THE SEASONAL MOVEMENTS AND ABUNDANCE DYNAMICS OF THE PACIFIC HARBOR SEAL (Phoca vitulina richardsi) ALONG THE SOUTHERN OREGON COAST

by

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Movements of harbor seals from the Umpqua River were determined by radio-tagging studies during May - September, 1992. Harbor seals moved to sites to the north and south of the Umpqua with individuals exhibiting variable patterns of movement and timing of movement. No seals that initially moved north of the Umpqua moved to sites to the south, likewise no seals which moved south used northern sites.

Observational surveys at Cape Arago and Pigeon Point near Coos Bay, Oregon determined seasonal variations in harbor seal abundances. They revealed distinct seasonal haul-out patterns and seasonal variations in seal numbers. At Cape Arago, the number of harbor seals hauled out was lower in the winter than in the spring and summer, but at Pigeon Point there was no clear pattern. At Cape Arago, peak numbers of seal coincided with the onset of molting

whereas at Pigeon Point numbers corresponded with the pupping season.

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Finally, I would like to extend my deepest appreciation to Monique Lance who deserves much of the credit for the completion of this thesis. She gave me all her love and support throughout the preparation and ended up stealing my heart.

DEDICATION

This thesis is dedicated to my parents Roy and Jean Wilson who gave me the confidence and independence to seek my own identity, and the love and support to achieve it.

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CHAPTER I

INTRODUCTION

The east Pacific harbor seal, Phoca vitulina richardsi (Gray, 1864) is one of the four pinnipeds common in Oregon. Occurring coastwide, these animals are generally most abundant around bays and estuaries and are present year-round. The range of the eastern Pacific harbor seal extends from Baja, California north to the Aleutian Islands near Alaska.

Pearson and Verts (1970) in what was likely an incomplete survey, suggested that there were less than 500 individuals present at 15 haul-out sites in 1967 and 1968. Since that time, the population has increased. Huber et al., (1992) found that 6978 harbor seals occupied haul-out sites along the coast of Oregon during 1992. This population growth is most likely due to the protection from hunting and disturbance afforded these animals by the Marine Mammal Protection Act. Concomitant to an increase in seal numbers is an increase in the number of haul-outs used by these animals as a response to reduced harassment.

A variety of factors affect harbor seal haul-out patterns. These include: (1) tide (Calambokidis et al., 1979; Schnieder and Payne, 1983), (2) weather conditions

with variables such as wind speed, solar input and wave action (Schnieder and Payne, 1983; Krieber and Barrette, 1984; Watts, 1991), (3) sleep (Schnieder et al., 1980), (4) predator avoidance (Terhune, 1985; DaSilva and Terhune, 1988), (5) mate selection (Renouf and Lawson, 1986), (5) skin cell maintenance (Feltz and Fay, 1966), and (6) response to pupping/breeding and molting (Stewart, 1981; Terhune and Almon, 1983).

Seasonally in Oregon, the number of harbor seals on land generally increases during the spring and summer months in most bays and estuaries. It is thought that this increase is in response to the accumulation of adults for the purpose of pupping/breeding and then molting (Graybill, 1981; Huber et al., 1992)

Female seals give birth around the same time each year due to delayed implantation of the fertilized egg in the uterine wall. Precocial pups are born on both land and in water, and are immediately able to swim. A pup nurses for four to six weeks after birth (Finch, 1966; Lawson and Renouf, 1987). The harbor seal female is the only phocid that nurses and cares for pups in the water as well as on land (Reidman, 1990). Mating occurs in the water after the pup is weaned, although the details and timing of mating are poorly known.

Molting, which occurs in all pinnipeds, is a slow sequential process in harbor seals, starting from hind

flippers and moving anteriorly (Scheffer and Slipp, 1944). Seals begin this process in Oregon by about the middle of July with pups molting before older animals (Bayer, 1985).

While harbor seals do not migrate en masse like other pinniped species, movements to and from haul-out sites and offshore have been observed. These movements are thought to be in response to food (Spalding, 1964; Wahl, 1977; Pitcher and Calkins, 1979; Brown and Mate, 1983; Johnson and Jeffries, 1983; Brown, 1986), weather (Naito, 1976; Loughlin, 1978; Boulva and McLaren, 1979) and human induced disturbance (Newby, 1971).

There is also contrasting evidence from Bigg (1969 and 1973), Shaughnessy and Fay (1977), Calambokidis et al. (1985) and Temte (1986), which supports the idea that there are distinct biogeographical populations of harbor seals that infrequently mix.

The data presented in this study was a subset of a three year project initiated by the National Marine Mammal Laboratory (NMML), Washington Department of Wildlife (WDW), and Oregon Department of Fish and Wildlife (ODF&W). The focus of the project was to estimate the abundance of harbor seals in Washington and Oregon, and to gather base line data on the harbor seal populations to assess the need for management, especially with regard to fisheries interaction.

The study in Oregon concentrated on harbor seals that haul out at the Umpqua river and Tillamook Bay. These sites

were chosen because large numbers of seals use these sites (774 and 527 seals respectively on June 1983, (Harvey et al., 1990), and there is easy access to seals at both sites so large numbers could be captured and tagged in a short period.

The NMML project concentrated on determining the following: (1) the number of harbor seals present at tagging sites, (2) dates of first, last and peak pupping periods to indicate when surveys would best be conducted for highest pup numbers, and thus give an estimation of the growth of the population, (3) daily haul-out patterns of radio tagged harbor seals with regard age/sex class, (4) local and regional movement of radio-tagged seals away from the tagging site.

My participation in this study addressed two aspects of the NMML project.

1) The timing and location of movements of harbor seals from the Umpqua haul-out site. Questions addressed here include: (a) do harbor seals move from the Umpqua tagging site, (b) when do seals leave the Umpqua, (c) where do seals go after they leave the Umpqua, (d) how long do seals remain at haul-out sites away from the Umpqua and do they return, (d) are there movement differences between age/sex classes of seals that leave the Umpqua.

2) Seasonal abundance patterns at two different harbor seal haul-out sites near Coos Bay, Oregon. Questions ad-

dressed in this part of the study were: (a) what are the seasonal variations in numbers of harbor seals at each site, (b) when is the best time to survey these haul-out sites in order to determine peak numbers of harbor seals and pups, (c) what is the timing of the pupping and molting season, (d) what is pup production, measured by the percentage of the population represented by pups, (e) are there differences between sites, (f) what are the seasonal variations in abundances of distinct regions in each site.

CHAPTER II

STUDY SITES

The monitoring of radio tagged harbor seals occurred at eight sites from Alsea Bay to Cape Blanco 182 km south (Figure 1). From north to south these sites were: Alsea Bay, Siuslaw River, Siltcoos River Outlet, Umpqua River, Pigeon Point in Coos Bay, Cape Arago, Bandon and Cape Blanco. At Cape Arago and Pigeon Point, surveys of the number of harbor seals hauled out were made to asses population numbers over a one year period.

Description of Haul-Out Sites

Alsea Bay (43° 52'N, 124° 08'W)

Harbor seals hauled out on a tideflat east of the U.S. highway 101 bridge (Figure 2). The tideflat was exposed by tides of less than +5.2 feet, so parts of it are exposed during all low tides.

Harbor seals, which were the only pinniped at this site, hauled out in large groups of over 100 animals on the northern bank of the mudflat near the rivers edge. The monitoring point for this site is approximately 500 meters

Figure 1. Map of the Oregon Coast from Waldport to Cape Blanco Representing the Haul-Out Sites Where Harbor Seals Were Resighted

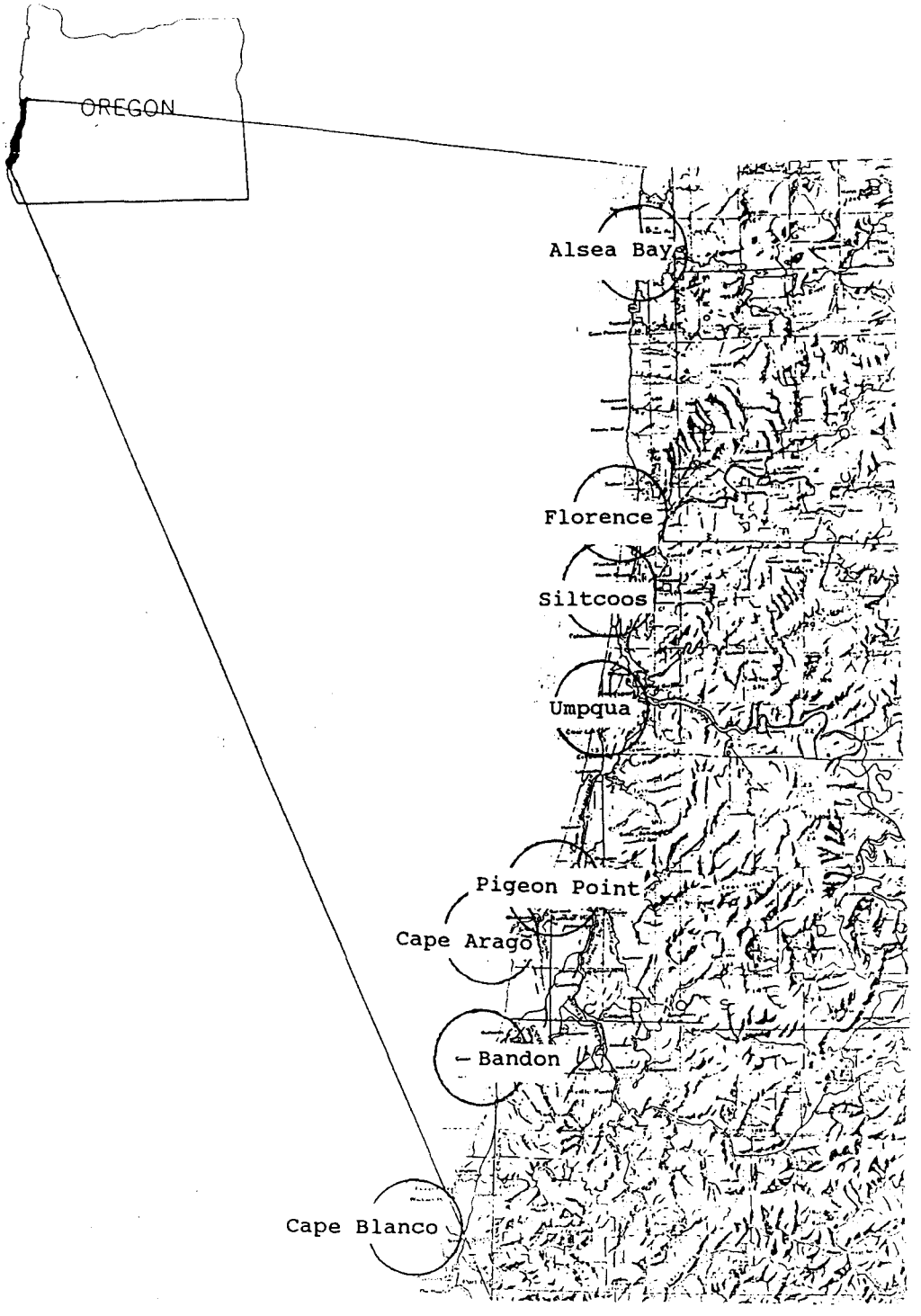
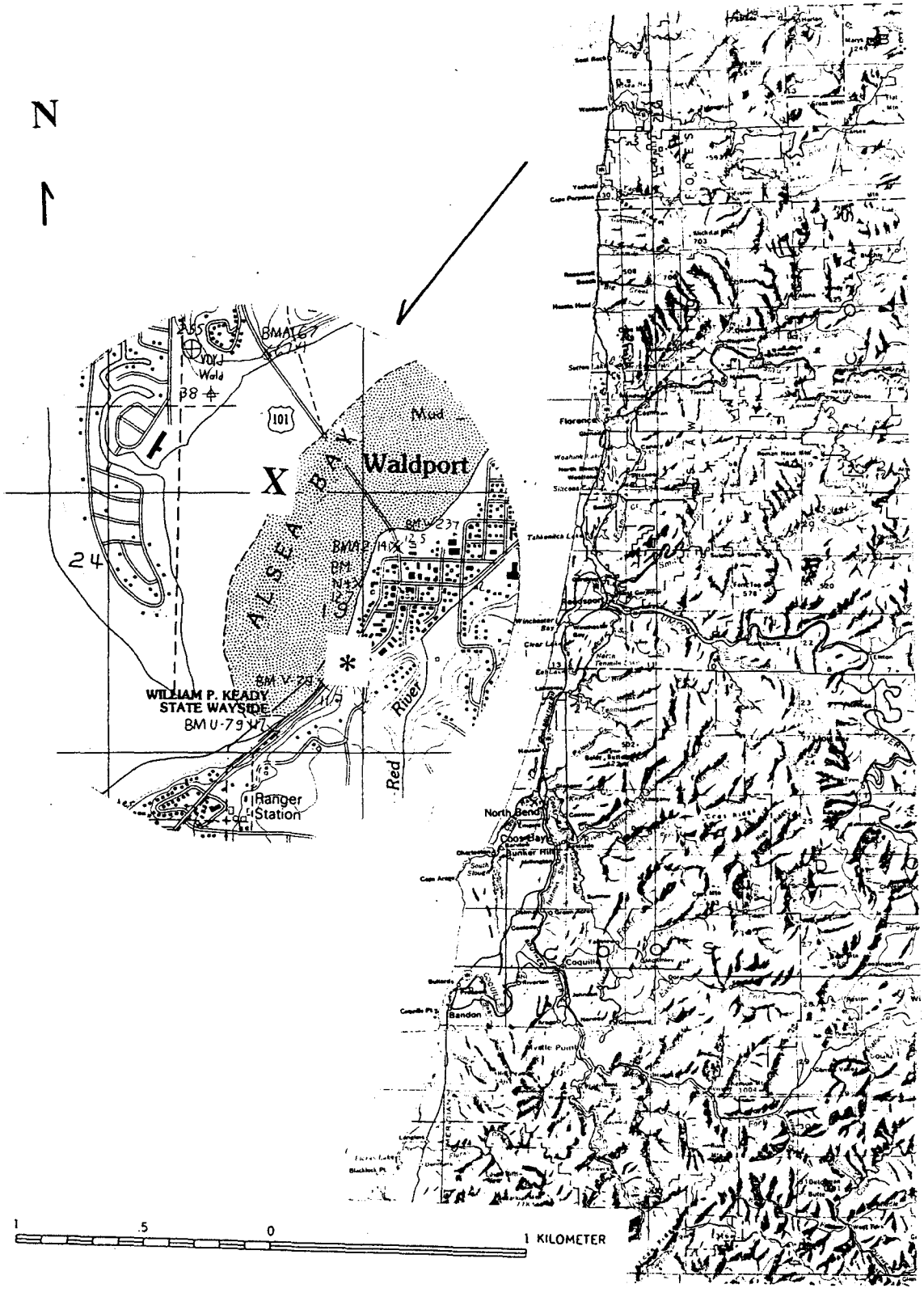


Figure 2. Map of the Alsea Bay Harbor Seal Haul-Out Site Near Waldport (X = Location of Harbor Seals; * = Monitoring Point)



from the haul-out site (Figure 2).

Siuslaw River (44° 00'N, 124° 07'W)

The Siuslaw River haul-out site near Florence is situated on the eastern bank of the Siuslaw River. This site is 3.2 km from the river mouth and is about 150 meters north of the Siuslaw Coast Guard station and boat launch also on the east bank (Figure 3).

The haul-out site used by the harbor seals is a flat muddy substrate shelf, which is used by seals only during low tide heights of less than about +2.3 feet.

The seals hauled out between two sets of old dock pilings, and when space is limited due to tide height or large numbers, they rested between individual pilings.

