Prey Choice of Intertidally Foraging Water Birds

Ethan Tanner Ellis[1], Petra Ditsche[2], Katie Dobkowski[1,2]

Aquatic Animals Research Experience 2014

Spring 2014

[1]Department of Biology, University of Washington, Seattle, WA, 98105

[2]Friday Harbor Laboratories, University of Washington, Friday Harbor, WA, 98250

Contact Information:

Ethan Tanner Ellis

Biology Department

University of Washington

5021 Brooklyn Avenue NE

Seattle WA, 98105

Ethan161@uw.edu

Keywords: 4th of July Beach, foraging, prey choice, Seagull, top-down control

ABSTRACT

The foraging behaviors and prey choice of intertidally foraging birds is largely undocumented. A series of four observations on prey choice was done at a discrete site during low tidal heights (<.0.61 m) and high tidal heights (>1.52m). Prey was defined as three distinct categories, “Fish”, “Crustacean”, and “Other”. There were significantly more crustaceans consumed than fish or other organisms. No observed feeding during high tidal heights. Conspicuous consistent behaviors also noted but not formally analyzed. There is potential for intertidally foraging birds to have top-down control of intertidal ecosystems.

INTRODUCTION

Food web ecology is based in the trophic interactions among organisms residing in niches within a system. Primary production may be controlled by the primary consumers. Secondary consumers negatively impact populations of primary consumers population. Systems in which secondary or tertiary consumers have larger impacts on the prey populations than primary consumers’ impact on primary production are known as top--down control systems. This is well understood in systems that contain sea otters, *Enhydra lutris. E. lutris* are associated with significant impacts in marine ecosystems by decreasing urchin populations and therefore indirectly increasing kelp populations (Estes & Duggins, 1995).

Intertidal foraging coastal water birds and their impact on primary production in intertidal is not well understood as well as otter controls. Top--down theory predicts that birds that forage in the intertidal should show similar indirect influence of algae populations through herbivore consumption, but testing of such in marine intertidal systems is largely undocumented

(Guillemain, & Fritz, 2002). Such information is needed in order to fully grasp the importance and function of individual niches plus organismal interactions within intertidal ecosystems.

Visual foraging is preferred to tactile or chemical foraging among most birds. Predation of cryptic organisms may be affected by water levels depending on normal foraging behaviors: dabbling vs. diving, tactile vs. visual foraging etc. (Blackwell et al., 2009). Dabbling is defined as feeding tactics where the bird is unable to overcome its own buoyancy requiring it to "dabble" in the extreme upper water column. Diving is the inverse of such; able to overcome its own buoyancy the bird is able to dive into the water. Both feeding tactics make a variety of prey available while having differing energetic costs. The experiment presumes that both marine and terrestrial birds have accesses to intertidal communities, either emerged or submerged (Nummi & Vaananen, 2001).

Specific access due to migratory patterns or the visual constraints non-dabbling birds will have an impact on systems (Irons, 1998; Guillemain, Martin & Fritz. 2002). Terrestrial birds will have difficulty foraging in shallow waters due to the visual, reflective and distorting barrier of the water surface, constricting foraging to times of medium and low tides (Fernandez-Juricic, Erichsen & Kacelnik. 2004). Prey access is further restricted due to defensive behaviors of prey during times of low and medium tides (Poysa, 1986). Dabbling birds have little difficulty in prey access, potentially increasing predation to times of higher tide where the cost of prey location and competition for prey is relatively lower (Hastad,, Ernstdotter & Odeen, 2005).

This study quantifies prey selection by birds foraging in the intertidal using a series of observations to compare predation during times of low and high tidal heights. There will be higher predation of primary consumers by foraging birds during times of low tidal levels due to a mechanical ease of accessing surfaced prey and relatively less visual constraints of locating surfaced prey.

METHODS

Study site

Locations were observed from May 21, 2014 through May 30, 2014 as tide height and weather permitted. Location is colloquially known as 4th of July Beach, (48° 27' 59.7"N 123°00'00.2"W) (Fig. 4).

