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Image segmentation for wetlands inventory: data considerations and concepts

Presented by :

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Wetland inventory needs:

- Small spatial scales
- High precision
- High accuracy
- Dynamic ecological setting

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Traditional photo interpretation strategies:

Modeling (Human)

- Field Observation
- Direct Recognition
- Interpretation by Inference
- Probabilistic Interpretation
- Stereo interpretation

+

Data inputs

Stereo CIR areal imagery

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Image object strategies require:

Modeling (computer)

- Segmentation modeling
- Machine learning

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Data inputs

- Multi spectral imagery
- High spatial resolution data
- Multi temporal scale
- Physiographic / structural characterization

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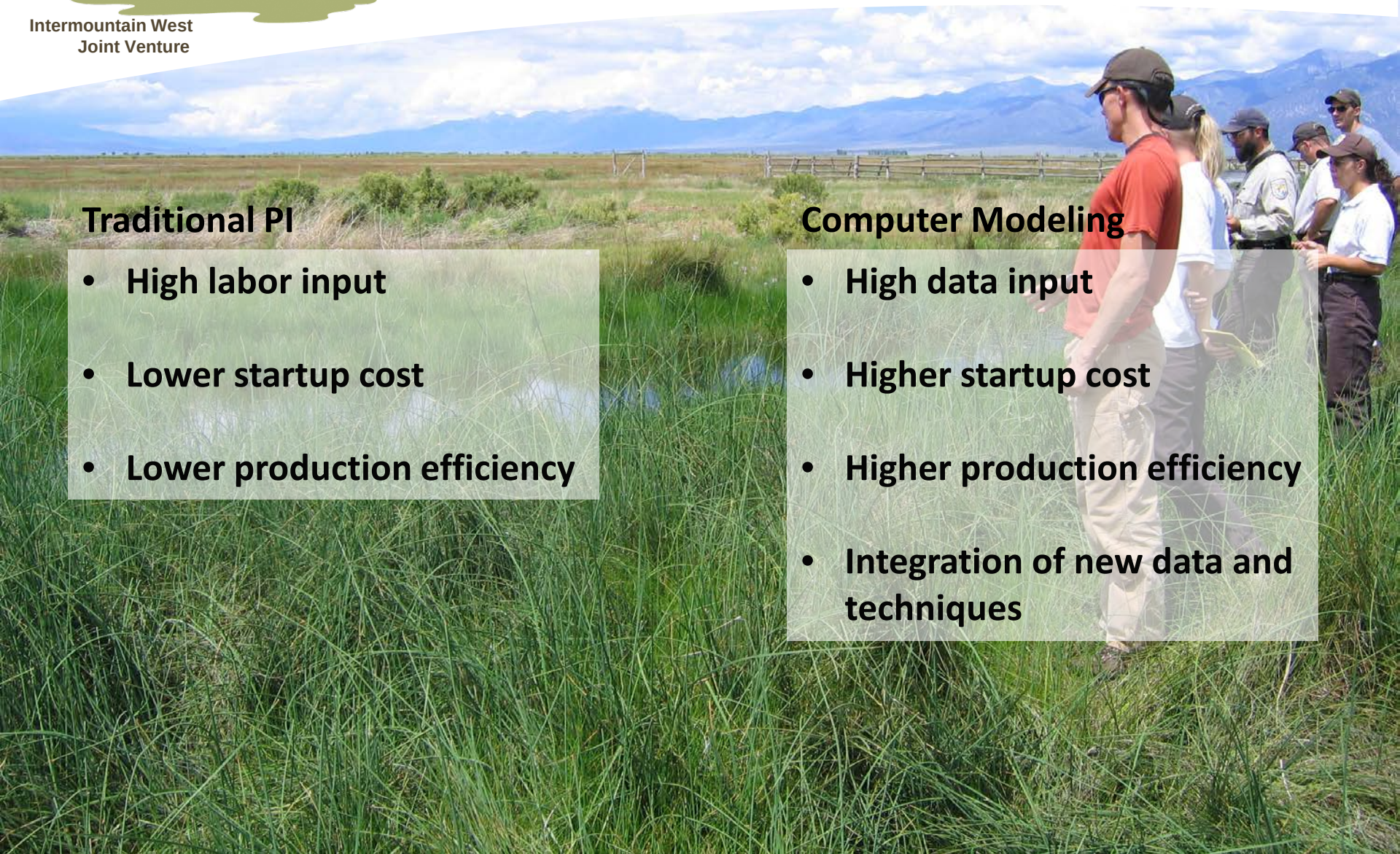
Potential tradeoffs:



Traditional PI

- High labor input
- Lower startup cost
- Lower production efficiency

Computer Modeling

- High data input
- Higher startup cost
- Higher production efficiency
- Integration of new data and techniques

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Investment considerations:

- Workforce skills
- Labor capacity and cost
- Available capital
- Conservation needs

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Evaluate needs:

Example 1.

Need to develop models that delineate wetland boundaries to be interpreted and labeled using traditional photo interpretation

Example 2

Need to develop models that delineate wetland boundaries and model (automate) wetland class labeling

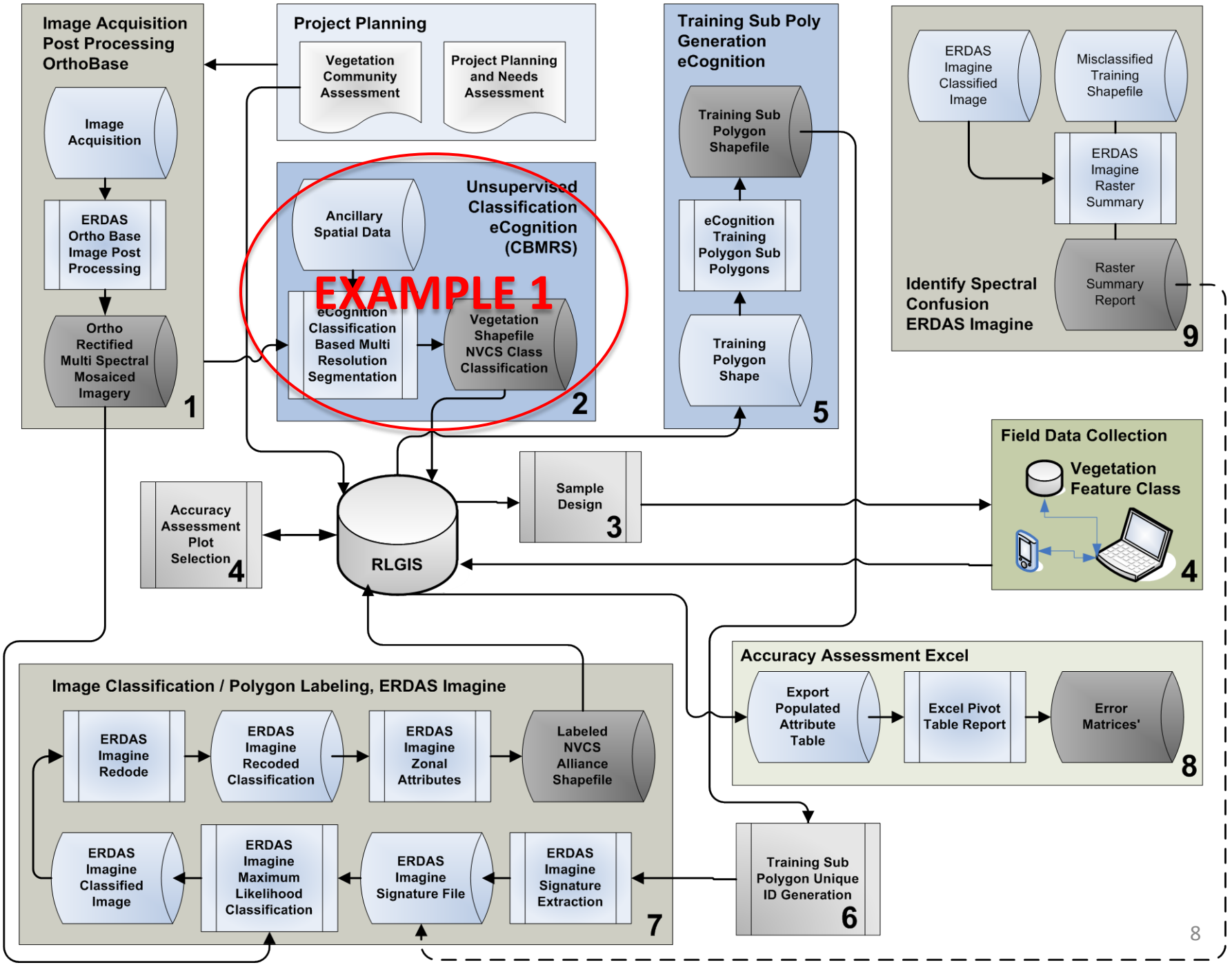
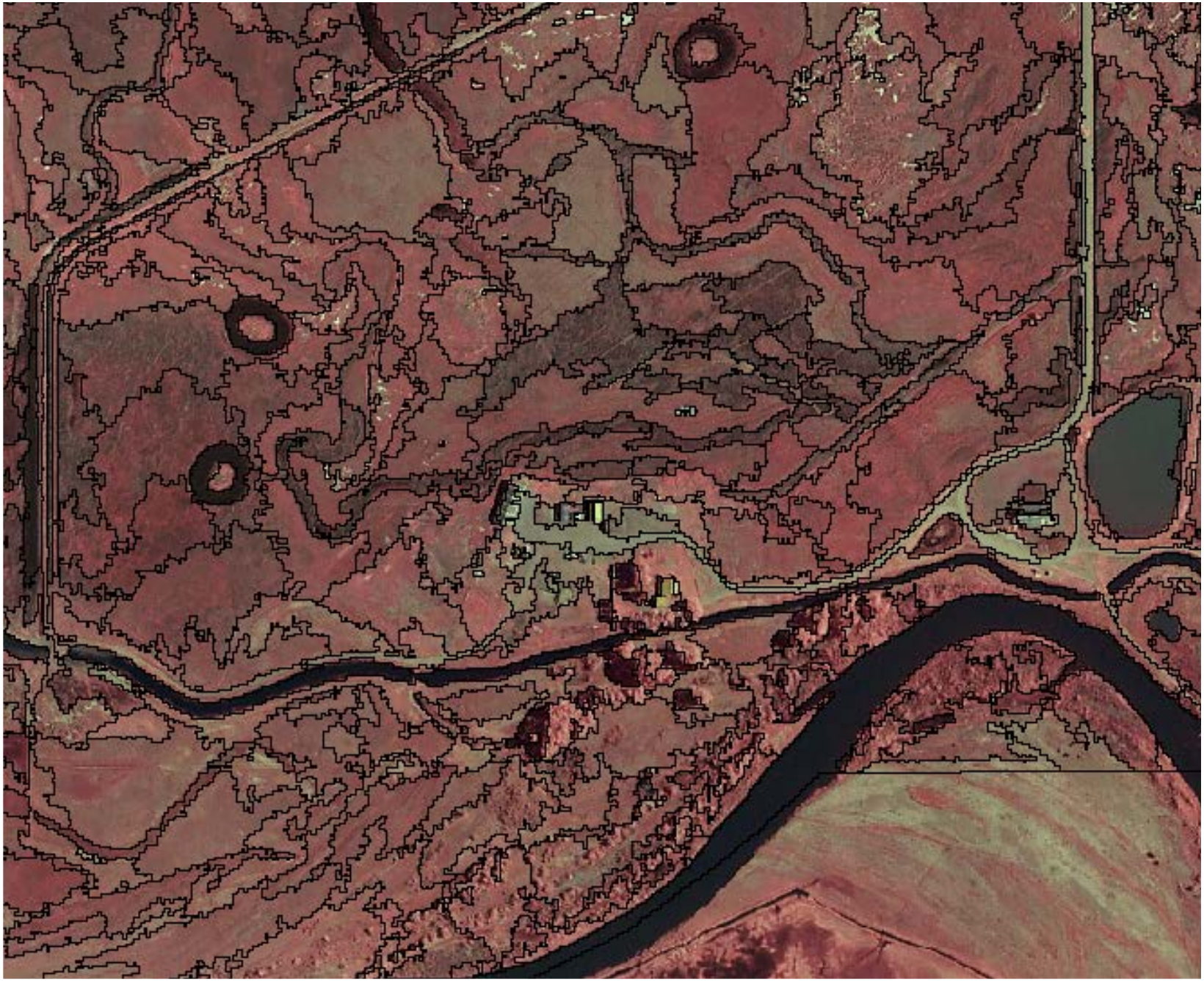


