The Use of Remote Sensing, GIS and Multivariate Vegetation Analyses to Explain the Distribution of Riparian Forest Communities at Multiple Spatial Scales

By

Lauren Mollot
Ph.D. Candidate
College of Forest Resources
University of Washington

Overarching Question

- PNW Watersheds
  - History of timber harvest
  - Degradation
  - Hardwood/Shrub dominated
  - Riparian restoration needed

Timber Harvest

- Under what conditions should we restore conifer to stands currently dominated by hardwood in our effort to rehabilitate fish habitat?
- Case study: Cedar River Watershed

Analytical Framework

- Remote Sensing (Macro Scale)
  - Used to characterize the current range of riparian forest conditions
- GIS (Meso Scale)
  - Develop a model to identify sites suitable for conifer restoration in riparian areas
- Multivariate Vegetation Analysis (Micro Scale)
  - Identifies plant communities and landforms that support conifer restoration

Remote Sensing Research Objectives

- Test the use of remote sensing tools of analysis in classifying 5 riparian forest cover classes.

1. Deciduous
2. Early Seral Conifer
3. Mid Seral/Mature Conifer
4. Late Seral/Old Growth Conifer
5. Mixed Conifer/Deciduous

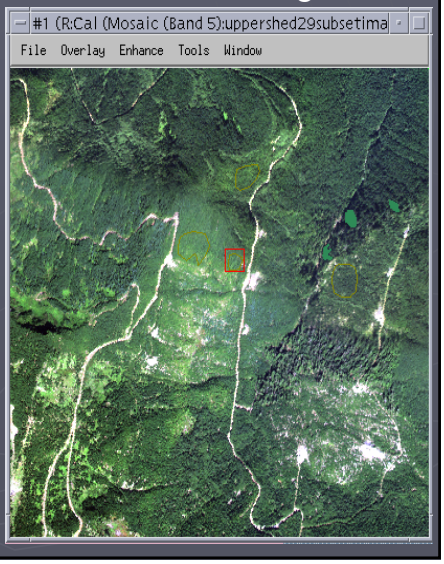
- Can stands be classified with overall accuracy $\geq$ 75% when compared with field observations?

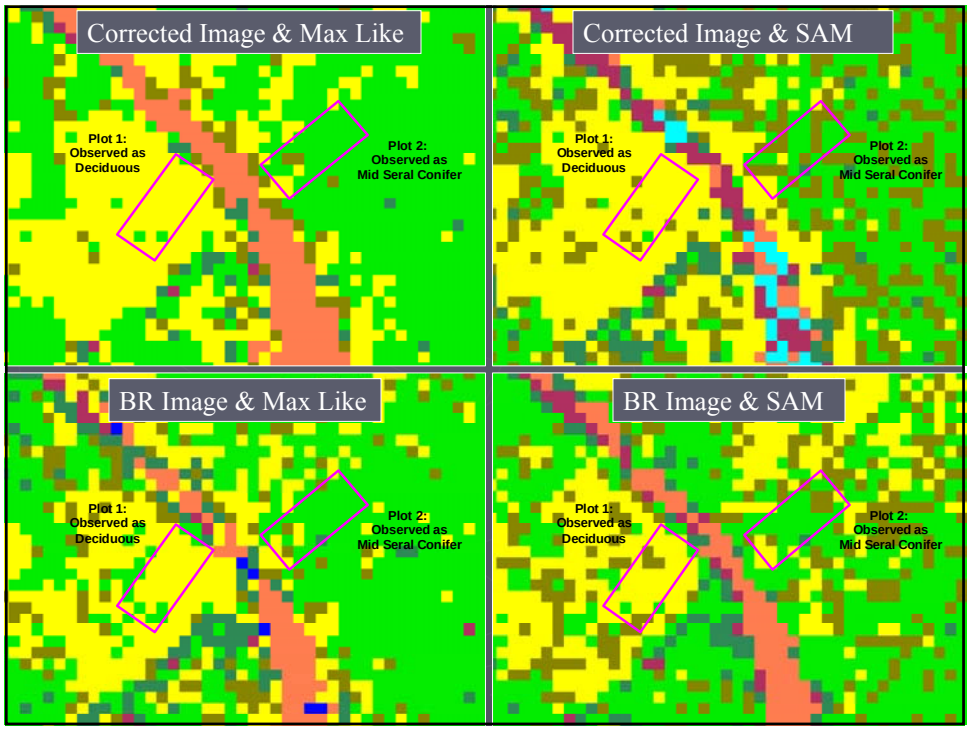
MASTER Data

Master Data (2001)

- High Resolution: 5 m
- Hyper-spectral: 50 bands
- Pixel contains spectral reflectance of features.

