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**Pinniped Interactions
with Tribal Steelhead and Coho Fisheries in Puget Sound**

by

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Introduction

Interactions between California sea lions and Tribal steelhead gillnet fisheries were documented during the 1986-87 season at Shilshole Bay in area 10. It was determined based on this study that net losses due to sea lion depredation of steelhead were a significant proportion of overall losses caused by sea lions on the Lake Washington bound steelhead run. Prior to this study, however, there were no quantitative data regarding net losses to sea lions in other areas of Puget Sound where steelhead fisheries occur. We had received reports for several years from tribal and state fisheries biologists that sea lions were robbing nets and damaging gear in other areas including; the Nisqually River, Elliot Bay, the Duwamish Waterways and Green River, the Snohomish River and also from the Skagit Bay-Deception Pass area.

During the 1987-88 steelhead season we monitored tribal gillnet fisheries in 4 areas in order to document interactions between sea lions or other pinnipeds and the fisheries. Our primary objective during this study was to identify potential problem areas for future more intensive investigation. The methods used to investigate pinniped fishery interactions involved boat surveys and shore observations of the 4 fishing areas. Pinnipeds observed during surveys were counted and their behaviors relative to the fishery were noted as to whether they were present in the vicinity and if they were actively working the nets and feeding on netted fish. The number of gillnets in

each area were counted and their approximate location was noted on nautical charts. Individual nets or net groups were monitored from shore or boat in order to document actual net robbing. Data was recorded on all steelhead kills which were observed including free swimming and net caught fish.

Scats were collected from known sea lion haulout sites in the vicinity of fishing areas to assess sea lion food habits in these areas. The following account summarizes our findings in each of the 4 fisheries which were monitored.

Sea Lion Behavior Around Nets

When sea lions or harbor seals encounter gillnets, they generally swim alongside the net within 1 meter and check for fish. We refer to this behavior as scanning. Scanning may often involve repeated passes by an animal back and forth along the entire net. Frequently, sea lions will leap over the corkline and scan both sides of a net. Generally, if more than one net is in an area, sea lions will scan each net in a pattern from the first to last and then return to the first net. In some areas, sea lions will continue this feeding effort all day and in effect may maintain a nearly constant presence near the nets.

Sea lions generally follow the shoreline within 100-200m of shore when transiting through the waters of Puget Sound. During such movements, they often encounter set nets along shore. When an animal encounters a set net as it moves from one area to another it will usually scan the net to check for fish before

moving on. If fish are in the net and fishermen are not present to chase away the animals, the sea lions will quickly tear out and eat the fish. A second strategy sea lions may utilize around gillnets is actually chasing fish into the nets where they can be more easily captured.

Method of Protecting Catch and Gear

Tribal fishermen can legally take steps to protect their catch and gear from marauding pinnipeds. Fishermen are required to obtain and possess certificates of inclusion which are issued by the National Marine Fisheries Service under the general permit system. The certificate of inclusion allows individual fishermen to take appropriate steps (including lethal removal) to save their catch and gear.

We witnessed numerous attempts by fishermen to chase away sea lions from their nets during our observations. Tribal fishermen generally used two methods including boat hazing and firecrackers. We did not witness any cases of shooting pinnipeds by the tribes. In general, we found that harassment techniques such as firecrackers and boat hazing have only a very short term effect. Sea lions will often return to the nets within minutes of being chased away.

Possibly the best method for saving fish and gear is for individual fishermen to stay near their gear in a small boat and to check their nets frequently. We found that most tribal fishermen keep a close watch on their nets during the day and thereby remove caught fish soon after they hit the net. Even

during daylight hours, it is often a race between the sea lions and fishermen to get to the fish first. It is much more difficult for fishermen to monitor and protect their nets at night or in rough weather when sea lions are not easily seen or chased away. Our observations indicate that sea lions continue scanning nets during the night and during rough weather.

