Management Applications of LANDFIRE BPS Models in California National Forests

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Presented to

California Fire Science Network
January 19, 2016

*LANDFIRE's mission is to provide agency leaders and managers with a common **"all-lands" data set** of vegetation and wildland fire/fuels information for strategic **fire and resource management** planning and analysis.*

Today's Agenda

Management Uses of State-and-Transition Models

- Background on S&T/BpS* model development in the Sierra Nevada
- Model limitations and assumptions
- Examples of management applications

**BpS = Biophysical Settings. State-and-transition models for every ecosystem mapped by LANDFIRE between 2005-2009. Models and descriptions combined offer information about vegetation dynamics, structure and composition on lands across the U.S. prior to Euro-American settlement. They are currently being reviewed & updated. Please participate in the update!*

What is a State-and-Transition Model?

- S&T models represent ecosystems and their dynamics as a set of box and arrow diagrams
  - boxes represent discrete ecosystem “states”
  - arrows linking the boxes represent “transitions” among the states
- Non-equilibrial, aspatial description of ecosystem dynamics that can incorporate
  - numerous successional pathways
  - multiple steady states
  - threshold effects
  - reversible and irreversible transitions
- LANDFIRE BpS models are a type of S&T model

State & Transition Modeling: VDDT Platform

Vegetation Dynamics Development Tool

ESSA 35 YEARS

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VDDT

The Vegetation Dynamics Development Tool (VDDT) is a user-friendly, Windows-based computer tool which provides a state and transition landscape modelling framework for examining the role of various disturbance agents and management actions in vegetation change. It allows users to create and test descriptions of vegetation dynamics, simulating them at the landscape level.

Projecting changes in vegetation structure and composition over time is an important part of landscape-level analyses. Vegetation may change for a variety of reasons, such as human activity, fires, insects, pathogens, mammals, weather, or growth and competition. The interaction of these factors is complex and the combined effects are difficult to predict over long periods.

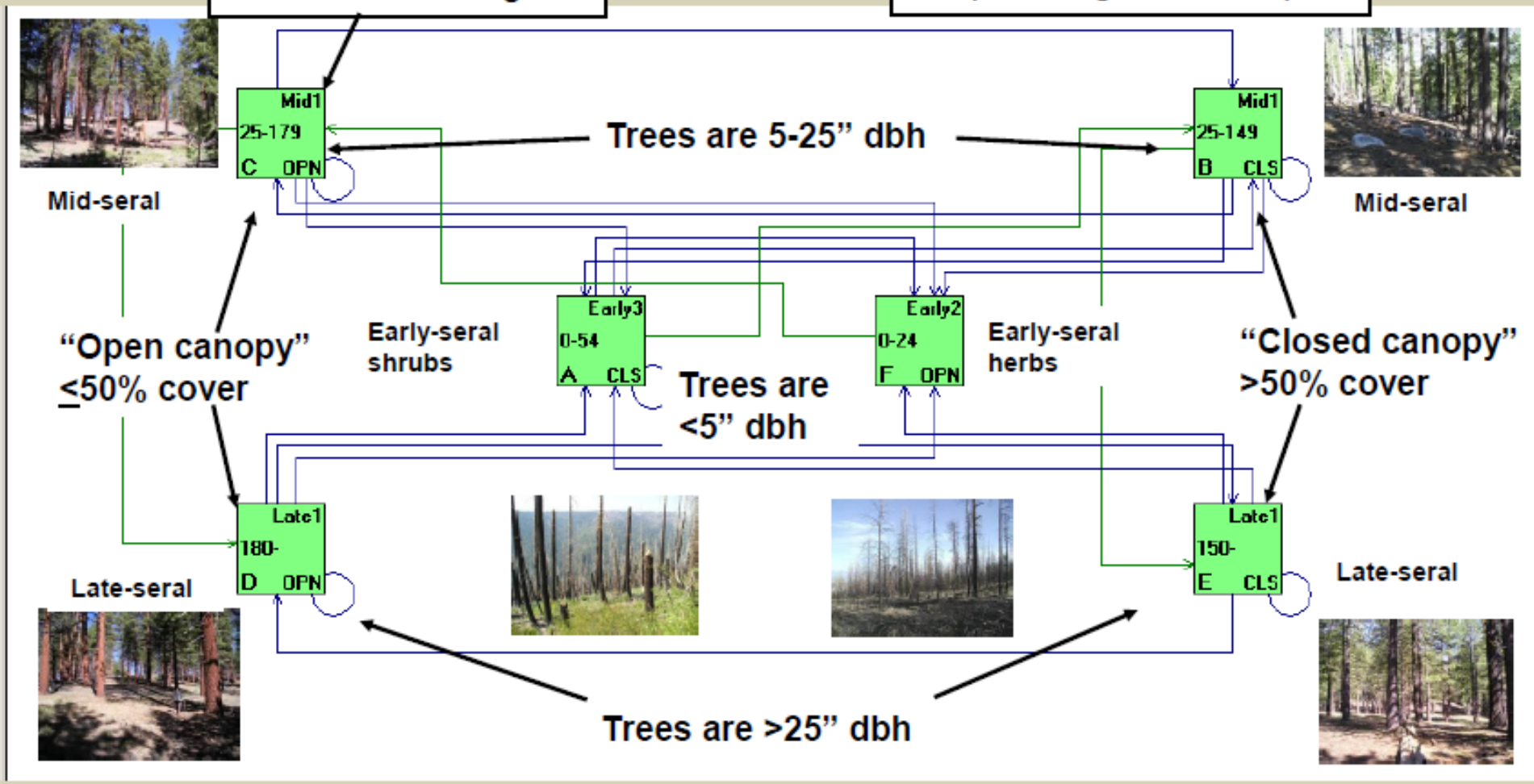
VDDT provides a common platform for specialists from different disciplines — e.g., entomology, pathology, fire ecology, silviculture, wildlife biology and ecology — to collectively define the roles of various processes and agents of change on landscape-level vegetation dynamics. Moreover, VDDT allows for rapid gaming and testing of the sensitivity of the ecosystem to alternative assumptions. It thus provides a means for learning and communication.

ESSA Tools

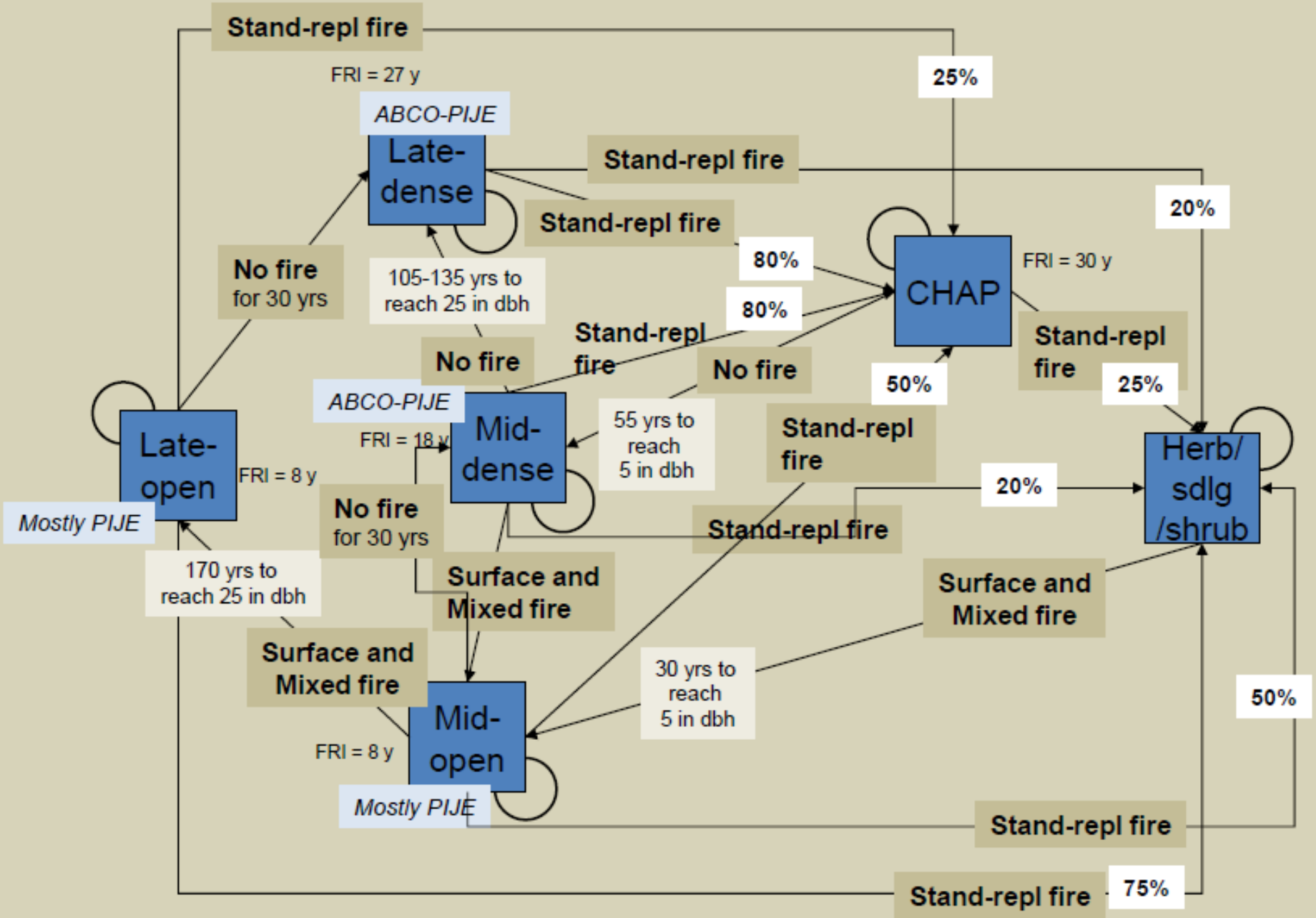
- MERCI & MERCI PET
- Okanagan Nation Alliance Data Portal
- Okanagan Water Viewer
- Spawn Mapping Tool
- Skeena Salmon Explorer
- Ecological Flows Tool
- Okanagan Fish Water Management Tool (FWMT)

