DEFINING NEW FUEL MAPS FOR MOUNT RAINIER NATIONAL PARK FROM A FUSION OF FIELD, LIDAR, AND ENVIRONMENTAL DATA

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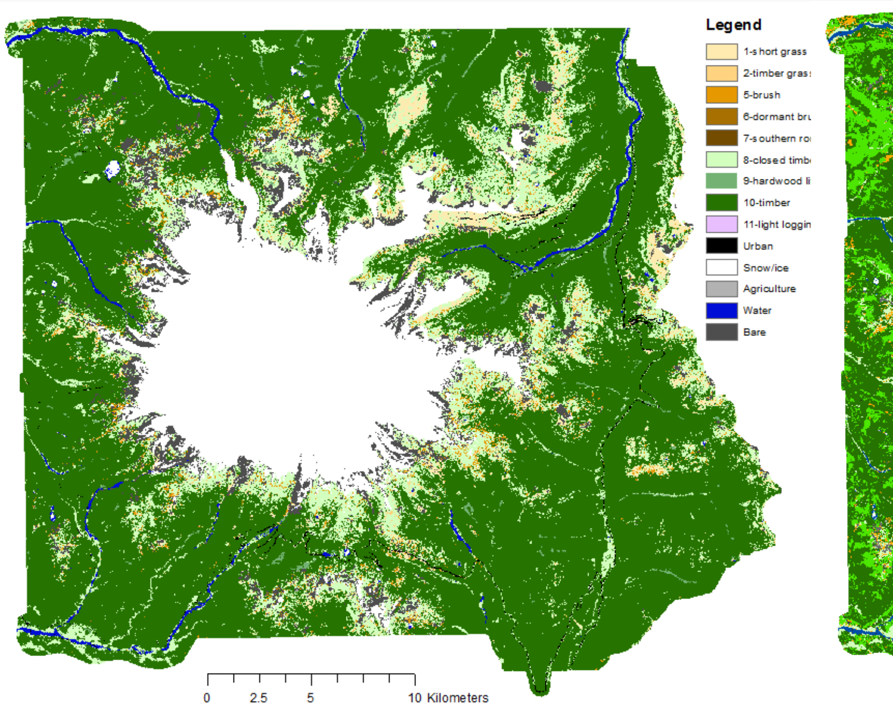
Mt. Rainier National Park

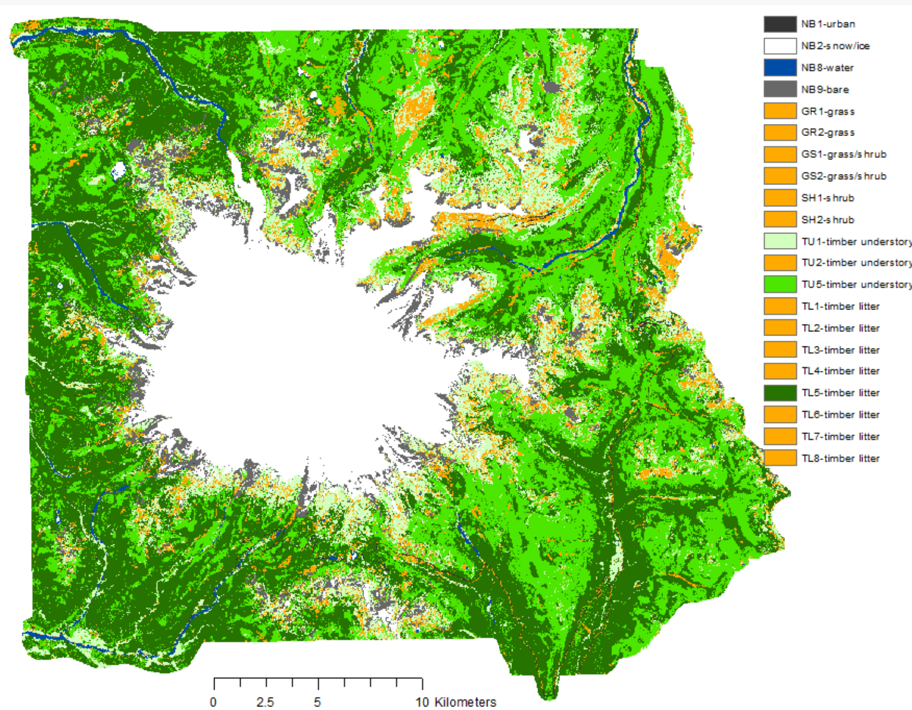
- Located west of Cascade mountain crest
- Extensive forests
  - Western hemlock, Douglas fir, Pacific silver fir, mountain hemlock, subalpine fir
- Historically high severity fire regime (primary), mixed severity (secondary)
- Climate change likely to lengthen fire season, increase fire size

