Progress Report:

DIET OF HARBOR SEALS AT A GLACIAL FJORD AND A TERRESTRIAL HAULOUT IN GLACIER BAY

1996 - 2001

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INTRODUCTION

Between 1992 and 2001, the number of harbor seals *(Phoca vitulina richardsi)* observed on terrestrial and glacial ice haulouts in Glacier Bay during August has declined from approximately to 6,300 to 3,200 seals (Mathews, unpublished data). An analysis of trends in seal numbers that incorporates environmental and other influential covariates indicates that numbers of seals on terrestrial haulouts in Glacier Bay declined by 48% (10.9%/yr) between 1992 and 1998 and by 34% (6.8%/yr) in Johns Hopkins Inlet, a tidewater glacial fjord in Glacier Bay where the majority of seals are found (Mathews and Pendleton 2000).

Because surveys document seals ashore, a decline in seals counted could be due to changes in seal haulout behavior or an actual reduction in the population, or both. For example, a change from nearshore to offshore prey could reduce the proportion of time that seals spend ashore (Green et al. 1995) and counts would be biased low. Shifts in prey distribution or the timing of key events, such as salmon spawning, can also affect seal distribution and haulout patterns. We collected scats in 1996 and 1999 - 2001 to document prey consumed during surveys with the longterm goal of incorporating diet as a covariate in seal population trend analyses. Reduced prey availability or quality can reduce survival and reproductive success, thus changes in prey could contribute both to seals spending more time in the water and to reduced productivity and survival. Given the magnitude of the decline in seals in Glacier Bay, and the absence of increases in numbers at haulouts outside of Glacier Bay, and data indicating that seal numbers in the water in Glacier Bay have also declined in the past decade, population declines, rather than changes in distribution or haulout behavior, are strongly suspected.

The goal of this work is to determine the primary prey of harbor seals in Glacier Bay during the time of surveys, so that we can: 1) test whether or not prey type (e.g., nearshore vs. pelagic) affects the number of seals on haulouts during surveys, 2) determine if the diet of seals in GB changes from year to year, 3) compare the diet of seals at the largest terrestrial (Spider Island Reefs) and glacial haulout (Johns Hopkins

Inlet) areas, and 4) compare the diet of seals in Glacier Bay to that of seals in other parts of southeastern Alaska in which seal numbers are stable or increasing.

Prey species were determined using otoliths as well as other hard parts. Several researchers have demonstrated that identifying prey using all hard parts, rather than otoliths alone, significantly improves prey assessment, particulary for species with small or fragile otoliths and fish species for which the predator does not typically consume the head (e.g., salmon).

This purpose of this report is to provide a preliminary summary of the results of scat collections to date. Summary data by study area are compared using only frequency of occurrence data, with no attempt at this time to incorporate fish size or nutritional value into assessments. Additional analysis, literature review, and interpretation of the data will occur when sample sizes are larger.

METHODS

Study Areas

We primarily sampled for scat in Johns Hopkins Inlet (JHI) (58.853 N, 137.096 W), a tidewater glacial fjord where the majority of seals in Glacier Bay rest on icebergs, and at reefs near Spider Island (SI) (58.517 N, 135.939 W), the largest terrestrial haulout area in Glacier Bay. In recent years, we have observed 2,000-3,000 seals in JHI and 300-500 seals at SI in August.

Sample Collection

All approaches to seal haulouts and icebergs were made by kayak, although one scat in 2001 was found on an iceberg that had grounded on the beach. Before approaching a haulout to collect scat, a count of seals was made either from shore or kayak. At the Spider Island reefs, samples were collected 1.5 - 2.5 hrs after peak low tide and after all aerial surveys for the season were completed. Samples were collected using a variety of tools and placed in labeled plastic bags. We attempted to get complete samples, but

occasionally this was not possible due to either the substrate or consumption of some of the scat by gulls. During some years, there were very few scat samples at one or both sites. Samples were kept cool while in the field and frozen upon return from the field and until shipping.

