1. Program Number: *See,* Reporting Policy at III (C) (1).

13120114-L

2. Project Title: *See,* Reporting Policy at III (C) (2).

Long-term monitoring of ecological communities in Kachemak Bay: a comparison and control for Prince William Sound

3. Principal Investigator(s) Names: *See,* Reporting Policy at III (C) (3).

Brenda Konar (UAF), Katrin Iken (UAF), Angela Doroff (KBRR)

4. Time Period Covered by the Report: *See,* Reporting Policy at III (C) (4).

February 1, 2014-January 31, 2015

5. Date of Report: *See,* Reporting Policy at III (C) (5).

Feb 1 2015

6. Project Website (if applicable): *See,* Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See,* Reporting Policy at III (C) (7).

Intertidal Monitoring

Sampling Conducted in 2014

Work during this period included intertidal field monitoring in Kachemak Bay, conducted April 27-May 2, 2014. Monitoring included four strata (high, mid, low and -1) at five rocky intertidal sites (Port Graham, Outside Beach, Cohen Island, Bluff Point, and Bishops Beach) and four seagrass sites (Homer Spit, Jakalof Bay, Pederson Bay, and Herring Island). Data collection at the rocky sites included percent cover of all sessile organisms, counts of all kelp stipes, and mobile organisms over 2 cm, and substrate classification). Limpet (*Lottia persona*) and mussel (*Mytilus trossulus*) size-frequency distributions were assessed at three of the rocky sites (Port Graham, Outside Beach, and Cohen Island). At the seagrass sites, data collected included percent cover of all sessile organisms, and counts of all seagrass plants, kelp stipes, and mobile organisms over 2 cm. All these data have been uploaded on the workspace.

Rocky Beach Comparison

We are now working with our Nearshore Gulf Watch colleagues from Prince William Sound, Kenai Fjords National Park, and Katmai National Park and Preserve to produce a manuscript on the influence of static habitat attributes on local and regional biological variability in rocky intertidal communities of the northern Gulf of Alaska. A draft of this paper was included in the Gulf Watch synthesis report. The preliminary results that we present in this manuscript are as follows:

We have found that although there were significant differences in intertidal rocky communities among regions and between the two sampling years, most of the variation in the biological data occurred at local scales, such as between strata and among sites within regions (Table 1). While we know that there are significant differences among intertidal strata in the Gulf of Alaska (Konar et al. 2009), the importance of the role that local-scale habitat drivers play across the Gulf is significant and new.

Table 1: PERMANOVA results testing differences in the biological data by year, region, stratum, and site (nested in region). Differences in the biological communities are based on Bray-Curtis similarities of square root transformed percent cover data. Largest pseudo-F values are associated with site and stratum.

Source	df	SS	MS	Pseudo-F	P(perm)
year	1	10486	10486	2.3257	0.038
region	5	4.2348E5	84696	3.9257	0.001
stratum	1	1.3568E5	1.3568E5	19.771	0.001
site (region)	24	5.4645E5	22769	19.149	0.001

Within and among regions, variation was evident, especially in the spread of sites within each region and in the separation of KBAY and KATM from other regions (Fig. 2, left panel). In some regions, such as KEFJ and EPWS, sites overlapped strongly. A CLUSTER analysis based on the biological data grouped sites into nine clusters according to biological community similarity at the 55% level. As expected, these biological clusters grouped closely on the nMDS (Fig. 2, right panel), and this grouping was regardless of region. This shows that, despite some regional structure, some sites from different regions shared common biological community elements. However, the classification "region" is foremost based on logistical and sampling design constraints and it is unclear how much this reflects differences in biology or environment. We, therefore, assessed the importance of static habitat attributes on the biological community structure and compared these results and that of the regional structure to the biological clustering (Fig. 2, right panel).