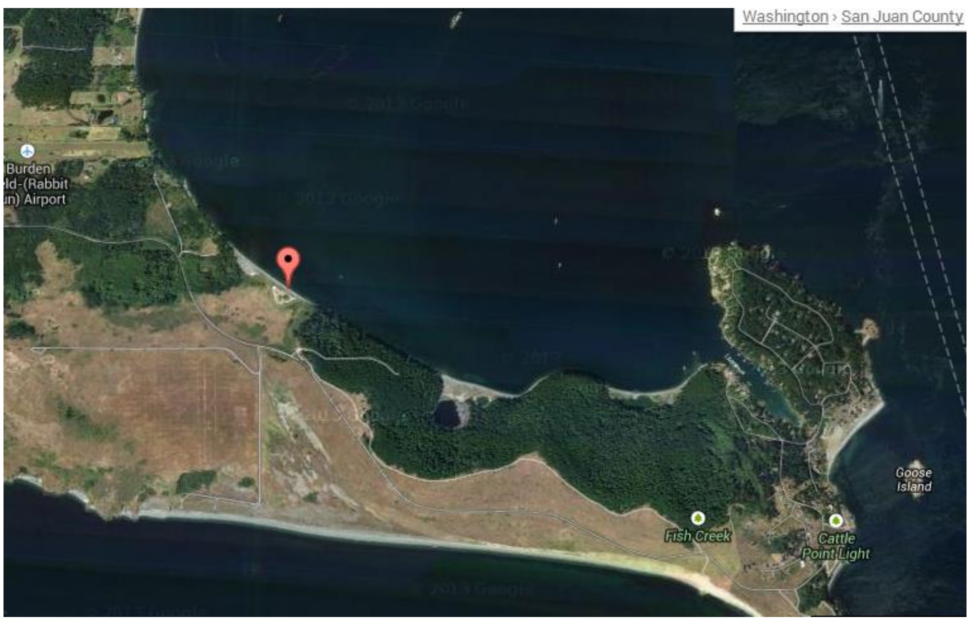

Figure 4

Observations were taken from a single point at the location; range of sight with Eagle Optic binoculars determining observational range. Data from observation sessions in which there was disturbance within 10 m of the observation site were discarded. Observations of intertidal foraging birds were taken at low and high tidal heights. Low tide height was defined as below 0.61 m. High tide defined as above 1.52 m. Tide height was determined by TideGraph

3.5, using measurements from 'Friday Harbor, San Juan Island' station. Observer identity, date, location, tidal height, time and weather were all recorded before observations began. Weather was defined categorically as cloudy, partly cloudy, sunny, rainy and slight to heavy wind. Relevant observations were colloquially recorded as notes.

The intertidal ecosystem at the site was predominately sand and cobble. Cobble dominated the high intertidal, sand dominated the lower and middle intertidal. Zonation of the intertidal is clearly marked by location of two distinct genera, *Ulva* and *Zostera marina*, present in the mid intertidal and shallow subtidal respectively.

Observations began during appropriate tidal heights and continued until tide was no longer in the appropriate range. Observation sessions concluded if no foraging was seen for 60 minutes.

Data collection

Consumption of prey item was determined by sight. Consumption of a prey item is defined by full ingestion. The site was scanned manually by the observer until individual foraging behaviors were evident. Individual groups of four to six were observed during feeding flocks, large numbers of birds foraging concurrently. Acquisition of prey was not noted, only consumption. Number of birds present as well as number of birds foraging was noted.

Data was recorded within categorical groups, quantifying predator consumption of prey. Prey data was recorded categorically as three separate, distinct groups: "Crustacean", "Fish" and "Other." "Crustaceans" were conspicuous, with further individual identification denoted when possible. "Fish" were identified through thrashing movement before ingestion. "Other" includes plants and animals that were not in "fish" or "crustacean" categories was defined as non-fish and non-crab and includes plants as well as animals. "Other" also includes consumption of unidentifiable prey. Predators were recorded in two groups, "Gulls" and "Other". Mac's Field Guide to Northwest Coastal Water Birds was used as a reference in identifying birds. I also noted whether prey was submerged or surfaced during predation. No birds were handled or directly disturbed during the course of the experiment.

