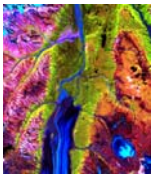
ASPRS Workshop 23:

Field Data Collection Techniques for the Development of Remote Sensing Ground-Truth



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Our Data Processing Focus

- **Resource Information Development**
  - Ecological Assessment and Characterization
  - Vegetation Classification
- **Remote Sensing**
  - Satellite Image Processing and Classification
    - Raster and stand level mapping
      - *Types*
      - *Size, density, and structure*
    - Fire-fuel modeling
    - Change detection
  - Accuracy Assessment

Our Field Data Collection Focus

- **Natural Resource Inventory**
  - Industrial Forest Inventory
    - Inventory
    - Growth and yield modeling

Our Field Data Collection Focus

- **Natural Resource Inventory**
  - Industrial Forest Inventory
    - Inventory
    - Growth and yield modeling
- **Land Cover/Vegetation Mapping**
  - Ground-truth based on field data collection
    - Image Classification training data descriptions
    - Accuracy assessment data descriptions
    - Vegetation Classification descriptions

Needs and Data Collection Efforts

- **Project goals determine data collection needs**
  - Vegetation Classification Projects
    - Botanically oriented species composition
    - Botanically oriented species presence
    - Possible disconnect – the detail you may see on the ground you may never be able to map but may be part of type rules.
  - Remote Sensing Projects
    - Overstory or Bird's-eye view/perspective
    - Land cover types
    - Tree/shrub size and density
      - Dbh and/or height

Remote Sensing Data Needs

- **Field data can be collected to describe**
  - Dominant visible canopy layer
    - Understory vegetation ?
    - Total vegetation ?
    - Trace species ?
  - Canopy structure ?
  - Surface condition ?
    - Down woody debris ?
    - Other abiotic features ?

Classification Training Data Needs

- **Field Training Data for Mapping**
  - Can't map what you don't know is there
  - Can't correctly map what you misidentify in the field
- **The field data you collect**
  - May define what you can map
  - May define what you can include in the data set

Accuracy Assessment Data Needs

- **Field Data for Accuracy Assessment**
  - Compatible with Mapping Project data
- **The accuracy assessment field data**
  - May define what map data you can test
  - May define how you can test the map data
    - Statistical comparisons and tests
    - Alternate classes

Technology and Data Needs

- **The resources being mapped are typically dynamic**
- **Technology ?**
  - Some technological changes have occurred quite rapidly e.g. advent of high resolution imagery and lidar
  - Some technological changes have occurred quite slowly – e.g. mapping/classification processes
- **Base our data needs on desired information rather than what current technology may provide**

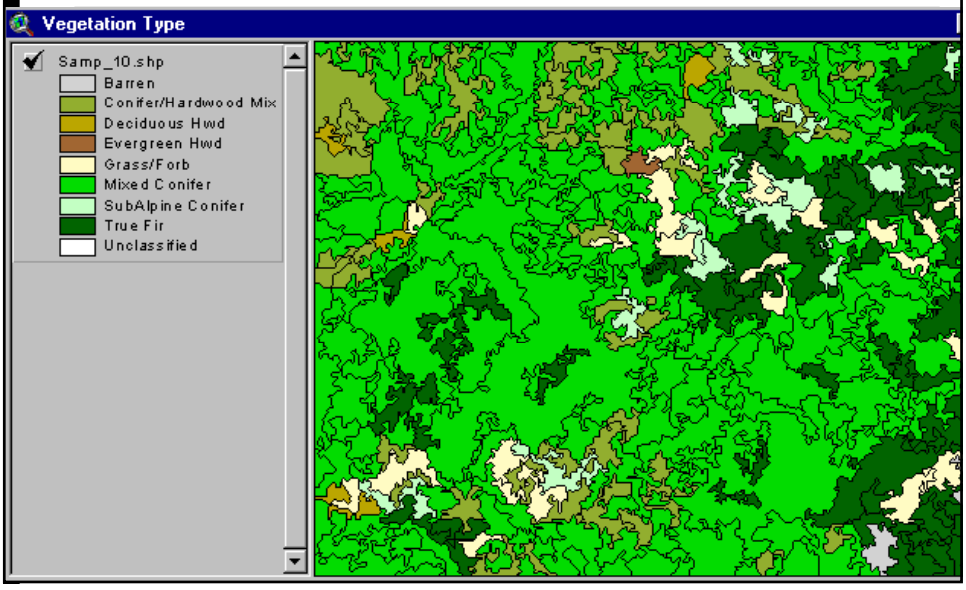
Definitions and Terminology

- **Traditional Remote Sensing Projects Use Categorical Values**
  - Types – National Vegetation Classification System
  - Classes = ranges of continuous discrete values defined by thresholds
    - Tree Size
    - Shrub Height
    - Cover Density
    - Canopy Structure
  - Need Rules to define these Categorical Values

Land Cover Classification Results

- **Categorical Maps – land cover classes**
  - **generalized lifeforms**
    - **Forb, Barren, Shrub, Conifer, Hardwood, …**

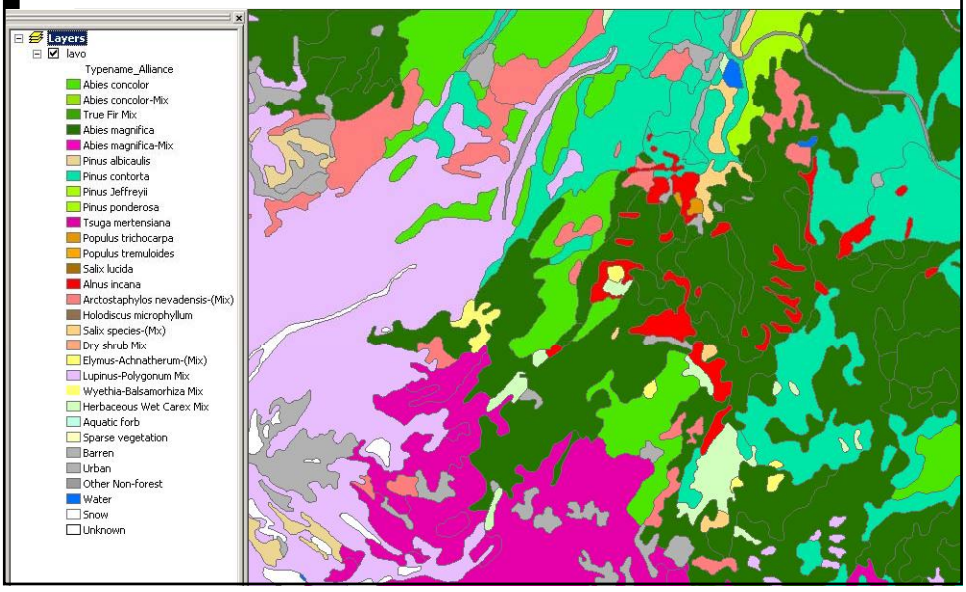
Categorical Land Cover Classes



Land Cover Classification Results

- **Categorical Maps – land cover classes**
  - generalized life forms
    - Forb, Barren, Shrub, Conifer, Hardwood, …
  - **generalized types / alliances**
    - ***Abies concolor, Pinus Jeffreyii, Pinus contorta, …***

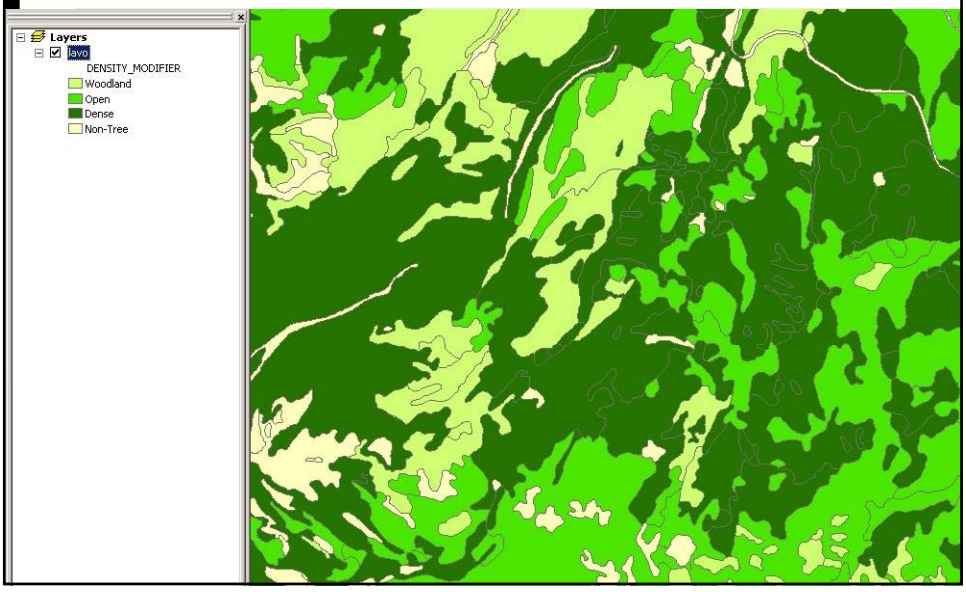
Categorical Land Cover Types



Land Cover Classification Results

- **Categorical Maps – land cover classes**
  - – generalized life forms
    - Forb, Barren, Shrub, Conifer, Hardwood, …
  - – generalized types/alliances
    - *Abies concolor, Pinus Jeffreyii, Pinus contorta, …*
  - – **generalized density class values**
    - **Woodland, Open, Closed …**

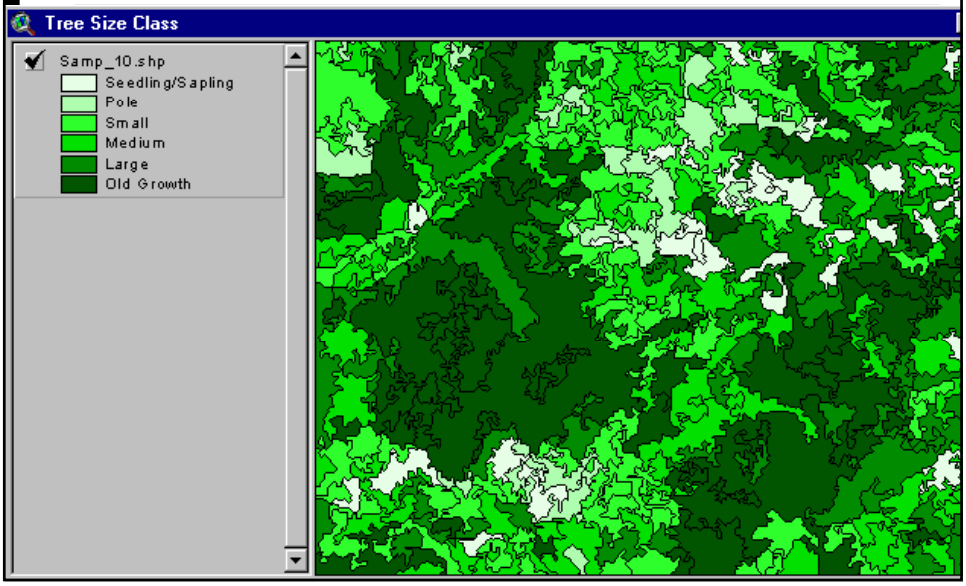
Categorical Density Classes



Land Cover Classification Results

- **Categorical Maps – land cover classes**
  - generalized cover-types
    - Forb, Barren, Shrub, Conifer, Hardwood, …
  - generalized types/alliances
    - *Abies concolor, Pinus Jeffreyii, Pinus contorta, …*
  - generalized density class values
    - Woodland, Open, Closed …
  - **generalized size class values**
    - **Sapling, Pole, Small, Medium, Large, …**

Categorical Tree Size Classes

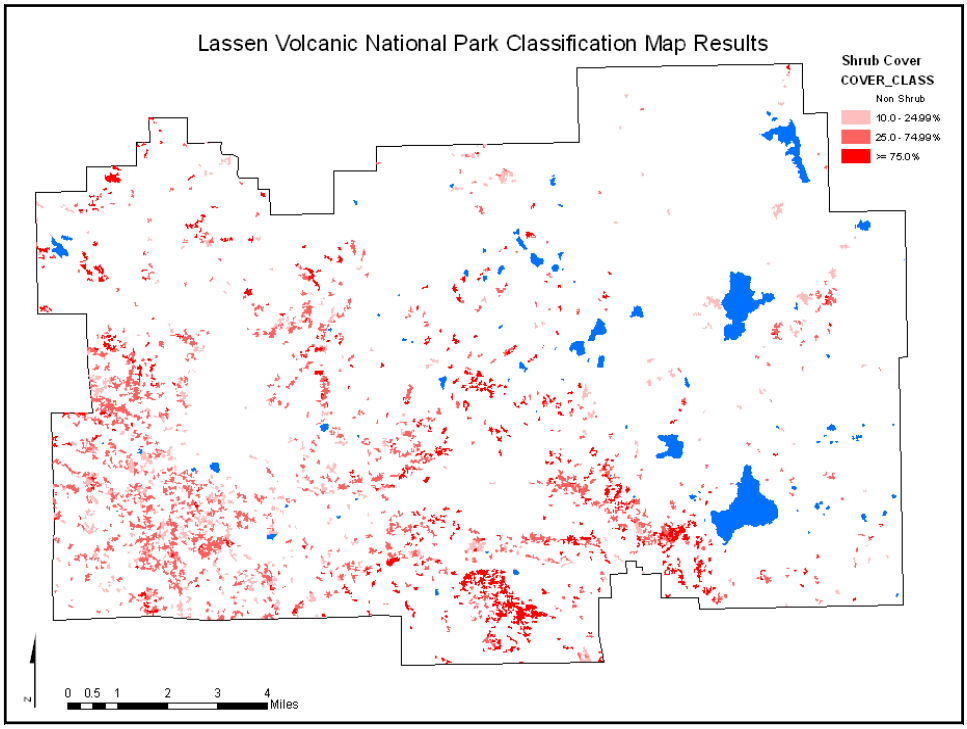


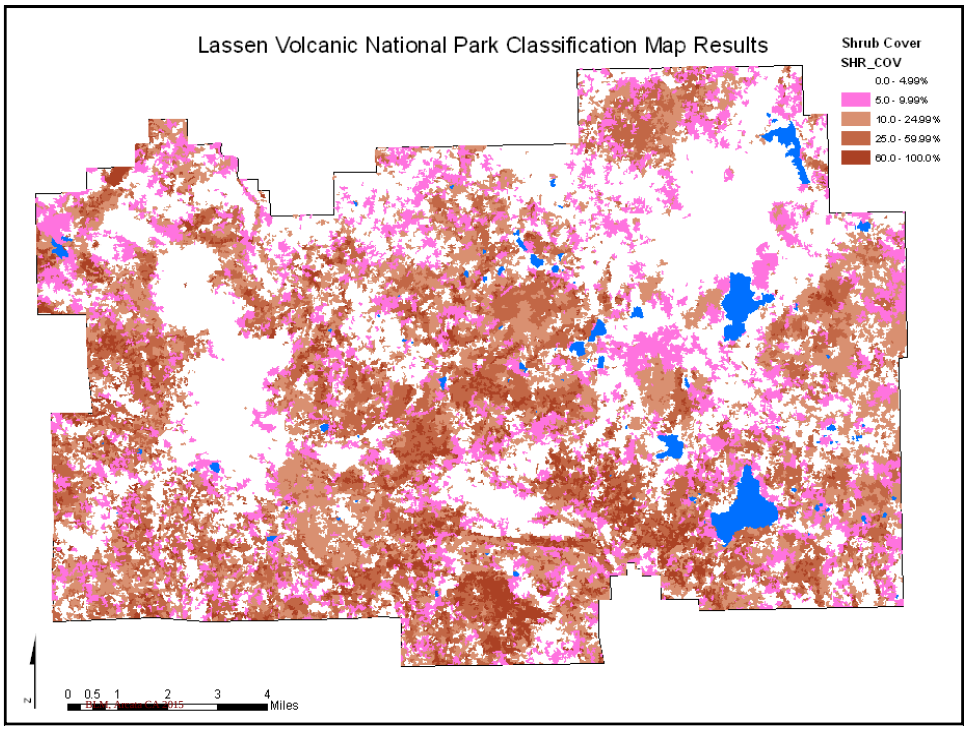
This Approach …

- **Based on Clustered/Categorical Processing**
  - Collect categorical field data
  - Process using categorical approaches
    - Supervised
    - Unsupervised
    - Segmentation
  - Develop categorical data sets
  - Test accuracy with categorical data and fuzzy logic
- **Many users think this is all we can do**

What's Wrong With This Approach?

- **Limited information for decision making**
- **Lack of statistics**
- **Potentially misleading results**
- **A generalized baseline is less sensitive to indicating change**
- **Need for Cross (Jay) walking of data**


Lassen Volcanic National Park Classification Map Results
Shrub Cover
COVER_CLASS
Non Shrub
10.0 - 24.99%
25.0 - 74.99%
>= 75.0%
N
0 0.5 1 2 3 4
Miles


Lassen Volcanic National Park Classification Map Results
Shrub Cover
SHR_COV
0.0 - 4.99%
5.0 - 9.99%
10.0 - 24.99%
25.0 - 59.99%
60.0 - 100.0%
N
0 0.5 1 2 3 4
Miles

Braun-Blanquet Vegetation Density Classes

Cover Class	Range of Cover (%)	Midpoint Cover(%)
8	75-100	87.5
7	50-75	62.5
6	25-50	37.5
5	5-25	15.0
4	1-5	3.0
3	0.1-1	0.6
2	0.01-0.1	0.06
1	0.001-0.01	0.006

Categorical Dos and Don'ts

- **Do estimate value using mid-point of range**
- **Do NOT ever process/analyze class index values**
  - Do not average class numbers
  - Do not use class numbers as relative measures

Percent Cover Summary for Bird's-eye Layer:
Site/Polygon Id: 72223

Dbh Size Class: Species	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover	Non-Tree Cover	Total Cover
Doug-fir	0.0	14.3	8.2	24.5	2.0	49.0		49.0
Jeffrey pine	0.0	0.0	8.2	0.0	0.0	8.2		8.2
Tanoak	8.2	4.1	2.0	0.0	0.0	14.3		14.3
California bay	0.0	4.1	6.1	0.0	0.0	10.2		10.2
Rhamnu Califor							12.2	12.2
Elymus Sp							2.0	2.0
Festuc Califor							2.0	2.0
Carex Sp							0.7	0.7
Galium Sp							0.7	0.7
Unknown							0.7	0.7
Totals	8.2	22.5	24.5	24.5	2.0	81.7	18.3	100.0

Tree Cover Composition Summary for Bird's-eye Layer 81.7 Cover:

Dbh Size Class: Species	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	All Sizes
Doug-fir	0.0	17.5	10.0	30.0	2.4	60.0
Jeffrey pine	0.0	0.0	10.0	0.0	0.0	10.0
Tanoak	10.0	5.0	2.4	0.0	0.0	17.5
California bay	0.0	5.0	7.5	0.0	0.0	12.5
Totals	10.0	27.5	30.0	30.0	2.4	100.0

Percent conifer composition= 70.0
Percent hardwood composition= 30.0
Most common specie is Doug-fir with 60.0 percent cover composition

Key to Forests and Woodlands

1. Combined absolute cover of all conifer tree species exceeds combined cover of all broadleaved tree species 2

2. Combined absolute cover of Pine trees exceeds combined absolute cover of all other conifers. Douglas-fir (*Pseudotsuga menziesii*) is typically present as co-dominant species in the tree layer. Occasionally cover of Douglas-fir may be equal or even slightly exceed cover of Pine tree species 3

3. Jeffrey Pine *(Pinus jeffreyi)* cover >= 10%. Combined cover of Idaho Fescue *(Festuca idahoensis)*, California Fescue *(Festuca californica)*, Blue Wildrye *(Elymus glaucus* ssp. *glaucus)*, California Oatgrass *(Danthonia californica)*, Prairie Junegrass *(Koeleria macrantha)*, Lemmon's Needlegrass *(Achnatherum lemmonii)* >= 10%. Little Bald Hills ..... ***Pinus jeffreyi alliance***
Pinus jeffreyi/Festuca idahoensis association

3'. Jeffrey Pine *(Pinus jeffreyi)* absent from the tree layer or present with cover <= 5% (much lower than other pine species). Combined cover of Dwarf Tanoak *(Lithocarpus densiflorus v. echinoides)*, Hairy Manzanita *(Arctostaphylos columbiana)* and other shrubs >= 50% 4

CAWHR Vegetation Density Classes

Cover Class	Range of Cover (%)	Midpoint Cover(%)
Dense	60-100	80.0
Moderate	40-59.9	50.0
Open	25-39.9	32.5
Sparse	10-24.9	17.5
Open Herb	10-39.9	25.0
Sparse Herb	2- 9.9	6.0

Crosswalking Estimates

- **Hard to reclassify categorical values of one data set into another set of values when the rules/thresholds do not match**
- **Very often there is not a direct or straightforward conversion of values from one set of rules to the other**

Not A Crosswalk

BB Cover Cover (%)	BB Range of Cover(%)	WHR Class	WHR Range of Cover(%)
8	75-100	D	60-100
7	50-75	M	40-59.9
6	25-50	O	25-39.9
5	5-25	S	10-24.9
4	1-5	OH	10-39.9
3	0.1-1	SH	2- 9.9
2	0.01-0.1		
1	0.001-0.01		

It is a Jaywalk!