Current Fuel Maps

Anderson (1982)



Scott & Burgan (2005)



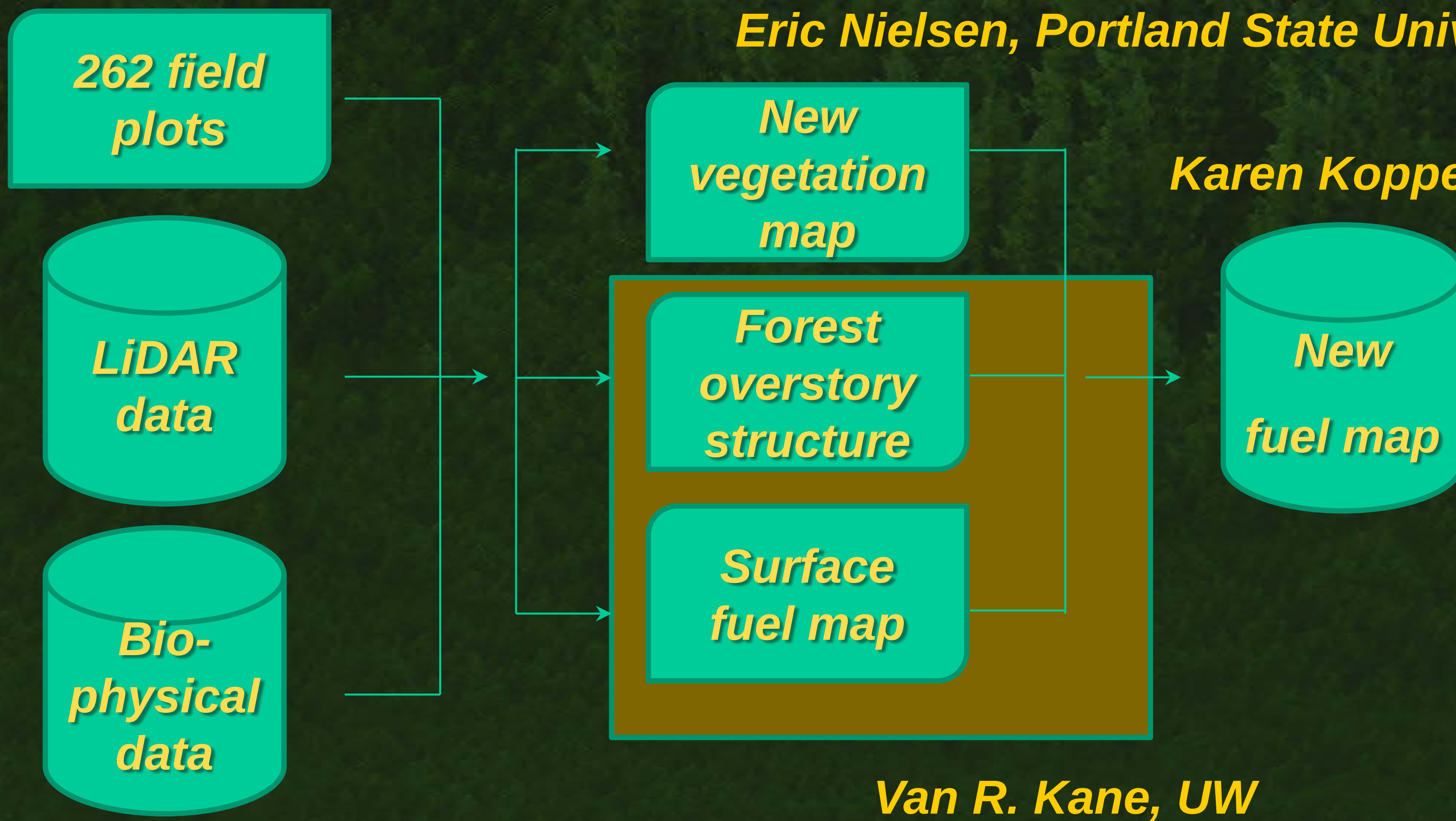
Coarse-scale LANDFIRE maps not accurate at scale of park operations