Statistical analyses

All data analysis was done using R for Statistical Computing. Data was analyzed using two-way analysis of variance (ANOVA) followed by a Tukey Honestly Significant Difference (HSD) test.

RESULTS

Only seagulls were seen during observations. Two species were identified california gull, *Larus californicus*, and ring-billed gull, *Larus delawarensis*. *L. californicus* was the predominate species. There were an average of 68 gulls visible on the beach during low-tide observation periods and an average of 41 gulls observed to be actively feeding (Fig. 1).

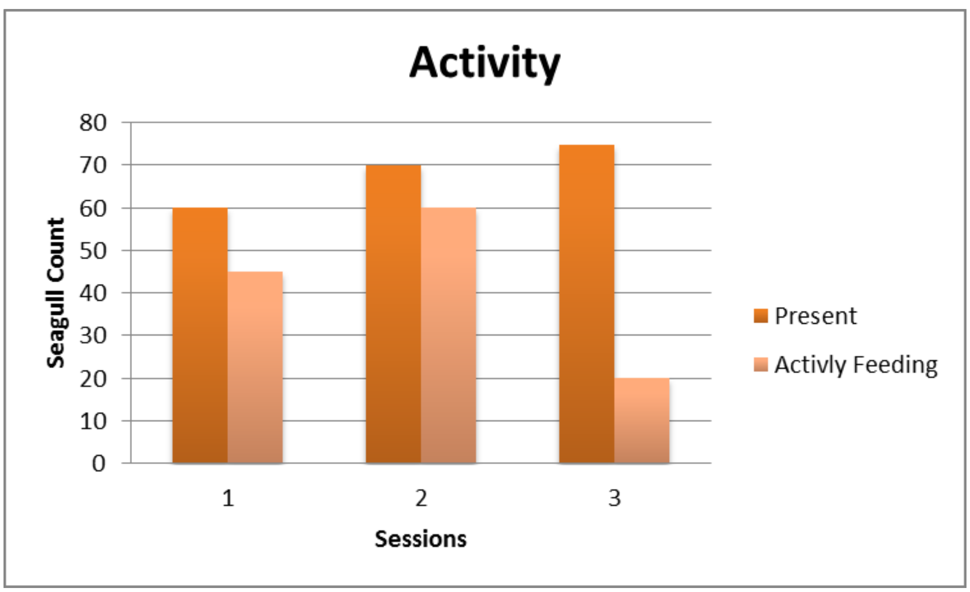

Figure 1.

No gulls were observed feeding during high-tide during any of the observation periods.

At low tide, there was significant difference between the amount of fish and crustaceans consumed (p=0.0064945) with crabs being the preferred prey item. Crustacean prey was also consumed in greater abundance than items in the “other” category (p=0.0209270). Results of significant Tukey HSD comparison can be found in Table 1.

Tide vs. Food Item	P-value
low:Crab-high:Crab	0.0000082
low:Other-high:Crab	0.0419380
high:Fish-low:Crab	0.0000082
low:Fish-low:Crab	**0.0011470**
high:Other-low:Crab	0.0000082
low:Other-low:Crab	**0.0058943**
low:Other-high:Fish	0.0419380
low:Other-high:Other	0.0419380

Table 1. Results of Tukey Test comparing Tide and Food Item variables. **Significant results of low tide interactions.

DISSCUSION

The significant preference towards low-tide crustaceans implies that the cost of foraging and the energetic intake from crustaceans is more profitable than that of fish or “other’ Prey choice is influenced by energetic costs of prey location and acquisition. If benefits, amount of energy in a prey item, outweigh the foraging costs then foraging is beneficial. If water were not a barrier in acquisition of prey it is expected that fish and crustacean consumption would be similar. Since they are not we assume that water functions as a substantial barrier, which may inhibit predation of submerged organisms by intertidally foraging seagulls. This is explicitly supported by a lack of observed foraging during high-tide, in which all organisms were submerged, and no observed dabbling for prey in the subtidal during low-tide.

Observational data resulted in colloquial data on foraging behaviors and sociality. This data was not statically analyzed. Regular foraging behaviors became evident during observations.

