAD TIME
LENGTH OF FIRE SEASON
RAIN FREQUENCY
From FireFamily+
Probability of burning
=
P_End x P_NoRain
P_End
likelihood of fire arriving before the end of the fire season
P_NoRain
likelihood of fire arriving before a significant rain event

Risks and Benefits

Where is fire most likely to burn within a landscape?

Risk-benefit assessments, priorities



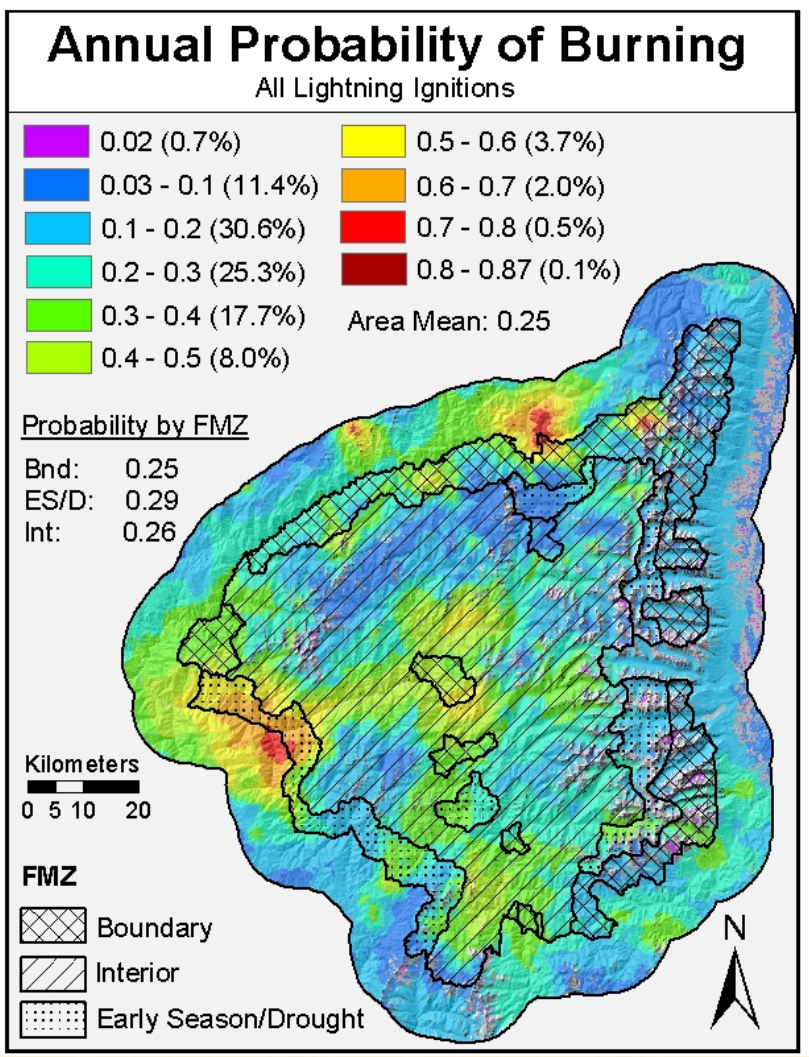


Gila/Aldo Leopold Wilderness, New Mexico

Opportunities

Where are the most frequent WFU opportunities? The most rare?

FMP, go/no-go support

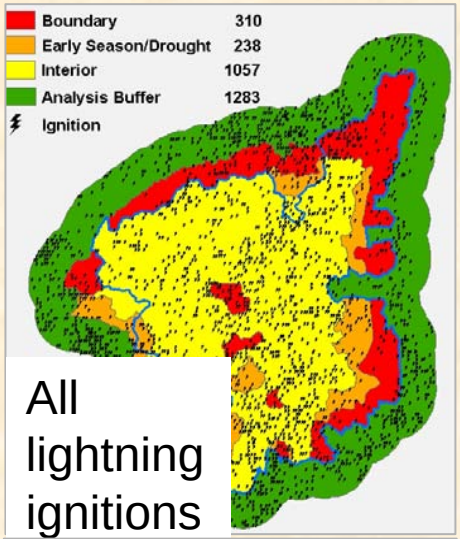


Selway-Bitterroot Wilderness, ID/MT

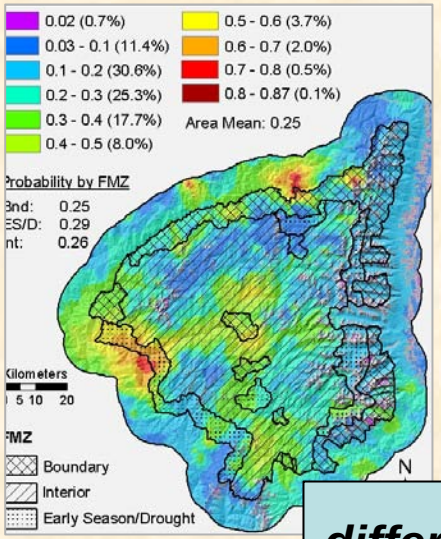
Cross-Boundary Suppression Effects

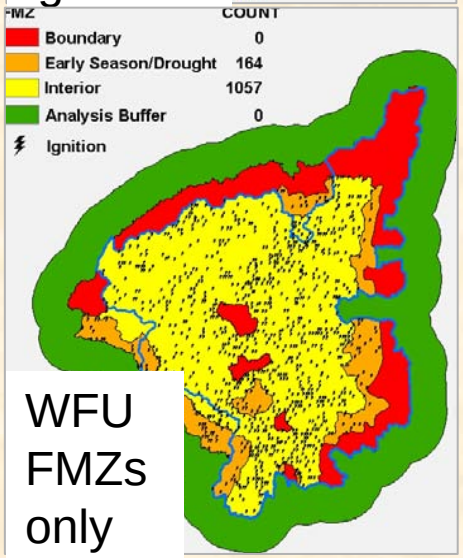
How does suppression on one side of a boundary affect WFU opportunities on the other side?

evaluating & revising objectives

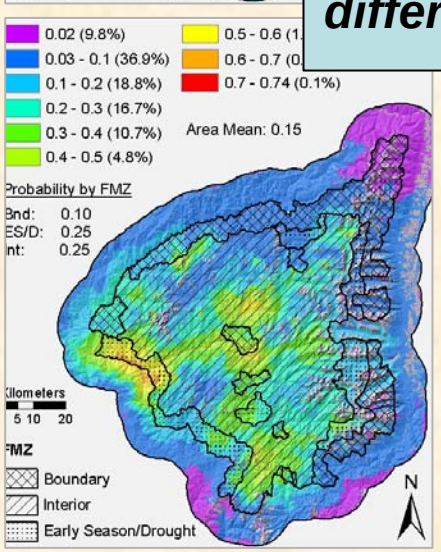


All lightning ignitions

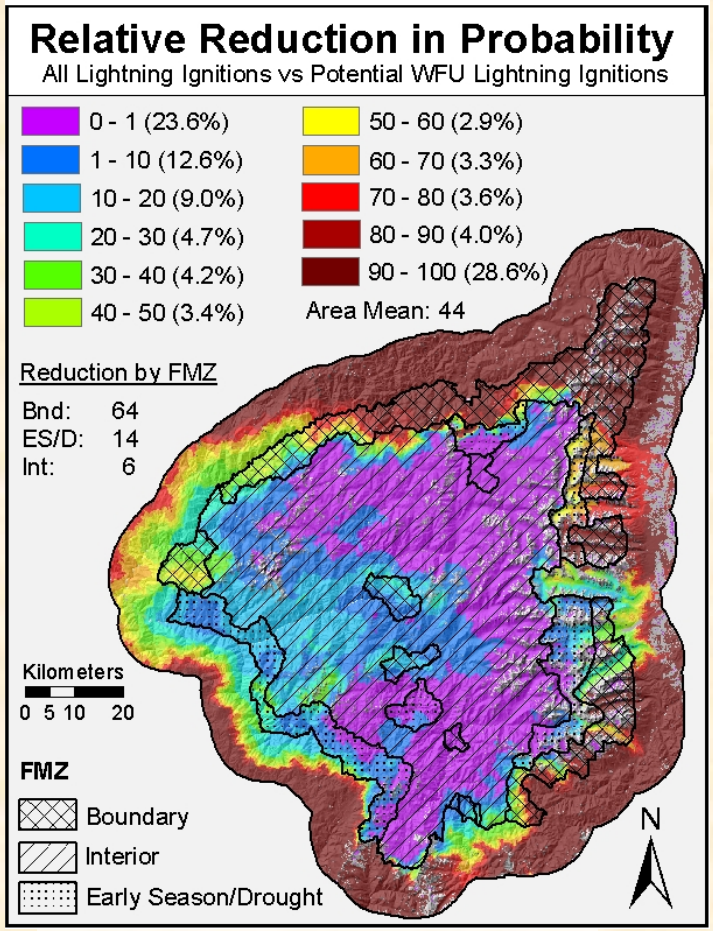




WFU FMZs only

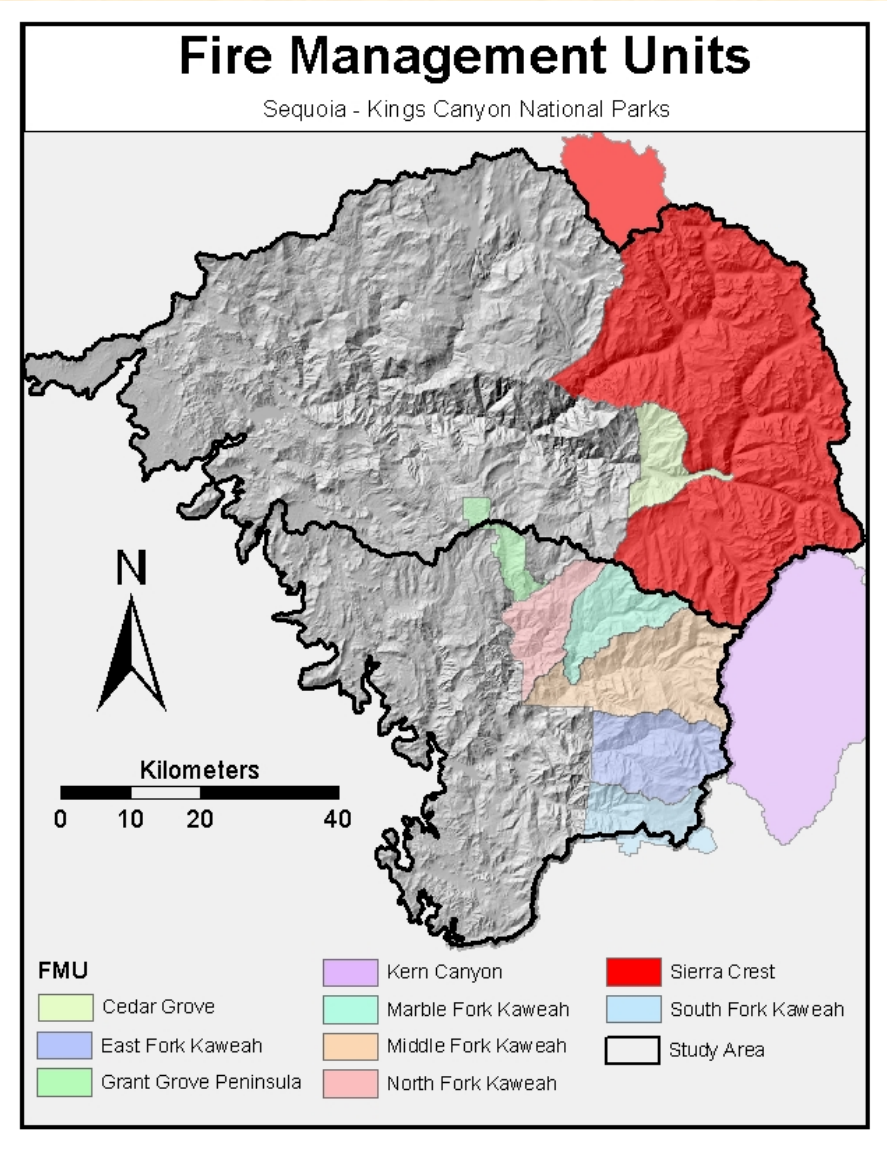


difference



Supplement with Rx?