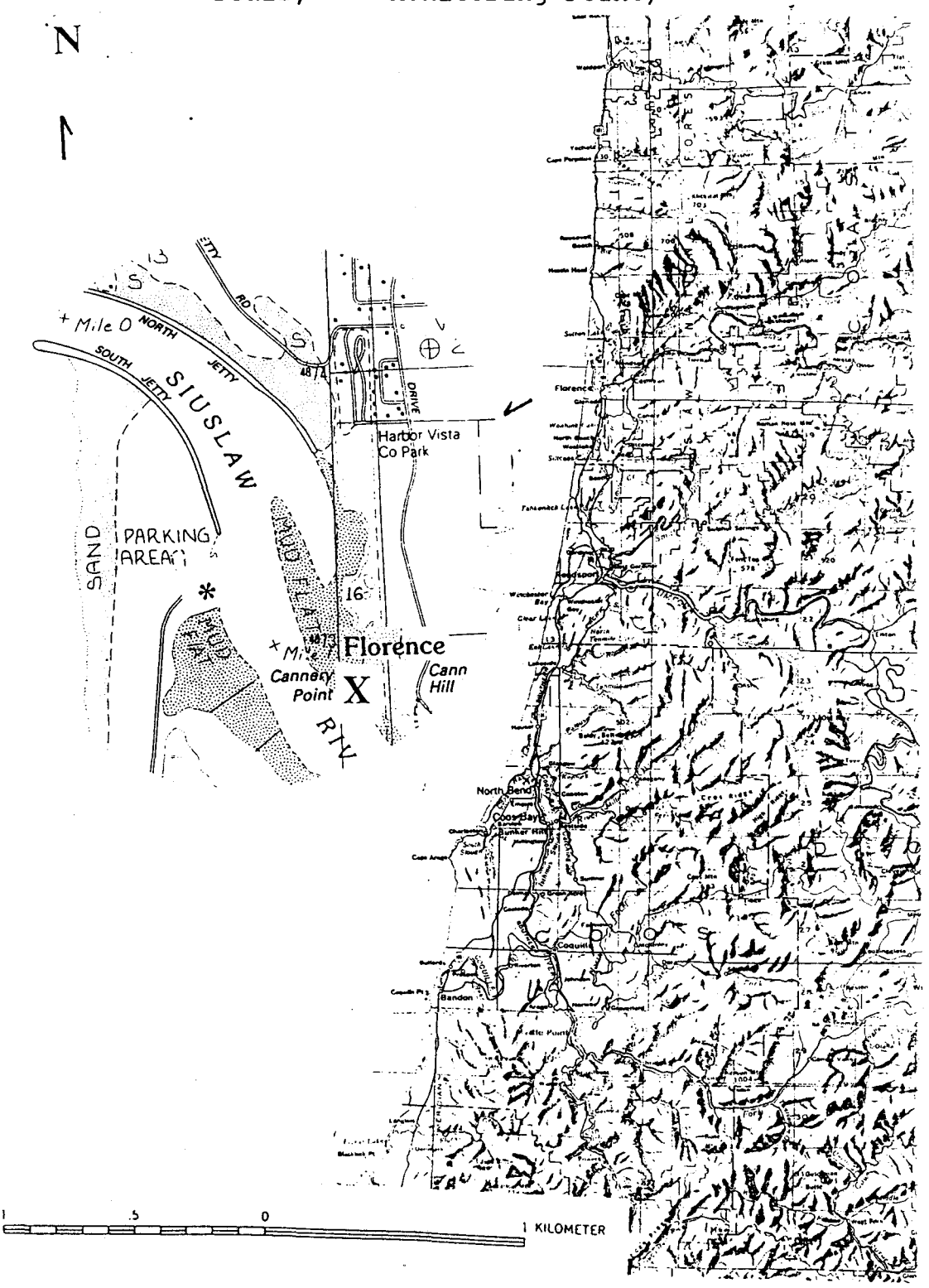
This site is protected on the landward side by 20 meter cliffs which rise nearly vertically from the shelf. These cliffs limit access to the haul-out site by land.

The vantage point where monitoring took place is on a fishing pier on the west side of the river, about 80 meters north of the jetty across from the site (Figure 3). This pier projects nearly 15 meters into the river.

Siltcoos Outlet (43° 53'N, 124° 10'W)

Seals hauled out on the beach where the Siltcoos river

Figure 3. Map of the Siuslaw River Harbor Seal Haul-Out Site Near Florence (X = Location of Harbor Seals; * = Monitoring Point)



emptied into the sea. Normally they were on the northern side of the outlet at the freshwater/saltwater interface, high enough on shore to avoid the ocean swash. The southern side is also used as a haul-out area but less frequently (Figure 4). When large numbers of animals were at this site, seals sometimes rested in the freshwater of the outlet.

The monitoring point for this site is a foredune overlooking the haul-out site on the south side of the outlet (Figure 4). This is accessed by a 1.5 km walk across the dunes from the Siltcoos Dune and Beach Access road.

Umpqua River (43° 42'N, 124° 10'W)

Harbor seals hauled out at two tideflat sites on the Umpqua river. One is about 2.1 km from the mouth and the other nearly half a kilometer further (Figure 5). The site closest to the sea is a sandflat which increased in area as the tide fell, and is used even at medium tides. The site further up the river is a mud flat which became uncovered when the tide dropped below about a +1.8 feet.

Harbor seals were first able to haul out on the north shore sandflat at higher tide levels than on the mudflat, and thus were usually present there in the greatest numbers. The north shore sandflat is the site of the capture and radio-tagging procedure.

Figure 4. Map of the Siltcoos River Harbor Seal Haul-Out Site Between Florence and the Umpqua River (X = Location of Harbor Seals; * = Monitoring Point)

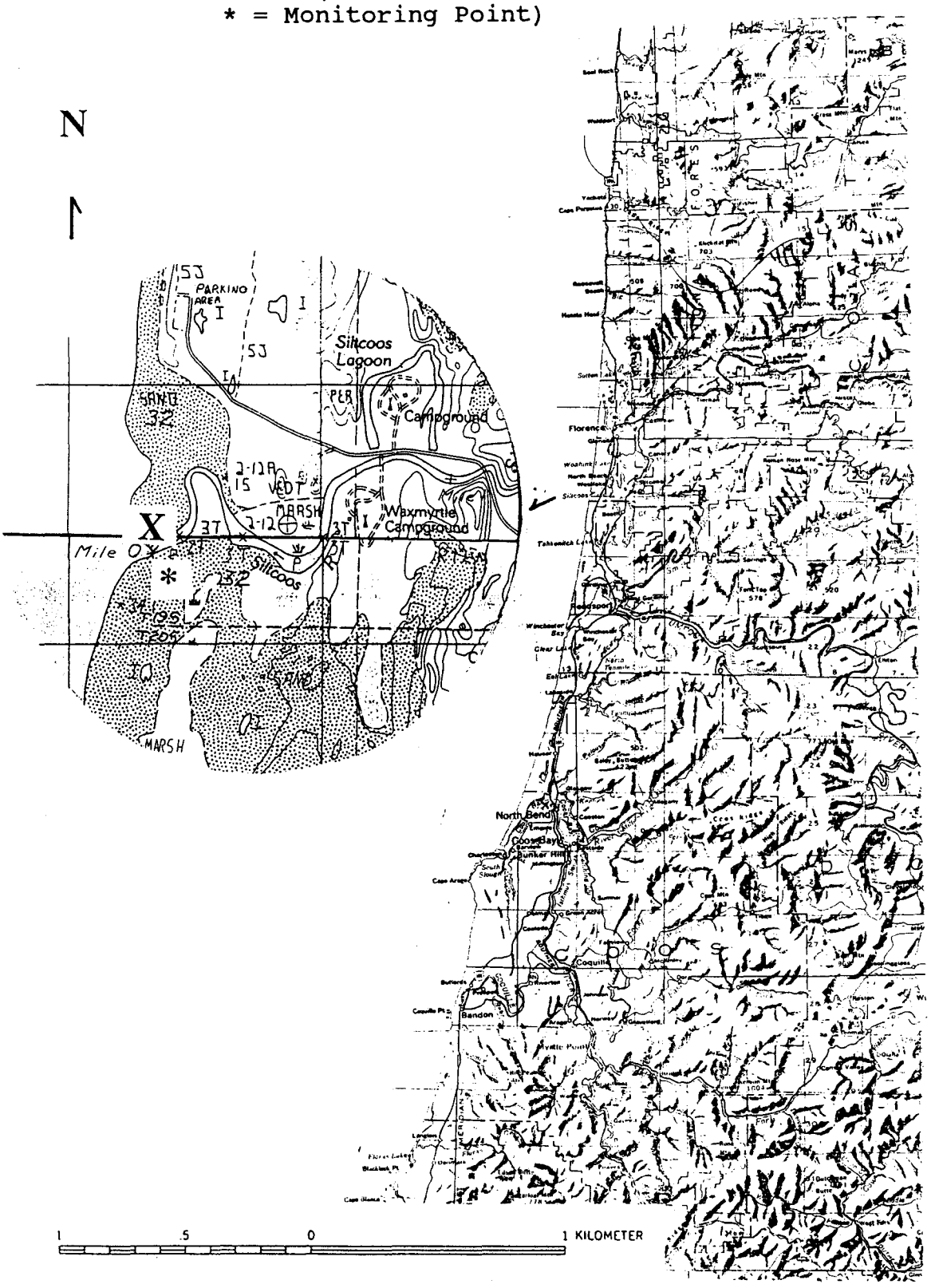


Figure 5. Map of the Umpqua River Harbor Seal Haul-Out Site Near Reedsport (X = Location of Harbor Seals; * = Monitoring Point)

The site was monitored from a bluff above the southern bank on the providence clearcut which was owned and logged by the International Paper Company (Figure 5).

Boat traffic was the primary factor which caused disturbance to the harbor seals at this site.

Pigeon Point (43° 22'N, 124° 19'W)

The Pigeon Point haul-out site is located on the east side of Coos Bay, 5.3 km from the bay entrance (Figure 6). The north and south dredge spoil islets that comprise the site are about 45 meters from the east bank, and were deposited in 1977, when the Coos Bay channel was dredged (Figure 7). These islets were continuous with a tidal mud flat at low tides. Harbor seals were the only pinnipeds that used Pigeon Point.

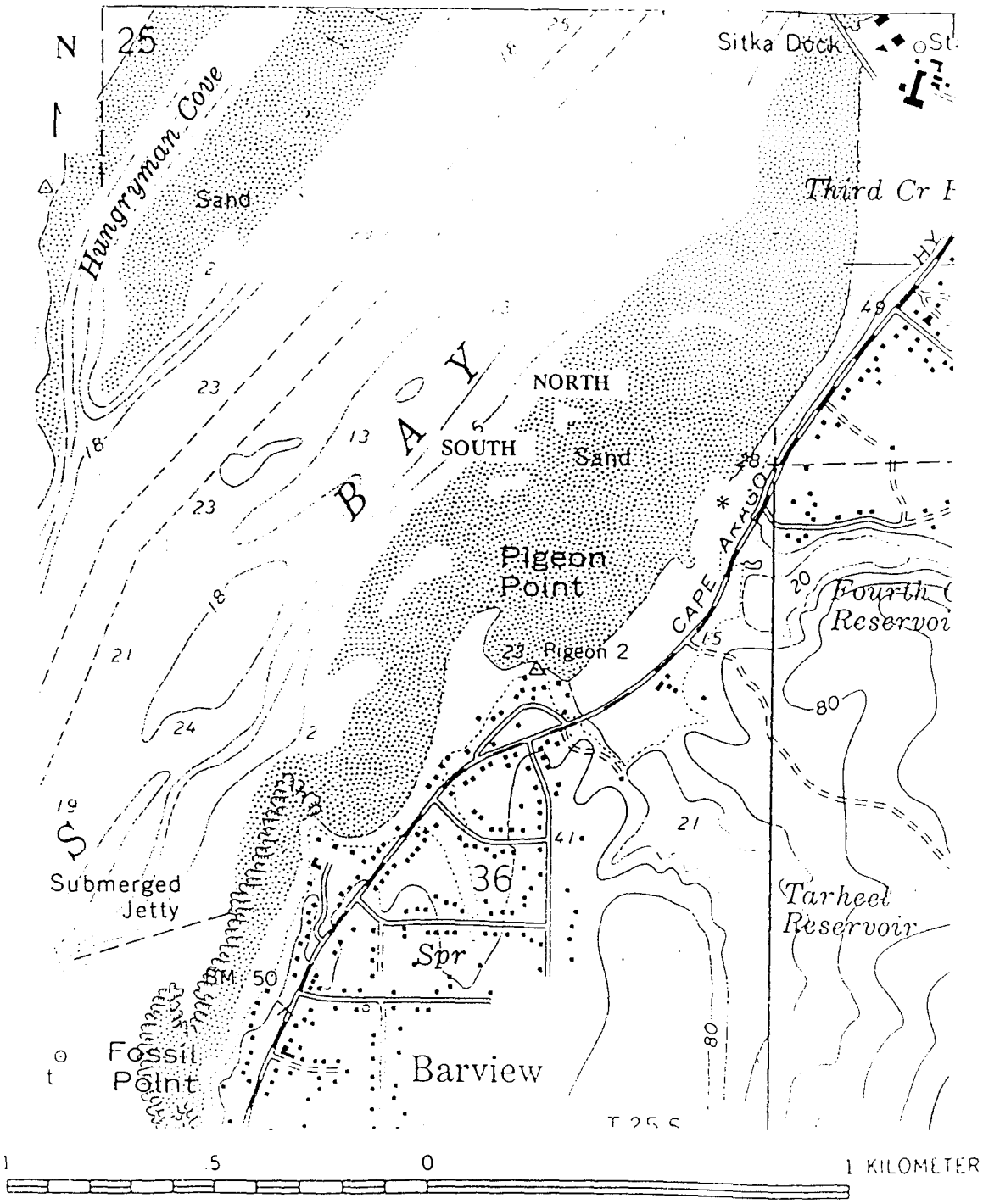
A channel which runs parallel to the islets on the landward side supplied harbor seals with a passageway to the that side of the islets during low tides. At low tides of less than about +0.2 feet, seals would usually not use the north islet, probably due to the shallowness of the channel.

Observations were made directly across from the haul-out site on the eastern bank of Coos Bay approximately 6.5 meters above the shoreline (Figure 7).

Disturbance events due to people clamming, were common at the Pigeon Point site during all months of the year, but

Figure 6. Map of the Pigeon Point Harbor Seal Haul-Out Site In Coos Bay (X = Location of Harbor Seals; * = Monitoring Point)

Figure 7. Map of Pigeon Point Showing the Site Divided into Two Regions



particularly during the summer months.

North Islet

This region is shaped like a boomerang at low tide (Figure 7). It is the larger of the two and is exposed first when tide heights fell below +4.2 feet. Seals usually moved from this site if South Islet was available.

South Islet

This region was the smaller islet and was shaped like a saddle at low tide. It became exposed at heights below +3.1 feet. Seals rested here when this islet became uncovered but moved back to North Islet as the tide rose (Figure 7).

Cape Arago (43° 18'N, 124° 24'W)

The North Cove of Cape Arago is a complex of exposed shoreline rocks, and is located 6.3 km south of the Coos Bay jetties (Figure 8). The two largest rock formations are locally known as Simpson's Reef and Shell Island (Figure 9). The North Cove of Cape Arago is one of the largest haul-out sites for harbor seals on the Oregon coast (R. Brown, Personal Comm.) and is protected from human disturbance by

Figure 8. Map of the Cape Arago Harbor Seal Haul-Out Site Near Coos Bay With Harbor Seals Located on Shell Island, Simpson's Reef and Associated Rocks (* = Monitoring Point)