Project Overview

Catharine Copass, NPS

Eric Nielsen, Portland State University

Karen Kopper, NPS

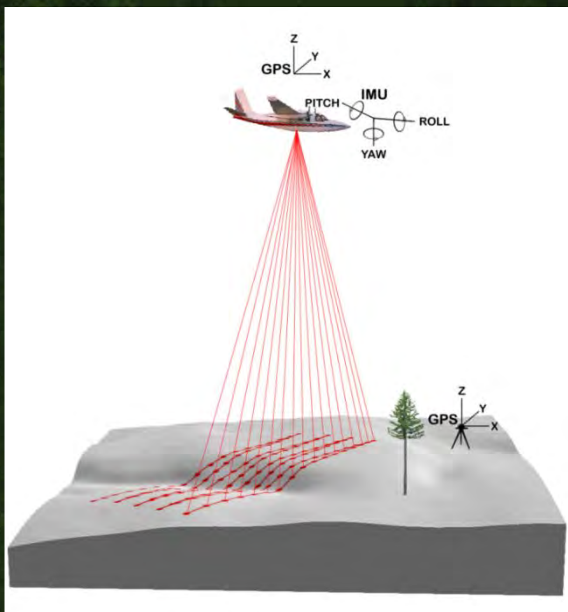


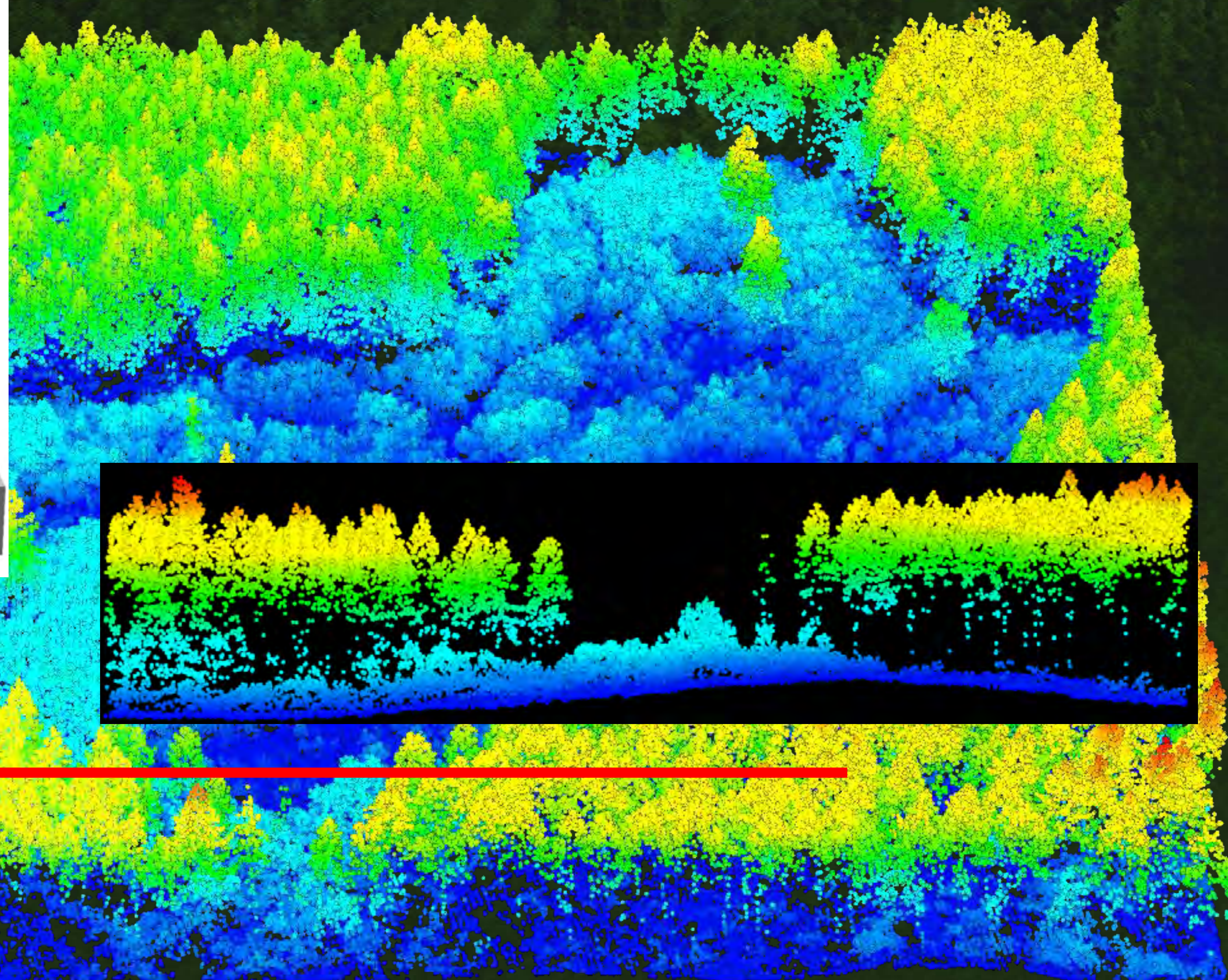
Van R. Kane, UW

Input Data (summary)