BurnPro Results - Fire Management Plans

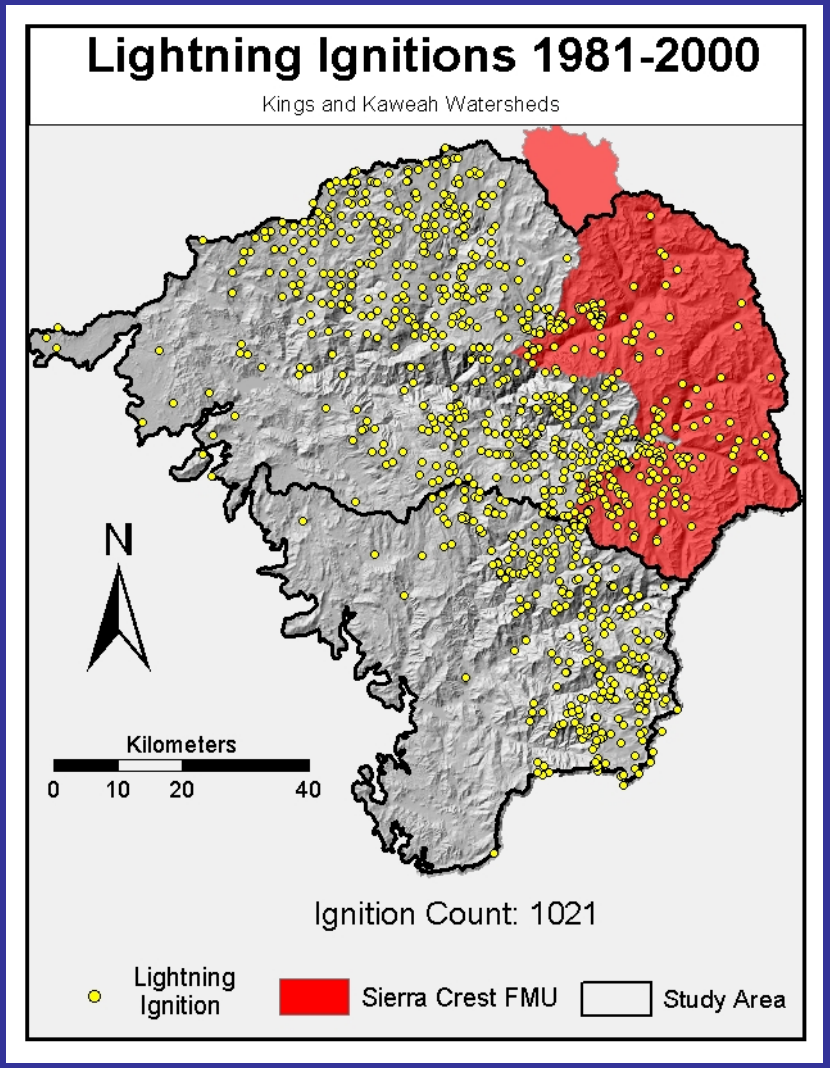


Sierra Crest FMU:

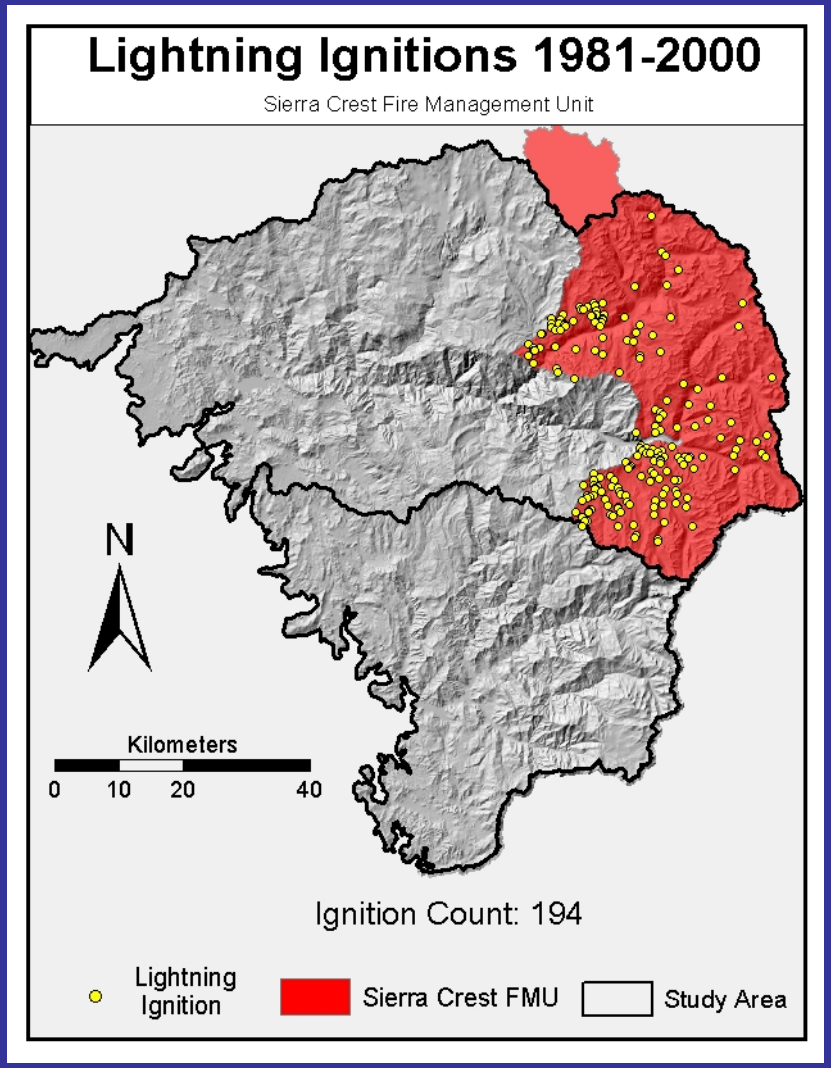
Managed for natural processes applying WFU as the primary tool

How much is the probability of burning reduced when we eliminate the importation of fire from outside the Sierra Crest FMU?

Probability of burning from all lightning ignitions



Probability of burning from FMU lightning ignitions only



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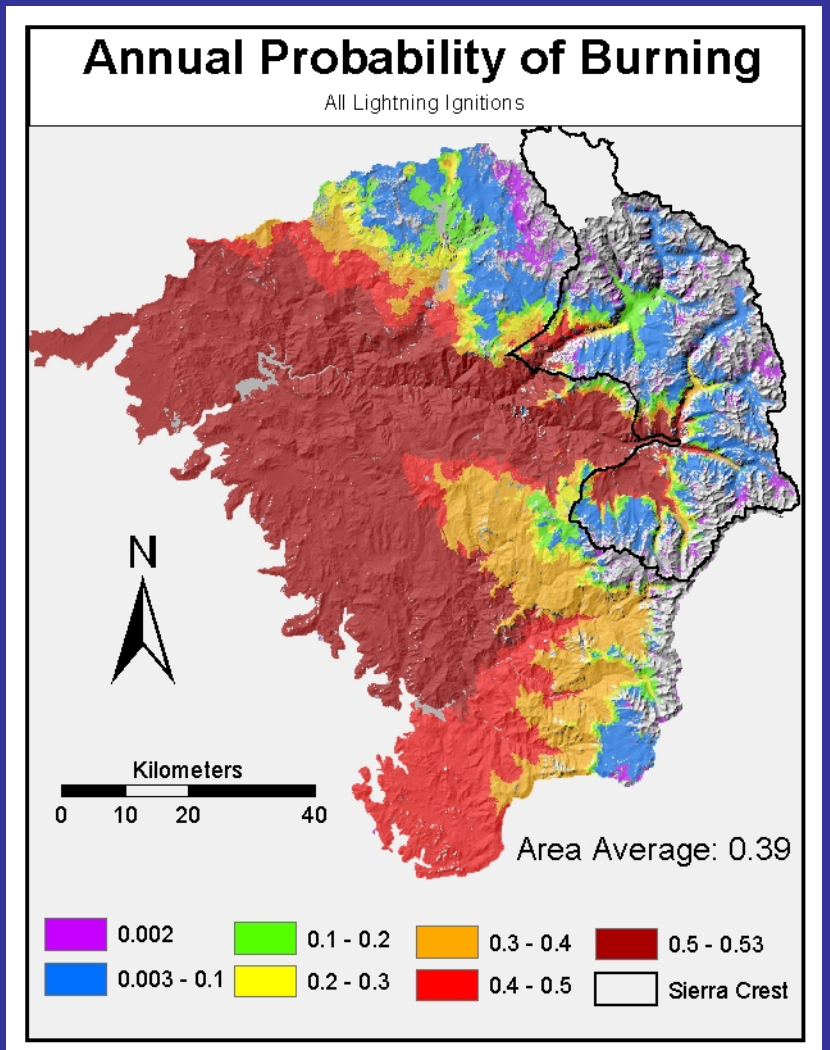