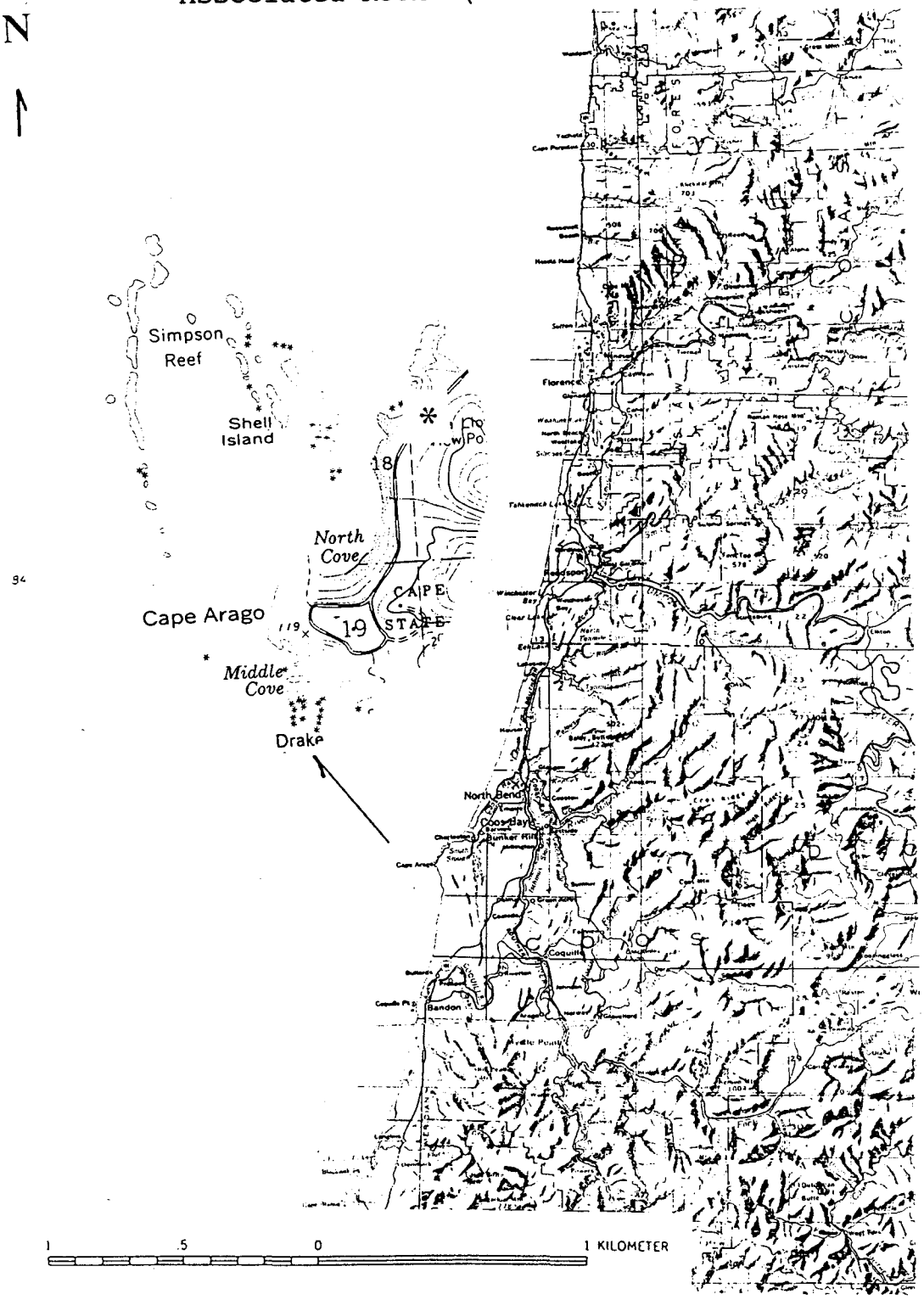
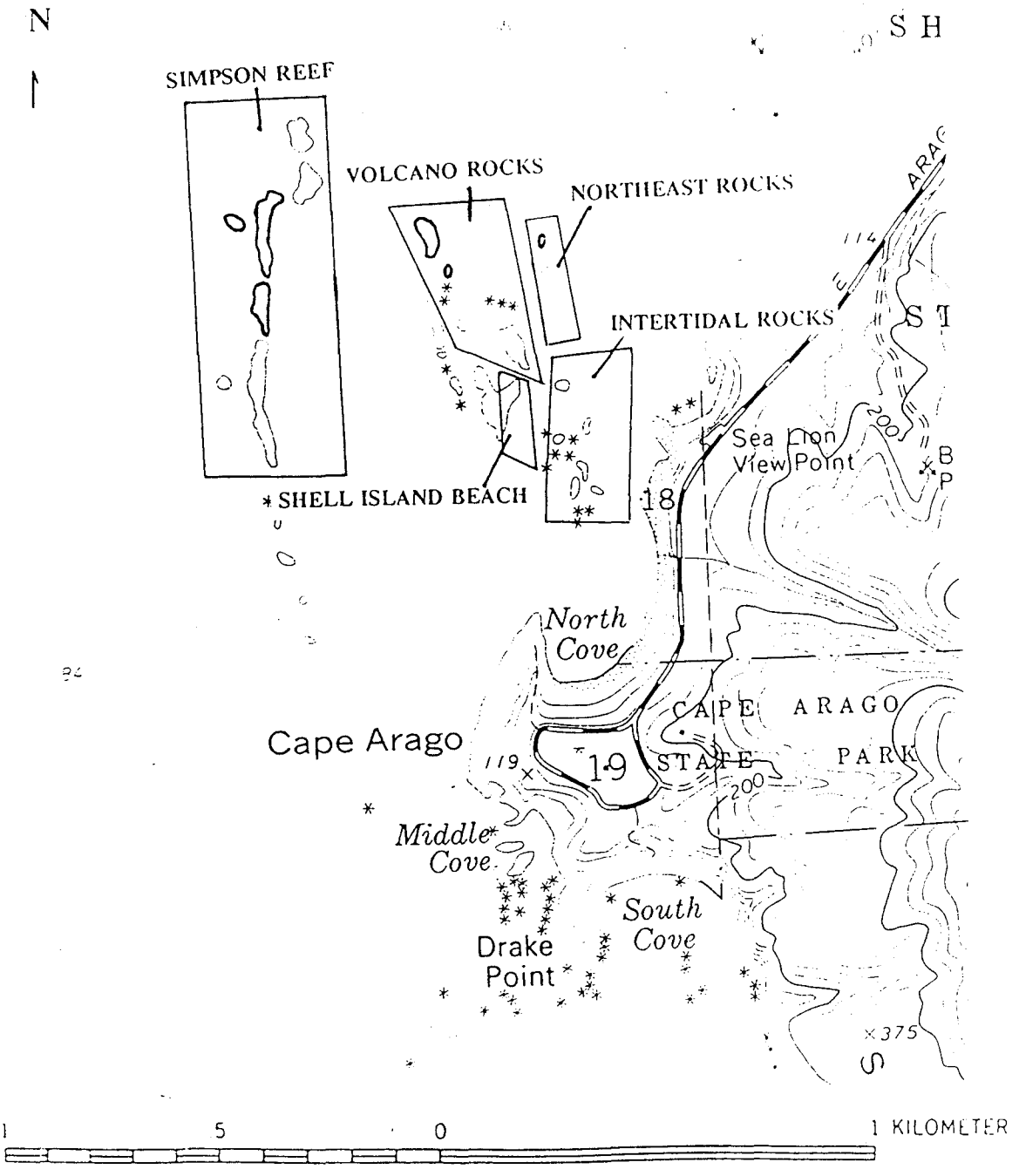


Figure 9. Map of Cape Arago Showing the Site Divided into Five Regions



being designated part of the Oregon Islands National Wildlife Refuge.

Observations of the site were made from the shoreline cliff northeast of North Cove, approximately 25 meters above the shore. This area is locally known as the sea lion lookout (Figure 9).

The site was divided into five regions including: Simpson's Reef, Intertidal Rocks, Volcano Rocks, Northeast Rocks and Shell Island Beach (Figure 9).

Simpson's Reef

Simpson's Reef is the western most rock exposure of the North Cove study site. It is approximately one kilometer due west of the view point and 600 meters northwest from the tip of Cape Arago, and is parallel to the shoreline. The reef is approximately 30 meters wide at its widest point and 700 meters long, being broken along its length. Morphologically it is characterized by a horizontal bench on the east side of the reef which faces the shoreline. This plateau is about 10 meters in width at the center of the reef and progressively decreases in width toward each end (Figure 9).

The reef is a barrier to most winter and summer swells thereby protecting the more eastern inshore rocks from wave action. The height of the seaward portion of the reef

prevents most waves from breaking over and onto the center of the horizontal bench at tides of less than about +7.0 feet. This creates an ideal haul-out site during low tides. However, during periods of storm activity or large wave height, water is splashed over and onto the bench, minimizing or eliminating the use of this site by pinnipeds.

Two otariid species also used this haul-out site primarily during the spring and summer months. The California sea lion (Zalophus californianus) and the Northern or Stellar sea lion (Eumetopias jubatus) hauled out on the northern end of the reef. These animals are able to climb to the apex of the reef without the aid of the bench, enabling them to exploit this section of rock which is inaccessible to the seals.

Intertidal Rocks

This region includes intertidal rocks which extended from the southeast side of Shell Island into the North Cove of Cape Arago (Figure 9). These rocks are protected from wave action throughout the year.

Volcano Rocks

This group of rocks is northwest of Shell Island (Figure 9). Harbor seals generally occupied the intertidal

areas close to the water. Other pinniped species also used this site and sometimes excluded harbor seals.

Northeast Rocks

This rock is flat, broad and long. It is located northeast of Shell Island and is parallel to shore (Figure 9). No other pinnipeds used this site.

Shell Island Beach

This island is located between Simpson's Reef and shore, and is roughly 470 meters from the monitoring point (Figure 9). The most recognizable feature of Shell Island is the beach on the eastern side, which is comprised of pulverized shell fragments and sand deposited by wave action. The beach has a relatively steep slope to the base of the rocks, but is regularly covered by water during the high tides. Both the beach and exposed rocks of Shell Island were used by harbor seals during middle to low tide heights. However, at low tides seals had difficulty accessing the beach due to the large subtidal cobbles which hindered the transition from the water onto the beach.

Other Pinniped Species at Cape Arago

Pinnipeds, other than harbor seals, that haul out at Cape Arago include California sea lions, which occurr throughout the year, achieving greatest numbers in the spring and late summer months during their migration to and from California. These animals haul out on the beach and rocks of Shell Island during low tides, which decrease the amount of space which other species were able to occupy.

While present in very small numbers during the late fall and winter, the Northern or Stellar sea lion is also most abundant during the spring and summer months.

In contrast to the two previously mentioned otariid species, the Northern elephant seals (Mirounga angustirostris) haul out only on the beach on Shell Island. Over forty animals were present during April and May 1992. Numbers declined to several individuals or less in July and August and then increased again to ten or fifteen animals by October 1992. Three pups were born in 1993.

Periodically, from March through August, one or two Northern fur seals (Callorinus ursinus) would use this haul-out site for several days and then leave for the rest of the year. These animals were always seen in the same locations, either on Shell Island, or on rocks north of the beach.

Bandon (44° 03'N, 124° 25'W)

Seals hauled out on a number of the offshore rocks at Coquille Point Rocks. The majority of them hauled out on a formation called cat and kittens rock, approximately 700 meters offshore, which could be accessed by harbor seals at all tide heights (Figure 10).

This site was monitored from the parking lot of the Bandon Ocean State Wayside approximately 800 meters from Cat and Kittens.

There is no human access to most of the rocks at this site so disturbance was minimal.

Cape Blanco (42° 50'N, 124° 37'W)

Harbor seals hauled out on many offshore rocks near Cape Blanco. These included, rocks of Orford Reef to the southwest and Gull and Castle Rocks to the north. The vantage point for monitoring was near the Cape Blanco lighthouse (Figure 11).

Figure 10. Map of the Coquille Point Rocks Harbor Seal Haul-Out Site Near Bandon (X = Location of Harbor Seals; * = Monitoring Point)

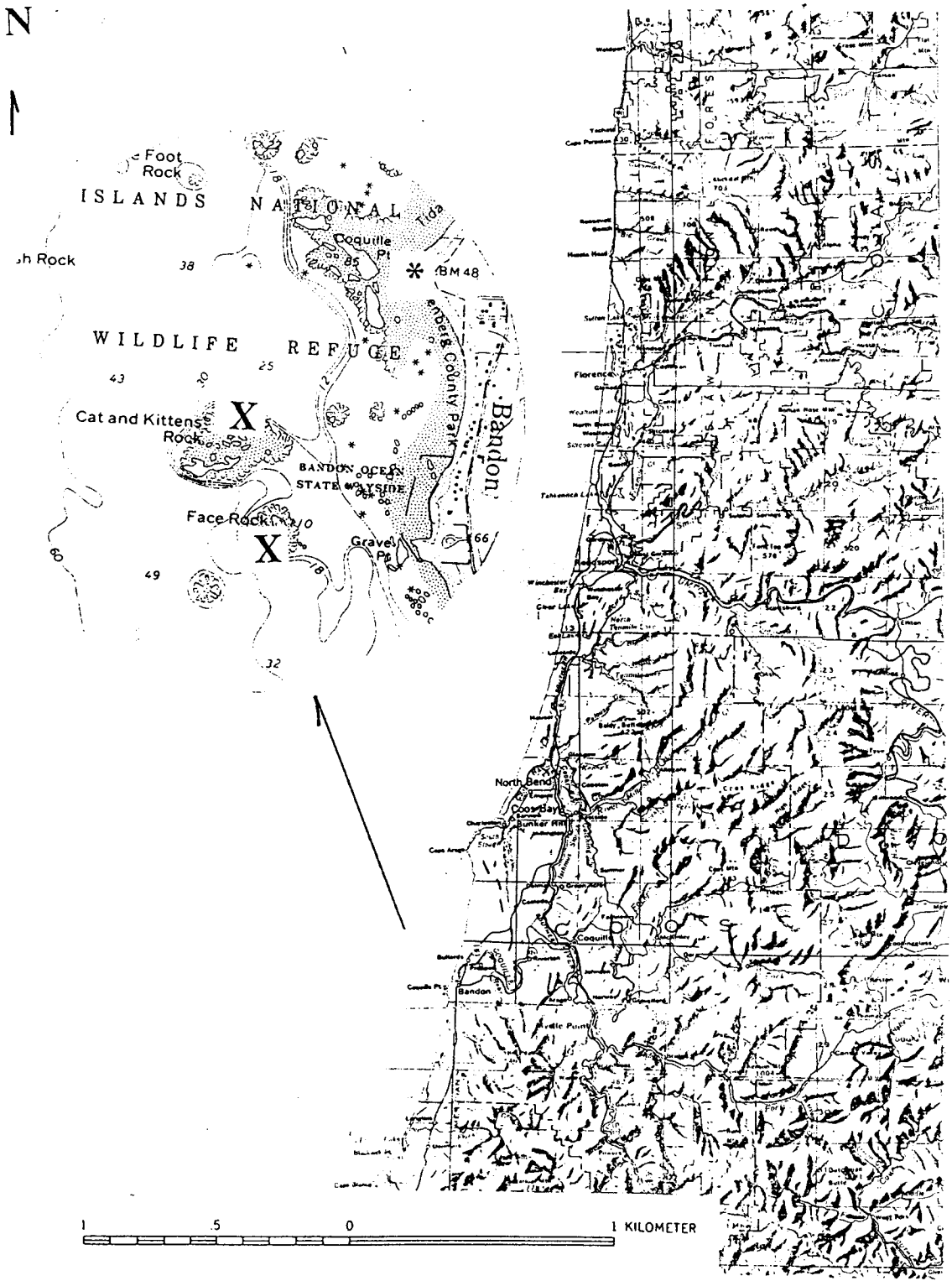
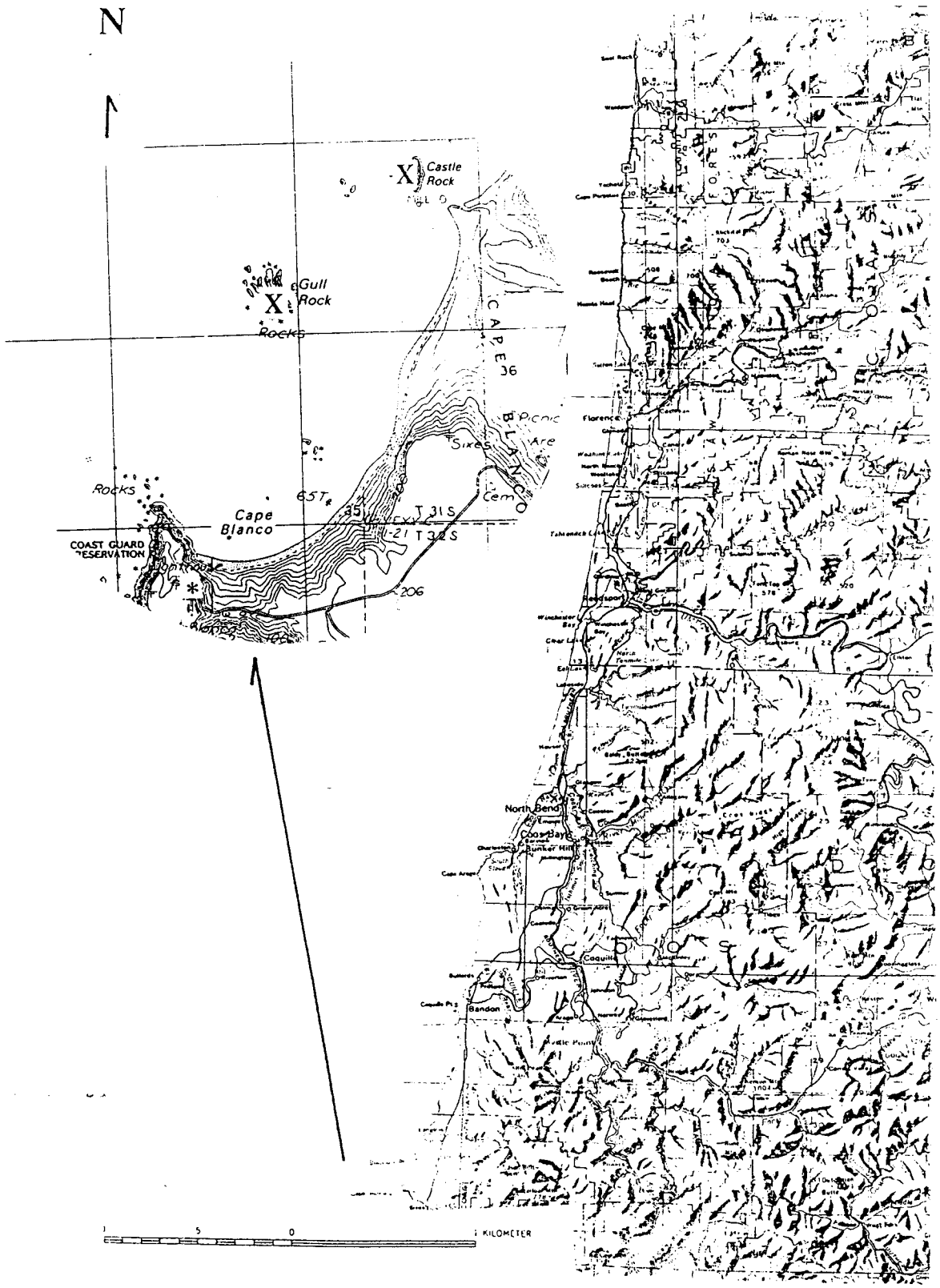


Figure 11. Map of the Cape Blanco Harbor Seal Haul-Out Site (X = Location of Harbor Seals; * = Monitoring Point)



CHAPTER III

METHODS

Radio Telemetry and Monitoring of Harbor Seal Movements Away from the Umpqua River

The harbor seals monitored in this study were tagged at the Umpqua River on May 5 and 6 1992, under the direction of personnel from the National Marine Mammal Laboratory, Washington Department of Wildlife, and Oregon Department of Fish and Wildlife.