- VDDT
- TELSA
- Path Landscape Model
- FVS/Prognosis

Example S&T Model Inputs: States



Model Inputs: Succession and Fire Transitions

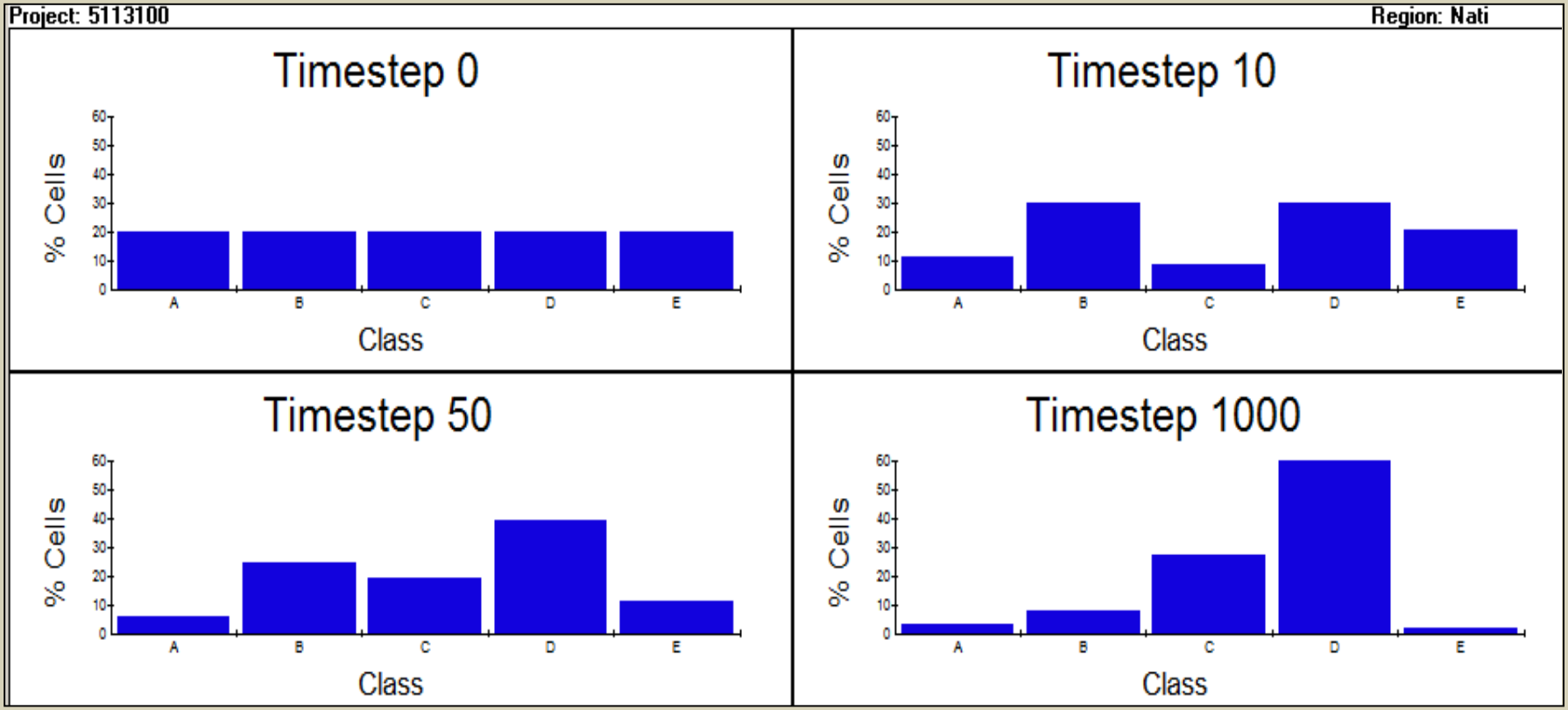


Transitional Probabilities Table

SCN:	To class	Transition code	Transition	Prob	Min age	Max age	Rel age	TSD
	1	LTBMU_PIJE_5						
	A	2	Closed	1003	Early-Develop			
	Succession:	B	54					
	A	1003	ReplacementFire	0.0264	0	54	-99	15
	A	1101	Competition/Maint	0.01	0	54	-5	
	B	2000	AltSuccession	0.3	25	54	0	
	F	1002	MixedFire	0.0066	15	54	0	
	B	2	Closed	2001	Mid-Develop			
	Succession:	E	124					
	A	1002	MixedFire	0.01	25	149	0	10
	A	1003	ReplacementFire	0.01083	25	149	0	5
	B	1001	SurfaceFire	0.0272	25	149	0	
	B	1101	Competition/Maint	0.01	25	149	-10	
	B	1201	Insect/Disease	0.0025	25	149	0	1
	C	1002	MixedFire	0.04	25	149	0	10
	C	1201	Insect/Disease	0.0025	25	149	0	1
	F	1003	ReplacementFire	0.00272	25	149	0	5
	C	3	Open	2001	Mid-Develop			
	Succession:	D	154					
	A	1002	MixedFire	0.0015	25	179	0	10
	A	1003	ReplacementFire	0.0012	25	179	0	5
	B	2000	AltSuccession	1	25	179	0	30
	C	1001	SurfaceFire	0.1	25	179	0	
	C	1002	MixedFire	0.02	25	179	0	10
	C	1201	Insect/Disease	0.002	25	179	0	1
	C	1501	Optional1	0.005	25	179	5	
	F	1002	MixedFire	0.0015	25	179	0	10
	F	1003	ReplacementFire	0.003	25	179	0	5

S&T Model Outputs

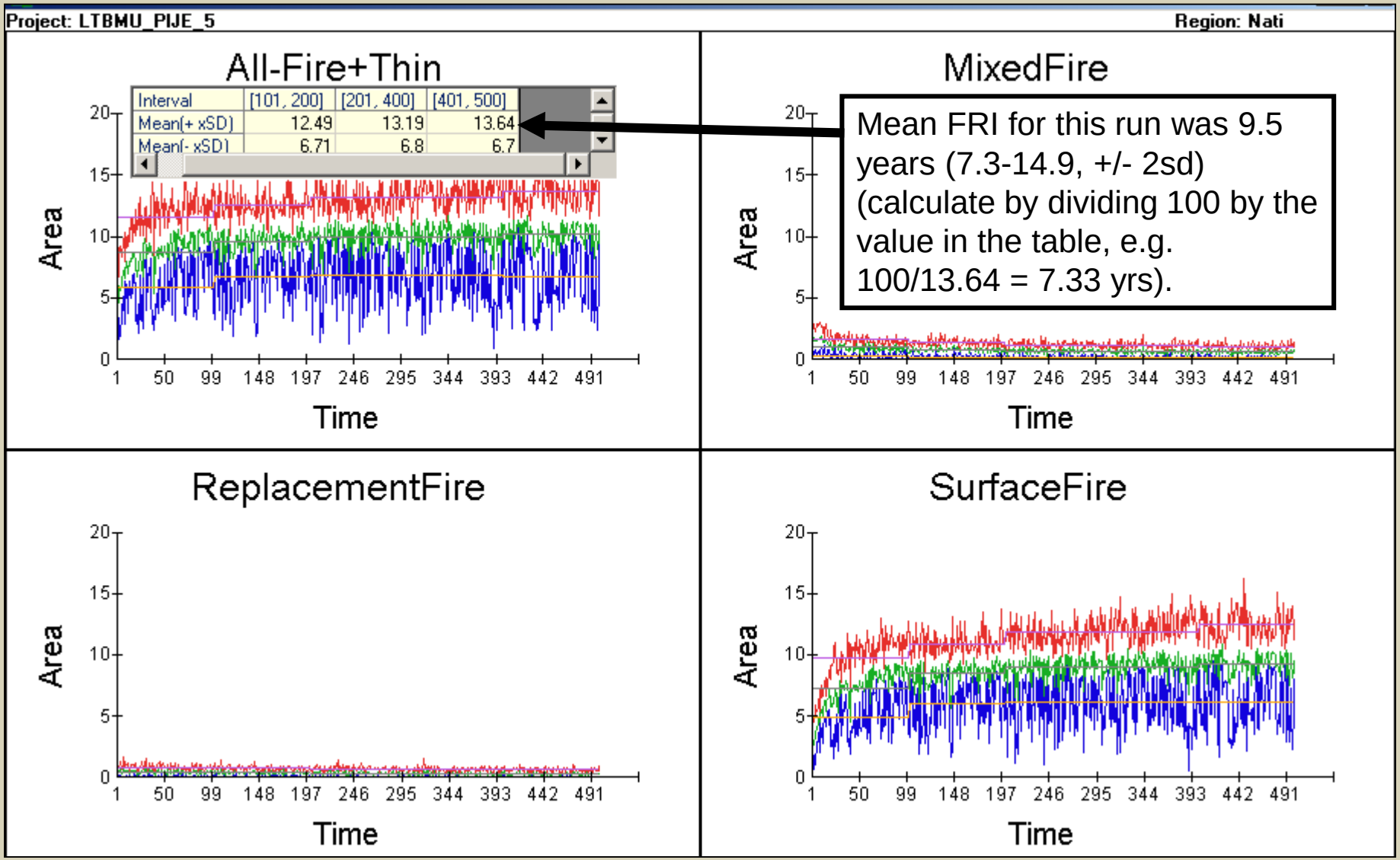
S&T simulations generate summaries of successional states over time



