

# Using High-Resolution Satellite Imagery to Map Riparian Habitat

Renee Walmsley  
John Armstrong, AICP  
Walsh Environmental, LLC

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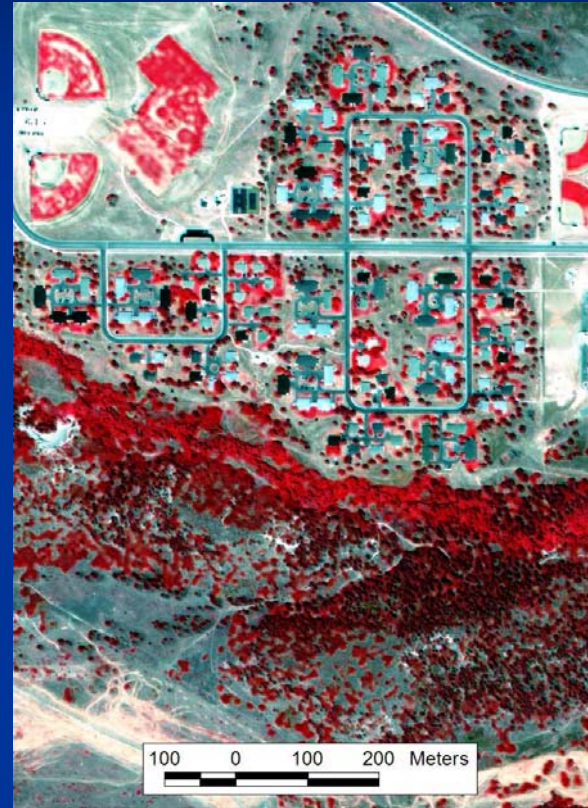
# Introduction

- Long history of using remotely sensed data to map riparian habitat, including LandSat
  - Limited by resolution
  - Availability
  - Processing requirements
- High-resolution satellite imagery available since late 1990s
  - Dramatic increase in usable resolution
  - Taskable
  - Generic file formats
- Two case studies using high-resolution imagery to map riparian features for habitat monitoring and wildlife management
  - Monument Creek (USAFA, El Paso County, Colorado)
  - St Vrain Creek (City of Longmont, Boulder and Weld Counties, Colorado)

# Specifications

- LandSat
  - 30 m spatial resolution
  - 7 bands of visible and infrared spectrum information
  - Program currently on hold
- Space Imaging Ikonos
  - 4 meter multispectral / 1 meter panchromatic spatial resolution
  - 3 bands of visible and 1 band of near-infrared spectral information
- Digital Globe Quickbird
  - 2.3 meter multispectral / 0.6 meter panchromatic spatial resolution
  - 3 bands of visible and 1 band of near-infrared spectral information

# LandSat TM v. Ikonos (W Monument Cr)

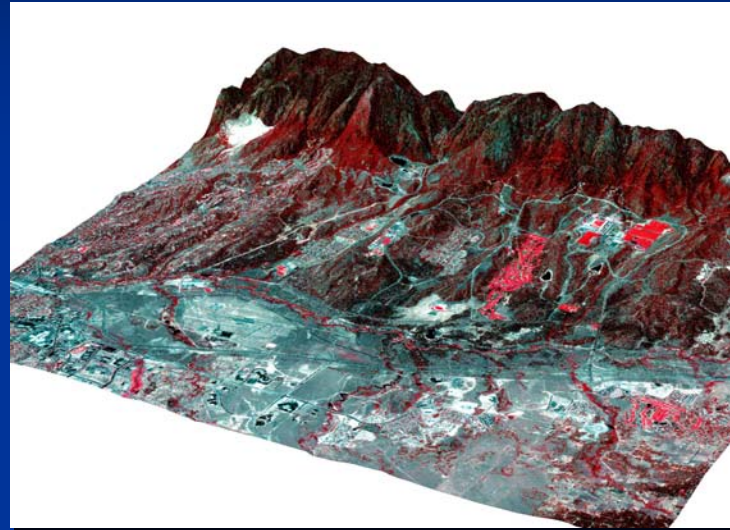


# Analytical Techniques

- Manual delineation
- Unsupervised classification
- Supervised classification
- Feature extraction
- Segmentation

