Improved Seagrass Change Detection Using Linear Spectral Unmixing

Amy V. Uhrin

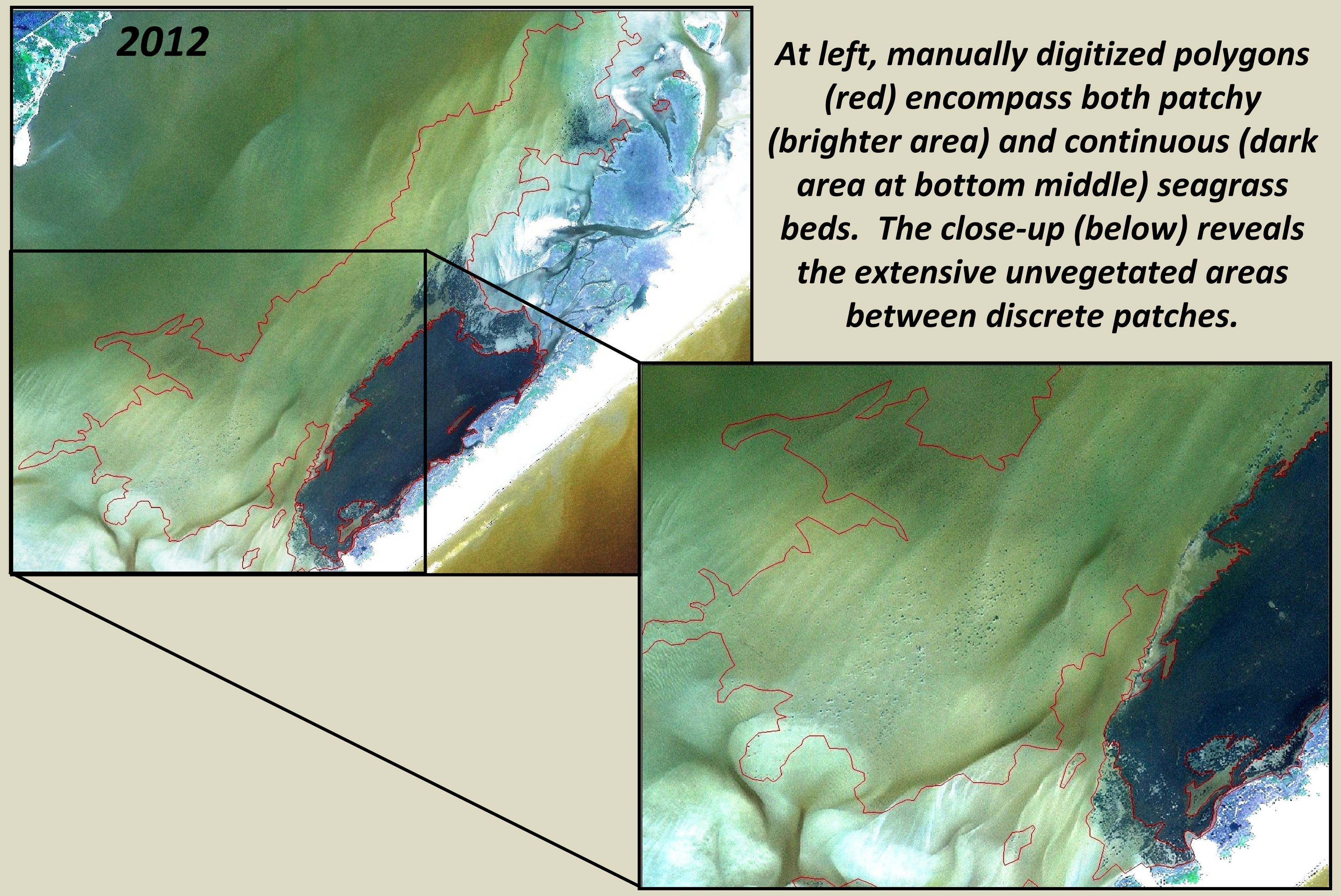
National Oceanic and Atmospheric Administration, Center for Coastal Fisheries and Habitat Research, Beaufort, NC USA

University of Wisconsin Madison, Department of Zoology, Madison , WI USA

Juvenile bay scallops attach themselves to the upper portions of eelgrass blades to escape predators (left). Eelgrass provides habitat for the winter flounder (right).