In this case, BpS model run for 1000 years, means of 10 simulations

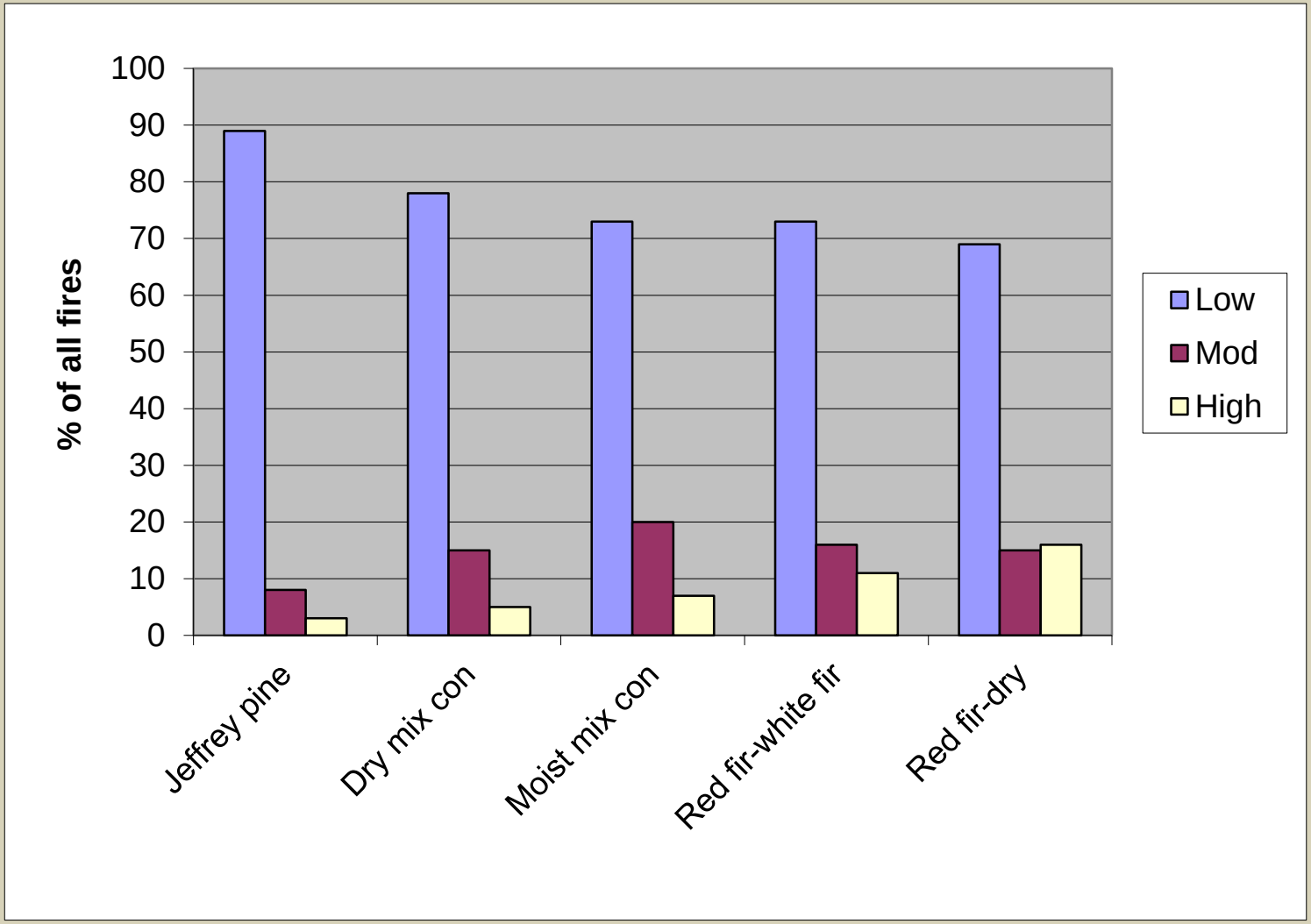
S&T Model Outputs

Fire return intervals (FRIs) and their variability



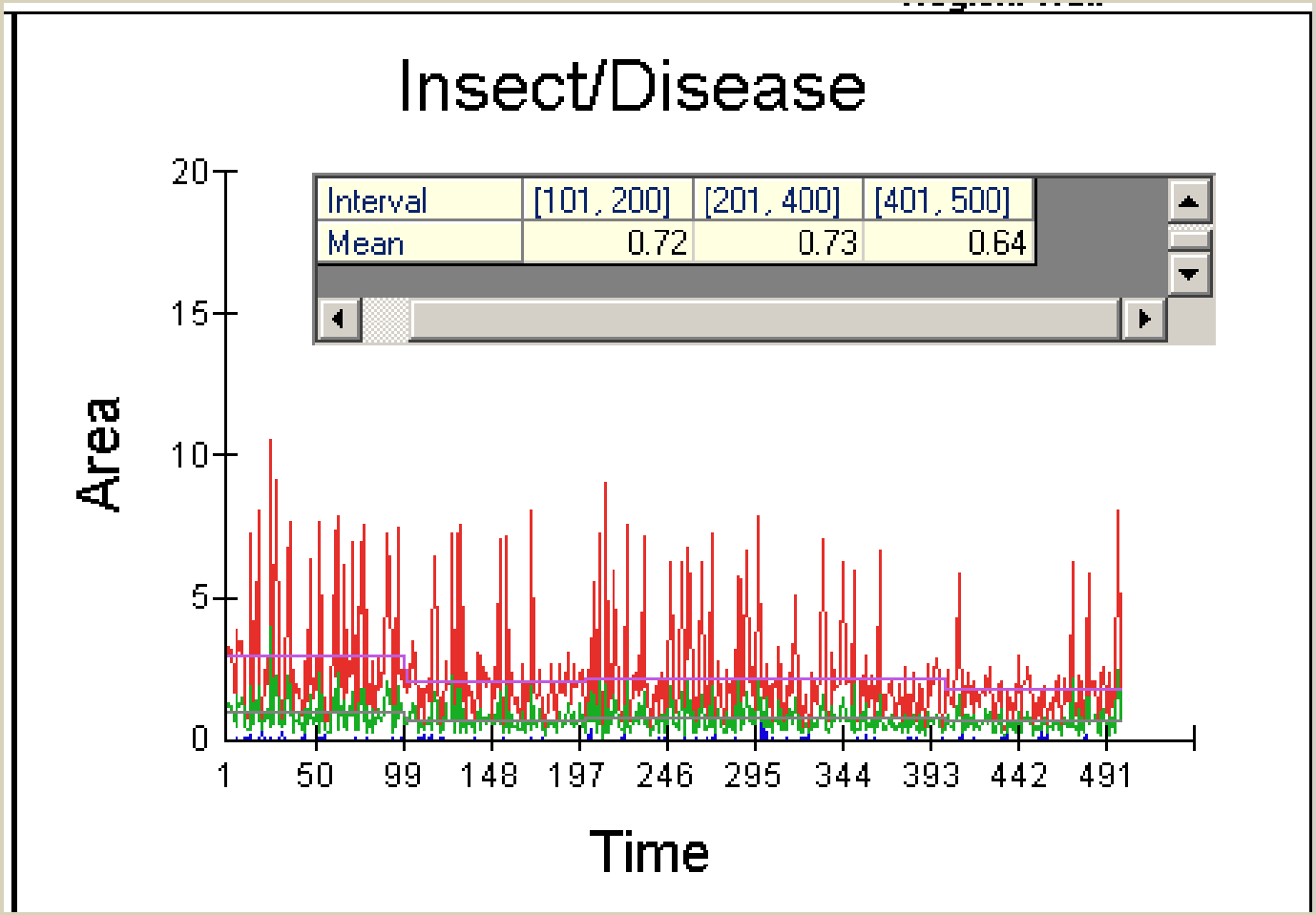
S&T Model Outputs

Fire severity: proportions of fire area burning at low, moderate, and high severity



S&T Model Outputs

Insect and disease mortality and their variability



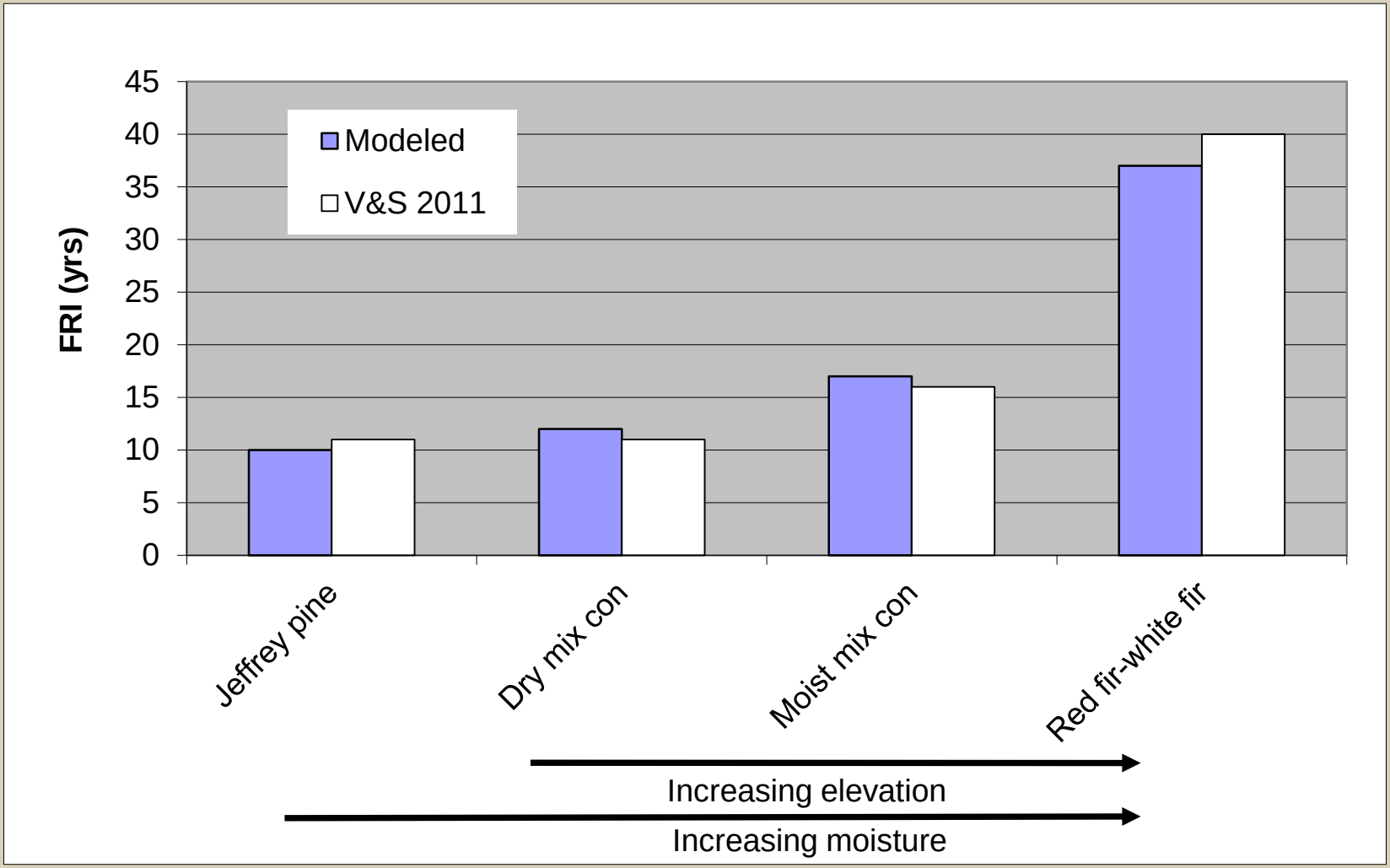
0.64% of landscape affected by insects/disease in average year, varying by up to about 20x

Seral stage	Drought multiplier (V/L/N/H/S)	A	FRI	B	FRI	C	FRI	D	FRI	E	FRI	F	FRI
Age		0-55		25-159		25-199		200+		160+		0-25	
Inferred dominants		Shrubs		PIJE+ABCO		PIJE		PIJE		PIJE+ABCO		Herbs	
Canopy Cover		High (mtn chaparral)		>40%		≤ 40%		≤ 40%		>40%		Low (herbs/sdlgs)	
dbh		<5”		5-25”		5-25”		>25”		>25”		<5”	
All fire		.033	30	.0906	11	.1272	8	.1254	8	.0632	16	.	
Low sev	0.5/ 1/ 1/ 1/ 1.2			.0272 (30%)	37	.1 (79%)	10	.122 (97%)	8	.0221 (35%)	45		90 %
Mixed sev	0.3/ 0.8/ 1/ 1.2/ 1.5	.0066 (20%)	152	.0498 (55%)	20	.023 (18%)	43	.002 (2%)	500	.0348 (55%)	29	.	7%
High sev	0.1/ 0.5/ 1/ 2/ 3	.0264 (80%)	38	.0136 (15%)	74	.0042 (3%)	238	.0014 (1%)	714	.0063 (10%)	159		3%
Insct/Dis	0.5/ 0.8/ 1/ 5/ 20			.005		.002		.001		.004			
% of landscape		7		5		30		51		3		4	

Jeffrey Pine

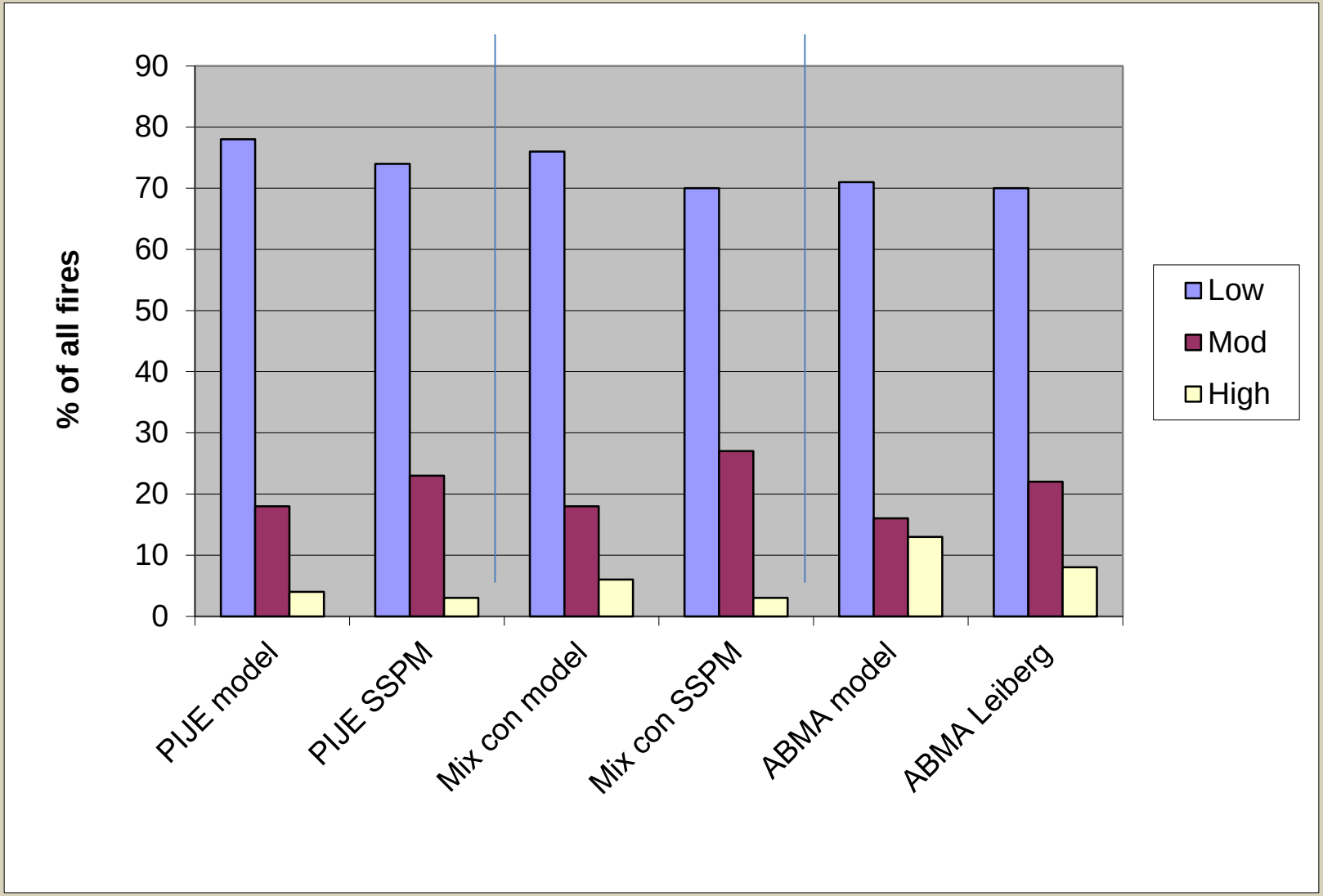
Overall FRIs: All – 9.9 (8-12)y; Replacement – 325 (167-5000)y; Mixed – 149 (91-417)y; Surface – 11 (9-13)y

