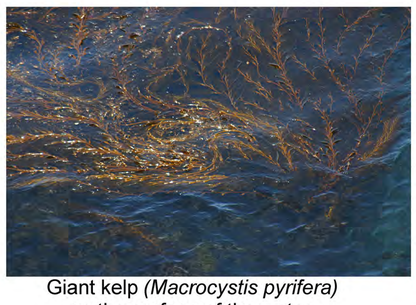
USING GEOGRAPHIC INFORMATION SYSTEMS (GIS) TO ANALYZE KELP FLUCTUATIONS IN THE MONTEREY BAY NATIONAL MARINE SANCTUARY

Maria H. Osiadacz[1], Arlene A. Guest[2] and Sophie DeBeukelaer[3]

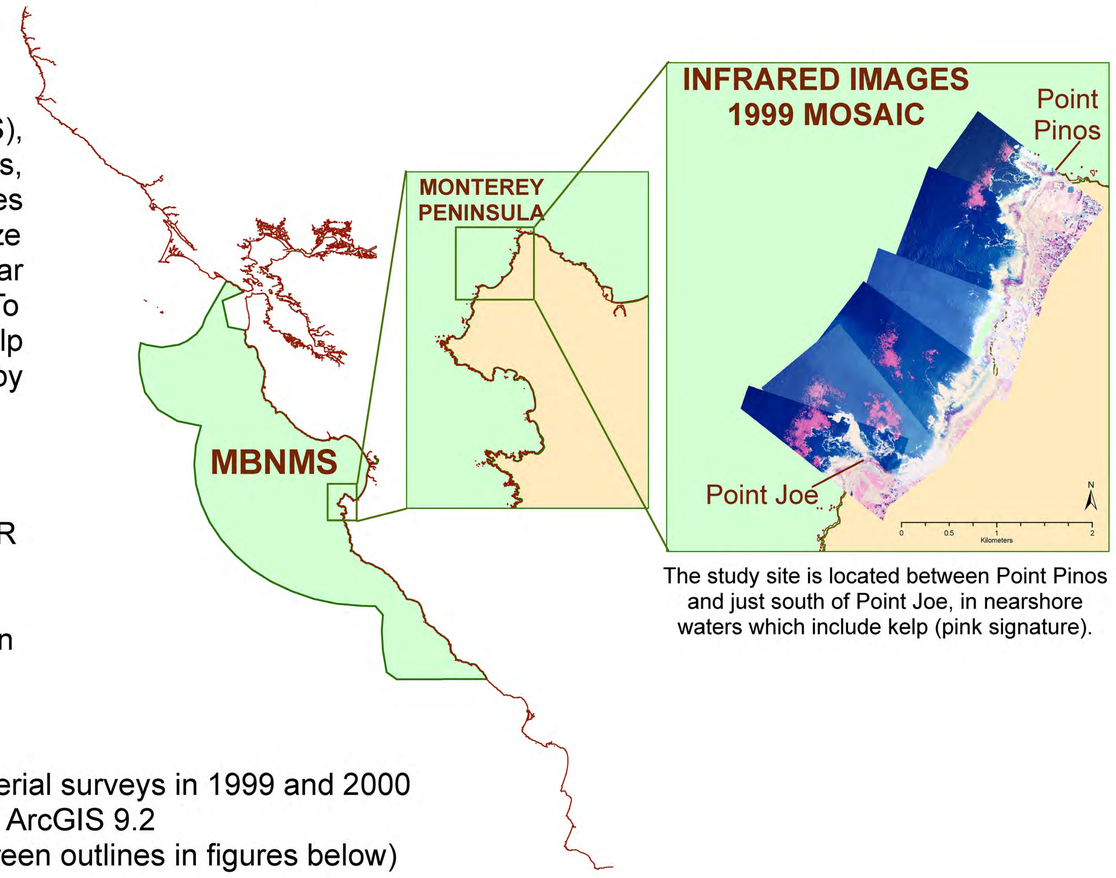
1. Monterey Peninsula College, 2. Naval Postgraduate School, 3. Monterey Bay National Marine Sanctuary



Giant kelp *(Macrocystis pyrifera)* on the surface of the water
Josh Pederson / SIMoN NOAA

INTRODUCTION

The Monterey Bay National Marine Sanctuary (MBNMS), one of the world's most productive marine ecosystems, supports extensive kelp forests. Kelp surface canopies are present along almost the entire sanctuary, but the size and diversity of these resources vary from year to year due to a variety of complex environmental influences. To reduce negative impacts and help manage kelp ecosystems, it is necessary to accurately assess canopy coverage in large areas over long periods of time.