Drift nets are difficult to protect from pinniped depredation because they are tended by a bowpicker which is tied off to one end. Fishermen may only be able to keep animals away from within throwing distance of their boat by using firecrackers.

Free Swimming Fish Kills

Free swimming fish kills are defined here as fish captures which occur when nets are not present. Free swimming steelhead captures were observed in at least 5 areas although they could also have occurred during times when nets were set. We observed free swimming steelhead captures in the following areas; Shilshole and Salmon Bays, West Point, Four Mile Rock, and in Elliot Bay off Duwamish Head and the entrance to the west channel of the Duwamish Waterway (Figure 1). In all cases, the steelhead appear to have been taken in relatively shallow water, close to shore and near shoals. There is no evidence currently which indicates that sea lions can capture steelhead in deep open water.

Area 10 - Shilshole and Salmon Bays (Figure 1)

Season Open - December 1

Tribes Active - Muckleshoot and Suquamish

Gear Type - Set nets which are hand pulled from small boats or from shore. From 10 to 32 set nets are utilized in this area.

Areas Covered - We surveyed by boat from Lake Union to the west entrance of the ship canal and from West Point to Meadow Point. Shore based observations were made near the mouth of Salmon Bay.

Results - The 1987-88 steelhead fishery was monitored in conjunction with the cooperative sea lion project at the Chittenden Locks. The State Department of Wildlife has taken the lead on monitoring this fishery and the results will be included in the final Locks report for 1987-88. Sea lions were a significant problem during the fishery this season as they were present every day and maintained an almost constant foraging effort around the nets.

Predation on Coho Salmon

Some preliminary observations were made in this area prior to the steelhead fishery which indicated that sea lions were consistently predating coho salmon from gillnets during October and November.

Sea lions were observed predating coho on 5 out of 7 days which were checked in October and November. Hourly predation

rates during this period were 1.68 fish per hour (see below).

<u>Date</u>	<u>Time</u>	<u>Minutes</u>	<u>Fish killed</u>	<u>Lions</u>
12 Oct. 1987	1615-1715	60	0	0
21 Oct. 1987	1600-1640	40	1	2
2 Nov. 1987	1645-1735	50	2	2
5 Nov. 1987	1700-1730	30	1	2
7 Nov. 1987	1300-1320	20	0	6
14 Nov. 1987	0950-1100	70	3	3
15 Nov. 1987	0820-0835	15	1	2
		<u>285</u>	<u>8</u>	<u>17</u>

8 Fish Killed = 1.68 fish per hour.
4.75 hours.

These data are not considered adequate for estimating losses since the observations were few and sporadic. They do, however, indicate that sea lions are consistently present and actively feeding from the nets in this area in late October through November. The sea lions are accustomed to feeding on salmon from nets and simply switch from salmon to steelhead when they appear in late November. We recommend a closer evaluation of this coho fishery in September-November of 1988.

Numbers of Pinnipeds - Area 10

Three species of pinnipeds were observed during the fishery including harbor seals, northern sea lions, and California sea lions. Only the California sea lion was observed to predate salmonids or interact with the fishery. The number of California sea lions in the area ranged from 2-6 in October and November and from 10-30 in December and January.

Area 10 and 10-A - Elliot Bay, Duwamish Waterways, and Green River (Figure 2)

Season Opens - December 1

Tribes Active - Muckleshoot and Suquamish

Gear Type - Primarily set nets in the Duwamish Waterways and Green River and a few drift nets in Elliot Bay. Set nets are usually pulled by hand from a small boat. Drift nets are usually set and pulled with a bowpicker type gillnet boat.

As many as 40-50 nets are utilized during full effort of which only 2 or 3 are driftnets.

Area Covered - We surveyed by boat from Alki Point, the entire shoreline of Elliot Bay and north to West Point. We also surveyed the east and west Duwamish waterways and the Green River up as far as the Boeing Bridge (Figure 2).