Model Validation: fire return intervals



Van de Water and Safford 2011 *Fire Ecology*

Model Validation: fire severity

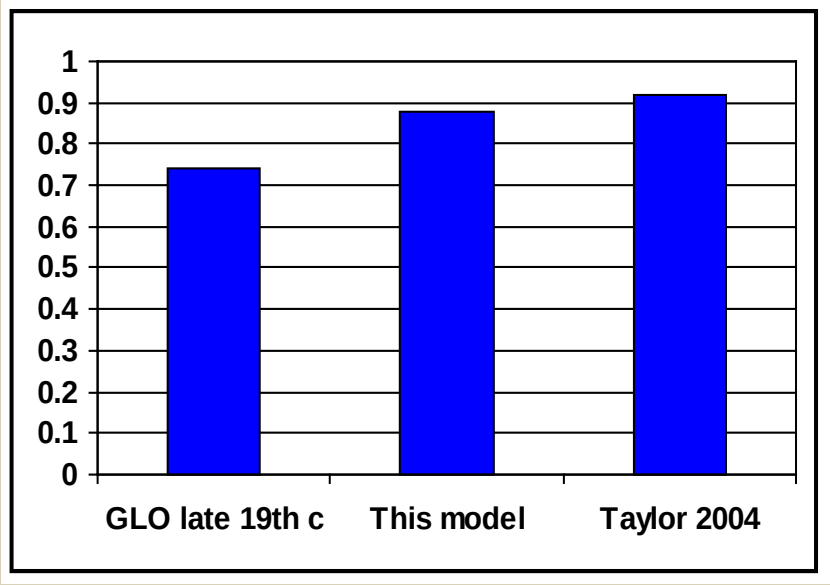


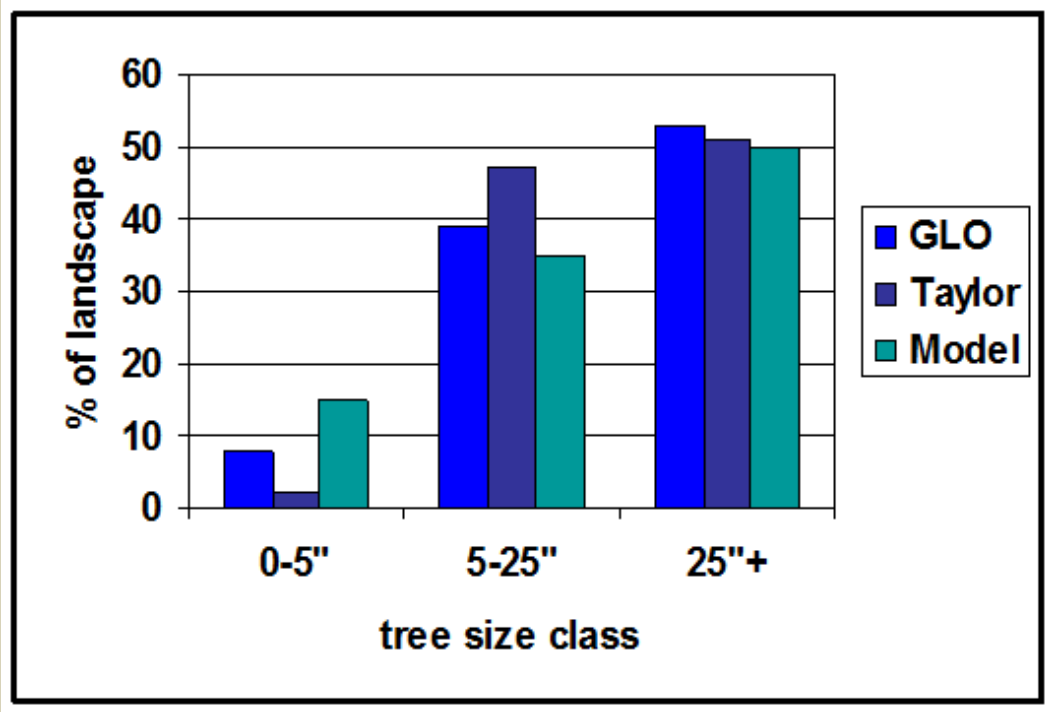
SSPM = Baja California ref forests, from Rivera et al. in press; ABMA: Leiberg 1902

Model Validation: tree size classes

Comparing model outputs versus reference data from the Lake Tahoe Basin, Jeffrey pine model

Ratio of large vs medium + small trees





% of landscape dominated by different size classes

GLO = General Land Office data, late 1800s; Taylor 2004 *Ecological Apps*

BpS: Some Assumptions and Limitations

- BpS outputs only applicable to large landscapes, not forest stands.
  - Sierra Nevada minimum = c. 10,000 acres
  - Manage within context of contribution
- BpS models must be clearly defined ecologically and assigned to parts of management landscape that meet that definition
  - Models apply to potential veg types, not existing veg
  - Transitions between BpS's are not possible

BpS: Some Assumptions and Limitations

- BpS models are not spatially explicit
  - Do not deal directly with landscape dynamics
  - Variability in model runs is often low
  - Differences in slope, aspect, elevation, soils can be explicitly incorporated only in certain situations

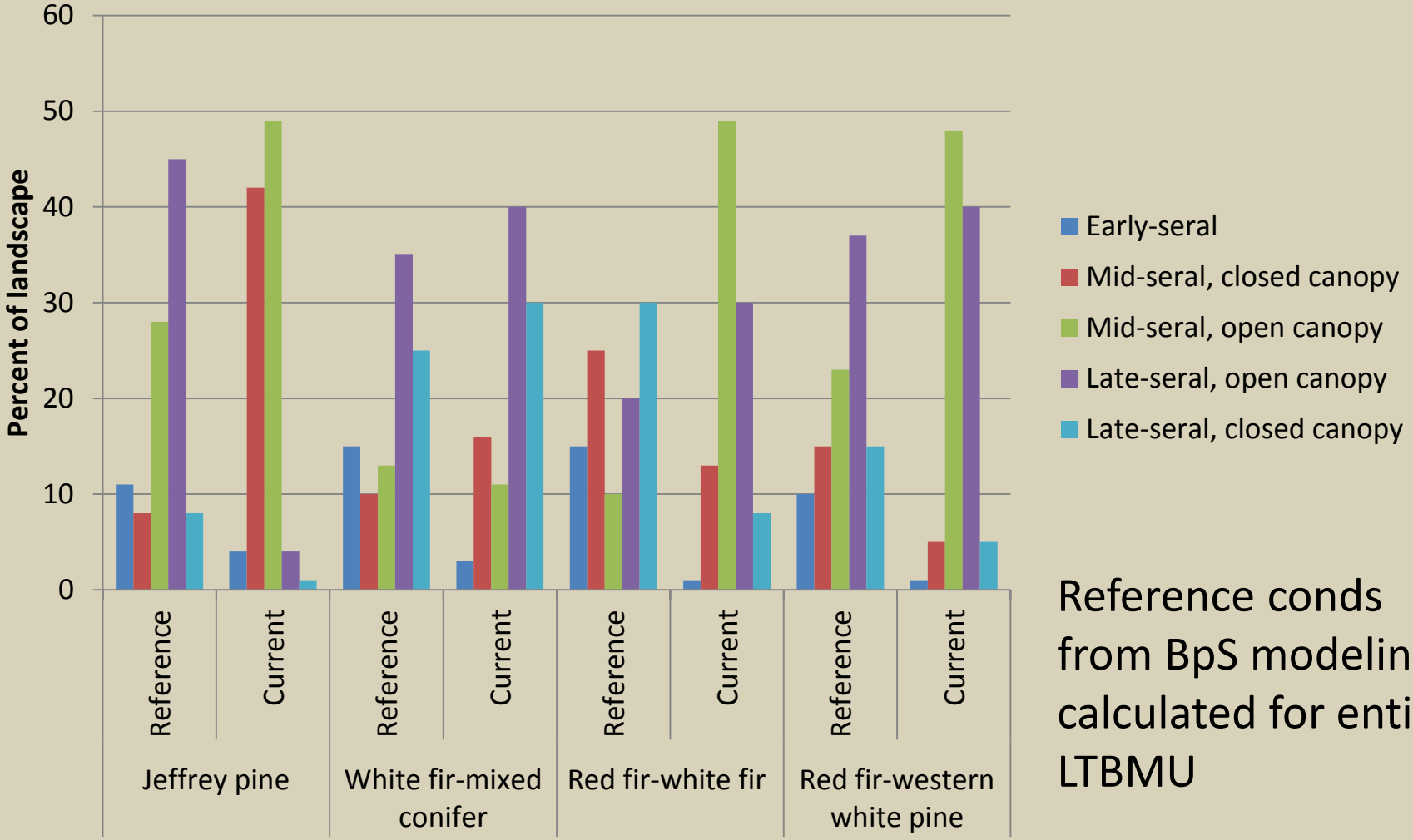
- BpS models are very simple
  - Strict limits on numbers of states and types of transitions
  - No incorporation of Landscape Multipliers or Year Type Multipliers
  - Time Since Disturbance fx only used to represent absence of a disturbance, not used to represent lack of fuels

BpS: Some Assumptions and Limitations

- BpS models represent pre-Euromerican settlement reference conditions
  - Outputs can be difficult to validate/assess for accuracy since there are few reference landscapes remaining
  - Models do not include effects of management or climate change