Harbor seals were captured in water adjacent to the haul-out site. The specially designed seal net was made up of five panels, each panel being 72′ x 24′ with eight inch mesh and a net web of #36 twine. The deployment of this net required three boats, all powered by outboard motors. Two boats approached the harbor seals, one behind the other, with the lead boat carrying the net on a transom mounted platform just above the motor (Figure 12 A). The net was loaded onto the platform in a manner, to avoid tangling during deployment. Both boats advanced toward the seals somewhat parallel to shore at a slow pace, until the animals displayed the "heads up" posture. The lead boat then accelerated to maximum speed causing the seals to start entering the water. Within about 15 meters of the haul-out,

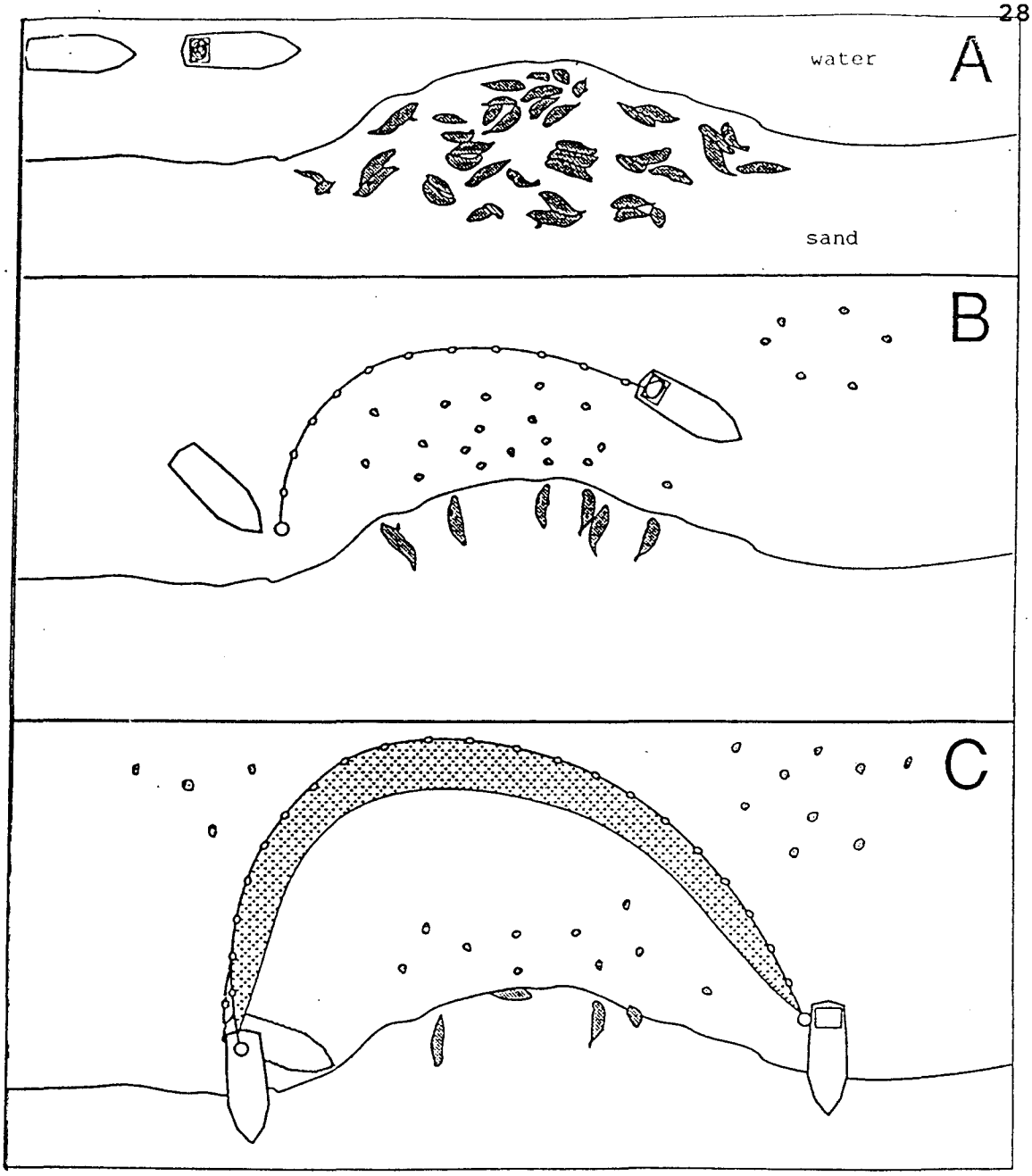


Figure 12. Representation of Capture Technique Used at the Umpqua River Haul-Out

A. Boats Approach Haul-Out Parallel to Shore

B. Net Dropped by Lead Boat which Encircles the Seals - Second Boat Brings Net Ashore

C. Capture Net Traps Seals in Water and on Shore - Net is Pulled in

and approximately 10 meters offshore, a round float 40 centimeters in diameter tied to the end of the net was thrown from the back of the boat toward shore. The foremost boat then curved around the haul-out site, landing on the other side of it with roughly ten meters of net still remaining on the platform (Figure 12 B). Personnel from the second boat recovered the float with a long hook and pulled it to shore in the boat, enclosing all animals in what amounted to a beach seine (Figure 12 C). At this time the third boat which was waiting offshore came swiftly ashore to let additional personnel onto the beach to aid in bringing in the net. The net deployment took less than 60 seconds and captured all animals in the water immediately adjacent to shore along with animals still on land.

The net was pulled ashore starting at each end working toward the middle until all seals in the net were onshore. It was crucial to bring both the leadline and floatline together and trap the seals so the animals could not escape the net by swimming over the floatline. It was also imperative that the net be dragged as far as possible onshore so the entangled harbor seals would be able to breath while still in the net. Each seal was untangled from the net by hand or on occasion was cut out with net cutters when twisted or in danger of suffocating. Individual animals were dragged out of the net by the hind flippers and placed head first into hoop nets and remained in the nets

until released. These nets were made from pieces of stout circular rubber tubing formed into hoops with stretch nylon mesh tied to the hoop and stitched at one end, forming a bag. All animals were retrieved from the capture net and placed into hoop nets before any tagging was initiated.

Before tagging, each captured harbor seal was sexed in order to determine which animals were to be equipped with transmitters. They were weighed while in the hoop net. The adult pinnipeds were rolled onto a stretcher while the pups were put head first into a small net bag. The animal was then lifted onto a 150 kg scale, and weighed.

The animals were physically restrained in order to expedite the tagging procedure. An individual harbor seal was approached from behind by a researcher who simultaneously straddled the animal and bent the pliant rubber of the hoop net forward off the rear portion of the seal, exposing the flippers and hind quarters. The researcher also held the head of the seal down with both hands so it could not bite or struggle. The larger animals sometimes had to be subdued by two people.

While the harbor seal was restrained, plastic Jumbo Roto cattle ear tags were attached between the first and second digits of both hind flippers by piercing the inter-digital webbing with a leather punch and inserting the tag post through the webbing and snapping the tag closed with the required tool. Green tags were applied to females,

white to males. Radio transmitters were attached to Temple cattle ear tags which were then secured to the seals hind flippers by inserting them through holes in the webbing and securing them with a small screw. These light blue units weighed 22 g, measured 45 cm x 16 cm x 12 cm and had a 12 inch flexible antennae which extended behind the seal. Each produced a frequency between 164-165 Mhz., with each seal receiving a transmitter with a distinct frequency. Each transmitter had a range of about four km and the battery was guaranteed for a minimum of four months. Thirty-three seals were equipped with flipper tags while twenty-one were simultaneously radio tagged (Appendix A). The radio transmitters were manufactured by Advanced Telemetry Systems of Isanti, Minnesota.

For the purpose of visual identification in the field, neoprene patches with large numerals made by permanent black marker were glued to each seal's dorsal pelage, between the animals foreflippers. None of the pups received patches. Patches were either fluorescent orange or light blue and had plastic mesh on the side epoxied to the seal. The pelage between the two scapulas was scrubbed with isopropyl alcohol and a clean towel, then blown completely dry with compressed air. About 30 cc of five minute epoxy (Devcon Corporation) was applied to the patch which was then placed on the seal's fur. Initially, the patch was moved slightly toward the anterior of the individual over the pelage so the hairs were

forced into the mesh on the neoprene for greater hold. The patch was then held firmly on the animal for about five minutes or until the patch started getting warm as the epoxy hardened. After this procedure, the animal's length and girth under the foreflippers was measured. Some of the larger males were too aggressive and uncooperative to permit these measurements. Two pups were captured on the mudflat site further upriver. These animals were captured by running onto the flat from boats and seizing them. The same procedure for tagging was then carried out.

A Yagi-Uda antennae array , used to monitor the presence of the seals at the Umpqua haul-out, was mounted on a pipe extending vertically from a large stump atop the providence clearcut on the south side of the Umpqua river, facing the haul-out sites. These antennae were connected to a programmable scanning receiver and Data Collection Computer both manufactured by ATS of Isanti, MN. Both these items were stored in a waterproof drum at the base of the stump. The monitoring system was powered by a 12 volt battery deep cycle marine battery.

Continuous automated recordings of radio transmissions occurred 24 hours a day from May 6 to September 27 except when the data collection computer was being down loaded to extract previously recorded information.

Approximately a week after the termination of tagging, monitoring of the other haul-out sites around the Umpqua was

initiated. Siltcoos River Outlet, Florence, and the Coos Bay Area were all monitored during low tide. The usual schedule was to drive north twice a week from Coos Bay and monitor Siltcoos River Outlet, Florence, haul-out sites during one low tide. Both Coos Bay and Cape Arago sites were monitored during seal population surveys. Once every three to four weeks an aerial survey was flown by the Oregon Department of Fish and Wildlife in order to listen to all haul-out sites from Newport to the California border during a single low tide. If a transmitter was received at a particular haul-out not being monitored, that site was included on the next ground survey. In total, eight haul-out sites were monitored; Alsea Bay, Strawberry Hill, Florence, Siltcoos, Pigeon Point, Cape Arago, Bandon and Cape Arago (Figure 1).

Seasonal Abundance of Harbor Seals at Cape Arago and Pigeon Point

The number of harbor seals hauled out at Cape Arago and Pigeon Point were counted on numerous occasions between April 15, 1992 and May 10, 1993. All counts were made with a 20-50x or 15-45x zoom spotting scope and a pair of 10x50 power wide angle binoculars. Total observation time was 226.8 hours (176.4 hours in 1992, 50.4 hours in 1993).

Harbor seal abundance at these two sites was determined by twice counting the number of seals hauled out at each

site. First the seals at the site were counted from left to right, then again from right to left. A seal was considered hauled out even if partially submerged, as long as any part of the animal was visible and the animal was in contact with an underwater surface. Counts presented are total number of harbor seals regardless of age. During the pupping/breeding season, pups were included with the total seal count but were also be counted and reported separately. Other pinniped species at each site were counted on approximately half the monitoring bouts in order to assess fluctuations in these populations. Total number of surveys conducted were 148 and 132 for Cape Arago and Pigeon Point respectively.

Seal counts were made throughout the year but the number of censuses conducted during the spring and summer months (April-September) were higher than in the winter (October-March) (Table 1). To determine if any haul-out patterns during the pupping/breeding season and molting seasons differed from the rest of the year, censuses were taken during daylight lowtides of all heights.

At Cape Arago 93% of surveys were conducted from two hours before to two hours after low tide, while 80% of surveys were made within an hour of low tide. At Pigeon Point, 86% of the surveys were conducted within two hours of low tide and 62% were conducted within one hour. 14% of Pigeon Point surveys were done two to three hours before or after low tide when tide heights were less than 0.0 feet

Table 1. Number of Surveys of Harbor Seals each Month at Cape Arago and Pigeon Point

Season Month, Year	Number of Surveys Each Month Cape Arago	 Pigeon Point
Spring/Summer:		
April, 1992	12	14
May, 1992	14	11
June, 1992	19	16
July, 1992	19	17
August, 1992	15	15
September, 1992	13	13
Seasonal Mean	x=15	x=14
Winter/Spring:		
October, 1992	12	7
November, 1992	11	7
December, 1992	8	9
January, 1993	7	7
February, 1993	7	6
March, 1993	3	3
April, 1993	6	5
May, 1993	2	2
Seasonal Mean	x=7	x=6

because seals did not haul-out at this site at low tide levels below this height. The number of seals on the five regions at Cape Arago and the two at Pigeon Point were counted separately. For the purpose of analyzing weekly data, the mean weekly total seal count (MWTS) and the mean weekly total pup count (MWTP) were used.

Air to ground counting comparisons were made on three occasions at Cape Arago and twice at Pigeon Point. Simultaneous counts were made from the vantage point at each site while the same site was counted by air. The aerial surveys were conducted by the Oregon Department of Fish and Wildlife from a single engine high-winged plane at an altitude of approximately 250 meters and a speed of 80 knots. Photographs were taken of the site and later projected onto a white background to facilitate the counting of individuals. The comparisons made to correct counting errors on land are included in appendix B, but results do not take these corrections into account.

CHAPTER IV

RESULTS

Movement of Harbor Seals

The presence or absence of the 21 radio tagged harbor seals was recorded at the Umpqua haul-out site from May 6 (Day 1) through June 6 (Day 32), and June 13 (Day 39) through September 29 (Day 147), 1992, a total of 141 days. The tag numbers, radio frequencies and measurements of the radio-tagged harbor seals are given in appendix A. The seven haul-out sites outside the Umpqua were sampled a total of 242 times from May 12 (Day 7) through October 4 (Day 152) (Table 2).

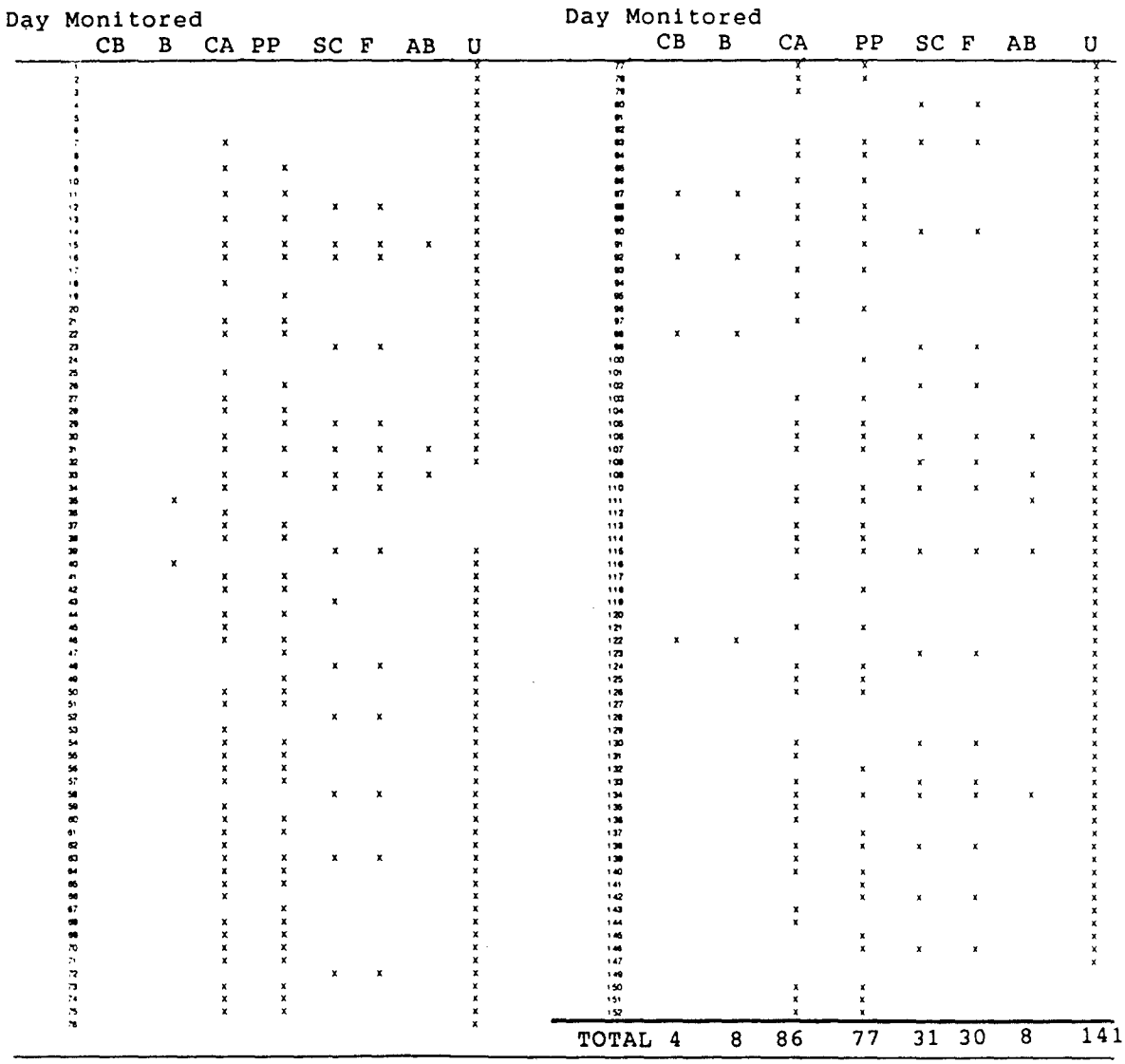
The radio tagged seals showed five categories of movements:

I. Animals which were resighted regularly at the Umpqua for a period, then left the Umpqua and were then resighted outside the Umpqua at one or more sites.

II. Animals present at the Umpqua which were resighted elsewhere for a period, and then returned to the Umpqua or may have left the Umpqua again.