- Field plots
  - 151 Surface fuel plots – organic, 1 to 100 hour, 1000 hour
  - Assigned to Anderson (1982) fuel models
  - 262 field plots – species and canopy characteristics assigned to final fuel beds
- Bio-physical
  - 1971-2000 Precipitation, temperature normals (PRISM)
  - Water balance (Lutz et al. 2010)
    - Actual evapotranspiration, climatic water deficit
  - Topography – elevation, slope position (Jenness 2006), slope, aspect, solar radiation index (Keating et al. 2007)
- LiDAR forest structure
  - Canopy heights, canopy cover

Airborne LiDAR Brief Basics

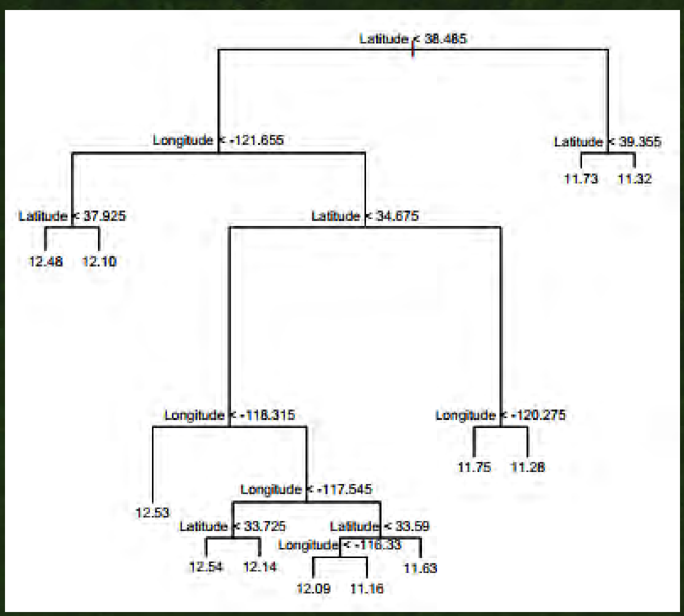




Return data colored by height

Modeling methods

- Regressions: Linear & random forests
- Classification: Random forests



__Random forests models__

- *Ensembles of classification and regression trees*
- *Bagging tests random subsets of training and validation data*
- *Works well with predictor interactions, non-linear relationships, non-normal data*

Breiman et al. (1984), Breiman (2001)

What Didn't Work

	Median value tons/acre	Regressions: RF variance explained	Regressions: Linear R^2
Fuel models			
High/low models			
Organic	22.6	0.15	0.24
1 to 100 hr	2.8	0.08	0.29
1000 hr	10.8	0.19	0.23

Regressions for surface fuel values

Predicted: Model	Actual: 1	2	4	5	6	7	8	9	10	Class error	Model description
1	<u>5</u>	0	0	0	0	0	1	0	0	0.167	Short grass (1 foot)
2	0	0	0	0	0	0	2	0	0	1.000	Timber (grass and understory)
4	0	0	0	1	0	0	0	0	0	1.000	Chaparral (6 feet)
5	1	0	0	13	1	0	4	0	0	0.316	Brush (2 feet)
6	0	0	0	3	0	0	0	0	0	1.000	Dormant brush, hardwood slash
7	0	0	0	0	0	0	1	0	0	1.000	Southern rough
8	0	0	0	1	0	0	<u>59</u>	1	0	0.033	Closed timber litter
9	0	0	0	0	0	0	19	<u>1</u>	0	0.950	Hardwood litter
10	0	0	0	0	0	0	2	1	0	1.000	Timber (litter and understory)
Overall internal OOB error rate										0.327	
Overall cross validation error rate											