Model Applications: Structural Outputs

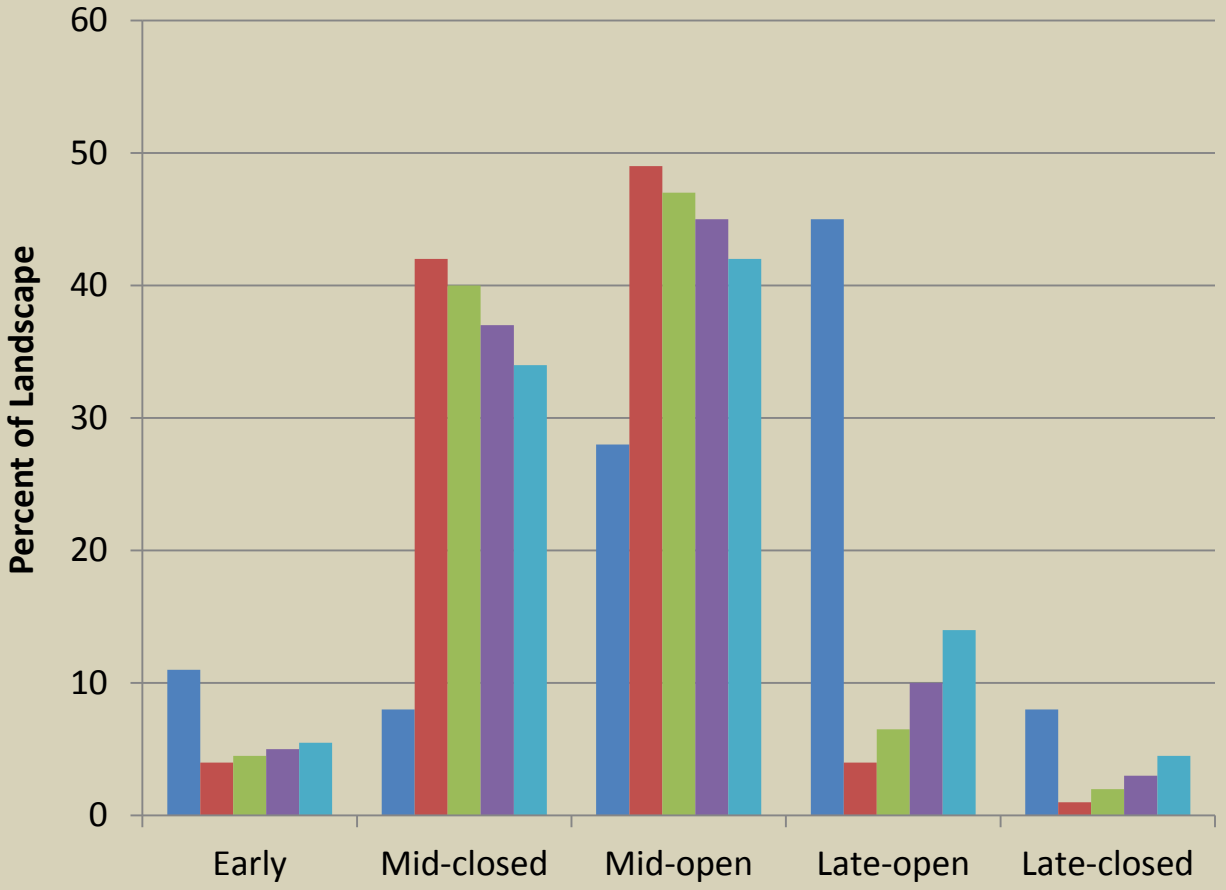
Lake Tahoe Basin Management Unit Forest Plan Vegetation Desired Conditions



Reference conds from BpS modeling: calculated for entire LTBMU

Model Applications: Structural Outputs

Lake Tahoe Basin Management Unit Forest Plan, Vegetation Desired Conditions

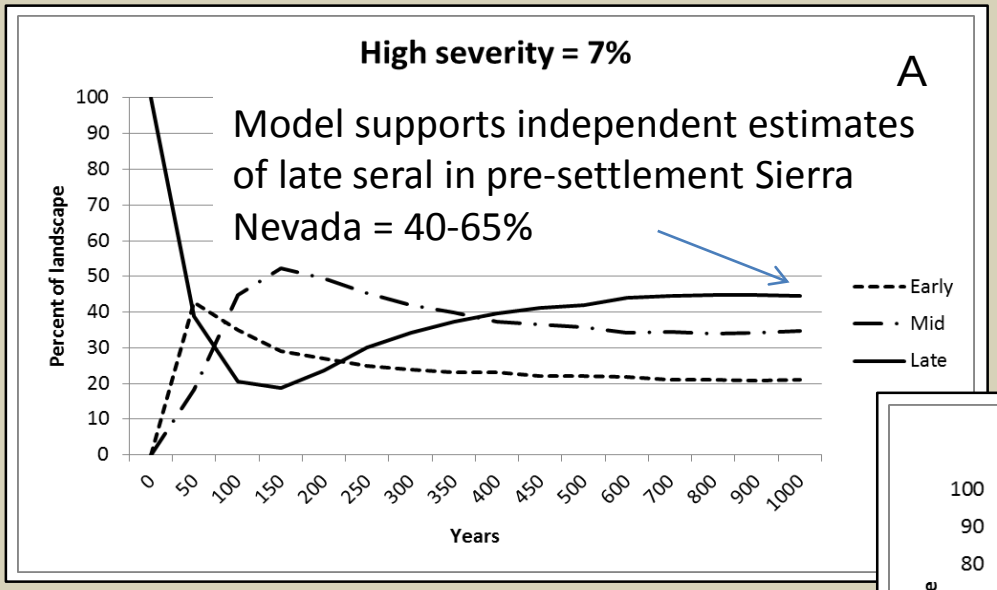


Projected restoration progress in Jeffrey pine forest, based on 1200 acres per year of treatment (RX fire, thinning, & succession)

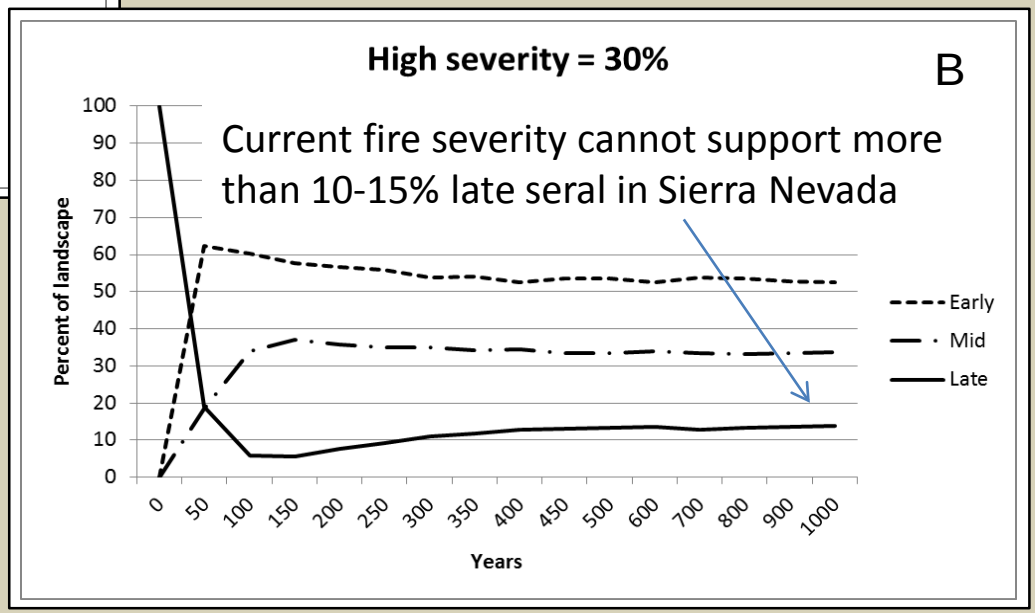
Progress will be slow, but progress can be made. Assumes no wildfire or other state changing event

Model Applications: Seral State Outputs

Sierra Nevada, comparison of landscape forest structure under different fire regimes



Response to claims that modern fires are not different than pre-settlement fires (e.g. Baker 2012, 2014; Odion et al. 2015)



BpS model 610270 (dry mixed conifer) run at different fire severity proportions (low:mod:high)

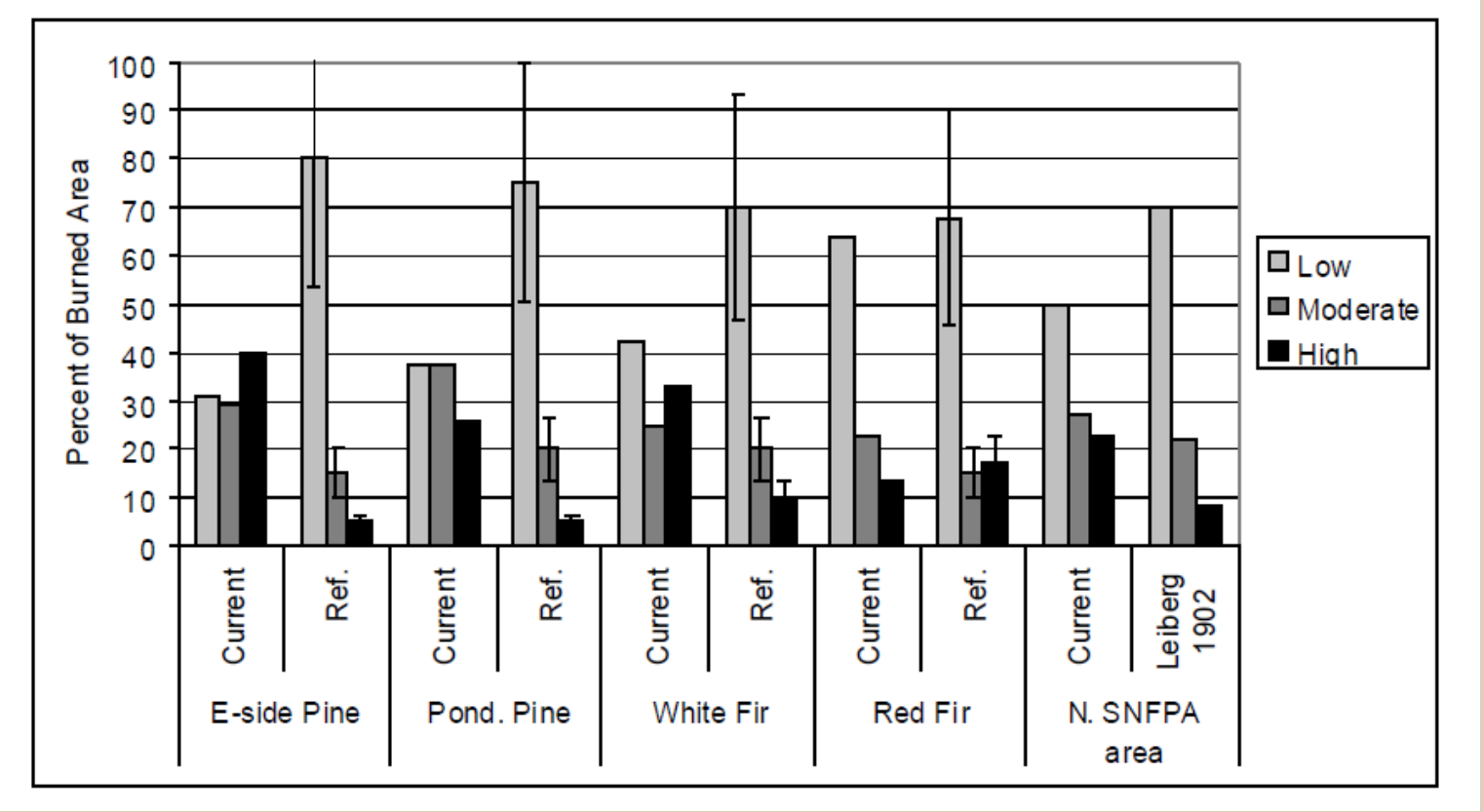
A – 7:30:63 pre-settlement ref

B – 30:22:48 modern average

Miller and Safford. In press. *Fire Ecology*

Model Applications: Fire Severity Outputs

Sierra Nevada Fire Severity Monitoring



Current versus hypothesized reference fire severity distributions for major forest types in the Sierra Nevada.
HRV reference estimates partly from BpS models