Image Acquisition Post Processing OrthoBase
Image Acquisition
ERDAS Ortho Base Image Post Processing
Ortho Rectified Multi Spectral Mosaiced Imagery
1
Project Planning
Vegetation Community Assessment
Project Planning and Needs Assessment
Unsupervised Classification eCognition (CBMRS)
Ancillary Spatial Data
eCognition Classification Based Multi Resolution Segmentation
Vegetation Shapefile NVCS Class Classification
2
EXAMPLE 1
Training Sub Poly Generation eCognition
Training Sub Polygon Shapefile
eCognition Training Polygon Sub Polygons
Training Polygon Shape
5
ERDAS Imagine Classified Image
Misclassified Training Shapefile
ERDAS Imagine Raster Summary
Raster Summary Report
Identify Spectral Confusion ERDAS Imagine
9
Field Data Collection
Vegetation Feature Class
4
Accuracy Assessment Plot Selection
4
RLGIS
Sample Design
3
Accuracy Assessment Excel
Export Populated Attribute Table
Excel Pivot Table Report
Error Matrices'
8
Image Classification / Polygon Labeling, ERDAS Imagine
ERDAS Imagine Redode
ERDAS Imagine Recoded Classification
ERDAS Imagine Zonal Attributes
Labeled NVCS Alliance Shapefile
ERDAS Imagine Classified Image
ERDAS Imagine Maximum Likelihood Classification
ERDAS Imagine Signature File
ERDAS Imagine Signature Extraction
7
Training Sub Polygon Unique ID Generation
6



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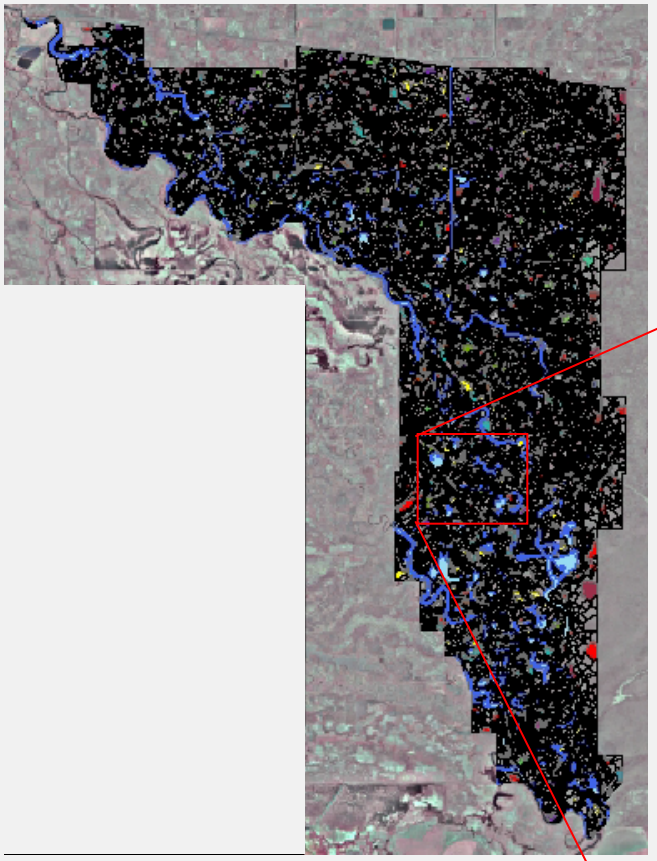
Object based (Segmentation) concept:

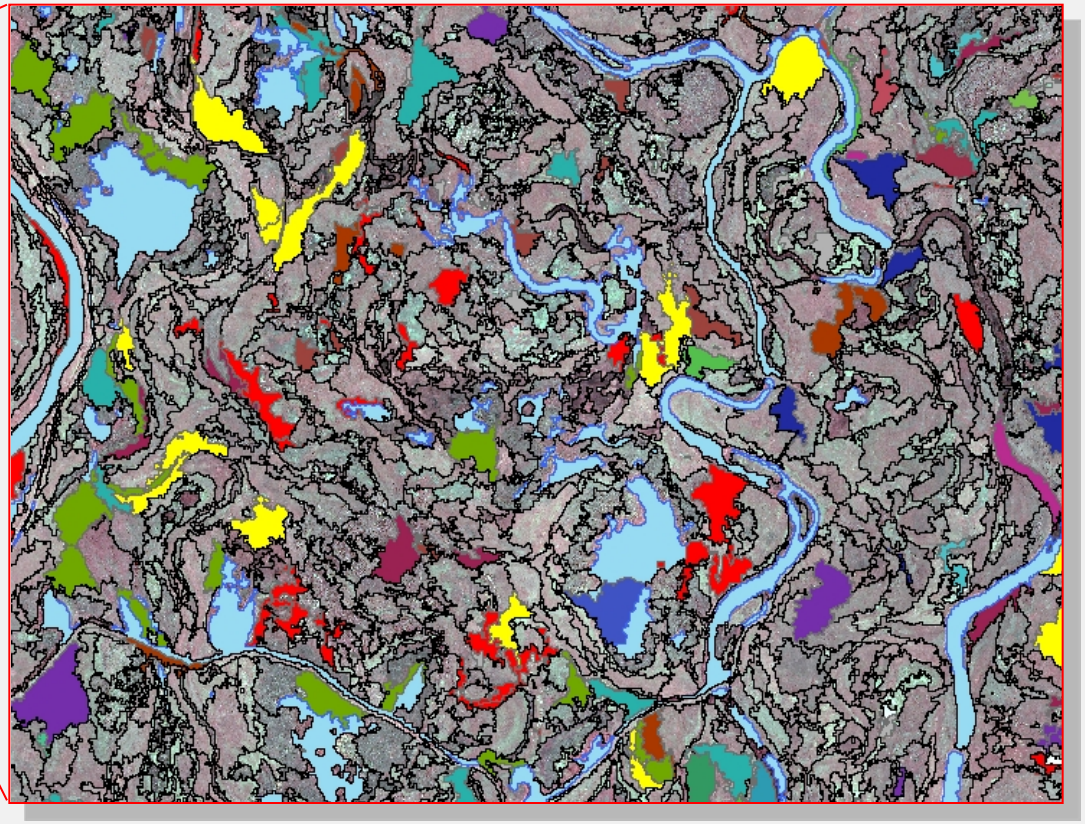
Need to simplify and model high resolution digital data in logical units that can consider:

- **Spectral resolution**
- **Radiometric resolution**
- **Spatial resolution**
- **Temporal resolution**

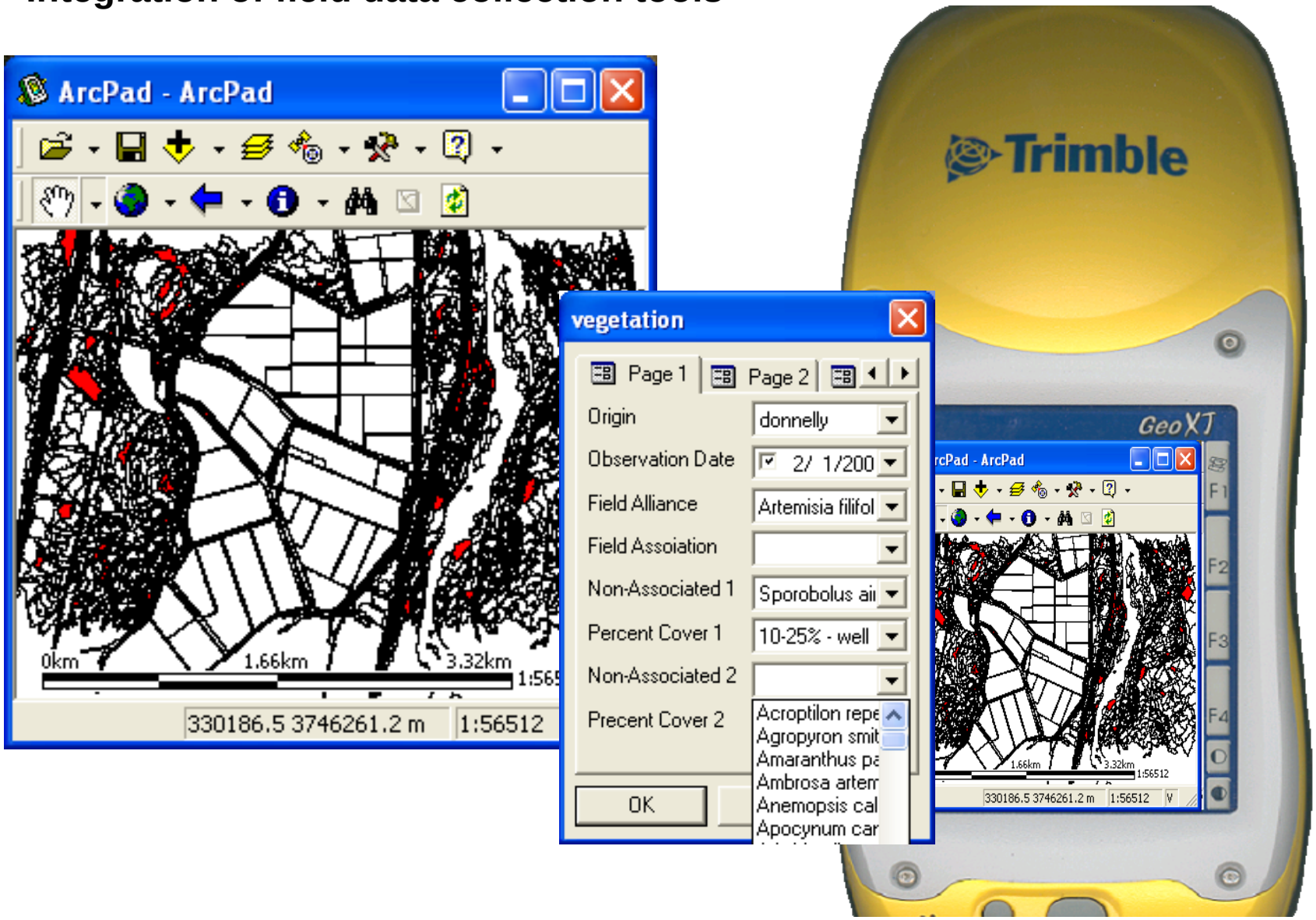


Alamosa NWR, CO - NVCS floristic level plant community inventory plot data collected within object based grid

Acquisition or collection of associated plot data is required to interpolate (model) wetland habitat classes continuously across project area.



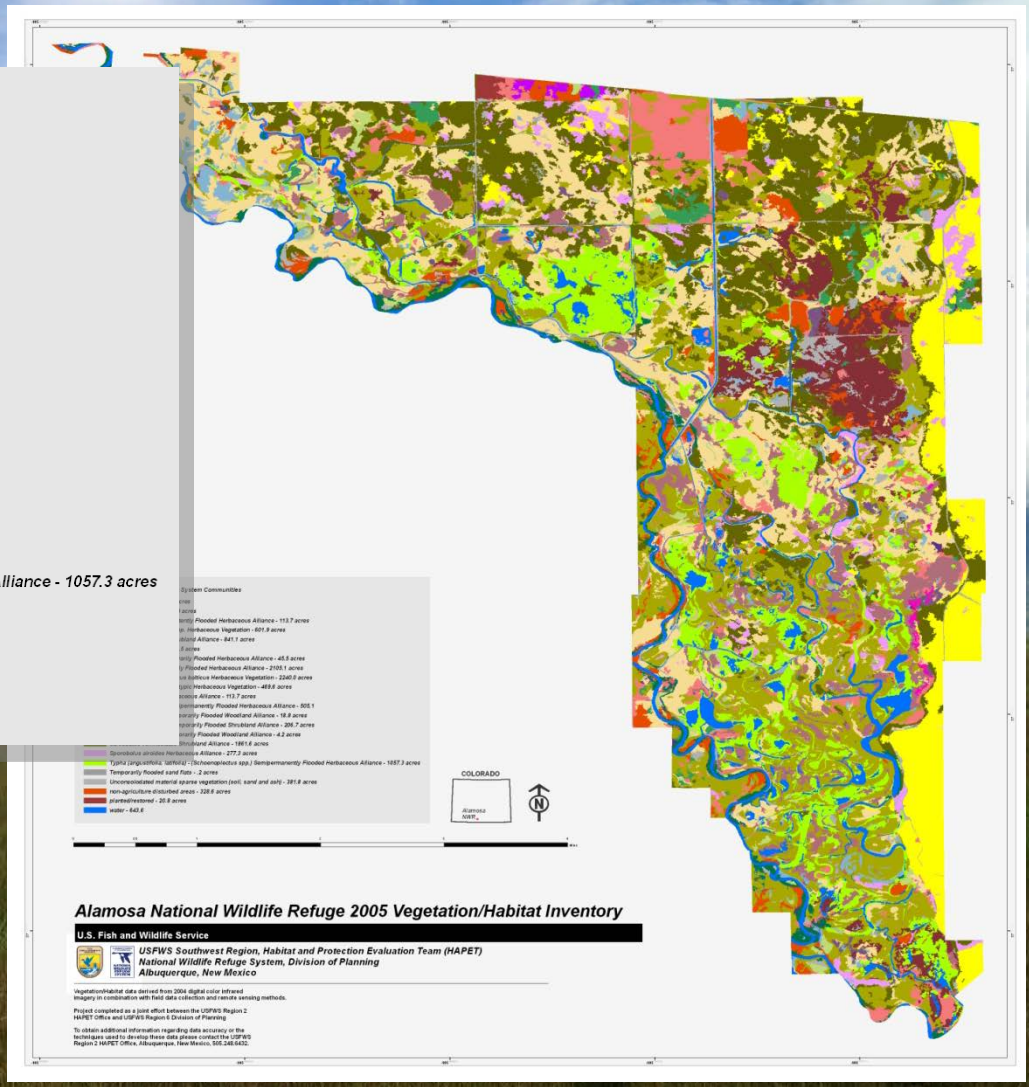
Integration of field data collection tools