Results - We surveyed this area on 6 days from 28 December 1987 to 15 January 1988. Sea lions were observed during each survey and predation on steelhead was observed on 2 out of 6 days. Hourly predation rates were .56 fish per hour (see below). During the times when nets were set, sea lions maintained a nearly continuous effort of scanning the nets. Of the 7 steelhead kills observed, 6 occurred in the west channel primarily near the mouth and one occurred off Duwamish Head.

Area 10 and 10A -

<u>Date</u>	<u>Time</u>	<u>Hours</u>	<u>Fish kills</u>	<u># Lions</u>
28 Dec.	1615-1645	.75	0	2
29 Dec.	1610-1650	.75	*1	2
05 Jan.	1530-1630	1.00	0	8
11 Jan.	0900-1300	4.00	0	15
14 Jan.	1130-1630	4.50	6	7
15 Jan.	1100-1220	<u>1.33</u>	<u>0</u>	<u>4</u>
		12.33	7	38

$$\text{Fish per hour} = \frac{7}{12.33} = .56$$

* Free swimming kill

Numbers and Distribution of Pinnipeds-Area 10A

One harbor seal was observed on one day in this area. The remainder of pinnipeds observed were California sea lions. Sea lions were observed in Elliot Bay, off Duwamish Head, in both the east and west channels of the Duwamish and up the Green river as far as the 16th street bridge. The only haul out site in this area was on a barge buoy off the West Channel of the Duwamish. The number of sea lions in this area ranged from 2-15 during the days of observation.

Area 8A - Port Susan, Tulalip Bay, Port Gardner, and Possession Sound (Figure 3).

Season Open - December 9

Tribe Active - Tulalip

Gear Type - Both drift and set nets are utilized. As many as 40-50 nets are used during full effort of which 10-12 may be drift nets. The fishing area extends from the ship wreck

off the SE entrance to Possession Sound, north to Kayak Point in Port Susan (Figure 3). The area where nets are most concentrated is from Priest Point to Kayak Point.

Areas Covered - We surveyed by boat from Edmonds north to Kayak Point. We did not survey the SE side of Whidbey or Camano Island although there are apparently a few nets in these areas.

Results - We surveyed in Area 8A on 11 days from 7 January to 3 February. Sea lions and harbor seals were observed on each day and predation on net caught steelhead was observed on 3 out of 11 days. The Tulalip fishery covers a large area, from the wreck south of Mukilteo to Kayak Point (Fig. 3). We divided the Tulalip fishery into 3 locations since they were so widely separated. The Tulalip area was from Priest Point to Kayak Point and included all nets in Port Susan and Tulalip Bay. The Everett area is from Mukilteo to Priest Point and includes Port Gardner, the Everett Jetty and the mouth of the Snohomish River. The third area is from Mukilteo to the ship wreck (3/4 mi north of Picnic Point). Depredation of net caught fish by sea lions was observed in only one area, near Tulalip Bay and to the north in the southeastern portion of Port Susan. We did not observe net depredation near the Everett Jetty or mouth of the Snohomish although both harbor seals and sea lions were frequently observed near the nets. Our observations of the Tulalip fishery indicated that shoreline set nets are more

susceptible to sea lion depredation than were deep water offshore driftnets. We suspect that this may result from the sea lions' habit of staying close to shore when transitting through Puget Sound. No steelhead kills and few sea lions were observed in the Mukilteo area, however, our coverage in this vicinity was minimal. We would expect to observe net depredation in this area as well with increased coverage.

