Prey Selection by Pigeon Guillemots, *Cepphus columba*, on Whidbey Island for the 2009 Breeding Season

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Cepphus columba (Pigeon Guillemot) is a burrow-nesting species of marine bird that is endemic to the coasts of the Northern Pacific Ocean; it is found from Alaska to California, and feeds on pelagic or benthic fishes within 10-30 m of water (Ewins, 1993). These are vocal, charismatic birds that are completely black with white markings on the wings. The inside of the bill is bright red, along with their legs and feet. Little is known about the winter range of these birds, as they may remain near natal sites or migrate north to Alaska (Ewins, 1993). Birds occupy breeding sites from spring to fall, and experienced males arrive to the sites up to two weeks before females and non-experienced males (Nelson, 1987). Pairs are most likely formed at sea, and once at the breeding colony, P. Guillemot pairs engage in vocal duets, copulation, and nest selection (Ewins, 1993).

Whidbey Island is the largest island in the Puget Sound, stretching for 40 miles from southern to northern tips. Whidbey Island lies in the rain shadow of the Olympic Mountains, and supports a variety of habitats. The coastline of the island has dynamic sandy bluffs that crumble easily, and are used as nesting habitat by Belted Kingfishers (*Ceryle alcyon*), Northern Rough Winged Swallows (*Stelgidopteryx serripennis*) and Pigeon Guillemots. Pigeon Guillemots arrive at nesting colonies on Whidbey Island in early spring to start the breeding season. P. Guillemots traditionally start laying eggs in June and stay until early fall.

The purpose of this study was to examine Pigeon Guillemots during the chick-rearing season of 2009. Five sites were selected for observation, all on the southern portion of Whidbey Island. Two sites were located on Admiralty Inlet: Mutiny Sands and Shore Meadows. Two other sites were located on Saratoga Passage, Harrington North and Harrington South. The last site, Rolling Hills, was located in Penn Cove. The beaches varied in substrate type, bluff height, and frequency of human disturbances.

Shore Meadows is a sandy beach that is frequented by humans, who are often accompanied by dogs. The bluffs at this site are the highest of the 5 sites, about 70 feet or so above the beach. Mutiny Sands is along the same stretch of shore, is also sandy, and also experiences a lot of human activity, but the bluff at this site is only about 20 feet above the beach. Harrington South is a rocky beach, and the top of the bluff is about 50 feet above the beach. During my observations at this site, I saw a group of 4 people once. At no other time were there humans on this beach, except for those involved with the survey. Harrington North is a rocky beach, the top of the bluff is about 40 feet above the beach, and is occasionally visited by humans. Rolling Hills is a sandy beach, with a bluff height of about 60 feet above the shore, and is also occasionally visited by humans.

Prey identification was carried out by observing the birds before they delivered prey items to the chicks. Pigeon Guillemots usually rested on the water with the prey item in their bill before delivering the item to the chicks. This allowed me to identify prey items with binoculars, or a spotting scope. Fish identification guides were used to identify prey items to the lowest taxonomic level. On occasion, I was not able to identify prey items. These were marked as "unknowns" and put into a separate category.

Observations took place starting on June 22, 2009, and were carried out Monday-Friday until Friday, August 18. One site per day was observed for 5 hour intervals, during which number of adults, weather, adult behaviors, disturbances, burrow activity, and prey items delivered to chicks were all recorded. Two days were missed, Friday, July 17th and Monday, July 27th. These day-surveys were later made-up by observing birds in the evening. During the last week of observation, surveys were less than five hours, due to the lack of activity in the colonies.

Among the data recorded, prey species delivered to the burrows had the most entries. I have chosen to focus on this aspect of P. Guillemots for this paper because of the amount of data available. Prey items delivered to burrows consisted of several types of fish. For simplification, and for lack of having prey items in hand, general categories are described.

Sculpins are small, spiny fish that are most numerous in the North Pacific. They inhabit shallow waters and tide-pools, have large, showy fins and usually have spines or knobs along the body. Most sculpin species are under 13 cm in length. There are numerous species of sculpin, and determining the differences between the species usually requires a microscope. Sculpins are listed as a main prey choice for P. Guillemots (Ewins, 1993; Litzow et al, 2004; Litzow et al, 2000; Litzow and Piatt, 2003; Golet et al, 2000; Litzow et al, 2002; Emms and Verbeek, 1991).