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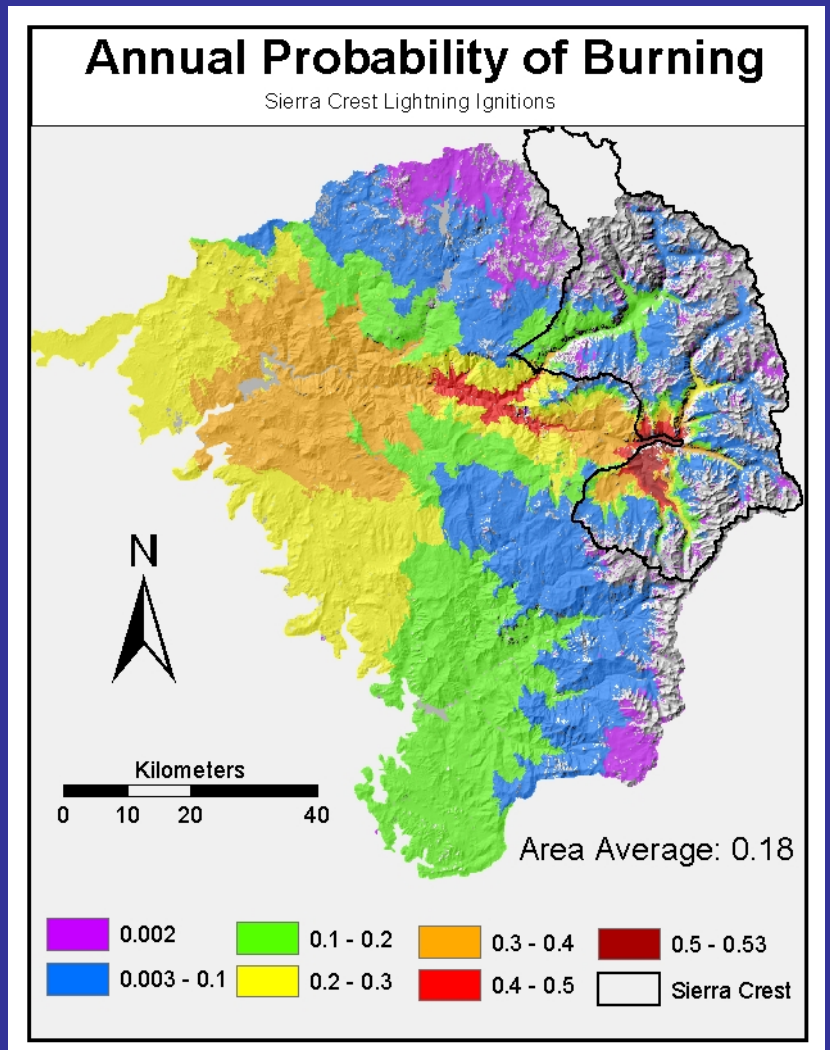

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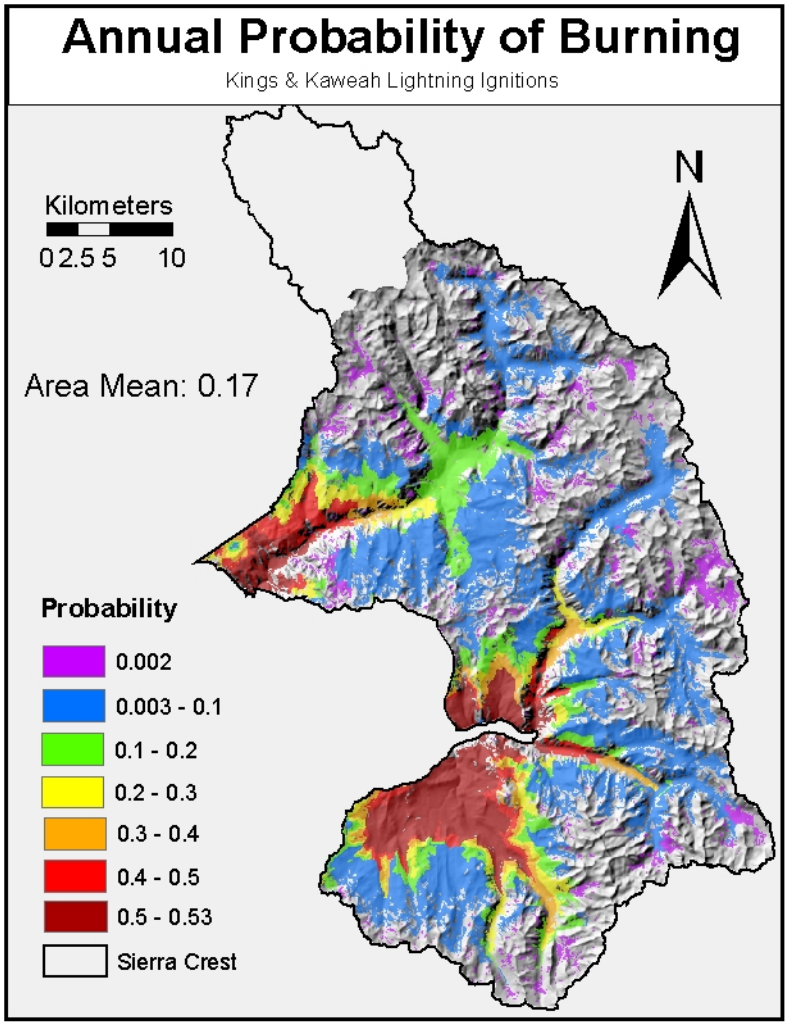

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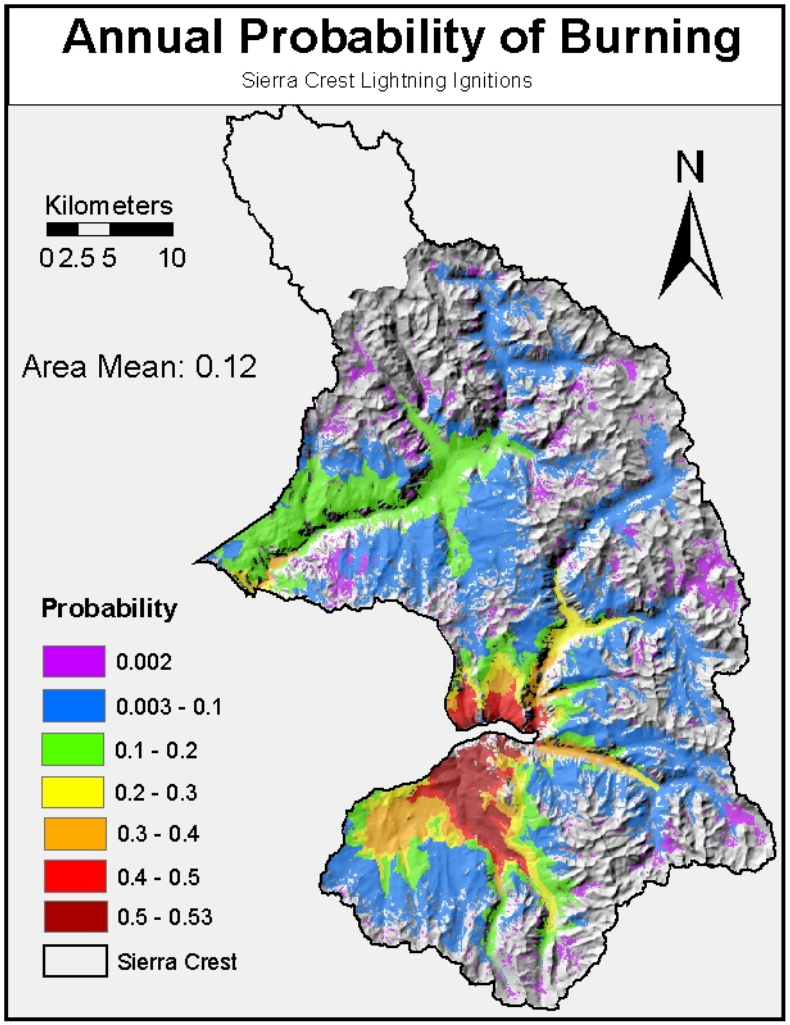
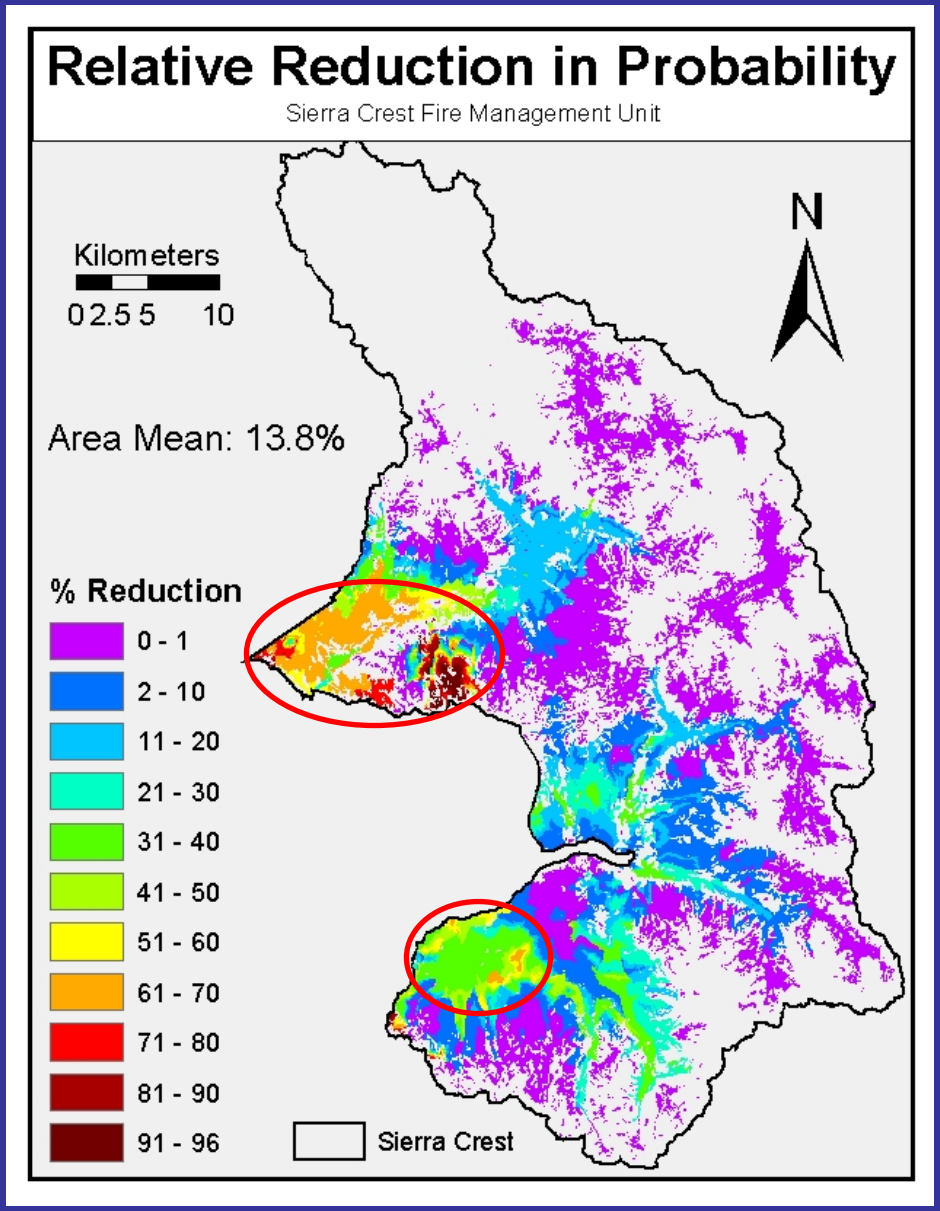




