



How sediment grain size, eelgrass, and clams relate in Netarts Bay, OR USA



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The Oregon Department of Fish and Wildlife's SEACOR project goal is to conduct bay clam population and estuarine habitat studies throughout all the bays along the coast of Oregon. The project's primary focus includes documenting where recreationally important bay clams are found and the abundance, biomass, and preferred habitat type for each species. This analysis evaluated the relationship between habitat variables and clam distribution in Netarts Bay.

Methods

The SEACOR team used two survey methods during 2013-14: rapid and detailed assessments.

- Rapid assessments** were conducted along a 100 x 100 m grid, and documented biotic and abiotic features in a 1 m² quadrat and a 2 m buffer around the quadrat.
- Detailed assessments** were stratified randomly by tide flat and tidal elevation. In addition to the rapid assessment method, sediment, eelgrass, and shellfish samples were collected and enumerated for these sites. Shellfish were sampled using a megacoring suction system (shown right).

Recording habitat data

Megacoring for benthic fauna

1 m² quadrats surveyed for habitat, flora and fauna

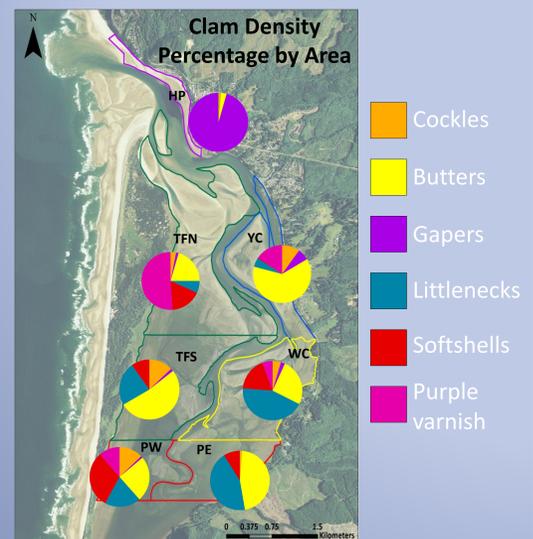
Bay Clam Densities and Habitat Distribution

Native species

- Butter clams (*Saxidomus gigantea*)
 - Most abundant clams in Netarts Bay
 - Associated with eelgrass beds
- Cockles (*Clinocardium nuttallii*)
 - Most commercially and recreationally harvested clams in Netarts Bay
- Gaper clams (*Tresus capax*)
 - Second greatest biomass in Netarts Bay
 - Patchy distributions
 - Higher densities in unvegetated areas
- Native littleneck clams (*Leukoma staminea*)
 - Stable population in Netarts Bay
 - Associated with eelgrass beds

Non-native species

- Softshell clams (*Mya arenaria*)
 - More associated with non-native eelgrass, *Zostera japonica*, and unvegetated areas than native eelgrass, *Zostera marina*, beds
- Purple varnish clams (*Nuttallia obscurata*)
 - Second most numerous after butter clams
 - Comprise less biomass than other bay clams in Netarts Bay because of their small size



Two-letter codes indicate SEACOR-designated tide flat names: HP=Happy Camp, TFN=Tank Flat North, TFS=Tank Flat South, YC=Yager Creek, WC= Whiskey Creek, PW=Shellfish Preserve West, PE=Shellfish Preserve East

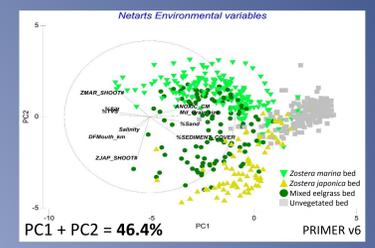
Environmental factors hypothesized to influence clam density:

- Eelgrass presence: species richness significantly differed between eelgrass bed types ($p < 0.0007$) except between *Zostera marina* and mixed eelgrass beds
- Sediment temperature at 15cm: significantly different between most tide flats
- Salinity: average wet season is 28.7ppt

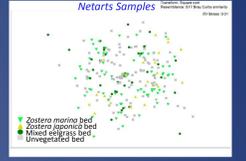
Analysis of Sample Characteristics

Environmental variables explaining sample variation were evaluated using Principle Components Analysis (PCA)

- Sediment** variables are the main influence along the horizontal axis (PC1, i.e. percent sand and silt, median grain size, and percent total volatile solids)
- Eelgrass** shoot count & %cover, distance-from-mouth, and temperature (not shown) are the important variables on the vertical axis (PC2)
- Figure left shows sample grouping by eelgrass bed type factor.