Classification by Anderson (1982) fuel classes

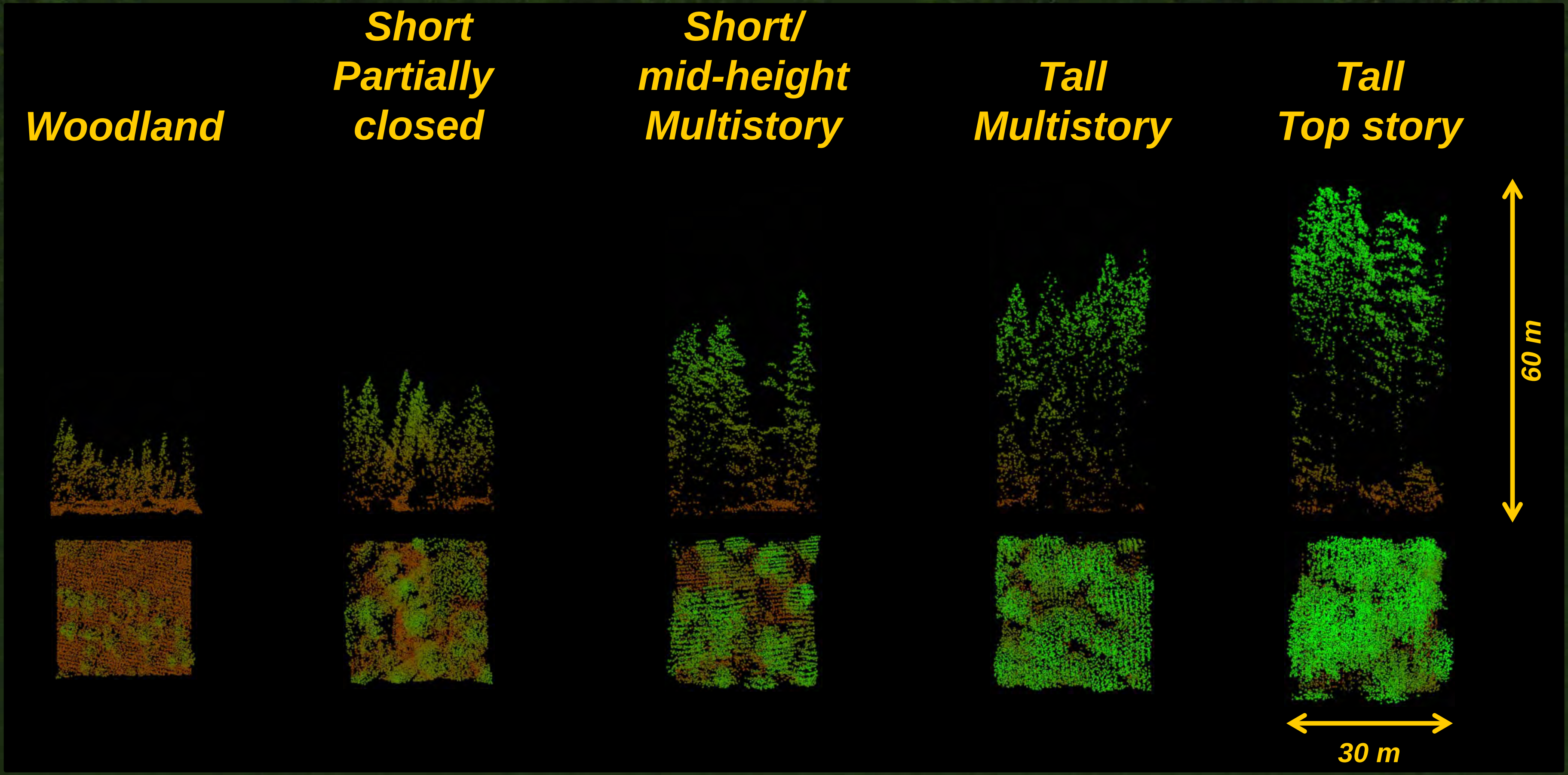
Similar to results of Jakubowski et al. (2013) and Peterson et al. (2013)

Defining Fuel Beds

- Fuels Characteristic Classification System (FCCS) (Ottmar et al. 2007)
- Rule-based classification based on local conditions

- This study - Two part classification
  - Forest overstory structure class measured from LiDAR data
  - Surface fuel high/low classes modeled from bio-physical setting and forest overstory structure
- Identified 29 fuel beds
  - Assigned FCCS fire potentials using 262 field plots and vegetation map classes

Forest Overstory Classes



Distinguished by height, canopy layering, canopy cover

Modeling Surface Fuels

Surface Fuel	Median value (tons/acre)	High/Low Accuracy	Most important predictors
Organic	22.6	73.8%	Precipitation, January temperature, aspect, deficit, AET
Small diameter (1 to 100 hour)	2.8	61.6%	Canopy height profile[1], canopy cover, slope position (2000 m scale)
Large diameter (1000 hour)	10.8	74.8%	Canopy cover, slope position(100 m & 2000 m scales), dominant tree height[2]