Overall small differences

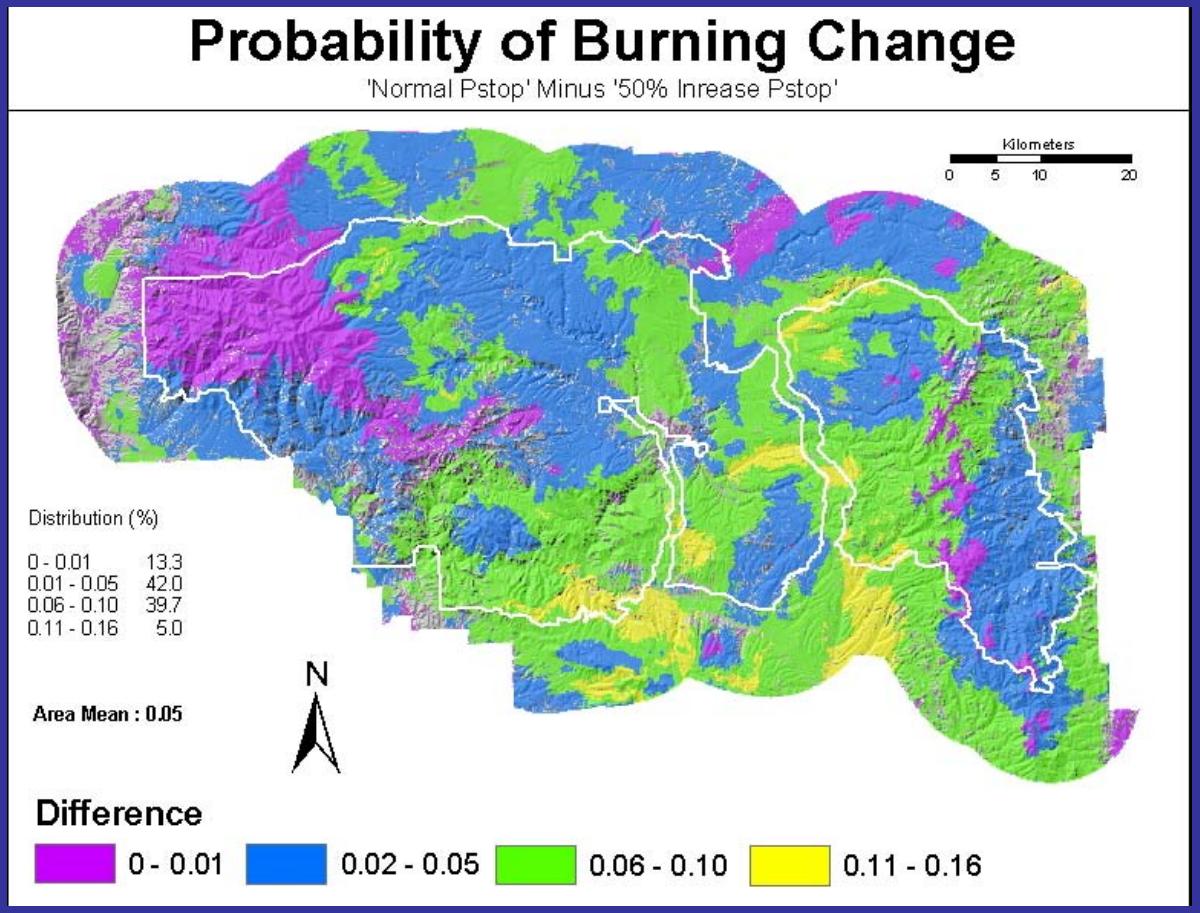
Certain areas with large differences

-Challenges for restoration objectives

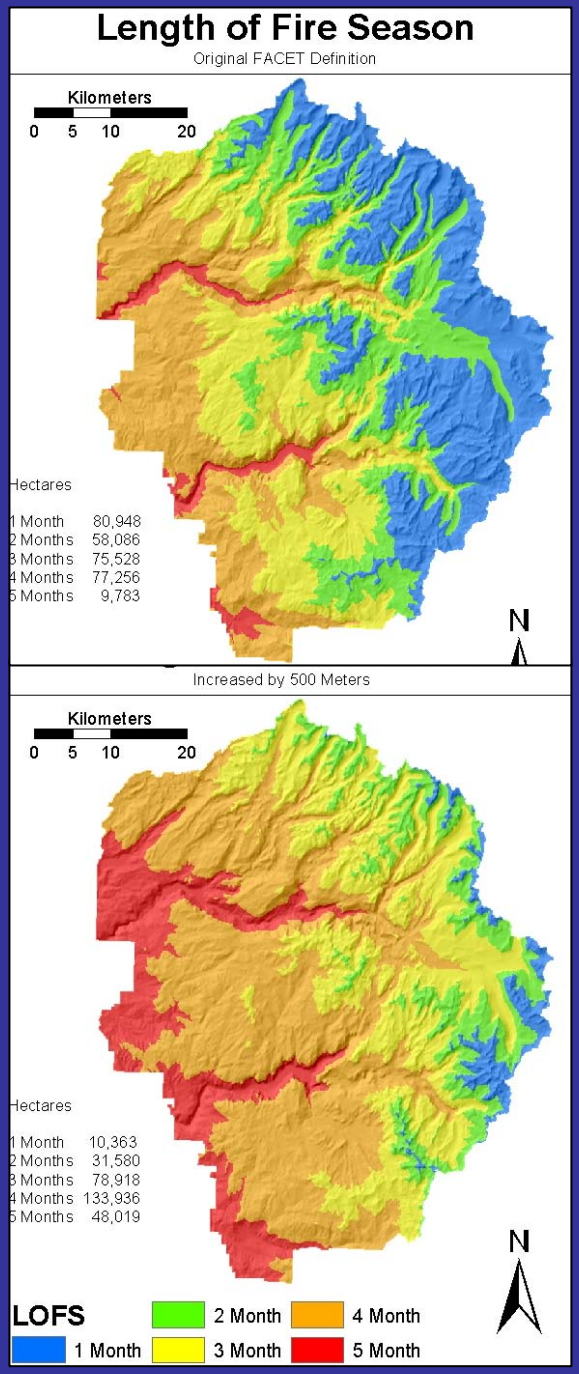
-Periodic Rx fire?

-Maximize WFU opportunities?

Sensitivity Analysis: frequency of fire-stopping events

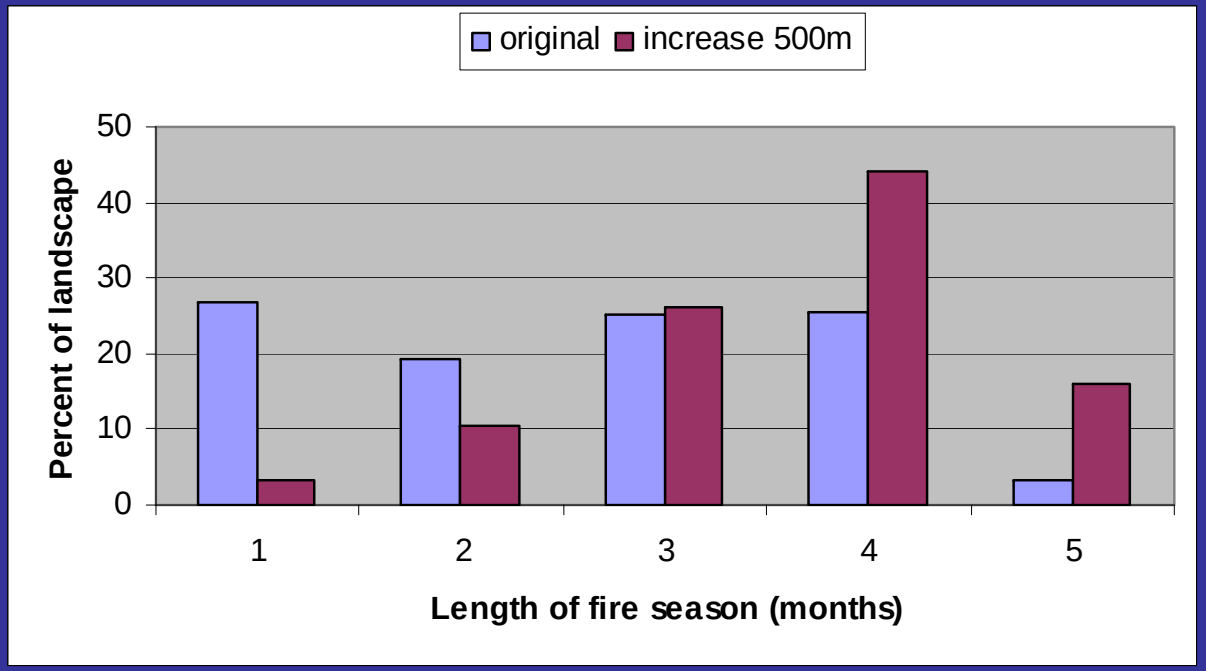


Some places are more sensitive to changes in rain frequency than others



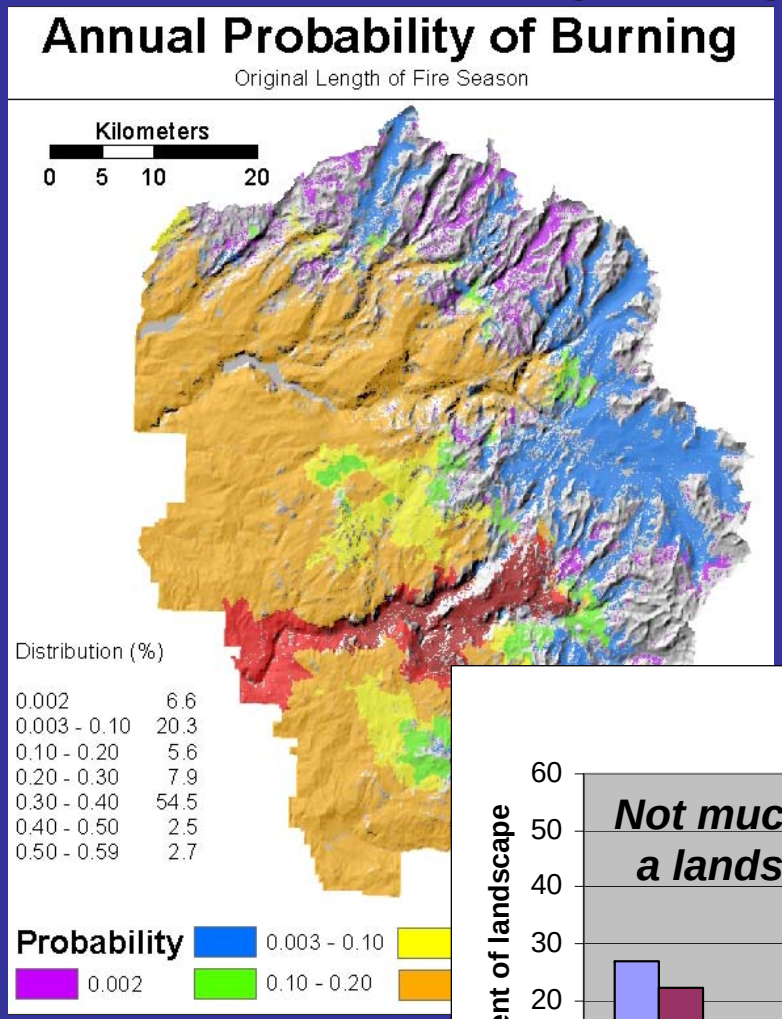
Sensitivity Analysis: length of fire season

