Applications of Predictive Models for Invasive Plants

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Why Use Predictive Models for Invasive Plants?

- Determine the likelihood of invasion over a broad scales
- Assist in setting priorities for control efforts
- Develop in conjunction with other mapping approaches

How Do They Work?

Relate field observations to environmental predictor variables

1. Input data: presence, presence/absence, or abundance data
2. Environmental predictors: direct/indirect effects on species

- Limiting factors: e.g., temperature, precipitation, soil type
- Disturbances: e.g., natural, human related
- Resources: e.g., energy, nutrients, water

Process of Model Building

1. Conceptualization
    - Natural history
    - Model selection
2. Data preparation (data sources, scale)
3. Model fitting (correlation of variables)
4. Spatial predictions
5. Model evaluation
6. Assess model applicability

(Adapted from Guisan & Zimmerman, 2000)

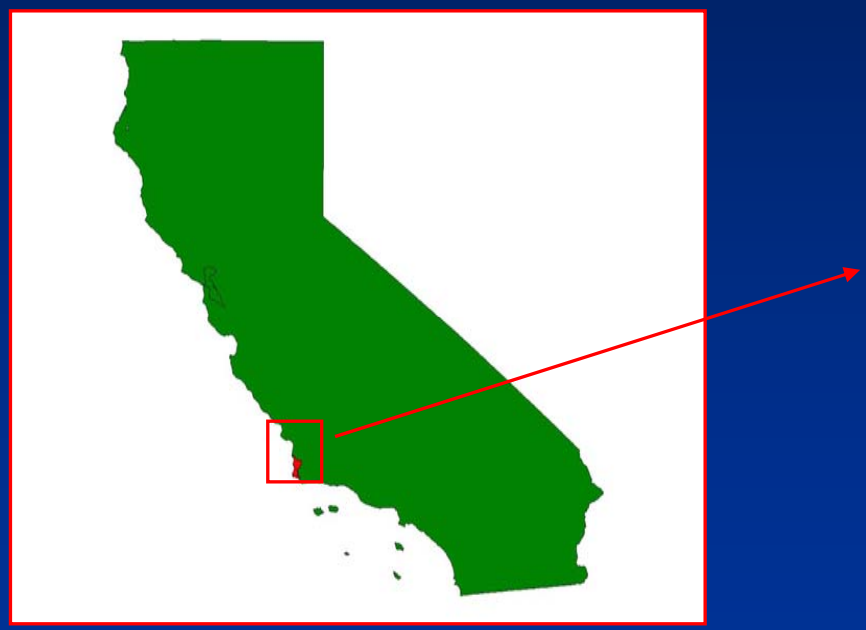
Model Selection

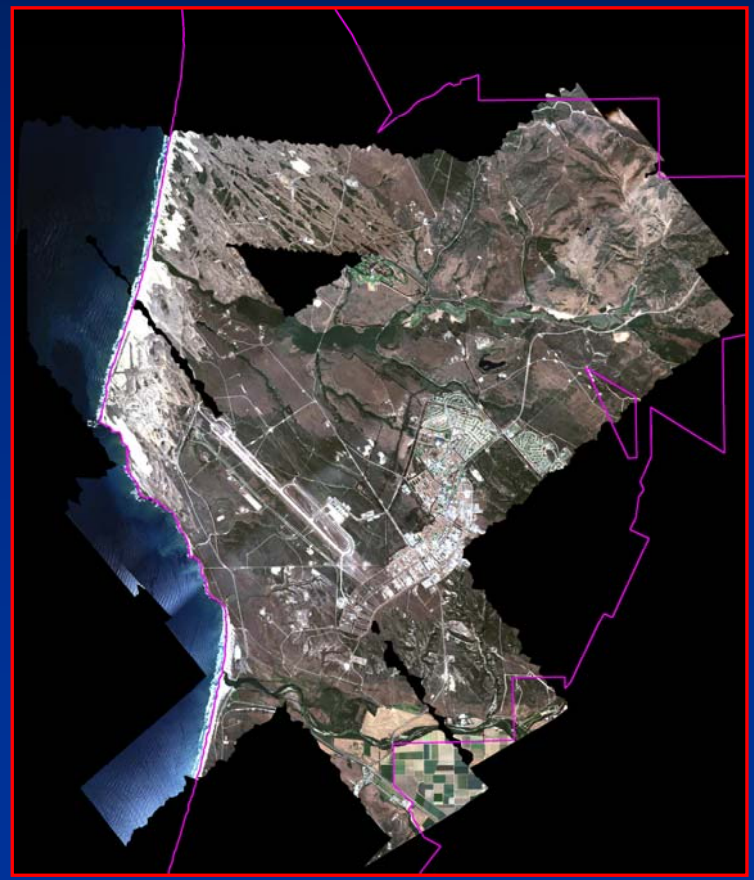
Types of models

- Climatic envelope
- Classification & Regression Tree
- Genetic algorithms
- Generalized Additive Models
- General Linear Models
- Co-Kriging

