Final Contract Report to the North Pacific Coast Marine Resource Committee:

Food Habits of River Otters (*Lutra canadensis*) in the Lake Ozette Watershed

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Abstract

River otter food habits have not previously been studied in the state of Washington. Food habits of river otters in the Lake Ozette watershed were of interest because anecdotal evidence suggested that river otters were predating threatened Lake Ozette sockeye salmon. Two hundred and seventy-two river otter scat samples were collected from the Lake Ozette watershed in 1998, 1999, 2002, and 2003. Food habits of river otters in the Lake Ozette watershed were similar to most published studies on river otter food habits. Of interest for the Lake Ozette watershed in relation to other studies was the high frequency of occurrence of salmonid remains in river otter scat samples. Samples collected in the lake and in the river had high frequency of juvenile salmonid remains in July. Adult salmonid remains were frequently observed from samples collected at the river and weir sampling areas in July and October. The high frequency of occurrence of adult salmon in river otter scat in July coincides with the upstream migration of Lake Ozette sockeye. Genetic analysis of salmonid bones collected from fecal samples is needed to determine what portion of salmonid remains found are in fact Lake Ozette sockeye salmon. Future studies should also focus on collecting river otter scat from the lake sampling area in the late fall and early winter to determine if river otters are predating on sockeye salmon that are holding or spawning in the lake.

Introduction

Few studies have been published on river otter diets in Pacific Northwest and none in the state of Washington. Washington State is of interest because the Lake Ozette evolutionary significant unit of sockeye salmon (*Oncorhynchus nerka*) was listed under the Endangered Species Act as Threatened (NOAA 2009). In a comprehensive review of threats to the recovery of Lake Ozette sockeye salmon predation was identified as potential factor (Haggerty et al. 2009). One of the threats of interest in this paper is the presence of predators and in particular river otters.

Past studies and anecdotal reports suggest that otters may be significant predators of sockeye salmon throughout the Lake Ozette watershed (Gearin et al. 2002). An area of particular concern is a man made weir at the mouth of Lake Ozette that is used for counting returning adult sockeye salmon (Gearin et al. 2002, Haggerty et al. 2009). This study presents the analysis of scat samples to determine food habits of river otters from collection areas in the lake, the river, and around the sockeye salmon counting weir. These samples will be used to document the food habits of river otters within the Lake Ozette watershed, determine if food habits vary by sampling area, and to document potential interactions of river otters and Lake Ozette sockeye salmon.

Methods

Study Area

The Lake Ozette watershed is located on the northern Olympic Peninsula of Washington State (figure 1). The Ozette River runs seven kilometers from Lake Ozette to the Pacific Ocean. A weir is located a half kilometer downriver of the lake mouth. The weir is used by Makah Fisheries Management to count returning adult sockeye salmon and to trap out-migrating sockeye smolt.

The lake has a surface area of 2,954 hectares and has beach spawning sites for sockeye salmon at Allen's Beach and Olson's Beach which are both located on the south end of the lake. Sockeye salmon also spawn in the major tributaries of Umbrella Creek and Big River which both drain into the Northwest portion of the lake.

Figure 1: River otter scat was collected from three sampling areas within the Lake Ozette watershed. Samples were collected in the lake, from Ozette River, and from the shaded area in near proximity to the Ozette River sockeye weir.

Sample Collections and Processing

River otter scats were collected from latrine sites by NOAA Fisheries' National Marine Mammal Lab from 1998 to 2000 and from 2002 to 2003 by a Makah Tribal Youth Program. Scats were collected from latrine sites and marking sites. Collected scat was stored in whirlpack bags and labeled to site and date collected. The scat was then frozen for later processing. Samples were separated into four collection locations; including within the watershed, within the lake, in close proximity to the salmon weir, and in the river habitat away from the weir.

During processing scats were washed through nested sieves of 1 cm, 0.5 cm, and 0.25 cm. All hard parts from prey species (i.e. bones, shells, and feathers) and vegetation were stored in 50% isopropyl alcohol. The samples were later dried in a coffee filter.