Miller and Safford 2008 *Fire Severity Monitoring Report*

Model Applications: Fire Severity Outputs

Southern Sierra Nevada National Forests, fire severity patterns of resource objective wildfires

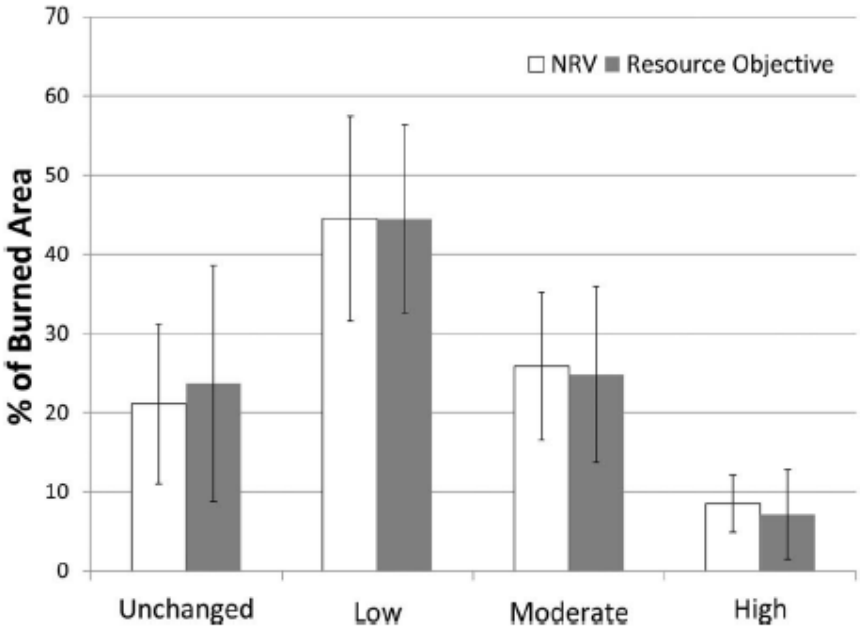


Figure 1. Mean (± SD) fire severity proportions in each severity class based on NRV and resource objective wildfires in the national forests of the southern Sierra Nevada.

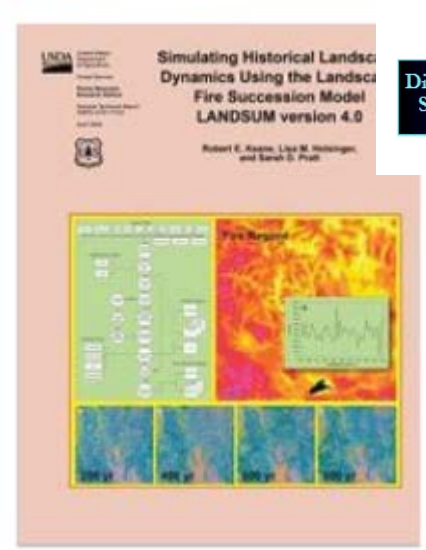
Natural Range of Variation estimates partly based on mean outputs of BpS models 610321 and 610322 (red fir-white fir and red fir-western white pine)

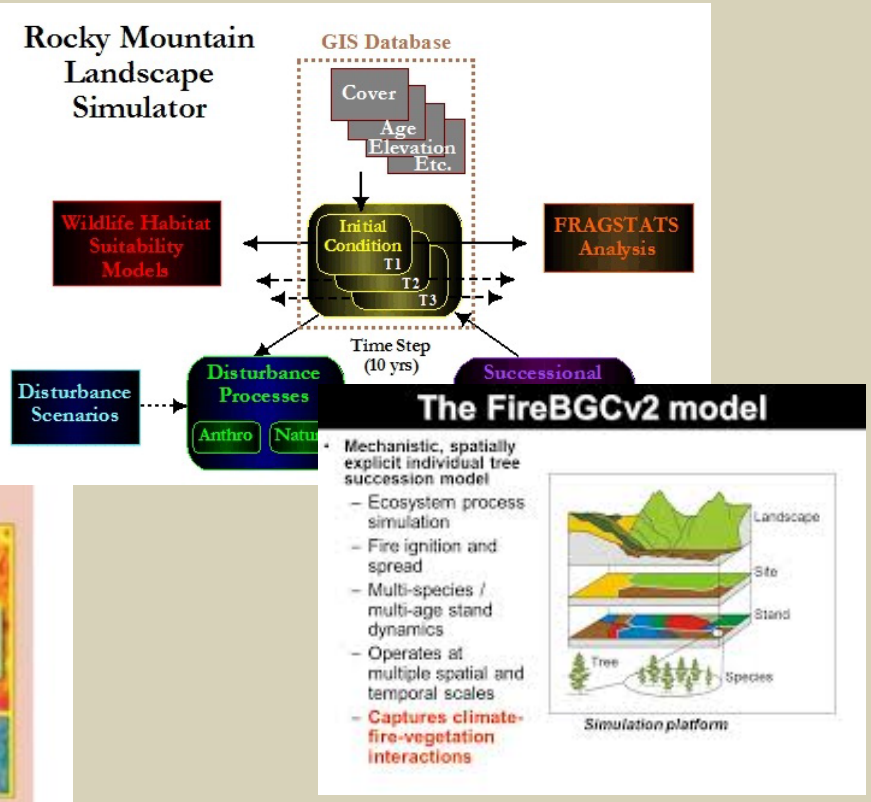
Meyer 2015 *Journal of Forestry*

Model Applications: Spatial applications

BpS models can be plugged into spatial simulations to generate more realistic disturbance dynamics on management landscapes

TELSA



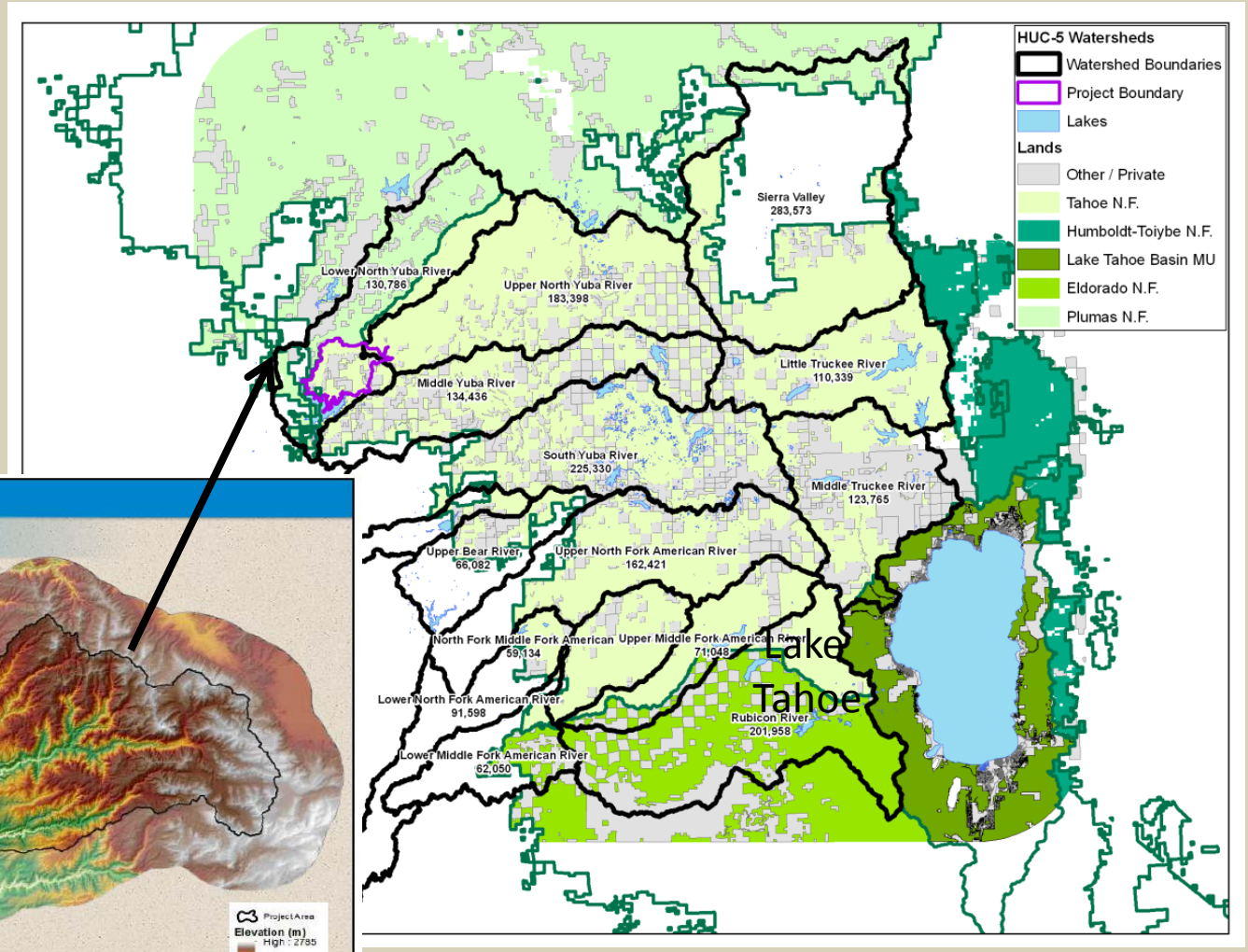


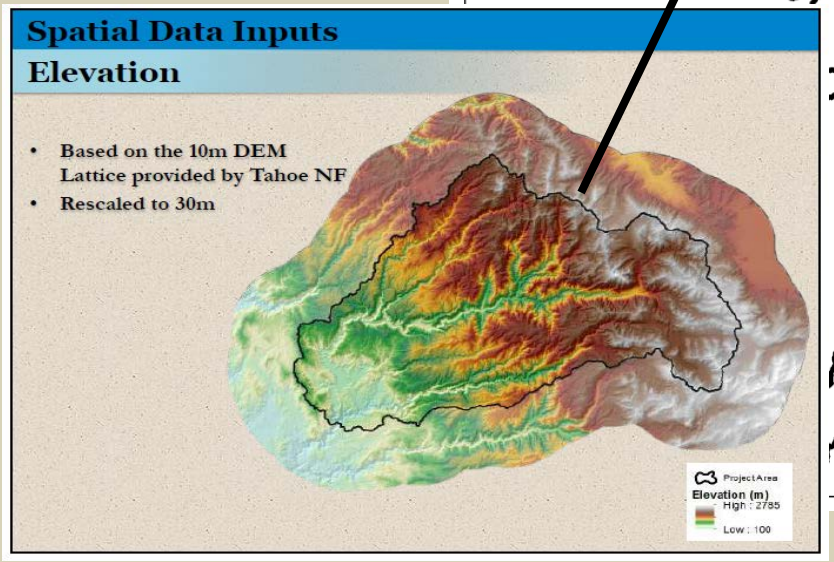
Spatial Applications: Yuba River Watershed

- Rocky Mountain Landscape Simulator (RMLands) used for HRV conditions in part of Tahoe NF, and to compare effects of management proposals/
- Modified BpS models provided “guts” of the landscape model
  - More recent reference information sources incorporated into transition probabilities
  - Canopy cover levels increased to three
  - Some models split into xerix and mesic versions
  - Extensive model validation and calibration
  - Some transitions between models permitted