[1] 25th, 50th, 75th percentile LiDAR return heights

[2] 75th & 95th percentile LiDAR return heights

Almost all relationships non-linear and interactive

Example Fuel Bed

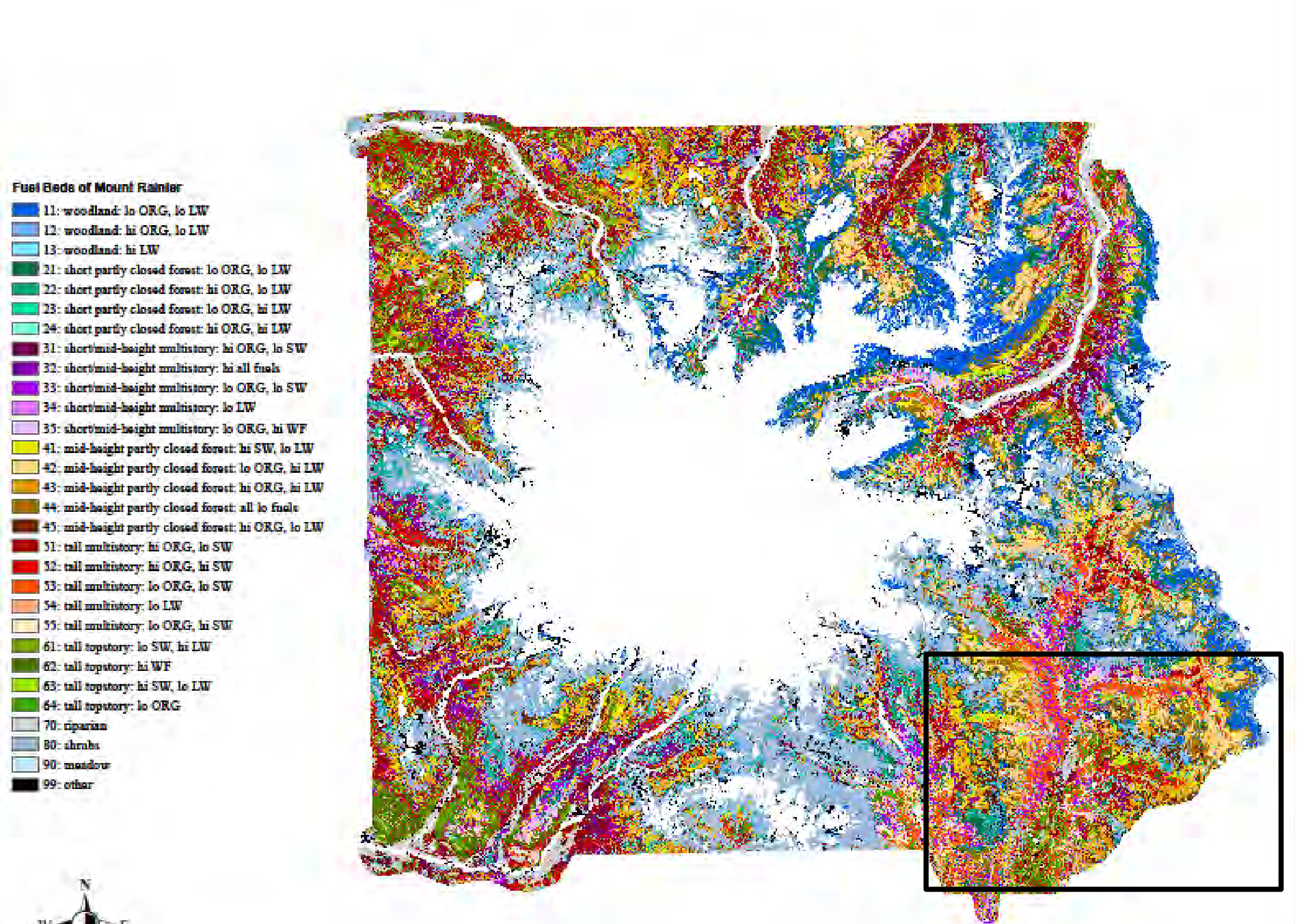
Fuel bed 52

- ***Overstory structure: Tall multistory***
- ***Surface fuels:***
  - ***Organic – high***
  - ***Small diameter – low***
  - ***Large diameter – high***
- ***Fire Potential (0 – 9, low to high)***
  - ***Surface fire behavior– 7***
  - ***Crown fire potential – 6***
  - ***Available fuel potential – 9***
- ***Fuel model 8 (Anderson 1982), TL5 (Scott & Burgan 2005)***