THE ISSUE

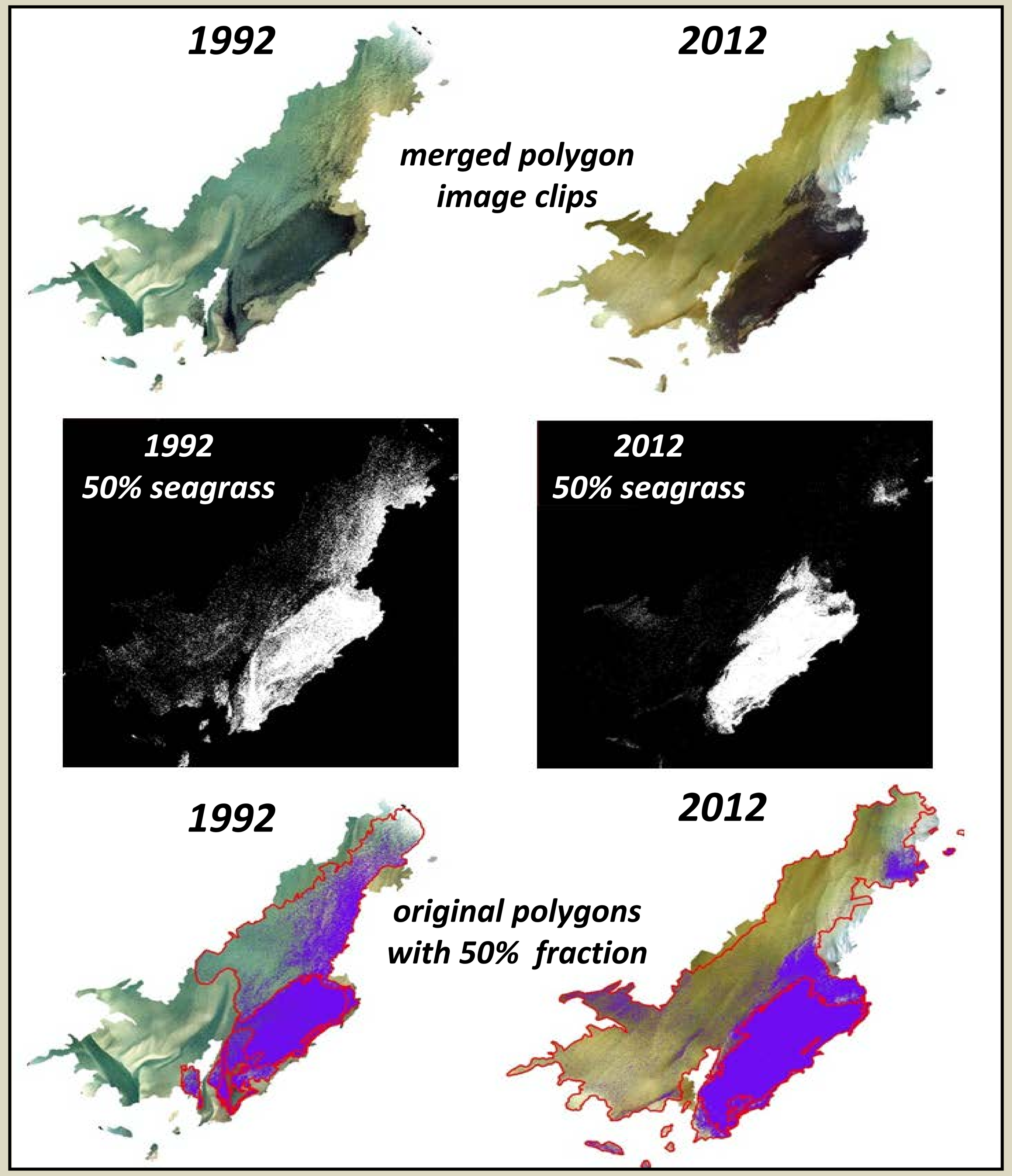
- Seagrasses (marine angiosperms) provide habitat, refuge, and foraging grounds for many important commercial fishery species
- Seagrass beds in North Carolina range from continuous meadows of tens of thousands of square meters to patchy mounds ≤ 1 meter across
- Small patches often go undetected when low resolution (30 m) imagery is used for mapping; therefore, visual interpretation (manual digitization) of high resolution aerial photos is the most widely-adopted approach
- Manual digitization often includes unvegetated gaps, overestimating seagrass acreage and skewing results of change analysis
- The goal is to demonstrate inherent differences between change analysis conducted using visual interpretation versus subpixel classification and implications for resource management