Example 1. CART

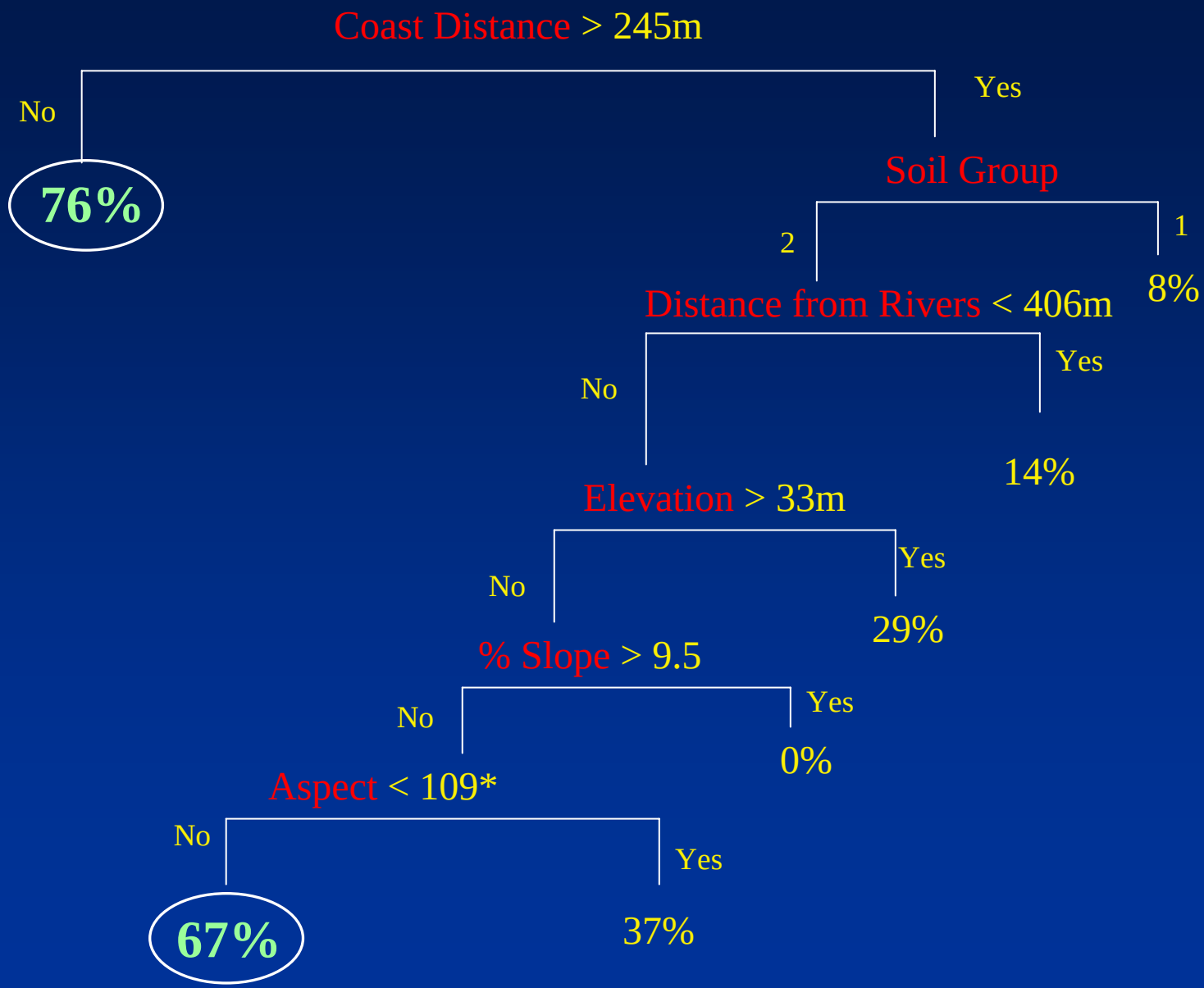
Iceplant: Vandenberg Air Force Base





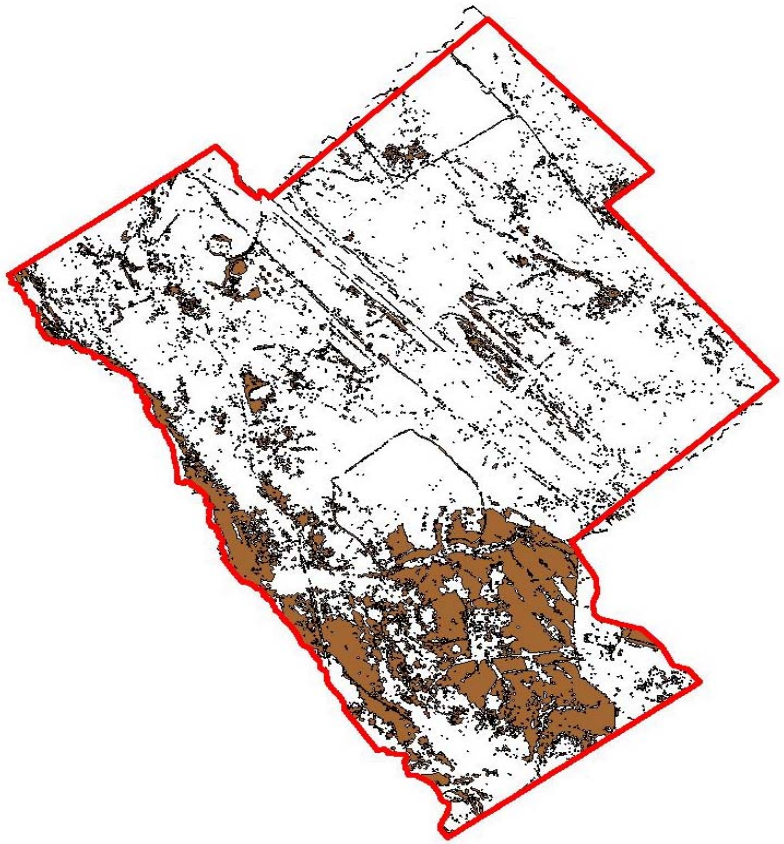
(Olmstead et al., 2004)

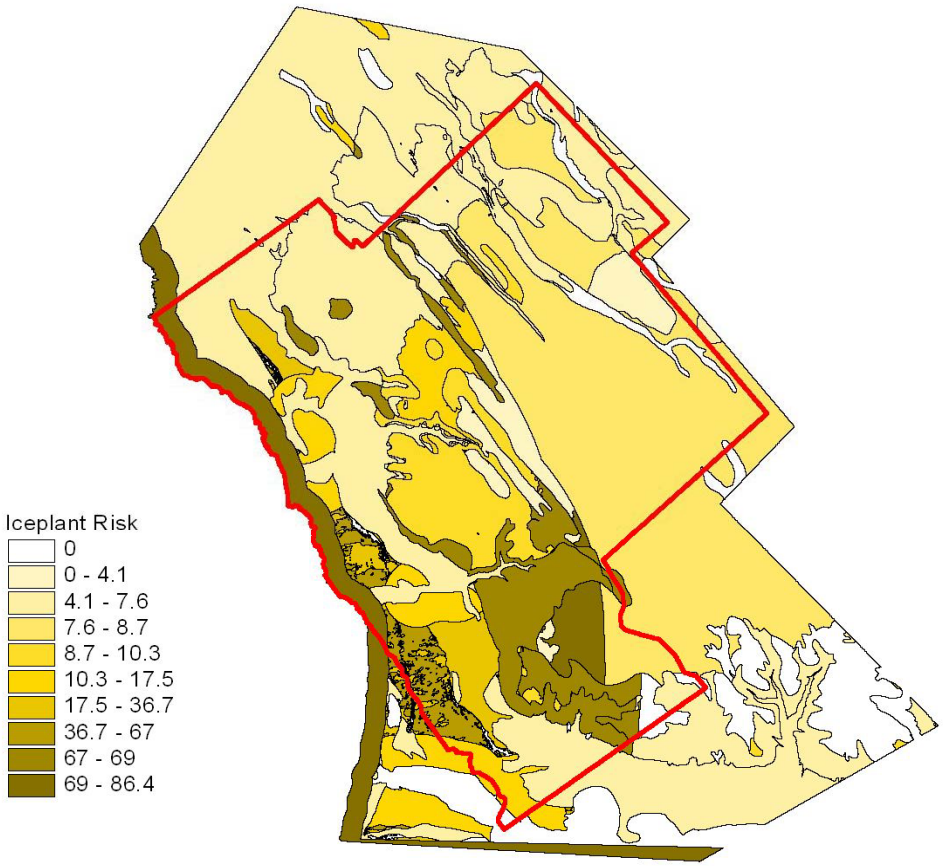
CART: Risk of Iceplant Invasion in Coastal Scrub Communities



Iceplant mapped from imagery

Iceplant risk of invasion (CART)