# Monument Creek

- Space Imaging Ikonos imagery acquired (July 2003) to develop landscape-scale monitoring protocol for Preble's meadow jumping mouse (*Zapus hudsonius preblei*)
- Part of habitat monitoring protocols written by Bear Canyon Consulting, LLC (Boulder, CO) for the United States Air Force Academy
- See [www.bear-canyon.com/monitoringprotocol.htm](http://www.bear-canyon.com/monitoringprotocol.htm)

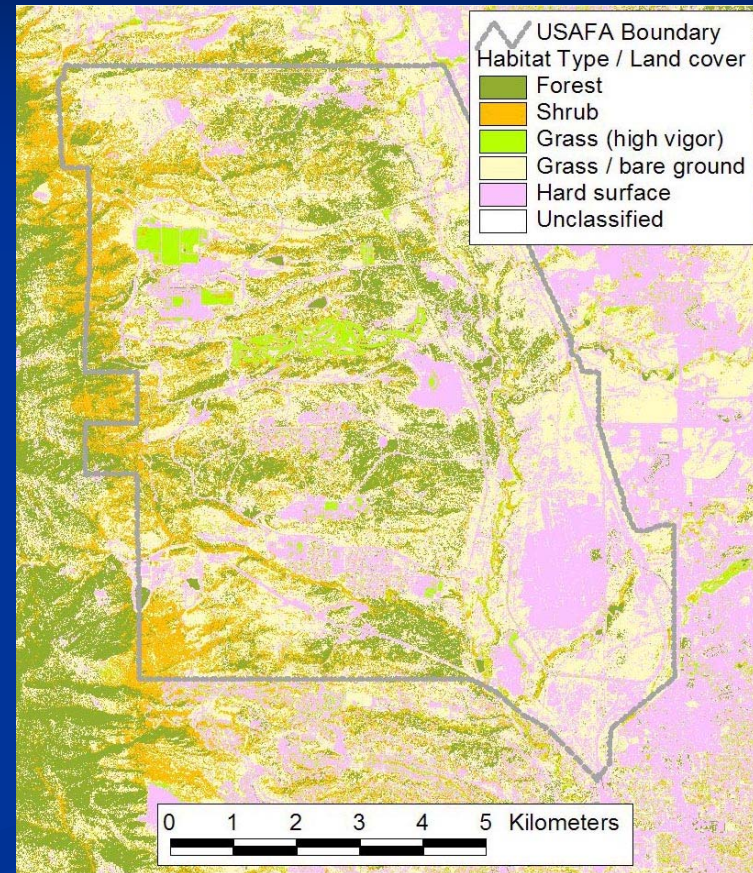


# Approach

- Land cover characterization
- NDVI values
- Landscape configuration metrics

# Land Cover Characterization

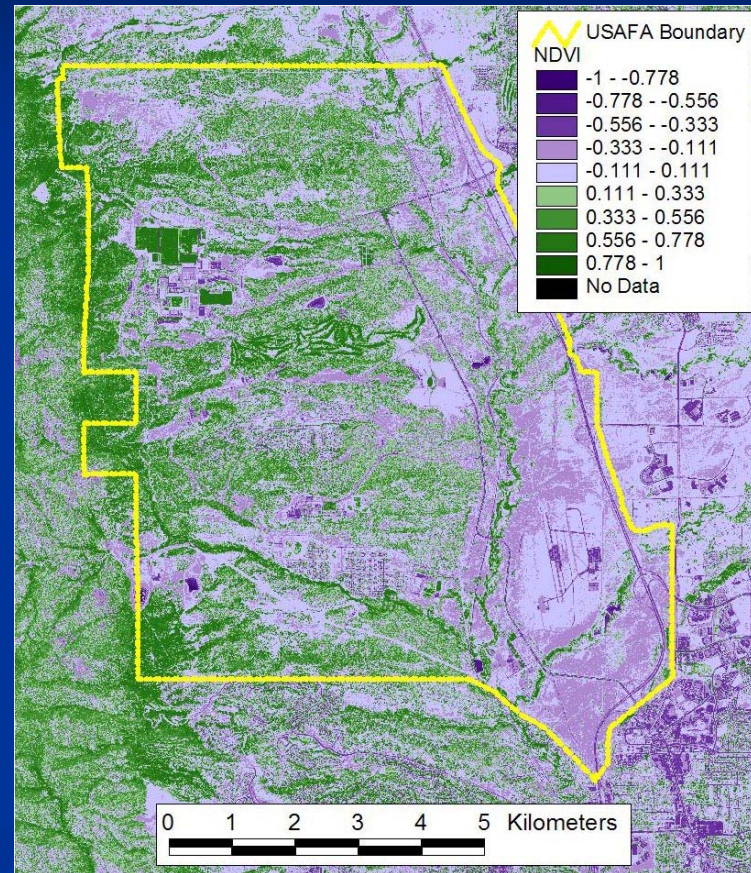
- Unsupervised classification
- Limited ground truthing
- Coarse habitat map derived from groups land cover classes