Scat Analysis

Undigested prey parts were isolated from feces and cleaned using an enclosed elutriator (Bigg 1990), a system that separates bones and otoliths based on their higher densities and tendency to remain in a tall column of water with a continuous flow of water. The identification of prey from the scat samples occurred in 1997, 2000, and 2001 by Susan Crockford or her staff at Pacific Identifications (Oldfield Rd., RR 3, Victoria, B.C. Canada, V9E 2J4), a group that specializes in identifying prey remains using otoliths as well as additional hard structures (e.g., cranial elements, teeth, vertebrae, scutes, scales, and gill and fin structures) from stomachs and feces of marine mammals (Crockford 1998). The presence or absence of body parts from invertebrates was noted, but these elements were not identified to species.

Identification of prey was based on comparisons of otoliths and bones and parts of bones to an extensive reference library of hard parts available to Pacific Identifications. Prey identification was to family, genus and species where possible, and the data base includes a confidence code ranking for each taxonomic level. In some cases only family identifications could be made.

Frequency of Occurrence of Prey Species

The frequency of occurrence of a prey item is the number of samples in which a particular species is found divided by the sum of all species found in all samples. This commonly used measurement of relative importance biases results such that less important species eaten in small amounts are ranked higher than they should be and common prey items eaten in large quantities are undervalued, since the size of prey items is not incorporated into the analysis (Olesiuk et al. 1990). For example, if a small fish such as sand lance *(Ammodytes hexapterus)* occurs as often as salmon *(Oncorhynchus*

spp.) these 2 species would have the same frequency of occurrence value, even though the salmon would likely be nutritionally more important, assuming that most of the salmon was consumed by an individual seal, rather than shared. For prey species of approximately equal volume and nutritional value, frequency of occurrence is a reasonable estimator of prey importance. I calculated the frequency of occurrence of prey items for all Glacier Bay samples combined and for each of the study areas separately.

Minimal Number of Fish per Scat

One estimate of the variety of fish in the diet or available in the habitat, is the minimal number of different prey species identified in a scat sample. The mean values of prey types per scat were calculated for all samples combined and for Johns Hopkins Inlet and Spider Island reefs separately. I also compared the mean number of fish in samples from the Spider Island reefs in 1996 and 2001, since we had larger sample sizes for these two years.

RESULTS

Samples Collected

From 1996 to 2001 we collected 86 scat samples from harbor seals in Glacier Bay. Of these, 10 did not contain any identifiable fish or invertebrate remains (Table 1). In 1994 and 1997 we also collected 5 regurgitated pellets from Bald Eagles in JHI. In 1999, we collected 2 scat samples from Steller sea lions. This report summarizes prey data from harbor seal scat only. Appendix I lists all species identified in harbor seal scats collected in Glacier Bay.

Minimal Number of Fish per Scat

Thirty-three different species of fish plus unidentifiable fish bones were identified in seal scat from both study areas combined (Table 2). The minimal number of individual fish identified at least to the family level in all years was 125 based on otoliths alone and 354 from available hard parts excluding otoliths. The best minimal estimate for the number

of fish identified in all scat samples (summing the higher count from bones or otoliths) was 406 fish (Table 3).

Significantly more individual fish were found in scats from Spider Island (mean = 6.5, SD = 7.7) than in JHI (mean = 2.5, SD = 2.6); collection year did not affect the number of prey items per scat (Analysis of Covariance, Statview, p = 0.02) (Table 2). One seal scat from the Spider Island area had otolths from at least 38 capelin and another scat sample contained bone elements from at least 33 sand lance. For samples from the Spider Island reefs, there was no difference in the mean number of individual fish per scat between 1996 and 2001 (mean = 7.3 and 5.8, respectively, Mann-Whitney U test, p = 0.399).

Frequency of Occurrence of Prey Species

For both study areas combined, pollock *(Theragra chalcogramma)*, salmon *(Oncorhynchus spp.),* capelin *(Mallotus villosus)*, and sand lance *(Ammodytes hexapterus)* were the species that found in scat most often (Table 3). At both Johns Hopkins Inlet and the Spider Island reefs individually, pollock was also the species with the highest frequency of occurrence (Table 4). In both areas salmon and capelin also ranked within the top 4 in frequency of occurrence, but sand lance was ranked slightly higher in importance at the Spider Island reefs compared to Johns Hopkins Inlet. Twenty-three percent of samples from Johns Hopkins Inlet contained bone or otolith parts that could not be identified, compared to only 1.9% of samples from the Spider Island reefs. Twelve different prey species were identified in the 30 scats from seals in Johns Hopkins Inlet compared to 27 prey species for the 159 Spider Island samples (Table 4). Herring *(Clupea spp.)* was notably absent from scats collected in Johns Hopkins Inlet.