Model Evaluation

Prediction errors

- Errors of omission
- Errors of commission

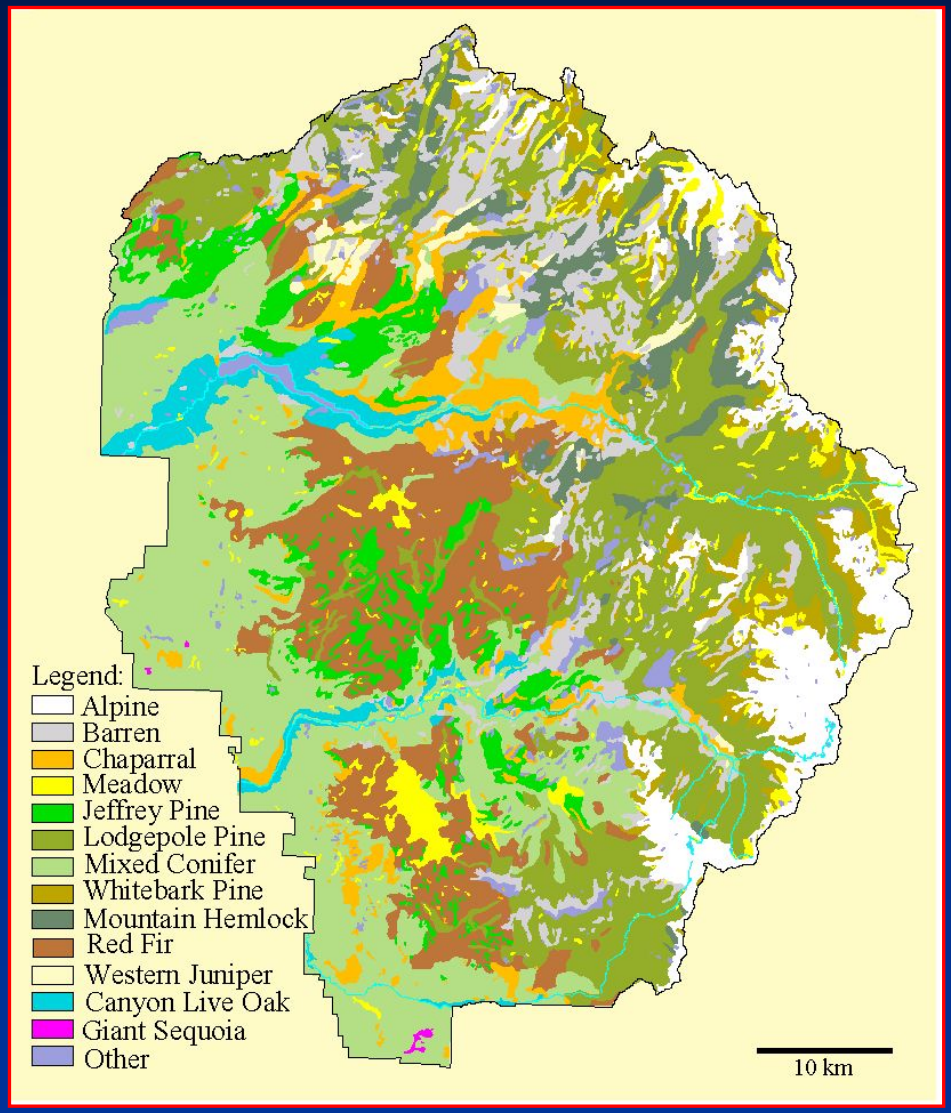
Sources of errors

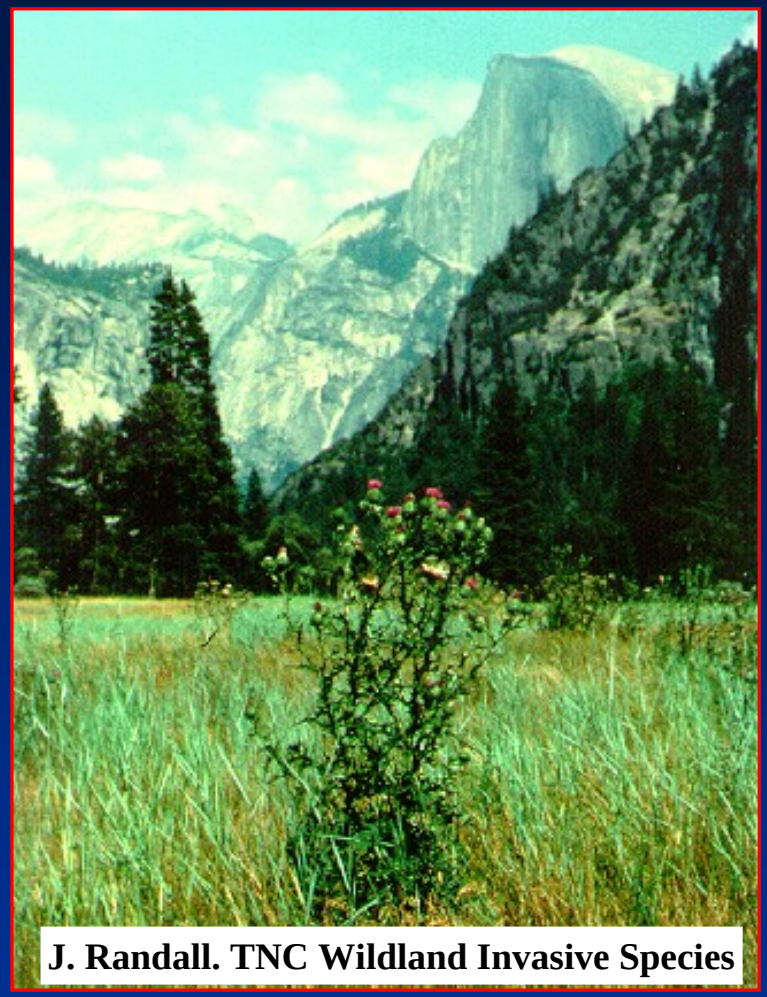
- Environmental
- Biological
- Algorithmic

Predicting Patterns of Non-Native Plant Invasions in Yosemite National Park, California

(Underwood et al., 2004)

Yosemite National Park





J. Randall. TNC Wildland Invasive Species

Objectives of Study

- Conduct community level analyses
- Develop landscape scale predictive model of invasive plants
- Suggest protocol for sampling of invasive plants in burned areas

Distribution of Invasives Determined by:

I. Vulnerability of community to invasion

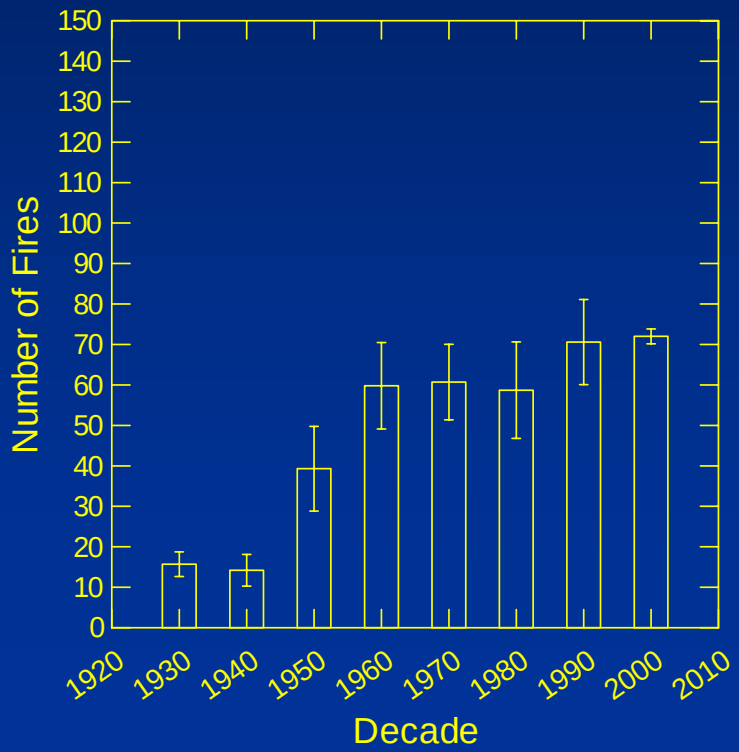
II. Environmental niche of invasive species

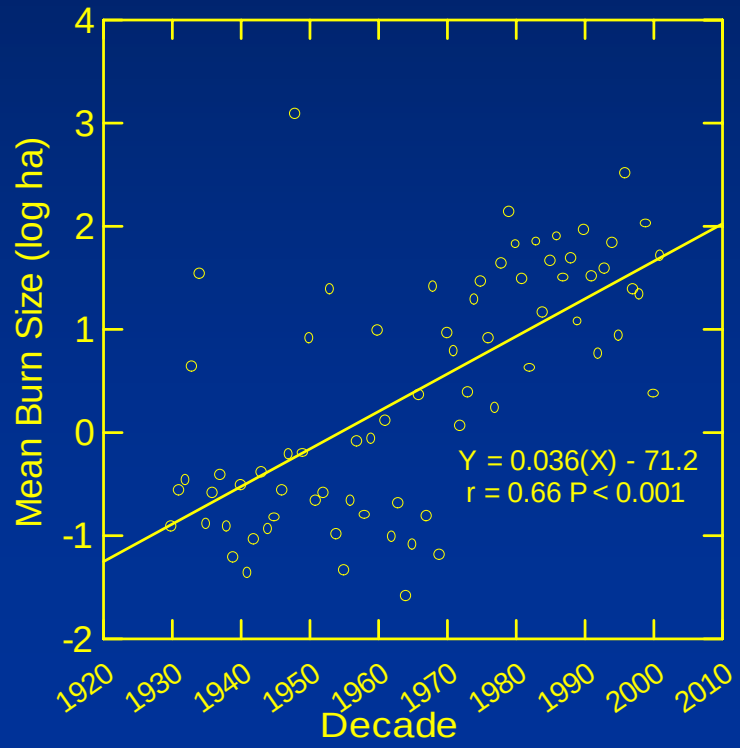
III. Areas of disturbance

- Natural (fire, flooding)
- Human related (hiking trails, campgrounds)

Fire Disturbance in Yosemite 1930-2000

- Fires permitted by NPS
- Burned areas are ideal environments for invasion
  - Remove dominant species
  - Increase bare ground, light, nutrients