III. Animals which were never resighted at the Umpqua but which were resighted elsewhere.

Table 2. Monitoring Efforts at Eight Harbor Seal Haul-Out Sites on the Oregon Coast
X= Site Monitored



Day Monitored	CB	B	CA	PP	SC	F	AB	U
TOTAL	4	8	86	77	31	30	8	141

UM-Umpqua AB-Alsea Bay FL-Florence SC-Siltcoos
PP-Pigeon Point CA-Cape Arago BN-Bandon CB-Cape Blanco

IV. Animals which were resighted regularly at only the Umpqua throughout the monitoring.

V. Animals which were resighted regularly at the Umpqua for a period of time, and then no further resightings were made.

The number of seals exhibiting each movement category is shown in Table 3.

Resightings at the Umpqua Haul-Out Site

Nine seals were recorded as being present only at the Umpqua haul-out site. Three of these seals exhibited category IV movement, while six displayed category V movement (Table 3).

I have interpreted the decrease in resightings of radio tagged harbor seals at the Umpqua study site as a result of seals moving out of the area. However, confounding factors such as transmitter failure, transmitter detachment, or seal death may have contributed to decreased and/or erroneous resightings at the Umpqua and outside the Umpqua over the study period. For example animals assigned to category V may have lost their transmitters and may not have left the Umpqua as I have interpreted.

Twelve seals exhibited category I,II or III movements and were present at the Umpqua for varying period of time.

Table 3. Movement Category for all Harbor Seals Tagged at the Umpqua Site

Gender & Age Class	Movement category				
	I	II	III	IV	V
Male	6	1	1	0	2
Female	2	2	0	3	4
Adult	5	1	1	1	3
Sub-Adult	0	1	0	2	1
Pup	3	1	0	0	2

Movement Category:

I. Animals which were resighted regularly at the Umpqua for a period, then left the Umpqua and were then resighted outside the Umpqua at one or more sites.

II. Animals present at the Umpqua which were resighted elsewhere for a period, and then returned to the Umpqua or may have left the Umpqua again.

III. Animals which were never resighted at the Umpqua but which were resighted elsewhere.

IV. Animals which were resighted regularly at only the Umpqua throughout the monitoring.

V. Animals which were resighted regularly at the Umpqua for a period of time, and then no further resightings were made.

For these animals, the greatest permanent movement from the Umpqua occurred during the first 56 days, about 15 days before the molt. Four animals left by day 28 and eight by day 56. By day 112 of the study, all twelve animals had left the Umpqua (Table 4).

Resightings at Haul-Out Sites Away from the Umpqua

Twelve harbor seals in movement categories I-III were resighted away from the Umpqua (Table 3). Individual seals were resighted an average of 6.8 times over the 152 days with the median of five resightings and a range from 1 - 31 resightings (Appendix C). This represents a minimum estimate of presence or absence due to manual monitoring of these sites in the field.

During successive 28 day periods from Day 1 through Day 140 there was both an increase in animals resighted for the first time outside the Umpqua and in the frequency of resightings. The largest increase was between day 84 and day 112 when four new seals were resighted and the frequency of seal resightings increased by 26 (Table 4).

It is, however, likely that the radio tag batteries failed during the later part of the study and this, rather than a decrease in the number of seals hauled out, was responsible for the decrease in resightings both at the Umpqua and at other locations after day 140.

Table 4. Number, Frequency and Location of Harbor Seals Resighted Outside the Umpqua

Day of Study	Number of category I-III seals absent from the Umpqua haul out site	Number of Seals Resighted Away From The Umpqua								Total Number of Resightings Away from the Umpqua							
	Location:	AB	FL	SC	PP	CA	BN	CB	Total No.	AB	FL	SC	PP	CA	BN	CB	Total No.
Day 1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Day 28	4	0	0	2	1	0	0	0	3	0	0	3	4	0	0	0	7
Day 56	8	0	0	2	1	2	1*	0	5	0	0	13	13	3	1	0	30
Day 84	10	0	1	2	1	3	0	0	7	0	3	16	20	9	1	0	43
Day 112	12	1	4	2	1	3	0	1*	11	3	15	16	24	10	1	0	69
Day 140	12	1	5	2	1	3	0	0	12	4	20	16	29	10	1	1	81
Day 152	12	1	5	2	1	3	0	0	12	4	20	16	30	10	1	1	82

UM-Umpqua AB-Alsea Bay FL-Florence SC-Siltcoos
PP-Pigeon Point CA-Cape Arago BN-Bandon CB-Cape Blanco
*= Same Seal Resighted at Another Location

Resightings at Haul-Out Sites North of the Umpqua

Eight of the 12 animals that were resighted outside the Umpqua moved to the three sites north. Resightings progressed northward from the Umpqua chronologically during the study period (Table 4). No animal which utilized any of the northern haul-out sites was ever resighted at more than one, nor did any of these animals travel to any of the southern haul-out sites during the study period (Table 5).

The Siltcoos haul-out site, 23 kilometers north of the Umpqua, was the first where any animals were resighted. Both the male adult (seal #17) and the female sub-adult (seal #4) exhibited category II movement (Appendix C). The two were resighted only at the Siltcoos and each made trips back to the Umpqua (Table 5).

During eight visits to the Siltcoos from day 83 to day 115, the female's transmitter was "resighted" on seven occasions but on all of these surveys no seals were present. Investigations with the hand held receiver determined that the transmitter tag had become detached and was buried in the sand near the Siltcoos site. Therefore, all positive sightings after day 80, when the seal was last visually identified, were not considered as true resightings.

Five tagged seals were resighted at Florence, 40.25 km north of the tagging site. All of these seals exhibited

Table 5. Presence or Absence of 12 Resighted Harbor Seals at Eight Sites Over the Study

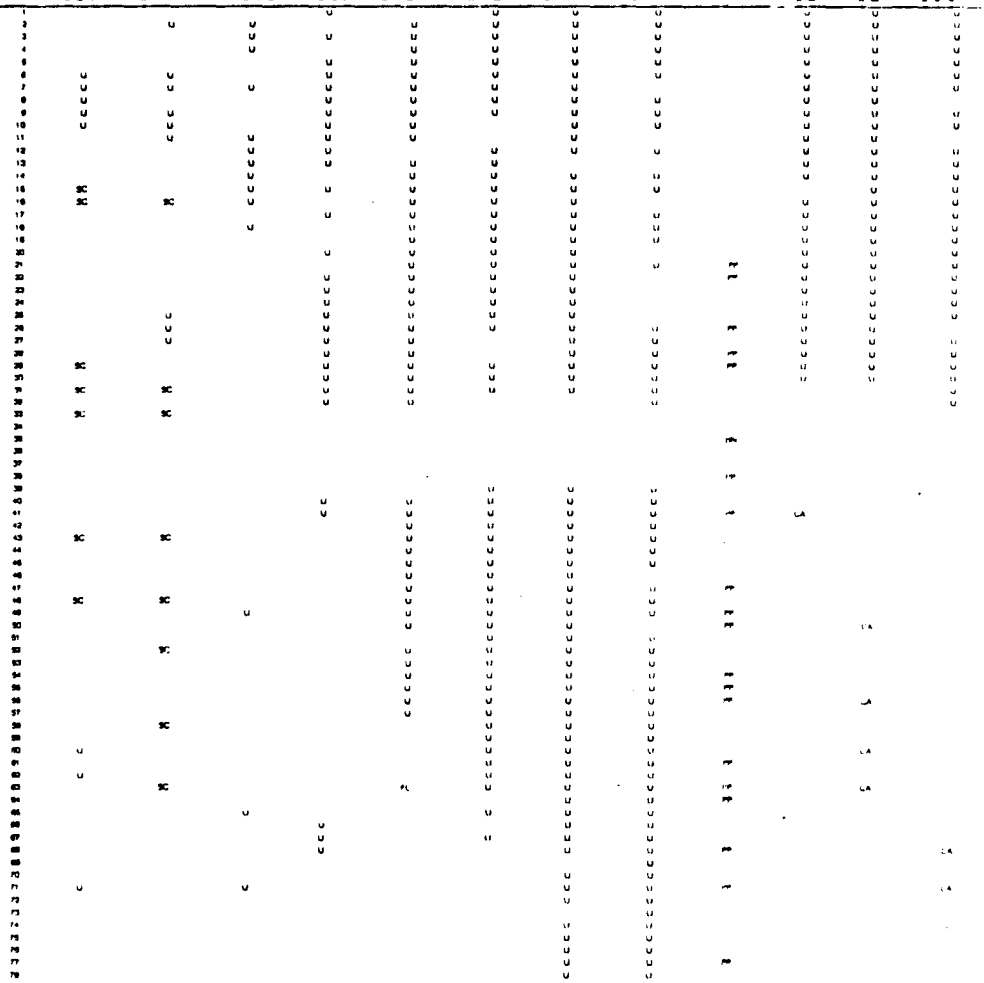
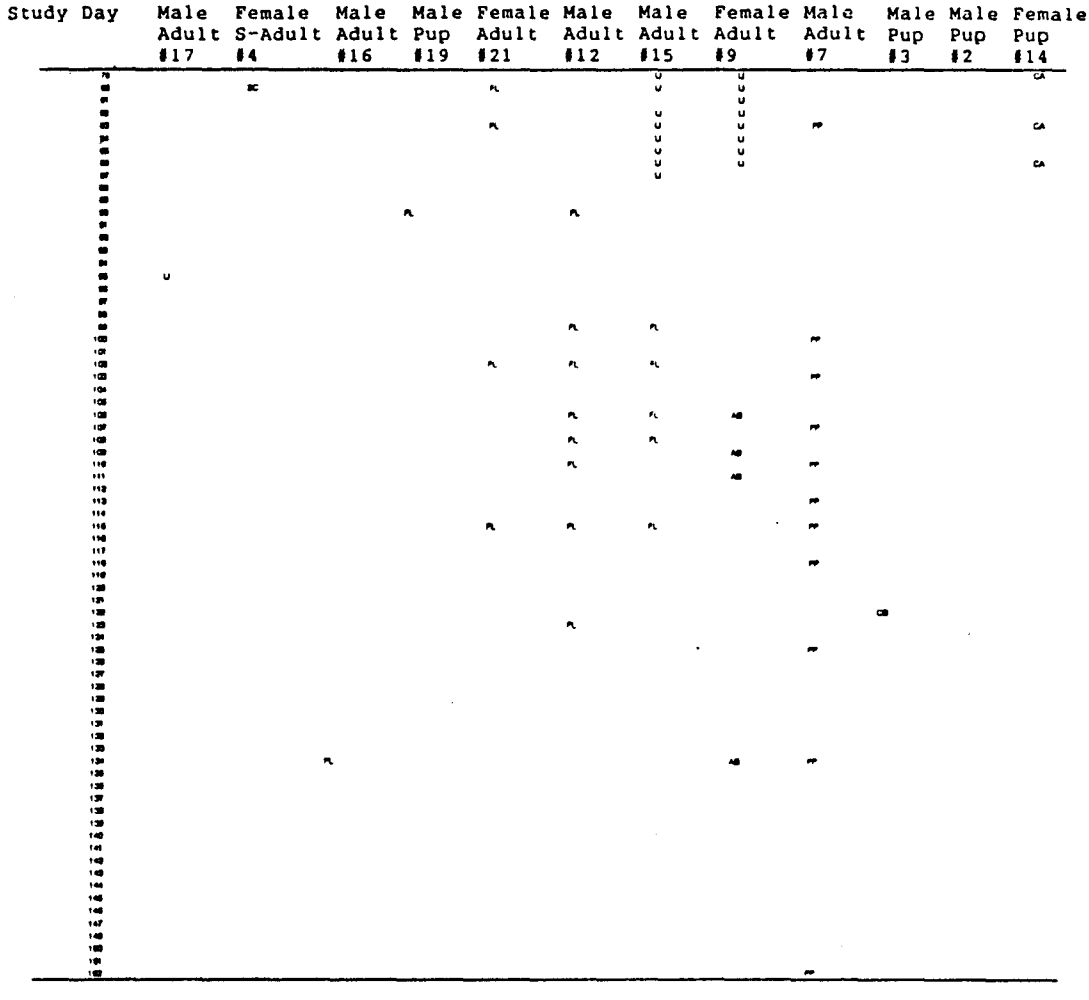
Study Day	Male Adult #17	Female S-Adult #4	Male Adult #16	Male Pup #19	Female Adult #21	Male Adult #12	Male Adult #15	Female Adult #9	Male Adult #7	Male Pup #3	Male Pup #2	Female Pup #14
												

Table 5. (Continued)



UM-Umpqua AB-Alsea Bay FL-Florence SC-Siltcoos
PP-Pigeon Point CA-Cape Arago BN-Bandon CB-Cape Blanco

category I movements, never returning to the Umpqua after leaving. Each of these animals also stayed at the Umpqua until the middle of the monitoring period between days 58 and 87, and were then heard at Florence during the middle of the study (Table 5). None of the five were heard at other sites, but they were not always present at Florence during monitoring. Of the times this site was surveyed after the seals left the Umpqua they were heard at Florence an average of 24% of the time with a range from 6%-47%. (Table 5).

Only one animal was heard at Alsea Bay, an adult female (seal #9) discovered on day 106. This animal stayed at the Umpqua until day 86 and then was only heard at Alsea Bay, thus exhibiting a category I movement pattern. The Alsea Bay haul-out was not monitored from day 34 to day 105 so it may have been present earlier than the first resighting.

Resightings at Haul-Out Sites South of the Umpqua

The remaining four harbor seals were resighted at four sites south of the Umpqua. There was a general progression of haul-out site utilization from the Umpqua south (Table 4). Two seals that moved south used more than one haul-out site, but no animals which travelled south were ever heard north of the Umpqua.

The Pigeon Point haul-out site, 45.25 kilometers to the south of the Umpqua, was the first southern site where any

tagged seal was resighted. This seal was also heard on the last day of the study on day 152. The male adult (seal #7), exhibited a category III movement pattern, and was resighted at the Bandon haul-out on day 35 (Table 5). The transmitter length of function on this animal was the longest of any tagged seal, lasting 152 days.

Three seals were resighted at Cape Arago. Two male pups (seal #2 and #3) exhibited category I movement. Seal #3 was also heard at Cape Blanco on day 122 (Table 5). A female pup (seal #14) demonstrated category II movement by travelling to Cape Arago, returning to the Umpqua for a brief period and then moving south again to Cape Arago (Table 5). All seals were resighted at Cape Arago in the first half of the study (Table 5).

Movement with Respect to Gender

The number of tagged animals in this study was not large enough to permit a statistical analysis of movement patterns. However there were some trends which may give some indication of patterns.

Twice as many male harbor seals than females were resighted at non-Umpqua sites (Table 5). The eight males resighted represent 80% of the males tagged in the study. Of the eleven females tagged at the Umpqua only four were resighted elsewhere.

The number of resightings for each animal was taken as a percentage of the monitoring bouts at the site(s) where it was heard. The mean percentage of resightings for each gender was calculated and found to be 18.8% (sd=14) for males and 31.3% (sd=11) for females.

In order to evaluate gender differences in distances traveled, minimum straight line distances between haul-out sites were determined for each seal.

The mean distance the four females travelled over the duration of the study was 85.2 km with a range of 40.3 - 144 km. Males traveled a mean distance of 58.9 km with a range of 40.3 - 115.3 km. The females moved 42% of the total kilometers in the study while only representing one third of the animals resighted in the field. However, because seals spend a significant amount of time away from the haul-outs, total distances travelled by animals may vary with gender but was not addressed in this study.

Movement with Respect to Age

Seals resighted at non Umpqua sites include four pups, one sub-adult and seven adults which comprised 67%, 25% and 64% of the seals tagged in each age class. Each pup was resighted an average of 2.8 times with a range of 1 - 5 times. The one sub-adult was heard 9 times. The adults were resighted an average of 8.7 times with a range of 1-31

times.

To compare the number of resightings per age class, each resighting was adjusted as before with respect to effort. The mean resightings for pups was 5.0% with a range of 2.8% - 6.9% while for adults the mean was 32.3% with a range of 3.7% - 66.7%.

There were no differences in movement categories between with age classes; the largest percentage of each class displayed category I movement (Table 3).

Minimum straight line travel distances between sites were grouped by age in order to compare the mean distances moved during the study. Pups travelled a mean straight line distance of 83.2 km with a range of 40.3 - 144 km, representing 41% of the total kilometers travelled. For adults, the mean straight line distance was 58.6 km with a range of 40.3 - 115.3 km, representing 51% of the kilometers travelled. The sub-adult moved 69 km or 8% of the total kilometers. Again, seals spend time away from the haul-out and thus total distance travelled will be greater than these straight line movements.

Seasonal Abundance of Harbor Seals in the Coos Bay Area

Each site was divided into regions which were counted separately, six at Cape Arago and two at Pigeon Point. In order to correct for daily variations in abundance counts,

weekly averages were analyzed. No counts were made at Cape Arago or Pigeon Point during the first week of January 1993, or during the second and third week of March, 1993. In addition, no counts were made on the last week in March, 1993 at Cape Arago.

Harbor Seal Abundance at Cape Arago

Harbor seals are residents at Cape Arago throughout the year. The number of seals hauled out increases in the spring and summer months and declines in the winter (Figure 13).

The highest number of MWTS occurred from July 12-18, 1992, with the peak occurring on July 14, 1992 (Table 6). A rapid decline observed until about the end of August, 1992 (Figure 13). Over the fall and winter months numbers were fairly constant at about 350 total animals. Another increase was observed to start at the end of March, 1993 which was similar to the one the year before (Figure 13).