? Categorical Values ?

- **Accuracy Assessment is much more difficult if we compare class values rather than discrete estimates.**
- **We can always generate class values based on discrete estimates.**

? Categorical Values ?

If we based our training data and mapping on Discrete Values and

we based our Accuracy Assessment/Ground Truth on Discrete Values

then would we ever need Fuzzy Logic?

Avoid Categorical Values !

A Different Approach – Discrete Data

- **Collect Discrete Data estimates**
- **Store Discrete Data**
- **Process and analyze Discrete Data**
- **Use the GIS and SQL update statements to apply the rules to the Discrete Data to develop the categorical data we use in our reports and maps!**

Ground Truth = Discrete Data

- **Cover/Frequency by**
  - Species
  - Size – dbh and crown width
  - Canopy position
  - Status
- **Species presence - traces**
- **Fine and Coarse Woody debris**
- **Other features – snags, water, …**

Percent Cover Summary for Bird's-eye Layer:
Site/Polygon Id: 60212
Number of Pixels: 1

Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover	Non-Tree Cover	Total Cover
Species								
Redwood	0.0	0.0	0.0	20.0	55.0	75.0		75.0
Doug-fir	0.0	0.0	0.0	7.5	7.5	15.0		15.0
West Hemlock	0.0	0.0	2.5	0.0	0.0	2.5		2.5
W. Hemlck dead	2.5	0.0	0.0	2.5	0.0	5.0		5.0
Vaccin Parvifo							2.5	2.5
Totals	2.5	0.0	2.5	30.0	62.5	97.5	2.5	100.0

Tree Cover Composition Summary for Bird's-eye Layer 97.5 Cover:

Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	All Sizes
Species						
Redwood	0.0	0.0	0.0	20.5	56.4	76.9
Doug-fir	0.0	0.0	0.0	7.7	7.7	15.4
West Hemlock	0.0	0.0	2.6	0.0	0.0	2.6
W. Hemlck dead	2.6	0.0	0.0	2.6	0.0	5.1
Totals	2.6	0.0	2.6	30.8	64.1	100.0

Percent conifer composition= 100.0
Percent hardwood composition= 0.0
Most common specie is Redwood with 76.9 percent cover composition

Quadratic Mean DBH and TPA Summary for Bird's-eye Layer:
Weighted by Cover

Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	All Sizes
Species						
Redwood	0.0"	0.0"	0.0"	43.2"	106.1"	93.5"
cov_wt	0.0	0.0	0.0	20.0	55.0	75.0
tpa	0.0	0.0	0.0	8.2	9.2	17.4
Doug-fir	0.0"	0.0"	0.0"	42.4"	54.3"	48.7"
cov_wt	0.0	0.0	0.0	7.5	7.5	15.0
tpa	0.0	0.0	0.0	3.3	5.4	8.7
West Hemlock	0.0"	0.0"	11.0"	0.0"	0.0"	11.0"
cov_wt	0.0	0.0	2.5	0.0	0.0	2.5
tpa	0.0	0.0	1.1	0.0	0.0	1.1
W. Hemlck dead	3.0"	0.0"	0.0"	40.0"	0.0"	28.4"
cov_wt	2.5	0.0	0.0	2.5	0.0	5.0
tpa	9.6	0.0	0.0	1.5	0.0	11.2
Conifer	3.0"	0.0"	11.0"	42.7"	101.2"	84.5"
cov_wt	2.5	0.0	2.5	30.0	62.5	97.5
tpa	9.6	0.0	1.1	13.0	14.6	38.4
All Species	3.0"	0.0"	11.0"	42.7"	101.2"	84.5"
cov_wt	2.5	0.0	2.5	30.0	62.5	97.5
tpa	9.6	0.0	1.1	13.0	14.6	38.4

Percent Cover Summary for All Layers:
Site/Polygon Id: 60212

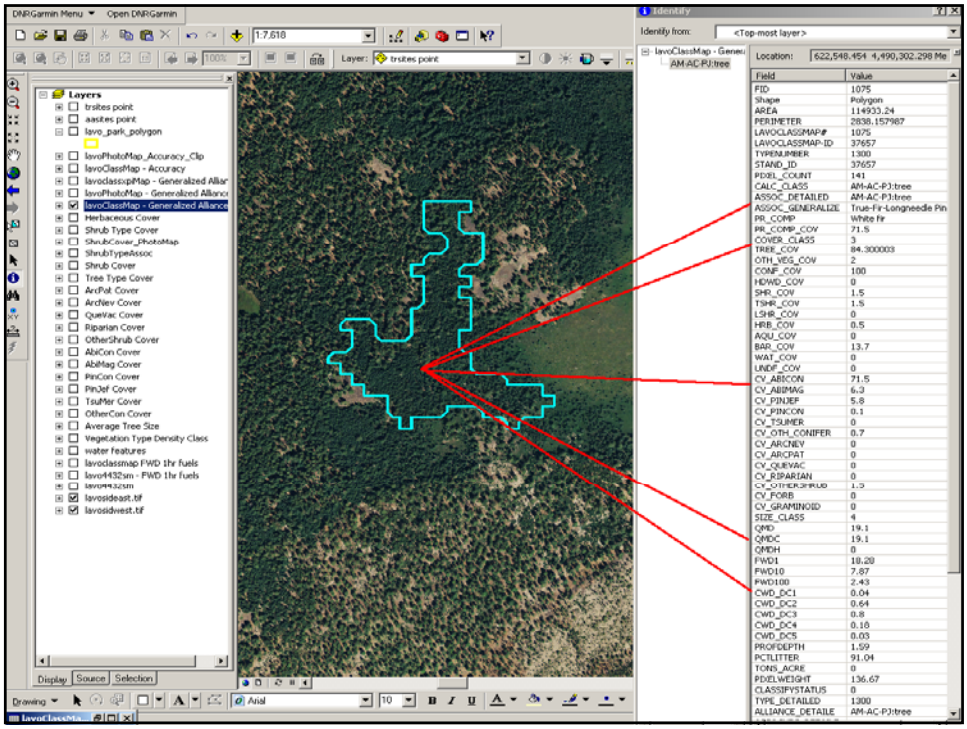
Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover	Non-Tree Cover	Total Cover
Species								
Redwood	0.0	5.0	5.0	30.0	55.0	95.0		95.0
Doug-fir	0.0	0.0	0.0	7.5	7.5	15.0		15.0
West Hemlock	7.5	8.8	5.0	0.0	0.0	21.3		21.3
W. Hemlck dead	2.5	0.0	0.0	5.0	0.0	7.5		7.5
Tanoak	0.0	1.3	0.0	0.0	0.0	1.3		1.3
Gaulth Shallon							12.5	12.5
Rhodod Macroph							1.3	1.3
Vaccin Ovatum							43.8	43.8
Vaccin Parvifo							3.8	3.8
Oxalis Oregana							30.0	30.0
Polyst Munitum							32.5	32.5
Trilli Ovatum							1.3	1.3
Coarse Wdydown							10.0	10.0
Fine Wdy Dbris							20.0	20.0
Litter							65.0	65.0
Vtree							2.5	2.5
Vherb							2.5	2.5
Traces:								
Berber Nervosa								
Rhamnu Purshia								
Dispor Hookeri								
Galium Trifidu								
Trient Latifol								
Vancou Hexandr								
Blechn Spicant								
Totals	10.0	15.1	10.0	42.5	62.5	140.1	225.2	365.3

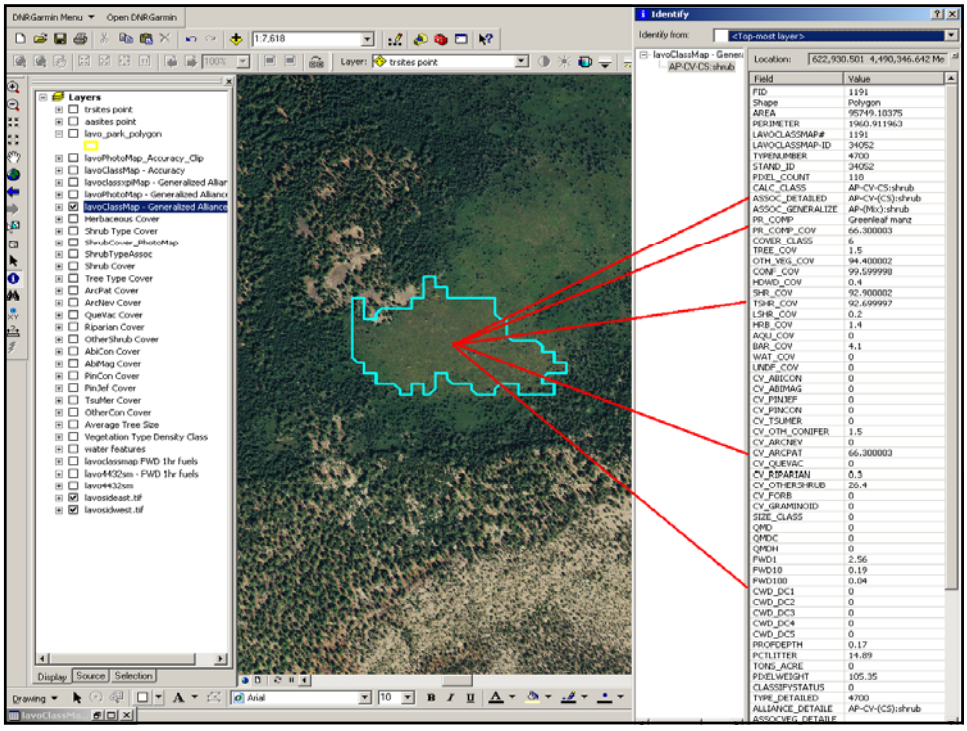
The Resulting Resource Data Set

- **A data set from which many maps may be developed.**
- **A data set that contains discrete estimates as well as the categorical class values.**
- **A data set for which statistics may be generated.**
- **A data set that may be checked using statistics rather than fuzzy logic.**

Discrete Data Sets May Contain …

- **Database Attributes**
  - Discrete estimates
  - Categorical values
    - Classes
    - Names
  - Map Accuracy
  - Alternate names/types





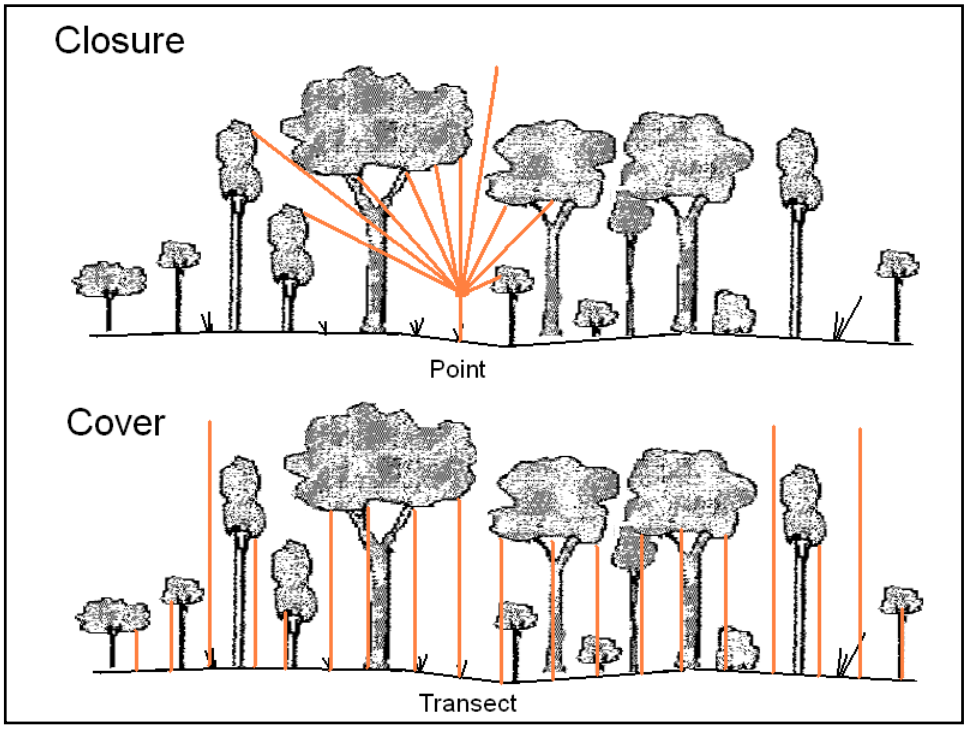
Discrete Map Data Set Examples

- **Coniferous Forest Types and Components**
  - Tree Size
  - Density
- **Shrub Types and Components**
- **Herbaceous Types and Components**
- **Non-vegetation Types and Components**

Break …

Some Specific Definitions

- **Cover**
- **Canopy Closure**
- **Canopy position/layering**
- **"Bird's-eye" versus "Total" Cover**
- **Frequency of Occurrence/Constancy**
- **Average Tree diameter (QMD)**
  - Frequency weighted QMD
  - Cover weighted QMD



Canopy Position / Layer

- **Variable Definitions**
  - Trees from Society of American Foresters
- **GRS Experience**
  - Top
  - Subordinate/Overtopped
  - Near ground/Intermediate
  - On the ground
  - Ground surface

"Bird's-eye" versus Total Cover

- **"Bird's-eye" View Cover is that cover as seen from above, as in Remote Sensing applications**
  - May include trees, shrubs, herbaceous plants and other features as seen/sensed from above regardless of canopy position/layer
- **Total Cover is the sum of the cover of all layers of the canopy.**
  - Includes cover of all trees, shrubs, herbaceous plants and other features as seen from the ground

Frequency of Occurrence / Constancy

- **The probability that you may expect to find a particular species or feature at a particular site of a particular type.**
- **A measure of the level of participation a certain species or feature has in a particular group of data.**
- **Probabilities based on an analysis of similar sites.**
- **Not the same as cover or closure.**

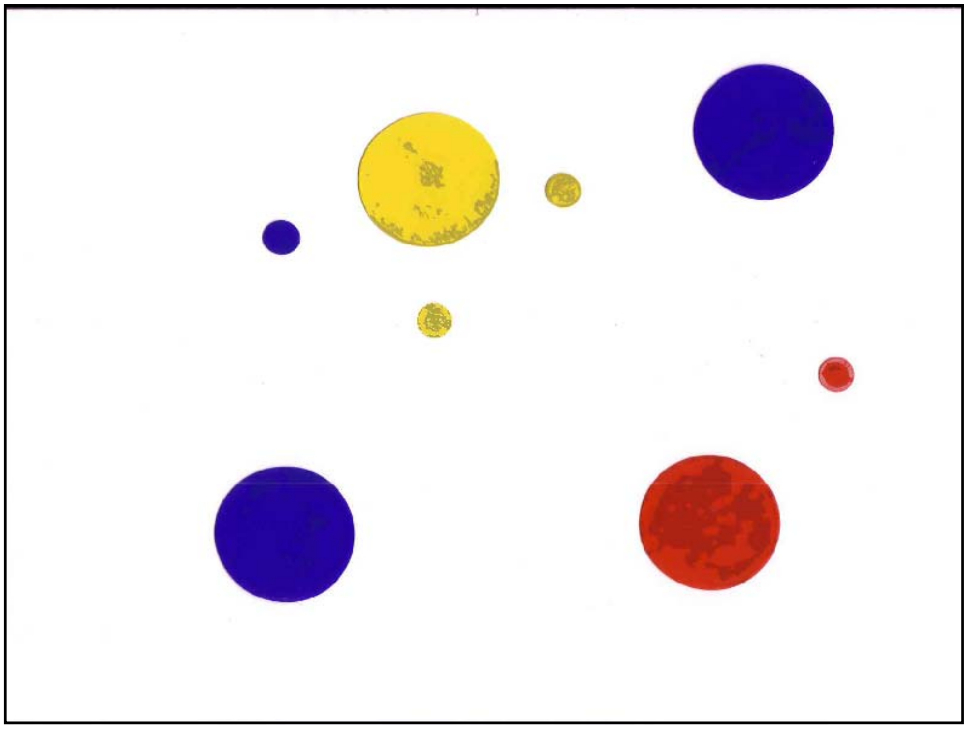
The following table shows all species and associated features in this association and gives percent frequency, average percent cover, and range (minimum and maximum) in cover for the plots in which they occur.