There are multiple species of shrimp that reside in the Puget Sound, and several of these could have been chosen as prey items. However, these also require careful examination to determine species. I was somewhat surprised to see shrimp delivered to the burrows. I do not believe that these were chosen because birds were unable to catch fish; Harrington North delivered the most shrimps to the burrows, and along this beach are literally millions of shore crabs. If fish were not available to the birds, there were plenty of crabs available, and these have been noted as prey items in other areas (Ewins, 1993).

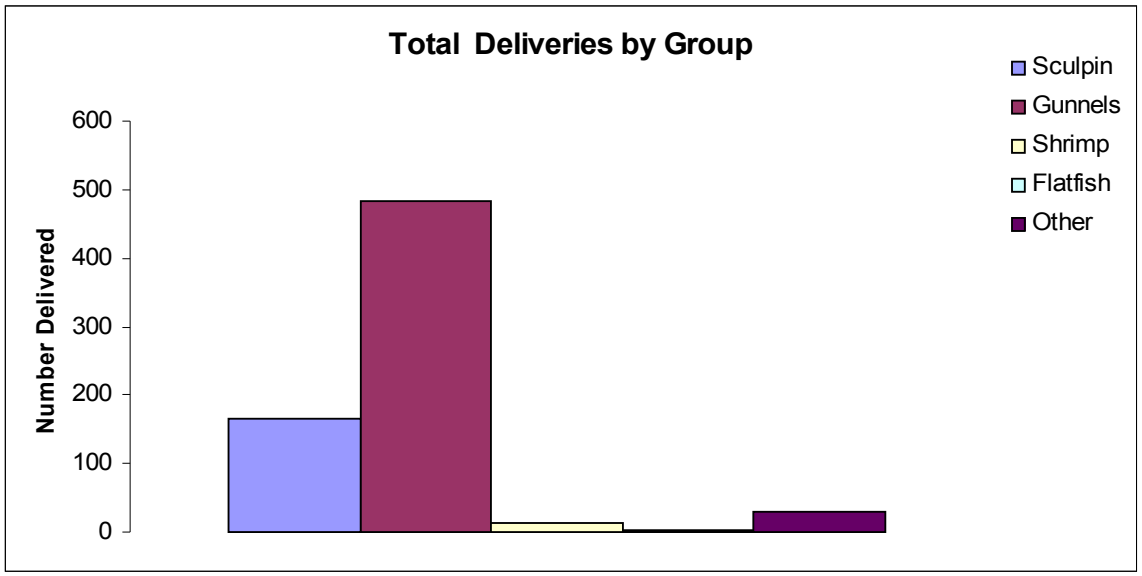
Gunnels are long, tapered eel-like fish that inhabit shallow waters. There are about 7 species of gunnels in the North Pacific. They are also similar to eel-blennies, and are sometimes referred to as blennies. This is a major difficulty in identifying small, marine fishes; there are numerous common names for each species of fish, and because they are difficult to identify to species without a microscope, mistakes are easily made. Blennies, as a whole, are stouter and much larger than gunnels. Golet et all, 2000, describe P. Guillemots choosing blennies as a prey item for their chicks. The authors used the term "blenny" as a general category for small, tapered, slender fishes, and later

identify the blennies as gunnels, pricklebacks, ronquils and other eel-like fishes (Golet et al, 2000).

Pacific Sand Lance (*Ammodytes hexapterus*) are lipid-rich schooling fish that inhabit the North Pacific. They are elongated and grayish in color, and difficult to identify unless in hand. They are described as being a main prey item for P. Guillemots, and the decline of certain populations of P. Guillemots has been attributed to the lack of these fish being available (Litzow et al, 2002). This seems to be unlikely in the Puget Sound, however, as spawning grounds for these fish are abundant, and in fact, are present in all the sites I monitored along the coast of Whidbey Island (Penttila, 1997). Late in the season I discovered how small these fish are, and I undoubtedly misidentified them as gunnels throughout the season. Eulachon (*Thaleichthys pacificus*) are also slender, high fatty fish that reside in the Puget Sound near shorelines and the mouths of rivers. They are also difficult to identify unless in hand, and, again may have been delivered to chicks and marked as gunnels.