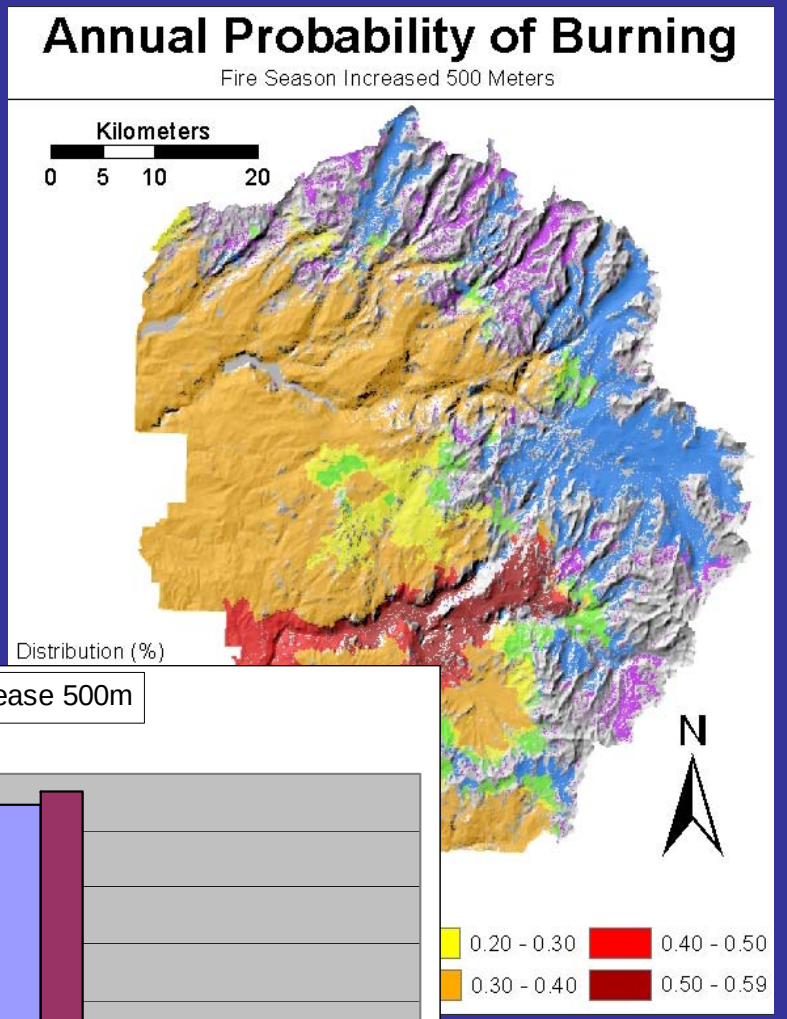
Shifted uphill by 500m

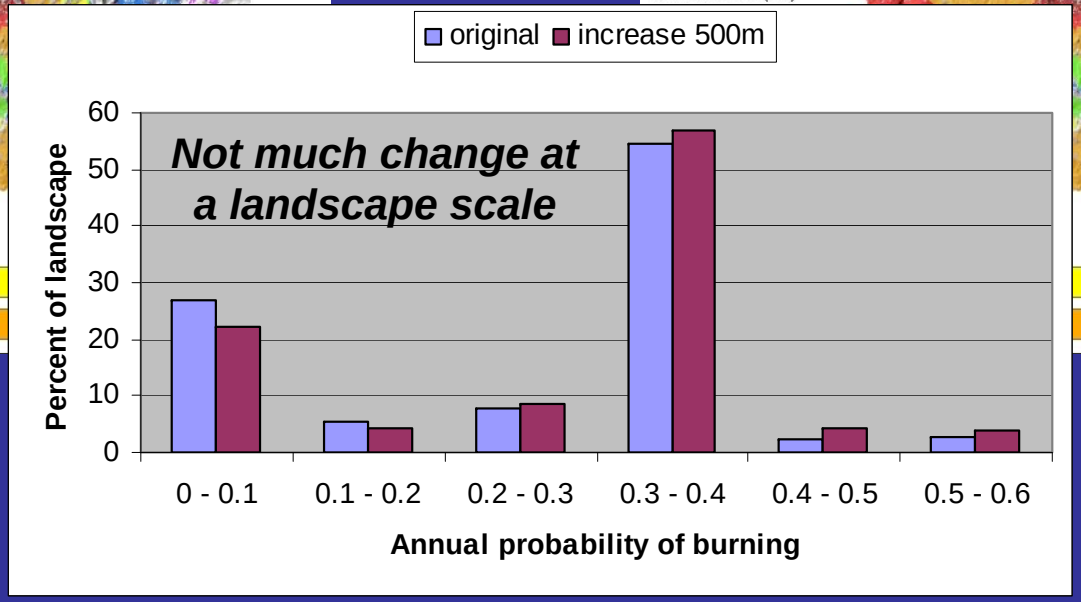


Dramatic change in length of season over much of landscape

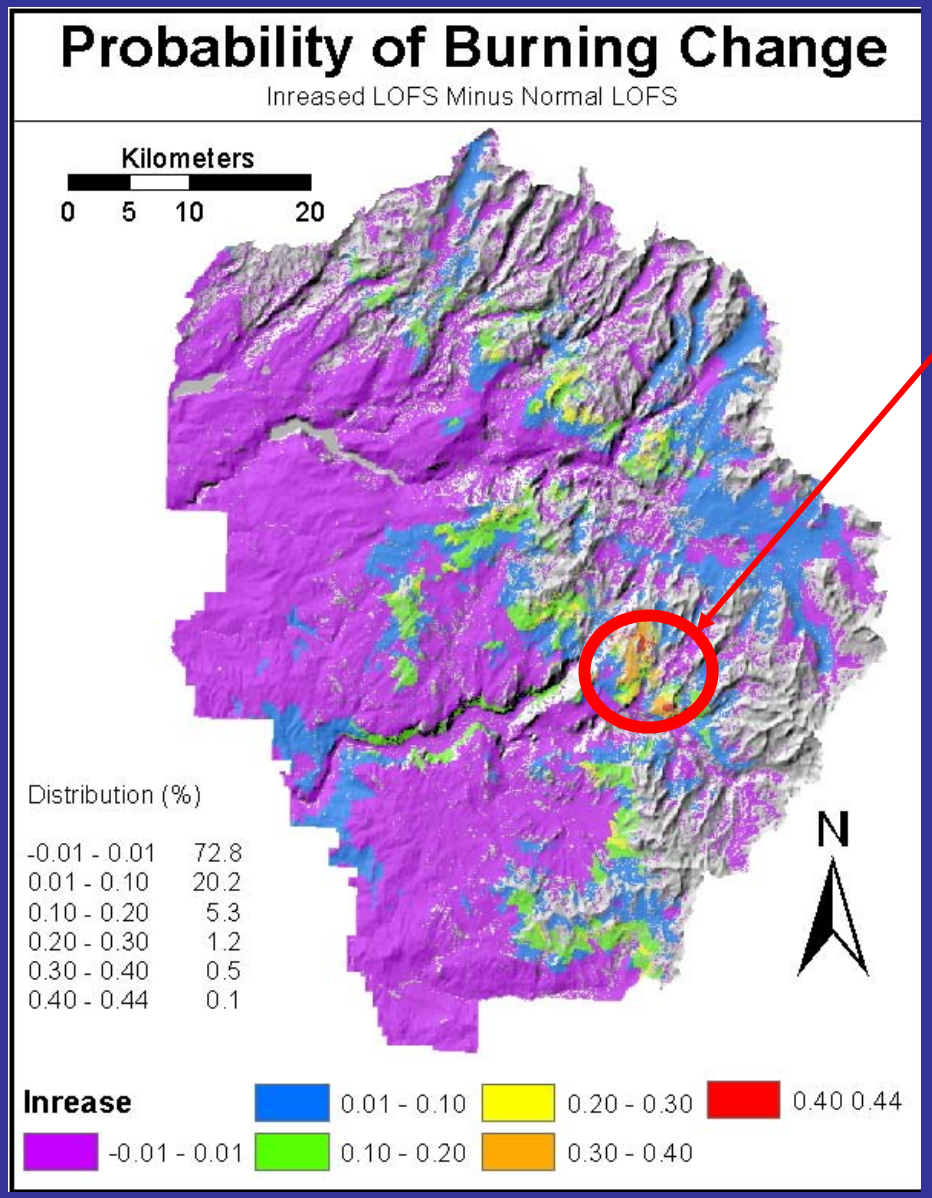
Sensitivity Analysis: length of fire season







Sensitivity Analysis: length of fire season

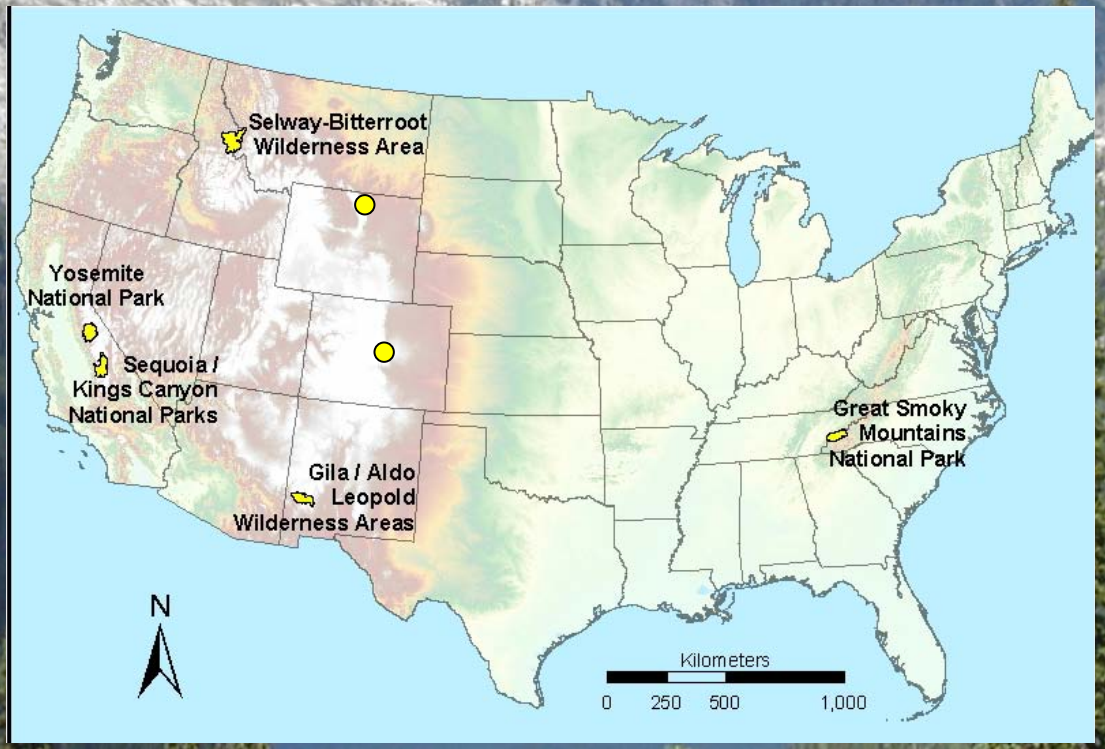


Dramatic change in some places

Spatial context matters!