Detailed Alliance / Species	Bird's-Eye Frequency (%)	Bird's-Eye Average Cover	Bird's-Eye Minimum Cover	Bird's-Eye Maximum Cover	Total Frequency (%)	Total Average Cover	Total Minimum Cover	Total Maximum Cover
Tsuga mertensiana	100	12.8	8	16	100	14.1	8	22
Pinus albicaulis	100	9.3	2	15	100	9.8	2	15
Total tree		**22.1**				**23.9**		
Total shrub		**0**				**0**		
Lupinus obtusilobus	87.5	25	10	43	87.5	25.3	10	43
Polygonum davisiae	87.5	6.4	1	10	87.5	6.4	1	10
Carex species	25	1.5	2	10.2	25	1.5	2	10.2
Other Graminoids	37.5	0.8	1	3.1	37.5	0.8	1	3.1
Eriogonum marifolium	25	0.6	2	3.1	37.5	0.6	2	3.1
Calyptridium umbellatum	12.5	0.5	4	4	12.5	0.5	4	4
Carex leptalea	12.5	0.5	4.1	4.1	12.5	0.8	6.1	6.1
Carex straminiformis	12.5	0.3	2	2	12.5	0.3	2	2
Arabis species	12.5	0.1	1	1	12.5	0.1	1	1
Aster integrifolius	12.5	0.1	1	1	12.5	0.1	1	1
Castilleja species	P	T	T	T	12.5	T	T	T
Elymus Elymoides	P	T	T	T	12.5	T	T	T
Monardella odoratissima	P	T	T	T	12.5	T	T	T
Penstemon species	P	T	T	T	12.5	T	T	T
Polygonum shastense	P	T	T	T	12.5	T	T	T
Viola species	P	T	T	T	12.5	T	T	T
Total herbaceous		**35.8**				**36.4**		
Lichen	12.5	0.3	2	2	12.5	0.3	2	2
Total nonvascular		**0.3**				**0.3**		
Fine Gravelly Soil	87.5	12.3	9	20.4	87.5	18.3	9	58
Bare Rock	100	25.1	6	50	100	28.6	8	50
Bare Soil	25	1.8	2	12	25	3	4.1	20
Gravel	12.5	0.3	2	2	12.5	0.8	6.1	6.1
Fine Woody Debris	25	0.5	2	2	25	0.6	2	3.1
Litter	87.5	2	1	6	87.5	10.9	1	34
Total other		**42**				**62.2**		
Totals		**100**				**146**		

Quadratic Mean Diameter (QMD)

- **The average size tree based on the average basal area per tree.**
- **Basal area is the cross-sectional area of a tree at 4.5‘ above the ground on the uphill side of the tree …**
- **QMD is the SQRT of $\frac{\text{Sum of Basal Area}}{\text{Sum of Weights}}$**

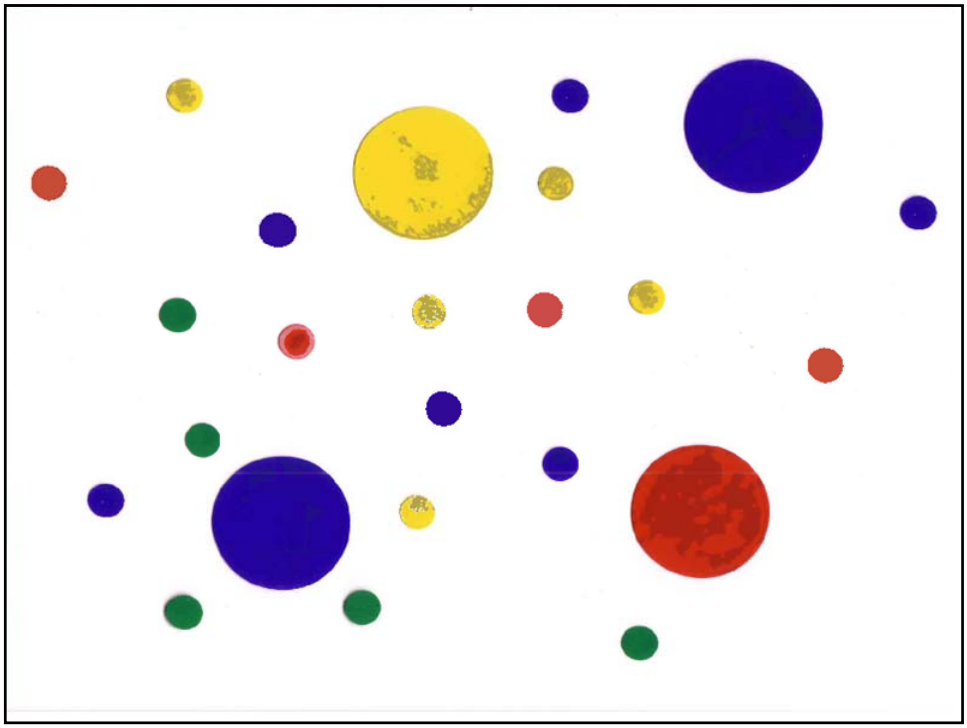
What is the Weight – Frequency or Cover ?



QMD – Equal Frequency

QMD - Frequency versus Cover Weighted

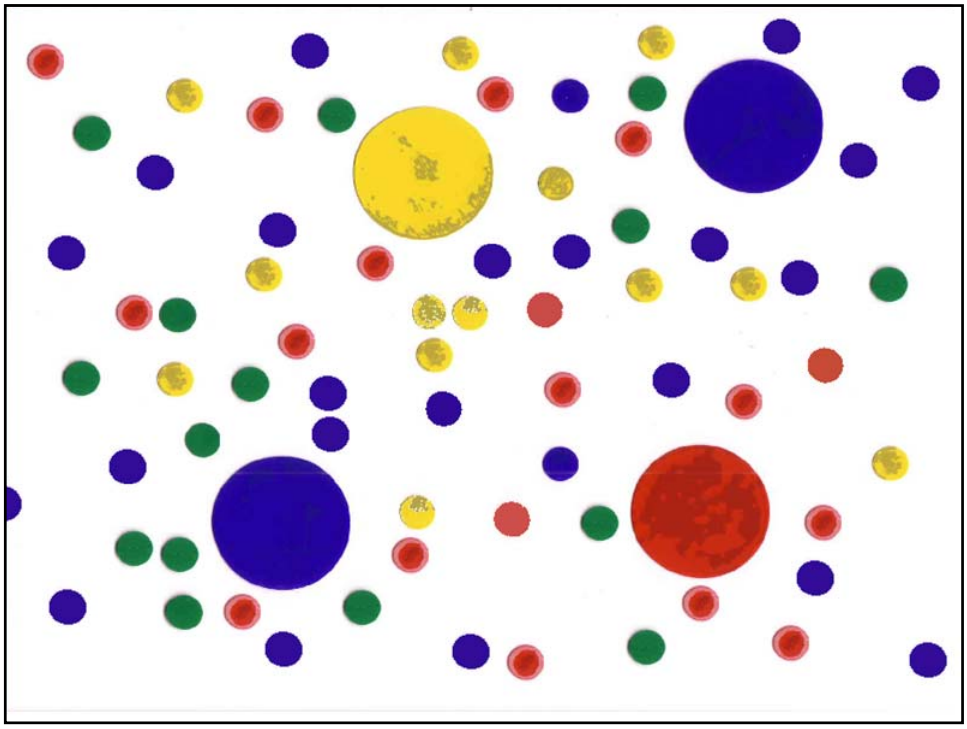
Size (dbh)	Count	QMD_{tpa}	Cover	QMD_{cov}
37	0	0.0	0.00	0.0
25	4	25.0	8.20	25.0
17	0	0.0	0.00	0.0
12	0	0.0	0.00	0.0
10	0	10.0	0.00	0.0
6	4	6.0	0.47	6.0
Total	**8**	**18.2**	**8.68**	**24.3**



QMD – Unequal Weights

QMD - Frequency versus Cover Weighted

Size (dbh)	Count	QMD_{tpa}	Cover	QMD_{cov}
37	0	0.0	0.00	0.0
25	4	25.0	8.20	25.0
17	0	0.0	0.00	0.0
12	0	0.0	0.00	0.0
10	0	10.0	0.00	0.0
6	20	6.0	2.36	6.0
Total	**24**	**11.6**	**10.57**	**22.2**



QMD – Equal Cover

QMD - Frequency versus Cover Weighted

Size (dbh)	Count	QMD_{tpa}	Cover	QMD_{cov}
37	0	0.0	0.00	0.0
25	4	25.0	8.20	25.0
17	0	0.0	0.00	0.0
12	0	0.0	0.00	0.0
10	0	10.0	0.00	0.0
6	69.4	6.0	8.20	6.0
Total	**73.4**	**8.3**	**16.40**	**18.2**

One Last Definition

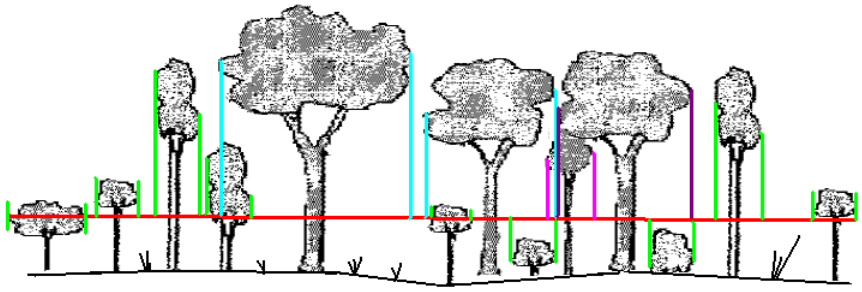
- **BIAS**
  - To intentionally or inadvertently alter the results or outcome of data collection activities. Happens when we
    - Sample only homogeneous areas
      - *Okay for training data collection*
      - *Not okay to withhold training data sites for Accuracy Assessment**
    - Sample only "typical" areas
    - Sample only a portion of the area
    - Use data collection techniques known to be biased or inaccurate

Field Data Collection Methodologies

- **Remote Sensing**
  - Photo Interpretation
- **Ocular**
  - Ground-based
  - Aerial
- **Measured or Quantifiable**
  - Statistical values
    - Means
    - Variances

Sampling Methodologies

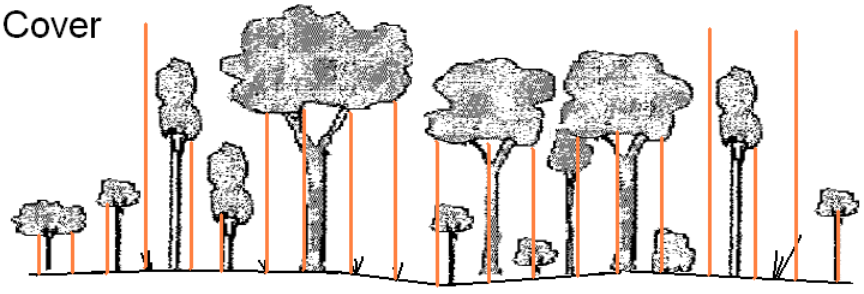
- **Fixed Area**
- **Transect**
  - Linear
  - Point
- **Point**
- **Integrate Multiple Configurations**
  - Disjoint Sampling Concerns
    - All species may not be present at all levels of sampling
      - *Detailed subplot versus larger generalized plot*



Transect - Linear

$$\%\text{cover} = \frac{\text{length of cover}}{\text{length of line}}$$

Cover



Line-point Transect

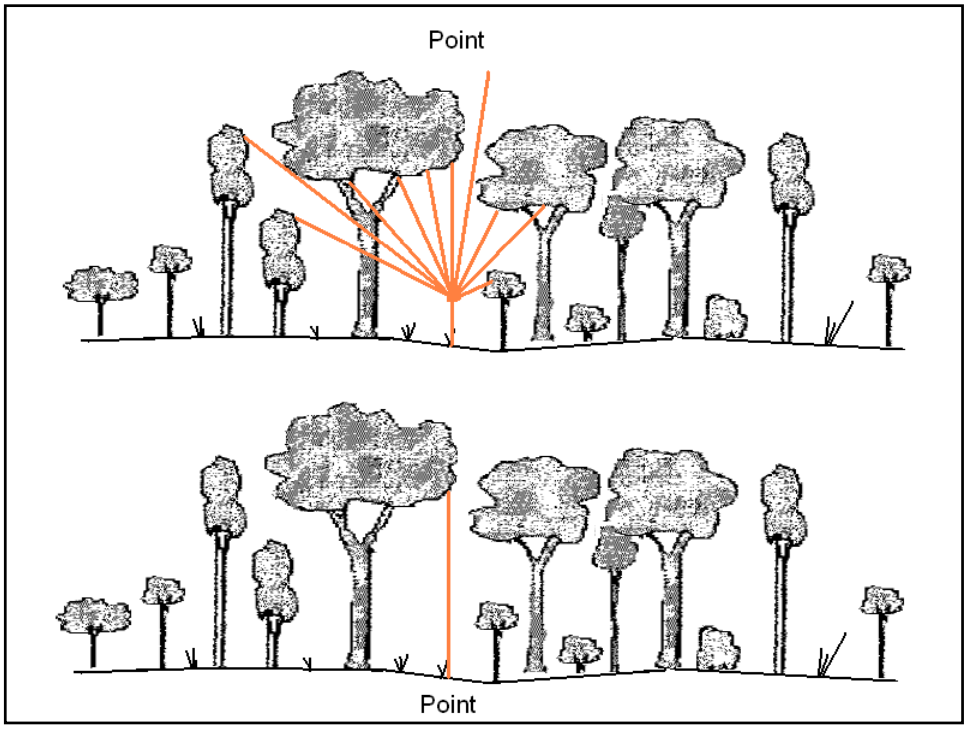
$$\%\text{cover} = \frac{\text{number of covered points}}{\text{total number of points}}$$

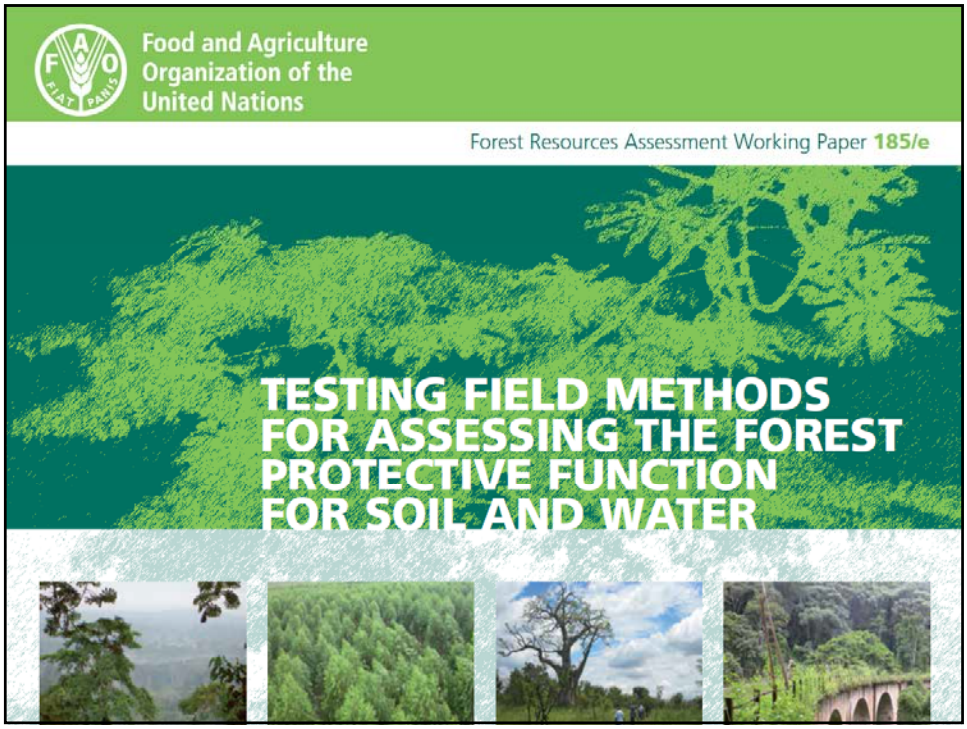
Binomial Sampling Statistics

Since the data being collected using this technique are binomially distributed (for each feature of interest there is a "yes" or "no" answer at every transect sample point), the statistical reliability of our sample, for different sample sizes, is known and is shown in the following table. A cover estimate based on a sample of one hundred points will yield a 95 percent confidence interval width between ± 6.0 percent and ±10.1 percent cover. An estimate based on 200 points will yield a 95 percent confidence interval width between ± 4.3 percent and ±7.1 percent cover.

95 Percent Confidence Interval (Two Standard Deviations)
Relative to Sample Size(n) and Population Estimate(p)

	Population Estimate(p)								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Sample Points									
10	20.0%	26.7%	30.6%	32.7%	33.3%	32.7%	30.6%	26.7%	20.0%
25	12.2%	16.3%	18.7%	20.0%	20.4%	20.0%	18.7%	16.3%	12.2%
50	8.6%	11.4%	13.1%	14.0%	14.3%	14.0%	13.1%	11.4%	8.6%
100	6.0%	8.0%	9.2%	9.8%	10.1%	9.8%	9.2%	8.0%	6.0%
200	4.3%	5.7%	6.5%	6.9%	7.1%	6.9%	6.5%	5.7%	4.3%
400	3.0%	4.0%	4.6%	4.9%	5.0%	4.9%	4.6%	4.0%	3.0%





10. Conclusions

This study tested four methods for collecting data on the soil and water protective function of forests. The study showed that the line-point transect forest cover assessment method was the most accurate, least expensive and most easily applied among the four methods tested. This method is scientifically accurate and records forest canopy and floor cover as a set. The instrument used in this method, the GRS Densitometer™, is small, light and easy to carry and comparatively cost efficient.

It is known that forest protects soil and water, but reporting on this function is not extensive and the mechanism of the protection is not clear. Therefore, it is desirable to identify the type or cover of forest that, along with other geophysical parameters, determines the protective function for soil and water. The discussions carried out in the context of this study concluded that comparing erosion evidence with vegetation parameters offers the most potential for understanding this function, and that a combination of vegetation cover, erosion evidence and slope could be used to derive a relationship. The vegetation cover and type and the slope parameters are different from site to site and biome to biome. Erosion evidence may be shaped by these parameters.