Spatial Applications: Yuba River Watershed

Project Landscape: N and Middle Yuba Watersheds

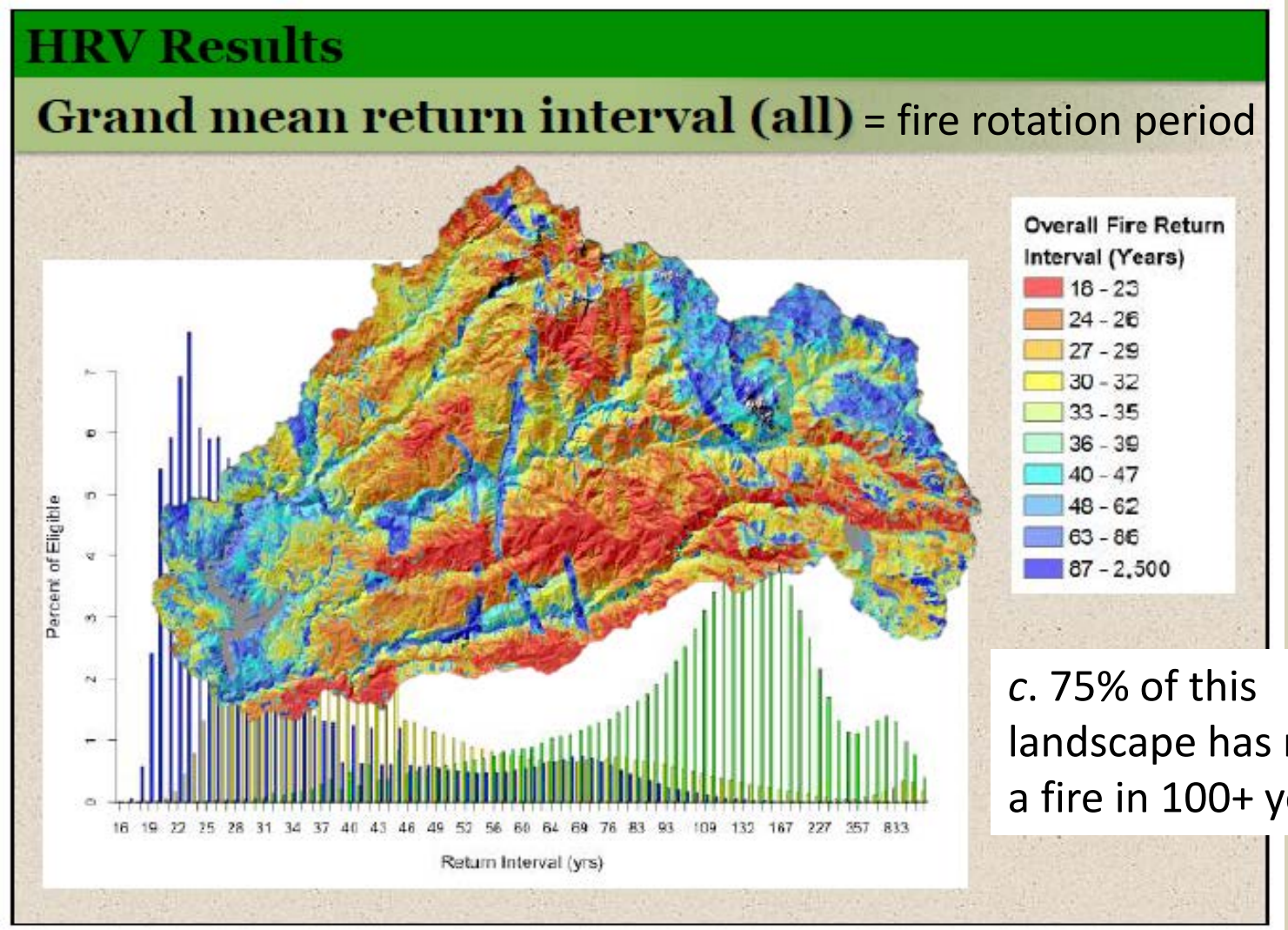




448,000 acres + 10 km buffer

Spatial Applications: Yuba River Watershed

Results: Historical Range of Variation (HRV)

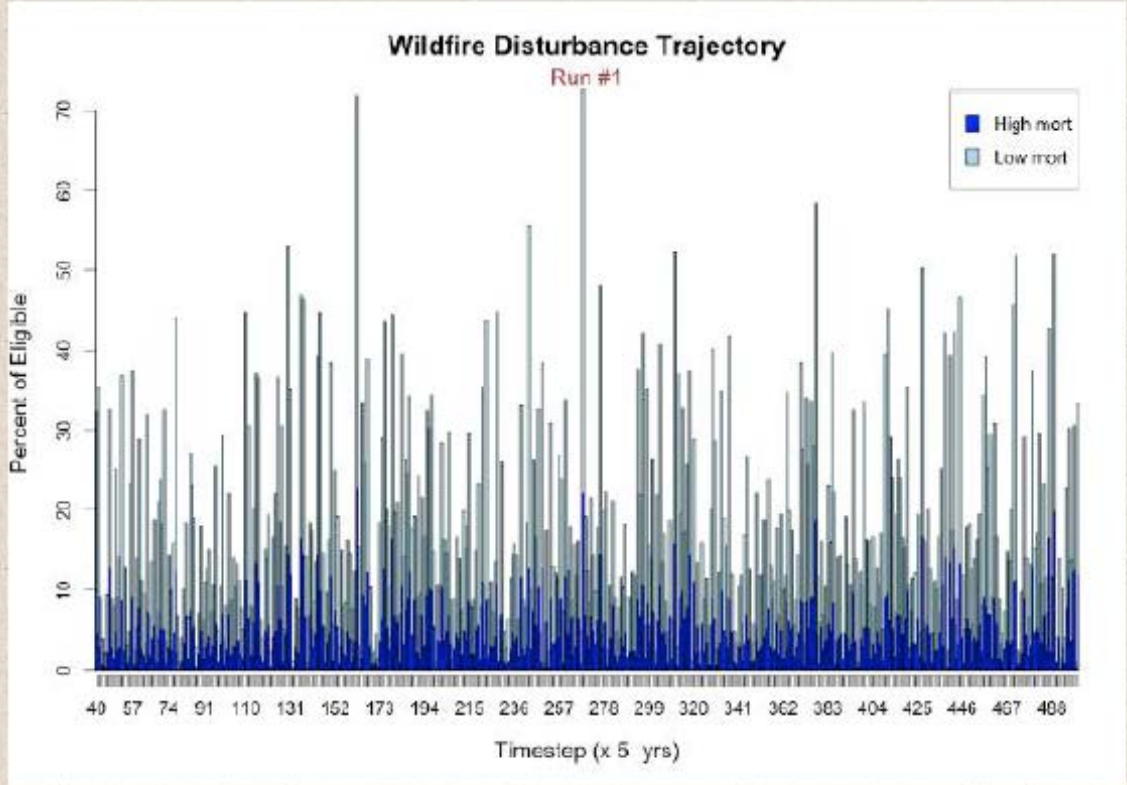


c. 75% of this landscape has not seen a fire in 100+ years

Spatial Applications: Yuba River Watershed

HRV Results

Disturbance area (total per timestep)



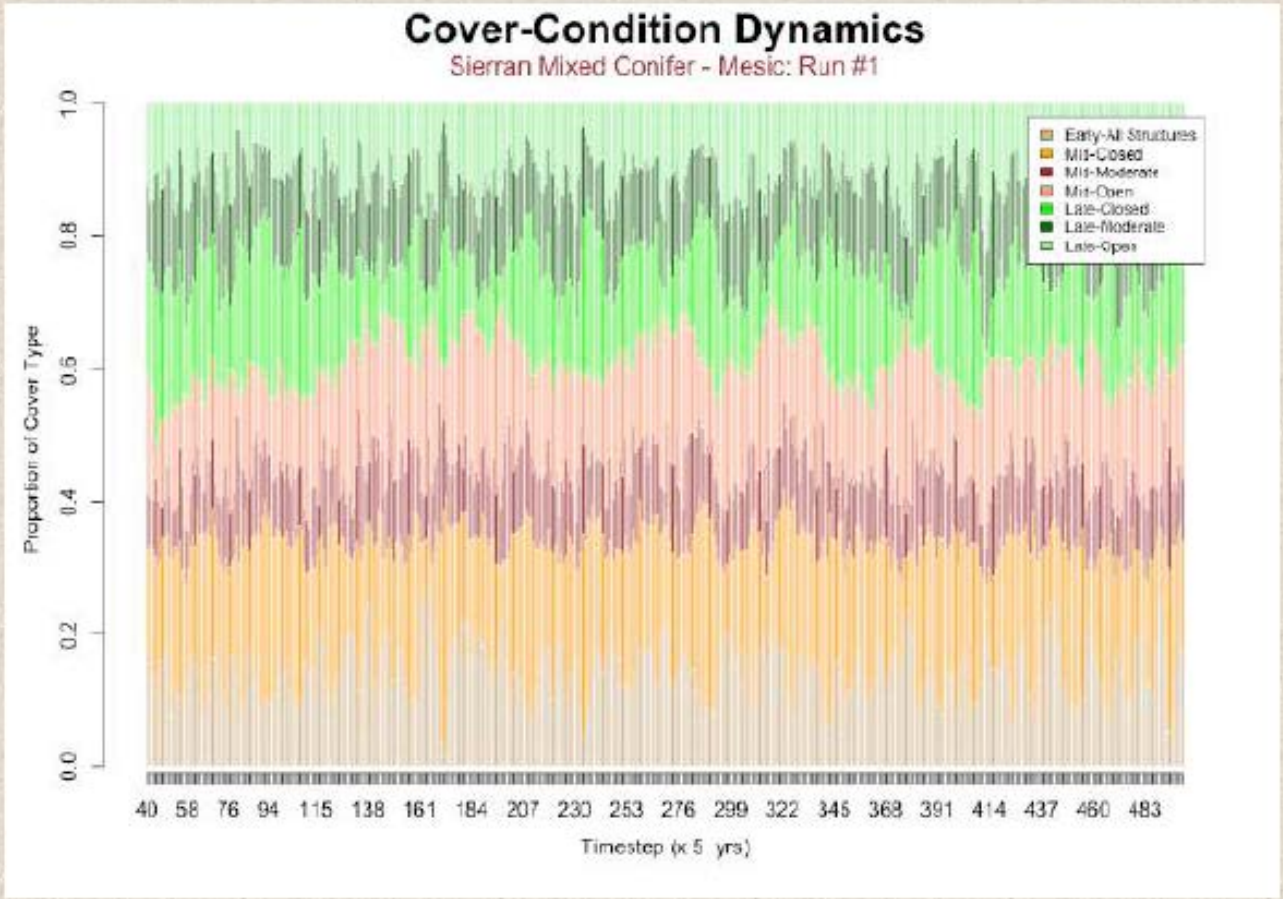
HRV modeling: 3.3% (15,000 acres) of landscape experienced fire in average year