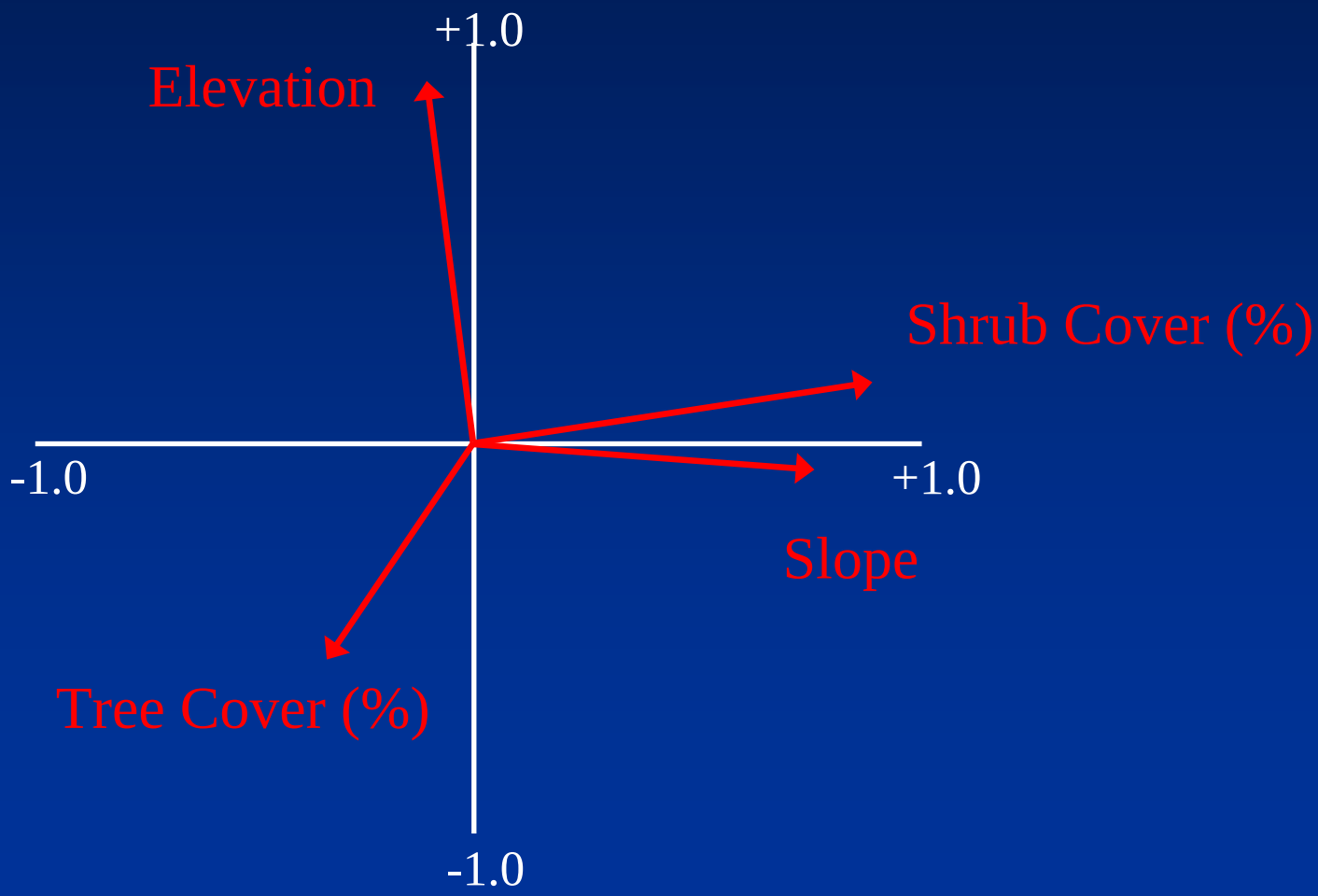




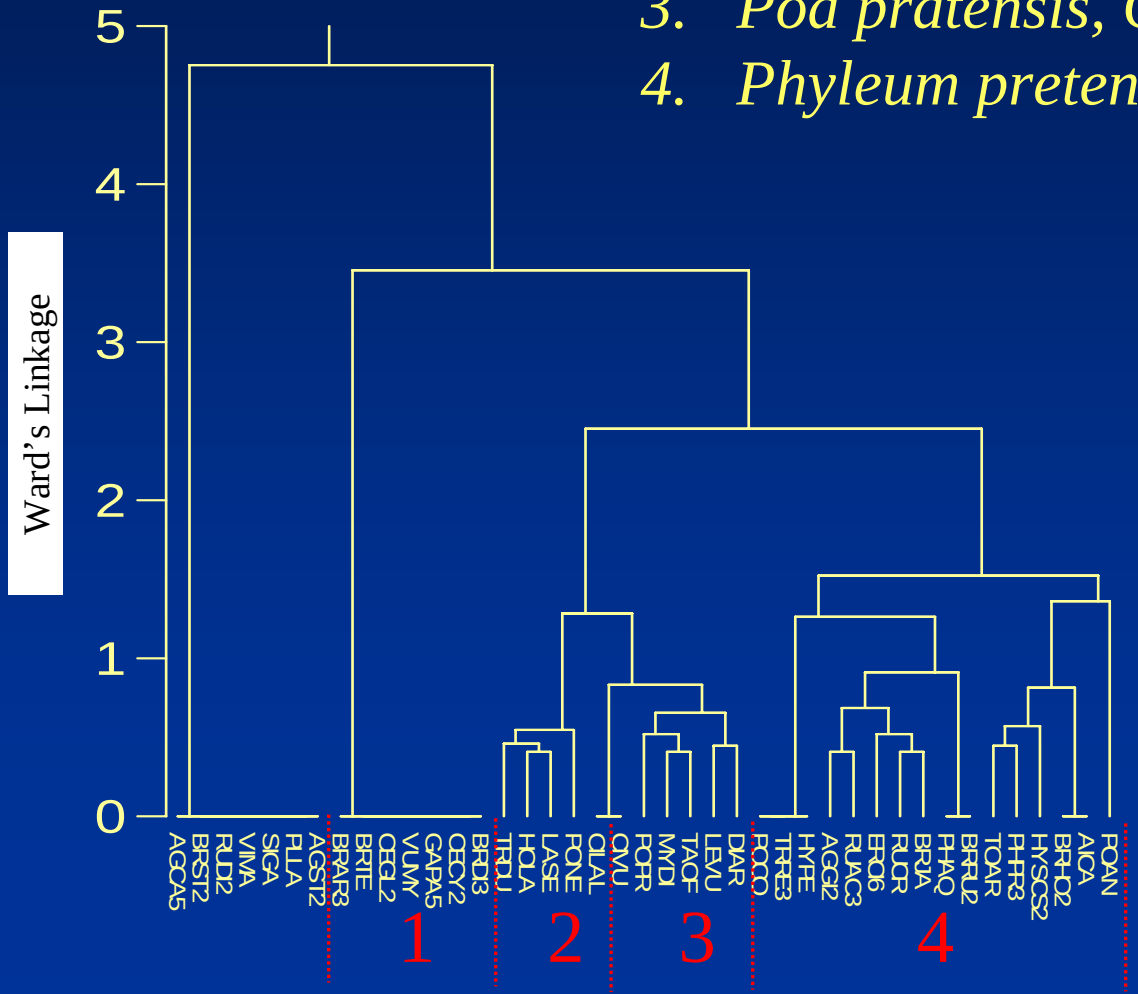
I. Community Level Analyses

- Analysis of field data (N=236)
- Supplemented with GIS derived data
  - Environmental variables: elevation, slope, aspect, % cover trees, shrubs, soil characteristics
  - Disturbance variables: years since burn, size of burn, distance to road, trail, campground
- Regression analyses
- Ordination analyses
- Grouped co-occurring species