The study site is located between Point Pinos and just south of Point Joe, in nearshore waters which include kelp (pink signature).

QUESTION

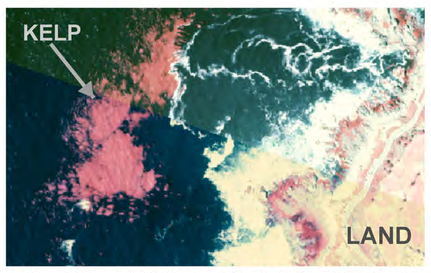
Which GIS analytical software is the most effective at extracting kelp signatures from IR images, and can canopy change be detected over time?

A combination of ESRI ArcGIS and an enhanced feature extraction software can accurately determine kelp coverage and detect change.

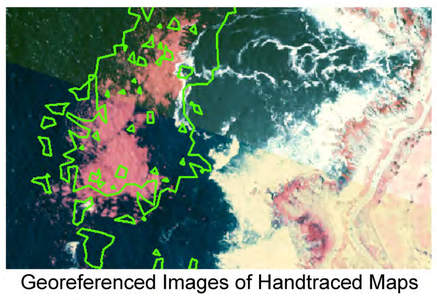
METHODS

1. Over 1000 digital infrared (IR) images of coastal kelp resources were taken during aerial surveys in 1999 and 2000
2. Images within the study site were georeferenced, rectified, trimmed and mosaiced in ArcGIS 9.2
3. The kelp signature was extracted using various analytical software packages (see green outlines in figures below)

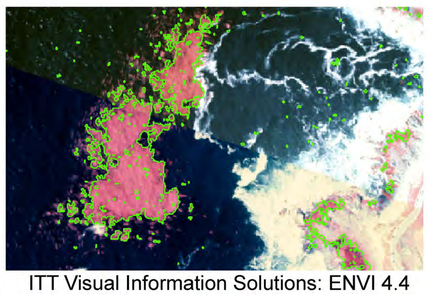
RESULTS



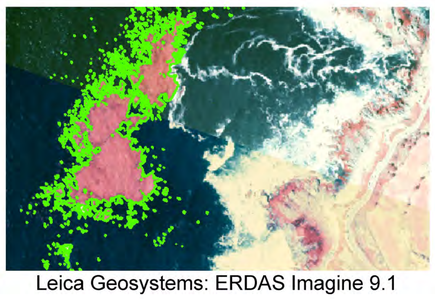
Section of 1999 Mosaic: Before Extraction



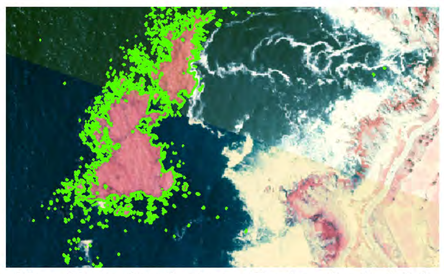
Georeferenced Images of Handtraced Maps



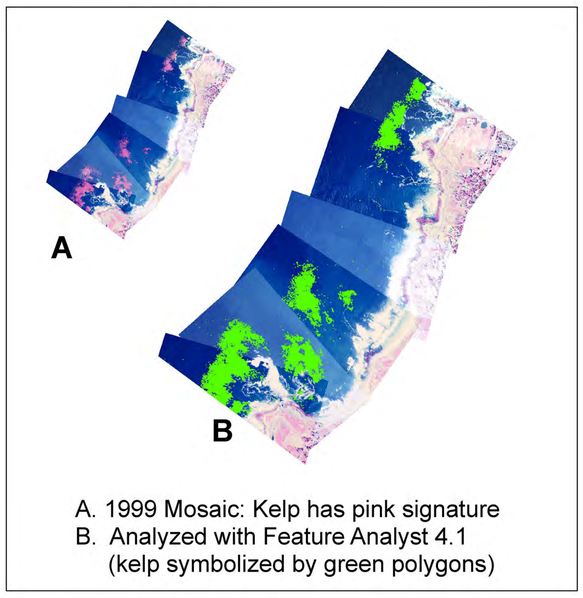
ITT Visual Information Solutions: ENVI 4.4