Pups were first sighted on April 15, 1992 and April 12, 1993 (Figure 13). After about three weeks a sharp increase in pup numbers occurred with a peak being observed on May 27, 1992 (Table 6). A slow decline in numbers resulted until about the first week in August when numbers dropped below ten animals. In 1993 the same pattern was observed for the early part of the pupping season (Figure 13).

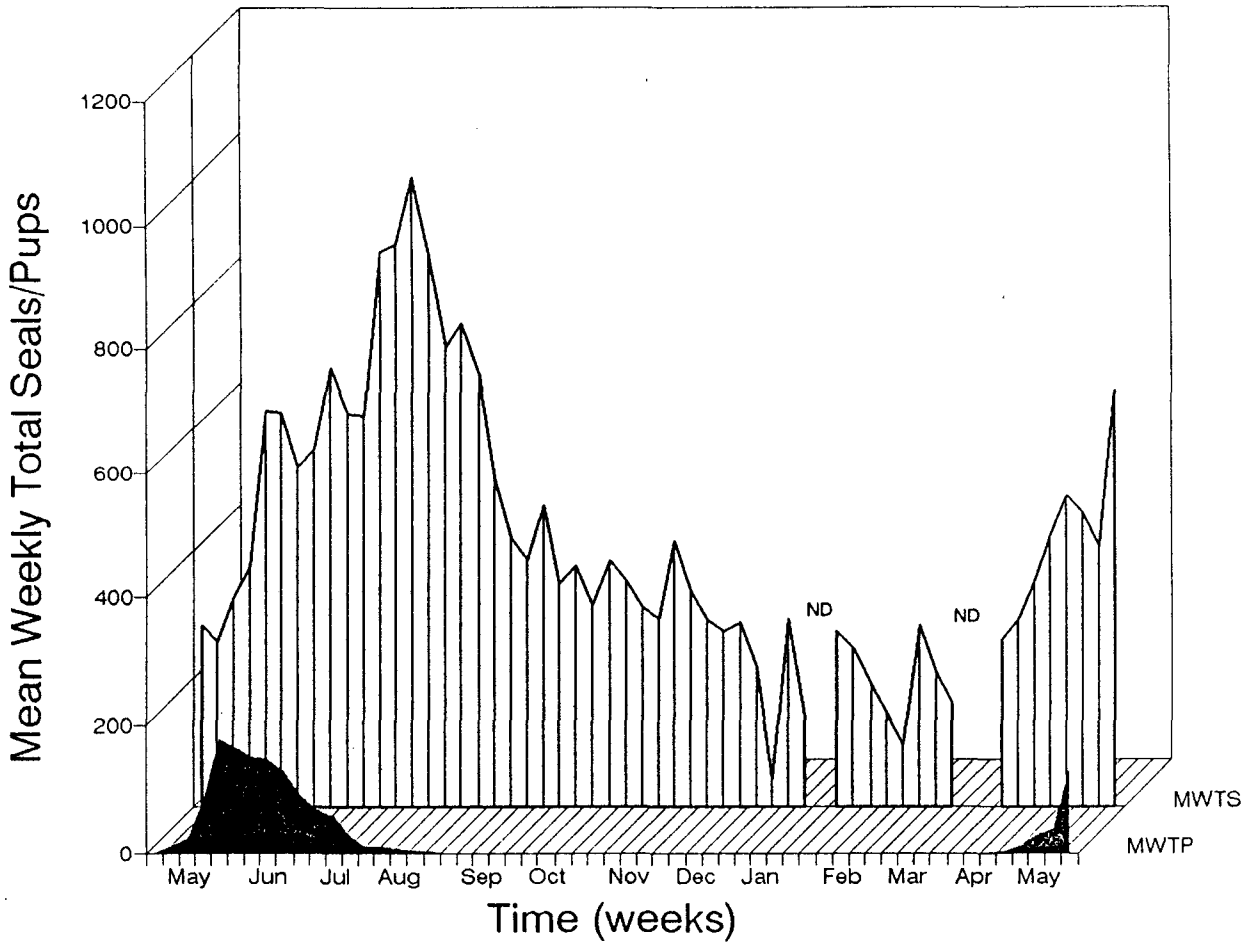


Figure 13. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Cape Arago (ND=Periods of No Data)

Table 6. Maximum Total Harbor Seal and Total Pup Counts for Surveys During 1992

Site	Date of Maximum Total Seal Count	Maximum Total Seal Count	Date of Maximum Pup Count	Maximum Pup Count	Beginning of Molt	End of Molt
Cape Arago	July 14	1250	May 27	225	July 17	Sep 3
Pigeon Point	May 27	233	May 27	47	July 19	Aug 27

Regional Use of Cape Arago by Harbor Seals

MWTS and MWTP counts were taken as a percentage of the MWTS and MWTP for all of Cape Arago. All 54 weekly percentages were then averaged to find the percentage of MWTS that haul out on each section over the study period.

Simpson's Reef

The highest percentage of MWTS hauled out at Cape Arago were found at Simpson's Reef. During the week of July 14, 1992 when the MWTS was at a maximum, 37% of the total seals were hauled out on Simpson's Reef (Table 7).

The annual haul-out pattern was similar to that of the entire Cape Arago site with the exceptions that both MWTS and MWTP peaks occurred later than the entire Cape Arago site. In 1993, the large increase in MWTP numbers started to occur before the increase in MWTS numbers, unlike the year before when both pups and total seals increased at the same time (Figure 14).

The reef had the second largest percentage of pups of any of the five sections. During May 10-16, 1992, when the MWTP count was at a maximum at Cape Arago, Simpson's reef made up 16% of those pups hauled out (Table 7). Simpson's Reef MWTP count peaked three weeks later than Cape Arago on May 31-June 6, 1992 (Figure 14).

Table 7. Mean Weekly Total Seal and Pup Counts for Cape Arago with Regional Percentages

Week	Mean Weekly Total Seals	Mean Weekly Total Pups	% of MWTS at Simpson's Reef	% of MWTP at Simpson's Reef	% of MWTS at Intertidal Rocks	% of MWTP at Intertidal Rocks	% of MWTS at Volcano Rocks	% of MWTP at Volcano Rocks	% of MWTS at Northeast Rocks	% of MWTP at Northeast Rocks	% of MWTS at Shell Island Beach	% of MWTP at Shell Island Beach
April 12-18	282	0	33	-	9	-	6	-	0	-	52	-
April 19-25	257	9	37	33	21	56	12	11	8	0	21	0
April 26-May 2	325	22	26	14	45	73	15	5	14	9	0	0
May 3-9	375	80	18	5	55	78	14	10	12	8	0	0
May 10-16	627	181	28	18	56	72	7	5	10	7	0	0
May 17-23	623	168	44	33	44	53	8	10	5	4	0	0
May 24-30	536	152	28	21	43	49	12	11	19	18	0	0
May 31-June 6	568	149	51	45	38	46	4	3	7	6	0	0
June 7-13	696	129	45	45	28	30	12	13	11	11	3	2
June 14-20	622	90	78	67	15	22	5	7	3	3	0	1
June 21-27	620	68	45	58	11	10	20	15	18	16	7	3
June 28-July 4	885	57	47	53	7	7	15	12	10	12	22	16
July 5-11	894	28	37	54	6	7	17	18	23	11	17	11
July 12-18	1,004	10	37	30	9	10	11	20	16	10	28	30
July 19-25	879	9	63	44	6	0	21	33	9	22	1	0
July 26-Aug 1	729	6	53	17	16	33	17	33	15	17	0	0
Aug 2-8	786	3	88	67	11	0	16	33	4	0	0	0
Aug 9-15	864	1	59	0	21	0	19	100	2	0	0	0
Aug 16-22	517	0	73	-	6	-	20	-	0	-	0	-
Aug 23-29	420	0	78	-	7	-	14	-	0	-	0	-
Aug 30-Sep F	385	0	74	-	8	-	18	-	0	-	0	-
Sep 6-12	474	0	63	-	11	-	26	-	0	-	0	-
Sep 13-19	345	0	65	-	12	-	23	-	0	-	0	-
Sep 20-26	377	0	70	-	12	-	18	-	0	-	0	-
Sep 27-Oct 3	313	0	71	-	2	-	27	-	0	-	0	-
Oct 4-10	385	0	53	-	15	-	32	-	0	-	0	-
Oct 11-17	352	0	61	-	18	-	22	-	0	-	0	-
Oct 18-24	309	0	36	-	32	-	31	-	0	-	0	-
Oct 25-31	293	0	47	-	21	-	25	-	0	-	7	-
Nov 1-7	415	0	27	-	36	-	32	-	0	-	5	-
Nov 8-14	337	0	58	-	22	-	18	-	2	-	0	-
Nov 15-21	290	0	32	-	31	-	37	-	0	-	0	-
Nov 22-28	271	0	64	-	16	-	19	-	0	-	0	-
Nov 29-Dec 5	285	0	24	-	28	-	24	-	0	-	25	-
Dec 6-12	217	0	35	-	28	-	33	-	2	-	3	-
Dec 13-19	42	0	129	-	17	-	83	-	0	-	0	-
Dec 20-26	293	0	81	-	11	-	4	-	0	-	3	-
Dec 27-Jan 2	140	0	12	-	14	-	39	-	0	-	47	-
Jan 3-9	no data											
Jan 10-16	273	0	0	-	6	-	16	-	0	-	78	-
Jan 17-23	246	0	64	-	8	-	25	-	0	-	3	-
Jan 24-30	187	0	2	-	18	-	26	-	0	-	55	-
Jan 31-Feb 6	145	0	76	-	3	-	13	-	2	-	6	-
Feb 7-13	95	0	29	-	46	-	15	-	3	-	6	-
Feb 14-20	281	0	75	-	6	-	6	-	0	-	13	-
Feb 21-27	207	0	28	-	10	-	20	-	0	-	43	-
Feb 28-Mar 6	163	0	22	-	27	-	21	-	4	-	26	-
Mar 7-13	no data											
Mar 14-20												
Mar 21-27	258	0	74	-	27	-	9	-	7	-	20	-
Mar 28-April 3	289	0	41	-	27	-	16	-	7	-	9	-
April 4-10	352	0	26	-	26	-	13	-	5	-	31	-
April 11-17	423	2	42	50	29	50	17	0	1	0	12	0
April 18-24	490	11	2	0	44	55	28	18	7	18	20	9
April 25-May 1	462	28	37	39	44	54	9	4	6	4	4	0
May 2-8	404	37	6	5	69	70	14	19	3	3	7	3
May 9-15	659	130	20	33	61	55	9	8	7	4	2	1
			x=44 sd=26	x=33 sd=21	x=23 sd=16	x=38 sd=25	x=16 sd=12	x=18 sd=16	x=4 sd=6	x=8 sd=6	x=10 sd=17	x=3 sd=5

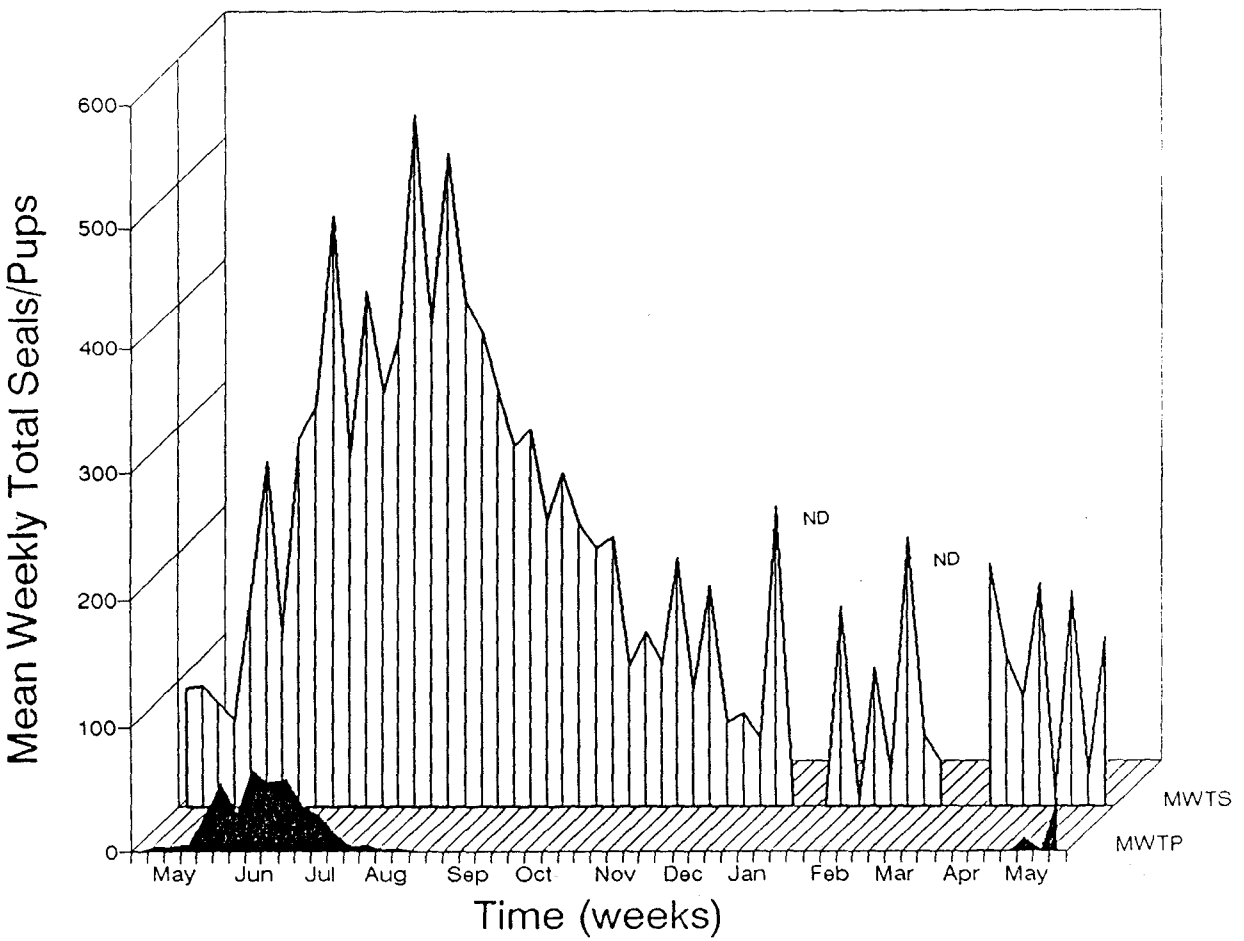


Figure 14. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Simpson's Reef Region (ND=Periods of No Data)

Intertidal Rocks

Seals used this site all year, but the pattern was different than that of the total Cape Arago area.. The highest number of seals hauled out here during the pupping season (Figure 15) and this region had the highest percentage of pups at Cape Arago. MWTP peaked at this section on May 10-16, 1992, the same time as all of Cape Arago (Figure 15). During this week 72% of the pups at Cape Arago were present at this site (Table 7).

The pattern of MWTS at this site did not mirror that of Cape Arago as a whole. Numbers here fell more rapidly here than for all of Cape Arago. On the week when Cape Arago was at its maximum, Intertidal Rocks made up only 9% of the MWTS (Table 7). Fall and winter numbers did show a decline at this site (Figure 15).

Volcano Rocks

This site had the third highest percentage of MWTS and MWTP (Table 7). Seals use the site all year and peak numbers of seals occur in July 19-25, 1992 (Figure 16).