Prey remains were examined using a dissecting microscope and were identified to the lowest taxonomic levels possible using all identifiable prey remains (e.g. vertebrae, teeth, scales and otoliths). All identifiable remains were compared to a reference collection of Pacific Northwest fishes; birds, mammals, amphibians, and plants. Salmonid remains were separated into three size classes large (adult fish), juvenile (smolts and fry) and salmonid (trout or small adult). Paired features (such as otoliths and mouthparts) were used to estimate the minimum number of individual salmonids consumed by size in each scat.

River otter prey was summarized by calculating the absolute frequency of occurrence (number of occurrences divided by the number of scat). Frequencies of occurrence of prey species of interest and of prey taxon were pair wise compared between the collection areas using a Fisher's Exact Test.

Results

In total 272 scat samples were collected from the Lake Ozette watershed; 76 were from the lake, 63 from the river, and 133 were sampled near the weir. The 76 scats in the lake were collected between 9 July and 16 August of 2002 and 4 August and 6 August of 2003. River collections were mostly made in June of 1998 with collections also made in July of 2002. Collections were conducted at the weir in June of 1998, in August and October of 1999, in July and August of 2002, and July and August of 2003. Twenty-one scat samples were also collected in the marine environment around the Neah Bay harbor. Results from scats collected in the marine environment are shown in appendix A.

Otters consumed a diverse range of prey within the Lake Ozette watershed. The most common prey species was crayfish (*Pacifastacus leniusculus*) (Table 1). Slow moving fish species such as cyprinids (northern pike minnow (*Ptychocheilus oregonensis*) and peamouth (*Mylocheilus caurinus*)) and Prickly sculpin (*Cottus asper*) were the most commonly observed teleost fish. Salmonid (*Oncorhynchus sp*.) remains were recovered in a third of the scat samples (n=97). Salmonid prey remains were separated by size (Table 1) and enumerated for minimum number of individuals to give an indication of the age of salmonid consumed. Most adult salmon and trout sized salmon bones recovered in a scat represented remains from one individual fish; juvenile salmon ranged from 1 to 7 individuals per scat with an average of 1.5 individuals per scat. Marine fish species were found in three river otter scats collected in freshwater.

Table 1: Species identified in 272 scat samples collected in the Lake Ozette watershed. The first figure is the number of scat the item appeared in and the figure in brackets is the frequency of occurrence of scats the item appeared within.

Taxon	Species	Size class	Lake (n=76)	River (n=63)	Weir (n=133)	Watershed total (n=272)
Invertebrate			67 (88.2)	56 (88.9)	119 (89.5)	243 (89.3)
	Crayfish		67 (88.2)	53 (84.1)	116 (87.2)	237 (87.1)
	Mussel		1 (1.3)	13 (20.6)	6 (4.5)	20 (7.4)
	Snail		3 (3.9)	6 (9.5)	6 (4.5)	15 (5.5)
	Clam		0 (0)	5 (7.9)	6 (4.5)	11 (4.0)
Fishes			72 (94.7)	50 (79.4)	108 (81.2)	231 (84.9)
	Prickly Sculpin		51 (67.1)	28 (44.4)	73 (54.9)	152 (55.9)
	Salmonid		26 (34.2)	19 (30.2)	46 (34.6)	91 (33.5)
		Adult	*2 (2.6)*	*11 (17.5)*	*28 (21.1)*	*41 (15.1)*
		Trout/small adult	*4 (5.3)*	*2 (3.2)*	*7 (5.3)*	*13 (4.8)*
		Juvenile	*21 (27.6)*	*10 (15.9)*	*19 (14.3)*	*50 (18.4)*