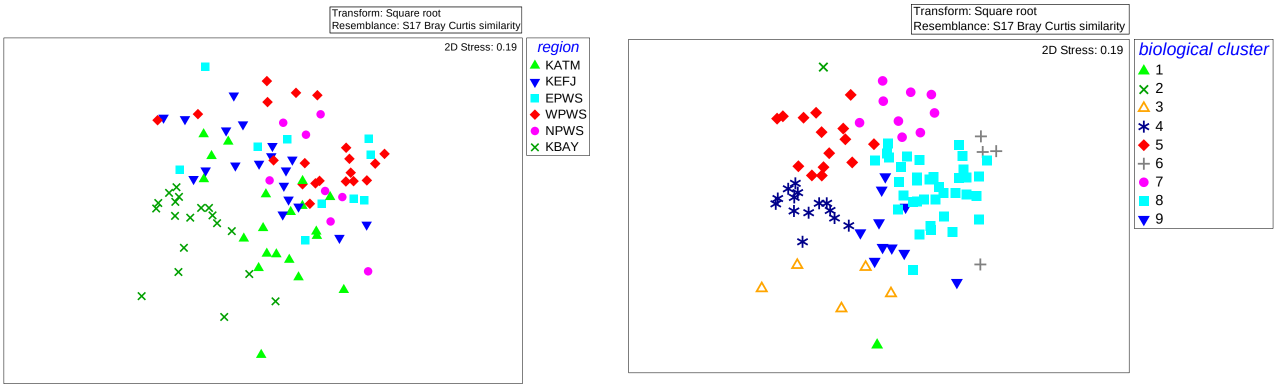

Figure 2: nMDS showing differences in biological data for each site by year and tidal stratum, color-coded by regional association of the sites (left panel), and with sites color-coded according to biological clusters (right panel).

A CLUSTER analysis performed on sites based on their static habitat attributes resulted in six clusters. When the nMDS based on biological community structure was overlaid by these habitat clusters, there still was overlap of sites from several static habitat clusters, especially static habitat clusters five and six. Static habitat clusters 1 and 3 displayed very similar patterns as those in the biological clusters, but especially static habitat clusters 5 and 6 did not separate similar to the biological associations (biological clusters 5, 7-9). Site separation based on static attributes was similar to the separation achieved by region groupings (compare Figs. 2 left panel and 3), but groupings differed. In summary, some structure in biological communities can be determined by static habitat attributes, although the variation in Fig. 3 clearly indicates that factors other than the static habitat characteristics measured here also influence rocky intertidal communities.

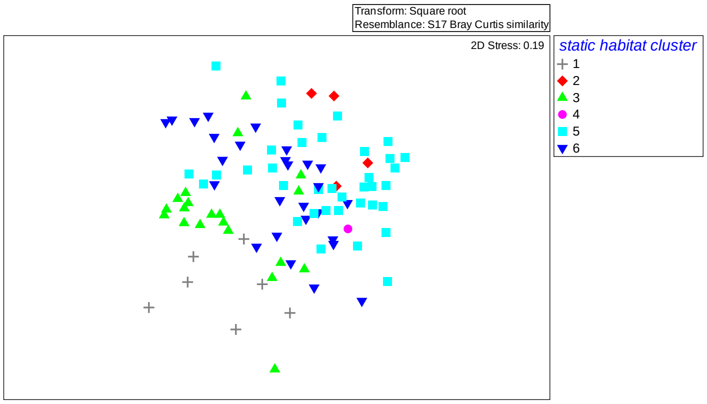

Figure 3: nMDS showing differences among sites based on static habitat clusters. Individual points are sites by year and tidal stratum.

When static attribute vectors were overlaid on the nMDS of sites based on biological clusters, tidewater glacial presence, slope, and distance to freshwater drove some clusters, while fetch, exposure, and substrate type most influenced other clusters (Fig. 4). The BIO-ENV analysis showed that when intertidal strata were combined per site, tidewater glacial presence, exposure, fetch at 200 m, and percent cover mud/sand were the most important attributes (ρ=0.410).