Recommendations

We are currently collecting very few scats per year (Table 1), and small sample sizes will reduce the sensitivity of statistical analysis for detecting changes in prey or regional

differences. Sample sizes in Johns Hopkins Inlet may be improved by allowing more time for searching for scats on icebergs. To increase sample sizes at terrestrial haulouts, we should begin collecting at more sites than just Spider Island and sample collection at Spider Island needs to occur more often than once per year.

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Table 1. Summary of scat samples collected from harbor seals and Steller sea lions and regurgitated pellets from Bald Eagles in Glacier Bay. (JHI = Johns Hopkins Inlet)

Year	Samples	Common Name	Species	Location
1994	1	Bald Eagle	*Haliaeetus leucocephalus*	JHI
1996	5	Harbor Seal	*Phoca vitulina*	JHI
1996	23	Harbor Seal	*Phoca vitulina*	Spider Is Rfs
1997	4	Bald Eagle	*Haliaeetus leucocephalus*	JHI
1998	4	Harbor Seal	*Phoca vitulina*	JHI
1999	1	Steller Sea Lion	*Eumetopias jubatus*	Bartlett Cv
1999	1	Steller Sea Lion	*Eumetopias jubatus*	SMI
1999	3	Harbor Seal	*Phoca vitulina*	JHI
2000	7	Harbor Seal	*Phoca vitulina*	JHI
2000	1	Harbor Seal	*Phoca vitulina*	Spider Is Rfs
2001	2	Harbor Seal	*Phoca vitulina*	JHI
2001	31	Harbor Seal	*Phoca vitulina*	Spider Is Rfs

Subtotals by Species	
76	Harbor Seals
2	Steller Sea Lions
6	Bald Eagles
84	Total Samples

Table 2. The minimal number of individual fish represented in scat samples from harbor seals in Johns Hopkins Inlet (JHI) and at the Spider Island reefs in Glacier Bay. Samples were collected from 1994 to 2001.

		Individual Fish Per Scat				Invertebrates	
Location	scat samples	Total	Mean	SD	Max	Present in Scat	% with Inverts
Glacial Fjord (JHI)	21	52	2.5	2.62	9	3	14%
Spider Is Reefs	55	357	6.5	7.75	43	5	9%

Table 3. Occurrence and frequency of occurrence (Freq Occ) of fish species identified in scat from harbor seals in Glacier Bay, 1994-2001.

	COMMON NAME	Species	Occ	Fr Occ
1	POLLOCK	*Theragra chalcogramma*	46	24%
2	SALMON	*Oncorhynchus sp.*	27	14%
3	CAPELIN	*Mallotus villosus*	25	13%
4	SAND LANCE	*Ammodytes hexapterus*	15	8%
	UNIDENT. FISH	Pisces	10	5%
5	HERRING	*Clupea harengus*	8	4%
6	GADID (NH)	*Gadidae, not hake*	8	4%
7	HERRING	*Clupea pallasi*	6	3%
8	DAUBED SHANNY	*Lumpenus maculatus*	5	3%
9	LAMPFISH SPP.	*Stenobrachius sp.*	4	2%
10	SCULPIN SP	*Cottidae*	3	2%
11	HAKE	*Merluccius productus*	2	1%
12	IRISH LORD SPP	*Hemilepidotus spp.*	2	1%
13	NORTH. LAMPFISH	*Stenobrachius leucopsarus*	2	1%
14	PACIFIC COD	*Gadus macrocephalus*	2	1%
15	FLATFISH SPP	*Pleuronectiformes*	2	1%
16	ROCK SOLE	*Lepidopsetta spp.*	2	1%
17	ROCK SOLE NORTH	*Lepidopsetta mochigarei*	2	1%
18	SNAKE PRICKLE.	*Lumpenus sagitta*	2	1%
19	PRICKLEBACK SPP	*Lumpenus spp.*	2	1%
20	GRT.-TYPE SCULP	*Myoxocephalus spp.*	1	1%
21	FLATHEAD SOLE	*Hippoglossoides elassodon*	1	1%
22	GADID	*Gadidae*	1	1%
23	GREENLING SP	*Hexagrammmos spp.*	1	1%
24	GUNNEL/PRICKLEB	*Stichaeidae/Pholididae*	1	1%
25	HERRING/SHAD?	*Clupeidae*	1	1%
26	AMERICAN SHAD	*Alosa sapidissima*	1	1%
27	NON-FISH	*Bird or mammal*	1	1%
28	YELLOW IRISH LD	*Hemilepidotus jordani*	1	1%
29	PRICKLEBACK SPP	*Stichaeidae*	1	1%
30	ROCKFISH SPP	*Sebastes spp.*	1	1%
31	SCULPIN SPP	*Cottidae*	1	1%
32	SMELT SPP	*Osmeridae*	1	1%
33	MYCTOPHID	*Myctophidae*	1	1%
		Total =	189	