Taxon	Species	Size class	Lake (n=76)	River (n=63)	Weir (n=133)	Watershed total (n=272)
	Cyprinidae		37 (48.7)	11 (17.5)	28 (21.1)	76 (27.9)
	Three Spine Stickleback		17 (22.4)	6 (9.5)	22 (16.5)	46 (16.9)
	Unidentified		13 (17.1)	8 (12.7)	11 (8.3)	32 (11.8)
	Cottidae		2 (2.6)	6 (9.5)	8 (6.0)	16 (5.9)
	Yellow Perch		2 (2.6)	0 (0)	4 (3.0)	6 (2.2)
	Lamprey		0 (0)	2 (3.2)	2 (1.5)	5 (1.8)
	Pacific Lamprey		0 (0)	3 (4.8)	2 (1.5)	5 (1.8)
	Gunnel		2 (2.6)	0 (0)	0 (0)	2 (0.7)
	Rockfish		0 (0)	0 (0)	1 (0.8)	1 (0.4)
	Clupeidae		0 (0)	0 (0)	1 (0.7)	1 (0.4)
	Perch		1 (1.3)	0 (0)	0 (0)	1 (0.4)
Mammal			4 (5.3)	8 (12.7)	6 (4.5)	18 (6.6)
	Unidentified		4 (5.3)	8 (12.7)	6 (4.5)	18 (6.6)
Amphibian			21 (27.6)	7 (11.1)	3 (2.3)	31 (11.4)
	Unidentified		21 (27.6)	7 (11.1)	3 (2.3)	31 (11.4)
Bird			1 (1.3)	1 (1.6)	1 (0.8)	3 (1.1)
	Unidentified		1 (1.3)	1 (1.6)	1 (0.8)	3 (1.1)
Plant			0 (0)	2 (3.2)	18 (13.5)	20 (7.4)
	Blackberry		0 (0)	0 (0)	15 (11.3)	15 (5.5)
	Unidentified		0 (0)	2 (3.2)	7 (5.3)	9 (3.3)

River otter food habits varied between sampling areas (Table 1). Figure 2 summarizes the frequency of occurrence that prey taxons were consumed. Fish and invertebrates were both the most common taxons consumed in all three sampling areas. Pair wise comparisons of proportions showed that fish are found in significantly more scat samples than in river samples (Fisher's Exact Test, $p = 0.008$). The proportion of amphibian in the scat samples was significantly different for each sampling area. Lake samples were 16 times more likely to have amphibian remains than weir samples (Fisher's Exact Test, $p << 0.001$); river samples were five times more likely to have amphibian samples than weir samples (Fisher's Exact Test, $p = 0.014$); and lake samples were three times more likely to have amphibian remains than river samples (Fisher's Exact Test, $p = 0.019$). Scat samples from the weir sampling area had significantly more plant material than river samples (Fisher's Exact Test, $p = 0.024$); comparisons were not made between the lake and river samples or between the lake and weir samples to avoid violations of low expected cell frequencies for the Fisher's exact test. It should be noted that only weir samples collected in 1998 and 1999 had plant material and most of that was blackberry and the two river samples collected with plant material was collected in

November and did not have fish or crayfish remains. No statistical differences in frequency of occurrence were seen for mammal or invertebrate by sampling area.