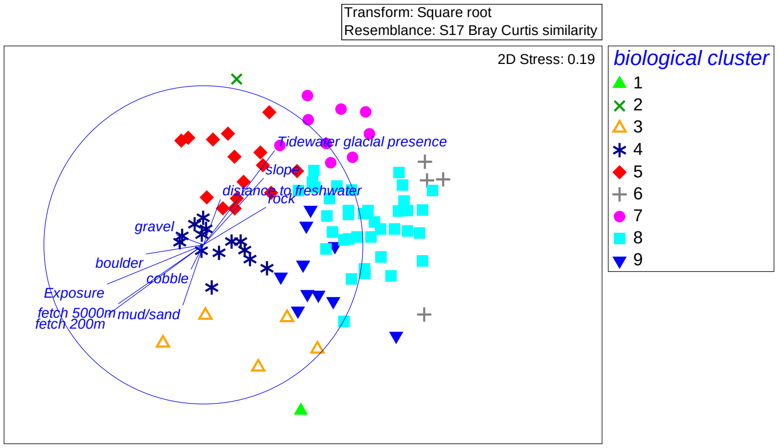

Figure 4. nMDS of sites by biological clusters with vectors of static attributes indicating variables driving separation. Individual points are sites by year and tidal stratum.

Site groupings of biological communities according to static habitat attributes also were confirmed for both intertidal strata separately (Fig. 5). Six habitat clusters were identified for both the mid and the low intertidal (at 55% similarity). Site community grouping by strata still showed some overlap, especially for habitat clusters 5 and 6. The BIO-ENV analysis showed that in the mid stratum, the five most important habitat attributes in driving biological communities were tidewater glacial presence, slope, fetch at 200 m, percent cover boulders, and percent cover gravel (ρ=0.630). In the low stratum, the four important habitat attributes structuring the biological communities included distance to freshwater, tidewater glacial presence, exposure, and percent cover mud/sand (ρ=0.523).

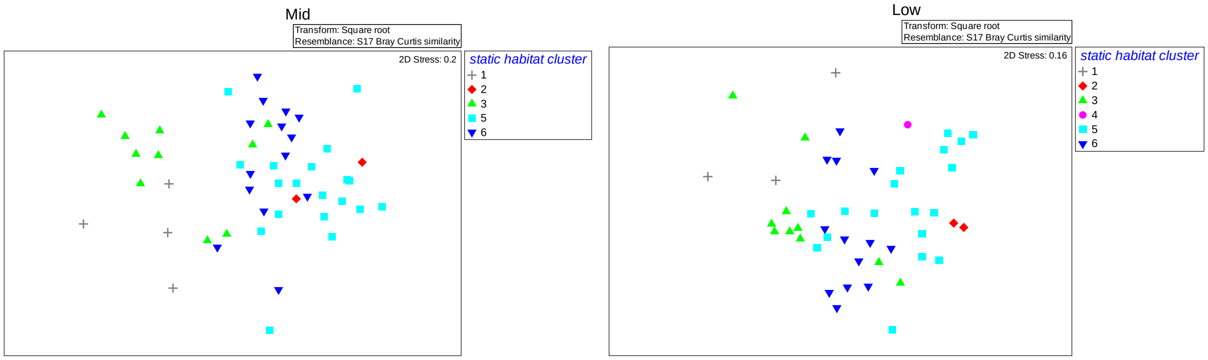

Figure 5: nMDS showing differences among site groups based on static habitat attribute clusters for the mid intertidal (left panel) and the low intertidal (right panel). Individual points are sites by year within each tidal stratum.

Overall, in the northern Gulf of Alaska, local static attributes explained some of the structure of biological communities. Static habitat attribute-based groupings differed from regional groupings, indicating that there were no consistent differences in static habitat attributes by region. This indicates that there are additional regional drivers, either static or dynamic, that are specific to each of the regions (i.e., WPWS, EPWS, NPWS, KEFJ, KATM, and KBAY). Understanding the importance of static attributes is essential to be able to tease them apart as much as possible from the role of temporally more dynamic drivers in these regions, particularly in the context of long-term monitoring of these communities and climate variation. For example, as mentioned before, some of the static attributes included in this analysis, such as distance to freshwater input and the regional presence of tidewater glaciers may be static but the amount of discharge from these sources is not. The inclusion of key static variables as covariates in future analyses of trends in community structure over time should help improve our ability to detect important temporal patterns and their causes. In addition, while the overall species pool for the more common and dominant species is probably relatively similar throughout the Gulf of Alaska, these data imply that static habitat attributes play a role in dictating species occurrence at a local/site level, contributing to site-specific differences in biological communities.

