Decadal ecological change at Kukutali Preserve, Washington

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Introduction

Long-term research provides valuable insight into ecological processes and environmental change. Results from decadal studies are especially informative when assessing human impacts, whether direct (e.g. implementation of management strategies) or indirect (e.g. land use change, climate change). While it is not uncommon to find examples of ecological research spanning several decades in the Salish Sea (e.g. Dethier & Berry 2008), there is a lack of research examining the effects of marine protected areas (MPAs) on intertidal ecology before and after implementation (Van Cleve et al. 2009).

Fig. 1. Map of Kukutali Preserve.

Kiket Island (Fig. 1), near La Conner, WA, had historically served as an important bivalve fishing area for the Swinomish Tribe. Two decades ago, however, harvesting efforts ceased due to a change in upland ownership that effectively discouraged individuals from digging clams on the tribally-owned tidelands. Thus, Kiket Island (now known as Kukutali Preserve (KP)) became a de facto marine reserve. In order to study the long-term impacts of harvest cessation on intertidal ecology, we replicated an intertidal study that was conducted on Kiket Island from 1968 – 1970 (Houghton 1973). Our 2011 study objectives were to quantify long-term ecological change at KP and examine the potential impact of a de facto no-take marine reserve on species abundance. For this component of the project we addressed the following questions:

(1) Do commercially targeted and non-targeted species densities change by elevation and year, and

(2) Do commercially targeted and non-targeted species densities or biomass change by beach aspect (i.e. north, south) and year.

Methods

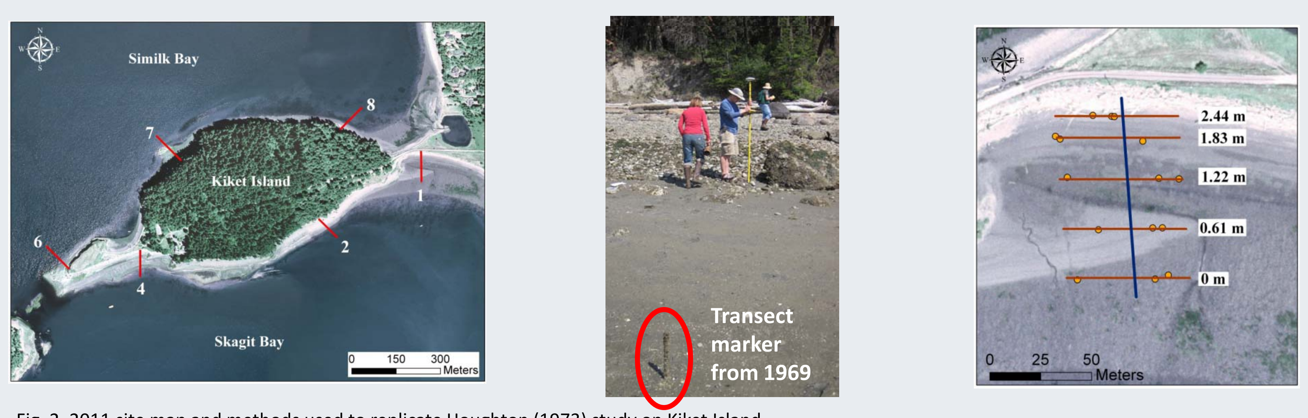


Fig. 2. 2011 site map and methods used to replicate Houghton (1973) study on Kiket Island.

Along five of the 1973 permanent transects, three samples were collected every 0.61 m from elevations -0.61 m to 2.44 m (relative to MLLW) (Fig. 2). Surficial species data (percent cover or count) were collected in 0.25 m² quadrats. Then each quadrat was dug to 30 cm and sieved through two nested screens (20 mm and 7 mm) to collect benthic species. Samples were preserved, identified, and quantified in the lab.

Our data analysis was constrained by lack of raw data from 1973 and limited sample replications in 2011. All historical data were digitized from tables and graphs in Houghton (1973). We used one- and two-factor ANOVAs for our analyses and an alpha value of 0.01 to avoid making a Type I error. For this particular analysis we used *Saxidomus gigantea* and *Leukoma staminea* as our representative "target" species (i.e. species that are targeted for harvest) and *Littorina sitkana*, *Littorina scutulata*, *Hemigrapsus nudus*, and *Hemigrapsus oregonensis* as our "non-target" species.