Flatfishes are extremely difficult to identify, even when you have them in hand. Because of the variety of flatfish that live in the sound, these fish were categorized as one group.

Figure 1



Total deliveries for the 2009 Season. "Other" includes fishes that I was not able to identify.

From the Figure 1, it is clear that the majority of deliveries consisted of long, slender fishes. The "Gunnel" group included several species of gunnels, pricklebacks, and most likely Pacific Sand Lance and Eulachon. Because P. Guillemots consume their food whole, feeding chicks these fishes would seem to be the most beneficial to avoid choking hazards, from which chicks have died (Ewins, 1993).

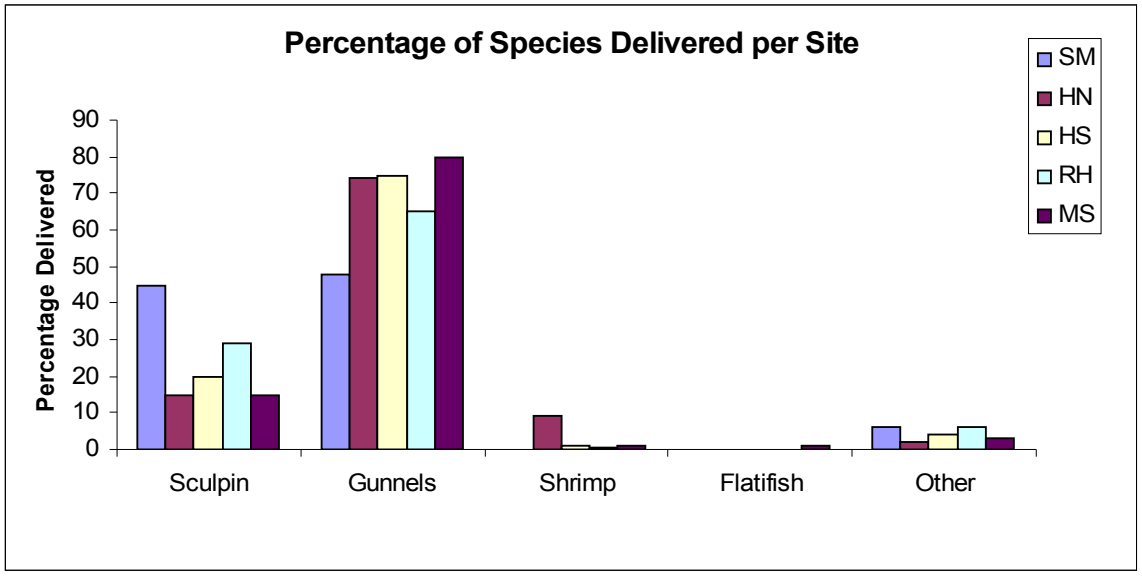
Table 1

Site	Sculpin	Gunnels	Shrimp	Flatfish	Other	Total
SM	43	46	0	0	6	95
HN	18	88	11	0	3	120
HS	27	101	1	0	5	134
RH	55	125	1	0	11	192
MS	22	122	1	2	5	152
Total	165	482	14	2	30	693

Table 1 shows total numbers of deliveries per site, and deliveries per group type.

Table 1 shows a breakdown of all the deliveries observed over the season. There were a total of 693, with Rolling Hills (RH) receiving the most deliveries. The most deliveries do not necessarily correlate with the most success (meaning, in this case, chicks that successfully fledged). Included in these numbers are failed burrows, which would only receive a few deliveries. Shore Meadows (SM) is interesting because of all the colonies that I monitored, it had the highest number of adults present; the highest number counted was 70, yet there were only 7 active burrows at that location. Harrington South (HS) had a high count of 32 adults, and a total of 8 active burrows. Harrington North (HN) had a high of 38 adults counted, and 8 burrows. Rolling Hills (RH) had 51 adults, and a total of 12 burrows, while Mutiny Sands (MS) had a high count of 55 adults and 9 active burrows.