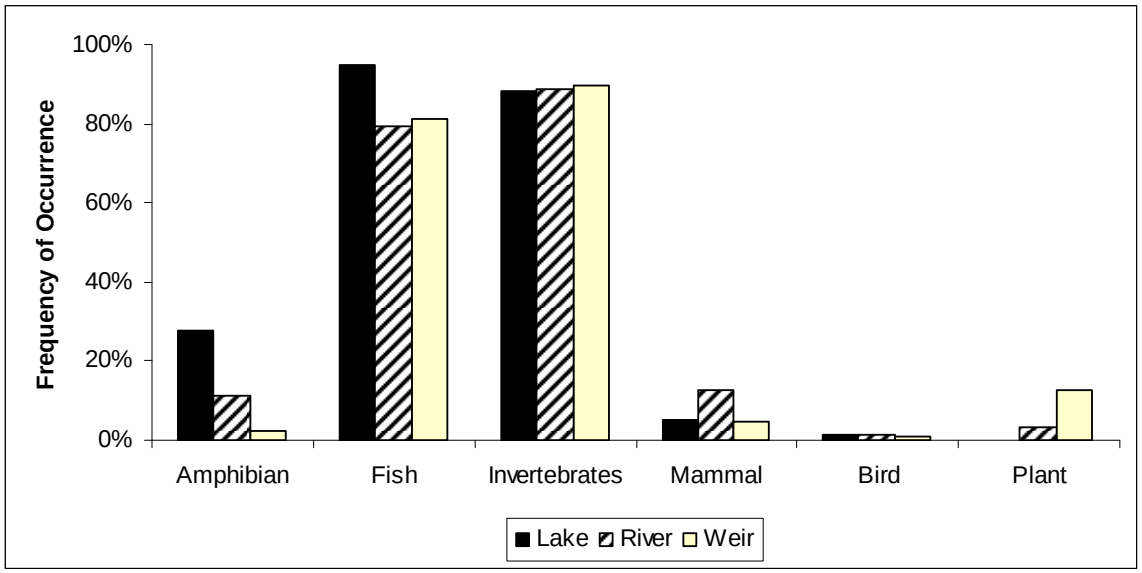

Figure 2: Frequency of occurrence of prey taxon of river otters by sampling area within the Lake Ozette watershed.

Salmonid remains by sampling area

All three sampling areas had high frequency of occurrence of salmonids in river otter scat samples (Figure 3). Inconsistencies of age class of salmon consumed by sampling area were observed. Scat samples collected in the lake were two to 2.3 times more likely to have juvenile salmonid remains than samples collected at river sites and at weir sites respectively (Fisher Exact Test $p = 0.11$, $p = 0.027$). Scat samples collected in the river and weir were 7.8 to 9.8 times more likely to have remains of adult salmon than samples collected lake sampling areas respectively (Fisher Exact Test $p = 0.0033$, $p = 0.00014$). Prevalence of trout to small salmon sized prey remains was relatively consistent by sampling area.

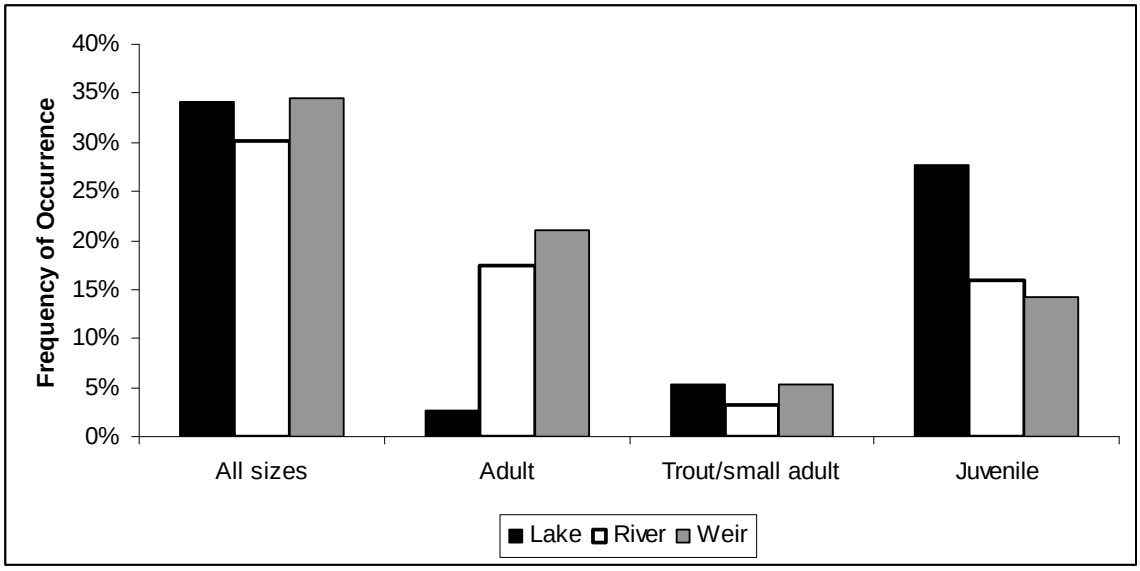

Figure 3: Frequency of occurrence of salmonid remains in river otter scat by size/age class based on sizes of bones observed.