- Identified key variables

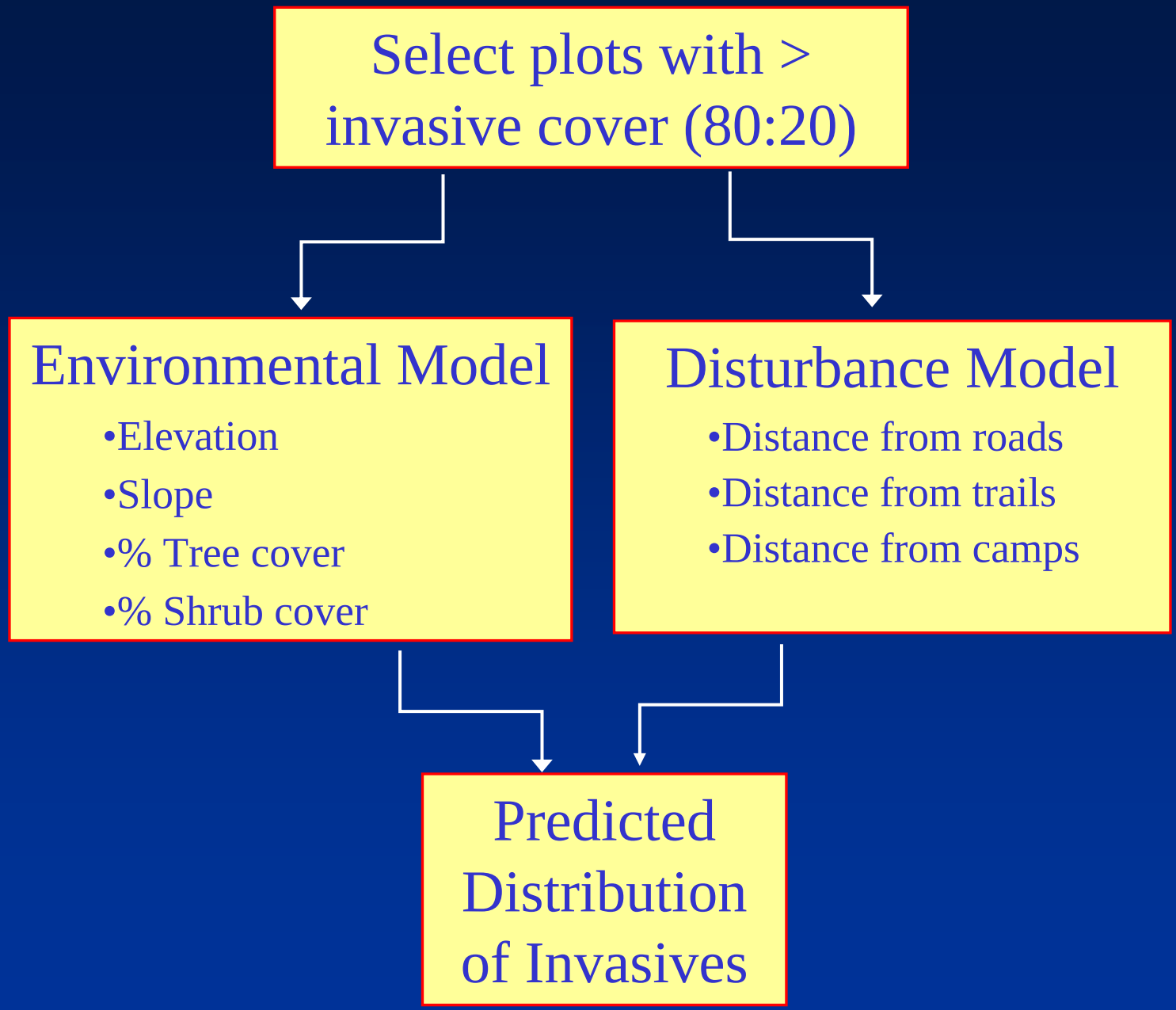


- Identified four species groups
  1. *Bromus tectorum, Vulpia myuros*
  2. *Holcus lanatus, Lactuca serriola*
  3. *Poa pratensis, Cirsium vulgare*
  4. *Phyleum pretense, Hypericum scouleri*

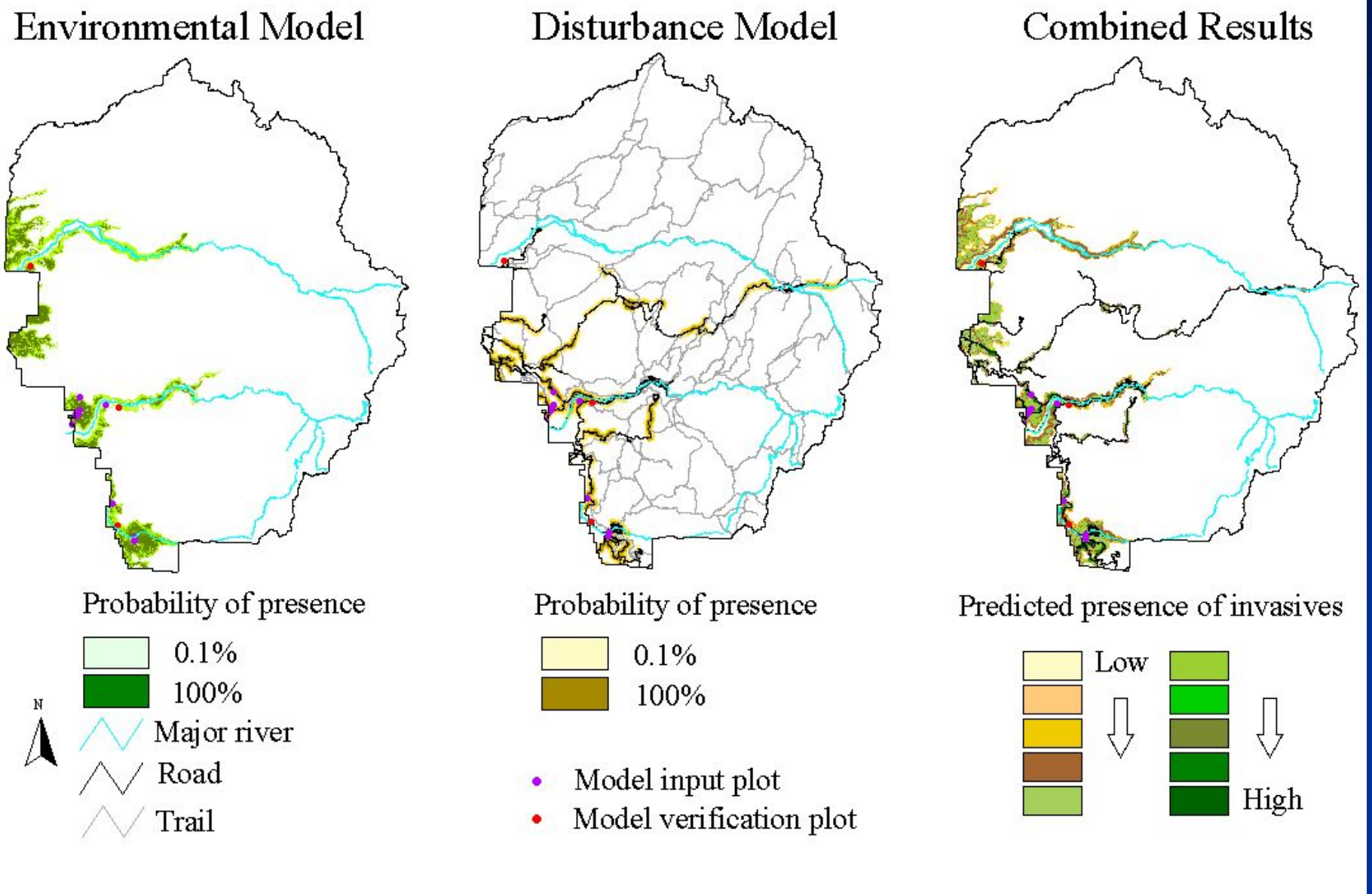


II. Predictive Modeling

- Goal
  - To extrapolate from plot to landscape scale
  - To compensate for limited field data
- Why GARP?
  - Readily available
  - No assumptions about underlying data
  - Combination of approaches means greater predictive ability
  - Novel application

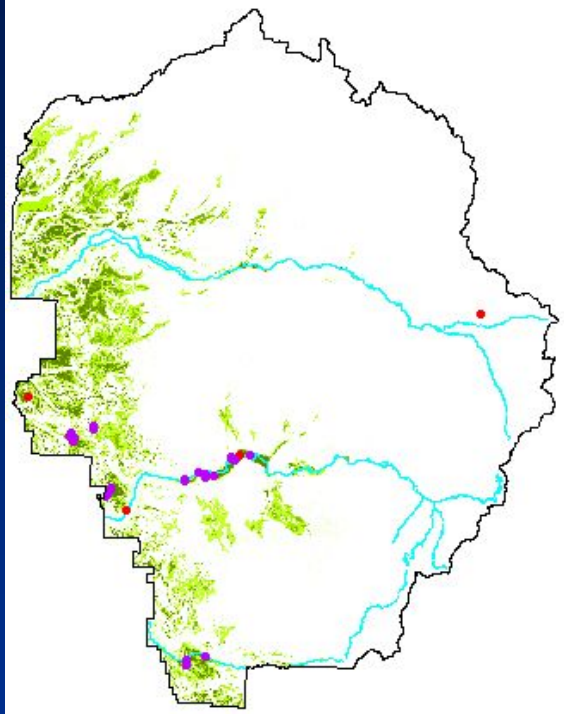

Select plots with > invasive cover (80:20)
Environmental Model
•Elevation
•Slope
•% Tree cover
•% Shrub cover
Disturbance Model
•Distance from roads
•Distance from trails
•Distance from camps
Predicted Distribution of Invasives