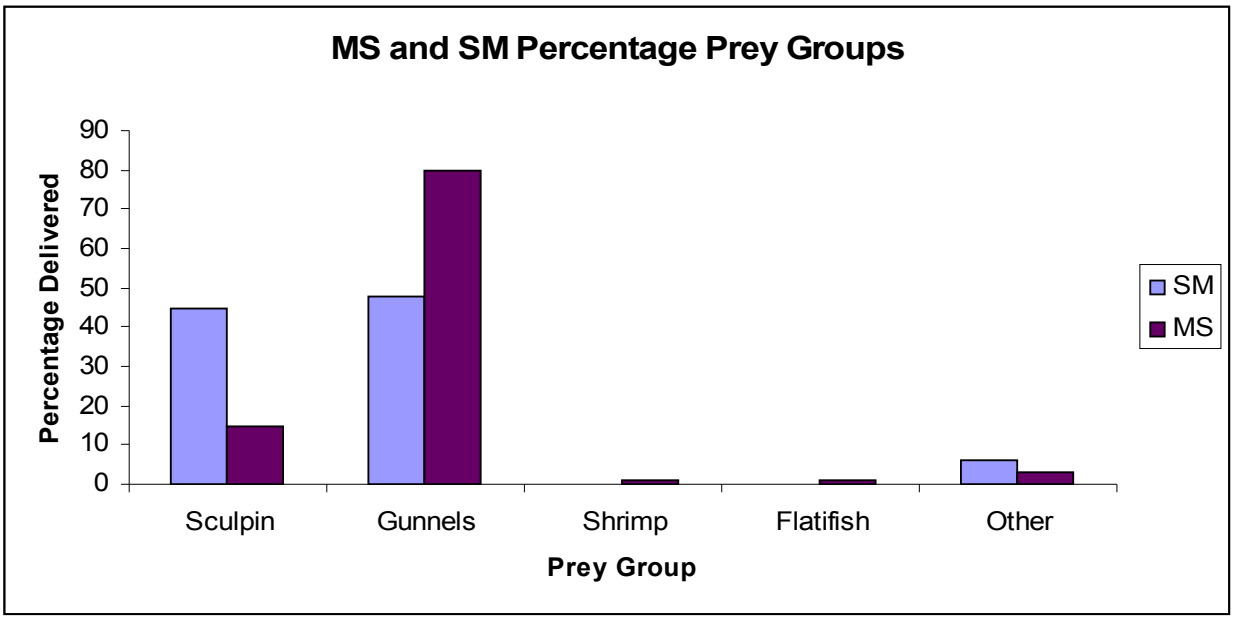
Figure 2



SM is Shore Meadows, HN is Harrington North, HS is Harrington South, RH is Rolling Hills, and MS is Mutiny Sands.

Figure 2 is a breakdown of the percentage of groups delivered per site. It is clear from this chart that gunnels and other slender fishes were the majority of prey items delivered.

Figure 3



MS is Mutiny Sands, and SM is Shore Meadows. Prey specialization is taking place at Mutiny Sands.

In one case, Shore Meadows, the percentage of gunnels and sculpin deliveries were just about even. Deliveries per burrow at Shore Meadows are shown in Figure 5 (below). It is interesting to note that P. Guillemots nesting at the Mutiny Sands site did not have this same pattern, even though these birds are separated by half a mile of beach, and have access to the same fishing areas. Mutiny Sands birds delivered more gunnels than sculpin. Prey specialization by adults has been documented, and it appears that prey specialization benefited the chicks, as the specialized adults chose larger, more lipid-dense prey items for their chicks (Emms and Verbeek, 1991; Golet et al, 2000). This resulted in fewer deliveries by the adults, and fewer chances of the burrow being exposed to predators (Golet, et al, 2000). From figures 2 and 3, it appears that certain sites have adults that specialize in prey choice.