FB52 Management Use

- FB52 is prime spotted owl habitat
- Expect high severity fire effects from wildfires – especially on east side
- Consider fuel treatments (R_x fire, thinning) in adjacent , higher elevation fuel types

Fuel Beds Mapped

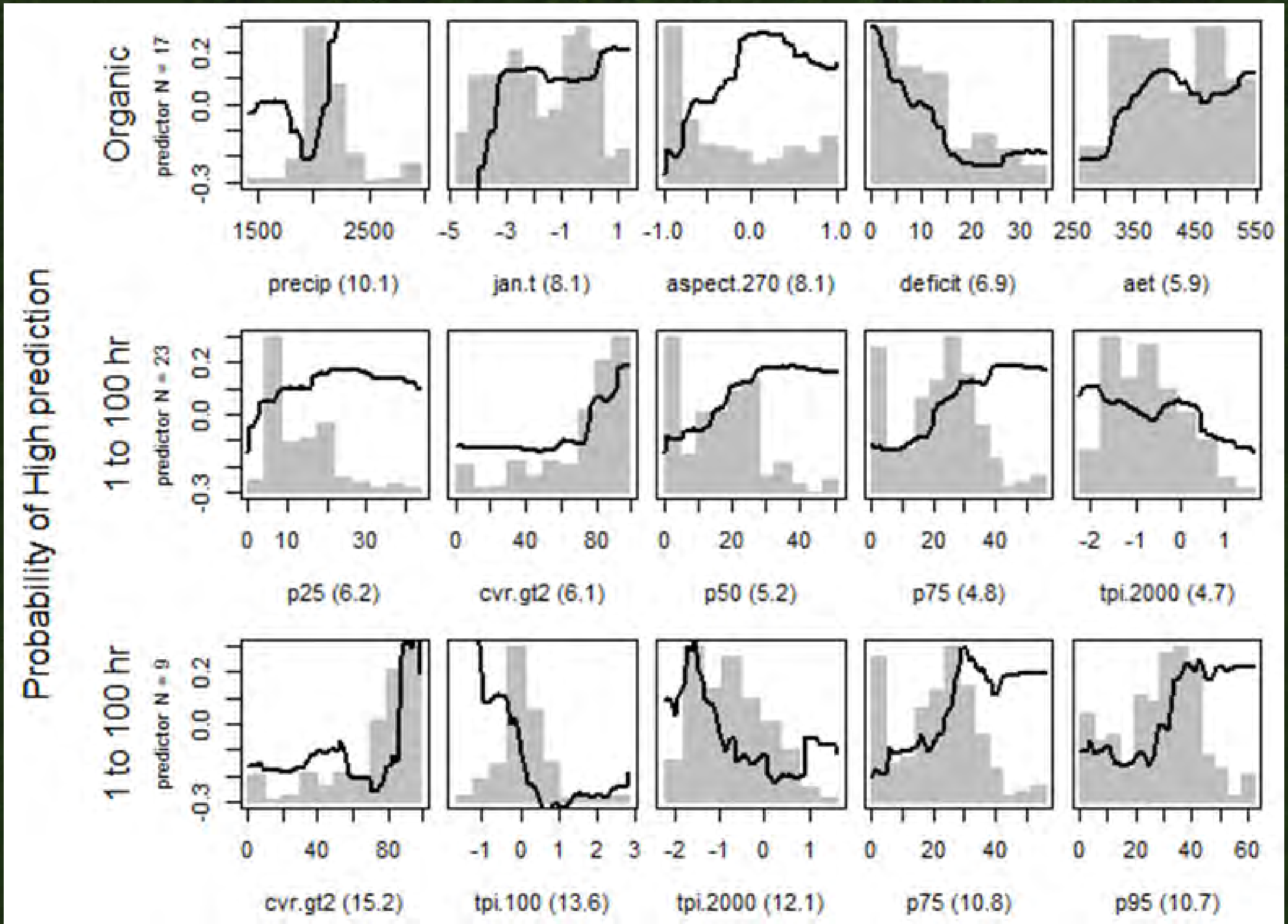


draft only - Kopper et al. (in prep.)