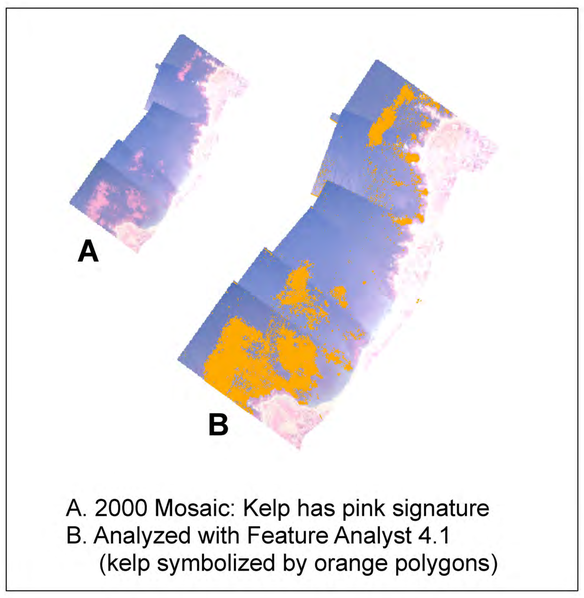
Leica Geosystems: ERDAS Imagine 9.1



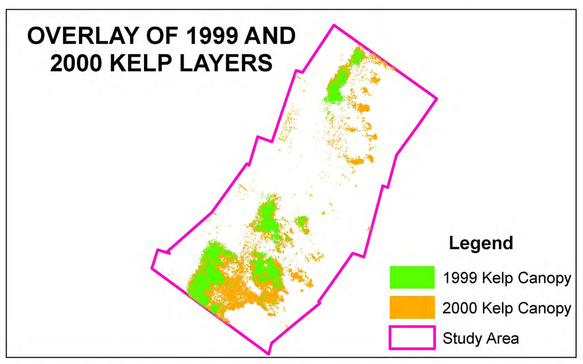
Visual Learning Systems: Feature Analyst 4.1

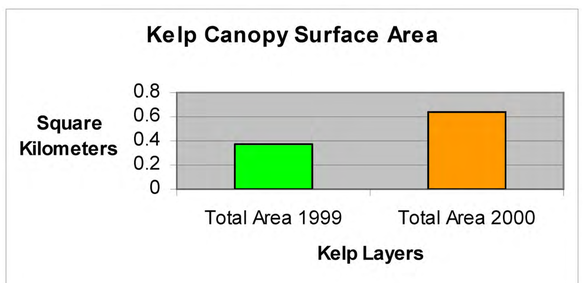


A. 1999 Mosaic: Kelp has pink signature
B. Analyzed with Feature Analyst 4.1 (kelp symbolized by green polygons)



A. 2000 Mosaic: Kelp has pink signature
B. Analyzed with Feature Analyst 4.1 (kelp symbolized by orange polygons)





Using Feature Anlayst, we found that the kelp bed area measurements showed ~72% increase in the canopy area from 1999 to 2000. Kelp extraction results by Feature Analyst and ERDAS Imagine were very similar but the resulting layers will need to be cleaned using an editing function. Feature Analyst software offers the novice user access to a powerful toolset but the extraction process was quite time-consuming. In contrast, building a model with criteria in ERDAS or ENVI provided more time-efficient results but lend themselves more to experienced GIS users.

DISCUSSION

Using sophisticated software to extract kelp signatures from the aerial images provided a more accurate result than the original hand digitizing method. All software required a significant learning period so that what the eye sees can be translated to an efficient computerized process. Other algae and seagrasses in the intertidal zone have the same IR signatures as giant and bull kelp so the final kelp layer will include all near and offshore vegetation.

FUTURE APPLICATIONS

The final kelp GIS layers can be used to futher develop the persistence and total extent kelp layers processed by other agencies. They can also be integrated with other GIS layers to explore biological, chemical and physical factors that impact kelp resource fluctuations. In addition, this analysis can offer a historical perspective that will help examine the effects of human induced climate change on kelp forests and provide a baseline for research in the newly adopted state Marine Protected Areas.

BIBLIOGRAPHY

"Ocean Archive System Accessions Detail for accessions_id 02429." National Oceanographic Data Center. 14 February 2008 <http://www.nodc.noaa.gov/archive/arc0013/0002429/01-version/data/0-data/>.

Rutz, Steven, Janice Beattie and Jan Roletto. "Task Order #L-24 for the Climate Database Modernization Program Contractor." California Coastal Marine Ecosystems Surveys—Slide Imaging and Archiving. 7 April 2005.

Van Wagenen, Robert F. California Coastal Kelp Resources Monterey Bay National Marine Sanctuary Summer 1999 and 2000 Final Reports. Fremont, CA: Ecoscan Resource Data, 28 February 2001.

ACKNOWLEDGEMENTS

Many thanks go out to Jamie Kum for his advice on using analytical software. We are also grateful to ITT Visual Information Solutions, Leica Geosystems and Visual Learning Systems for providing software evaluation licenses and for their invaluable and extensive technical assistance.