Development of a Protocol to Classify and Map *Phragmites australis* in Tidal Marshes of the Lower Connecticut River Using Satellite Multi-spectral Imagery

Emily Hoffhine Wilson emily.wilson@uconn.edu
Center for Land Use Education and Research
Department of Extension, College of Ag. and Natural Resources
University of Connecticut

Marty Gilmore, *Wesleyan University*
Sandy Prisloe, *University of Connecticut*
Cary Chadwick, *University of Connecticut*
Nels Barrett, *USDA Natural Resources Conservation Service*
Bill Moorhead, *Consulting Ecologist*
Dan Civco, *University of Connecticut*
James Hurd, *University of Connecticut*

The Need to Map and Monitor

Phragmites australis has been and continues to be treated on many Connecticut marshes. It is difficult and time consuming to monitor the results of different *P. australis* treatments over large areas. Aerial imagery and mapping is perfectly suited to monitor *P. australis* over time and answer questions, such as:

- Where has *P. australis* been eradicated?
- How much area has been treated?
- Where does *P. australis* still grow?
- Is *P. australis* reinvading areas?

Objectives

- Identify and map *Phragmites australis* through time using:
  - o Field Spectroscopy
  - o Multi-spectral high-resolution imagery
    - Quickbird satellite imagery 2.5m resolution
    - ADS40 airborne imagery 0.5m resolution
  - o Lidar data
- Verify the map with detailed floristic inventory
- Map other tidal marsh plant communities as possible

Methods

1. Field Plant Reflectance

A **portable spectrometer** was used to measure the energy reflected from a variety of plant species at different times during the growing season.

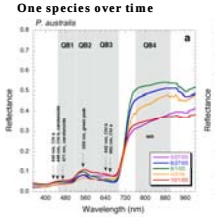
Dr. Marty Gilmore, Wesleyan, collecting *in situ* spectra of the previous year's *Typha sp.* using a portable spectrometer at the study site in Old Saybrook, CT in May 2004.

2. Field Plant Reflectance + Satellite Image Reflectance

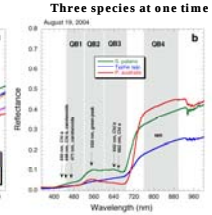
The portable spectrometer measures the reflectance of each species at every wavelength (colored lines).

The spectra were averaged to match the spectral characteristics of the four bands of a Quickbird satellite image (grey).

Reflectance: One species over time

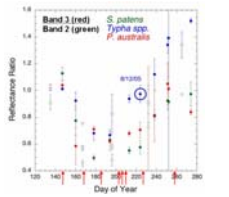


Reflectance: Three species at one time

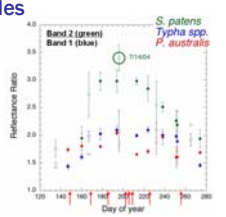


3. Classification Rules

Field spectra were processed and compared over the growing season. The time of year and rule that best identified each species was revealed.

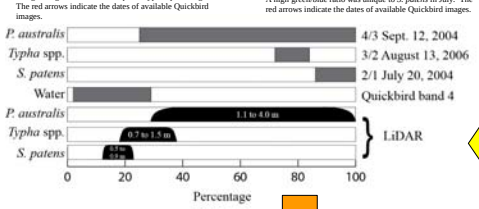


A high red/green ratio was unique to *Typha sp.* in August. The red arrows indicate the dates of available Quickbird images.



A high green/blue ratio was unique to *S. patens* in July. The red arrows indicate the dates of available Quickbird images.

The bar graph (right) summarizes all rules used in the image classificatio n.

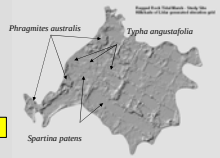


Quickbird Satellite Images

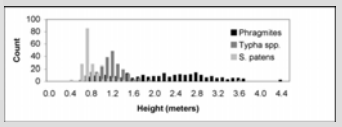
Nine Quickbird images were captured over the growing season. Five were used in image classification because plants and their reflectance change over the warm months.

	Day
May	27 2004
June	2 2004, 17 2004
July	2 2004, 20 2004, 23 2004, 31 2004
August	13 2004
Sept.	12 2004

Elevation

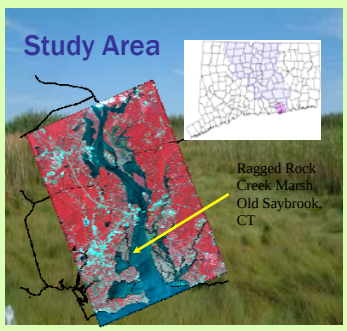


The major communities on Ragged Rock Creek marsh have very different heights. LiDAR elevation data contributed to the species separation.

