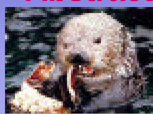
MEDIATION OF FORAGING BEHAVIOR AND SPATIAL DISTRIBUTION OF THE ALASKAN SEA OTTER BY HARMFUL ALGAL BLOOMS

Rikk Kvitek, Carrie Bretz, Kate Thomas - California State University Monterey Bay

Abstract



We tested the general hypothesis that the foraging behavior and distribution of high level marine predators (Sea Otters) under natural conditions are mediated by benthic prey toxicity due to harmful algal blooms (HAB's). Sea Otters in southeast Alaska did change their foraging behavior at sites where Butter Clams (*Saxidomus giganteus*) were found to contain paralytic shellfish poisoning toxins (PSPT) in high concentrations. At the most toxic sites Sea Otters shifted their diet away from their primary Butter Clam prey to smaller and less abundant non-toxic species. At sites of intermediate prey toxicity some Sea Otters continued to forage on Butter Clams while discarding the most toxic body parts.

Introduction

Sea Otters and chronically toxic prey in southeast Alaska

In southeast Alaska, the recent and rapid range expansion of the Sea Otter population eastward into the protected waters of the Inside Passage presented an ideal opportunity to test the influence of HAB toxins on the distribution and feeding ecology of this important marine predator. Prior to 1991, Sea Otters in southeast Alaska were found only along the outer coast, where they preyed primarily upon populations of Butter Clams with no history of PSPT toxicity. The Inside Passage of southeast Alaska, however, is well known for large populations of Butter Clams containing chronically high levels of PSPT.

We tested the general hypothesis that PSPT distribution regulated Sea Otter foraging by determining: 1) whether or not the expanding southeast Alaskan Sea Otter population has occupied inside passage sites where Butter Clams are abundant but contain biologically significant levels of PSPT, and 2) if so, whether the Sea Otters have either shifted their diet away from their primary Butter Clams prey to alternate non-toxic species, or are continuing to eat Butter Clams, while discarding the most toxic body parts.

Study area and sampling sites

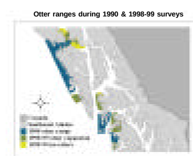
Study areas for comparison were selected along the Inside Passage of southeast Alaska based on documented patterns of Butter Clams toxicity and recent Sea Otter range expansion. Prior to selecting specific observation sites, each area was subdivided and thoroughly surveyed by small boat. Specific sampling stations within sites were selected where Sea Otters were observed to be actively feeding.

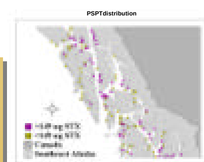
Because previous work with captive Sea Otters suggests that 149 µg PSPT $100g^{-1}$ in Butter Clams is a threshold level for Sea Otters, sites or prey were not considered toxic unless average levels were above this value.

General question and hypotheses

Does the spatial distribution of HAB's and resulting toxic Butter Clam populations influence the spatial distribution and foraging behavior of Sea Otters in southeastern Alaska?

- H_0: Sea Otters under natural conditions do not respond to the presence of PSPT in their prey.
- H_1: Sea Otters shun sites where their primary prey (Butter Clams) are toxic due to HAB's.
- H_2: Sea Otters switch to alternate non-toxic prey at sites where Butter Clams are toxic.
- H_3: Sea Otters continue to forage on toxic Butter Clams, but discard those tissues containing the highest levels of PSPT.
- H_4: Sea Otters reduce their consumption of Butter Clams and eat a more varied diet at sites where Butter Clams are toxic.



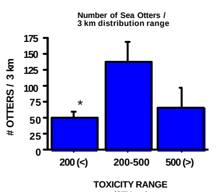


Methods

Methods included direct observation of feeding Sea Otters, SCUBA diver collection and identification of bivalve shells discarded by feeding otters (shell record), SCUBA sampling of available prey species composition, size, biomass, and abundance, and assessment of tissue toxicity from collections of live prey, including Butter Clams, and other benthic species.

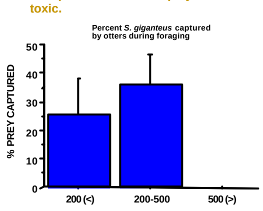
Sea Otter diet composition, feeding behavior (including dive times, surface intervals, feeding rate and foraging success), and prey tissue rejection (particularly the large siphon of Butter Clams) were determined via direct observation at each site. Taxonomic identification of otter prey species was also independently determined via collection of the otter discarded shell record. Shells from Sea Otter eaten bivalves can easily be distinguished from other causes of death and predation.