Results

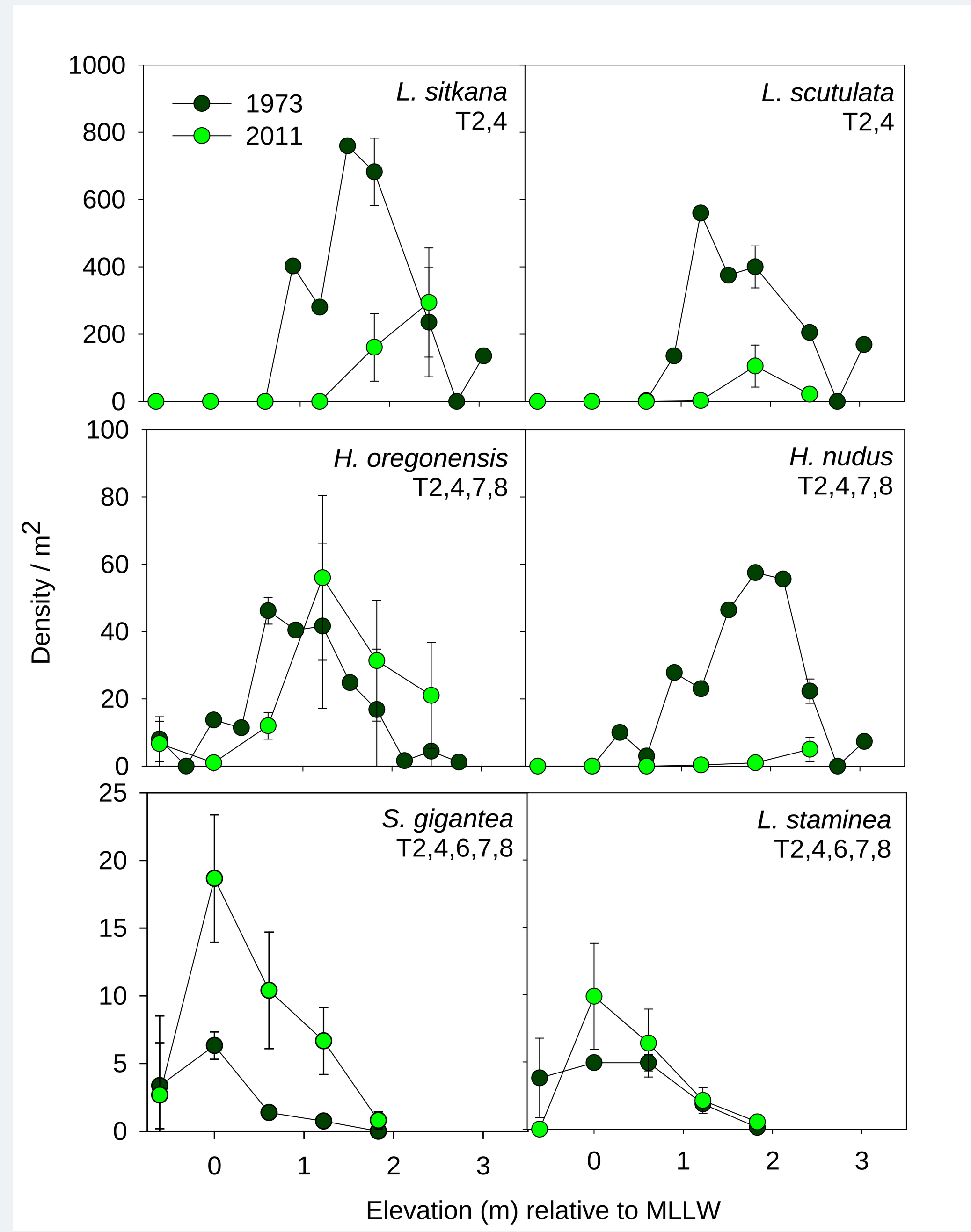


Fig. 3. 1973 and 2011 mean densities per m² across elevations. Note varying scale and number of transects.

The mean densities for *L. sitkana*, *L. scutulata*, and *H. nudus* decreased significantly by elevation, year, and the interaction of the two, while the mean density significantly increased for *S. gigantea* by elevation and year. *L. staminea* densities were only affected by elevation and there was no significant change in *H. oregonensis* (Fig. 3).