The net depredation rates as a whole were .23 fish per hour

Date	Time	*Net hours	Location	Steelhead kills	Sea Lions
7 Jan.	1330-1500	0	Port Gardner	0	6
12 Jan.	0900-1530	0	Mukilteo to Kayak Pt	0	30
19 Jan.	1000-1705	4.00	Port Gardner	0	51
20 Jan.	1445-1730	2.00	Mukilteo to Wreck	0	0
21 Jan.	0800-1730	6.75	Port Gardner to Tulalip	0	109
25 Jan.	0900-1630	6.25	Port Gard. to Tulalip	0	111
26 Jan.	0745-1715	7.50	Port Gard. to Tulalip	0	112
27 Jan.	0800-1510	1.00	Mukilteo to Edmonds	0	8
1 Feb.	1415-2340	6.25	Tulalip	3	8
2 Feb.	0945-1710	6.00	Tulalip	6	16
3 Feb.	0810-1210	<u>4.00</u>	Tulalip	<u>1</u>	<u>4</u>
		43.75		10	445

$$\frac{10}{43.75} = .228 \text{ fish per hour}$$

* Net Hours - the actual time spent watching nets.

Number of Pinnipeds - Area 8A

We observed three species of pinnipeds during the surveys including harbor seals, California sea lions, and northern sea lions. California sea lions were by far the most commonly seen and abundant pinniped in the region. The numbers of California sea lions in Area-8A ranged from 6 to 112. The majority of sea lions in this area are found near log rafts in Port Gardner which is the primary haulout and staging site in the region. Groups of sea lions from Port Gardner were observed moving north into Port Susan at dusk on numerous occasions. We also noted a southward movement by groups of sea lions during the morning hours from Port Susan to Port Gardner. These daily movements are animals transiting from the hauling areas in Port Gardner to the feeding areas in Port Susan. Port Susan is the area where a large hake (Pacific whiting) stock aggregates during the winter months. Sea lions often encounter gillnets during their movements in and out of Port Susan.

We observed harbor seals during 8 of 11 days in Area 8A. Harbor seals were generally observed in Port Gardner near the log rafts or by the Everett Jetty. The number of harbor seals observed in any one day ranged from 2-12 during the period. We did not observe harbor seals prey on steelhead, however, we did observe them around gillnets on numerous occasions. Harbor seals were commonly observed off the Everett Jetty in the vicinity of set nets. Harbor seals were also observed offshore near drift nets in Port Susan and Possession Sound. Harbor seals do not

appear to be a significant factor on steelhead net depredation at least during the day when they are quite cautious and easily chased away. They may be more of a problem at night when they can patrol nets undetected by fishermen. Northern sea lions were observed on 3 days in Area 8A, however, only 1 or 2 animals were seen. We did not observe northern sea lions preying on steelhead or interacting in any way with the fishery.

Area 8 - Skagit Bay, Deception Pass, and Skagit River (Figure 4).

Season - Open - December 1

Tribe - Swinomish

Gear Type - Primarily set nets. We monitored this fishery during the end of the netting season so we did not obtain extensive coverage. This fishery covers a large area; 50 or more nets could be used during full effort.

Areas Covered - We surveyed by boat from the north part of Similk Bay south to the Skagit River (north fork). This survey included Skagit Bay and Swinomish Channel and the Skagit River from the mouth of the north fork to the Mount Vernon bridge. We also surveyed Deception Pass from West Point to Hoypus Point and along the northeast shore of Whidby Island from Ben Ure Spit to Dugualla Bay (Figure 4).

Results - We monitored this fishery on 9 and 10 February. We had not originally intended to monitor this fishery this season, however, we did so in response to inquiries by the Swinomish Tribe which indicated that they were experiencing problems

with pinnipeds. On 9 February we surveyed by boat in all areas except Deception Pass. An observer was on shore in Deception Pass on this day. We saw no sea lions during either day in this area. We did observe 6-8 harbor seals near the La Conner Jetty on 10 February and one harbor seal at the mouth of the Skagit River. We conducted informal interviews with 5 tribal fishermen who indicated that sea lions were only infrequently sighted in Skagit Bay, Skagit River, or the waters east of Deception Pass. They did indicate, however, that sea lions were commonly seen in Deception Pass and that they were a significant problem around the gillnets. Unfortunately, there were no nets set in Deception Pass during the day we surveyed so we did not observe any sea lions around the area. Based on our interviews with tribal fishermen and on our observations it appears that reported net losses around the Skagit Bay area are probably attributable to harbor seals and not sea lions.