Sensitivity varies across landscape

BurnPro is still under development and testing



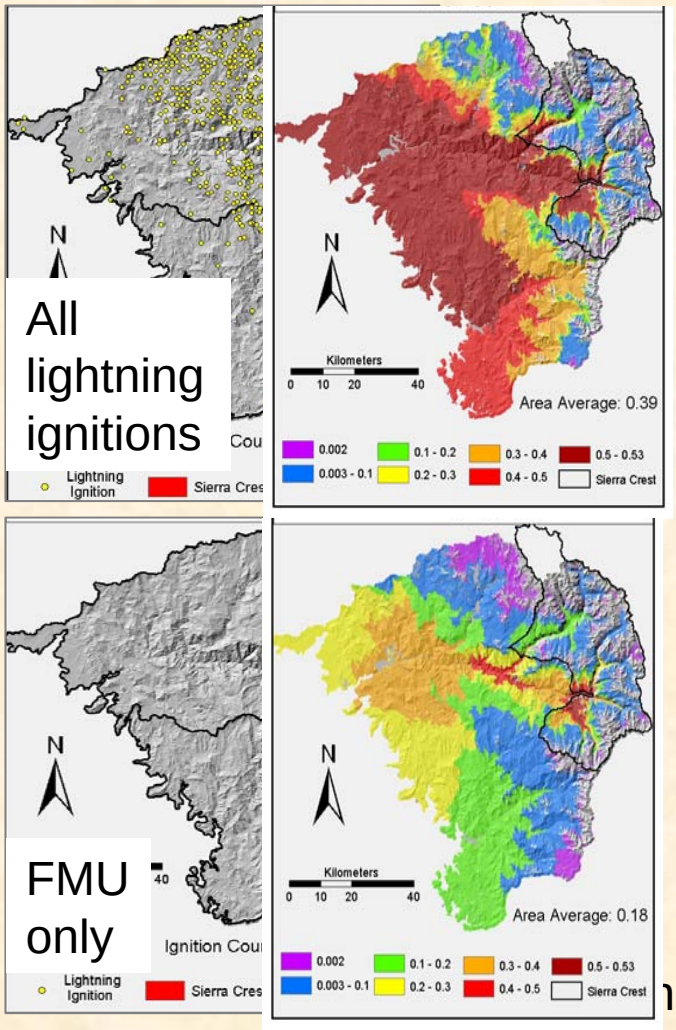
website http://leopold.wilderness.net/research/fprojects/F002.htm


Thanks!
aeblack@fs.fed.us or cmiller04@fs.fed.us
http://leopold.wilderness.net

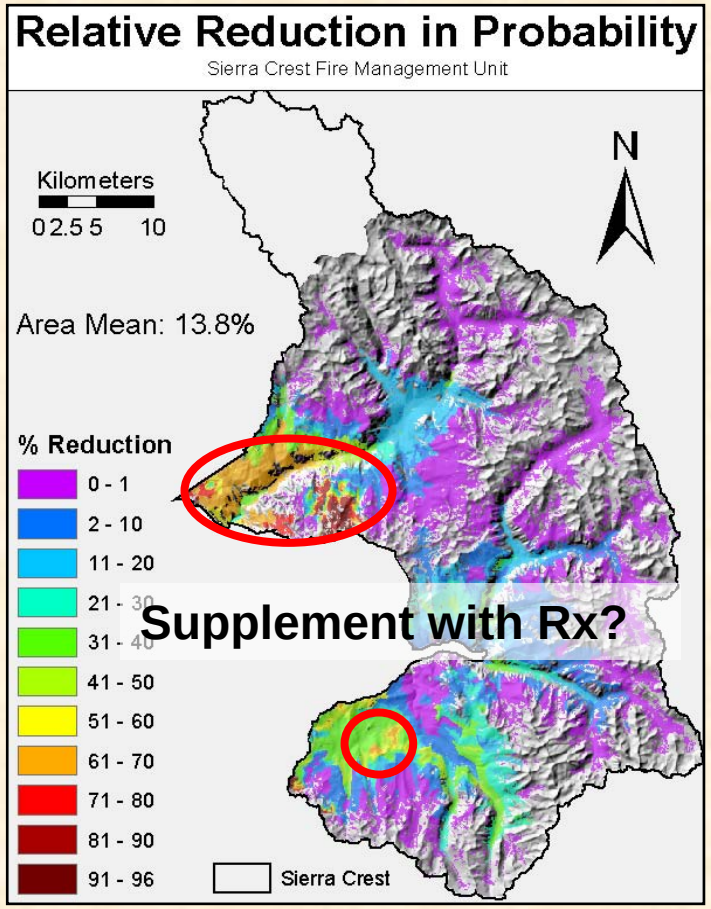
Cross-Boundary Suppression Effects

How does suppression on one side of a boundary affect WFU opportunities on the other side?

evaluating & revising objectives

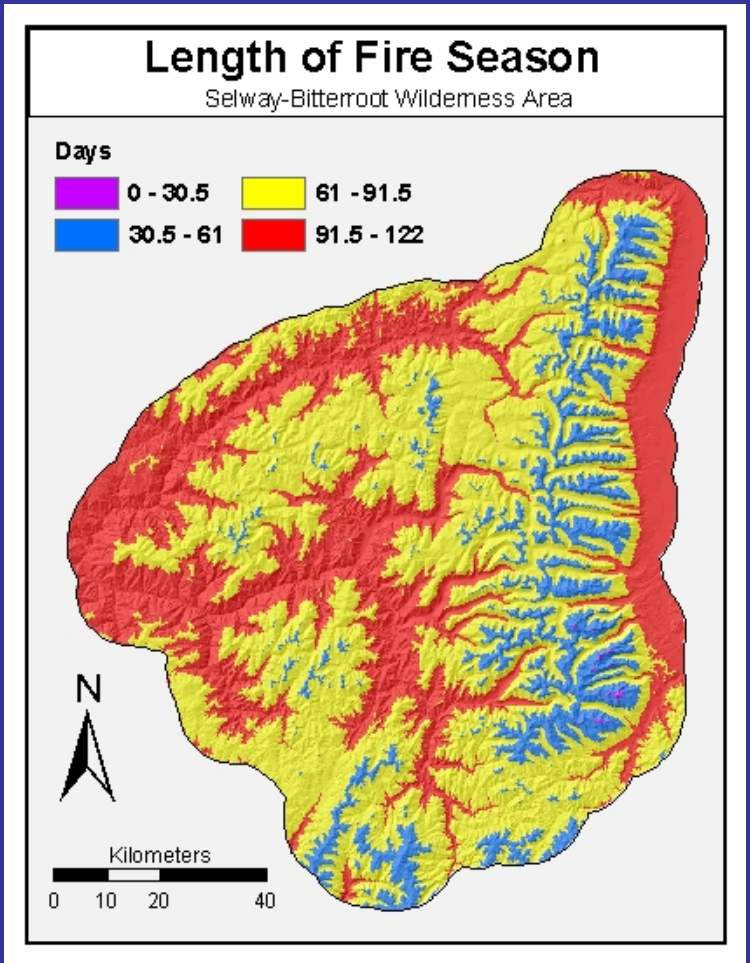


difference

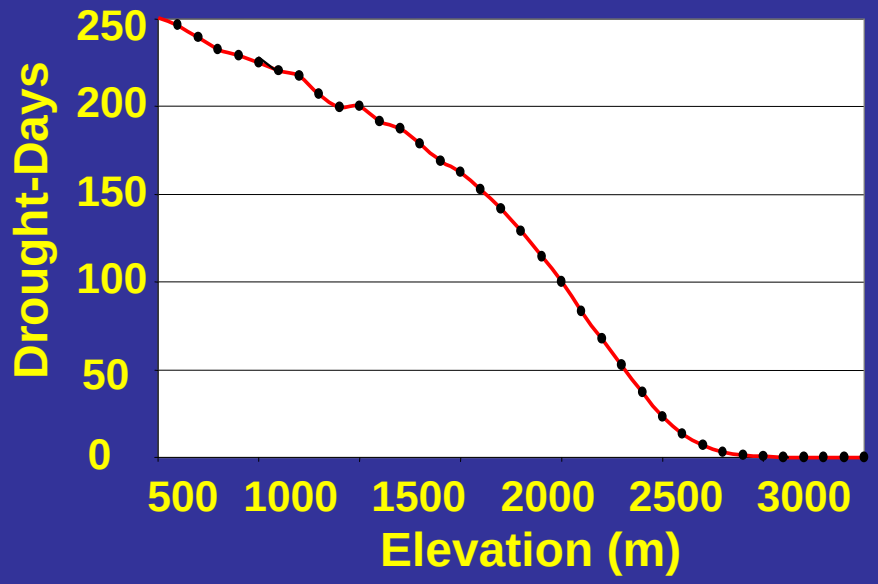


n Sierra: Sequoia-Kings Canyon NP and neighbors

1. How does length of fire season vary over elevation?



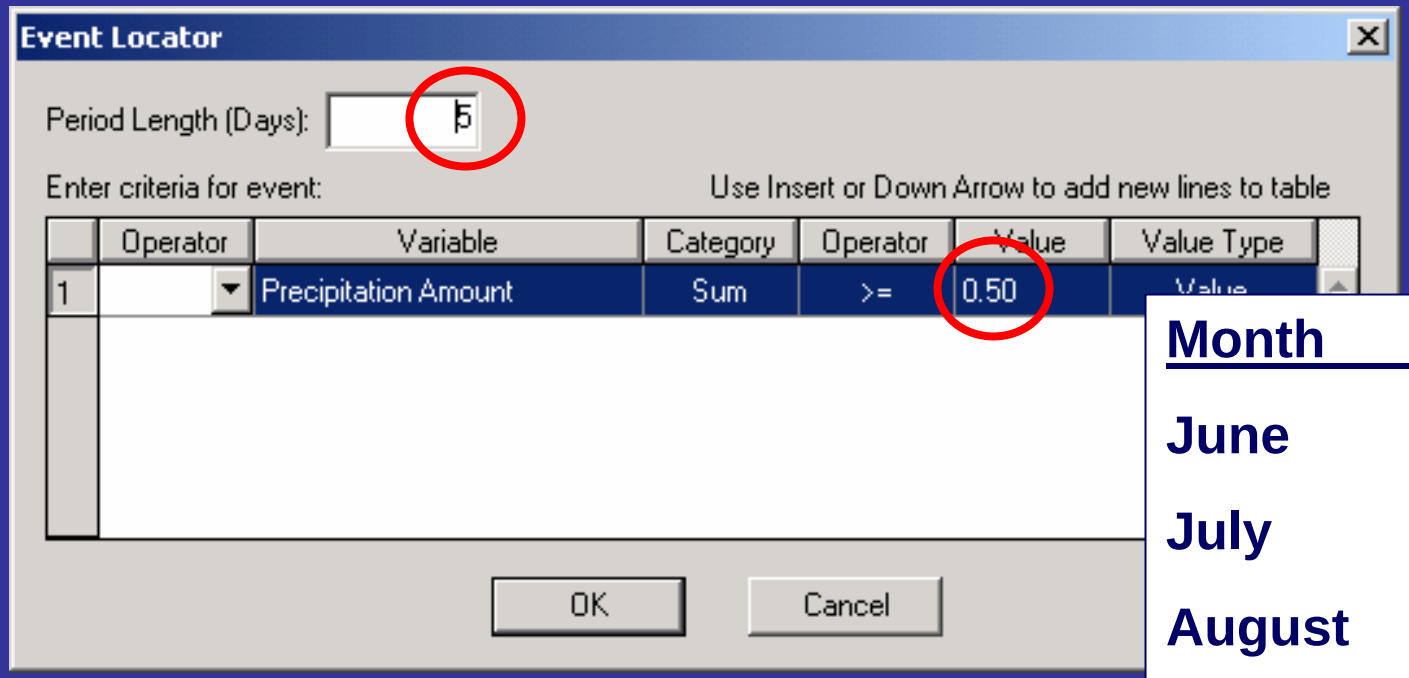
- **FACET** ***(Urban, D.L. et al. 2000)***
  - Drought-day function
  - Historic weather data