Occurrence of salmonid remains in the scat changed monthly (Table 2). Adult salmon frequency of occurrence was highest in July at all sites and had a second peak in October at the weir. Frequency of occurrence of juvenile salmon in river otter scats was highest in August at samples from the weir and lake sampling areas. The river sampling area had a high frequency of occurrence of juvenile salmon in July; samples were not collected there in August. Trout/small adult sized salmon are not reported in the Table NN. Generally in all months frequency of occurrence of trout/small adult salmon in otter scat was low and ranged between 0 and 9.6% frequency of occurrence.

	Lake		River		Weir	
Month	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult
June	No data	No data	8.3	13.9	0.0 *	0.0 *
July	6.7	6.7	29.1	25.0	11.5	28.8
August	41.3	0.0	No data	No data	22.2	13.0
October	No data	No data	No data	No data	4.3	26.0

Table 2: Frequency of occurrence of juvenile and adult salmonids found in river otter scat in the Lake Ozette watershed reported by month. * Only four samples were collected at the weir in June; all other computed frequencies of occurrences have a sample size between 23 and 54 samples.

Discussion

Past studies of river otter food habits have shown that fish are the most important prey item for river otters. Other taxons of animals and plants are consumed but in most cases are not the primary component of scat or stomach samples. The results of this study largely agreed with results of past studies. The frequency of occurrence of invertebrates (specifically crayfish) and amphibians at sample sites in the lake were much

higher than has been reported in past studies. Mammals and birds were not significant prey items during the sampling period. Blackberries were frequently found in river otter scat collected at the Ozette weir in 1999. It is unclear if the observed consumption of blackberries was the behavior of one individual or if this is a common behavior of otters in the system. As noted by Erlinge (1968) river otter diet is primarily determined by the vulnerability and seasonal availability of prey items as is observed with most opportunistic predators. It is likely that mammals and birds were less available for otters to consume in the Lake Ozette watershed as compared to other published studies and that crayfish were more available. Ryder (1955) opined that otters predominantly prey in proportion to the abundance of prey but in inverse proportion to the prey's swimming ability. The results of this study do not support Ryder's opinion as salmon were often observed in river otter scat samples.

River otter predation of salmonids has been well documented in the Pacific Northwest in the past (Toweill 1974, Melquist and Hornocker 1983, Manning 1990) and by this study. This study is unique in that it categorized salmonid prey remains by size/age classes. This study shows that river otters predate on all age classes of salmonids within the watershed. Past studies have concluded that river otter predation of adult salmonids is due to the increased vulnerability of spawning salmon (Melquist and Hornocker 1983, Reid et al. 1994). The high occurrence of adult salmon in river otter scat in July coincides with the upriver migration of Lake Ozette sockeye salmon. This result agrees with the visual observations reported in Gearin et al (2002) of river otters observed attacking adult sockeye salmon and of otter bite scars on captured adult sockeye salmon. Therefore it is assumable that many or most of the adult salmon prey remains in July came from ESA listed Lake Ozette sockeye salmon. A genetic analysis of the salmonid bones collected from river otter scats in this study is required to determine if the above assumption is correct.

The occurrence of adult salmon in river otter scat in the month of October at the weir site suggests either that the river otters are predating on other species of salmon that are spawning in the river or that these the otters are foraging in the lake on sockeye salmon holding before spawning. Again genetic analysis of the salmonid bones collected from river otter scat in this study will add clarity to resolving the potential impact of river otters on Lake Ozette sockeye salmon.