Sea Lion Food Habits

We collected sea lion scats and spewings from known haul out sites in order to evaluate food habits during the steelhead season. A total of 88 samples were collected of which 36 were from the Everett vicinity (Area 8A) and 52 were collected from the Shilshole Bay vicinity (Area 10). The samples were analyzed and sorted and identifiable food remains were enumerated. Prey taxa were determined by identification of fish otoliths, vertebrae, and other bony parts. Cephalopods were identified by

their chitinous beaks, or cartilaginous membranes. We utilized a new method of prey identification by which certain fish taxa can be identified by examining vertebral characters or other diagnostic bony parts. This methodology allowed us to identify and determine percent occurrences of salmonids, herring, hake, and dogfish from scats or spewings which may not have contained otoliths. Identifying prey from vertebrae represents a significant improvement in that fish bones were found in 86.4% of the total samples and otoliths were found in only 27.3% (Table 1).

There were some significant differences in prey taxa recovered from the 2 regions. In Everett, hake appeared to be one of the primary prey and was found in 50% of the total samples. Salmonids and dogfish shark remains were found in 16.7% of the Everett samples (Table 1).

The Shilshole samples were dominated by squid and salmonid remains. Squid remains were found in 57.6% of the Shilshole samples and salmonids were found in 28.8%. Dogfish shark (11.5%) and herring (9.6%) were other prey of importance in the Shilshole area.

The occurrence of salmonids in the samples was determined primarily by vertebral identification. We have not attempted to differentiate between which salmon species were found, however,

it appears that they were primarily steelhead. There also appear to be small salmonids in some samples based on vertebral size. These could well be resident coho, chinook, or cutthroat trout.

We identified 9 different prey taxa from the samples of which 4 are new prey records for sea lions in Puget Sound based on scat or spewing samples.

We believe this new methodology is important because it allows us to identify prey remains from samples which contained no otoliths. Since otoliths were found in only 27.3% of the total samples, the ability to identify prey by other means has a great deal of value. For example, salmonid otoliths were found in only 1 of the 88 samples yet salmonid vertebrae or other bony parts were found in 21 of the 88. In the past, we would have recorded salmonids in only 2% of the samples, instead of 23.9%. Although we cannot at this time gauge the numerical importance of certain prey taxa based on only bone identification we can obtain a much more accurate representation of the prey spectrum upon which sea lions feed.

We conclude therefore that the primary prey for both areas was squid, hake, salmonids, dogfish, and herring in order of percent occurrence (Table 1).

Predation on Other Salmonids

We documented predation by sea lions on net caught coho salmon at Shilshole Bay during October and November of 1987. We strongly suspect that sea lions depredate coho in other tribal

fisheries as well. It is probable that sea lions could begin depredating other salmon runs which occur during the times when sea lions are present in Puget Sound from early September until the end of May. Peak sea lion numbers occur in March and April, however, several hundred may be present as early as October. Sea lions could therefore depredate chum, coho, pink, and chinook salmon which occur during these times. Although at this time there does not appear to be a problem with predation on these other salmonids, we expect such predation to become increasingly prevalent in the future. We recommend, therefore, that monitoring of other salmonid fisheries be undertaken to begin to identify potential problems which may surface in the future.

Recommendation for Protecting Catch and Gear

We recommend as a first step towards reducing pinniped depredation of caught fish or damage to gear that individual fishermen be fully informed of their legal rights and recourse under the provisions of the Marine Mammal Protection Act. It appears that there is a great deal of confusion among fishermen at this time about what these rights are.