Birds followed the water line while tide receded, foraging only in areas in which they were able to stand. Gulls foraged in a nearby *Ulva spp.* bed during times of high-low tides. *Ulva spp.* most likely acting as a refuge for prey as the water receded. Gulls transported algae by grasping it in their beaks and moving it, exposing the substrate and potential organism below. At times of low-low tide, this method was abandoned for exposed substrates. Consumption of algae was observed twice. Algae consumption is most likely a side effect of ineffective prey removal from algae. Feeding flocks occur for a short amount of time 30-60 minutes, after which time the birds disperse from the intertidal.

There are many possible impacts that gulls can have on ecosystems. These unknown impacts are further complicated by migratory patterns, population fluctuations etc. Potential for top-down control of intertidal ecosystems is present. Top-down control would only be possible if gull foraging has substantial impact on the ecosystem present. As their diet is largely unquantified further data is need in order to correctly analyze gull impact on prey populations and the impact those prey populations have on populations of primary producers.

ANOVA Results	P-value
Tide	4.67e-07
Food Item	0.00504
Tide:Food Item	0.00504

Table 2. Results of ANOVA test. All results are significant

Food Item vs. Food Item	P-value
Fish-Crustacean**	0.0064945**
Other-Crustacean**	0.0209270**
Other-Fish	0.8492634

Table 3. Results of Tukey Test comparing Food Item to Food Item variables. **Significant results.

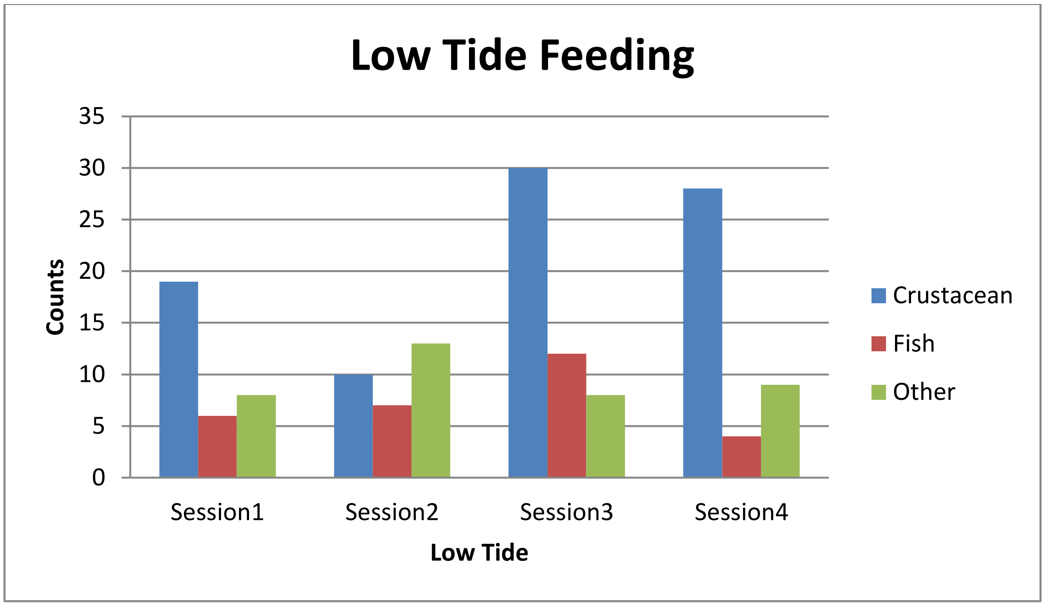

Figure2. Raw results of Low Tide Feeding. Counts are defined as full ingestion of prey. Low tide defined as below 0.6 m tidal height. Crustaceans have highest feeding counts on all sessions but session 2. No birds observed feeding during high tide.