Figure 5

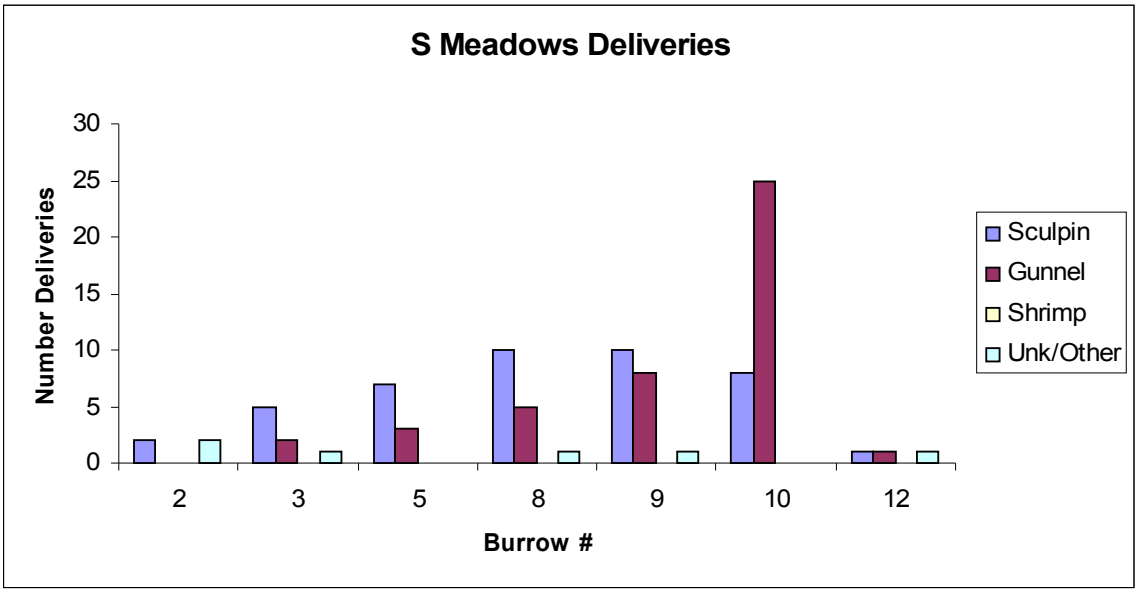


Figure 5 shows the prey selection for Shore Meadows; it is obvious by the breakdown that these birds, as a whole, were not specializing in prey choice.