Master Data Image





Validation

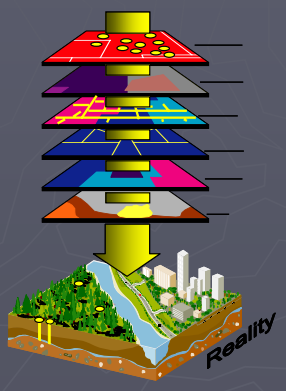
- Evaluate the accuracy of classification against field observations.
- Producer Accuracy
  Proportion of pixels correctly classified as X/# pixels observed to be X

** Small sample size. Not well represented

ID	Producer
Decid	88%
Young Con	91%
Mid Con	86%
Old Con	43% **

GIS Analysis

- Classified riparian forest cover map brought into GIS.
- Base layer
- Perform spatial analysis



GIS Habitat Suitability Model

Develop a GIS model to conduct a salmon habitat suitability analysis.

Where are sites across the watershed that exhibit both:

1. High biological potential for fish: geomorphic context
2. Suitable for conifer restoration

GIS Habitat Suitability Model

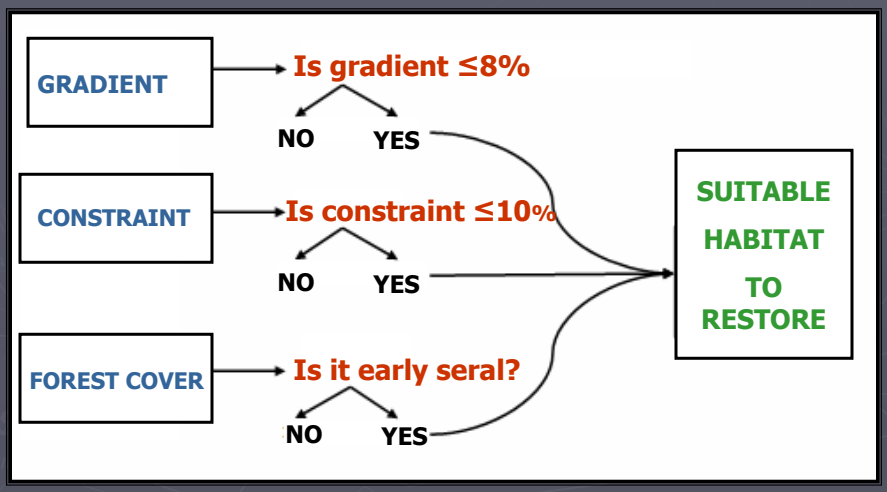
Assumptions:

- confinement, gradient, old conifer
- 3 major factors

Layers in GIS Model:

1. Channel confinement (Lidar)
2. Channel gradient (Lidar)
3. Riparian forest cover

Decision Tree: Boolean logic for locating ideal restoration sites



GIS Model Results

- Model identifies a suite of potential sites.
- Need to examine micro scale landforms at sites.

Multivariate Vegetation Analysis

Objectives:

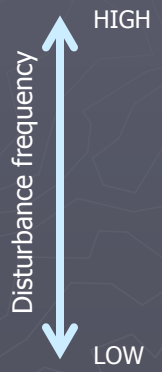
Identify sites with landforms supporting conifer.

1. Characterize the distribution of riparian plant communities.
2. Analyze community distribution relating to:
   - Alluvial landform

Phase 2: Alluvial Landform Classification

Field plots assigned to 4 landform classes:

1. 2 yr. Active Floodplain
2. 2-100 yr. floodplain
3. Terrace
4. Hillslope



GEE Statistical Analysis

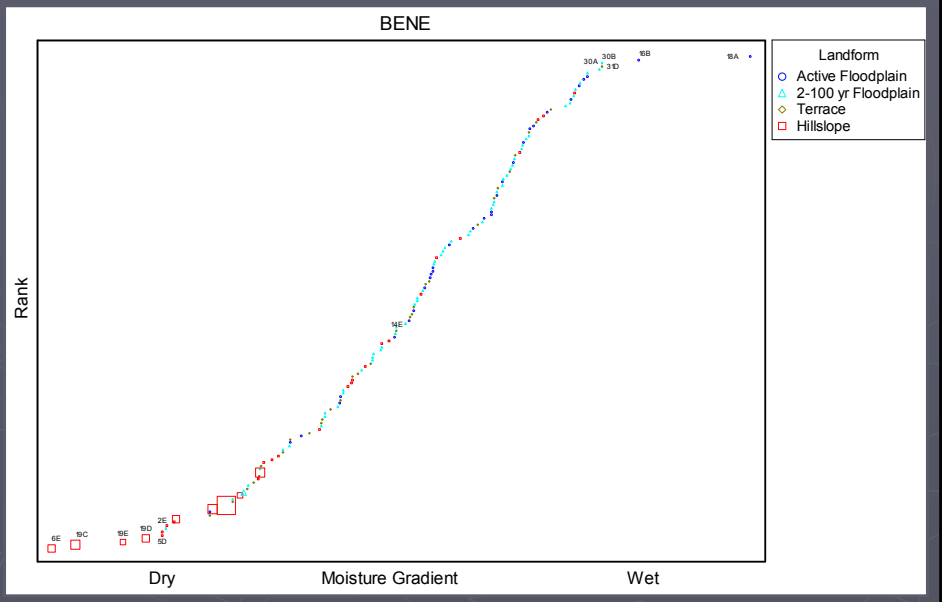
- Similar to MANOVA
- Key variables tested: %Conifer, %HW, sapling density
- H_o = No difference between conifer basal area across 4 landforms
- Z > 3 * Std. Error=Difference in means not due to chance.
- Reject H_o

GEE RESULTS	Estimate	Robust Std. Error	Robust Z value	p value
Intercept	2.00	0.41	4.88	.0001
Landform 2	0.81	0.26	3.13	.0001
Landform 3	1.31	0.35	3.73	.0001
Landform 4	1.67	0.33	5.10	.0001

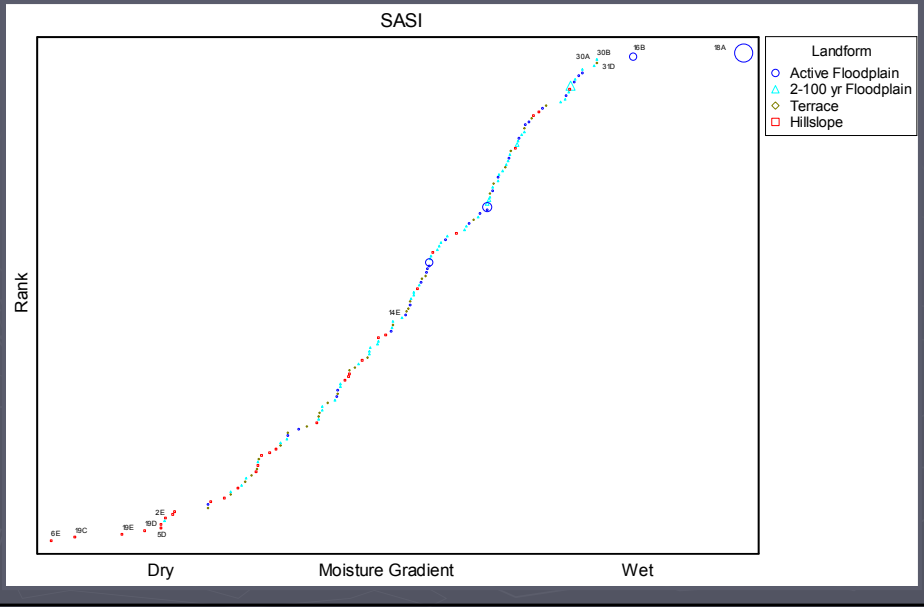
Weighted Averaging Ordination

- Multivariate technique to understand the patterns in community data.
- Relationship between moisture gradient and species distribution.
- Assigned weighted values (1-10) (Reed 1989).
- Correlate landform to moisture gradient.