Integration of field data collection tools

National Vegetation Classification System Communities

- *Acroptilon repens - 20.8 acres*
- *Chenopodium spp. - 198.9 acres*
- *Distichlis spicata Intermittently Flooded Herbaceous Alliance - 113.7 acres*
- *Eleocharis spp. - Carex spp. Herbaceous Vegetation - 601.9 acres*
- *Ericameria nauseosa Shrubland Alliance - 841.1 acres*
- *Helianthus tuberosus - 16.5 acres*
- *Hordeum jubatum Temporarily Flooded Herbaceous Alliance - 45.5 acres*
- *Juncus balticus Seasonally Flooded Herbaceous Alliance - 2105.1 acres*
- *Lepidium latifolium - Juncus balticus Herbaceous Vegetation - 2240.0 acres*
- *Lepidium latifolium monotypic Herbaceous Vegetation - 469.6 acres*
- *Pascopyrum smithii Herbaceous Alliance - 113.7 acres*
- *Phragmites australis Semipermanently Flooded Herbaceous Alliance - 505.1*
- *Populus angustifolia Temporarily Flooded Woodland Alliance - 18.8 acres*
- *Salix (exigua, interior) Temporarily Flooded Shrubland Alliance - 206.7 acres*
- *Salix amygdaloides Temporarily Flooded Woodland Alliance - 4.2 acres*
- *Sarcobatus vermiculatus Shrubland Alliance - 1861.6 acres*
- *Sporobolus airoides Herbaceous Alliance - 277.3 acres*
- *Typha (angustifolia, latifolia) - (Schoenoplectus spp.) Semipermanently Flooded Herbaceous Alliance - 1057.3 acres*
- *Temporarily flooded sand flats - .2 acres*
- *Unconsolodated material sparse vegetation (soil, sand and ash) - 381.8 acres*
- *non-agriculture disturbed areas - 328.6 acres*
- *planted/restored - 20.8 acres*
- *water - 643.6*



Modeling outputs create tremendous efficiencies that are capable of addressing ecological complexity if the necessary data inputs are available

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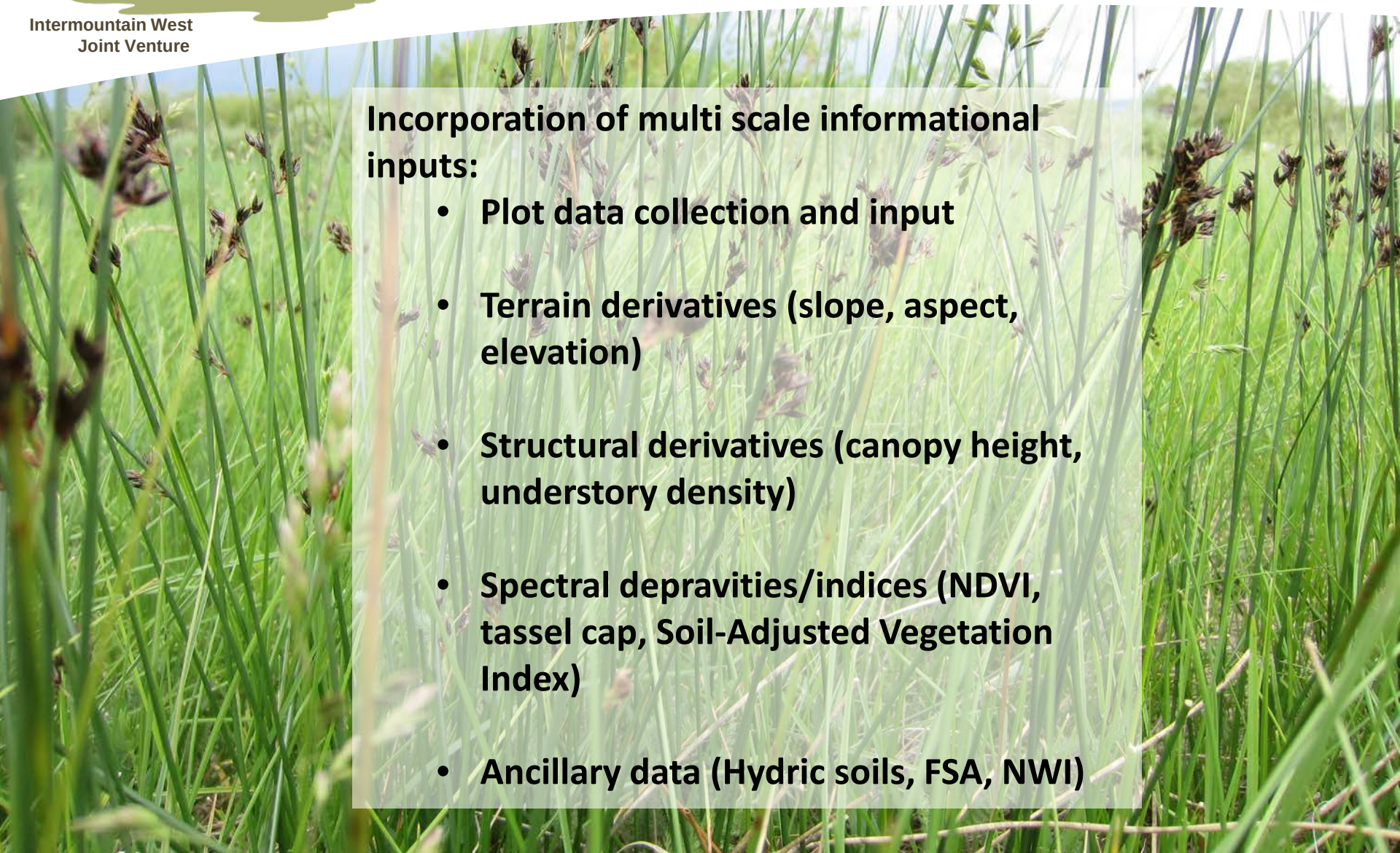
Object based classification model concept:



Incorporation of multi scale informational inputs:

- **Plot data collection and input**
- **Terrain derivatives (slope, aspect, elevation)**
- **Structural derivatives (canopy height, understory density)**
- **Spectral depravities/indices (NDVI, tassel cap, Soil-Adjusted Vegetation Index)**
- **Ancillary data (Hydric soils, FSA, NWI)**

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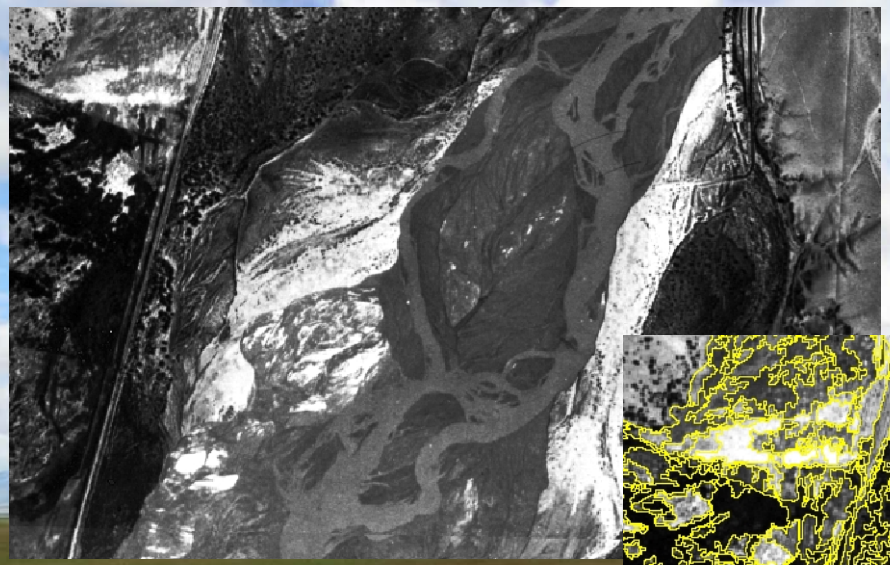
Object based classification model – measuring historic ecological settings:

Understanding of historic biotic and abiotic process prior to large scale impacts to ecological processes (agriculture, damming, ditching, road construction, etc…) (Laubhan et al., 2005).

Provides insight to the distribution of different wetland types and processes…

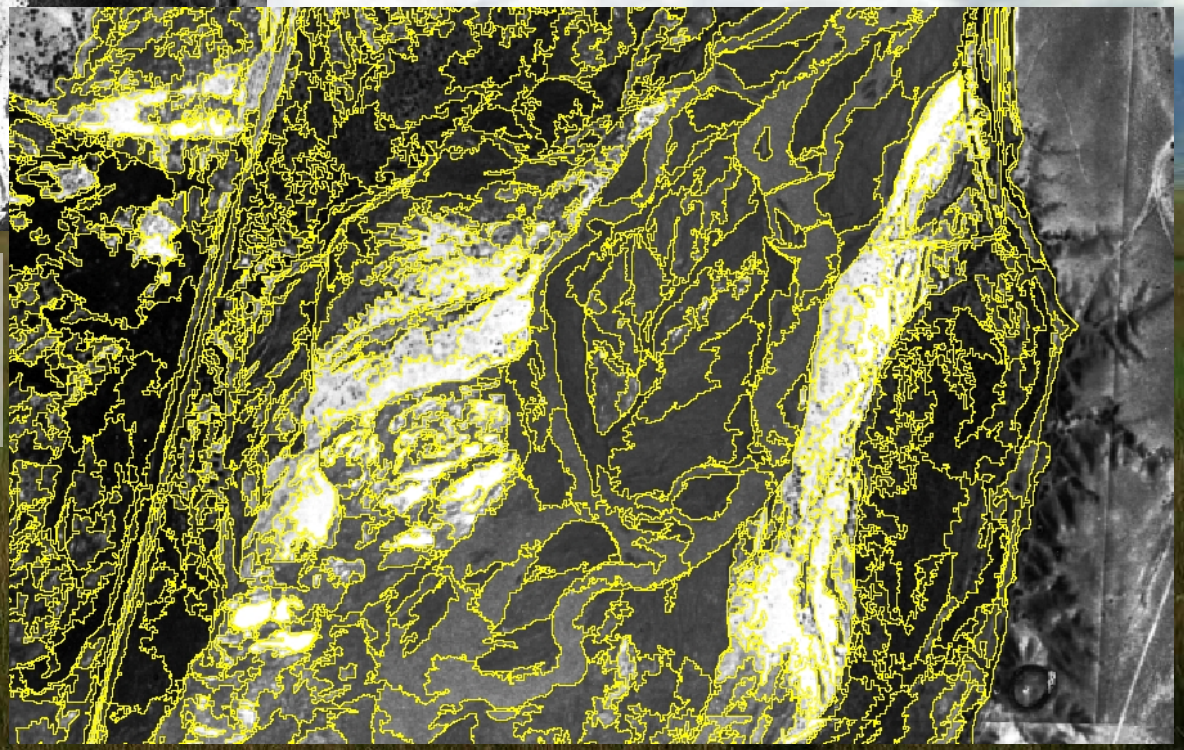
Features can be overlooked during restoration efforts because many of the identifiable wetland feature characteristics are no longer recognizable.