Figure 6

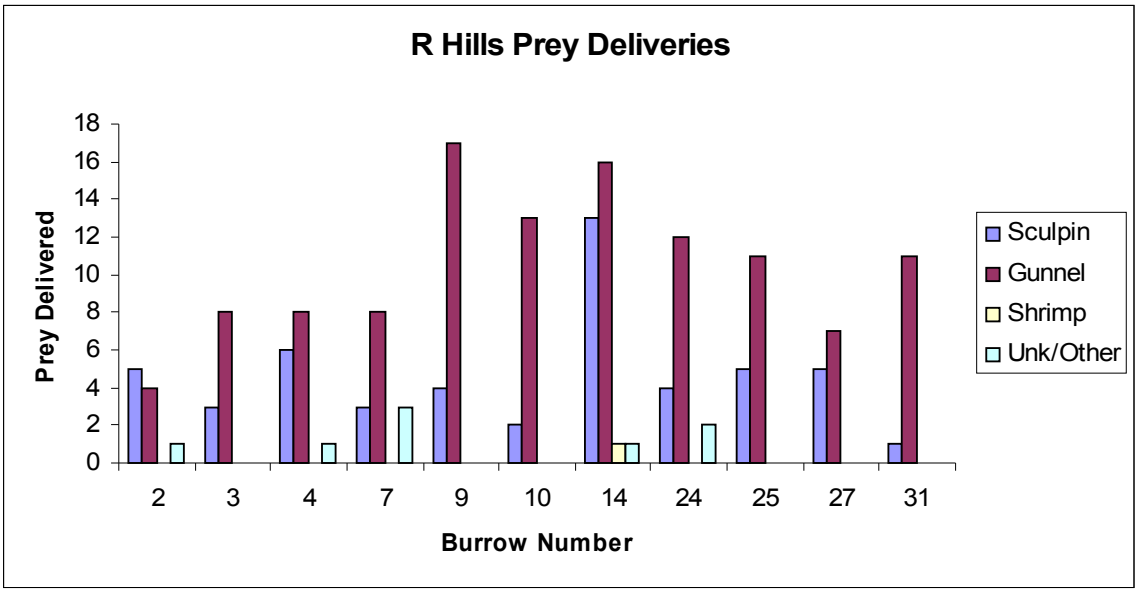


Figure 7

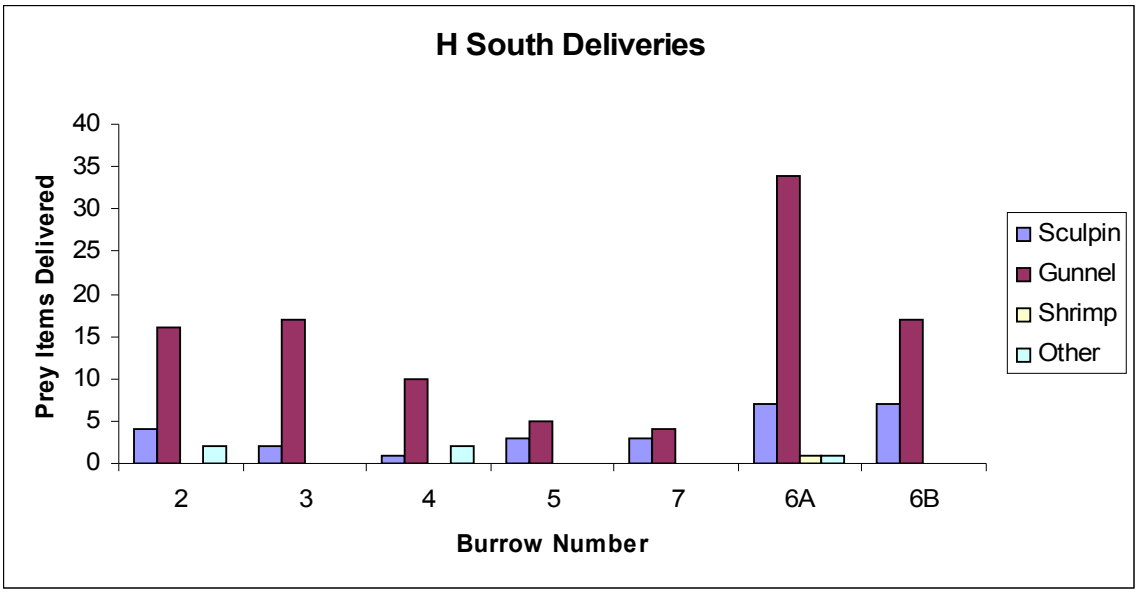


Figure 8

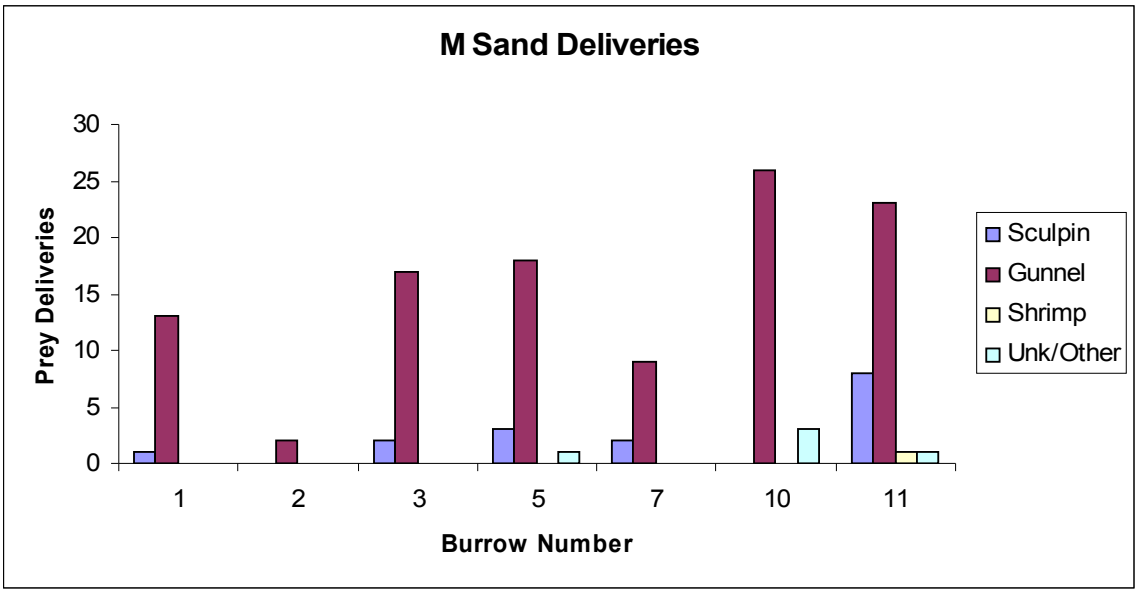
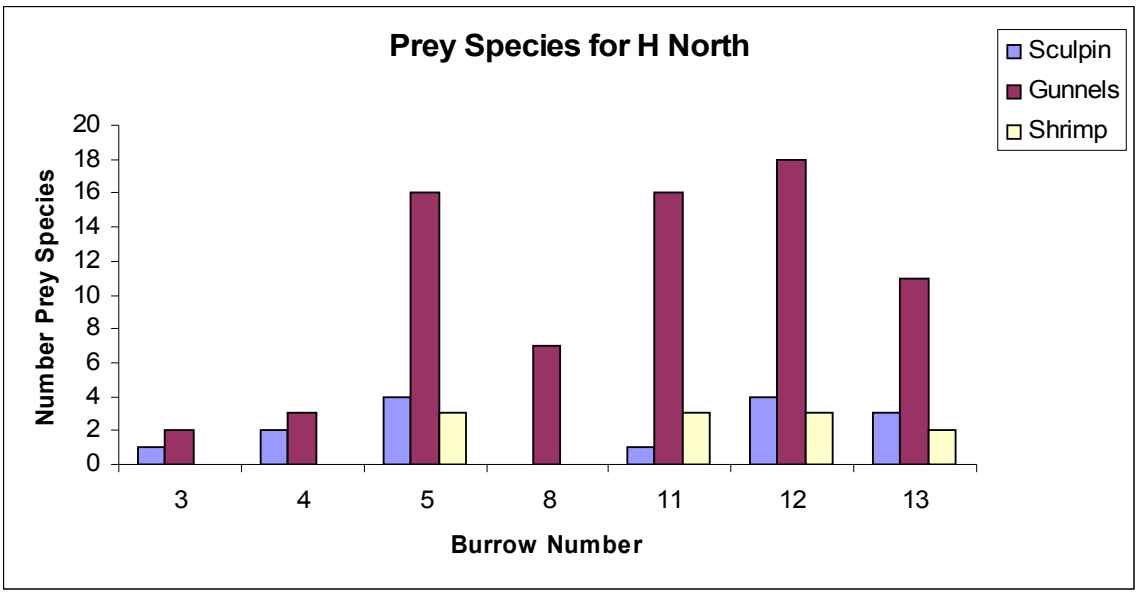


Figure 9



Prey selection by adults nesting in Harrington North Burrows. Note Burrow 8 had only Gunnels delivered.

Adults at the Harrington North, Harrington South, Mutiny Sands and Rolling Hills colony appear to be specialized in prey selection. P. Guillemots using burrows at Mutiny Sands and Harrington North seem to be quite specialized; these birds rarely fed sculpin, but relied heavily on gunnels, as shown in Figures 8 and 9. For the Harrington North site, burrow 11, had more shrimp delivered than sculpin. This phenomenon did not repeat itself at other sites. Especially interesting is Burrow 8 at Harrington North, which was observed delivering only gunnels. This would be considered to be specialization on the part of both adults, since both parents feed the chicks (Ewins, 1993).