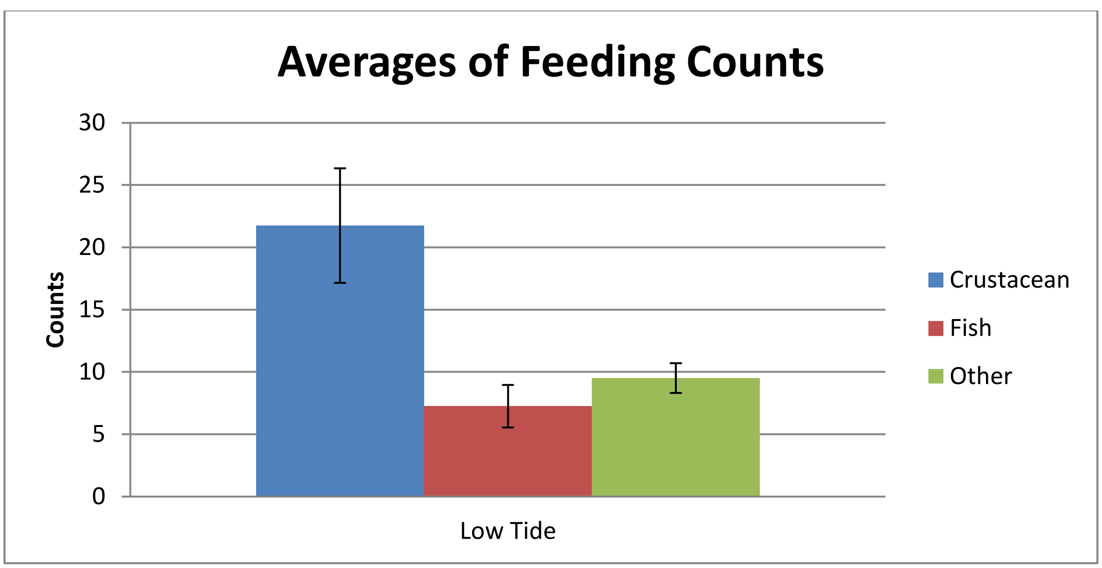

Figure 3. Averages of feeding counts for both high and low tides. Averages for high tide are not shown as they have counts of 0. Significance between Crustacean:Fish (p=0.0064945) and Crustacean:other (p=0.0.0209270)

BIBLIOGRAPHY

Blackwell, B. F., E. Fernandez-Juricic, T. W. Seamans, and T. Dolan. 2009. Avian visual system configuration and behavioural response to object approach. Animal Behaviour 77:673-684.

Estes, J. A., and D. O. Duggins. 1995. Sea Otters and Kelp Forests in Alaska: Generality and Variation in a Community Ecological Paradigm. Ecological Monographs. 65:75-100.

Fernandez-Juricic, E., J. T. Erichsen, and A. Kacelnik. 2004. Visual perception and social foraging in birds. Trends in Ecology & Evolution 19:25-31.

Guillemain, M., and H. Fritz. 2002. Temporal variation in feeding tactics: exploring the role of competition and predators in wintering dabbling ducks. Wildlife Biology 8:81-90.

Guillemain, M., G. R. Martin, and H. Fritz. 2002. Feeding methods, visual fields and vigilance in dabbling ducks (Anatidae). Functional Ecology 16:522-529.

Hastad, O., E. Ernstdotter, and A. Odeen. 2005. Ultraviolet vision and foraging in dip and plunge diving birds. Biology Letters 1:306-309.

Irons, D. B. 1998. Foraging area fidelity of individual seabirds in relation to tidal cycles and flock feeding. Ecology 79:647-655.

Nummi, P., and V. M. Vaananen. 2001. High overlap in diets of sympatric dabbling ducks - an effect of food abundance? Annales Zoologici Fennici 38:123-130.

Poysa, H. 1986. Species Composistion and Size of Dabbling Duck Feeding Groups: Are Foraging Interacions Impoartant Determinates? Ornis Fennica 63:33-41.

Thaxter, C. B., B. Lascelles, K. Sugar, A. S. C. P. Cook, S. Roos, M. Bolton, R. H. W. Langston, and N. H. K. Burton. 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas. Biological Conservation 156:53-61.

Wootton, J. T. 1997. Estimates and tests of per capita interaction strength: Diet, abundance, and impact of intertidally foraging birds. Ecological Monographs 67:45-64.