Northeast Rocks

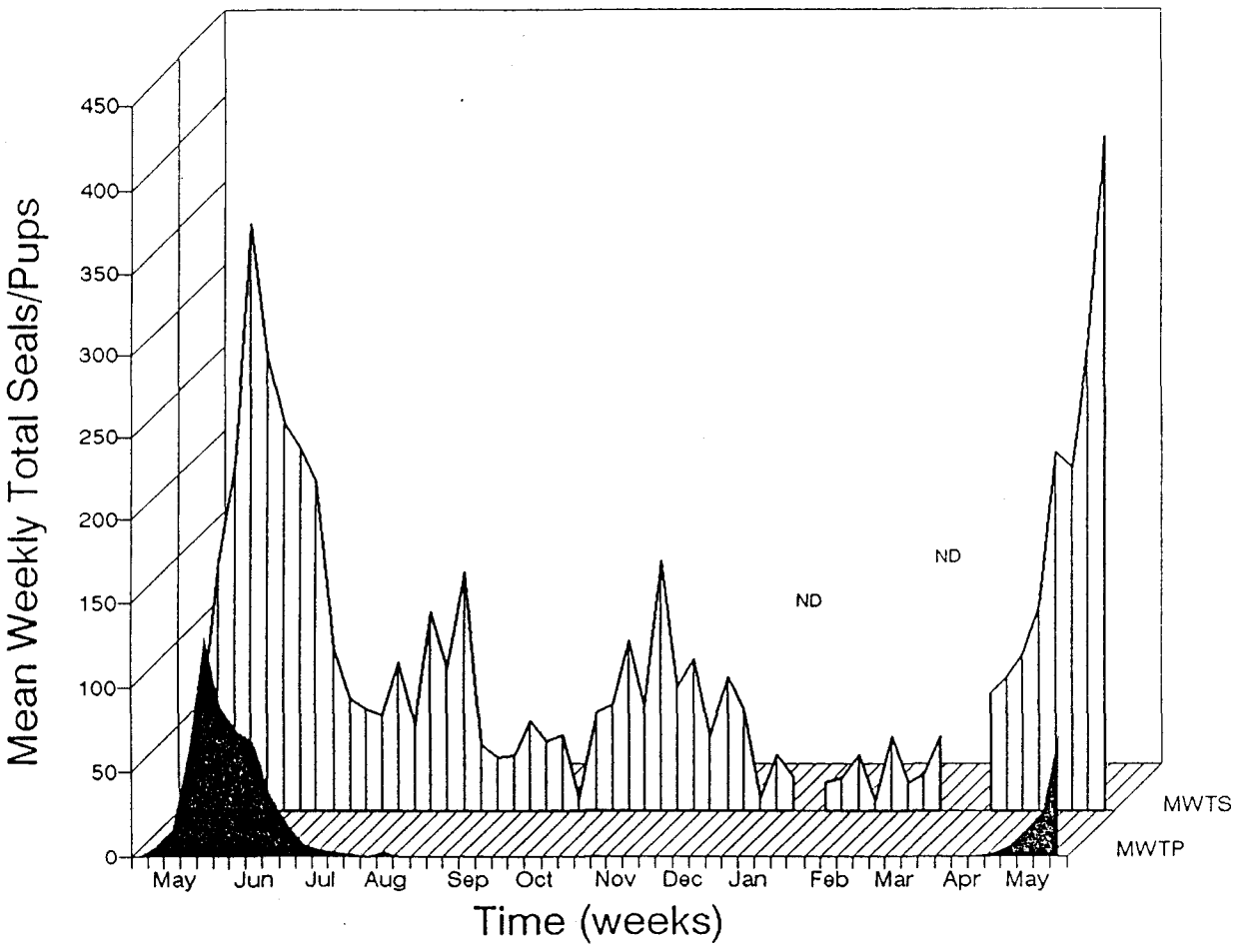


Figure 15. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Intertidal Rocks Region (ND=Periods of No Data)

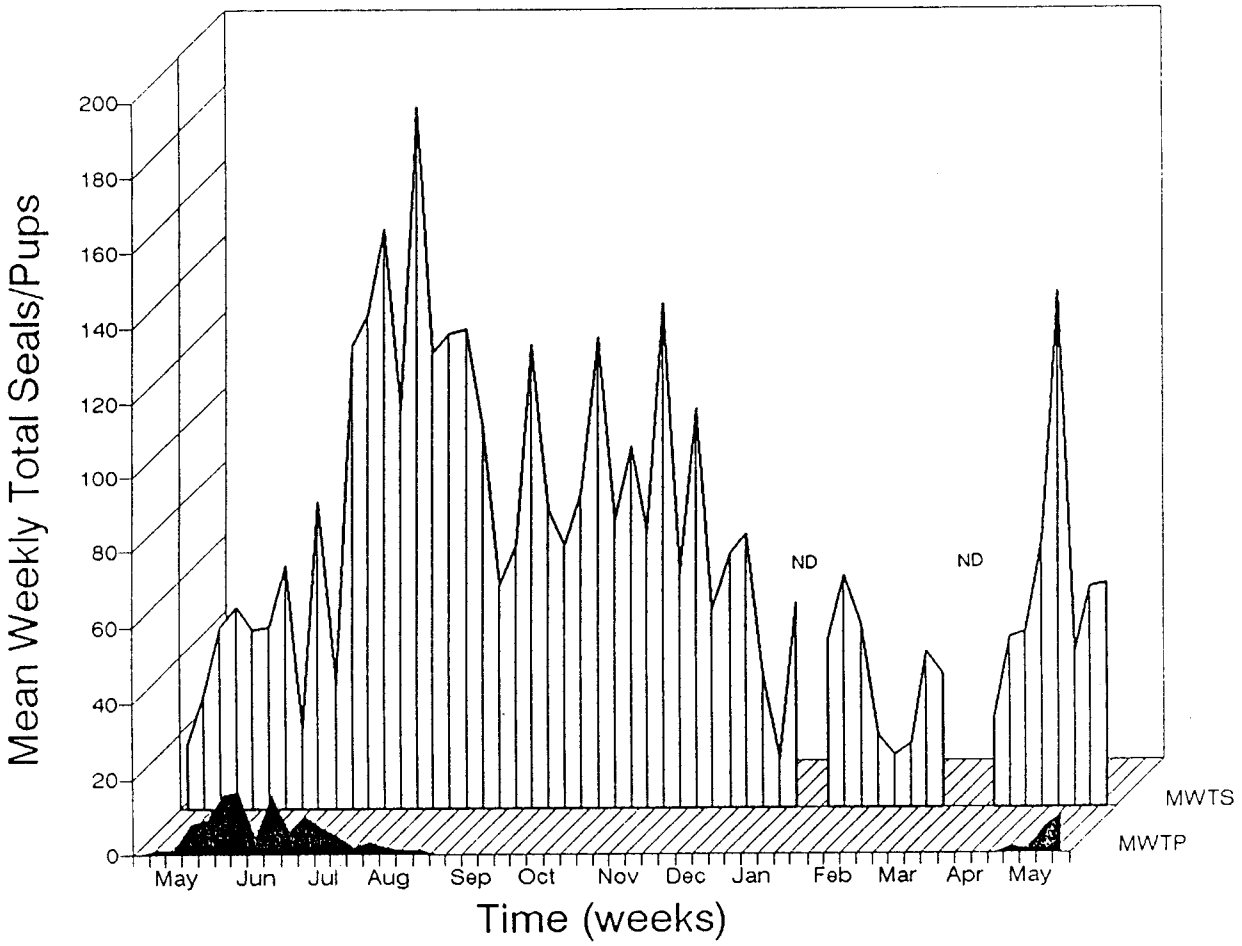


Figure 16. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Volcano Rocks Region (ND=Periods of No Data)

Seals do not haul-out here year round. They use it mostly during the pupping/breeding season and sporadically during the fall and winter (Figure 17) and are present during 65% of the weekly counts (Table 7).

Throughout the study, MWTS here represented the smallest proportion on Cape Arago seals (Table 7). It is also not an important site for pups during the peak in pups on May 10-16, 1992, only 7% of them hauled out at this site.

Shell Island Beach

This site exhibits the most sporadic use by seals and there is no annual pattern (Figure 18). Haul-out patterns are greatly influenced by tidal height and the presence of other pinniped species. When minus tides occur, harbor seals do not haul out here probably because their escape route from the beach to the water is over an approximately 30 meter wide intertidal boulder field. When California sea lions are present on Shell Island in numbers exceeding 500, space is limited on the beach and harbor seals are excluded.

Shell Island does not appear to be a pupping site. Pups were first seen at this region on the second week of June, 1992, 8 weeks after the first pups were observed at Cape Arago (Table 7).

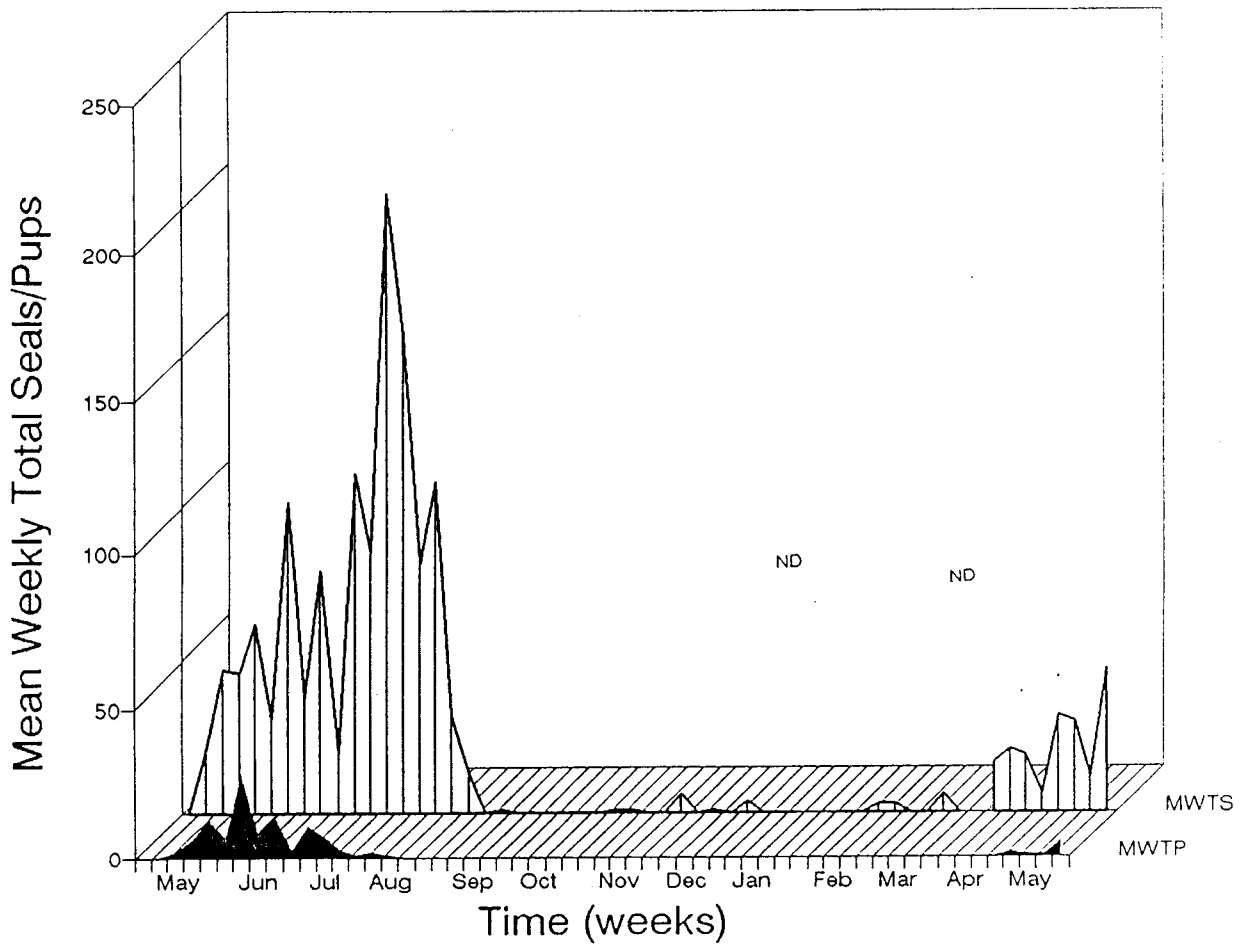


Figure 17. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Northeast Rocks Region (ND=Periods of No Data)

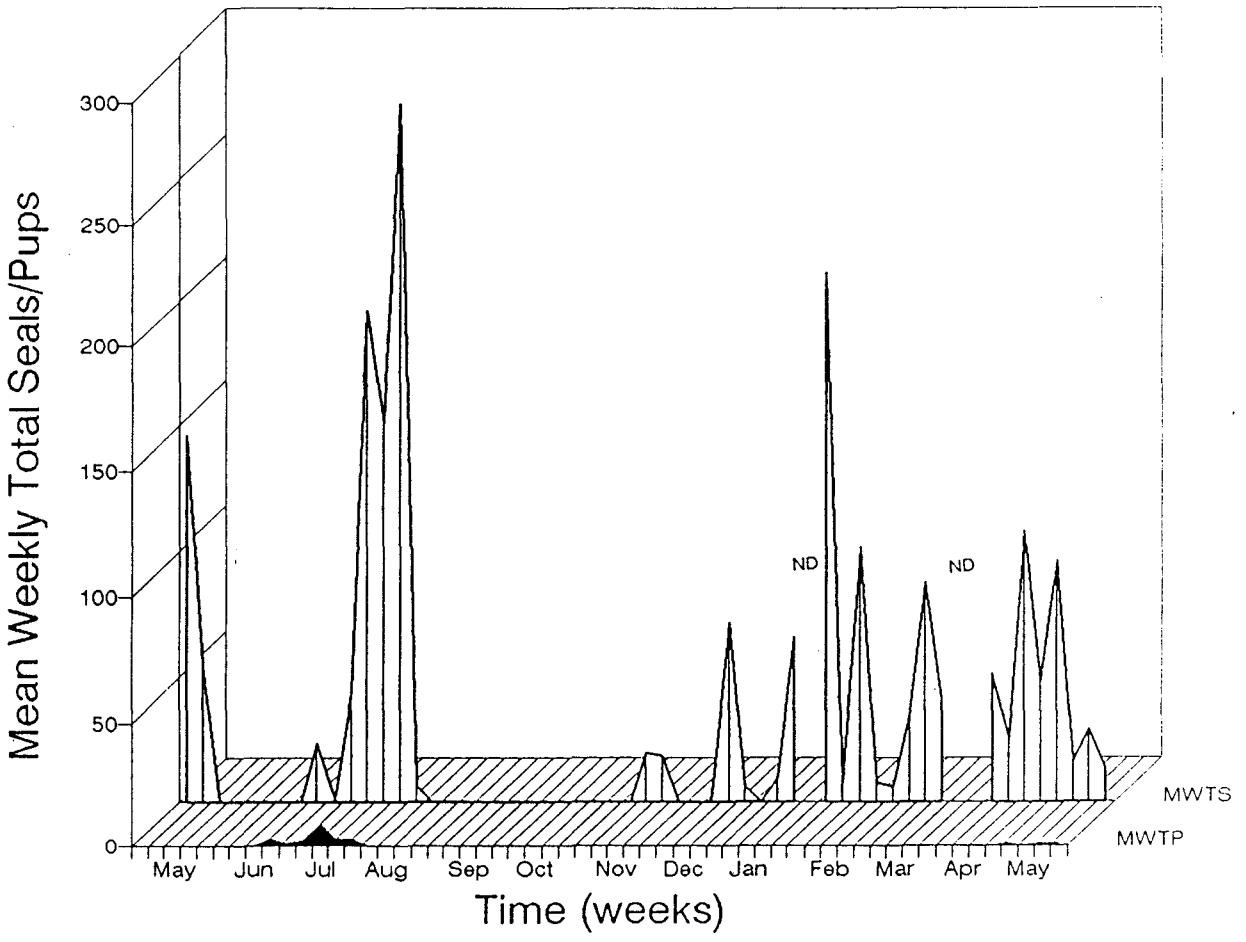


Figure 18. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Shell Island Beach Region (ND=Periods of No Data)

Harbor Seal Abundance at Pigeon Point

Harbor seals haul out at Pigeon Point throughout the year, but there is a large variation in daily attendance and there is no obvious seasonal trend (Figure 19).

There are consistently fewer seals hauled out at Pigeon Point than Cape Arago. The highest number of seals (233) occurred during May 27, 1992 (Table 8), which is 48 days earlier than the peak at Cape Arago. In 1992, the date of maximum pup count occurred on the same day as that for Cape Arago in 1992 (Table 8). Pups accounted for 20.1% of the total seals on the May 27, 1992. The first pups were seen one week later in 1993 than in 1992 (Figure 19).

Other than this increase in numbers during the pupping season there is only a weak seasonal pattern at this site. Numbers fluctuated throughout the summer and fall, and dropped to slightly lower level in winter.