Field Sample Allocation

- **Field Training Sites**
  - Opportunistic sampling - “Hunt and Peck”
  - “A priori” knowledge
  - Other – e.g Gradsect
  - Sample area stratification
- **Accuracy Assessment Sites**
  - Map data set stratification
    - Random location within each stratum

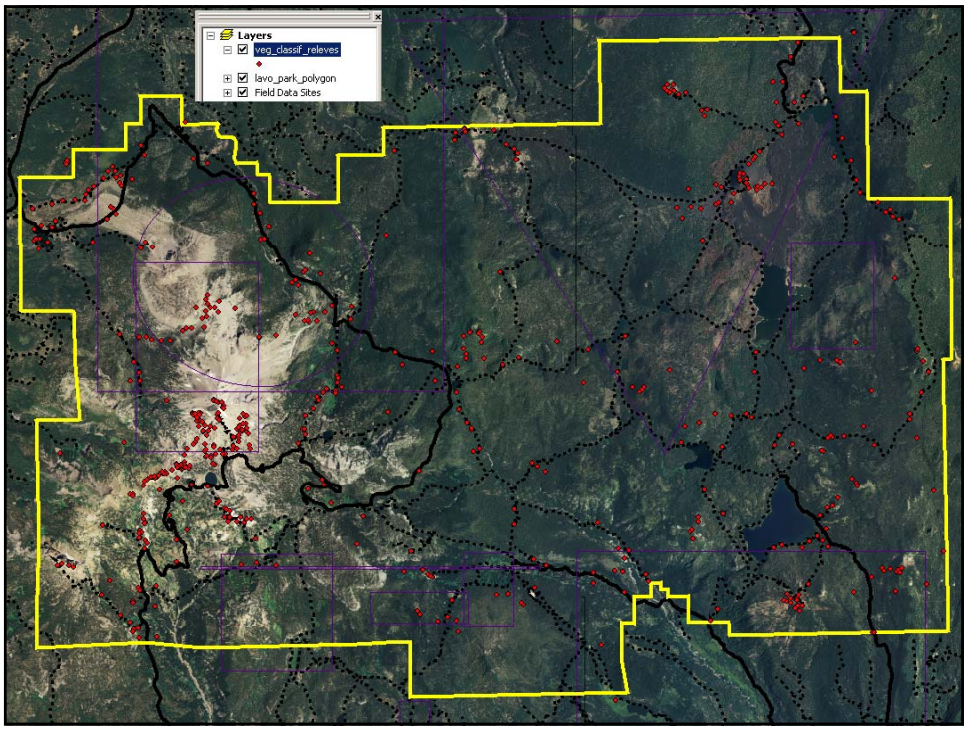
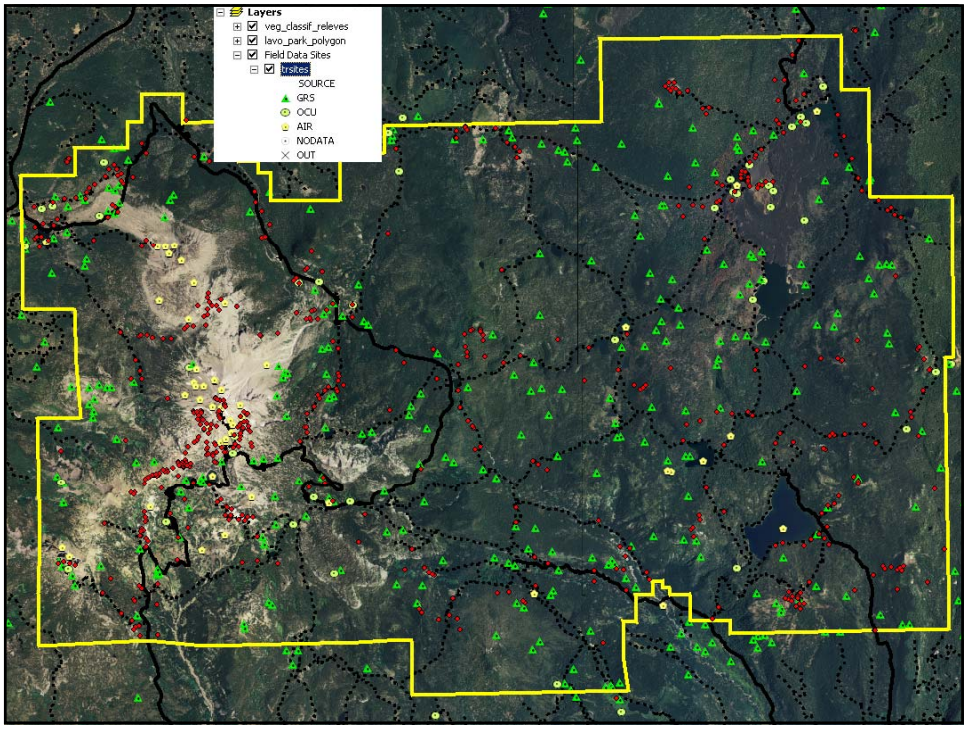


Table 1: SSNF Sample Frequency by Alliance			
Alliance	Total Number	Pct (%) of Total	Cumulative Pct(%)
Quercus wislizeni	93	9.7%	9.7%
Quercus douglasii	84	8.8%	18.5%
Ceanothus cuneatus	52	5.4%	24.0%
Aesculus californica	46	4.8%	28.8%
Pinus sabiniana	33	3.5%	32.2%
Platanus racemosa	25	2.6%	34.8%
Eriogonum fasciculatum	22	2.3%	37.1%
Artemisia tridentata	17	1.8%	38.9%
Lupinus albifrons	17	1.8%	40.7%
Populus fremontii	16	1.7%	**42.4%**
Quercus chrysolepis (tree)	16	1.7%	44.0%
Cercocarpus montanus	15	1.6%	45.6%
Eriodictyon californicum	15	1.6%	47.2%
Quercus lobata	15	1.6%	48.7%

Field Sample Allocation

- **Stratification**
  - Image classification or segmentation to identify potential field training data collection sites
  - Existing map data set for Accuracy Assessment
    - Withheld training sites ?
      - *Segmentation – YES !*
      - *Classification – NO !*
  - Enables identification of population characteristics that can be used to plan data collection activities
    - Rare versus abundant
    - Geographic distribution

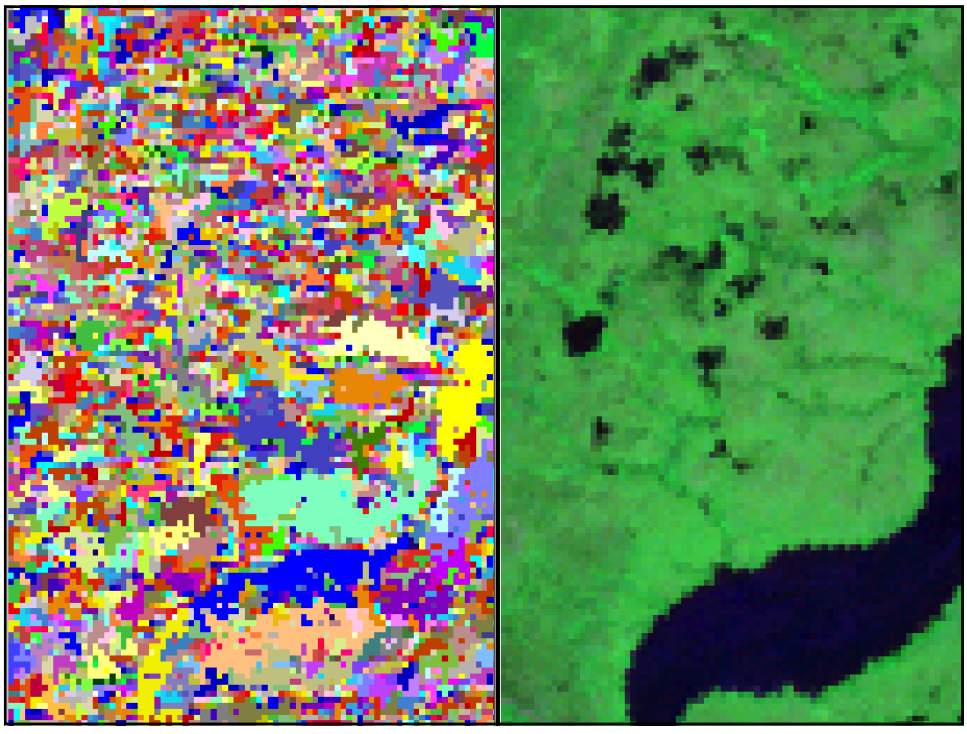


Field Sample Allocation

- **Stratification**
  - Image classification or segmentation to identify potential field training data collection sites
  - Existing map data set for Accuracy Assessment
    - Withheld training sites ?
      - *Segmentation – YES !*
      - *Classification – NO !*
  - Enables identification of population characteristics that can be used to plan data collection activities
    - Rare versus abundant
    - Geographic distribution

Training Sample Site Selection

- **Training Data - user defined locations necessary to sample diversity of types across project area**
  - Develop candidate training site data set
    - Isodata classification – 100+ classes
    - Identify largest homogeneous areas within each stratum
  - Build Field Sampling Plan(s)
    - Avoid limiting area of data collection activities
  - Avoid bias by not selecting only 'typical' sites near midpoints of types/classes and not representing the continuum of resource information
    - Cluster analysis can be easily biased
      - *self fulfilling prophecy.*



Determine Class Area and Relative Magnitude

Histogram d:\mgeprojects\npsa03\grd\7219cls.grd

Value	Frequency	%	Cum. %	Area (sq_m)	(Each * represents 1%)
.....					
13001	97827	1.22	1.22	88044300.0	*
13002	8525	0.01	1.23	7672500.0	
13003	188309	2.35	3.58	169478100.0	****
13004	242908	3.00	6.58	218617200.0	***
13005	205191	2.56	9.14	184671900.0	***
13006	221868	2.77	11.91	199681200.0	***
13007	354165	4.43	16.34	318748500.0	****
13008	34564	0.43	16.77	31107600.0	
13009	307886	3.85	20.62	277097400.0	****
13010	236191	2.95	23.57	212571900.0	***
13011	187121	2.34	25.91	168408900.0	**
13012	66805	0.84	26.75	60124500.0	*
13013	147286	1.84	28.59	132557400.0	**
13014	181647	2.27	30.86	163482300.0	**
13015	199983	2.50	33.36	179984700.0	**
13016	85332	1.07	34.43	76798800.0	*
13017	130294	1.63	36.05	117264600.0	**
.....					

Unique Area Isodata Class Database

id	iso_class	#pixels
...		
24971	13024	14
24972	13003	1
24973	13020	1
24974	13021	1
24975	13003	3
24976	13009	134
24977	13024	3
24978	13003	9
24979	13007	2
24980	13010	1
24981	13010	12
24982	13024	1
24983	13019	5
24984	13010	3
24985	13010	1
24986	13024	70
24987	13027	1
24988	13011	1
...		

Candidate Training Site Database Refinement

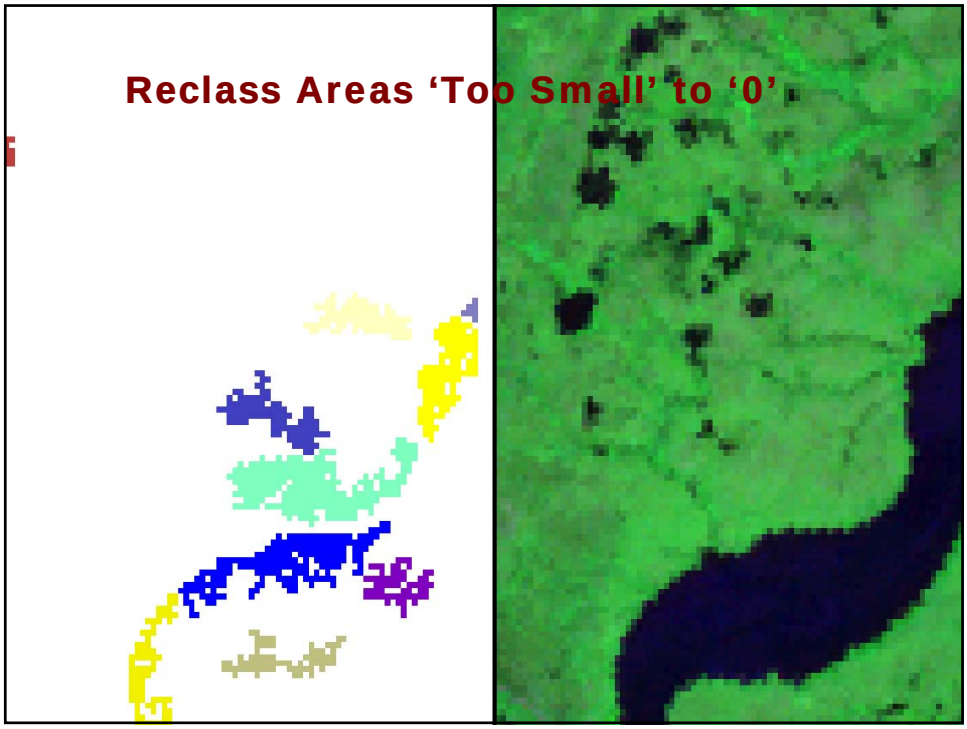
- **Apply minimum size limit of 60 pixels or 13 acres to the area listing and create a new set of candidate training site locations**

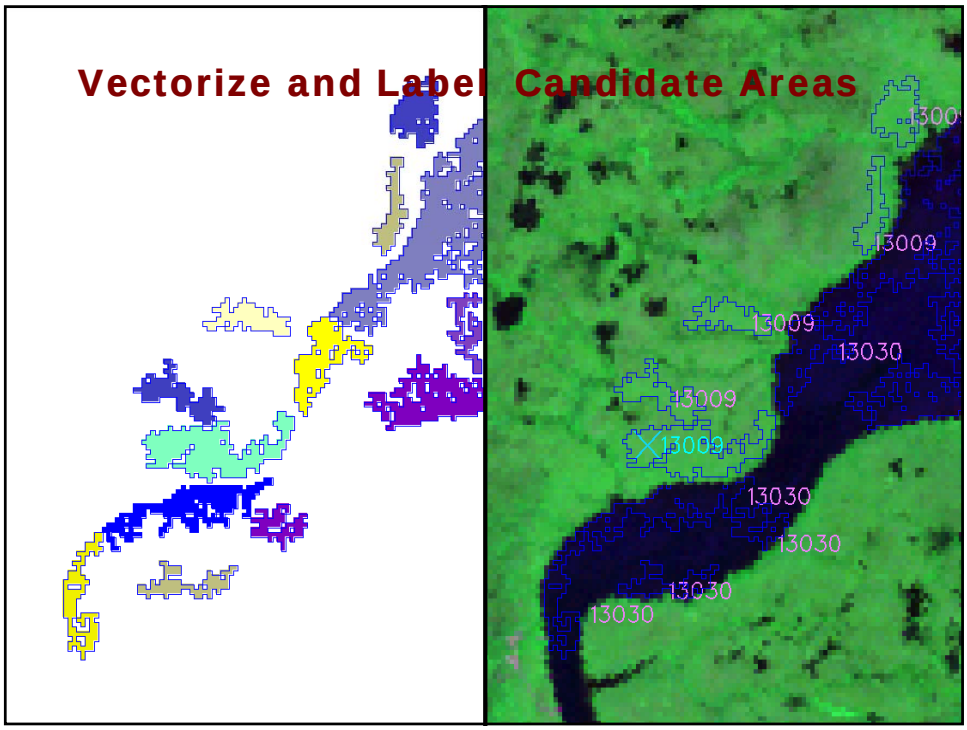
```
select id, iso_class  from  grid_val
            where  pix_count  >=  60
```

Reduced 8.6 million unique areas to 36,833 candidate areas

Characterize Candidate Sites Frequency by Class

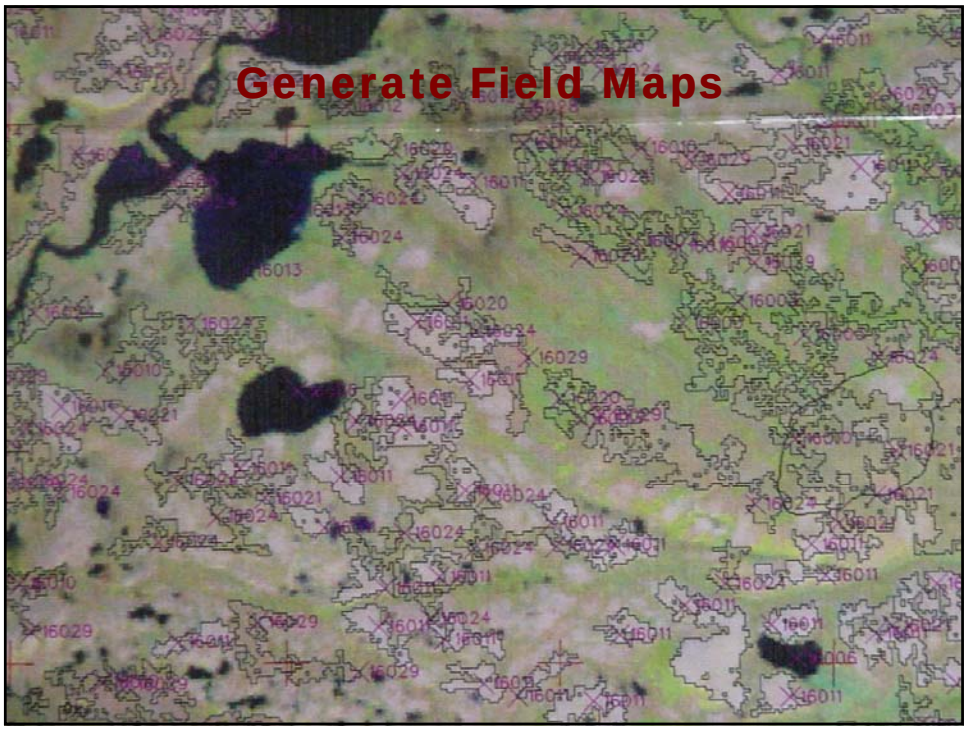
iso_class	freq	pixels	ave_size
13001	56	5699	101
13002	2	8497	4248
13003	175	22232	127
13004	96	10802	112
13005	44	4262	96
13006	64	6561	102
13007	428	73239	171
13008	87	17090	196
13009	393	77351	196
13010	278	37048	133
13011	90	9730	108
13012	25	60551	2422
13013	176	27261	154
13014	130	16639	127
13015	10	192441	19244
13016	104	18261	175
13017	138	19150	138
13018	20	1809	90
13019	56	6002	107
13020	148	24548	165

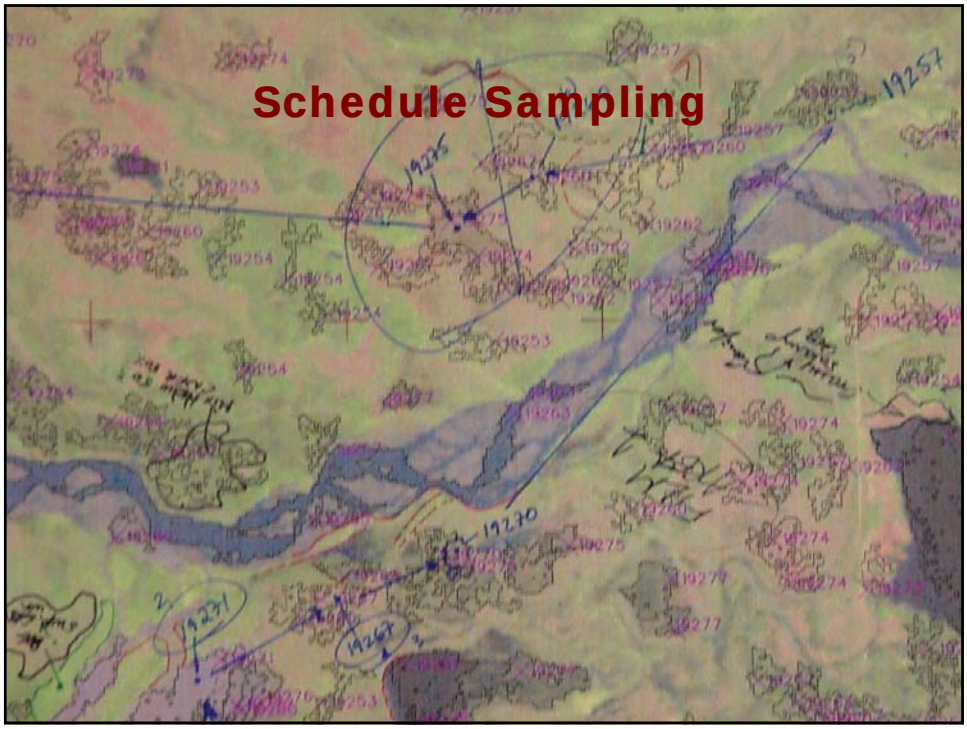

Reclass Areas 'Too Small' to '0'


Vectorize and Label Candidate Areas
13009
13009
13030
13009
13009
13030
13030
13030
13030

Candidate Training Site Database Contains ...