P. Guillemots are capable of raising more than one chick; the alpha chick is born first, then beta chicks, and prey choice plays a large role in the health of the beta chick. Litzow et al, 2002 observed that when P. Guillemots fed their chicks high-lipid prey items, the beta chicks had higher growth rates than beta chicks that receive prey items with lower lipid levels. Overall chick (alpha and beta) survival rates were also greater when they received high lipid items; survival to day 15 after hatching was 47% higher when fed fatty fishes (Litzow, et al, 2002). Beta chicks, however, fledge later and at lower weights than their alpha siblings (Emms and Verbeek, 1991). It may be that beta chicks that are fed low-lipid fishes do not survive to fledging; adults are not able to

provide enough food for optimal growth rates when more than one chick is in the brood (Emms and Verbeek, 1993). High fatty fishes, even if delivered at slower rates, may provide enough nutritional content to support the beta chick to fledging. It is important to note that delivery rates differ from provisioning rates; three sculpin to a chick within an hour may be good, but two Pacific Sand Lance would be better because of the difference in nutritional value.

High lipid fishes in the Puget Sound include Eulachon, which are 50% fat, and Pacific Sand Lance, which are 25% fat; sculpins and gunnels are only 10% fat (Anthony et al, 2000). Prey choice is clearly an important component to raising chicks. Pigeon Guillemot chicks have extremely fast growth rates, and go from hatching to adult size in less than 40 days (Ewins, 1993; Golet et al, 2000; Emms and Verbeek, 1991). This growth requires a large amount of nutrition supplied by the adults.

The differences in prey selection indicate that the Pigeon Guillemots using burrows at Mutiny Sands, both Harrington sites and Rolling Hills are more selective about what they are feeding their chicks. This indicates that those populations of birds are more likely to have successful beta chick survival, and over-all chick survival to day 15 than those at Shore Meadows. It is also interesting to note that the burrows at Shore Meadows are the highest, at 70 feet above the shore, compared to 20-40 feet above the shore for other sites. The height differences among the burrows, paired with the difference in prey selection, indicate that the Pigeon Guillemots at Shore Meadows are not as experienced as P. Guillemots using other sites.

Based on prey selection and number of deliveries there did not seem to be a shortage of prey during the 2009 season; the limiting factor for breeding birds on Whidbey Island appears to be lack of burrows available. The burrows used at Shore Meadows appear to be the least desirable; if experienced birds arrive at nesting colonies two weeks before the inexperienced birds, this would indicate that the other sites would already have been occupied when the Shore Meadows breeding birds arrived.

Predation rates are a large factor in burrow selection. Northwestern Crows (*Corvus caurinus*), Garter Snakes (*Thamnophis* sp.), Raccoons (*Procyon lotor*), Great Horned Owls (*Bubo virginianus*), Peregrine Falcons (*Falco peregrinus*), Bald Eagles (*Haliaeetus leucocephalus*) and River Otters(*Lutra canadensis*) are just some of the listed predators of eggs, chicks and adult Pigeon Guillemots (Vermeer et al, 1993; Emms and Verbeek, 1989; Ewins, 1993) Invasive rats have been found to be responsible for an 83% decrease in some Alcid populations (Jones, et al, 2007); there are rats on Whidbey Island that could be affecting the breeding success of P. Guillemots. Also present are River Otters and I noticed several groups of otters along beaches late in the season, and one individual started to use a pile of driftwood as a den at Harrington South. I attributed the loss of at least one chick to this otter, and was intrigued by the amount of activity under the burrows by this animal. There was an abundance of otter tracks and fecal matter beneath the burrows of the Harrington South site that were not present earlier in the

season. The lack of River Otters in the beginning of the season implies that it would be beneficial to the P. Guillemots to lay eggs earlier to avoid predation from at least one predator. It is unclear why River Otters arrived in the last weeks of the season and were not present in the beginning weeks; these could be the pups from the 2009 season leaving and finding territory of their own.

More information is needed to determine if the burrows at Shore Meadows are less desirable; it is possible that height does not matter and that these burrows may be suitable for successful fledglings; there is more to burrow selection than height. Predation rates, burrow depth and chamber complexity all have large roles in chick rearing, but nesting near conspecifics is apparently not important when selecting a burrow (Emms and Verbeek, 1989). Further study on the burrows of Whidbey Island may be able to shed light on why these burrows are being used, and if the correlation between prey choice and burrow selection can be used to predict fledgling success in this unique habitat.

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