# NDVI

- Normalized Difference Vegetative Index values calculated from imagery:

$$\text{NDVI} = (\text{IR} - \text{R}) / (\text{IR} + \text{R})$$



# Landscape Configuration Metrics

- Habitat patch metrics calculated using Patch Analyst (FRAGSTATS):
  - Patch number
  - Patch size
  - Edge density
  - Patch complexity
  - Adjacency

The screenshot shows the 'Statistics for USAFA PMJM Monitoring' dialog box. The 'Themes' dropdown is set to 'Habitat Type / Land cover'. The 'Class' dropdown is set to 'Class\_names'. The 'Analyze By' section has 'Landscape' unchecked and 'Class' checked. The 'Output Table Name' is 'Spatial Statistics Output'. The 'Append' and 'Overwrite' options are both checked. The 'Class Area' section has 'Class Area' and 'Total Landscape Area' checked. The 'Patch Density & Size Metrics' section has 'No. of Patches', 'Mean Patch Size', and 'Patch Size Coefficient of Variance' checked. The 'Edge Metrics' section has 'Total Edge' and 'Edge Density' checked. The 'Shape Metrics' section has 'Mean Shape Index', 'Area Weighted Mean Shape Index', 'Mean Patch Fractal Dimension', and 'Area Weighted Mean Patch Fractal Dimension' checked. The 'Core Area Metrics' section has 'Total Core Area', 'Core Area Density', 'Mean Core Area', 'Core Area Standard Deviation', 'Core Area Coefficient of Variation', and 'Total Core Area Index' checked. The 'Diversity and Interspersion Metrics' section has 'Mean Nearest Neighbour Distance', 'Mean Proximity Index', and 'Interspersion Juxtaposition Index' checked. The 'Additional Class Metrics' section has 'Additional Class Metrics' checked. The 'Verbose error tracking messages' checkbox is also checked. At the bottom, there are buttons for 'Select Basic', 'Select None', 'Select All', 'Cancel', 'Batch', and 'OK'.

# Results

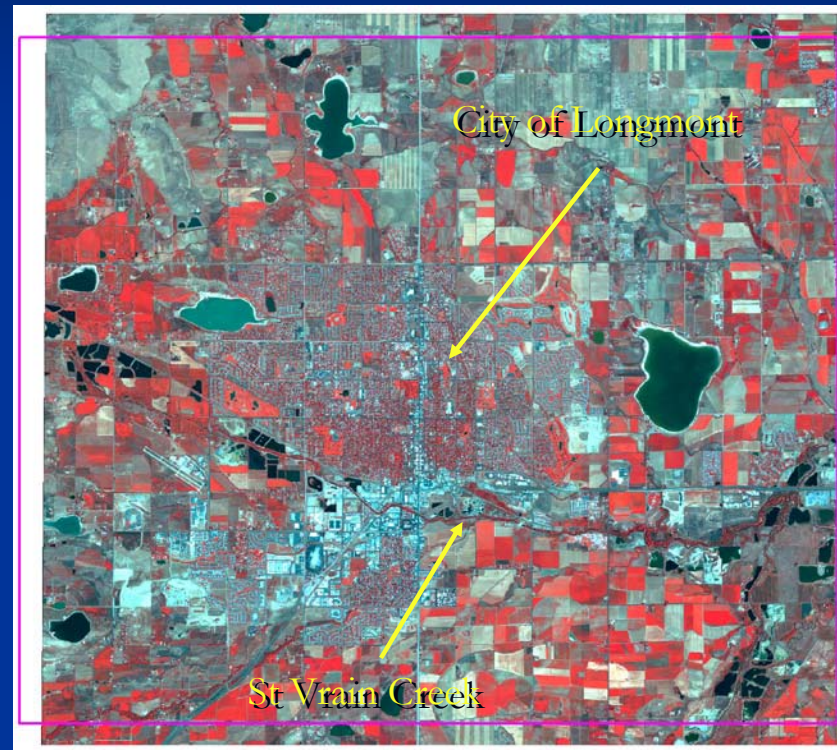
- Establishment of baseline condition of riparian habitat
- Revisit every 2 to 5 years
- Eventual development of change thresholds (*e.g.*, using Kappa statistics) to inform habitat management and planning