Perhaps the single most important method of reducing depredation is for fishermen to stay near and tend their gear. Harassment methods such as seal bombs and boat hazing may help to reduce net depredation in the short term, however, sea lions are known to habituate rapidly to these techniques. It will be necessary to kill these habituated animals to decrease the overall depredation from nets. We also recommend that some

fishermen consider pulling their set nets at night or during times when they cannot be actively checked. Unattended set nets are probably the main source of net losses from sea lions.

Summary

We monitored four tribal fisheries during January and February of 1988 and documented predation of net caught steelhead by sea lions in three of the four. We also observed predation on free swimming steelhead at 5 locations in Area 10 and 10A. We cannot make assessments at this time about sea lion impacts on specific fish runs, however, we can at least say where potential problems exist. The three problem areas which we identified are: Shilshole Bay, the Duwamish waterways and near Tulalip. These areas can be characterized by 1) daily presence of sea lions, 2) relatively large numbers of sea lions in the vicinity, 3) near continuous presence of sea lions around the nets, 4) active scanning of nets by sea lions, 5) net predation of steelhead. The Tulalip area fishery is one area which should be closely monitored in the future due to the large numbers of sea lions in the vicinity. We suspect that due to the large number of sea lions in this area that they potentially could impact the Snohomish River steelhead run. A more intensive investigation of this fishery and the Elliot Bay/Duwamish fishery would allow us to estimate total steelhead losses due to sea lions and their impact on run size, if any. Several other areas need closer inspection to determine the extent of potential problems. The Deception Pass area and the Nisqually River area are locations

from which we have received numerous complaints regarding sea lion problems. A few well timed surveys in these areas would at least allow us to confirm these reports.

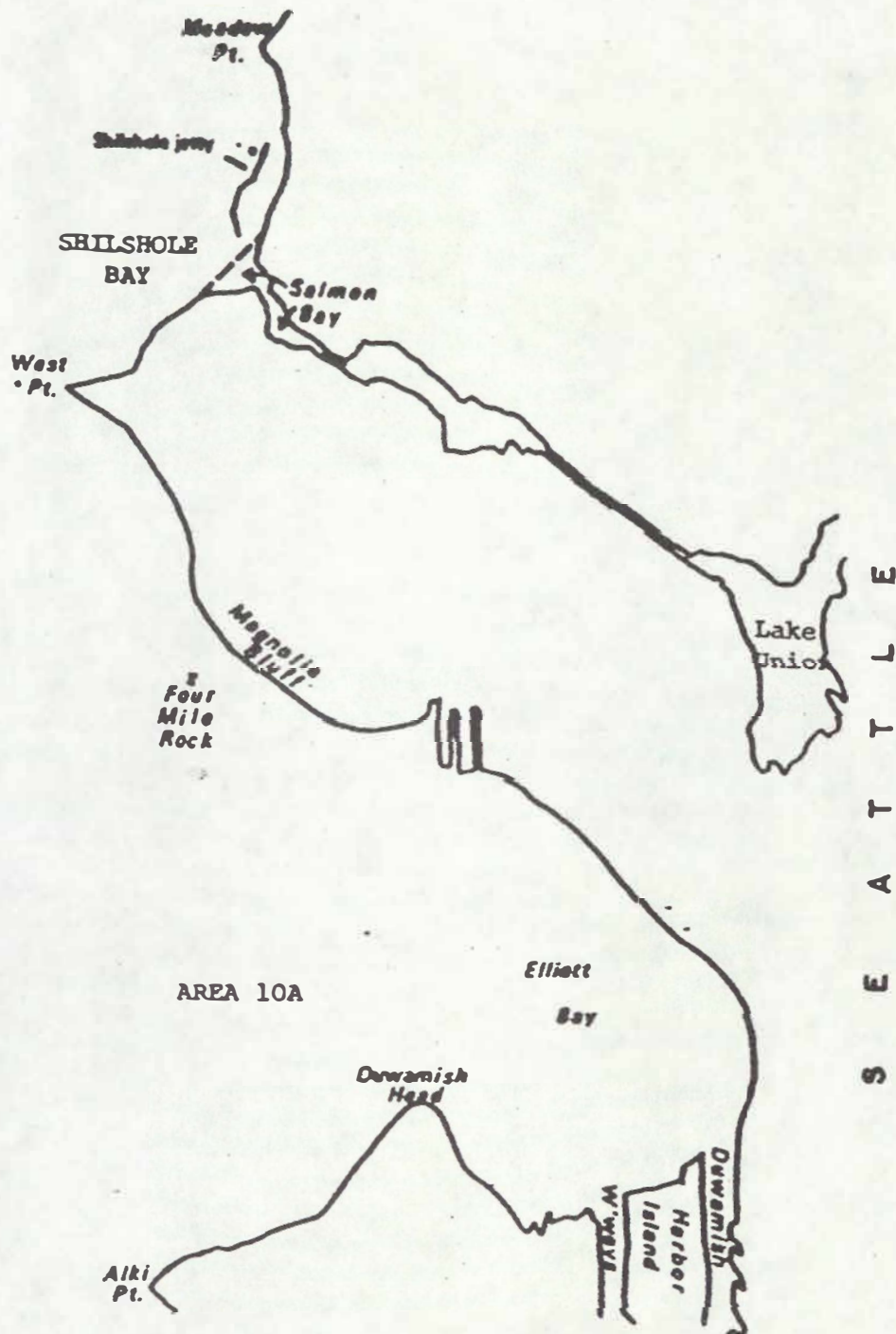
Table 1. Prey remains recovered in sea lion scats and spewings during January - March 1988.