- Isodata class value
- Area - number of pixels
- X,Y coordinates
- Slope, aspect, and elevation
- Scene indicator
- Scarcity indicator
- Training group number

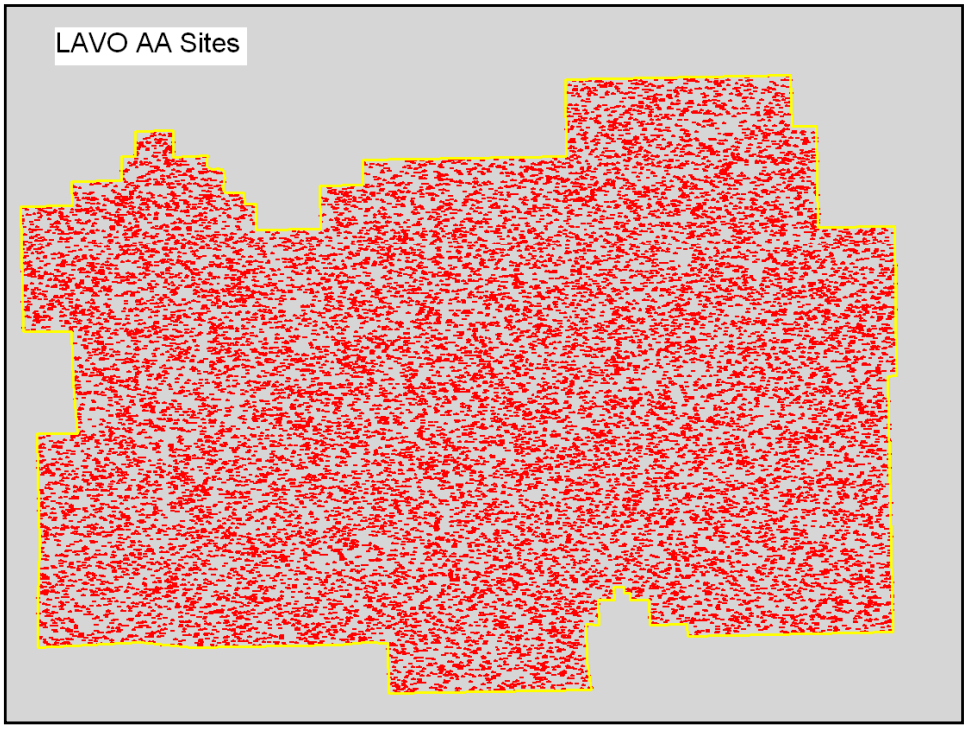


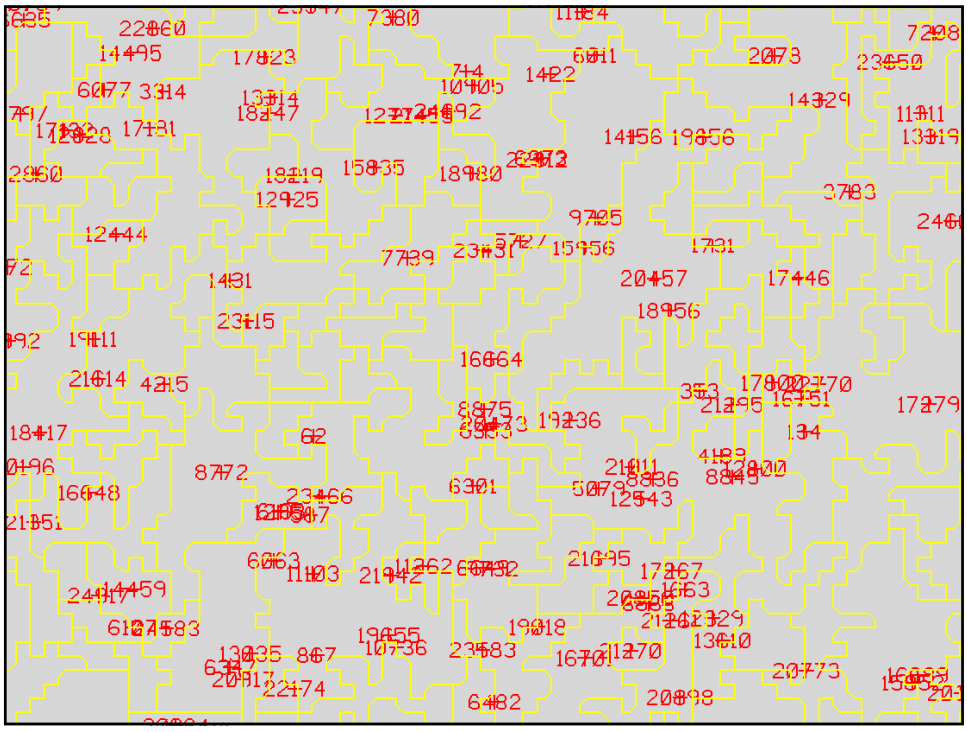


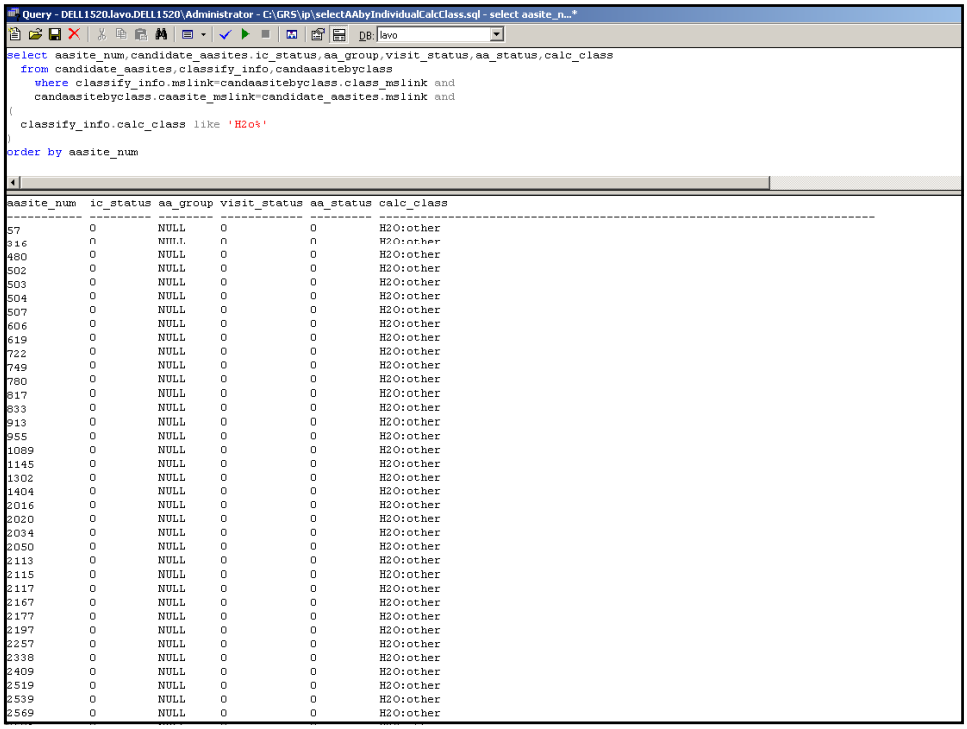
AA Sample Site Selection

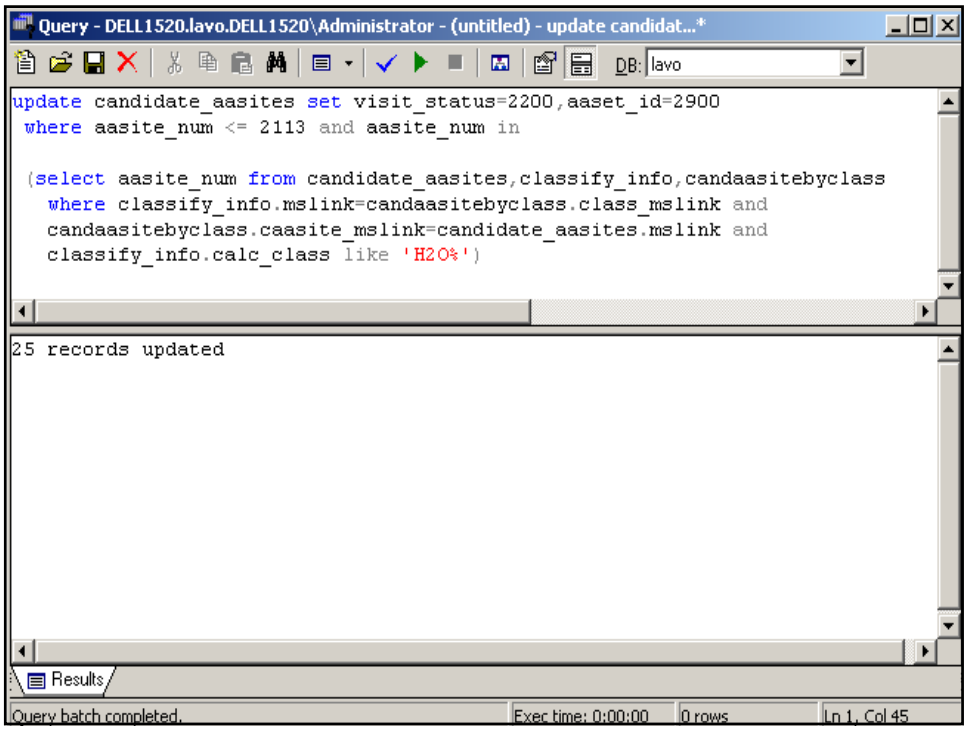
- **Accuracy Assessment**
  - Random allocation of X,Y locations within different strata selected for testing
  - Relate to map units using GIS
  - List sample potential sites within each map stratum
    - Select first “n” samples of a stratum where “n” is minimum number of samples per stratum
  - Develop schedules and plans

Note: Randomly selected sites are typically clumped


LAVO AA Sites




Query - DELL1520.lavo.DELL1520\Administrator - C:\GRS\ip\selectAAbyIndividualCalcClass.sql - select aasite_n...*
DB: lavo
select aasite_num,candidate_aasites.ic_status,aa_group,visit_status,aa_status,calc_class
from candidate_aasites,classify_info,candaasitebyclass
where classify_info.mslink=candaasitebyclass.class_mslink and
candaasitebyclass.caasite_mslink=candidate_aasites.mslink and
(
classify_info.calc_class like 'H2o%'
)
order by aasite_num
aasite_num ic_status aa_group visit_status aa_status calc_class
57 0 NULL 0 0 H2O:other
480 0 NULL 0 0 H2O:other
502 0 NULL 0 0 H2O:other
503 0 NULL 0 0 H2O:other
504 0 NULL 0 0 H2O:other
507 0 NULL 0 0 H2O:other
606 0 NULL 0 0 H2O:other
619 0 NULL 0 0 H2O:other
722 0 NULL 0 0 H2O:other
749 0 NULL 0 0 H2O:other
780 0 NULL 0 0 H2O:other
817 0 NULL 0 0 H2O:other
833 0 NULL 0 0 H2O:other
913 0 NULL 0 0 H2O:other
955 0 NULL 0 0 H2O:other
1089 0 NULL 0 0 H2O:other
1145 0 NULL 0 0 H2O:other
1302 0 NULL 0 0 H2O:other
1404 0 NULL 0 0 H2O:other
2016 0 NULL 0 0 H2O:other
2020 0 NULL 0 0 H2O:other
2034 0 NULL 0 0 H2O:other
2050 0 NULL 0 0 H2O:other
2113 0 NULL 0 0 H2O:other
2115 0 NULL 0 0 H2O:other
2117 0 NULL 0 0 H2O:other
2167 0 NULL 0 0 H2O:other
2177 0 NULL 0 0 H2O:other
2197 0 NULL 0 0 H2O:other
2257 0 NULL 0 0 H2O:other
2338 0 NULL 0 0 H2O:other
2409 0 NULL 0 0 H2O:other
2519 0 NULL 0 0 H2O:other
2539 0 NULL 0 0 H2O:other
2569 0 NULL 0 0 H2O:other

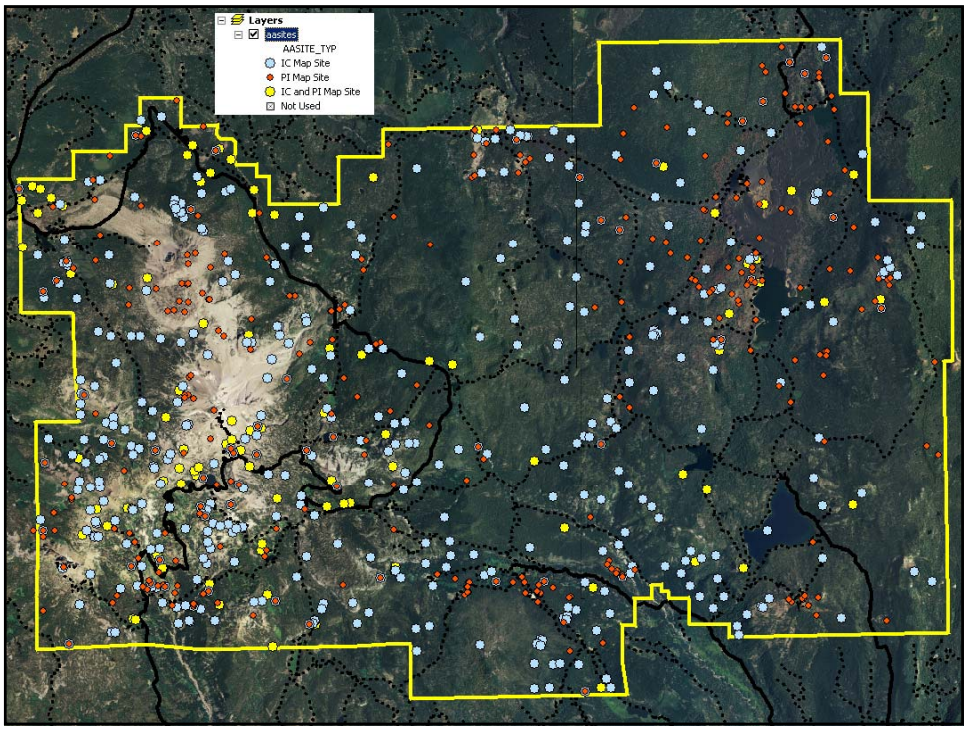

Query - DELL1520.lavo.DELL1520\Administrator - (untitled) - update candidat...*
DB: lavo
update candidate_aasites set visit_status=2200,aaset_id=2900
where aasite_num <= 2113 and aasite_num in
(select aasite_num from candidate_aasites,classify_info,candaasitebyclass
where classify_info.mslink=candaasitebyclass.class_mslink and
candaasitebyclass.caasite_mslink=candidate_aasites.mslink and
classify_info.calc_class like 'H2O%')
25 records updated
Results
Query batch completed.
Exec time: 0:00:00
0 rows
Ln 1, Col 45

Query - DELL1520.lavo.DELL1520\Administrator - C:\GRS\ip\selectAAbyIndividualCalcClass.sql - select aasite_n...*

DB: lavo

```
select aasite_num,candidate_aasites.ic_status,aa_group,visit_status,aa_status,calc_class
  from candidate_aasites,classify_info,candaasitebyclass
    where classify_info.mslink=candaasitebyclass.class_mslink and
    candaasitebyclass.caasite_mslink=candidate_aasites.mslink and
(
  classify_info.calc_class like 'H2o%'
)
order by aasite_num
```

aasite_num	ic_status	aa_group	visit_status	aa_status	calc_class
57	100	701	2200	10129	H2O:other
316	100	802	2200	10102	H2O:other
480	100	501	2200	10120	H2O:other
502	100	3304	2200	102	H2O:other
503	100	501	2200	10104	H2O:other
504	100	303	2200	10101	H2O:other
507	100	700	2200	10106	H2O:other
606	100	700	2200	10105	H2O:other
619	100	501	2200	10120	H2O:other
722	100	2401	2200	105	H2O:other
749	100	984	2200	10101	H2O:other
780	100	303	2200	10100	H2O:other
817	100	3304	2200	105	H2O:other
833	100	302	2200	10102	H2O:other
913	100	503	2200	10121	H2O:other
955	100	700	2200	10104	H2O:other
1089	100	3304	2200	103	H2O:other
1145	100	2551	2200	101	H2O:other
1302	100	501	2200	10120	H2O:other
1404	100	501	2200	10120	H2O:other
2016	100	302	2200	10103	H2O:other
2020	100	2551	2200	102	H2O:other
2034	100	501	2200	10120	H2O:other
2050	100	3304	2200	104	H2O:other
2113	100	3304	2200	101	H2O:other
2115	0	NULL	0	0	H2O:other
2117	0	NULL	0	0	H2O:other
2167	0	NULL	0	0	H2O:other
2177	0	NULL	0	0	H2O:other
2197	0	NULL	0	0	H2O:other
2257	0	NULL	0	0	H2O:other
2338	0	NULL	0	0	H2O:other
2409	0	NULL	0	0	H2O:other
2519	0	NULL	0	0	H2O:other
2539	0	NULL	0	0	H2O:other
2569	0	NULL	0	0	H2O:other



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Date:	13-Oct-08									By:	KS			
2	tr_group	aasite_id	aa_id#1	aa_id#2	lat	lat_min	long	long_min	aspect	slope	elev_ft	map	TRStart	TRInt	TRAz(s)
25	1064	AA3650			40	26:44.0	-121	33:47.9	209	67	8961	0			
26	1064	AA2770			40	26:43.3	-121	33:48.5	212	67	8879	0			
27	1064	AA508			40	26:30.1	-121	33:56.9	183	38	8246	0			
28	1064	AA1037			40	26:07.4	-121	33:28.0	142	31	8066	0			
29	1064	AA12590			40	26:02.4	-121	34:14.5	236	27	7636	0			
30	**1064**	**AA202**			**40**	**25:29.9**	**-121**	**33:42.3**	**208**	**9**	**7429**	**0**			
31	1065	AA353			40	30:43.4	-121	28:33.8	85	38	6832	0			
32	1065	AA4189			40	30:39.2	-121	28:32.0	83	40	6783	0			
33	1065	AA134			40	30:40.6	-121	28:24.9	336	18	6616	0			
34	1065	AA1282			40	30:49.2	-121	28:02.0	21	7	6478	0			
35	1065	AA978			40	30:49.2	-121	28:00.0	48	9	6472	0			
36	1065	AA17868			40	30:51.4	-121	27:50.3	165	22	6393	0			
37	1065	AA3274			40	30:50.3	-121	27:36.4	167	22	6353	0			
38	1065	AA1900			40	30:54.9	-121	27:43.2	111	7	6452	0			
39	1071	AA18354			40	32:28.3	-121	31:15.0	210	58	7092	0			
40	1071	AA11662			40	32:29.0	-121	31:10.4	185	67	7183	0			
41	1071	AA11345			40	32:32.4	-121	31:16.9	239	47	7160	0			
42	1071	AA3183			40	32:36.2	-121	31:19.0	265	36	7167	0			
43	1071	AA14706			40	32:37.6	-121	31:10.3	26	36	7223	0			
44	1071	AA3699			40	32:40.7	-121	31:18.2	304	22	7174	0			
45	1071	AA171			40	32:35.8	-121	32:00.6	297	24	6462	0			
46	1072	AA105			40	34:23.8	-121	20:46.4	309	33	8292	0			
47	1072	AA218			40	34:37.2	-121	21:00.1	330	29	7866	0			
48	1072	AA290			40	34:15.3	-121	21:04.9	13	16	7961	0			
49	1072	AA2000			40	34:02.4	-121	21:29.8	260	40	7587	0			
50	1072	AA1695			40	33:37.7	-121	21:44.0	227	33	7078	0			
51	1073	AA281			40	32:01.9	-121	16:52.4	292	16	6294	0			
52	1073	AA21			40	32:12.9	-121	17:15.1	38	11	6258	0			
53	1073	AA147			40	32:11.9	-121	17:18.3	326	9	6268	0			
54	1073	AA137			40	32:24.7	-121	17:44.3	349	4	6183	0			
55	1073	AA3473			40	32:29.0	-121	17:42.0	292	4	6180	0			
56	1073	AA4864			40	32:35.6	-121	17:40.3	301	2	6176	0			
57	1073	AA1354			40	32:37.0	-121	17:37.4	307	2	6180	0			
58	1074	AA3914			40	28:47.9	-121	30:37.8	203	44	9043	0			

Clustered Sampling

- **Select an initial stand with a random point**
- **Implement a cluster of multiple sites**
- **Must be sure to avoid bias**
  - Avoid spacing that results in resampling the same type
  - Avoid sampling types are correlated with each other
  - Oversample abundant types and undersample rare types
- **Always select sample stands the same way**
- **Never found it necessary**