Sea Otter Monitoring

Sea Otter Population Assessment

The 2012 survey results were analyzed but are still preliminary and have not undergone formal review within U.S. Geological Survey. However, the increase in sea otter numbers is important and relevant to the community ecology within Kachemak Bay and we are working with the preliminary population estimate of 5,927 ± 672 until results are finalized. No new population abundance data are available for this area during the reporting period.

Sea Otter Mortality

The Alaska Marine Mammal Stranding Network in Homer, AK in collaboration with the U.S. Fish and Wildlife Service (FWS), Marine Mammals Management Office has been collecting year-around data on sea otter carcass recovery, causes of mortality, and managing live strandings since the beginning of this study. The local marine mammal stranding network is voluntary and the following people have been instrumental in local response to sea otter strandings, Marc Webber, Debbie Tobin, three Kachemak Bay Campus students, and Rachael Rooney. The FWS have not published the data on the number of mortalities since the Unusual Mortality Event in 2006; however, they have continued to collect and manage data on sea otter mortality in this area.

In 2014, the FWS responded to 132 sea otter strandings state-wide. Kachemak Bay and lower Cook Inlet comprised 72% of the sample and the sex and age classes are as follows: 20 were female (majority young of the year), 30 male (adult/old adult), and 8 unknown sex. The FWS conducts forensic-level necropsies on freshly dead sea otters. From the Kachemak Bay/lower Cook Inlet region they have completed 67 necropsies to date (and in some cases, lab results are still pending and will inform reported results). Interim results indicate that while Strep Syndrome is still a primary cause of sea otter mortality in the region, this past year only 18% of the cases analyzed so far were directly related to the syndrome and most cases were unconfirmed as to whether or not the mortality was related to the Strep Syndrome. Primary causes of mortality reported to date include: blunt trauma/trauma, encephalitis/menigoencephilitis, gun shot, septicemia, and were 33% unknown (K. Worman, personal communications).

Sea Otter Prey Assessment

Student involvement:University of Alaska, Kachemak Bay Campus, Semester by the Bay student volunteer Lauren Mc Caslin and University of Alaska graduate student, Sarah Traiger contributed valuable field work and interpretation to this year's sea otter prey assessment report.

Visual Observations: All current and historical focal animal sampling data on sea otter diet were archived and sent to USGS to be included in the sea otter program's database for Gulf Watch; no independent assessments are provided in this report. Data from previous studies in Kachemak Bay can be found in this article: http://www.otterspecialistgroup.org/Bulletin/Volume29/Doroff_et_al_2012.pdf. It is important to note that the relative proportions of prey types identified in sea otter diet vary by the methods used to assess diet. Based on visual observations in Kachemak Bay we identified clam, mussel, and crab to make up 38%, 14%, and 2% respectively based on foraging dives where prey were identifiable (Doroff et al. 2012).

In order to better link the benthic sampling of seagrass beds to sea otter foraging activity, we conducted opportunistic scan samples of sea otter numbers and behaviors (resting, foraging, and swimming) for a seagrass monitoring site located in Mud Bay during September and October 2014. In September, we conducted 25 scan sample events and classified sea otter behavior for 489 sea otters; of these 1% were foraging and 97% were resting. In October, we conducted 27 scan sample events and classified behavior for 1081 sea otters; 1% were foraging and 90% were resting. Obtaining direct observations of sea otter foraging behavior in the soft sediment habitat study sites remains challenging.