Non-metric Multi-dimensional Scaling (NMDS)

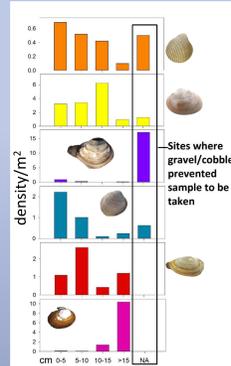
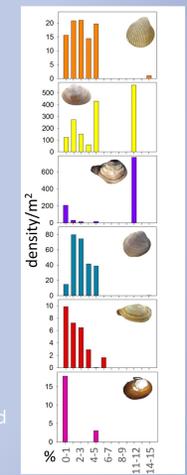


- Density of 6 clam species
- No clear groupings** by eelgrass bed type (shown above), or other factors evaluated.

BEST BioEnv method identified 4 environmental variables that explain clam densities, $\rho = 0.24$:
* distance from mouth * depth of anoxic layer * percent sand * percent total volatile solids

...by percent total volatile solids (TVS)

- Percent TVS is a measure of the sediment organic load and was correlated with percent silt.
- Cockles and littlenecks were found in sites with 0-5% TVS.
- Butters and gapers were found between 0-5% but had the highest densities in 11-12% TVS.
- Softshells were found with decreasing densities as %TVS increased.
- Purple varnish were nearly all found in sediments with less than 1% TVS.

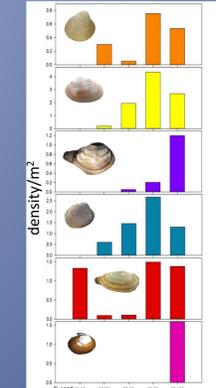
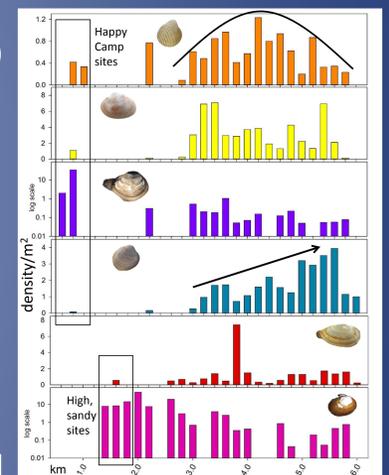


*Reference Sobral & Widdows. 1997. Marine Biology 127(3): 445-461.

Mean clam densities

...by distance from mouth (DFM)

- Distance from mouth may represent sediment transport. The two bins closest to the mouth indicate sites in Happy Camp (HP).
- Cockle density peaked 4-4.2 km from the mouth
- Gaper densities were greatest near the mouth and low in the rest of the bay
- Littleneck densities increased as DFM increased.
- Purple varnish densities were greatest in the high, sandy sites where few other clams were found.
- No patterns based on DFM for butter or softshell clams



...by percent sand

- All sites within Netarts Bay had 50% or greater percent sand in the sediments.
- Cockle, butter and littleneck clam densities were greatest for sand between 80-90%
- Gaper clams had significantly higher densities for sand 90-100%
- Softshell clams had a bimodal pattern of high densities with sand 50-60% and 80-100%
- Purple varnish clams were only found in sand greater than 90%

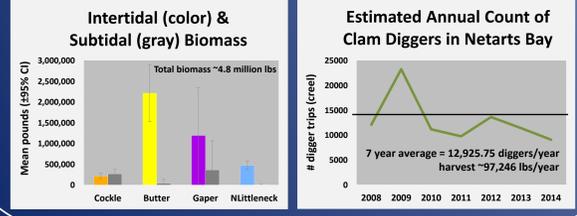
Conclusions

While eelgrass is indicated as an important variable for clam density with univariate statistics, multivariate statistics reveal sediment variables to be more explanatory for site-by-site comparison of clam densities. These sediment variables and distance from mouth show different trends for each clam species. PCA and BEST BioEnv illustrated that multiple environmental factors explain bay clam distribution. ODFW will repeat this survey on a decadal cycle to evaluate temporal changes.

Netarts Bay, Oregon

- North coast
- Marine-dominated ecosystem
- Utilized by multiple resource user groups
- Oyster aquaculture
- Commercial and recreational harvest of several clam species
- Recreational crab harvest
- Kayaking
- SCUBA diving

Figures below show the biomass of the 4 main clam species harvested and the amount of recreational use of these resources. The abundance of clam resources and resource use make Netarts Bay a priority for documenting bay clam habitats and maintaining long-term trend data to inform management decisions.



SEACOR is the Shellfish and Estuarine Assessment of Coastal Oregon



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