<u>Prey Category</u>	<u>Shilshole (52)</u>		<u>Everett (36)</u>		<u>Total (88)</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Fish bone	40	77	36	100	76	86.4
Otoliths	7	13.4	17	47	24	27.3
Squid (<i>Loligo opalescens</i>)	30	57.6	0	0	30	34.1
Hake (<i>Merluccius productus</i>)	4	7.7	18	50	22	25.0
Salmonidae	15	28.8	6	16.7	21	23.9
Spiry Dogfish (<i>Squalus Acanthias</i>)	6	11.5	6	16.7	12	13.6
Herring (<i>Clupea harengus</i>)	5	9.6	4	11.1	9	10.2
Gadid sp.	3	5.7	3	8.3	6	6.8
Pacific Cod (<i>Gadus macrocephalus</i>)	1	1.9	0	0	1	1.1
Pollock (<i>Theragra chalcogramma</i>)	1	1.9	0	0	1	1.1
Shiner Perch (<i>Cymatogaster aggregata</i>)	1	1.9	0	0	1	1.1
Midshipman (<i>Porichthys notatus</i>)	1	1.9	0	0	1	1.1

<u>Prey Category</u>	<u>Shilshole</u>		<u>Otoliths Recovered Everett</u>		<u>Total</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Hake	3	18.75	24	77.4	27	57.5
Pollock	3	18.75	0	0	3	6.4
Cod	3	18.75	0	0	3	6.4
Gadid sp.	1	6.25	3	9.7	4	8.5
Herring	1	6.25	3	9.7	4	8.5
Salmonidae	1	6.25	0	0	1	2.1
Shiner Perch	1	6.25	0	0	1	2.1
Midshipman	1	6.25	0	0	1	2.1
Unknown	2	12.50	1	3.2	3	6.4
	16	100	31	100	47	100

AREA 10

PUGET SOUND



S E A T T L E

FIGURE 1. Marine fishing areas 10 and 10A. Area 10 from West Point to Meadow Point and from Salmon Bay to Lake Union.