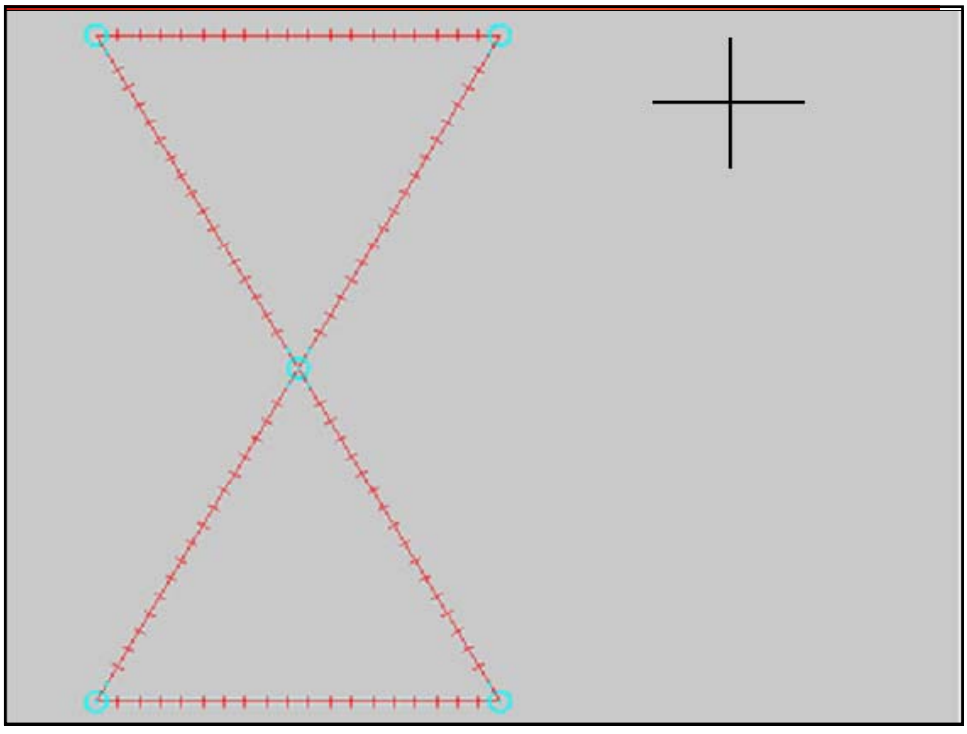
Break …

Field Sampling

- **Primary Sampling Goal – for reasonable cost and effort accurately represent within the sample area**
  - the vertical features and structure
  - horizontally across the landscape

Sample Site Layout

- **Sample across topography**
  - Area or transect shaped as triangle, rectangle, figure-8
- **Hard to sample very narrow areas, such as riparian stringers**
  - Use a linear sample layout



Field Sample Size

- **Relative to the characteristics being estimated**
  - Would like to sample <u>across</u> the features being sampled rather than <u>within</u> the features
    - Avoid small areas for large features and visa versa
      - *e.g. don't want sample to fall under one large tree canopy*
  - Sample size relative to crown diameter
  - Sample size relative to vegetation lifeform
    - 3' for herbaceous, sparse or barren;
    - 6' for shrub or sparse tree
    - 9-15' for trees based on size

Homogeneity vs. Patchiness

- **Stands are naturally patchy unless intensively managed plantations/monocultures**
- **Types of distributions**
  - Naturally variable
  - Clumped or bimodal
- **Determine sample size that samples across the distributions and "smoothes" out the variability.**
- **What can appear variable in the field can be correctly estimated by proper sampling**

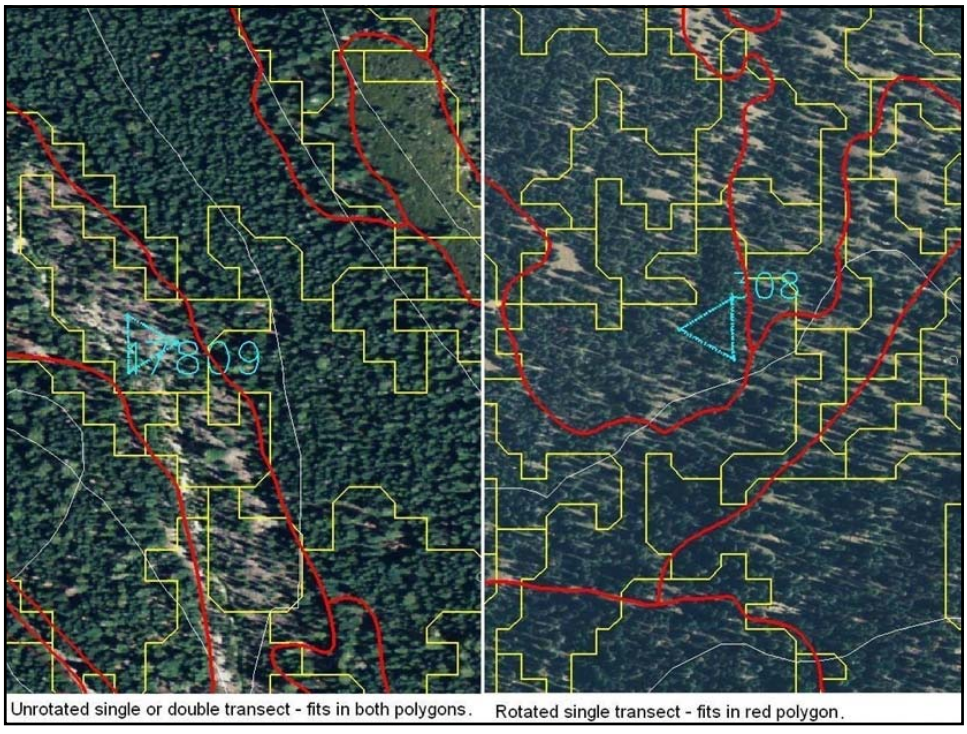

06/12/2009 14:46


2 2:48PM

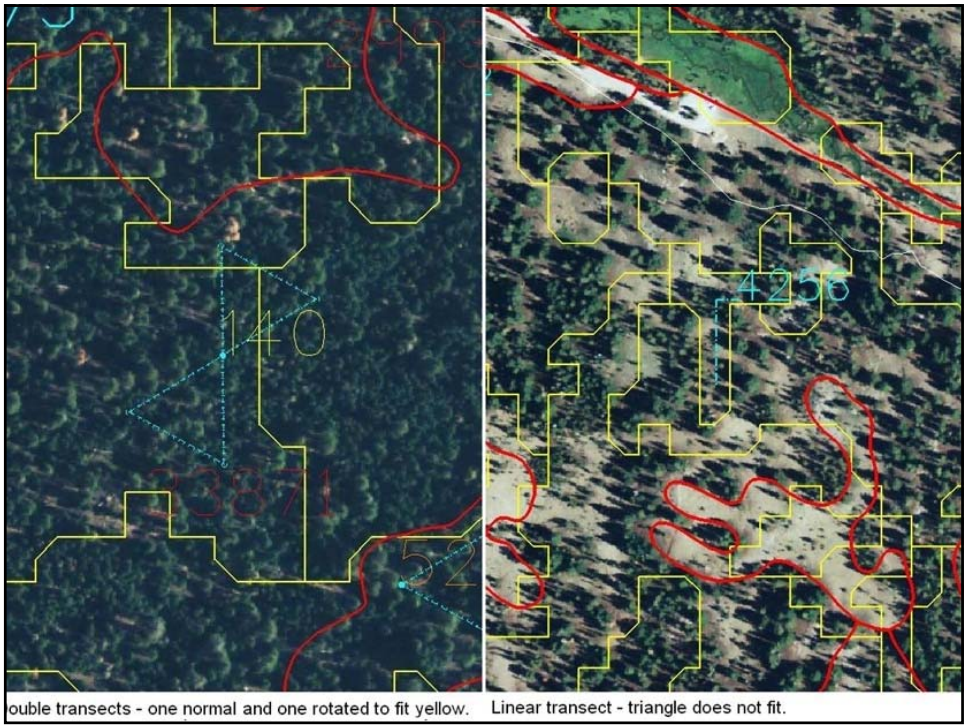

2 3:51PM

Sampling and Area Boundaries

- **Avoid crossing sample area boundaries**
  - For training, pollute training data by sampling multiple stands
  - For AA, sample as close as possible as you cannot just sample the interior portions of a stand.
- **Develop and adhere to rules of sample placement. Do not move points into sample areas.**
  - e.g. For AA, rotate sample element 60 degrees until if fits in the area



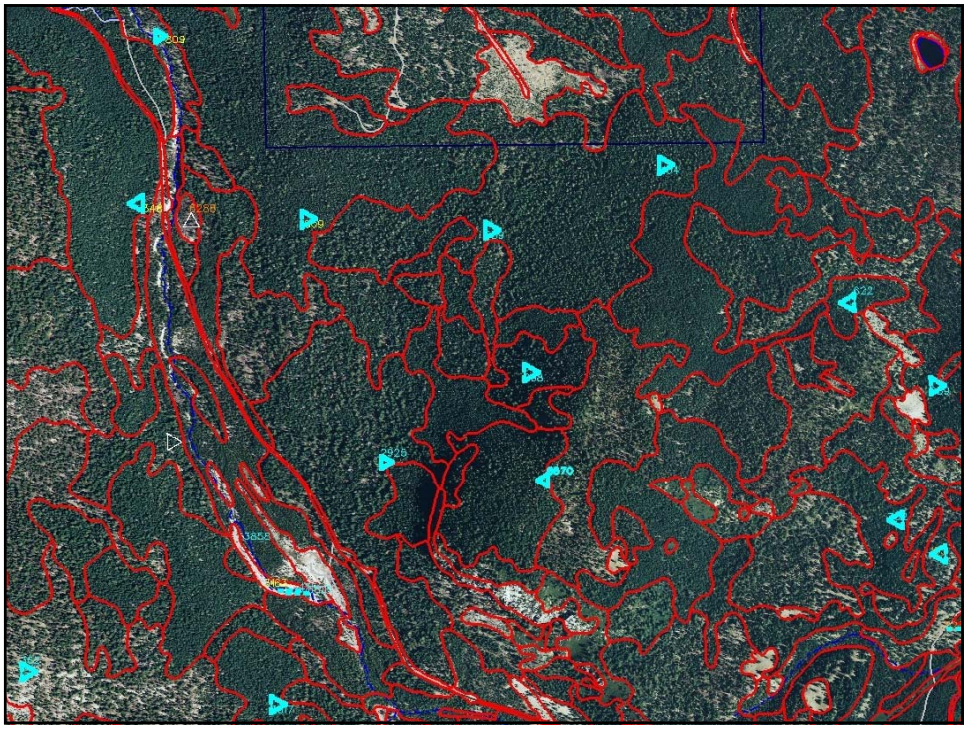
Unrotated single or double transect - fits in both polygons. Rotated single transect - fits in red polygon.



ouble transects - one normal and one rotated to fit yellow. Linear transect - triangle does not fit.

Accessibility and Cost

- **Approximately 2/3rds of field data collection costs are due to getting to and from the site.**
  - If you spend very little time at the site, then this percent of time increases
- **Develop a cost surface and avoid high cost sites**
  - Sample close to points of access
- **Develop a danger surface and avoid dangerous sites**
- **You must test sites in more area during an Accuracy Assessment**



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Date:	13-Oct-08									By:	KS			
2	tr_group	aasite_id	aa_id#1	aa_id#2	lat	lat_min	long	long_min	aspect	slope	elev_ft	map	TRStart	TRInt	TRAz(s)
25	1064	AA3650			40	26:44.0	-121	33:47.9	209	67	8961	0	SW	6	T-0
26	1064	AA2770			40	26:43.3	-121	33:48.5	212	67	8879	0	SE	9	T-300-60-180
27	1064	AA508			40	26:30.1	-121	33:56.9	183	38	8246	0	SE	9	T-300-60-180
28	1064	AA1037			40	26:07.4	-121	33:28.0	142	31	8066	0	SW	9	T-0
29	1064	AA12590			40	26:02.4	-121	34:14.5	236	27	7636	0	E	6	T-240-360-120
30	**1064**	**AA202**			**40**	**25:29.9**	**-121**	**33:42.3**	**208**	**9**	**7429**	**0**	**W|E**	**12**	**T-60|T-240**
31	1065	AA353			40	30:43.4	-121	28:33.8	85	38	6832	0	NW	6	T-120-240-360
32	1065	AA4189			40	30:39.2	-121	28:32.0	83	40	6783	0	SE	6	T-300-60-180
33	1065	AA134			40	30:40.6	-121	28:24.9	336	18	6616	0	SW	9	T-0
34	1065	AA1282			40	30:49.2	-121	28:02.0	21	7	6478	0	sw	12	T-0
35	1065	AA978			40	30:49.2	-121	28:00.0	48	9	6472	0	sw	12	T-0
36	1065	AA17868			40	30:51.4	-121	27:50.3	165	22	6393	0	W	6	L-50@90
37	1065	AA3274			40	30:50.3	-121	27:36.4	167	22	6353	0	SE	6	L-50@330
38	1065	AA1900			40	30:54.9	-121	27:43.2	111	7	6452	0	SW	12	T-0
39	1071	AA18354			40	32:28.3	-121	31:15.0	210	58	7092	0	SW	12	T-0
40	1071	AA11662			40	32:29.0	-121	31:10.4	185	67	7183	0	NW	12	T-120
41	1071	AA11345			40	32:32.4	-121	31:16.9	239	47	7160	0	NE	6	T-180
42	1071	AA3183			40	32:36.2	-121	31:19.0	265	36	7167	0	SW	12	T-0
43	1071	AA14706			40	32:37.6	-121	31:10.3	26	36	7223	0	SE	12	L-25@285-25@355
44	1071	AA3699			40	32:40.7	-121	31:18.2	304	22	7174	0	SW	12	T-0
45	1071	AA171			40	32:35.8	-121	32:00.6	297	24	6462	0	SW	12	T-0
46	1072	AA105			40	34:23.8	-121	20:46.4	309	33	8292	0	NW|SE	126	T-120-240-360|T-300(occ)
47	1072	AA218			40	34:37.2	-121	21:00.1	330	29	7866	0	W	12	T-60-180-300
48	1072	AA290			40	34:15.3	-121	21:04.9	13	16	7961	0	NW	12	T-120-240-360
49	1072	AA2000			40	34:02.4	-121	21:29.8	260	40	7587	0	W	6	T-60-180-300
50	1072	AA1695			40	33:37.7	-121	21:44.0	227	33	7078	0	E	6	T-240-360-120
51	1073	AA281			40	32:01.9	-121	16:52.4	292	16	6294	0	NE	12	T-180-300-60
52	1073	AA21			40	32:12.9	-121	17:15.1	38	11	6258	0	SW	12	T-0
53	1073	AA147			40	32:11.9	-121	17:18.3	326	9	6268	0	W|E	12	T-0|T-240-360-120
54	1073	AA137			40	32:24.7	-121	17:44.3	349	4	6183	0	SW	6	T-0
55	1073	AA3473			40	32:29.0	-121	17:42.0	292	4	6180	0	SW	6	T-0
56	1073	AA4864			40	32:35.6	-121	17:40.3	301	2	6176	0	W	6	T-60
57	1073	AA1354			40	32:37.0	-121	17:37.4	307	2	6180	0	W	6	T-60
58	1074	AA3914			40	28:47.9	-121	30:37.8	203	44	9043	0	0	0	OCCULAR?
59	1074	AA2033			40	29:02.1	-121	31:05.9	252	44	8617	0	NW	9	T-120-240-360

Sheet1 | 0702sched

Field Site Sampling

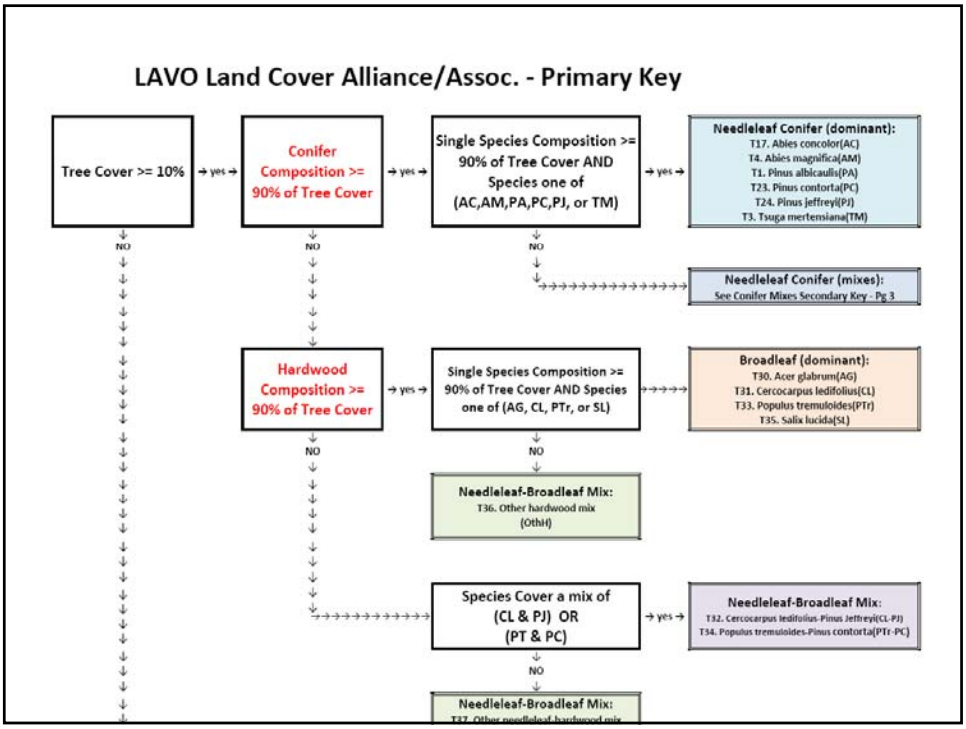
- **Positional Attributes**
  - Unique ID (meaningful)
  - GPS Data
    - Points
    - Track
- **Landscape features**
  - Slope, aspect, and elevation
  - Soils and exposed rock
  - Hydrologic regime and other site modifiers …

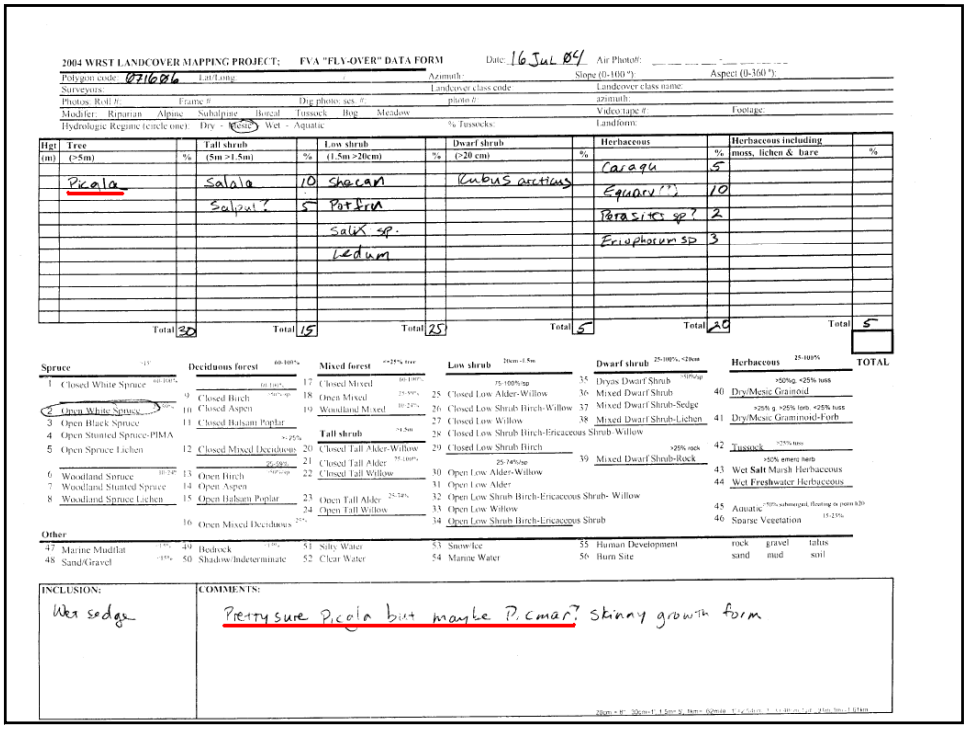
Field Site Sampling (2)