# Discussion

- Fine-grain habitat map effectively shows subtle habitat variation (not possible using LandSat data)
- Fine spatial resolution allows for shorter revisit period
- Attention need to ensure subsequent data are ecologically comparable (seasonal, climatic variability, etc.)
- Patch Analyst not fully calibrated for use with high-resolution imagery, subtle variation difficult to quantify

# St Vrain Creek

- Digital Globe Quickbird acquired (August 2002) for St Vrain Creek / Longmont area to develop habitat map for City of Longmont Wildlife Management Plan (Open Space and Trails, currently ongoing)
- Riparian areas (St Vrain, Left Hand and Boulder Creeks, irrigation ditches) provide important habitat for Bald Eagle, PMJM, several native non-game fishes; corridors, community separators, viewshed and recreation



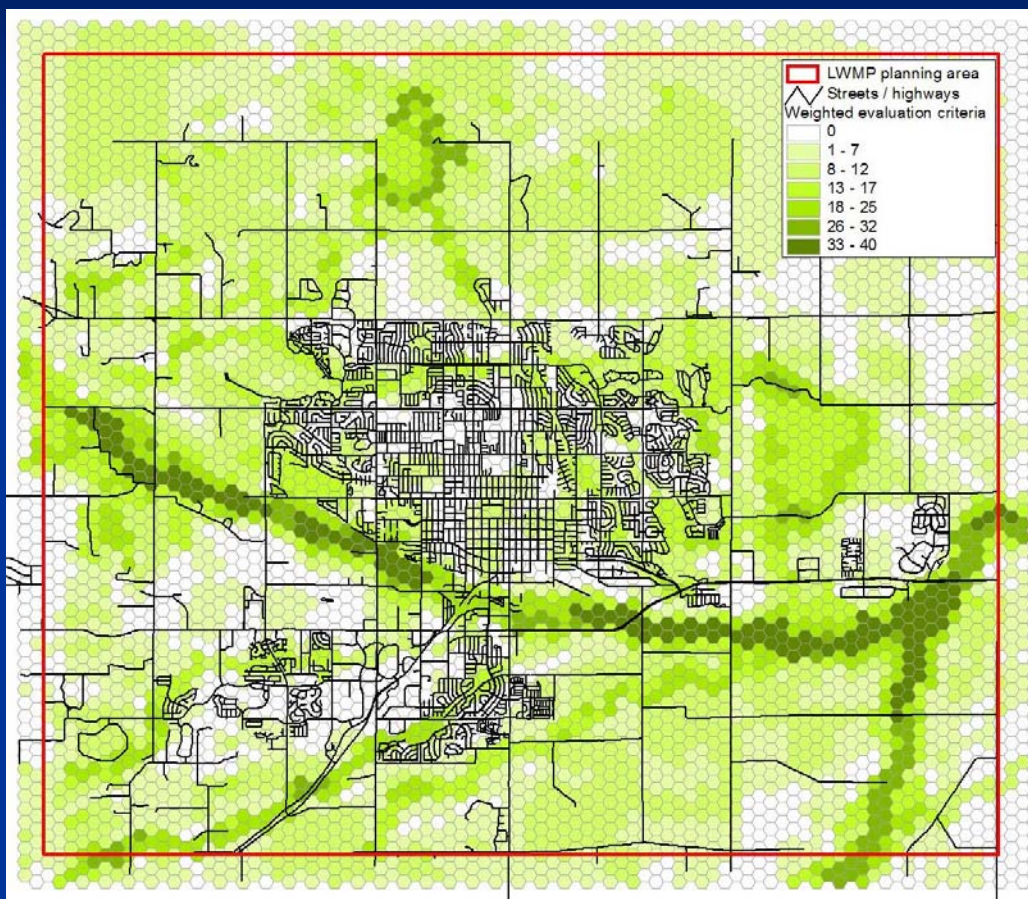
# Approach

- Unsupervised and supervised methods used to derive initial land cover classification
- Rules-based GIS analysis performed to refine classification based on proximity and size
- Land cover classes grouped into habitat types established by CDOW
- Habitat types weighted based on CDOW information and public meetings