Unidentifiable wetland feature can lead to improper site selection when developing restoration and management planning efforts (King and Fredrickson 1998).

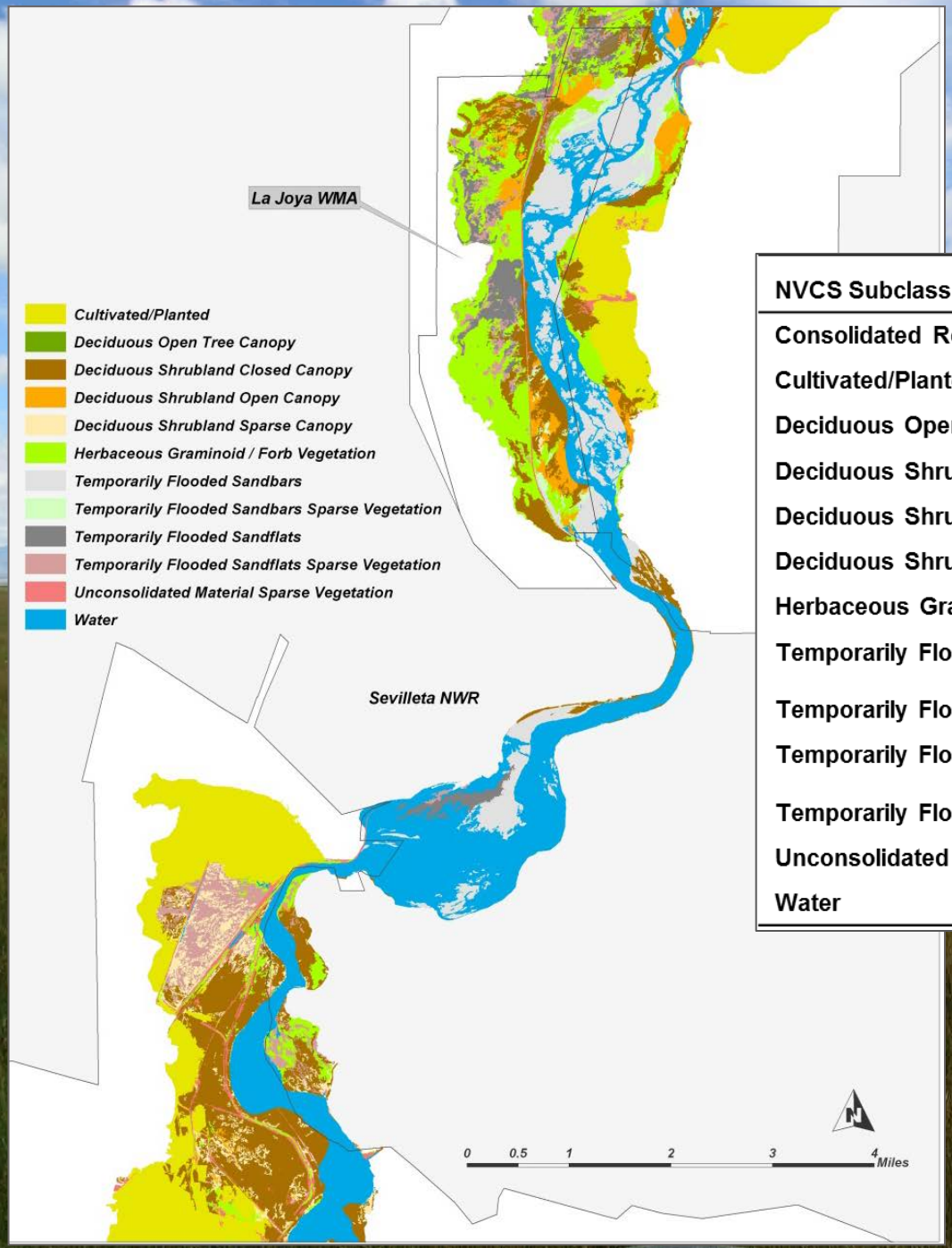


Rio Grande 1935 panchromatic orthorectified imagery

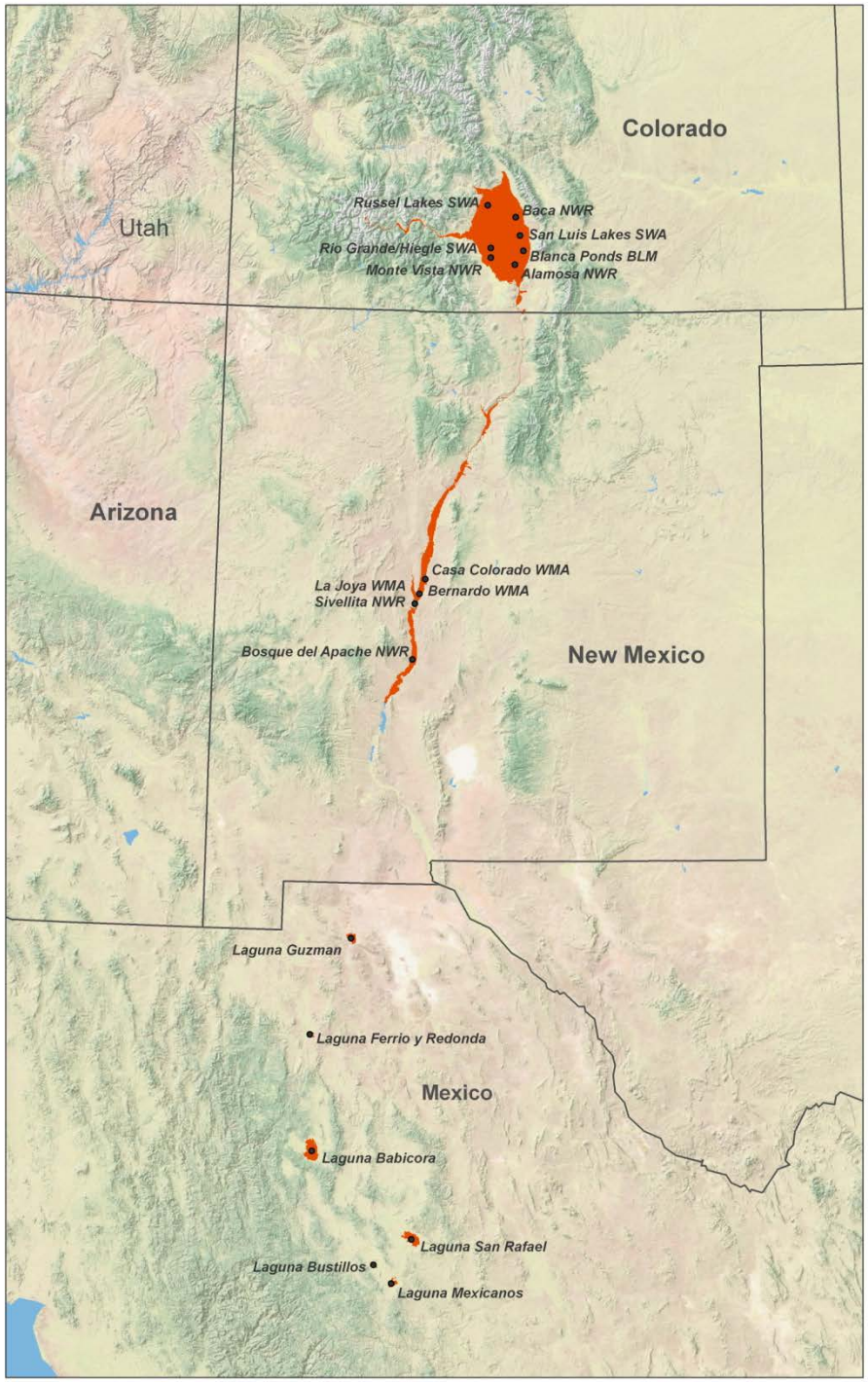
Rio Grande 1935 segmented

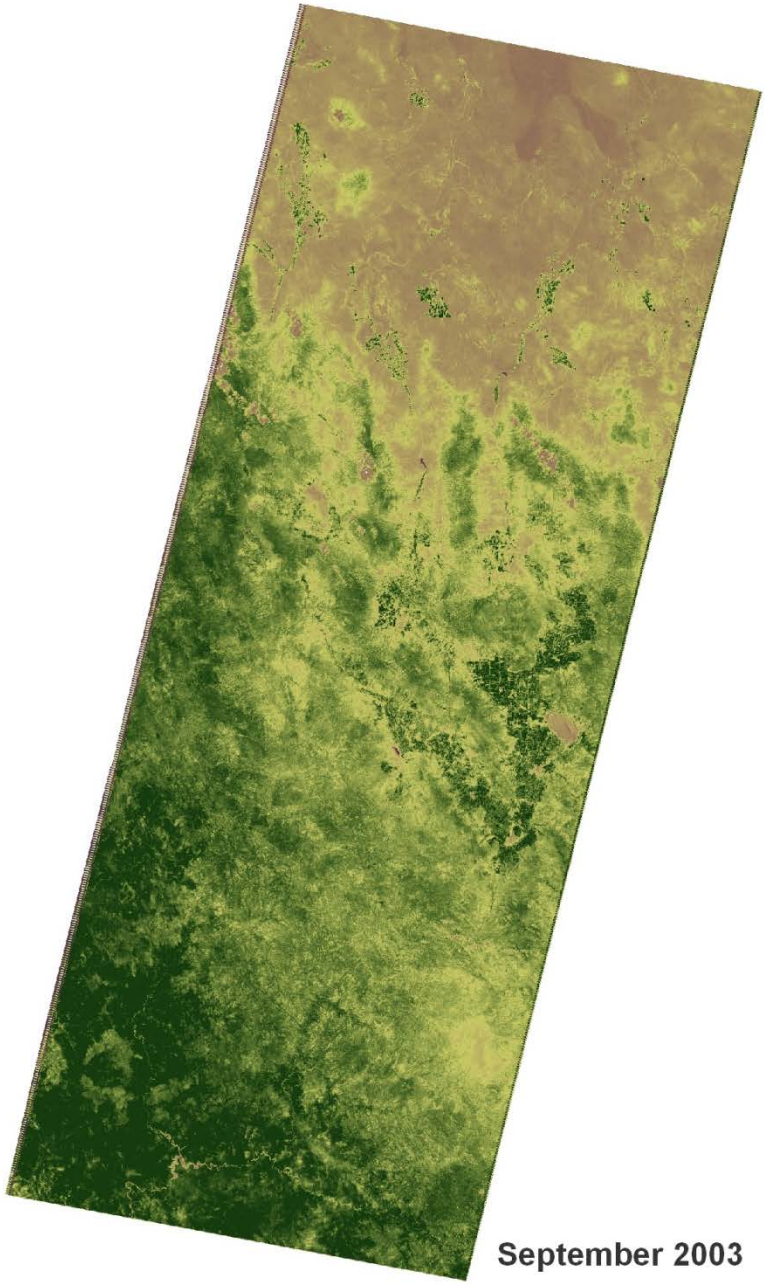


Rio Grande 1935 (La Joya Reach) Landcover Inventory

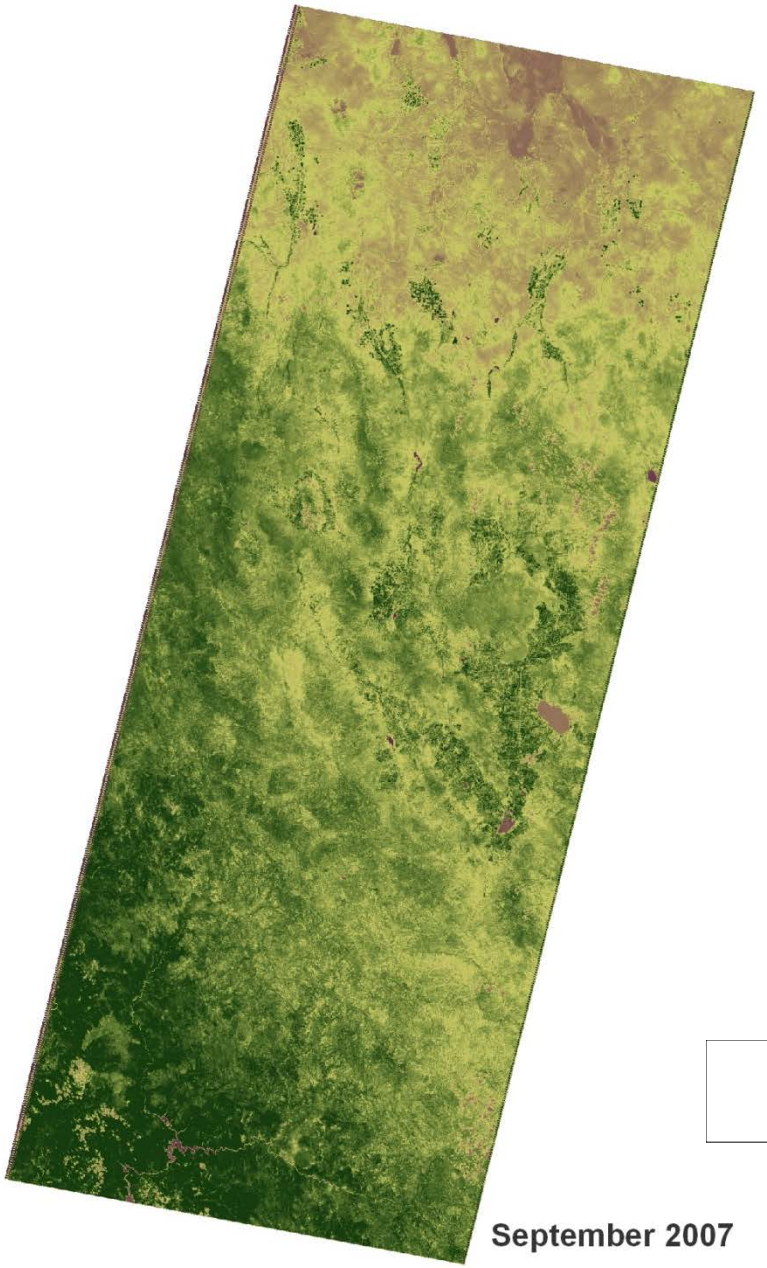


NVCS Subclass	Acres	% of reach
Consolidated Rock Sparse Vegetation	64.8	0.6%
Cultivated/Planted	2334.6	21.1%
Deciduous Open Tree Canopy	2.7	0.0%
Deciduous Shrubland Closed Canopy	1738.7	15.7%
Deciduous Shrubland Open Canopy	319.1	2.9%
Deciduous Shrubland Sparse Canopy	336.4	3.0%
Herbaceous Graminoid / Forb Vegetation	1345.5	12.2%
Temporarily Flooded Sandbars	1068.3	9.7%
Temporarily Flooded Sandbars Sparse Vegetation	92.4	0.8%
Temporarily Flooded Sandflats	365.3	3.3%
Temporarily Flooded Sandflats Sparse Vegetation	506.3	4.6%
Unconsolidated Material Sparse Vegetation	211.5	1.9%
Water	2662.3	24.1%


Colorado
Utah
Russel Lakes SWA
Baca NWR
San Luis Lakes SWA
Rio Grande/Hiegle SWA
Blanca Ponds BLM
Monte Vista NWR
Alamosa NWR
Arizona
Casa Colorado WMA
La Joya WMA
Bernardo WMA
Sivellita NWR
Bosque del Apache NWR
New Mexico
Laguna Guzman
Laguna Ferrio y Redonda
Mexico
Laguna Babicora
Laguna San Rafael
Laguna Bustillos
Laguna Mexicanos