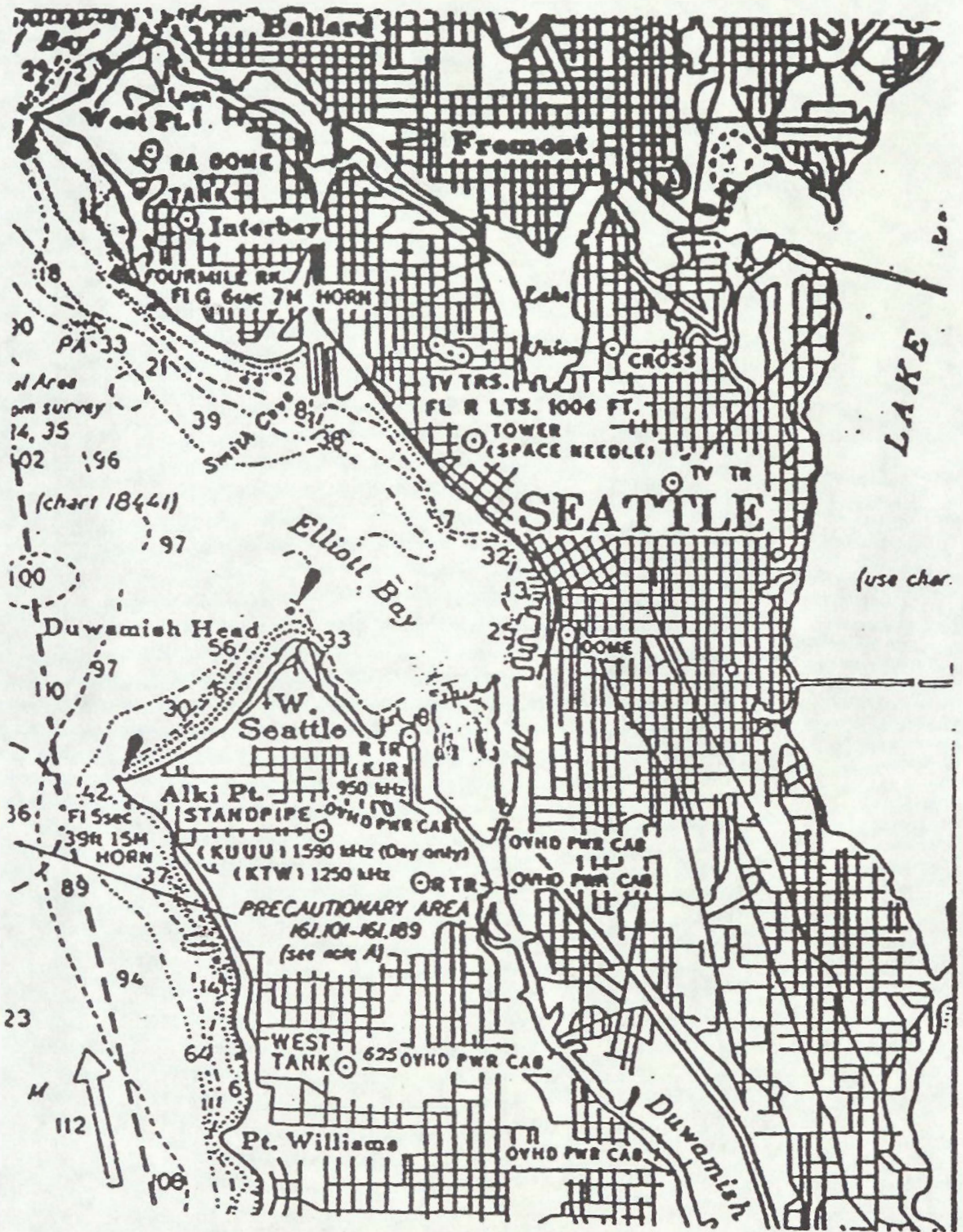


FIGURE 2.

Marine fishing area 10A, Alki Point to West Point, includes Elliott Bay, Duwamish Waterways, Duwamish River and Green River.