Table 4. Frequency of occurrence of fish species identified in scat from harbor seals in Johns Hopkins Inlet, a tidewater glacial fjord, and from seals at the Spider Island reefs, a terrestrial haulout.

			Johns Hopkins Inlet			Spider Island Reefs		
	COMMON NAME	**Species**	**Occ**	**Fr Occ**	**Rel#**	**Occ**	**Fr Occ**	**Rel#**
1	POLLOCK	*Theragra chalcogramma*	8	27%	1	38	24%	1
2	SALMON	*Oncorhynchus sp.*	2	7%	4	25	16%	2
3	CAPELIN	*Mallotus villosus*	3	10%	3	22	14%	3
4	SAND LANCE	*Ammodytes hexapterus*	1	3%		14	9%	4
5	HERRING	*Clupea harengus*				8	5%	
6	GADID (NH)	*Gadidae, not hake*	1	3%		7	4%	
7	HERRING	*Clupea pallasi*				6	4%	
8	DAUBED SHANNY	*Lumpenus maculatus*				5	3%	
9	LAMPFISH SPP.	*Stenobrachius sp.*				4	3%	
10	UNIDENT. FISH	*Pisces*	7	23%	2	3	1.9%	
11	SCULPIN SPP	*Cottidae*	1	3%		3	1.9%	
12	SNAKE PRICKLE.	*Lumpenus sagitta*				2	1.3%	
13	ROCK SOLE NORTH	*Lepidopsetta mochigarei*				2	1.3%	
14	ROCK SOLE	*Lepidopsetta spp.*				2	1.3%	
15	PRICKLEBACK SPP	*Lumpenus spp.*				2	1.3%	
16	PACIFIC COD	*Gadus macrocephalus*				2	1.3%	
17	NORTH. LAMPFISH	*Stenobrachius leucopsarus*				2	1.3%	
18	IRISH LORD SPP	*Hemilepidotus spp.*				2	1.3%	
19	YELLOW IRISH LD	*Hemilepidotus jordani*				1	0.6%	
20	SMELT SPP	*Osmeridae*				1	0.6%	
21	PRICKLEBACK SPP	*Stichaeidae*				1	0.6%	
22	HERRING/SHAD?	*Clupeidae*				1	0.6%	
23	HAKE	*Merluccius productus*	1	3%		1	0.6%	
24	GUNNEL/PRICKLEB	*Stichaeidae/Pholididae*				1	0.6%	
25	GRT.-TYPE SCULP	*Myoxocephalus spp.*				1	0.6%	
26	GREENLING SP	*Hexagrammmos spp.*				1	0.6%	
27	FLATFISH SPP	*Pleuronectiformes*	1	3%		1	0.6%	
28	AMERICAN SHAD	*Alosa sapidissima*				1	0.6%	
29	ROCKFISH SPP	*Sebastes spp.*	1	3%				
30	NON-FISH	*Bird or mammal*	1	3%				
31	MYCTOPHID	*Myctophidae*	1	3%				
32	GADID	*Gadidae*	1	3%				
33	FLATHEAD SOLE	*Hippoglossoides elassodon*	1	3%				
		Total Occurrences =	30			159		
		Fish Species =	12			27		

APPENDIX I. Summary of all prey species identified in harbor seal scat samples by collection date and sample number. The minimal number of individual fish was determined both from bones and other hard parts (Bone) and from Otoliths only. Samples are from Glacier Bay.