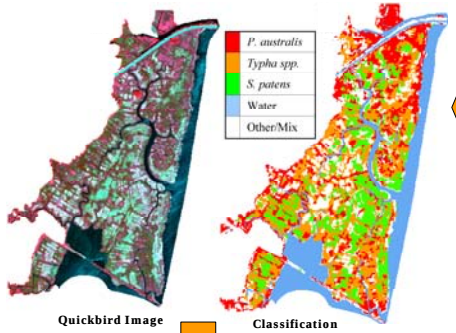


LiDAR (Light Detection and Ranging) is a method of acquiring elevation data that uses a laser onboard an airplane.

Study Area



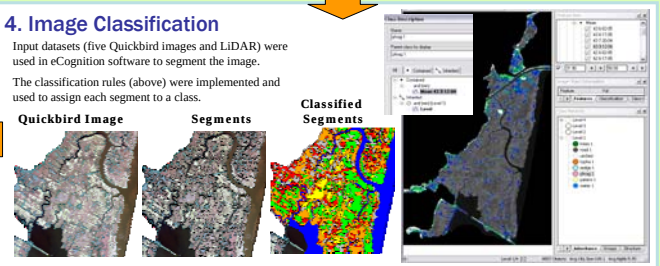
5. Classification Results



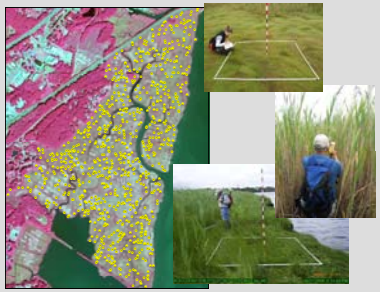
4. Image Classification

Input datasets (five Quickbird images and LiDAR) were used in eCognition software to segment the image.

The classification rules (above) were implemented and used to assign each segment to a class.



Field Work



A floristic inventory was conducted during the summer of 2006 to establish validation data for the image classification. A set of 1,000 randomly distributed point locations was generated. At each location 4 m2 quadrats were placed, plant community composition and species abundance were recorded and a GPS coordinate was recorded. In total, 917 unique vegetation plots were recorded.

For the purposes of accuracy assessment, all points were assigned to one of five dominant classes: *P. australis*, *Typha* spp., *S. patens*, Water, and Other/mixed to correlate with the classification.

6. Accuracy Assessment

Map label	Sites	Technical evaluation of matches (ground data) MAX (M)		RIGHT (R)		Improvement (R-M)		Area weights
Phragmites	68	66	(97.1%)	66	(97.1%)	0	(0.0%)	0.24130
Typha	157	99	(63.1%)	119	(75.8%)	20	(12.7%)	0.35783
S. patens	90	72	(80.0%)	83	(92.2%)	11	(12.2%)	0.21994
Other/Mix	64	46	(71.9%)	64	(100.0%)	18	(28.1%)	0.18093
Total	379	283	(74.7%)	332	(87.6%)	49	(12.4%)	1
Weighted total			(76.5%)		(88.8%)		(12.3%)	

Area weights were determined by the contributing areal proportion of the map label categories.

A fuzzy accuracy method accounts for the fact that, in the real world, vegetation types exist together in varying amounts.

The table shows the frequency of correct matches for all map label categories based on two fuzzy operator choices:
best choice, MAX (M) and acceptable choice RIGHT (R). The overall accuracy of all map labels, *i.e.*, the entire map, is given as the total.

Conclusions

- Phenology of major marsh species, including *P. australis*, results in distinct spectral signatures. *P. australis* is most distinct in late summer. *S. patens* and *Typha spp.*, are most distinct in midsummer.
- Classification of marsh species in Ragged Rock yields 67 - 83% accuracy.

Next Steps

- Write "recipe" for mapping vegetation using minimal datasets and generic rules.
- Apply the method to other marshes and assess accuracy.
- Test how much LiDAR contributed to the classification and results.
- Use results for baseline monitoring of restoration efforts.

These ventures require new funding.

Funding

Portions of this project funded by the EPA Long Island Sound Study, National Oceanic and Atmospheric Association (NOAA) Coastal Services Center, DEP License Plate Fund, National Aeronautics and Space Administration (NASA) and the Institute for Applied Geospatial Technology (IAGT).