  - Scaled to fire season (4 months)
  - Proxy for season variation

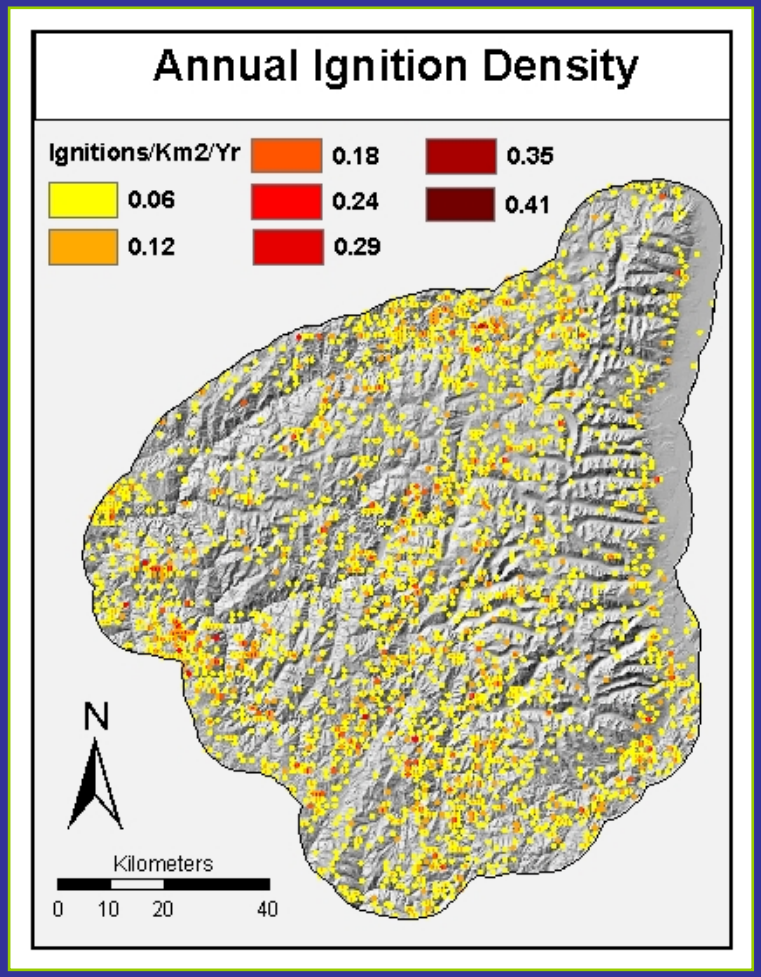
2. How frequently does the area experience a fire-stopping event?

- **Fire Family Plus: Event Locator**
  - 0.5 in. rain w/in 5 days (Latham, D.J. and Rothermel, R.C. 1993)
- **Compute mean monthly frequency**



Month	Frequency
June	2.43
July	1.29
August	1.40
September	1.25

3a. Where and when are ignitions?



- **Historic ignition data**

From NIFMID (1986 - present), separated into month of occurrence

- **Calculate ignition density**

Arc POINTSTATS, search radius 564m, divided by #years of data

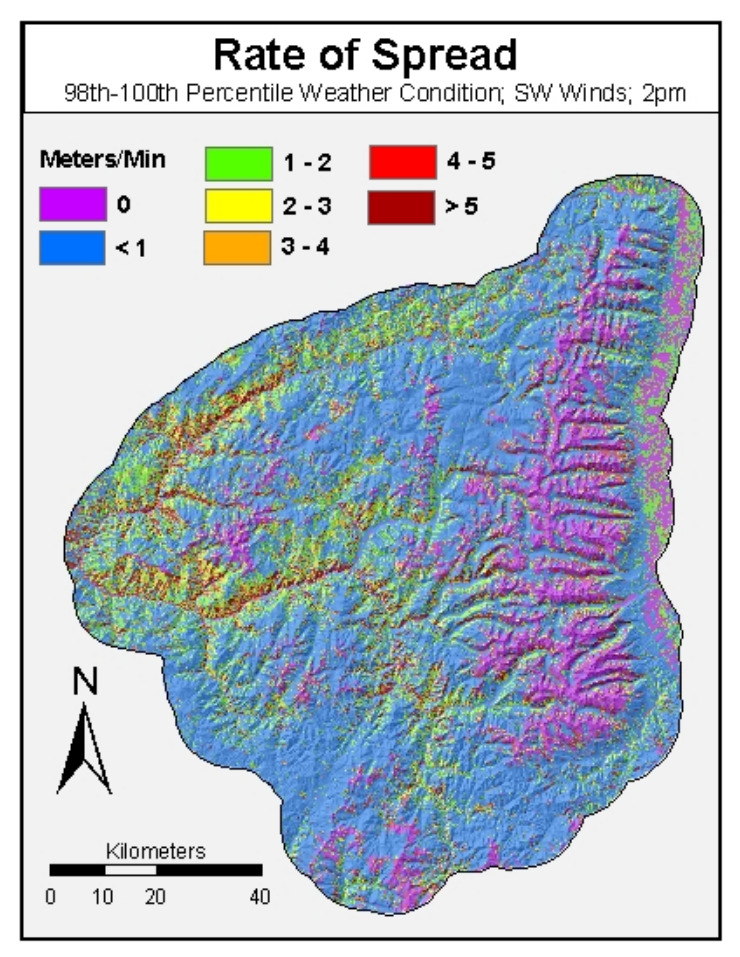
- **Create up to 5 density classes per month**

1, 2, 3, 4, 5+ per km^2 per year

- **Create up to 20 ignition grids: 4 months x 5 classes**

Month & density class will allow weighting of probability results

3b. How fast can fire spread?



- **ROS from FlamMap**

  Snapshot of expected fire behavior

  Current fuels

  Constant wind

  Constant fuel moistures conditioned under specified weather conditions

- **Static Conditions = Multiple Runs**

  Wind direction (8)

  Fuels conditioned with percentile weather defined using FireFamily+ (4)

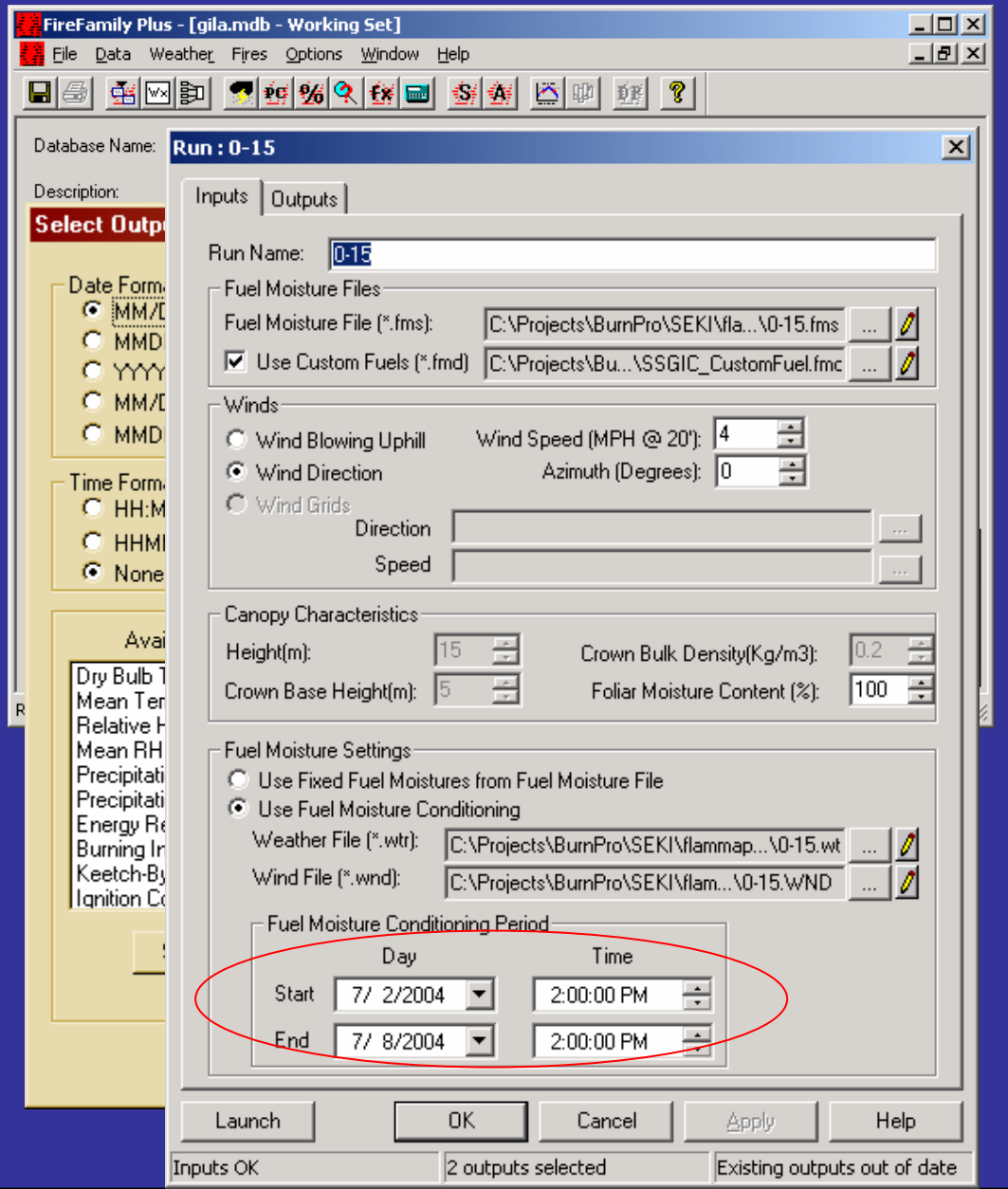
- **Create up to 32 ROS grids: 8 wind directions x 4 weather classes**