Sea otter forage pit structures are regularly observed in the soft sediment benthic monitoring sites in Kachemak Bay. In 2014, we monitored pit structures and retention over the field sampling period (May – Aug) at four long-term monitoring sites on the south side of Kachemak Bay and supplemented this information with collections of bivalve shell litter at the same sites. The two known sources for pits were sea stars (*Pycnopodia helianthoides*) and sea otters. Sea otter predated bivalves have a fairly distinctive break pattern on the shell and are easily distinguishable from other sources of mortality (Kvitek et al. 1992). All shells without evidence of sea otter predation were classified as whole (sea star), bore-hole, crab cracked, or unknown mortalities. There were 13 species of bivalves identified in the shell litter but approximately 83% of the sample was *Saxidumus gigantea*. In Figure 6, we see all soft sediment monitoring sites had sea otter cracked shell litter and probable sea star predation; the size class of bivalve was larger in the older shell record than for the recent shell record in all cases with the exception of Kasitsna Bay dock in the non-otter mortality.

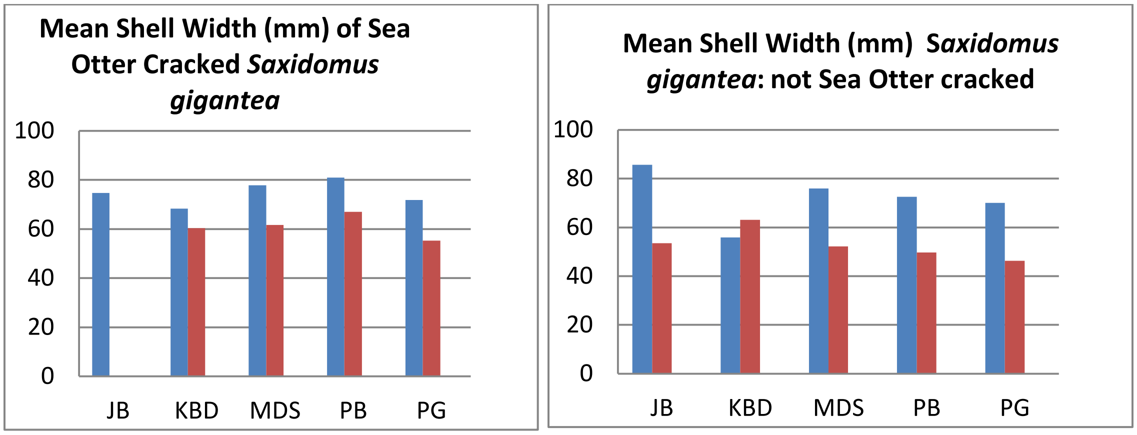

Fig. 6. Frequency of occurrence of *Saxidomus gigantea* at five sites in Kachemak Bay (JB = Jakolof Bay, KBD= Kasitsna Bay dock, MDS=McDonald Spit, PB=Peterson Bay, and PG=Port Graham) sampled May – August 2014. Dark blue indicates older shell litter (signs of shell breakdown) and red indicates more recent shell litter (no signs of shell breakdown).

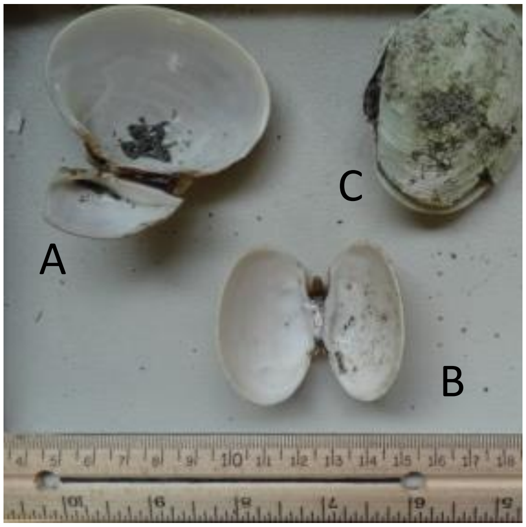

Fig. 7. *Saxidomus gigantea* shell litter from Kachemak Bay 2014. **A**. indicates a recent sea otter cracked shell, **B**. indicates a non-sea otter cracked shell; probable sea star predation, and **C**. an older shell and likely is the result of crab predation