H_1 Sea Otters avoid areas where their preferred prey are toxic (>150-200 µgSTX/100g).



Sea Otters did **not** exhibit *site avoidance* in the presence of toxic prey.

H_2 Sea Otters enter toxic areas but avoid their preferred Sea Otter prey when it is toxic.



Sea Otters shunned Butter Clams in areas where tissues were highly toxic (>500µgSTX/100g). In areas of intermediate toxicity (200-500µg), prey were individually "tested" by feeding otters.

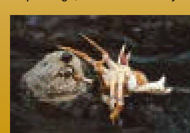
Sea Otter diet and prey status at highly toxic sites

What Sea Otters were observed eating:

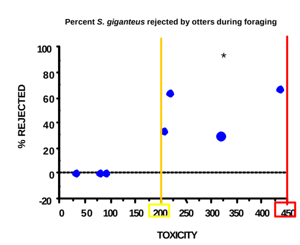
- Sea Urchins - very small and rare
- Macoma clams - small and rare
- Sea Pens - common but very watery

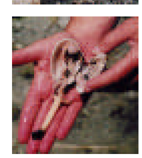
What Sea Otters were not observed eating:

- Butter Clams - large, abundant and very toxic
- Surf Clams - large, abundant and very toxic
- Scallops - large, abundant and very toxic



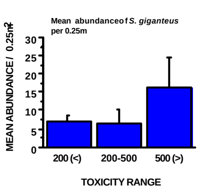
H_3 Sea Otters continue to forage for preferred prey when it is toxic but test and discard tissues or individuals that are too toxic.

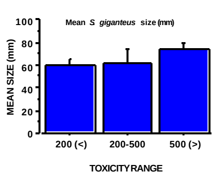


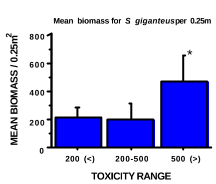


Observations of foraging Sea Otters recorded a significantly greater percentage of rejected Butter Clam tissue, especially siphons (shown in photos), at toxic sites. No Sea Otters were observed feeding on Butter Clams at sites where the tissue toxicity was >450µg STX/100g.

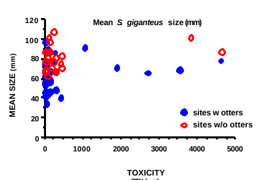
H_5 Butter Clam prey are more abundant and generally larger at toxic versus non-toxic foraging areas.



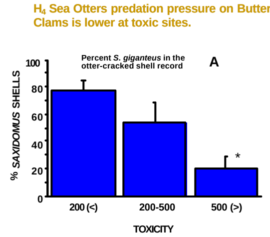


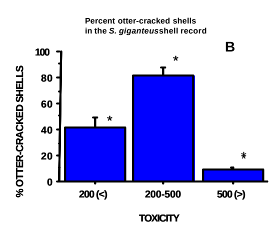


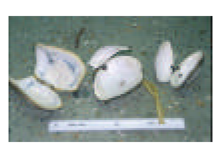
Butter Clams (*S. giganteus*) were significantly more abundant at sites with extreme toxicity (>500µgSTX/100g). There was no apparent difference in the size classes over the toxicity range, although, Butter Clams were generally larger in areas without Sea Otters.



H_4 Sea Otters predation pressure on Butter Clams is lower at toxic sites.







A- Butter Clams constituted a significantly lower percentage of the Sea Otter diet at highly toxic sites (>500µgSTX/100g). B- The majority of Butter Clam mortality by Sea Otters was greatest at sites of intermediate toxicity where Sea Otters were actively "testing" and discarding tissues.

Conclusions

- PSP toxins in prey do not exclude Sea Otters from foraging areas.
- Sea Otters do change both their diet and foraging behavior in a graded response to PSPT (breakpoints @ 250 and 500 µg/100g wet tissue wt).
- PSP toxins may protect some prey populations from Sea Otter predation.

Acknowledgements We thank the following researchers for assistance with foraging observations and SCUBA sampling: P. Iampietro, E. Sandoval, K. Conlan, B. Head, S. Lamerdin, K. Carlson, E. Ross, M. Castleton, S. Maldonado, L. Dippold, M. Silberstein, M. Patyten, N. Slattery, M. Ferdin, T. Manouki, S. Kvitek, L. Lunsten, and P. Mullins. Special thanks to the dedicated crew of the R/V Alpha Helix for their generous logistical support during this project. Also thanks to D. Barrett and C. Allison of the Alaska Department of Health Services, Palmer AK, for their timely tissue analyses for PSPT. This project was funded through NSF/ECOHAB grant# OCE-9726263.