- **Sample Information – enables verification**
  - Type of sample
    - Ocular, relevé, transect, aerial, …
  - Orientation
  - Size or Distance
  - Digital photos
    - Horizontal into and/or along borders
    - Up towards sky and down towards ground

Field Site Sampling (3)

- **Site attributes - estimate before and after sampling**
  - Type based on interpretation of key/rules
    - Alternate values if near key threshold(s)
    - Complex of types
  - Cover/Density of major lifeforms
  - Size - QMD
    - Average and range
  - Height
    - Average, range, and base of live crown
  - Notes and comments





2004 WRST LANDCOVER MAPPING PROJECT; FVA "FLY-OVER" DATA FORM Date: 16 JUL 04 Air Photo#:

Polygon code: 071686 Lat/Long: Azimuth: Slope (0-100 %): Aspect (0-360 °):

Surveyors: Landcover class code Landcover class name:

Photos: Roll #: Frame #: Dig photo: ses. #: photo #: azimuth:

Modifier: Riparian Alpine Subalpine Boreal Tussock Hog Meadow Video tape #: Footage:

Hydrologic Regime (circle one): Dry - Mesic Wet - Aquatic % Tussocks: Landform:

Hgt (m)	Tree (>5m)	%	Tall shrub (5m >1.5m)	%	Low shrub (1.5m >20cm)	%	Dwarf shrub (>20 cm)	%	Herbaceous	%	Herbaceous including moss, lichen & bare	%
	Picala		Salala	10	Shecan		Rubus arcticus		Caraqu	5		
			Salpul?	5	Potfru				Equarv??	10		
					Salix sp.				Parasites sp?	2		
					Ledum				Eriophorum sp	3		
	Total 20		Total 15		Total 25		Total 5		Total 20		Total 5	TOTAL

Spruce: 1 Closed White Spruce; 2 Open White Spruce; 3 Open Black Spruce; 4 Open Stunted Spruce-PIMA; 5 Open Spruce Lichen; 6 Woodland Spruce; 7 Woodland Stunted Spruce; 8 Woodland Spruce Lichen

Deciduous forest: 9 Closed Birch; 10 Closed Aspen; 11 Closed Balsam Poplar; 12 Closed Mixed Deciduous; 13 Open Birch; 14 Open Aspen; 15 Open Balsam Poplar; 16 Open Mixed Deciduous

Mixed forest: 17 Closed Mixed; 18 Open Mixed; 19 Woodland Mixed

Tall shrub: 20 Closed Tall Alder-Willow; 21 Closed Tall Alder; 22 Closed Tall Willow; 23 Open Tall Alder; 24 Open Tall Willow

Low shrub: 25 Closed Low Alder-Willow; 26 Closed Low Shrub Birch-Willow; 27 Closed Low Willow; 28 Closed Low Shrub Birch-Ericaceous Shrub-Willow; 29 Closed Low Shrub Birch; 30 Open Low Alder-Willow; 31 Open Low Alder; 32 Open Low Shrub Birch-Ericaceous Shrub- Willow; 33 Open Low Willow; 34 Open Low Shrub Birch-Ericaceous Shrub

Dwarf shrub: 35 Dryas Dwarf Shrub; 36 Mixed Dwarf Shrub; 37 Mixed Dwarf Shrub-Sedge; 38 Mixed Dwarf Shrub-Lichen; 39 Mixed Dwarf Shrub-Rock

Herbaceous: 40 Dry/Mesic Graminoid; 41 Dry/Mesic Graminoid-Forb; 42 Tussock; 43 Wet Salt Marsh Herbaceous; 44 Wet Freshwater Herbaceous; 45 Aquatic; 46 Sparse Vegetation

Other: 47 Marine Mudflat; 48 Sand/Gravel; 49 Bedrock; 50 Shadow/Indeterminate; 51 Silty Water; 52 Clear Water; 53 Snow/Ice; 54 Marine Water; 55 Human Development; 56 Burn Site

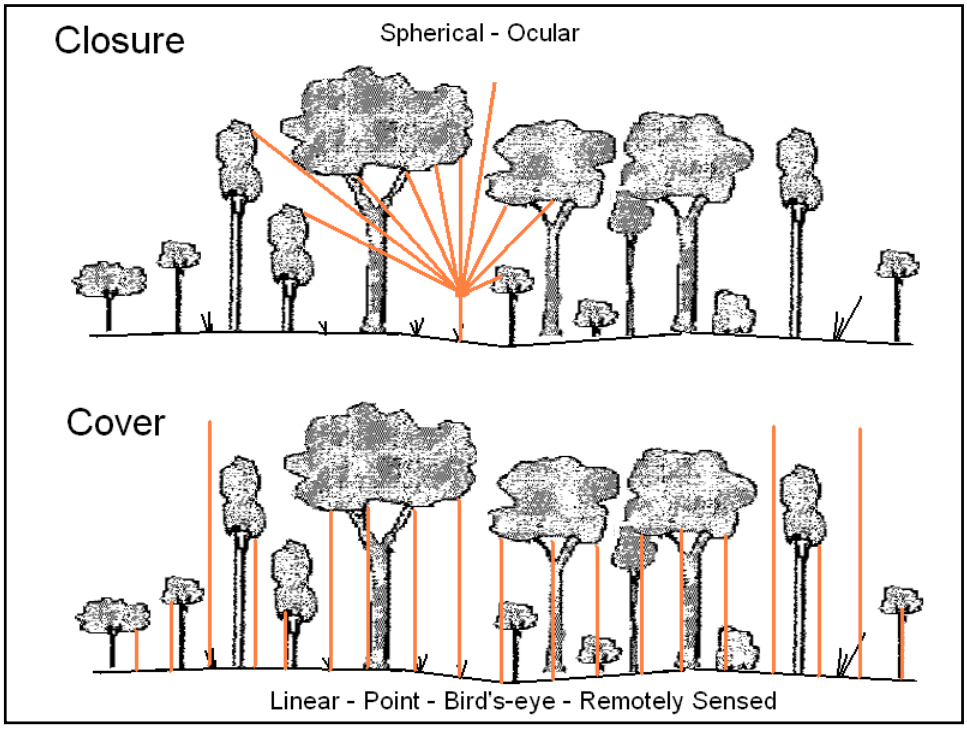
rock gravel tafus sand mud soil

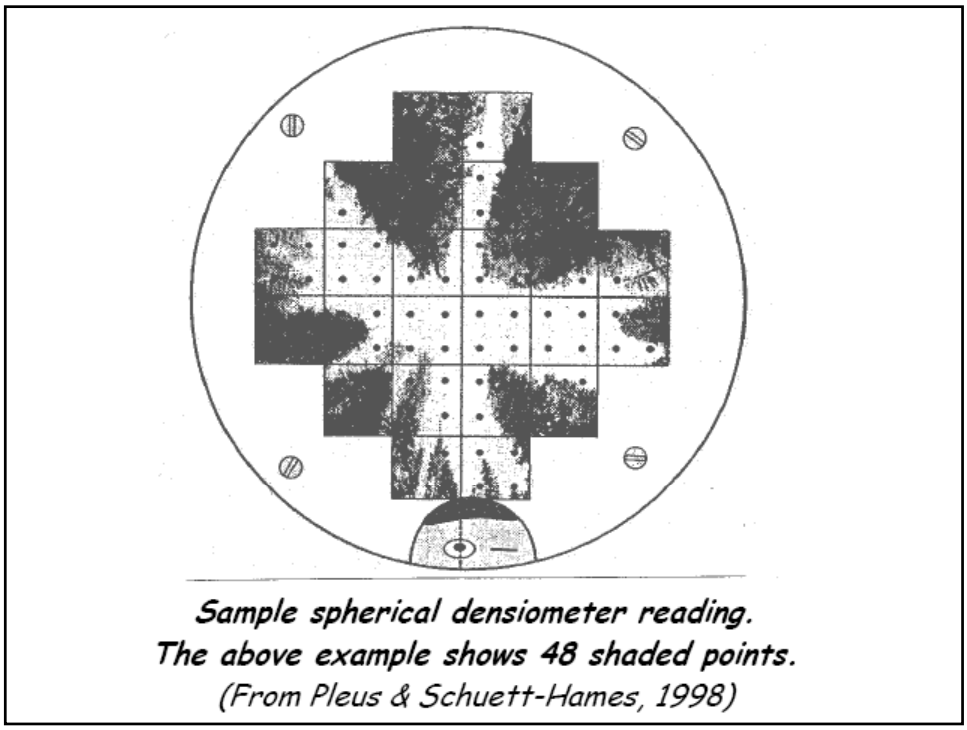
INCLUSION: Wet sedge

COMMENTS: Pretty sure Picala but maybe P. cmar? skinny growth form

Field Site Features

- **Cover**
- **Species**
- **Size**
  - Diameter (DBH)
  - Crown Size
  - Height
- **Canopy Position**
- **Status**





Sample spherical densiometer reading.
The above example shows 48 shaded points.
(From Pleus & Schuett-Hames, 1998)

RNSP Land Cover Transect Form

TRSite_id: ____________ **Page**: ___ of ___

IsoClass: ____________ **Crew**: BH SV CS RC KS ___ **Date**: / / 2009

Target_GPS_ID: _______ **GPS Pnt(s)**: ___________ **PhotoID(s)**: _____________

Slope: _____ % **Aspect**: ______ **Elevation**: ____ ft **TrAzimuths**: ____-____-____-____

Hydrologic Regime: Dry Mesic Wet Aquatic **TRStart**: N NE E SE S SW W NW **TRInt**: _____ ft

Modifier: Alpine Subalpine Boreal Upland Lowland Riparian Meadow **HTLC**: _____ ft

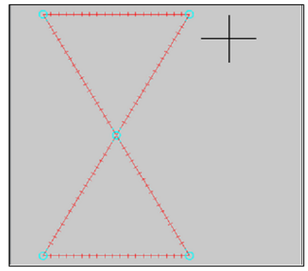
LC Calls Type: ______________________ **TreeSize**: ______ **Density**: __________

Transect Point Sample Data					Transect Point Sample Data				
Point#	**LCCode**	**Size**	**CDFreq**	**Layer**	**Point#**	**LCCode**	**Size**	**CDFreq**	**Layer**

GRS RNSP lcsurvey fieldform v1.4

RNSP Land Cover Transect Form

Crew: BH SV CS RC KS ____ **Date**: / / 2009



TRSite/Species Notes:

Data Collection Quality Control

- **Use techniques that facilitate the collection of high quality data that yield consistent and reliable results by all field crew members regardless of level of experience**
  - Tools
  - Software
  - Techniques

Tools

- **Compass**
- **Diameter tape**
- **Clinometer**
- **Spencer (linear) tape**
- **Densitometer (cover) or Spherical densiometer (closure)**
- **GPS**
- **Digital Camera**

Tools(2)

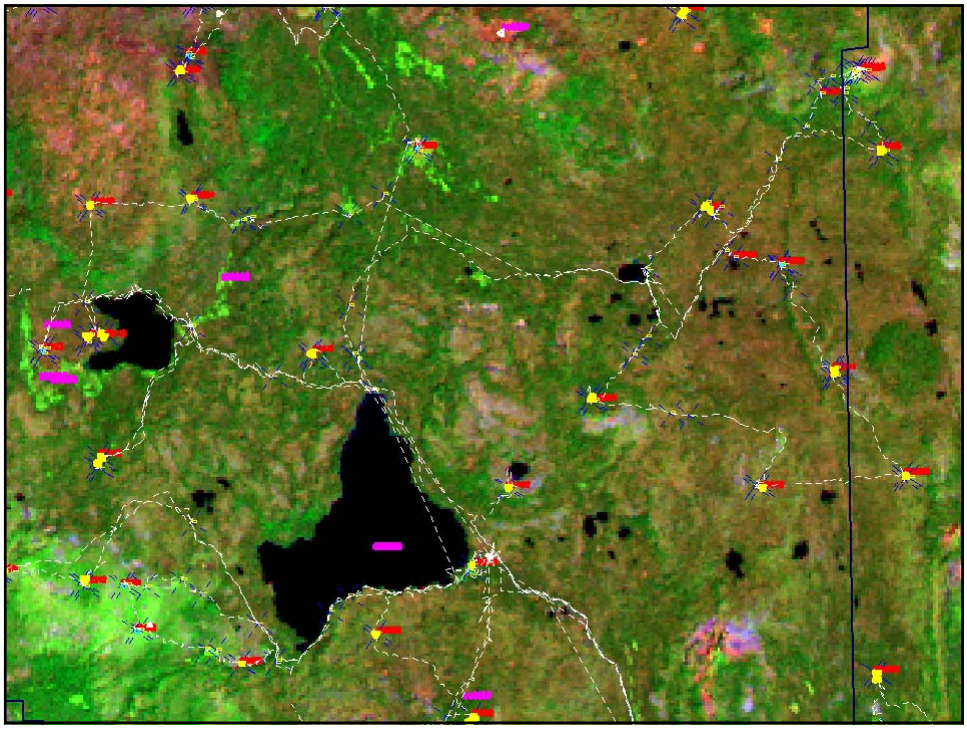
- **Plant guides**
  - Collect and bag unknowns for later identification
- **Keys/rules**
- **High resolution photography**
- **Field data collector**

Field Data Collection Software

- **Handles data collection and output**
- **Error detection and correction**
  - Identify invalid data
    - Erroneous species codes
    - Erroneous layer specification
  - Identify incomplete data
    - Trees without diameter or crown size
    - Missing layer specification
- **Data backup**

Field Techniques

- **Follow data collection procedures and standards**
  - Top down approach, take pictures, use GPS properly, …
- **Correctly locate and document sites**
  - Use two GPSes independently
- **Complete data collection in the field**
  - For ocular sites verify "Bird's-eye" view totals 100%
- **Identify critical decision points in key(s) or rules that might result in different type assignments**
- **Identify all trace species**

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Results - Field Sampling Output

- **Types of information**
  - Cover by species, size, and layer
  - Relative composition
  - Average QMD and Crown Size
    - Cover weighted
    - Frequency weighted
  - Frequency/unit area
  - Down woody debris counts
  - Traces

Field Sampling Output(2)

- **Land cover type (NVCS Association)**
- **Alternate type(s), if near a critical decision point**
- **Predominant species**
- **Cover by lifeform**
- **Average size**
- **Structure**
- **Ground surface condition**

Transect Cover Percent Density Summary for Top Layer:
Site/Polygon Id: 60212

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover	Non-Tree Cover	Total Cover
Redwood	0.0	0.0	0.0	20.0	55.0	75.0	75.0
Doug-fir	0.0	0.0	0.0	7.5	7.5	15.0	15.0
West Hemlock	0.0	0.0	2.5	0.0	0.0	2.5	2.5
W. Hemlck dead	0.0	0.0	0.0	2.5	0.0	2.5	2.5
Totals	0.0	0.0	2.5	30.0	62.5	95.0	0.0	95.0

Transect Tree Cover Composition Summary for Top Layer 95.0 Cover:

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover
Redwood	0.0	0.0	0.0	21.1	57.9	78.9
Doug-fir	0.0	0.0	0.0	7.9	7.9	15.8
West Hemlock	0.0	0.0	2.6	0.0	0.0	2.6
W. Hemlck dead	0.0	0.0	0.0	2.6	0.0	2.6
Totals	0.0	0.0	2.6	31.6	65.8	100.0

Percent conifer composition= 100.0
Percent hardwood composition= 0.0
Most common specie is Redwood with 78.9 percent cover

Transect Quadratic Mean DBH and TPA Summary for Top Layer:
Weighted by Cover

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover
Redwood	0.0"	0.0"	0.0"	43.2"	106.1"	93.5"
cov_wt	0.0	0.0	0.0	20.0	55.0	75.0
tpa	0.0	0.0	0.0	8.2	9.2	17.4
Doug-fir	0.0"	0.0"	0.0"	42.4"	54.3"	48.7"
cov_wt	0.0	0.0	0.0	7.5	7.5	15.0
tpa	0.0	0.0	0.0	3.3	5.4	8.7

Transect Cover Percent Density Summary for Over-Topped Layer:
Site/Polygon Id: 60212

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover	Non-Tree Cover	Total Cover
Redwood	0.0	5.0	5.0	10.0	0.0	20.0	20.0
West Hemlock	2.5	7.5	2.5	0.0	0.0	12.5	12.5
W. Hemlck dead	0.0	0.0	0.0	2.5	0.0	2.5	2.5
Totals	2.5	12.5	7.5	12.5	0.0	35.0	0.0	35.0

Transect Tree Cover Composition Summary for Over-Topped Layer 35.0 Cover:

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover
Redwood	0.0	14.3	14.3	28.6	0.0	57.1
West Hemlock	7.1	21.4	7.1	0.0	0.0	35.7
W. Hemlck dead	0.0	0.0	0.0	7.1	0.0	7.1
Totals	7.1	35.7	21.4	35.7	0.0	100.0

Percent conifer composition= 100.0
Percent hardwood composition= 0.0
Most common specie is Redwood with 57.1 percent cover

Transect Quadratic Mean DBH and TPA Summary for Over-Topped Layer:
Weighted by Cover

Dbh Size Class: Species	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover
Redwood	0.0"	10.0"	20.0"	29.1"	0.0"	23.4"
cov_wt	0.0	5.0	5.0	10.0	0.0	20.0
tpa	0.0	4.4	5.0	4.3	0.0	13.7
West Hemlock	3.0"	10.0"	11.0"	0.0"	0.0"	9.3"
cov_wt	2.5	7.5	2.5	0.0	0.0	12.5
tpa	2.2	8.7	1.1	0.0	0.0	12.0

Transect Cover Percent Density Summary for Pole/Sapling Layer:
Site/Polygon Id: 60212

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"		Tree Cover	Non-Tree Cover	Total Cover
Species								
West Hemlock	5.0	1.3	0.0	0.0	0.0	6.3		6.3
W. Hemlck dead	2.5	0.0	0.0	0.0	0.0	2.5		2.5
Tanoak	0.0	1.3	0.0	0.0	0.0	1.3		1.3
Gaulth Shallon							11.3	11.3
Rhodod Macroph							1.3	1.3
Vaccin Ovatum							43.8	43.8
Vaccin Parvifo							3.8	3.8
Totals	7.5	2.6	0.0	0.0	0.0	10.1	60.2	70.3

Transect Tree Cover Composition Summary for Pole/Sapling Layer 10.1 Cover:

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"		Tree Cover
Species						
West Hemlock	49.5	12.9	0.0	0.0	0.0	62.4
W. Hemlck dead	24.8	0.0	0.0	0.0	0.0	24.8
Tanoak	0.0	12.9	0.0	0.0	0.0	12.9
Totals	74.3	25.7	0.0	0.0	0.0	100.0

Percent conifer composition= 87.1
Percent hardwood composition= 12.9
Most common specie is West Hemlock with 62.4 percent cover

Transect Quadratic Mean DBH and TPA Summary for Pole/Sapling Layer:
Weighted by Cover

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"		Tree Cover
Species						
West Hemlock	2.3"	4.9"	0.0"	0.0"	0.0"	3.0"
cov_wt	5.0	1.3	0.0	0.0	0.0	6.3
tpa	27.8	1.7	0.0	0.0	0.0	29.6

Transect Cover Percent Density Summary for Ground Layer:
Site/Polygon Id: 60212

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"		Tree Cover	Non-Tree Cover	Total Cover
Species								
Gaulth Shallon							1.3	1.3
Oxalis Oregana							30.0	30.0
Polyst Munitum							32.5	32.5
Trilli Ovatum							1.3	1.3
Totals	0.0	0.0	0.0	0.0	0.0	0.0	65.1	65.1

NO TREE COVER/Quad Mean DBH TO REPORT

Transect Cover Percent Density Summary for Surface Condition Layer:
Site/Polygon Id: 60212

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"		Tree Cover	Non-Tree Cover	Total Cover
Species								
Coarse Wdydown							10.0	10.0
Fine Wdy Dbris							20.0	20.0
Litter							65.0	65.0
Cwd Dc5							5.0	5.0
Totals	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0

FireMon Sample Averages:

FWD 1 hour = 4.7 CWD DC1 = 0.00 Soil Profile Depth = 2.90"
FWD 10 hour = 1.3 CWD DC2 = 1.70 Percent Litter = 82.80
FWD 100 hour = 0.0 CWD DC3 = 0.00
CWD DC4 = 0.00
CWD DC5 = 16.70

NO TREE COVER/Quad Mean DBH TO REPORT

Percent Cover Summary for Bird's-eye Layer:
Site/Polygon Id: 60212
Number of Pixels: 1

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	Tree Cover	Non-Tree Cover	Total Cover
Species							
Redwood	0.0	0.0	0.0	20.0	55.0	75.0	75.0
Doug-fir	0.0	0.0	0.0	7.5	7.5	15.0	15.0
West Hemlock	0.0	0.0	2.5	0.0	0.0	2.5	2.5
W. Hemlck dead	2.5	0.0	0.0	2.5	0.0	5.0	5.0
Vaccin Parvifo						2.5	2.5
Totals	2.5	0.0	2.5	30.0	62.5	97.5	2.5	100.0

Tree Cover Composition Summary for Bird's-eye Layer 97.5 Cover:

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	All Sizes
Species					
Redwood	0.0	0.0	0.0	20.5	56.4	76.9
Doug-fir	0.0	0.0	0.0	7.7	7.7	15.4
West Hemlock	0.0	0.0	2.6	0.0	0.0	2.6
W. Hemlck dead	2.6	0.0	0.0	2.6	0.0	5.1
Totals	2.6	0.0	2.6	30.8	64.1	100.0

Percent conifer composition= 100.0
Percent hardwood composition= 0.0
Most common specie is Redwood with 76.9 percent cover composition

Quadratic Mean DBH and TPA Summary for Bird's-eye Layer:
Weighted by Cover

Dbh Size Class:	> 4.95" <= 4.95"	>10.95" <=10.95"	>23.95" <=23.95"	>49.95" <=49.95"	All Sizes
Species					
Redwood	0.0"	0.0"	0.0"	43.2"	106.1"	93.5"
cov_wt	0.0	0.0	0.0	20.0	55.0	75.0
tpa	0.0	0.0	0.0	8.2	9.2	17.4
Doug-fir	0.0"	0.0"	0.0"	42.4"	54.3"	48.7"
cov_wt	0.0	0.0	0.0	7.5	7.5	15.0
tpa	0.0	0.0	0.0	3.3	5.4	8.7
West Hemlock	0.0"	0.0"	11.0"	0.0"	0.0"	11.0"
cov_wt	0.0	0.0	2.5	0.0	0.0	2.5
tpa	0.0	0.0	1.1	0.0	0.0	1.1
W. Hemlck dead	3.0"	0.0"	0.0"	40.0"	0.0"	28.4"
cov_wt	2.5	0.0	0.0	2.5	0.0	5.0
tpa	9.6	0.0	0.0	1.5	0.0	11.2
Conifer	3.0"	0.0"	11.0"	42.7"	101.2"	84.5"
cov_wt	2.5	0.0	2.5	30.0	62.5	97.5
tpa	9.6	0.0	1.1	13.0	14.6	38.4
All Species	3.0"	0.0"	11.0"	42.7"	101.2"	84.5"
cov_wt	2.5	0.0	2.5	30.0	62.5	97.5
tpa	9.6	0.0	1.1	13.0	14.6	38.4

Transect Cover Percent Density Summary for All Layer:
Site/Polygon Id: 60212

Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover	Non-Tree Cover	Total Cover
Species								
Redwood	0.0	5.0	5.0	30.0	55.0	95.0		95.0
Doug-fir	0.0	0.0	0.0	7.5	7.5	15.0		15.0
West Hemlock	7.5	8.8	5.0	0.0	0.0	21.3		21.3
W. Hemlck dead	2.5	0.0	0.0	5.0	0.0	7.5		7.5
Tanoak	0.0	1.3	0.0	0.0	0.0	1.3		1.3
Gaulth Shallon							12.5	12.5
Rhodod Macroph							1.3	1.3
Vaccin Ovatum							43.8	43.8
Vaccin Parvifo							3.8	3.8
Oxalis Oregana							30.0	30.0
Polyst Munitum							32.5	32.5
Trilli Ovatum							1.3	1.3
Coarse Wdydown							10.0	10.0
Fine Wdy Dbris							20.0	20.0
Litter							65.0	65.0
Cwd Dc5							5.0	5.0
Totals	10.0	15.1	10.0	42.5	62.5	140.1	225.2	365.3

Traces found at site: Berber Nervosa, Rhamnu Purshia, Dispor Hookeri, Galium Trifidu, Trient Latifol, Vancou Hexandr, Blechn Spicant
7 traces found

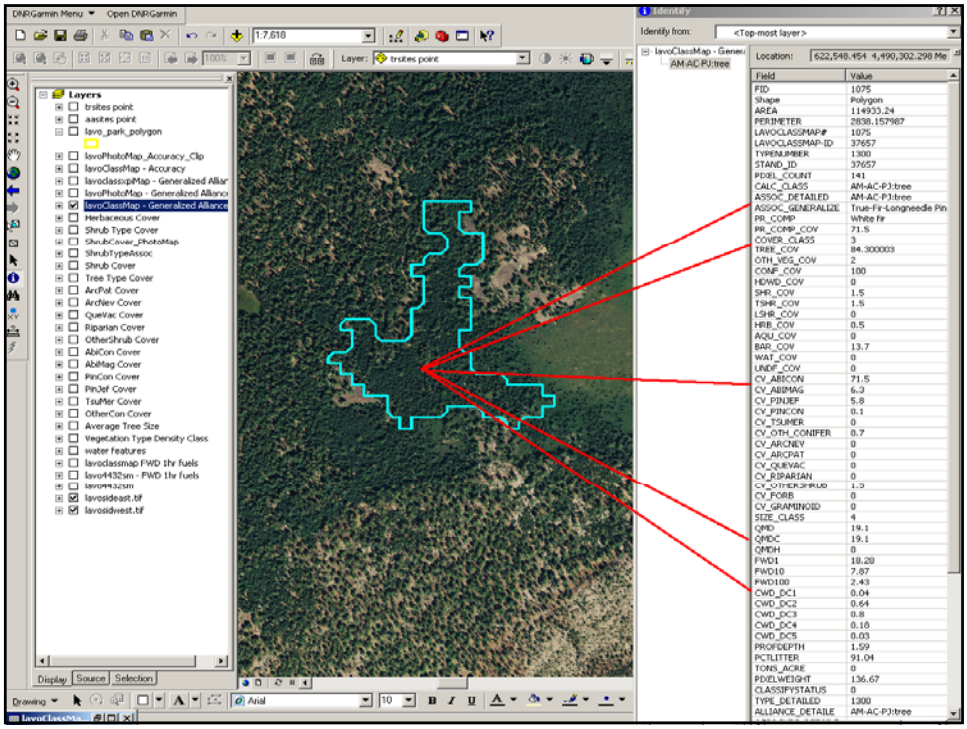
Site/Polygon Id: 60212
Transect Tree Cover Composition Summary for All Layer 140.1 Cover:

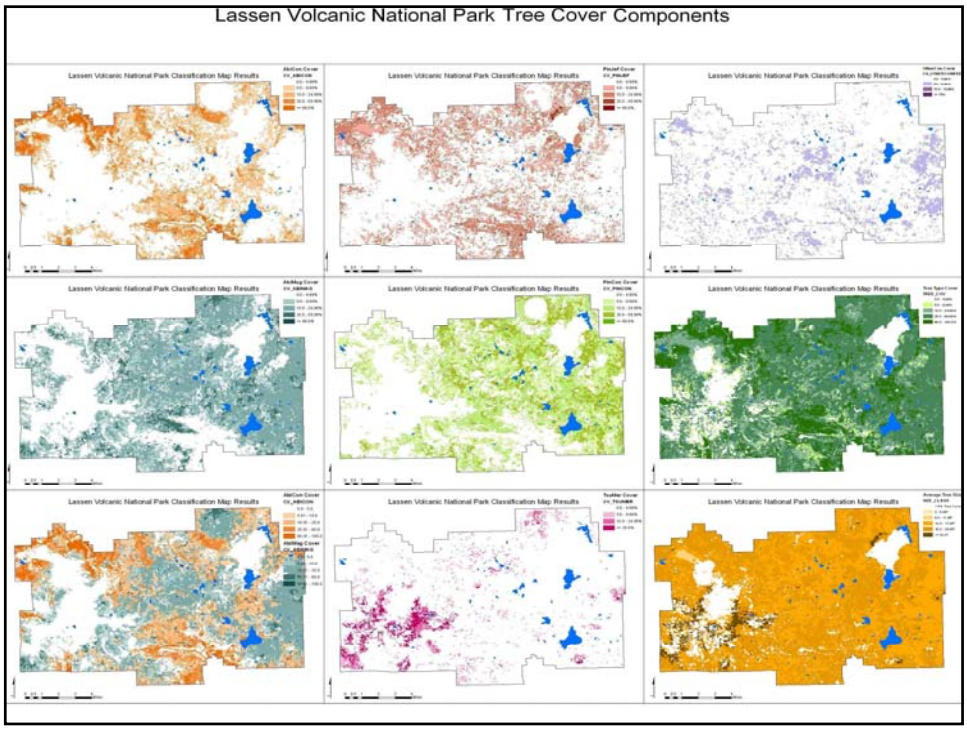
Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover
Species						
Redwood	0.0	3.6	3.6	21.4	39.3	67.8
Doug-fir	0.0	0.0	0.0	5.4	5.4	10.7
West Hemlock	5.4	6.3	3.6	0.0	0.0	15.2
W. Hemlck dead	1.8	0.0	0.0	3.6	0.0	5.4
Tanoak	0.0	0.9	0.0	0.0	0.0	0.9
Totals	7.1	10.8	7.1	30.3	44.6	100.0

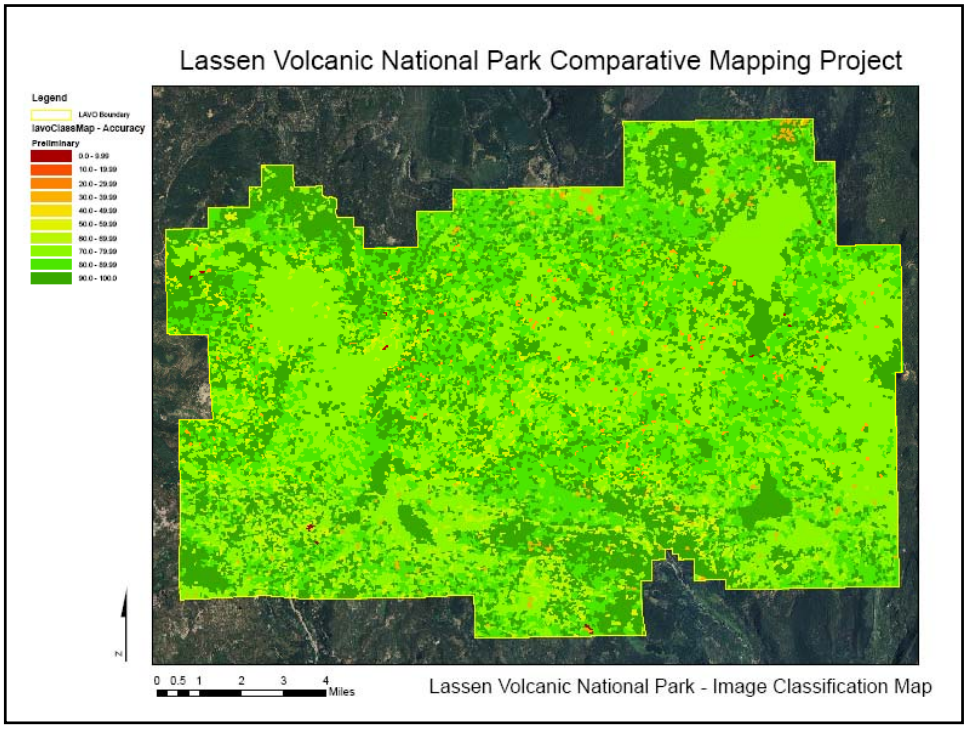
Percent conifer composition= 99.1
Percent hardwood composition= 0.9
Most common specie is Redwood with 67.8 percent cover

Site/Polygon Id: 60212
Transect Quadratic Mean DBH and TPA Summary for All Layers:
Weighted by Cover

Dbh Size Class:	<= 4.95"	> 4.95" <=10.95"	>10.95" <=23.95"	>23.95" <=49.95"	>49.95"	Tree Cover
Species						
Redwood	0.0"	10.0"	20.0"	39.0"	106.1"	83.8"
cov_wt	0.0	5.0	5.0	30.0	55.0	95.0
tpa	0.0	4.4	5.0	12.5	9.2	31.1
Doug-fir	0.0"	0.0"	0.0"	42.4"	54.3"	48.7"
cov_wt	0.0	0.0	0.0	7.5	7.5	15.0
tpa	0.0	0.0	0.0	3.3	5.4	8.7
West Hemlock	2.5"	9.4"	11.0"	0.0"	0.0"	8.2"
cov_wt	7.5	8.8	5.0	0.0	0.0	21.3
tpa	30.0	10.4	2.1	0.0	0.0	42.6
W. Hemlck dead	3.0"	0.0"	0.0"	40.0"	0.0"	32.7"
cov_wt	2.5	0.0	0.0	5.0	0.0	7.5
tpa	9.6	0.0	0.0	3.1	0.0	12.7
Tanoak	0.0"	4.9"	0.0"	0.0"	0.0"	4.9"
cov_wt	0.0	1.3	0.0	0.0	0.0	1.3
tpa	0.0	1.1	0.0	0.0	0.0	1.1
	------	------	------	------	------	------
Conifer	2.6"	9.6"	16.1"	39.8"	101.2"	71.6"
cov_wt	10.0	13.8	10.0	42.5	62.5	138.8
tpa	39.6	14.8	7.1	18.9	14.6	95.1
	------	------	------	------	------	------
Hardwood	0.0"	4.9"	0.0"	0.0"	0.0"	4.9"
cov_wt	0.0	1.3	0.0	0.0	0.0	1.3
tpa	0.0	1.1	0.0	0.0	0.0	1.1
	------	------	------	------	------	------
	------	------	------	------	------	------
All Species	2.6"	9.3"	16.1"	39.8"	101.2"	71.3"
cov_wt	10.0	15.1	10.0	42.5	62.5	140.1
tpa	39.6	15.9	7.1	18.9	14.6	96.2




Lassen Volcanic National Park Tree Cover Components



Field Sampling Considerations

- **Cost and effort**
- **Representative sample of project area**
- **Personnel training and experience**
- **Reliability and error**
- **Subjectivity and repeatability of estimates**
- **Potential bias**
- **Difficulty of implementation**
- **Information content and utility**
- **Integration with other data collection needs**

Relative Ranking of Field Data Collection Techniques and Strategies

Sampling Technique	Cost & Effort	Ease of Access	Representative Sampling	Crew Training & Expertise	Reliability & Consistency	Statistical Measures	Subjectivity	Verifiable	Lack of Bias	Complexity	Categorical Values	Discrete Values	Cover By Species	Cover By Size	Cover By Layer	Size and Frequency by Layer	Canopy Structure	Traces	Integration w/ other methods	Other - Meets Standards	Other - Exceeds Standards	TOTAL Score
Line Transect																						
Line-point Transect																						
Point																						
Point ocular																						
Relevé - ocular																						
Other Fixed Area																						
Ocular - Categorical																						
Stratification																						
Near Access Trails & Roads																						
Hunt & Peck																						
Existing Information																						
Use 0-10 for Low to High, or Unacceptable to Excellent ...																						

Relative Ranking of Field Data Collection Techniques and Strategies

Sampling Technique	Cost & Effort	Ease of Access	Representative Sampling	Crew Training & Expertise	Reliability & Consistency	Statistical Measures	Subjectivity	Verifiable	Lack of Bias	Complexity	Categorical Values	Discrete Values	Cover By Species	Cover By Size	Cover By Layer	Size and Frequency by Layer	Canopy Structure	Traces	Integration w/ other methods	Other - Meets Standards	Other - Exceeds Standards	TOTAL Score
Line Transect	4	6	10	9	9	10	10	10	10	6	**10**	10	10	10	10	10	10	10	10	10	5	189
Line-point Transect	7	8	10	9	8	10	10	10	10	7	**10**	10	10	10	10	10	10	10	10	10	5	194
Point	8	9	5	9	8	9	10	10	10	8	**10**	10	0	0	0	0	0	6	5	10	5	132
Point ocular	10	9	3	5	5	1	6	5	4	9	**10**	8	8	0	0	0	3	6	5	10	5	112
Relevé - ocular	8	6	8	5	5	1	5	5	6	5	**10**	8	8	1	1	0	3	9	7	10	5	116
Other Fixed Area	7	6	10	7	8	8	9	7	8	5	**10**	10	10	10	10	10	10	10	7	10	5	177
Ocular - Categorical	10	9	5	6	5	1	3	5	4	9	**10**	0	1	0	0	0	0	0	3	10	10	91
Stratification	5	5	9	7	9	10	10	10	10	8												83
Near Access Trails & Roads	8	9	5	9	6	0	10	10	5	9												71
Hunt & Peck	9	8	3	9	5	0	1	5	1	10												51
Existing Information	5	5	9	7	9	10	10	10	10	8												83
Use 0-10 for Low to High, or Unacceptable to Excellent ...																						

Recommendations

- Develop quantitative data and statistics that enable the generation of categorical values, as well as alternative types of information
- Implement easy to use standardized techniques that make use of less experienced and less costly personnel
- Eliminate subjectivity and bias
- Sample as much of the area as practical, but always sample more area during the AA
- Use and develop statistics to eliminate “fuzzy logic”

Questions and Comments

If you happen to think of something later, Sage and I will be at the conference through Thursday. Feel free to talk with us.