From this pilot work, we conclude the presence of pits in the sediment alone is not a particularly good indicator of the rate of foraging by bivalve predators in either intertidal or subtidal habitats. Confounding factors may include sea stars utilizing sea otter forage pits to obtain prey more readily, thus altering the structure of the pits. Having direct observations for sea otter foraging and concurrent collection of shell litter at sites where forage pits are monitored would improve how we interpret pit structures in the soft sediment habitats in our study area. Methods, results, and conclusions were presented in a poster at the Alaska Marine Science Symposium in January 2015: Traiger SB, B Konar, A Doroff, L McCaslin. Distinguishing sources of foraging pits using pit dimensions and shell litter in nearshore soft substrates.

Scat Analyses: We are collecting monthly sea otter scat samples in Little Tutka Bay, located along the south shore of Kachemak Bay, during the winter months of 2012-2014 (Fig. 8). The collection of these samples was accomplished through citizen science collaboration with the land/dock owners and the regularly scheduled mail delivery run in the area (see Doroff et al., 2012 for sample collection and methods). We collected 20 sea otter scat samples between October 2013 and December 2014, which were processed during this reporting period; sample collection is still ongoing for this winter. We worked with Dr. Deborah Tobin and Marc Webber at the UAA Kachemak Bay Campus and their students enrolled in a course on Marine Mammals to process the scat samples and summarize the data. Students and staff sorted each scat sample by prey type and assigned a percentage frequency method using a 1 – 6 ranking (1 = 1 – 5%; 2 = 5 – 25%; 3 = 25 – 50%; 4 = 50 – 75%; 5 = 75 – 95%; 6 = 95 – 100%). To summarize the categorical data on diet from scat samples, we used the median value for each category and averaged by winter period (Fig. 8).

The relative proportion of prey types were averaged by collection day (or event) since the beginning of the project in 2008. In spring 2008 and fall 2008-09, sample locations were diverse and sample sizes were higher until collections were standardized to one site (Little Tutka Bay) and the collections limited to one per month of approximately one week's worth of sea otter scats per sampling event. The two dominant prey types evident in the scat samples in this study were blue mussels (*Mytilus trossulus*) and crab. The relative proportion of crab quantified in the diet by season ranged from approximately 22% to 52% of all prey. While there is an increasing trend in mussel present in the scat samples, the sample size has decreased since 2013 and is restricted to a single collection site. In 2011, we began to work with students to build a guide to the crab species found in sea otter scats. Thus far, known species of crab in sea otter diet at this site include: helmet crab (*Telmessus cheiragonus*), pygmy rock crab (*Glebocarcinus oregonensis*), hairy crab (*Hapalogaster mertensii*), graceful kelp crab (*Pugettia gracilis)*, graceful decorator crab *(Oregonia gracilis)*, and potentially Tanner crab *(Chionoecates bairdi)*. This year, our student intern, Lauren McCaslin, updated our sea otter scat species handbook for crabs. We began by collecting and photographing whole crabs during the course of other routine sampling events, dried them, and broke the exoskeletons down into sea otter scat pieces for the handbook. We field tested the handbook on the UAA Kachemak Bay Campus Marine Mammals students fall 2014 by providing them crab material from sea otter scat and the draft handbook and asked them to identify the sample to species if possible. The students provided valuable feedback that improved the utility of the handbook.