At left, manually digitized polygons (red) encompass both patchy (brighter area) and continuous (dark area at bottom middle) seagrass beds. The close-up (below) reveals the extensive unvegetated areas between discrete patches.

METHODS

- Using established protocols, manual digitization of seagrass beds was performed within identical 8 km² areas of Core Sound, North Carolina from two high resolution R G B images: a 1992 aerial photo (1.4 m) and a 2012 WorldView-1 image (2.4 m)
- Digitized polygons for each year were merged into one feature and images were clipped to the boundaries of said feature to facilitate comparisons
- Linear Spectral Unmixing (LSU) is an ENVI® classifier that relies on a user-defined training set of image components called endmembers
- LSU calculates the fraction of each endmember in each pixel of the image and outputs an individual fraction plane for each endmember
- LSU was applied to clipped images using defined endmembers of sand, deep water channel, and seagrass
- Initial comparisons were made using only the 50% seagrass fraction plane



For each year, the merged polygon image clip (top) and 50% seagrass fraction plane (middle) are shown. At the bottom, image clips are overlain with the 50% seagrass fraction plane (purple) and the original mapped polygon for each year (red line).

RESULTS

Method	1992 Seagrass areal extent (hectares)	2012 Seagrass areal extent (hectares)
Manual digitization	253.1	428.2
Linear Spectral Unmixing	128.6	125.2
Difference	124.5	303.0
% of digitized polygon classified as seagrass by LSU	50.8%	29.2%

- Error matrices produced overall accuracies for LSU of 72% and 71% for the 1992 and 2012 images, respectively
- LSU discriminated seagrass from sand
  - In 1992, 50.8% of the manually digitized polygon was actually seagrass
  - In 2012, 29.2% of the manually digitized polygon was actually seagrass
- LSU gave a more precise estimate of seagrass change
  - Visual interpretation indicated a 69.2% increase from 1992 to 2012
  - LSU eliminated non-seagrass areas and revealed a 2.6% decrease

CONCLUSIONS

- LSU can be readily applied to aerial photos as well as high resolution satellite imagery for classification of seagrass in shallow, coastal waters of North Carolina
- LSU can improve seagrass maps providing fisheries managers with more realistic representations of seagrass extent and acreage available for use by commercial species
- A distinct advantage of LSU is the ability to identify subtle differences in landscape composition, common in shallow water benthic habitats, through quantitative classification of pixels as proportions of representative image endmembers
- LSU may be useful in other systems where landscapes are composed of a mixture of highly contrasted cover types or cover types having sparse representation

Acknowledgments

I thank X. Liu, M. Ozdogan, R. Phetteplace, B. Spaier, and P. Townsend for helpful discussion and technical assistance. This work also benefited from discussions with fellow classmates in the Remote Sensing of Ecosystems and Digital Image Processing courses at UW Madison. I appreciate comments from P. Blank, E. Erdmann, M. Fonseca, M. Gooch, R. Graves, B. Harvey, J. Qiu, M. Turner, and T. Whitby. Direct support provided by UW Madison and the NOAA National Centers for Coastal Ocean Science. Presented at the 98th Annual Meeting of the Ecological Society of America, held August 4-9, 2013, Minneapolis MN, USA with travel support provided by the Department of Zoology, UW Madison John Jefferson Davis Travel Award. The views expressed here do not necessarily reflect those of NOAA.