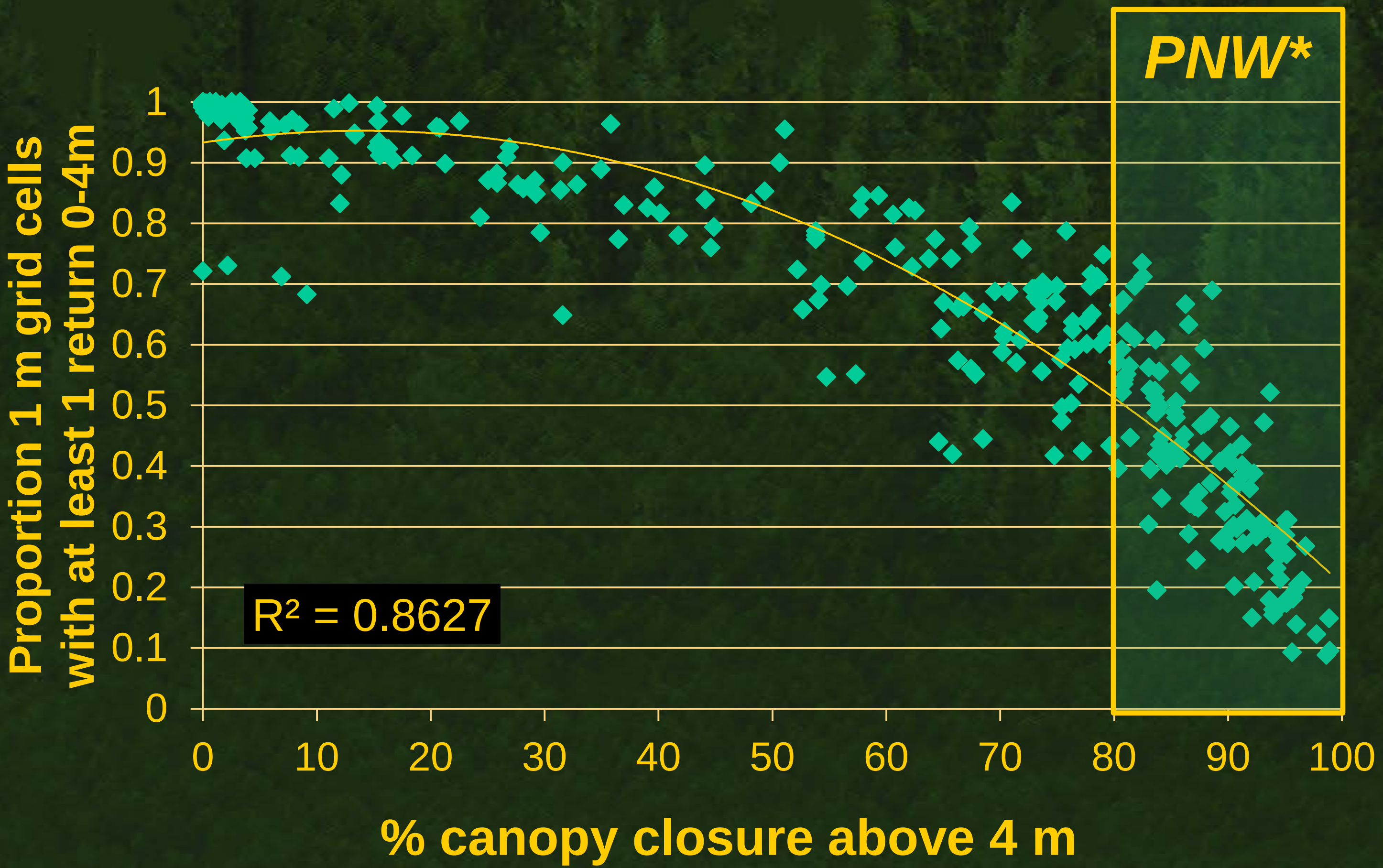
Conclusions

- *Fusion of field, LiDAR, environmental data essential*
- *Experimented to learn what could be modeled*
  - *In this case, high/low surface fuel classes*
- *Random forest modeling rocks*
  - *Handled non-linear, interactive relationships*

Backup: Modeling Surface Fuels



Backup: Return Extinguishment



***common closure ranges; Mt. Rainier data**

Backup: What Does LiDAR Cost?

PSLC Cost Summary	Base Deliverables	
Area Extent	Price per Acre	Price per Square Mile
Mobilizations (Full or Partial)	$0	$0
50 to 100 sq. miles (32,000 to 64,000 acres)	$1.42	$909
100 to150 sq. miles (64,000 to 96,000 acres)	$1.11	$710
150 to 200 sq. miles (96,000 to 128,000 acres)	$0.94	$602
200 to 250 sq. miles (128,000 to 160,000 acres)	$0.84	$538
Greater than 250 sq. miles Greater than 160,000 acres)	$0.78	$499

Example costs from Watershed Sciences fall 2012