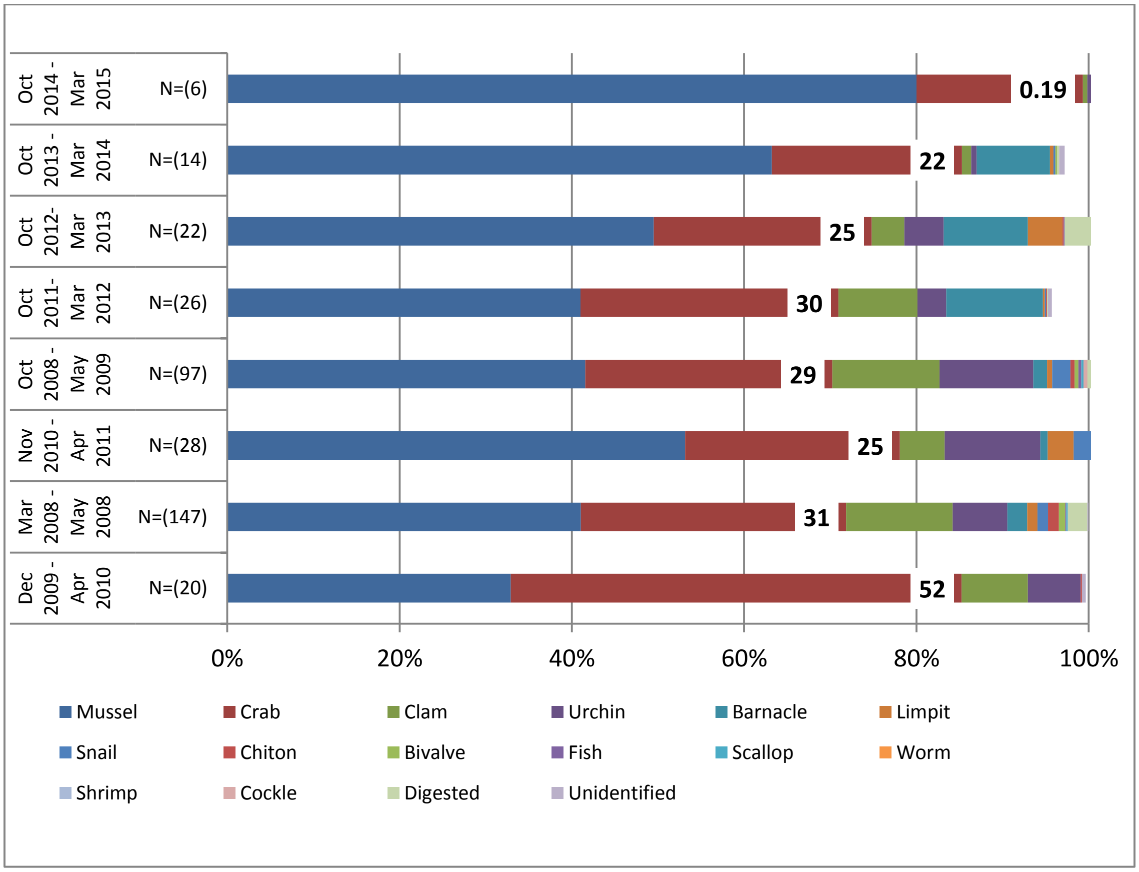

Fig. 8: Relative prey composition from sea otter scat collected during 2008-2013 during the winter months in Kachemak Bay, Alaska. Prey composition of individual scat samples was averaged by "winter period" and compared over time. In 2008-2009, scats were collected and processed from multiple sampling sites; however, 2009-2013 a single site was sampled

monthly from late fall (October or November when sea otters began to haul out) through the spring (March or April when sea otters stopped hauling out). Note that 2014-2015 is a partial year.

Kachemak Bay was one of 16 sites in a recent study that examined the interaction of intraspecific competition and habitat on individual diet specialization for sea otters (Newsome et al. 2015). The study utilized stable isotope data to quantify population and individual-level diet variation between rocky and mixed substrate habitat types. Stable isotope data were collected from 43 sea otter vibrissae and 103 sea otter prey samples from Kachemak Bay. The results of this study suggest that prey functional diversity in combination with prey diversity need to be considered when examining the causes of individual diet specialization in sea otters. In mixed or heterogeneous habitats like Kachemak Bay, sea otters may forage on a diversity of bivalves but most of the forage species are filter feeders in the soft sediment intertidal and subtidal habitats. High calorically rich (lipid rich) prey such as crabs and sea urchins are preferred but easily depleted whereas infaunal bivalves (protein rich) are reduced in size and relative abundance but have refuges from sea otter predation (burrowing depth) not available to epifaunal prey.