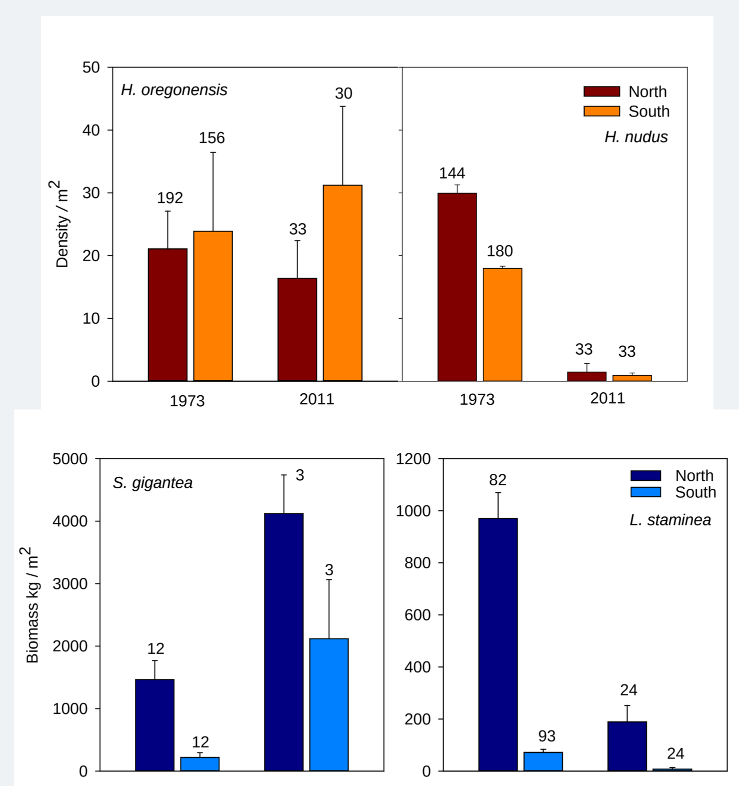


Fig. 4. 1973 and 2011 mean density per m² for *H. oregonensis* and *H. nudus* and mean biomass (kg) per m² for *S. gigantea* and *L. staminea*.

Both *H. nudus* and *L. staminea* experienced significant declines by beach aspect, year, and the interaction of the two factors. *S. gigantea* significantly increased by beach aspect and year and there was no significant change in *H. oregonensis* (Fig. 4).

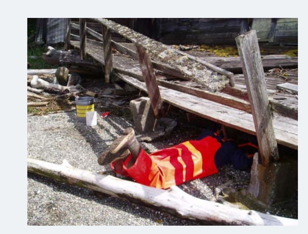
Discussion

Many MPA management strategies aim to protect and restore marine communities to pre-harvest conditions. However, 20 years after becoming a de facto no-take marine reserve, KP has experienced a decline in four of the six species examined in this study. While observed abundance trends include an increase in *S. gigantea* biomass, harvest cessation cannot be directly identified as the sole cause for these results. Interestingly, the population changes recorded for *S. gigantea* and *L. staminea* at KP concur with those observed at other locations in the Whidbey Basin (Barber, unpub. data). Dynamic local and regional processes influence intertidal communities and can confound the ability of a monitoring study to assess the effects from a single factor. Our ability to determine the exact causes for these results is limited because our study was not originally designed for multivariate analyses. We still, however, qualitatively considered the following alternative explanations:

Photo by Kari Neumeyer

- Pollution: According to Bard (1998), all of our studied species are tolerant to depleted dissolved oxygen, corrosive and toxic chemicals, and smothering by pulp fibers. Thus, pollution is not likely to have influenced our results.
- Predator-prey interactions: While numerous predator-prey interactions undoubtedly occur on KP, results from the one relationship we could assess imply that there was no increased predation on *Littorina* spp. by *Hemigrapsus* spp.
- Sea surface temperature and pH: A nearby water quality station recorded negligible change in pH and temperature over the last 15 years. However, long-term temperature records from the Salish Sea indicate a temperature increase of ~0.5°C over the last 40 years.
- Shoreline development: Prior to 2001 approximately 0.5 miles of soft and hard armoring was installed along a potential feeder bluff directly updrift from the southern aspect of KP (MacLennan et al. 2010). These shoreline changes may have altered sediment transport and consequently the beach characteristics and nearshore habitat at the Preserve.

Future multivariate analyses could examine long-term sediment transport, substrate type, and vertical zonation to better understand the changes observed at KP and Whidbey Basin.



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