Predictive Model Results: Species Group 1



Predictive Model Results: Species Group 3

Environmental Model



Probability of presence

0.1%

100%

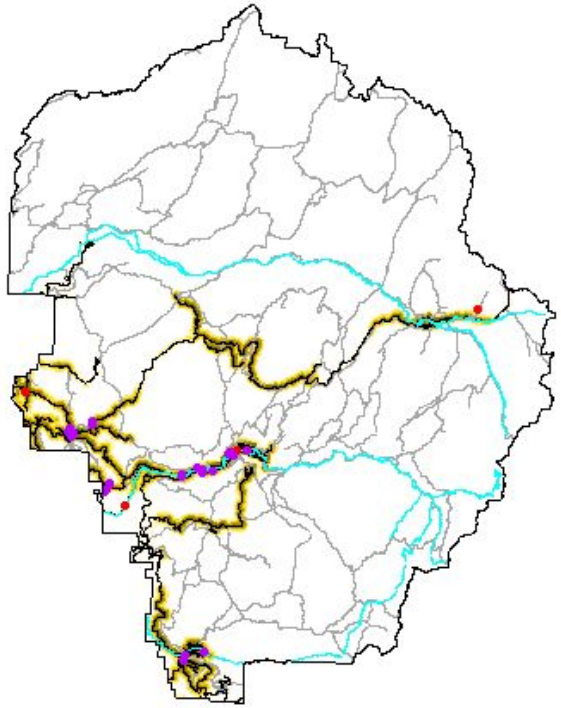
N

Major river

Road

Trail

Disturbance Model



Probability of presence

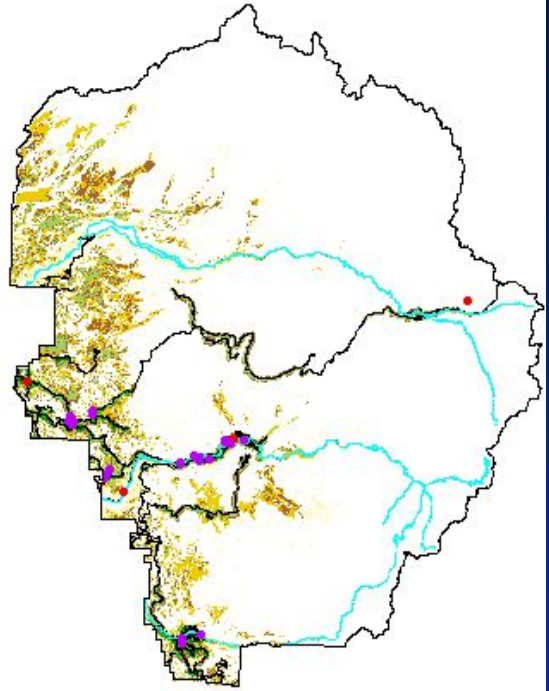
0.1%

100%

Model input plot

Model verification plot

Combined Results



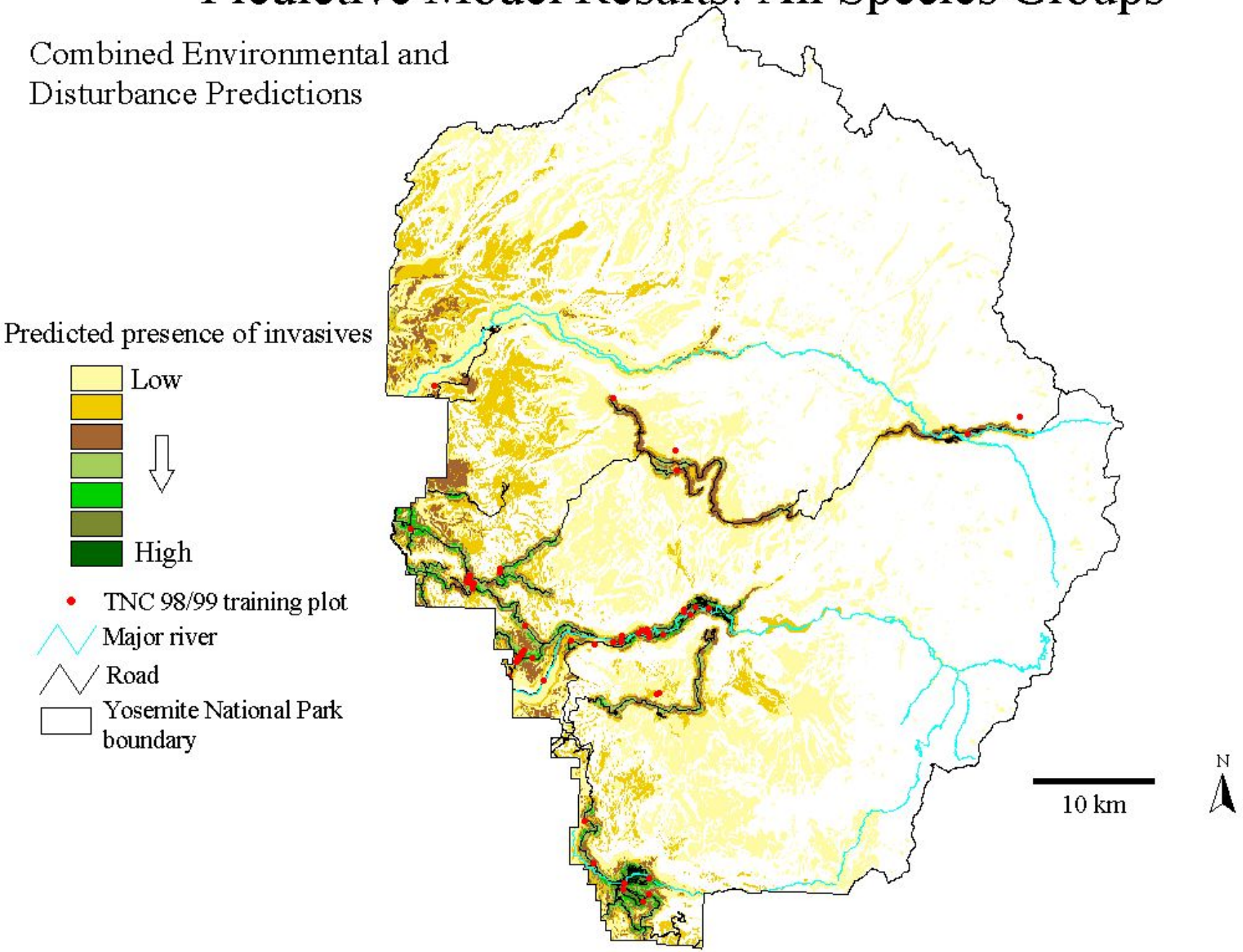
Predicted presence of invasives

Low

High

Predictive Model Results: All Species Groups

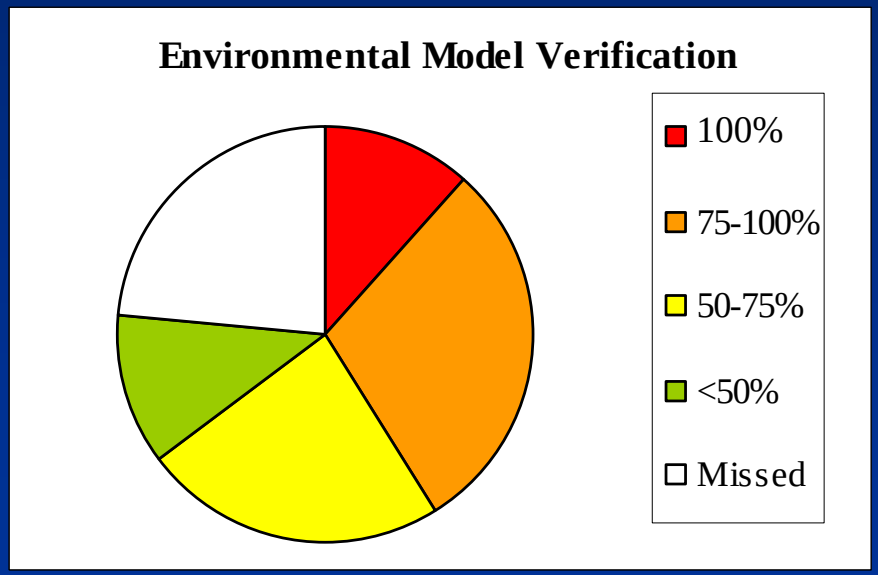
Combined Environmental and Disturbance Predictions

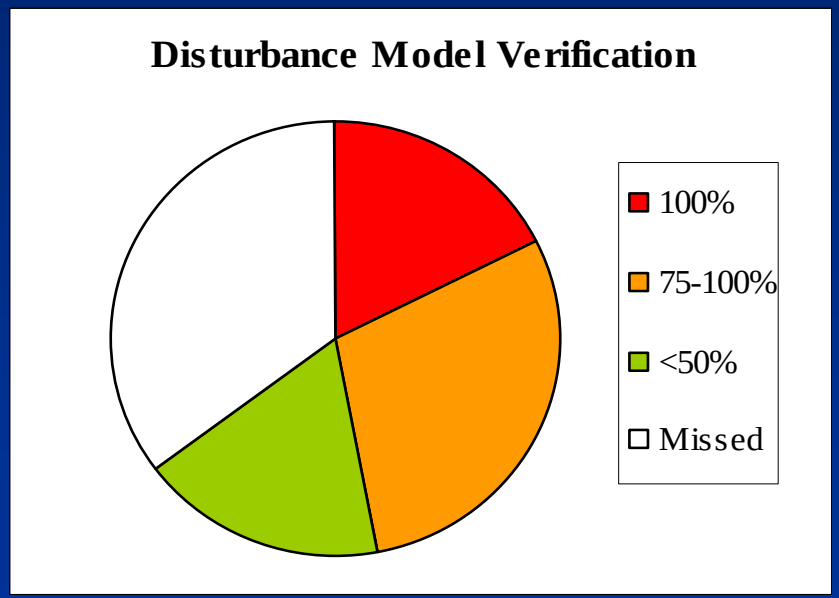


Model Evaluation

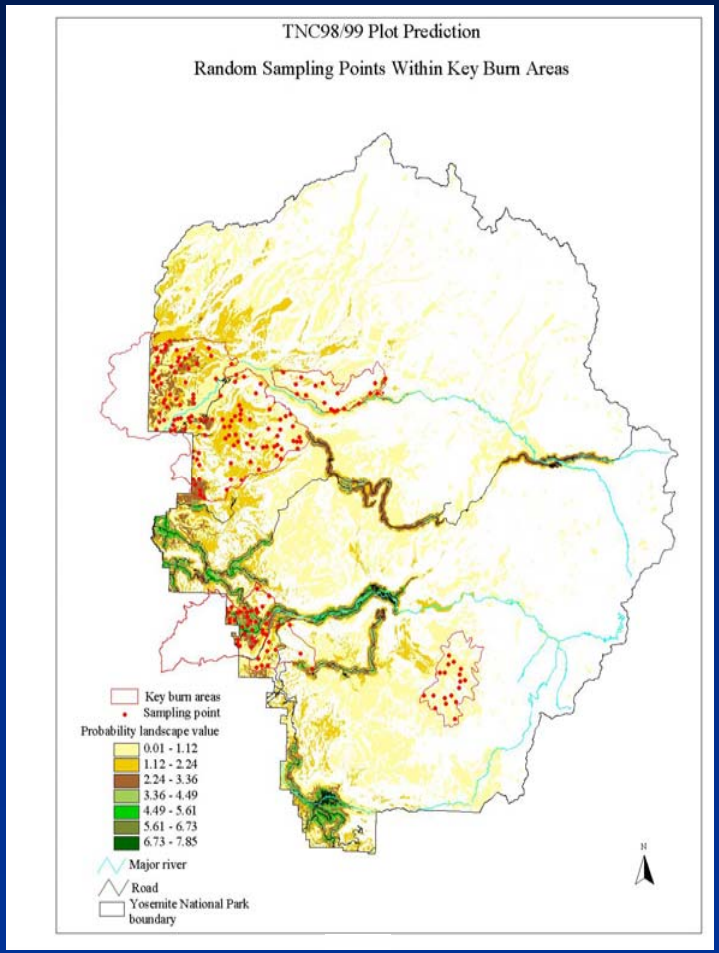
Plots predicted as present

- Environmental Model = 76%
- Disturbance Model = 65%





Significance of Study



- Predictive model developed with an ecological basis
- Includes both environmental and disturbance variables
- Results provide foundation for NPS sampling and monitoring activities

Limitations of Predictive Models

- Risk of over- and under- prediction
- Static & fail to reflect environmental variability
- Models based on limited input data, extrapolation must be done carefully
- Temporal scale

Conclusions

- Models offer valuable tools for extrapolating to broader scales
- Multiple models available, allows flexibility
- Predictive modeling field is maturing, but requires shared experiences

Acknowledgements

- Peggy Moore; Western Ecological Research Center, USGS
- Linda Mutch; NPS Inventory & Monitoring Coordinator
- Marcel Rejmanek; University of California, Davis
- John Randall; Invasive Species Initiative, The Nature Conservancy
- National Park Service & Yosemite National Park
- David Stockwell; University of California, San Diego
- Karen Olmstead; CSTARS, University of California, Davis