  Wind direction & weather class will allow weighting of probability results

Additional detail: conditioning fuels

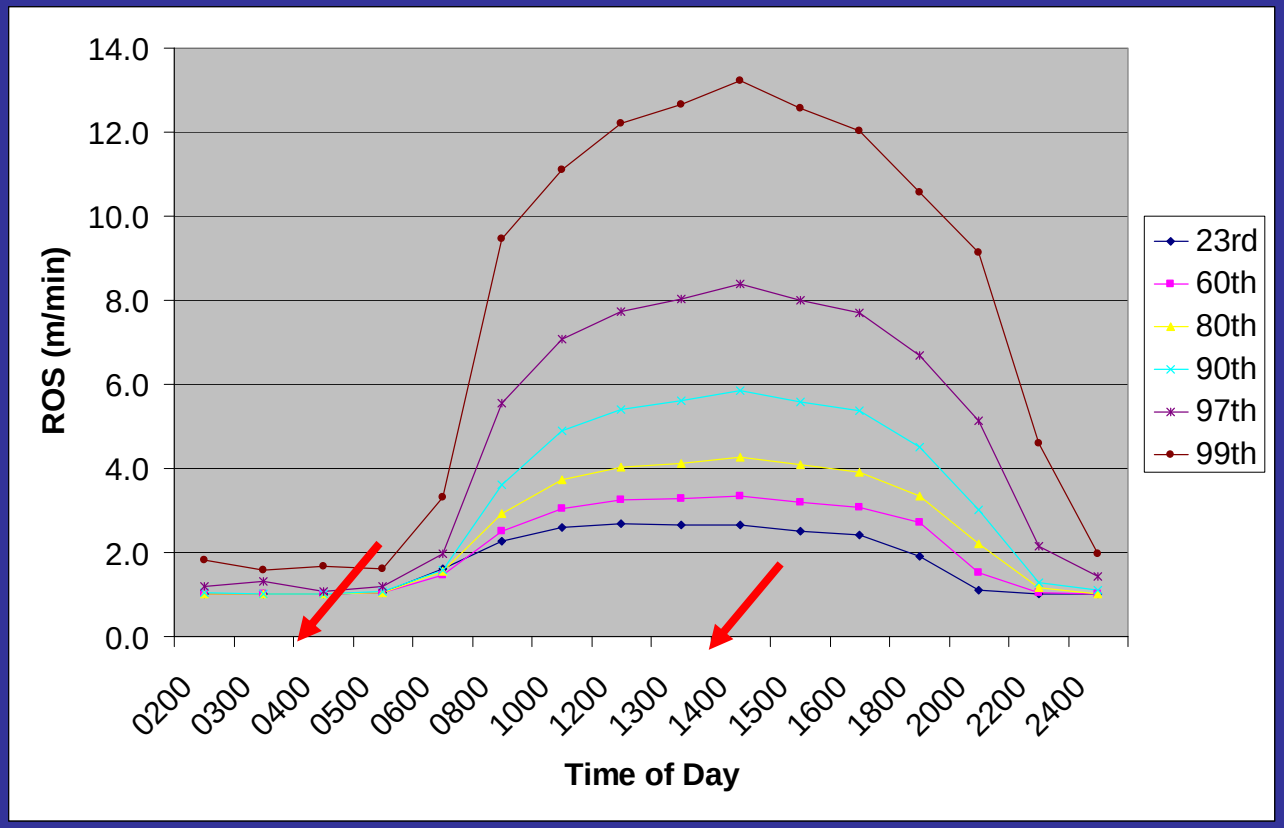
FireFamily+ to compute Spread Component index and weather parameters associated with selected percentile weather conditions

Average daily Rhmin, Rhmax, Tmin, Tmax, and wind speed used in FlamMap's .WTR and .WND files to condition fuels



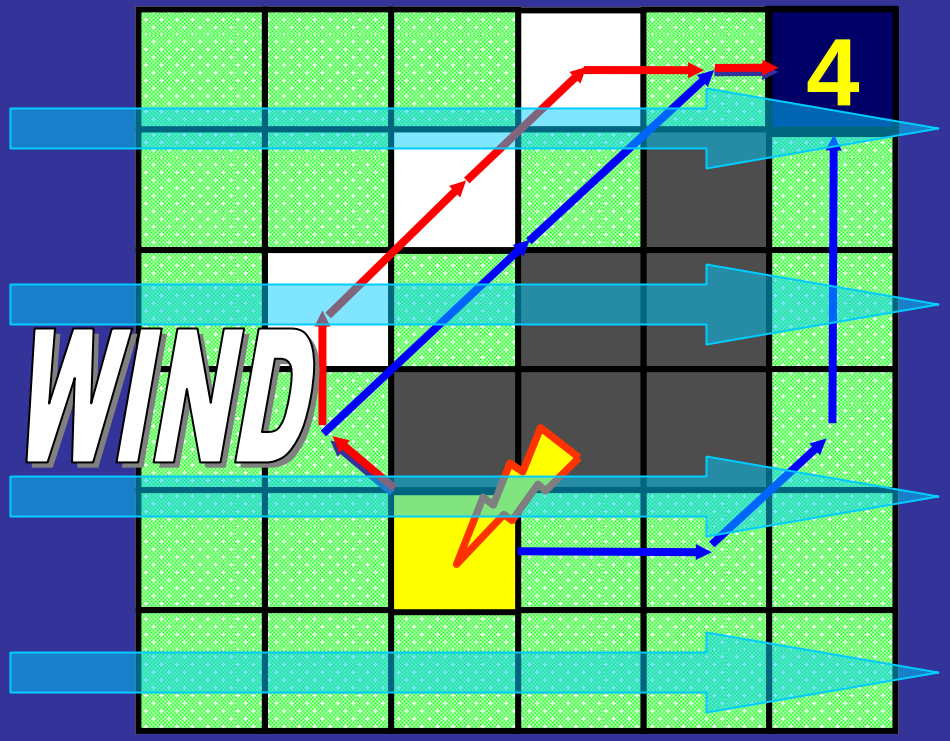
Additional detail: diurnal variation

Averaged ROS for conditioning periods ending at 4am and 2pm



3. How many days for fire to spread to each point?

- **PATHDISTANCE – Least Accumulative ~~Cost Distance~~ Spread Time**



Rock

“Slow” fuels (e.g., timber)

“Fast” fuels (e.g, grass)

-“**Source**” grid = ignition grid

Up to 20 of these: 4 months x 5 density classes

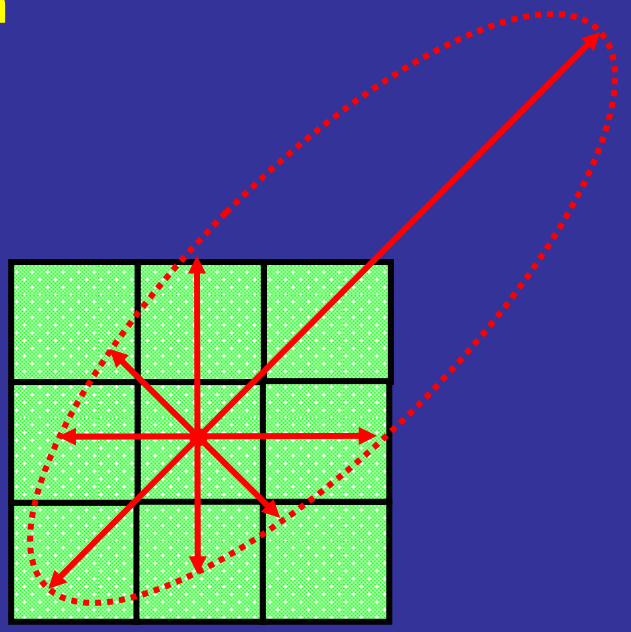
-“**Cost**” grid = Time = 1/ROS

32 of these: 4 weather conditions x 8 wind directions

-Cumulative Spread Time

Up to 640 of these: 20 source grids x 32 cost grids (e.g., June ignitions, density class 1, ROS for 90th percentile weather and winds from west.)

Additional detail: spread direction



ROS values apply to the direction of maximum spread.

We use Maximum Spread Direction (from FlamMap) and a table of adjustment factors (Anderson 1983) to account for different spread rates in heading, backing and flanking directions

Factors vary with windspeed

Direction Max ROS = 45 degrees

Direction	Adj factor 2 mph wind	Adj factor 6 mph wind
45 (max)	1.00	1.00
75	0.74	0.47
105	0.53	0.28
135	0.43	0.21
175	0.36	0.16

CST to compute P*End* and P*NoRain*

Length of Fire Season

CST (640 Grids)

Rain Frequency

P*Burn*

=

P*End*

X

P*NoRain*

640 Probability Grids

$$P_{End} = \exp\left[-\left(\frac{CST}{\text{season length}}\right)^{\eta}\right]$$

$$P_{NoRain} = 1 - P_{Rain}$$

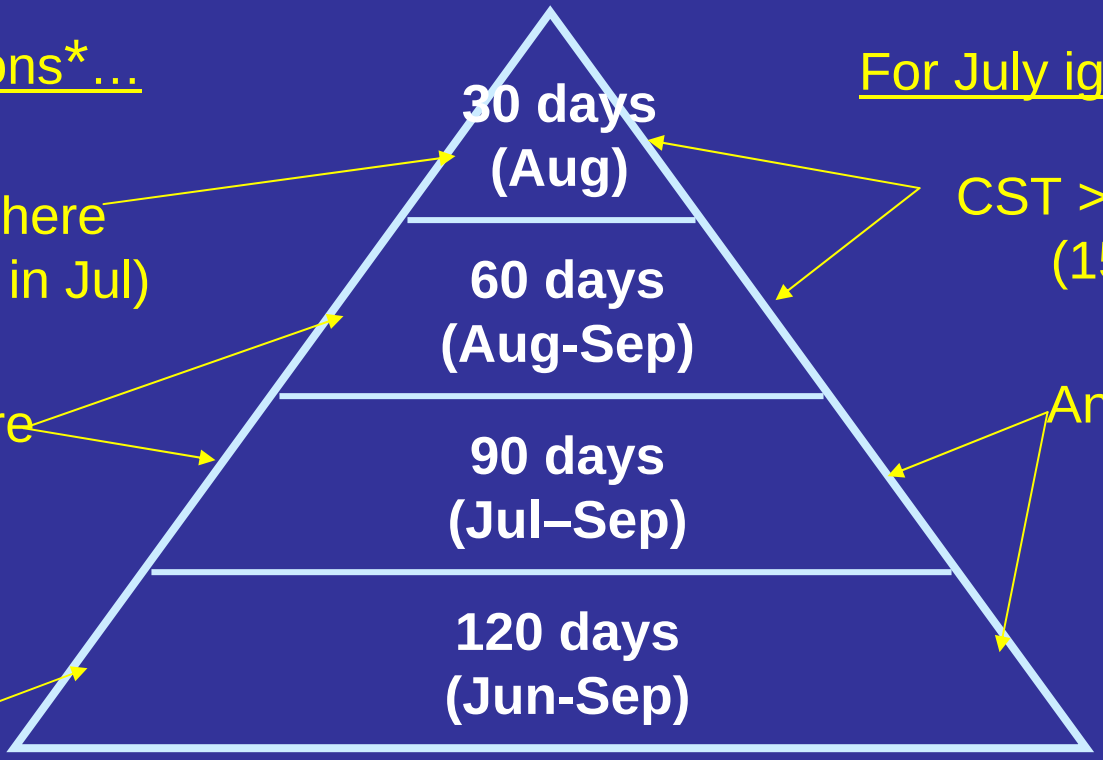
Additional detail: timing of fire season and spread time

For June ignitions*…

CST >= 45 d here
(15 in Jun + 30 in Jul)

CST >= 15 d here
(15 in Jun)

Any CST valid here



For July ignitions*…

CST >= 15 d here
(15 in Jul)

Any CST valid here

* For simplicity, ignitions assumed to occur mid-month

Average Annual Probability of Burning

Length of Fire Season

CST (640 Grids)

Rain Frequency

=

X

***P*Burn**

***P*End**

***P*NoRain**

640 Probability Grids → ***Weighted Averaging*** *(weather percentile, wind distribution & ignition density)* → **Average Annual Probability Grid**