Coll Date	Sample#	Location	COMMON NAME	SPECIES	Bone	Otoliths
7/15/96	1996.502	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/15/96	1996.502	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/15/96	1996.503	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/15/96	1996.503	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
7/15/96	1996.504	Spider Is Rfs	CAPELIN	*Mallotus villosus*	2	0
7/15/96	1996.504	Spider Is Rfs	DAUBED SHANNY	*Lumpenus maculatus*	2	0
7/15/96	1996.504	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/15/96	1996.504	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	15	0
7/15/96	1996.505	Spider Is Rfs	CAPELIN	*Mallotus villosus*	2	0
7/15/96	1996.506	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
7/15/96	1996.508	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
7/15/96	1996.509	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/15/96	1996.509	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	3	0
7/15/96	1996.510	Spider Is Rfs	CAPELIN	*Mallotus villosus*	2	0
7/15/96	1996.510	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/15/96	1996.510	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
7/15/96	1996.511	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	1
7/15/96	1996.511	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
7/15/96	1996.513	Spider Is Rfs	UNIDENT. FISH	*Pisces*	1	0
7/29/96	1996.514	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.514	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	33	4
7/29/96	1996.515	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
7/29/96	1996.515	Spider Is Rfs	PRICKLEBACK SPP	*Lumpenus spp.*	1	0
7/29/96	1996.515	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.516	Spider Is Rfs	GRT.-TYPE SCULP	*Myoxocephalus spp.*	1	1
7/29/96	1996.517	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	1
7/29/96	1996.517	Spider Is Rfs	HERRING	*Clupea harengus*	1	1
7/29/96	1996.517	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
7/29/96	1996.517	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.518	Spider Is Rfs	CAPELIN	*Mallotus villosus*	12	38
7/29/96	1996.518	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	4	5
7/29/96	1996.519	Spider Is Rfs	CAPELIN	*Mallotus villosus*	2	3
7/29/96	1996.519	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
7/29/96	1996.519	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	2	1
7/29/96	1996.520	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	1
7/29/96	1996.520	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	4	0
7/29/96	1996.520	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.521	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.521	Spider Is Rfs	IRISH LORD SPP	*Hemilepidotus spp.*	1	0
7/29/96	1996.521	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
7/29/96	1996.521	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	2	0

APPENDIX I (continued)

Coll Date	Sample#	Location	COMMON NAME	SPECIES	Bone	Otoliths
7/29/96	1996.522	Spider Is Rfs	AMERICAN SHAD	*Alosa sapidissima*	1	0
7/29/96	1996.522	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.522	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/29/96	1996.522	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
7/29/96	1996.522	Spider Is Rfs	PRICKLEBACK SPP	*Lumpenus spp.*	1	0
7/29/96	1996.522	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	2	0
7/29/96	1996.522	Spider Is Rfs	YELLOW IRISH LD	*Hemilepidotus jordani*	1	0
7/29/96	1996.523	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.523	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.524	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.524	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/29/96	1996.524	Spider Is Rfs	HERRING/SHAD?	*Clupeidae*	1	0
7/29/96	1996.524	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.524	Spider Is Rfs	SNAKE PRICKLE.	*Lumpenus sagitta*	1	0
7/29/96	1996.525	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.525	Spider Is Rfs	FLATFISH SPP	*Pleuronectiformes*	1	0
7/29/96	1996.525	Spider Is Rfs	GUNNEL/PRICKLEB	*Stichaeidae/Pholididae*	1	0
7/29/96	1996.525	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
7/29/96	1996.525	Spider Is Rfs	SCULPIN SPP	*Cottidae*	1	0
7/29/96	1996.526	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
7/29/96	1996.526	Spider Is Rfs	HERRING	*Clupea harengus*	1	0
7/29/96	1996.526	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	0
7/29/96	1996.526	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0
7/29/96	1996.526	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
8/13/96	1996.005	JHI	POLLOCK	*Theragra chalcogramma*	7	3
8/13/96	1996.006	JHI	SALMON	*Oncorhynchus sp.*	1	0
8/13/96	1996.007	JHI	POLLOCK	*Theragra chalcogramma*	2	0
8/13/96	1996.008	JHI	UNIDENT. FISH	*Pisces*	1	0
8/13/96	1996.009	JHI	FLATHEAD SOLE	*Hippoglossoides elassodon*	1	0
8/13/96	1996.009	JHI	POLLOCK	*Theragra chalcogramma*	2	2
8/23/98	1998.001	JHI	GADID (NH)	*Gadidae, not hake*	2	0
8/23/98	1998.001	JHI	POLLOCK	*Theragra chalcogramma*	2	0
8/24/98	1998.003	JHI	POLLOCK	*Theragra chalcogramma*	1	0
8/25/98	1998.007	JHI	CAPELIN	*Mallotus villosus*	1	0
8/25/98	1998.007	JHI	FLATFISH SPP	*Pleuronectiformes*	1	0
8/25/98	1998.007	JHI	POLLOCK	*Theragra chalcogramma*	7	3
8/25/98	1998.008	JHI	GADID	*Gadidae*	1	0
8/9/99	1999.008	JHI	UNIDENT. FISH	*Pisces*	1	0
8/11/99	1999.013	JHI	CAPELIN	*Mallotus villosus*	1	0
8/11/99	1999.013	JHI	POLLOCK	*Theragra chalcogramma*	7	0
8/11/99	1999.013	JHI	SALMON	*Oncorhynchus sp.*	1	0
8/13/99	1999.036	JHI	POLLOCK	*Theragra chalcogramma*	1	0
8/18/00	2000.024	JHI	SAND LANCE	*Ammodytes hexapterus*	1	0