Unlike the weir and river collection areas, adult salmon were not frequently observed in samples collected from the lake. This is likely due to the timing of scat collections. Data on radio tagged adult sockeye salmon holding in Lake Ozette showed that survival rates were relatively high through September, after September survival rates dropped precipitously through breeding in December (Hughes et al. 2002). Scat samples collected from the lake were collected in the months of July and August which is too early to determine if river otter predation is a causal factor to decreased adult sockeye survival. Further sampling in the lake from September through the end of spawning in December would help determine the role river otters have in preventing or limiting Lake Ozette sockeye salmon recovery.

Prior to the study it was hypothesized that river otter predation of adult sockeye salmon would be greater than other sampling areas within the watershed. Predators of salmon have been shown to take advantage of human made obstructions that slow salmon passage to increase foraging success (Scordino 2010). The frequency of occurrence of

adult salmon remains in scat samples collected near the weir and collected in the river were not statistically different. This can be caused by a variety of factors. First, the arbitrary allocation of sites as river or weir may include the home range of otters that make use of the weir site to predate on salmon. Second, the result may show that otters are able to take advantage of other stream features, such as log jams, that obstruct salmon passage to increase their foraging success on adult salmon. Despite the lack of observed differences in frequency of occurrence of adult salmon remains at sites near the weir and at sites in the river it would still be advisable for managers to devise methods to deter otters from utilizing the weir.

Otter predation of juvenile salmonids was much greater in the lake than at the weir or river sites. This is likely caused by the life history of sockeye salmon. Lake Ozette sockeye salmon have a one-year residency time in Lake Ozette before migrating to the ocean (Haggerty et al. 2009). River otters did have a high frequency of occurrence of juvenile salmon but enumerations of individuals per scat suggest that not many individual juvenile salmon are eaten. River otters are likely a less significant predator of juvenile salmon than cutthroat trout (*Oncorhynchus clarkii*), northern pikeminnow, or other piscivorous fish in Lake Ozette (Beauchamp et al. 1995). While any mortality of an ESA listed species is a concern, the predation of juvenile Lake Ozette salmon is less likely to affect the recovery of the population as predation on adult individuals that have returned to spawn.

Aknowledgements

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Appendix A: Food habits of river otters in Neah Bay

River otter food habits were examined from 21 scat samples collected in Neah Bay. The samples were collected in July of 2002 by the Makah Youth Program. The observed food habits were very similar to observations of river otter food habits in the marine environments of British Columbia and Alaska (Stenson et al. 1984, Larsen 1984). Like Alaska, the river otters appear to have a food preference for slow moving fishes like rockfish, gunnel, and sculpin. The frequency of occurrence of rockfish and gunnel were much greater in this study than in Alaskan studies and Irish lords were less frequent. This likely represents differences in local availability of the noted species. Salmonids of both adult and juvenile age classes were also observed.

Taxon	Species	Size	Number	FO
Invertebrate			3	14.3
	Shellfish		1	4.8
	Urchin		1	4.8
	Mussel		1	4.8
	Snail		1	4.8
Fish			21	100.0
	Rockfish		19	90.5
	Gunnel		19	90.5
	Buffalo Sculpin		5	23.8
	Salmonid		4	19.0
		Adult	*2*	*9.5*
		Juvenile	*1*	*4.8*
	Hexagrammidae		4	19.0
	Snailfish		3	14.3
	Cottidae		3	14.3
	Unidentified		2	9.5
	Three Spine Stickleback		2	9.5
	Perch		2	9.5
	Irish Lord		2	9.5
	Flatfish		2	9.5
	Starry Flounder		1	4.8
	Sand Sole		1	4.8
	Pacific Sandlance		1	4.8
	Herring		1	4.8
	Clupeidae		1	4.8
	Clingfish		1	4.8
	Prickly Sculpin		1	4.8
Bird			1	4.76
	Unidentified		1	4.76