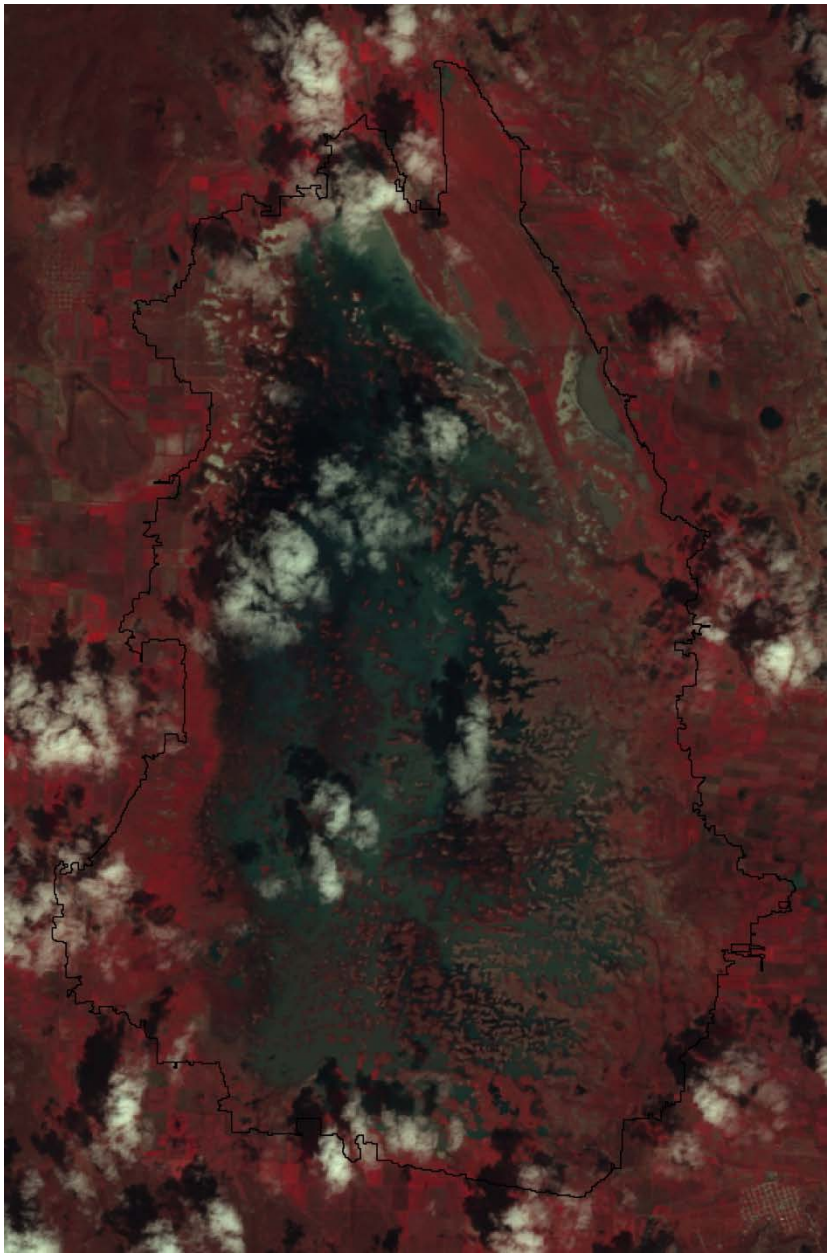
September 2003



September 2007

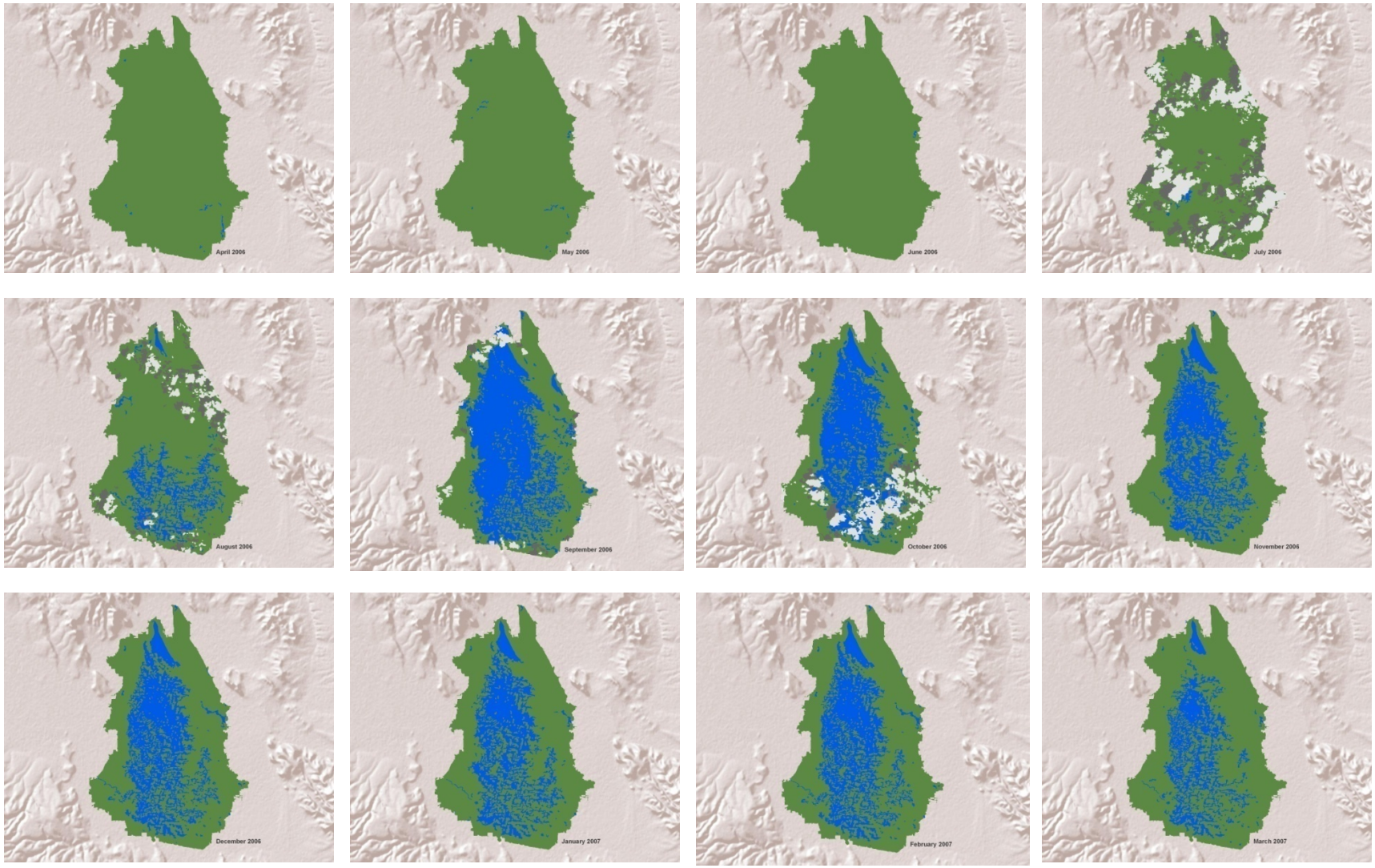
Overview

1. *23,775 hectare closed basin*
2. *Convective summer precipitation drives productivity*
3. *>5,000 hectares of adjacent cultivated lands*