APPENDIX I (continued)

Coll Date	Sample#	Location	COMMON NAME	SPECIES	Bone	Otoliths
8/20/00	2000.031	Spider Is Rfs	CAPELIN	*Mallotus villosus*	2	0
8/20/00	2000.031	Spider Is Rfs	HERRING	*Clupea pallasi*	2	0
8/20/00	2000.031	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	3	0
8/20/00	2000.031	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/23/00	2000.068	JHI	UNIDENT. FISH	*Pisces*	1	0
8/23/00	2000.072	JHI	UNIDENT. FISH	*Pisces*	1	0
8/23/00	2000.079	JHI	UNIDENT. FISH	*Pisces*	1	0
8/23/00	2000.080	JHI	MYCTOPHID	*Myctophidae*	1	0
8/24/00	2000.089	JHI	UNIDENT. FISH	*Pisces*	1	0
8/24/00	2000.097	JHI	NON-FISH	*Bird or mammal*	1	0
8/24/00	2000.097	JHI	SCULPIN SPP	*Cottidae*	1	0
8/18/01	2001.026	JHI	UNIDENT. FISH	*Pisces*	1	0
8/18/01	2001.029	JHI	CAPELIN	*Mallotus villosus*	1	0
8/18/01	2001.029	JHI	HAKE	*Merluccius productus*	1	1
8/18/01	2001.029	JHI	ROCKFISH SPP	*Sebastes spp.*	1	1
8/25/01	2001.504	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
8/25/01	2001.505	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
8/25/01	2001.505	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
8/25/01	2001.505	Spider Is Rfs	ROCK SOLE NORTH	*Lepidopsetta mochigarei*	1	0
8/25/01	2001.508	Spider Is Rfs	HERRING	*Clupea pallasi*	1	0
8/25/01	2001.508	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	3	0
8/25/01	2001.508	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
8/25/01	2001.520	Spider Is Rfs	HERRING	*Clupea pallasi*	2	0
8/25/01	2001.520	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0
8/25/01	2001.521	Spider Is Rfs	ANOTHER FISH SP	*Pisces (none of the above)*	1	0
8/25/01	2001.521	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	7	6
8/25/01	2001.522	Spider Is Rfs	ANOTHER FISH SP	*Pisces (none of the above)*	1	0
8/25/01	2001.522	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	5	0
8/25/01	2001.523	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	0
8/25/01	2001.525	Spider Is Rfs	NORTH. LAMPFISH	*Stenobrachius leucopsarus*	1	0
8/25/01	2001.525	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	3
8/25/01	2001.525	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.525	Spider Is Rfs	SCULPIN SPP	*Cottidae*	1	0
8/25/01	2001.526	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
8/25/01	2001.526	Spider Is Rfs	LAMPFISH SPP.	*Stenobrachius sp.*	1	0
8/25/01	2001.526	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	10	0
8/25/01	2001.526	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.527	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
8/25/01	2001.527	Spider Is Rfs	ROCK SOLE NORTH	*Lepidopsetta mochigarei*	9	7
8/25/01	2001.528	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
8/25/01	2001.528	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.529	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	7	9
8/25/01	2001.529	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0

APPENDIX 1 (continued)