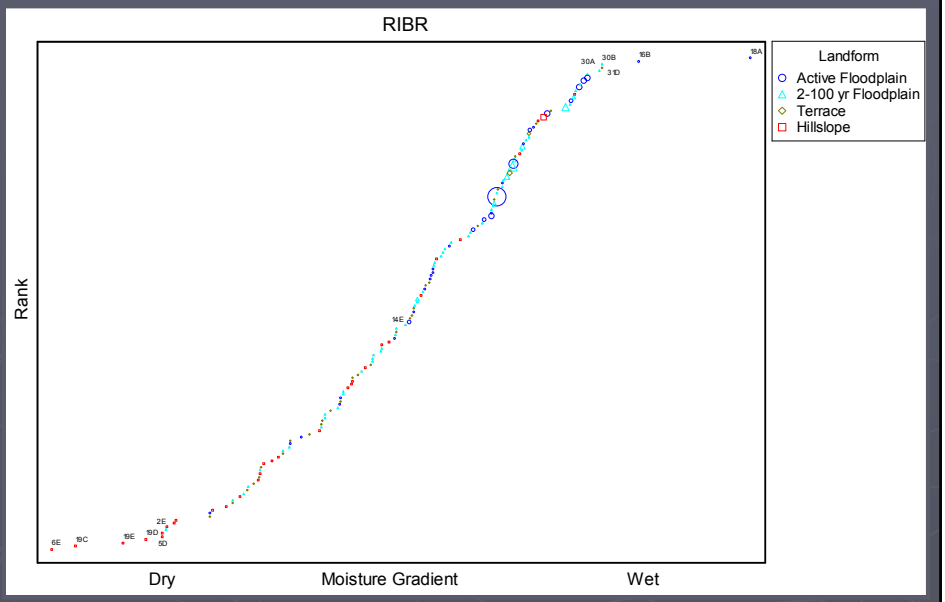
Oregon Grape



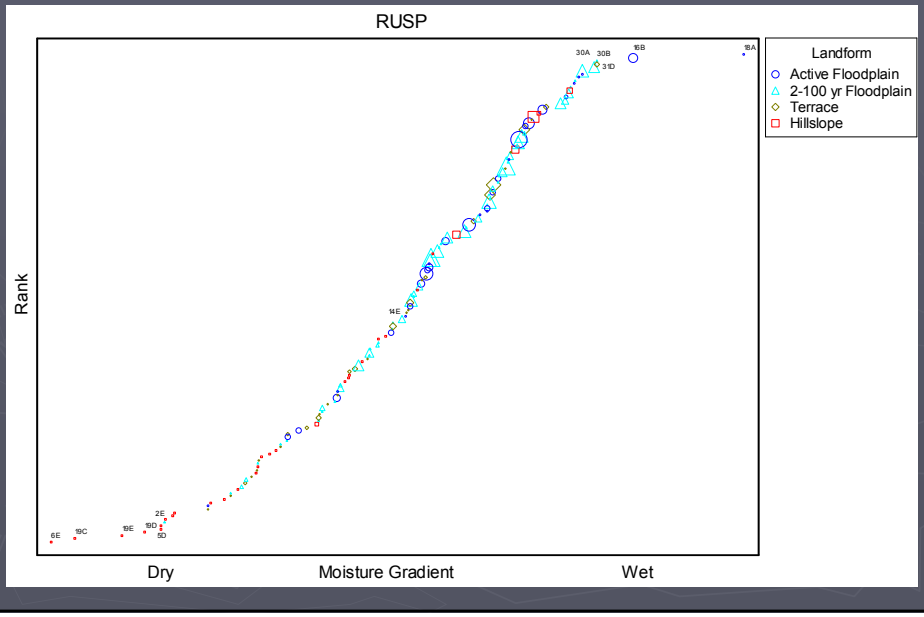
Sitka Willow



Stink Currant



Salmonberry



Indicator Species Analysis

- Classification Method
- Detects the value of a species in defining an environmental condition
- Condition = landform

Indicator species with significant p values

Species Code	Landform Class	p value	Comment
ALRU	1,2,3,4	0.03	Gradient
PSME	4	0.001	
TSHE	4,3,2,1	0.001	Gradient
ConSap	4,3,2,1	0.02	Gradient
HWSap	1,2,3	0.001	Gradient
BENE	4	0.001	Exclusive
RIBR	1	0.001	
RUPA	1,2	0.02	Equal
SASI	1	0.03	
DIFO	2	0.005	Exclusive

Multi-Response Permutation Procedure

- Non-parametric classification procedure
- Tests H_o : No difference between plant assemblages across 4 landform groups

MRPP Results:

- *T* Statistic: Between Group Agreement
  Negative *T* = strong separation (≤ -10.0)
  Result: *T* = -17.8 (p = 0.00000)
- *A* Statistic: Within Group Agreement
  Positive *A* = strong homogeneity (≥ 0.1)
  Result: *A* = 0.1

Vegetation analysis establishes which landforms host plant communities that would support conifer restoration

Management Implications

Scientists can use this collective research as:

Methodology for addressing the question of watershed restoration.

1. Remote Sensing Classification:
   - baseline that characterizes the range of conditions
2. GIS Model:
   - identifies potential restoration sites
   - high biological potential for fish
3. Multivariate Vegetation Analysis:
   - Identifies landforms that support conifer retention.

Acknowledgements

Committee Members:

Dr. R.E. Bilby
Dr. R. Edmonds
Dr. D.L. Peterson
Dr. J.F. Franklin
Dr. D. Maclaclan

Cedar River Watershed:

Dr. D. M. Chapin
(Aquatic Scientist)
Dr. D. Munro
(Remote Sensing Analyst)