Literature Cited:

Doroff AM, O Badajos, K Corbell, D Jenski and M Beaver. 2012. Assessment of sea otter (*Enhydra lutris kenyoni*) diet in Kachemak Bay, Alaska (2008-2010). IUCN Otter Specialist Bulletin Vol 29:15-23.

Kvitek RG, JS Oliver, AR DeGange, and BS Anderson. 1992. Changes in Alaskan soft-bottom prey communities along a gradient in sea otter predation. Ecology 72:413-428.

Newsome SD, MT Tinker, VA Gill, AM Doroff, L Nichol, and JL Bodkin. 2015. The interaction of intraspecific competition and habitat on individual diet specialization. (Accepted Oecologia IpNV special issue).

Deliverable/Milestone	Status
Sample intertidal communities in Kachemak Bay	Completed May 2014
Collect monthly sea otter scat samples	Ongoing through the winter months
Conduct sea otter observations	Completed October 2014
Present work at Alaska Marine Science Symposium	Completed January 2015

8. **Coordination/Collaboration:** *See*, Reporting Policy at III (C) (8).

Text description of needed content:

- Item 8A would cover collaboration and coordination both within your program and between the two programs: We have been coordinating with the other partners in the nearshore Gulf Watch Program. This is illustrated in the publication described above.
- Item 8B would include coordination with other EVOSTC funded projects (e.g. marine debris, harbor protection, or PIGU projects): N/A
- Item 8C would include coordination with our trust agencies: N/A

9. **Information and Data Transfer:** *See*, Reporting Policy at III (C) (9).

Stewart NL, B Konar and A Doroff. 2014. Sea otter (*Enhydra lutris*) foraging habitat use in a heterogeneous environment in Kachemak Bay off Alaska. Bulletin of Marine Science 90:921-939.

Poster presentations at the Alaska Marine Science Symposium in Anchorage Alaska in January 2015 include:

- Konar B, K Iken, H Coletti, T Dean and D Monson. Static habitat attributes influence biological variability in intertidal communities in the central Gulf of Alaska.

- Traiger SB, B Konar, A Doroff and L McCaslin. Distinguishing sources of foraging pits using pit dimensions and shell litter in nearshore soft substrates.

Poster presentation of project at AMSS that was leveraged with Gulf Watch includes:

- Konar B, K Iken, M Rogers and S Vanderwaal. Testing the use of unmanned aircraft systems for intertidal surveys- proof of concept.

Oral presentation of project at the Coastal Marine Institute Annual Review in Anchorage Alaska that was leveraged with Gulf Watch includes:

- Konar B, K Iken, M Rogers and S Vanderwaal. Testing the use of unmanned aircraft systems for intertidal surveys- proof of concept.

The 2014 data that were uploaded on workspace and linked to the data portal include: rocky intertidal community structure (species and percent cover), mussel size-frequency, seagrass shoot count and community structure (species and percent cover), limpet size-frequency, and sea otter scat data. All files included dataset metadata**.**

10. Response to EVOSTC Review, Recommendations and Comments: *See*, Reporting Policy at III (C) (10).

n/a

11. Budget: *See,* Reporting Policy at III (C) (11).

Actual spending differed from proposed budget by more than 10% for several reasons: In past years, we were able to leverage some personnel time and contractual services for lab fees from other projects. Some supplies that were left from previous projects were used. However, more funds will be used during the upcomong field work (April 2015, prior to end of fiscal year) for personnel time and contractual services. In addition, now that we are moving into the synthesis phase, we will use more personnel time on this project to work on syntheis products. Some of the supplies will now need to be replaced. Travel was underbudgeted (and overspent) because we only budgeted for field work travel and did not account for PI meeting travel.