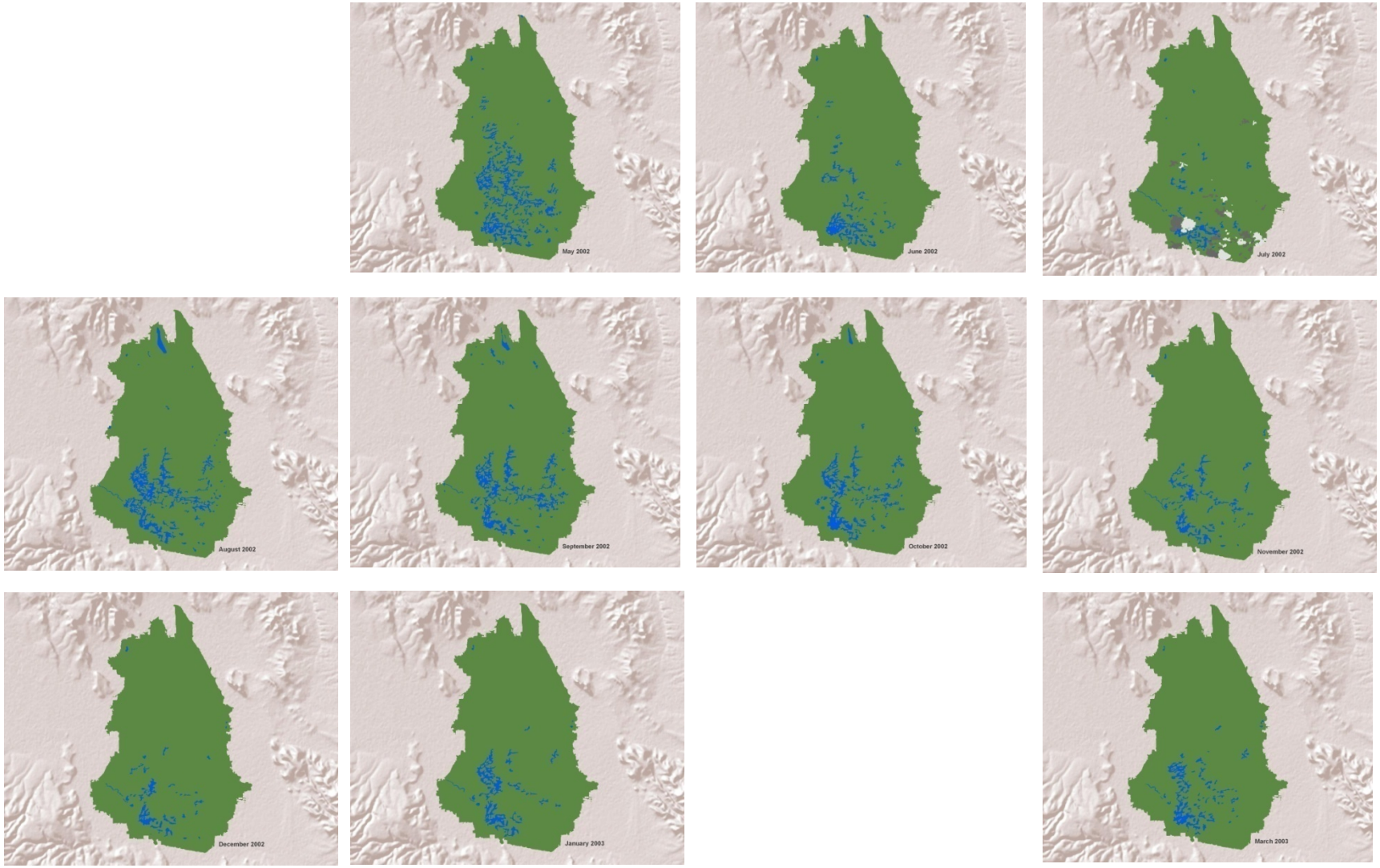


Sept. 2006

Sept. 2002

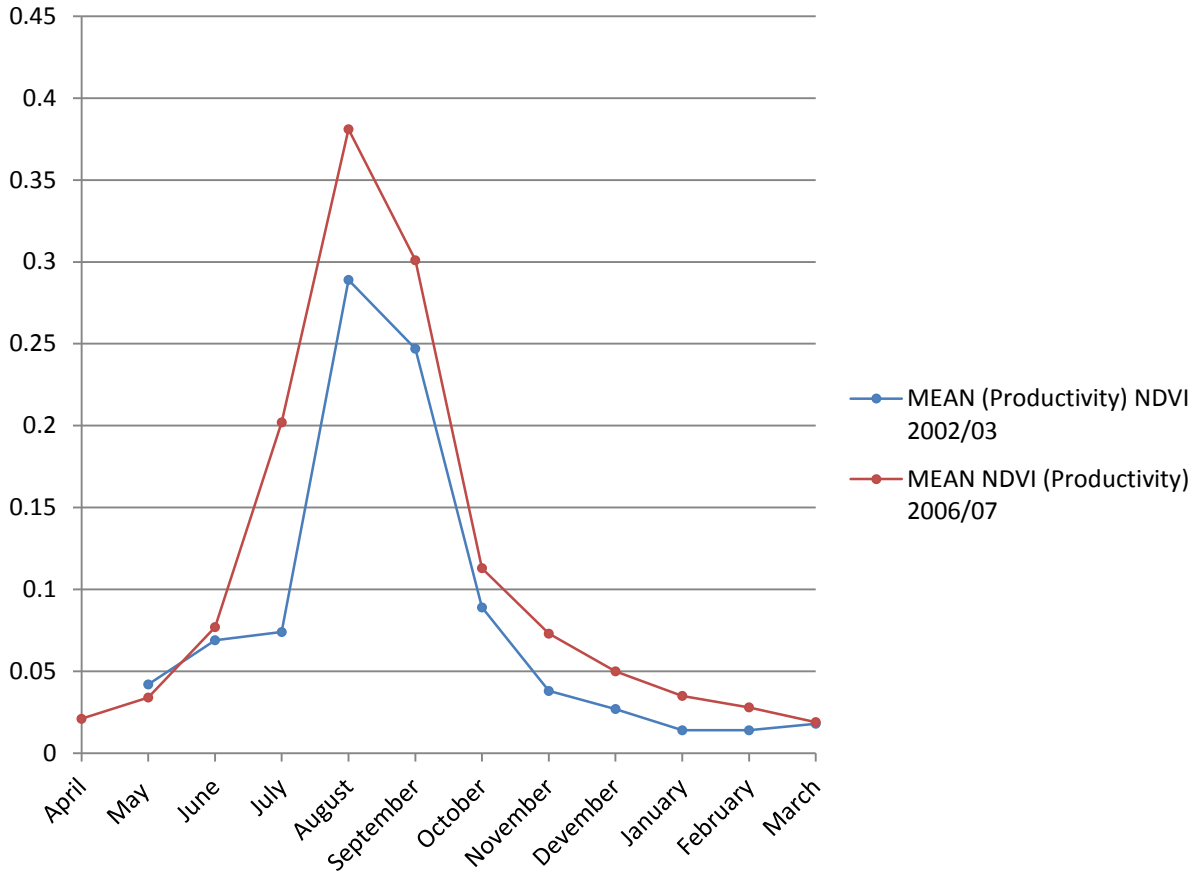


Babicora Basin, Mexico April 2006 – March 2007 (green-ms, blue-surface water)



Babicora Basin, Mexico April 2002 – March 2003 (green-ms, blue-surface water)

Monitoring and Analysis: 2002/03 – 2006/07 wetland productivity curve

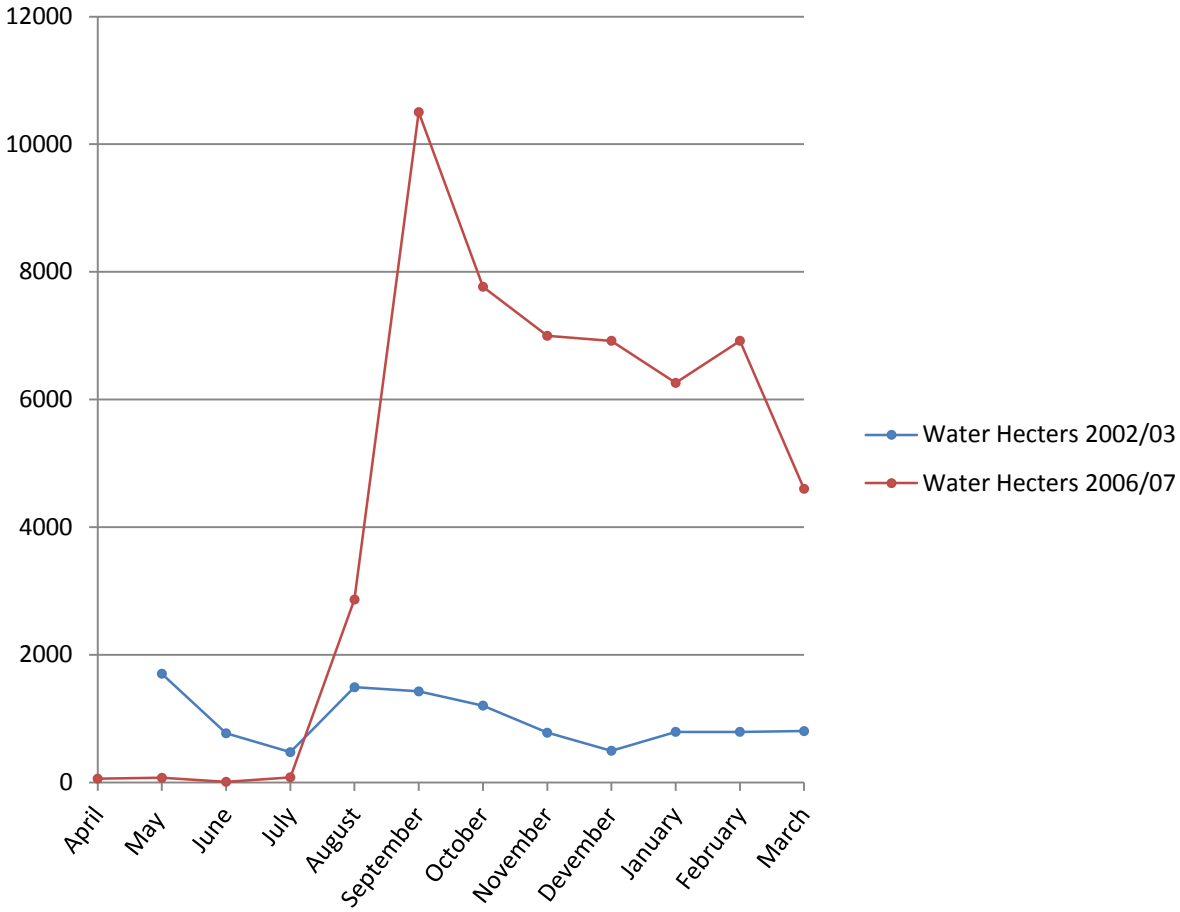


P(T<=t) two-tail	0.020635

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	0.0907	0.1285
Variance	0.009431	0.015635
Observations	10	10
Pearson Correlation	0.957189	
Hypothesized Mean Difference	0	
df	9	
t Stat	-2.8023	
P(T<=t) one-tail	0.010317	
t Critical one-tail	1.833113	
P(T<=t) two-tail	0.020635	

Monitoring and Analysis: 2002/03 – 2006/07 surface water abundance



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Segmentation and related software:

Segmentation
eCognition
SPRING
Berkeley Segmentation
Monteverdi
ERDAS
ENVI

Data Mining/Machine Learning
R
R – Rattle
R – Random Forest
R- SVM (Support Vector Machines)

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Additional resources:

USFWS - Remote Sensing application Center (RSAC)
http://www.fs.fed.us/eng/rsac/

Intermountain West Joint Venture (IWJV)
patrick_donnelly@fws.gov

eCognition Developer 8 Quickstart
http://www.ecognition.com/products/trial-software

Rattle: A data Mining GUI for R
http://journal.r-project.org/archive/2009-2/RJournal_2009-2_Williams.pdf

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QUESTIONS?