Coll Date	Sample#	Location	COMMON NAME	SPECIES	Bone	Otoliths
8/25/01	2001.530	Spider Is Rfs	GADID (NH)	*Gadidae, not hake*	1	0
8/25/01	2001.530	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.531	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
8/25/01	2001.531	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.532	Spider Is Rfs	LAMPFISH SPP.	*Stenobrachius sp.*	1	0
8/25/01	2001.532	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.533	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	1
8/25/01	2001.533	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.534	Spider Is Rfs	DAUBED SHANNY	*Lumpenus maculatus*	1	0
8/25/01	2001.534	Spider Is Rfs	HERRING	*Clupea pallasi*	1	0
8/25/01	2001.534	Spider Is Rfs	IRISH LORD SPP	*Hemilepidotus spp.*	1	0
8/25/01	2001.534	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	5	7
8/25/01	2001.534	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.535	Spider Is Rfs	HAKE	*Merluccius productus*	1	1
8/25/01	2001.535	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	2
8/25/01	2001.535	Spider Is Rfs	ROCK SOLE	*Lepidopsetta spp.*	1	0
8/25/01	2001.536	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	1
8/25/01	2001.536	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.537	Spider Is Rfs	HERRING	*Clupea pallasi*	1	0
8/25/01	2001.537	Spider Is Rfs	LAMPFISH SPP.	*Stenobrachius sp.*	1	0
8/25/01	2001.537	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
8/25/01	2001.537	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.538	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	2
8/25/01	2001.538	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.539	Spider Is Rfs	PACIFIC COD	*Gadus macrocephalus*	1	0
8/25/01	2001.539	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	4	2
8/25/01	2001.539	Spider Is Rfs	ROCK SOLE	*Lepidopsetta spp.*	1	0
8/25/01	2001.539	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.540	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
8/25/01	2001.540	Spider Is Rfs	DAUBED SHANNY	*Lumpenus maculatus*	1	0
8/25/01	2001.540	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	3	1
8/25/01	2001.540	Spider Is Rfs	PRICKLEBACK SPP	*Stichaeidae*	1	0
8/25/01	2001.540	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.540	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
8/25/01	2001.540	Spider Is Rfs	SCULPIN SPP	*Cottidae*	1	0
8/25/01	2001.540	Spider Is Rfs	SMELT SPP	*Osmeridae*	1	0
8/25/01	2001.541	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.546	Spider Is Rfs	LAMPFISH SPP.	*Stenobrachius sp.*	1	0
8/25/01	2001.546	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	5	5
8/25/01	2001.546	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0

APPENDIX 1 (continued)

Coll Date	Sample#	Location	COMMON NAME	SPECIES	Bone	Otoliths
8/25/01	2001.547	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	1	1
8/25/01	2001.547	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.547	Spider Is Rfs	SAND LANCE	*Ammodytes hexapterus*	1	0
8/25/01	2001.548	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	1
8/25/01	2001.548	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	1	0
8/25/01	2001.549	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
8/25/01	2001.549	Spider Is Rfs	DAUBED SHANNY	*Lumpenus maculatus*	12	0
8/25/01	2001.549	Spider Is Rfs	PACIFIC COD	*Gadus macrocephalus*	1	0
8/25/01	2001.549	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	0
8/25/01	2001.549	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0
8/25/01	2001.549	Spider Is Rfs	SNAKE PRICKLE.	*Lumpenus sagitta*	5	0
8/25/01	2001.550	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	2
8/25/01	2001.550	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0
8/25/01	2001.551	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	2	2
8/25/01	2001.551	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	2	0
8/25/01	2001.554	Spider Is Rfs	CAPELIN	*Mallotus villosus*	1	0
8/25/01	2001.554	Spider Is Rfs	DAUBED SHANNY	*Lumpenus maculatus*	1	0
8/25/01	2001.554	Spider Is Rfs	GREENLING SP	*Hexagrammmos spp.*	1	0
8/25/01	2001.554	Spider Is Rfs	HERRING	*Clupea pallasi*	1	0
8/25/01	2001.554	Spider Is Rfs	NORTH. LAMPFISH	*Stenobrachius leucopsarus*	1	0
8/25/01	2001.554	Spider Is Rfs	POLLOCK	*Theragra chalcogramma*	4	0
8/25/01	2001.554	Spider Is Rfs	SALMON	*Oncorhynchus sp.*	3	0