Current average (wildfire plus mgt) = 1,000 to 2,000 acres

Spatial Applications: Yuba River Watershed

HRV Results

Cover-Condition plots

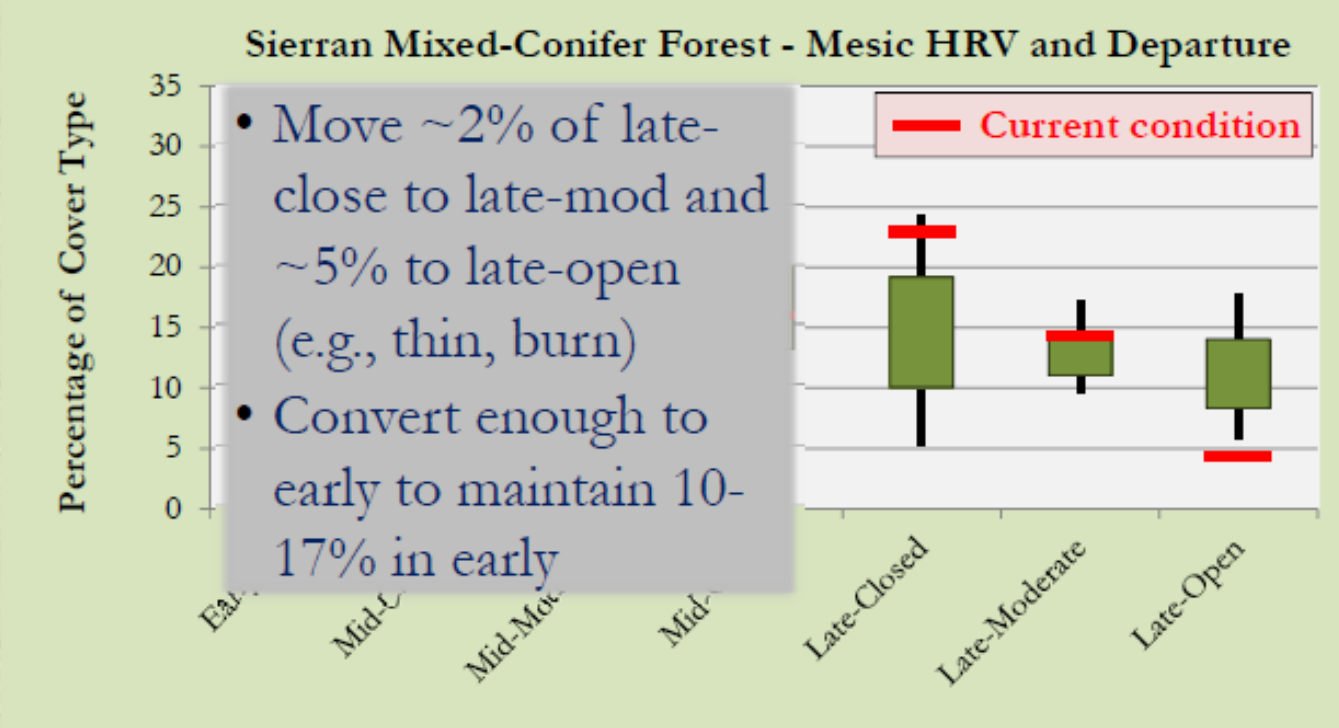


Model Applications: N. Yuba River Watershed

RMLands – Historical Range of Variability

Results: vegetation

- HRV and departure in the seral-stage distribution for each cover type



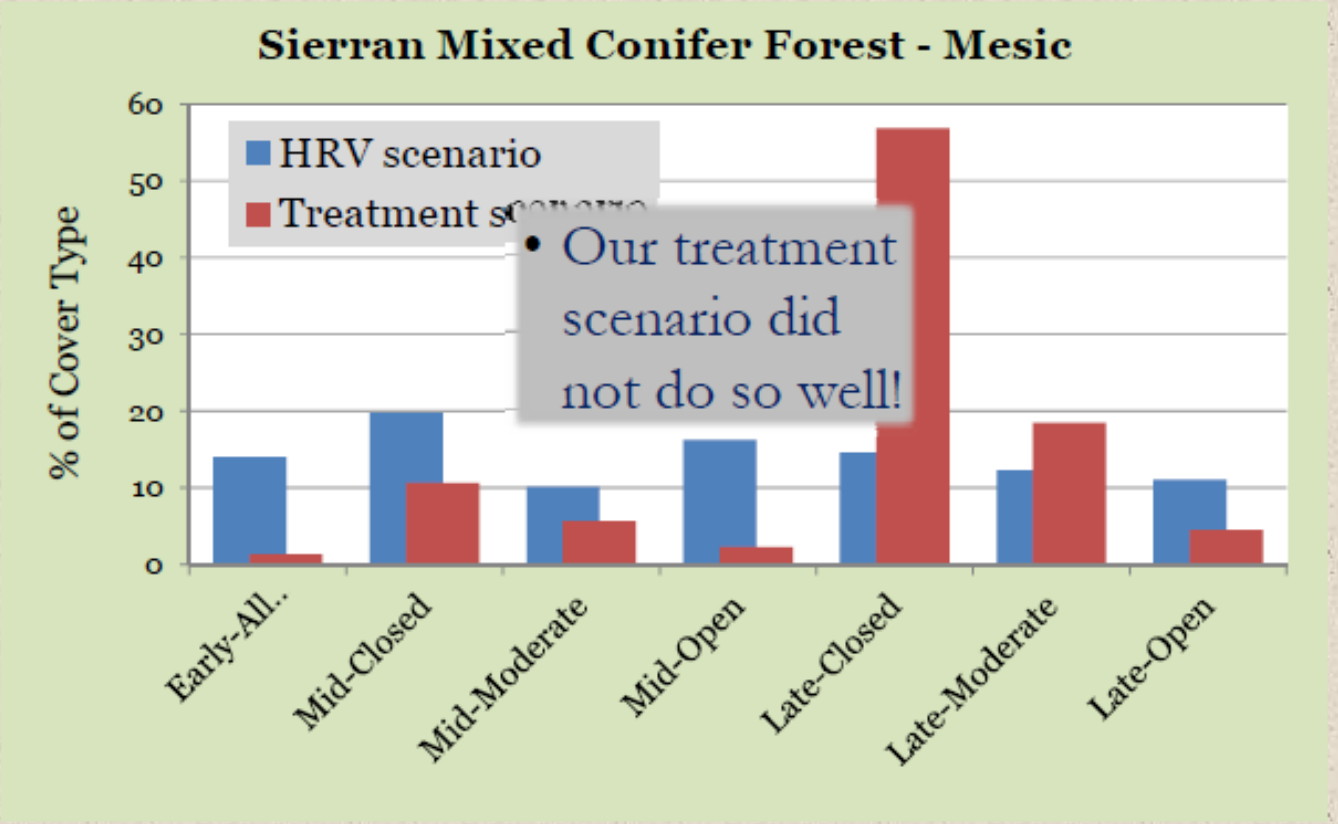
- Move ~2% of late-close to late-mod and ~5% to late-open (e.g., thin, burn)
- Convert enough to early to maintain 10-17% in early

Model Applications: N. Yuba River Watershed

RMLands Vegetation Treatments

Results: HRV vs treatments

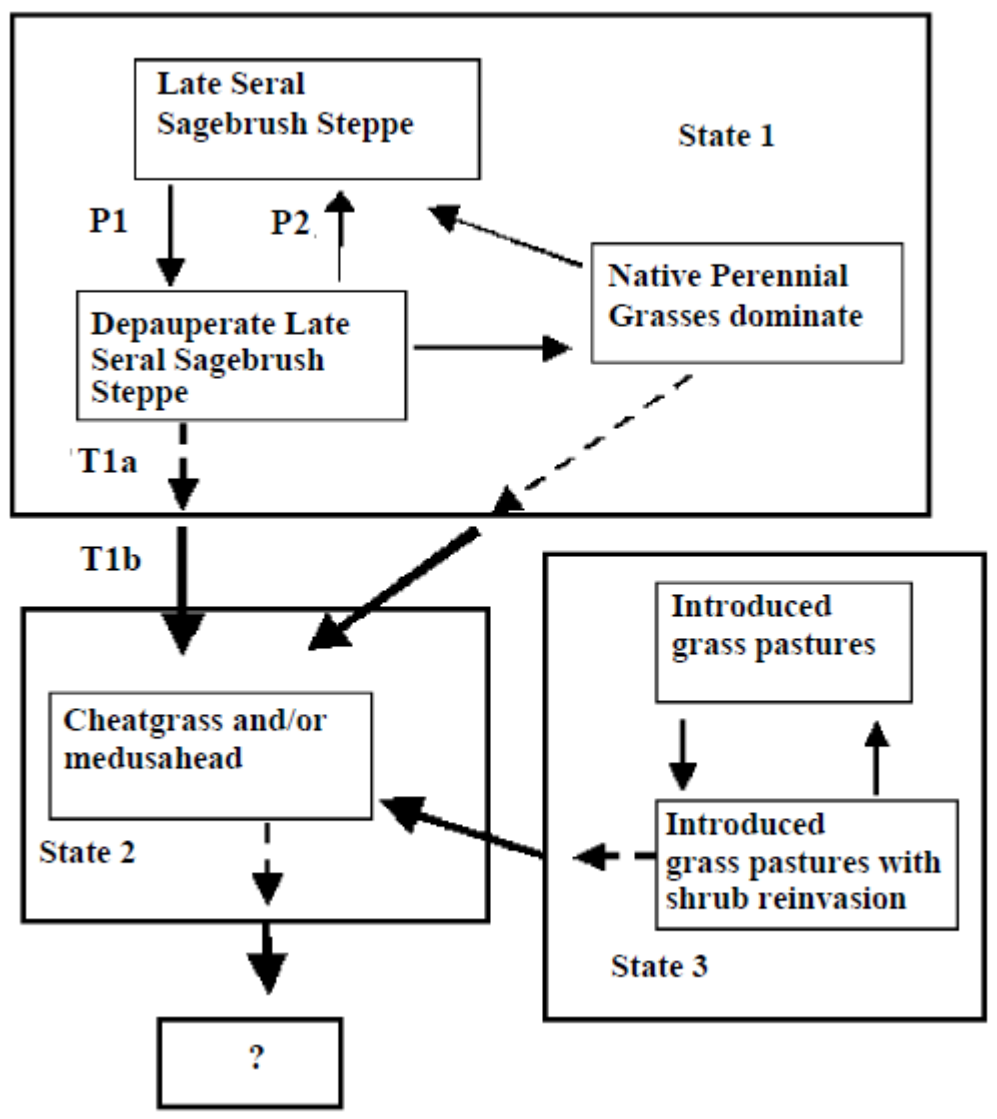
- Median seral-stage distribution



Conclusions

S&T models are extremely useful tools

- Better understanding of successional and disturbance dynamics of ecosystems
- Identifying key stages or transitions for mgt focus
- Predicting outcomes of complex ecosystem processes to disturbances or management actions
- Developing hypotheses of HRV/NRV/ref conditions to help guide management



Conclusions re BpS Models

- Are relatively simple S&T models, with many potential uses
- Have important assumptions and limitations
- Were built mostly by expert teams, and quality-controlled, but…
- …The level of validation varies, you should contact the model builders before using a BpS (info in the model metadata available from LANDFIRE)*

**BpS review is underway now, and expert input is welcome! TNC-LANDFIRE is heading up the project and a website with all you need to help with models and descriptions is http://www.landfirereview.org/.*

More Conclusions re BpS Models

- Can form the basis for local or regional modeling efforts
- Can be modified to include management actions, climate change, local conditions, etc.
- Can be employed in spatial modeling

QUESTIONS?
COMMENTS?

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Online Connections

LANDFIRE Program Home http://www.landfire.gov

Conservation Gateway: http://nature.ly.landfire

Twitter: @nature_LANDFIRE

YouTube: LANDFIREvideo

Bulletins/Post cards via e-mail

- Opt in: http://eepurl.com/baJ_BH

Email: LANDFIRE@tnc.org

BpS Review website: http://www.landfirereview.org/