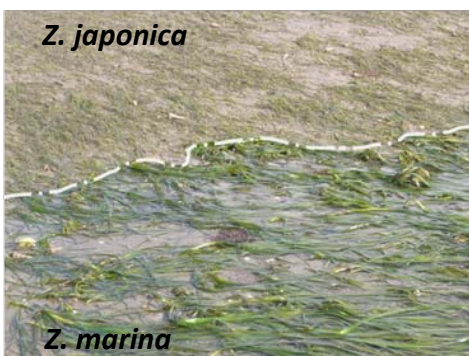


Predicting an Invasive Species' Distribution with LiDAR-derived Topography

Background Topography can influence the distribution of plants on the scale of kilometers (Whittaker, 1956), and on the scale of centimeters (Harper, 1965). Environmental gradients associated with elevation are particularly strong in nearshore environments, making them useful model ecosystems that have yielded important advances in ecological theory (Little, 1996). Here, elevational differences of even centimeters in elevation can lead to considerably different physical exposures, and thus exert great influence upon community composition (Doty, 1946, Lebednik, 1973).

Thought to have been introduced to North America in the 1950s, the asian seagrass *Zostera japonica*, now ranges from British Columbia to Northern California. A congener of the native *Z. marina*, the invasive *Z. japonica* typically lives higher in then intertidal than the native seagrass (Shafer, 2007), but the two species occur in mixed stands at Padilla Bay (Bulthuis, 1995) and other broad shallow sites in the region (Shafer, 2007). Within portions of Padilla Bay, the two species form a patchy mosaic, with *Z. marina* appearing to be limited to shallow pools, and *Z. japonica* limited to hummocks (Shafer, 2007). Here, the ability to accurately and extensively measure microtopography and its changes through time could afford important insights into the distribution of these two species.



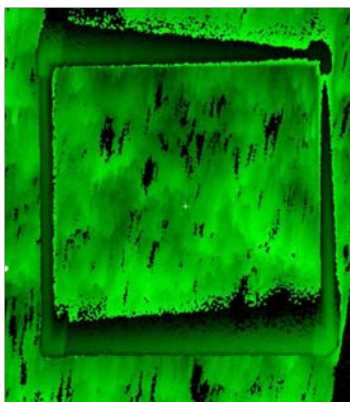
Sharp ecotone between native *Z. marina* and invasive *Z. japonica*.

A Traditional Approach

During the Summer of 2008, we used traditional surveying techniques to quantify this pattern at radomly selected sample locations. Using a survey level and stadia rod, we recorded the elevation of each sample site, as well as the elevation at every meter for 6 meters along a transect perpendicular to shore. From the transect data, I calculated a topographic index: the

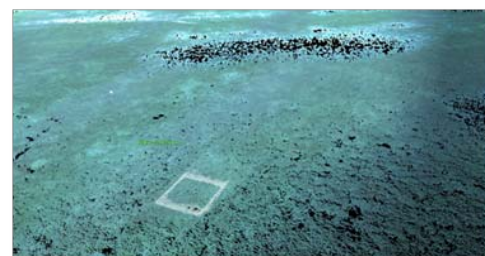
difference between quadrat elevation and the mean of the 12 transect elevation measurements.

This 2-dimensional index proved a significant predictor of species presence for both species, but it's descriptive power was lo ($R^2=.24$), due probably to the limitations of it's 2-dimensional nature and inability to address multiple scales of pattern. Traditional survey techniques are too time consuming to allow collection of data with fine grain and large extent.

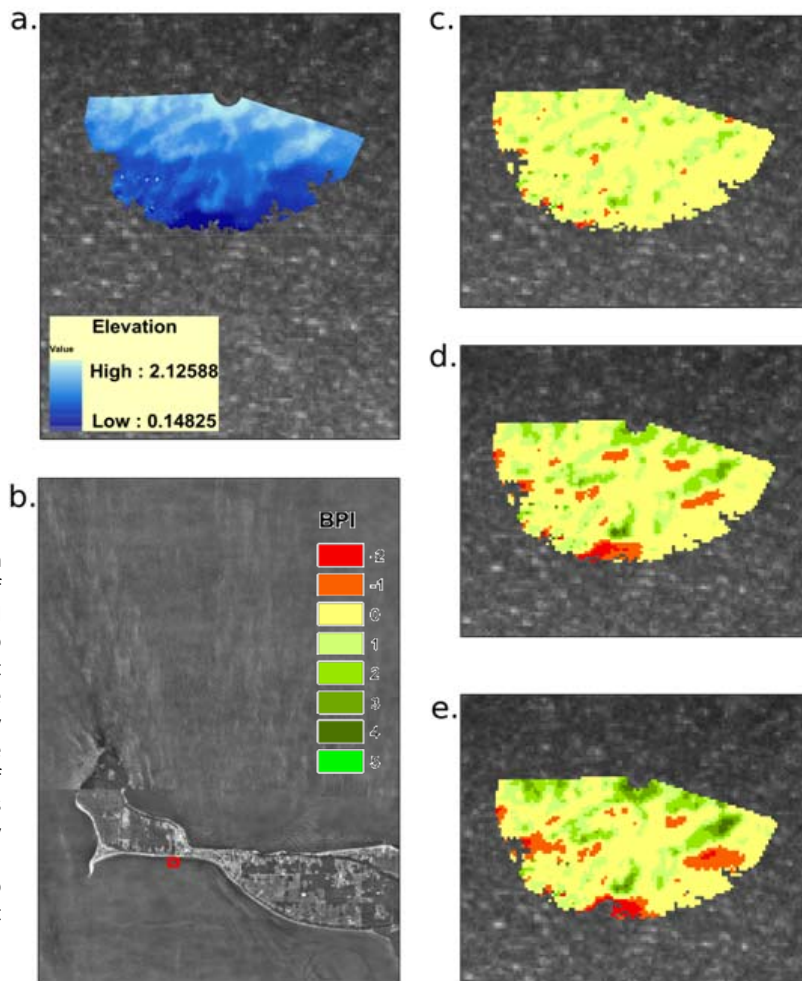


LiDAR scan of a .5m x .5m quadrat lying on *Z. japonica*. LiDAR returns colored according to elevation.

LiDAR's Promise Ground-based LiDAR scanners are tripod mounted instruments that can be operated by a few people, cost less to deploy than airborne LiDAR, and resolve sub-centimeter scale structure. We've developed techniques that allow us to successfully deploy this instrument in the challenging environment of soft-bottomed, intertidal, mud flats. By employing special tripod anchors, and survey-grade GPS, we can acquire and georeference high resolution, three dimensional topographic data in a dynamic environment with few stable features. These data promise more flexible and accurate description of the relationships of these two seagrasses to their physical setting, as well as the mapping and monitoring of their distribution at a site.



LiDAR scan of tideflat. LiDAR returns colored by photographic colormap (top), and elevation colormap (bottom)



THE ISSUE: Where an invasive seagrass and it's native congener co-occur, subtle microtopographic features sometimes appear to dictate species distribution. Traditional survey methods are sufficient to confirm that relationship, but suffer from limited descriptive power due to their limited scope. Terrestrial LiDAR offers a rich 3-dimensional dataset to explore these patterns.

THE KEY QUESTIONS:
Will terrestrial LiDAR offer new insights into pattern and process in the nearshore?