# Results

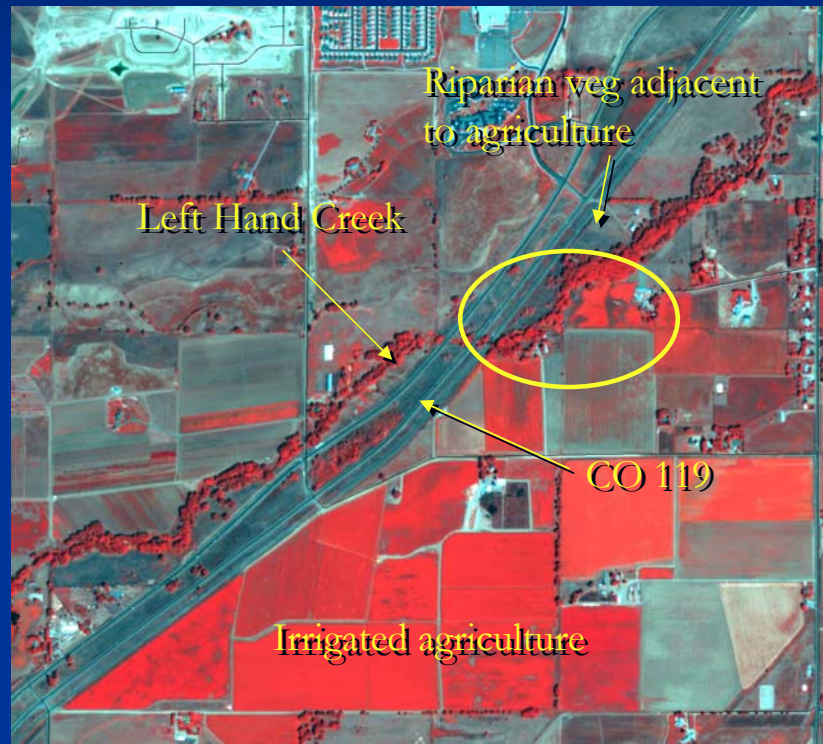
- Project area predominantly agriculture
- 2% (approximately 350 ha) classified as riparian habitat
- Habitat map used to:
  - Inform management strategies (including restoration opportunities and identify fragment corridors)
  - Develop acquisition priorities based on high value habitat (i.e., riparian), proximity to other open spaces, patch size, etc.

# Habitat Priorities



# Discussion

- Analysis hampered by:
  - Acquisition period (late summer of peak drought year)
  - Limited spectral information made distinguishing some habitat types difficult (*e.g.*, riparian vegetation adjacent to irrigated agriculture)
  - Size of resulting GIS dataset (1.6 million polygons)
- Analysis currently be re-run using segmentation software in test environment
- Resulting habitat map still useful for developing management strategies and acquisition priorities



# Conclusions

- High-resolution satellite imagery allows riparian habitat to be mapped at finer scales
- Additional opportunities for habitat monitoring and quantifying landscape configuration
- Some methods and tools not fully calibrated for use with high-resolution data
- New analytical methods (*e.g.*, feature extraction and segmentation) may provide even greater accuracy and speed

# Resources

- Walsh Environmental, LLC (GIS, remote sensing and ecological services, high-resolution imagery reseller) – 303.443.3282
- ESRI (GIS software) – [www.esri.com](http://www.esri.com)
- Patch Analyst (Patch Metrics)-  
[flash.lakeheadu.ca/~rrempel/patch/](http://flash.lakeheadu.ca/~rrempel/patch/)
- FRAGSTATS -  
[www.umass.edu/landeco/research/fragstats/fragstats.html](http://www.umass.edu/landeco/research/fragstats/fragstats.html)
- eCognition (Segmentation Analysis)- [www.definiens-imaging.com/](http://www.definiens-imaging.com/)
- Feature Analyst (Feature Extraction)- [www.featureanalyst.com/](http://www.featureanalyst.com/)