Regional Use of Pigeon Point by Harbor Seals

Harbor seals have a tendency to move between the two islets at Pigeon Point during a tide cycle. Seals haul out first at North islet, as it is exposed, then move to South Islet as it is uncovered. As the tide rises and covers South Islet, seals move back to North Islet until it too is covered and seals were forced into the water. Thus the time

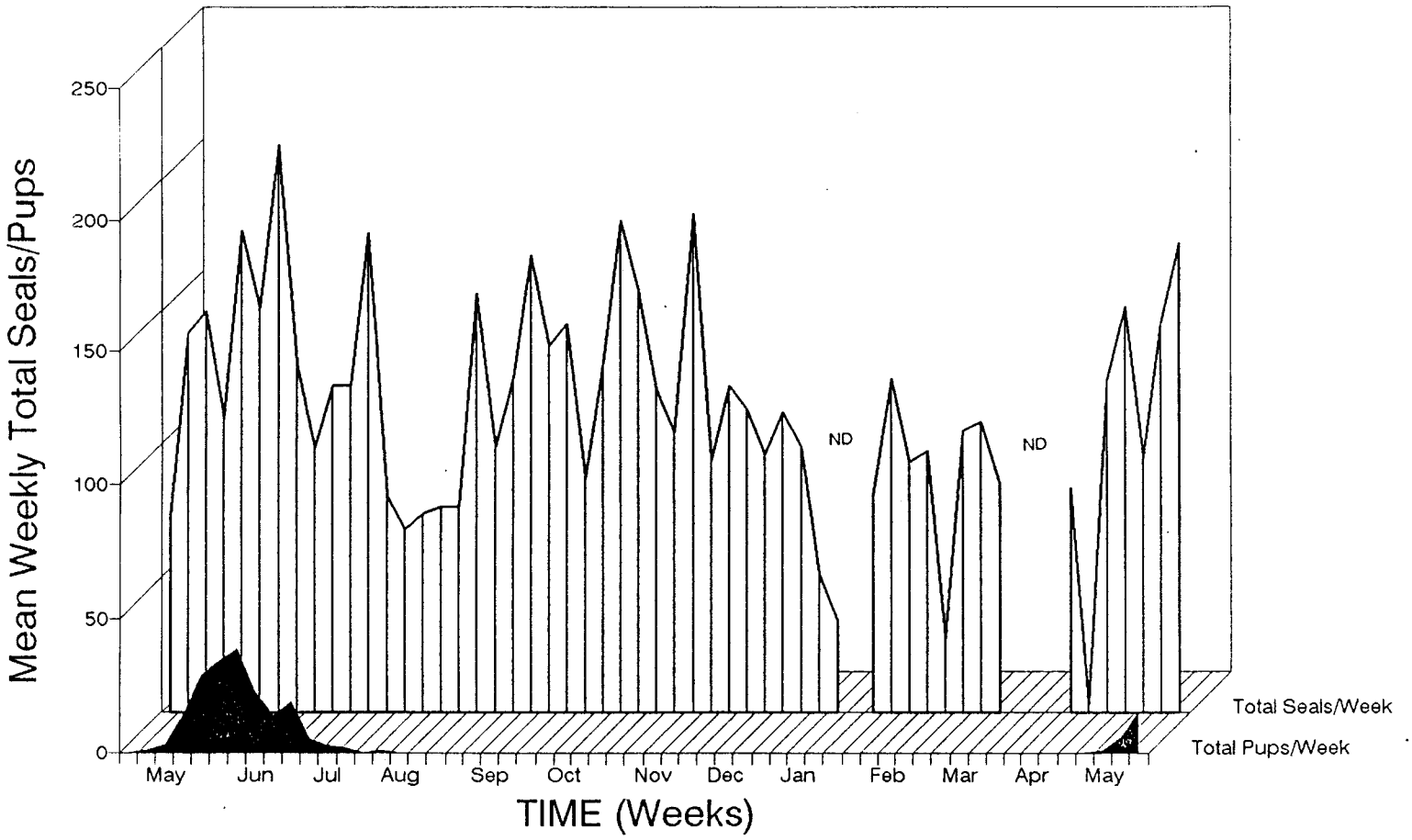


Figure 19. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at Pigeon Point (ND=Periods of No Data)

Table 8. Mean Weekly Total Seal and Pup Counts for Pigeon Point with Regional Percentages

Week	Mean Weekly Total Seals	Mean Weekly Total Pups	% of MWTS at North Islet	% of MWTP at North Islet	% of MWTS at South Islet	% of MWTP at South Islet
April 12-18	72	0	42	--	58	--
April 19-25	142	1	48	0	52	100
April 26-May 2	150	3	25	33	75	67
May 3-9	110	14	41	57	59	43
May 10-16	181	29	64	69	36	31
May 17-23	151	34	97	94	3	6
May 24-30	213	39	39	46	61	54
May 31-June 6	130	23	77	70	23	30
June 7-13	98	14	99	100	1	0
June 14-20	122	19	76	84	24	16
June 21-27	122	5	17	20	83	80
June 28-July 4	180	3	56	67	44	33
July 5-11	80	2	51	50	49	50
July 12-18	68	0	100	--	0	--
July 19-25	74	1	5	0	95	100
July 26-Aug 1	76	0	100	--	0	--
Aug 2-8	76	0	33	--	67	--
Aug 9-15	157	0	58	--	42	--
Aug 16-22	99	0	30	--	70	--
Aug 23-29	125	0	58	--	42	--
Aug 30-Sep 5	172	0	0	--	100	--
Sep 6-12	137	0	55	--	45	--
Sep 13-19	145	0	0	--	100	--
Sep 20- 26	87	0	66	--	34	--
Sep 27-Oct 3	130	0	100	--	0	--
Oct 4-10	185	0	100	--	0	--
Oct 11-17	158	0	0	--	100	--
Oct 18-24	121	0	39	--	61	--
Oct 25-31	104	0	0	--	100	--
Nov 1-7	187	0	72	--	28	--
Nov 8-14	94	0	0	--	100	--
Nov 15-21	122	0	7	--	93	--
Nov 22-28	113	0	14	--	86	--
Nov 29-Dec 5	96	0	13	--	88	--
Dec 6-12	112	0	0	--	0	--
Dec 13-19	99	0	0	--	0	--
Dec 20-26	51	0	0	--	100	--
Dec 27-Jan 2	34	0	3	--	97	--
Jan 3-9	no data					
Jan 10-16	80	0	21	--	79	--
Jan 17-23	125	0	100	--	0	--
Jan 24-30	93	0	0	--	100	--
Jan 31-Feb 6	97	0	0	--	100	--
Feb 7-13	28	0	0	--	100	--
Feb 14-20	105	0	0	--	100	--
Feb 21-27	108	0	0	--	100	--
Feb 28-Mar 6	85	0	0	--	100	--
Mar 7-13	no data					
Mar 14-20						
Mar 21-27						
Mar 28-April 3	83	0	0	--	100	--
April 4-10	3	0	0	--	100	--
April 11-17	124	0	0	--	100	--
April 18-24	152	0	100	--	0	--
April 25-May 1	95	1	0	0	100	100
May 2-8	146	6	7	17	93	83
May 9-15	176	15	10	27	90	73
			x=37 sd=37	x=46 sd=28	x=63 sd=38	x=54 sd=31

of censusing affects how many seal are found at each islet.

Pups were first observed on April 15, 1992 and numbers increased sharply to a peak on May 27, 1992 (Table 8). MWTP numbers decreased sharply to zero by the end of August (Figure 19). In 1993 initial pupping patterns were similar to patterns in 1992. Both regions exhibited variable attendance during the study period and showed no noticeable pattern of abundance (Figure 20 and 21).

North Islet was not used during the winter of 1992 or during most of the spring in 1993 (Figure 20).

Comparison of Aerial and Ground Counts of Harbor Seals at Cape Arago and Pigeon Point

This comparison shows that ground counts are, on average, within about 10% of the seals counted from the air during aerial surveys (Appendix B). This correction factor was not used in the data analysis.

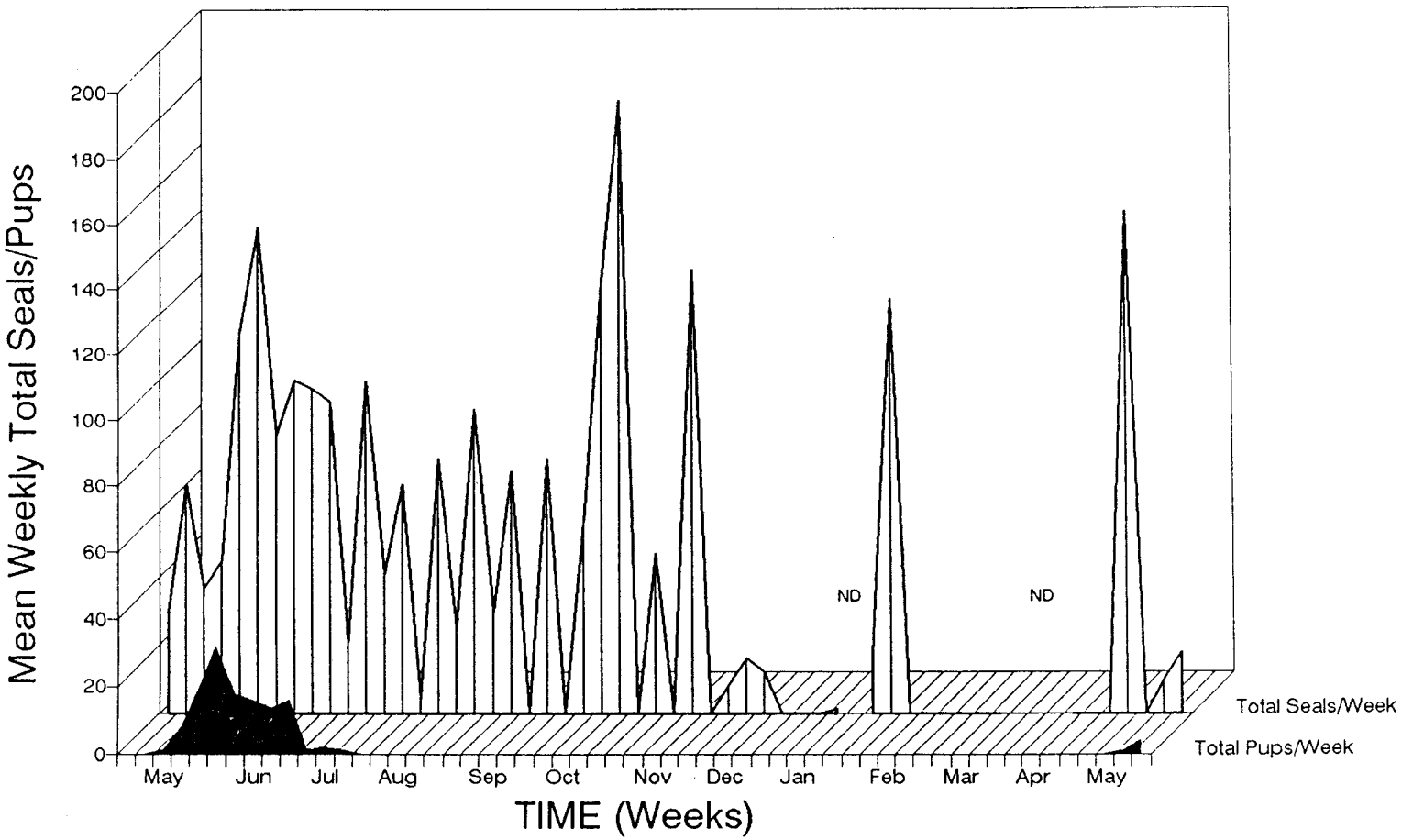


Figure 20. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at North Islet Region (ND=Periods of No Data)

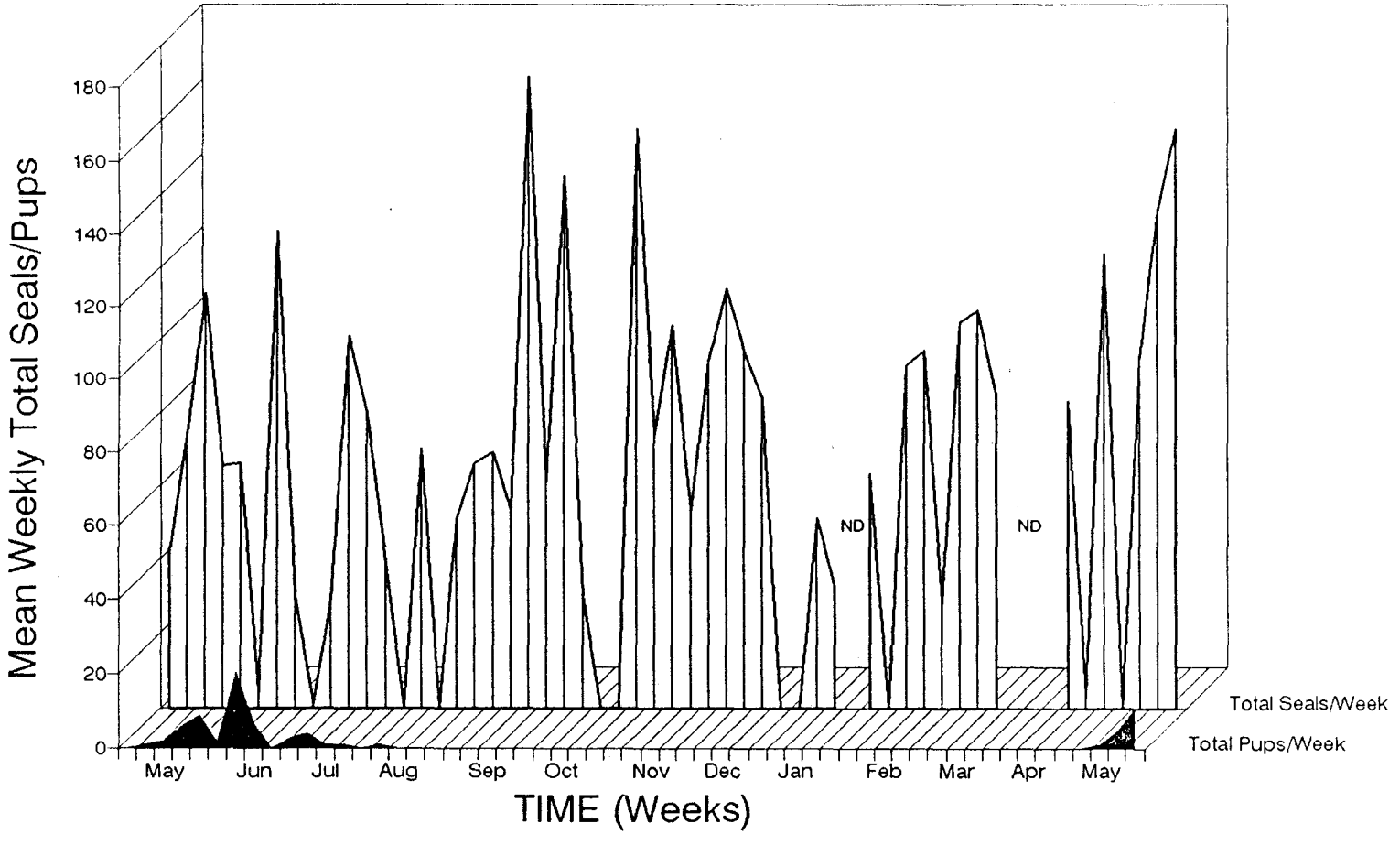


Figure 21. Mean Weekly Total Seals and Pups Over the Duration of the Study Period at South Islet Region (ND=Periods of No Data)

CHAPTER V

DISCUSSION

Movement Parameters

Some Umpqua seals, regardless of gender or age, did not reside at the Umpqua throughout duration of the study. The movement patterns of these harbor seals away from the Umpqua haul-out site are complex. At least 57% of the radio-tagged seals in this study left the Umpqua during the study period and were resighted elsewhere, indicating that many animals do not always occupy the same area. Additional seals were also thought to have left but were not resighted again. The lack and reduction of resightings over time at the Umpqua and elswhere may have been a result of transmitter malfunction, detachment or seal death.

Other observational and telemetry studies support these findings. These implied that harbor seal numbers at haul-outs oscillate in response to a myriad of factors, including: seasonal variations in food (Fisher, 1952; Pitcher & Calkins, 1979; Pitcher, 1980; Graybill, 1981), weather conditions (Loughlin, 1978, Boulva & McLaren, 1979) pupping/breeding (Bartholomew, 1949, Bigg 1969) along with changes in ice flows (Naito, 1976), and the freezing of northern inlet haul-out sites in the winter (Boulva &

McLaren, 1979). Human induced disturbance (Newby, 1971; Renouf et al., 1981) and hunting pressure (Pearson & Verts, 1970) have also been suggested as influencing population numbers. Telemetry studies have also found that harbor seals do not stay at one haul-out site inter-seasonally (Pitcher and McAllister, 1981; Beach et al., 1985; Harvey, 1987; Stein, 1989).

Still other published research obtained results contrary to mine, suggesting that harbor seals are generally non-migratory with relatively sedentary persistence at major haul-out sites and breeding grounds (Scheffer & Slipp, 1944; Bigg, 1981; Stoel, 1981; Ognev, 1935). Certain harbor seals have also been reported to repeatedly occupy the same area (Knudtson, 1975; Reijnders, 1976; Calambokidis et al., 1978; Boulva & McLaren, 1979). These studies rely heavily on visual resightings of seals with distinct, recognizable features, or counts of the number of seals at haul-outs over periods of time.

The 12 radio-tagged harbor seals which were eventually resighted outside the Umpqua all left the site by the second week of the molt and did not return during the study period. This impies migration out of the Umpqua with harbor seals using this site primarily as a pupping and breeding ground.

Some telemetry studies have implied that harbor seals leave various bays and estuaries in Washington and Oregon after the spring and summer, and move to other preferred

areas such as the lower Columbia River in the winter to feed (Brown and Mate, 1983; Jeffries, 1985; Brown 1986). Other studies presented evidence that harbor seals may be somewhat migratory during the post breeding and molting seasons and may even become pelagic feeders 75-100 km offshore during fall and winter. (Wahl, 1977; Yochem and Stewart, 1985; Kajimura and Loughlin, 1988; Thompson and Miller, 1990).

Radio-tagged seals dispersed both north and south once they left the Umpqua. However, more of the seals moved to sites north of the Umpqua than to sites south. This suggests that harbor seals may have left the area to feed in the Columbia river in the fall and winter (Brown and Mate, 1983; Jeffries, 1985; Brown, 1986).

Harbor seals were resighted at seven sites other than the Umpqua, ranging from Alsea Bay south to Cape Blanco. Seal #14 moved the greatest cumulative straight line distance of 144 km, while seal #3 moved the furthest from the tagging site, 100.5 km. This wide dispersement from a tagging site is not unusual but is in fact modest. Other studies have resighted tagged seals from 194-550 km from the tagging site (Bonner and Witthames, 1974; Brown and Mate, 1983; Beach et al., 1985; Yocum and Stewart, 1987).

However, physiological data contradicts my results that seals may move long distances between many sites. Clines in pelage patterns, pupping chronology and estrus cycles along the northeast Pacific coast suggest distinct populations,

with little genetic mixing (Bigg, 1969; Bigg, 1973; Shaughnessy and Fay, 1977; Temte, 1986). Also, a study on contaminant levels in Washington found that concentrations and ratios in seals from Puget Sound were different from seals using the outer coast (Calambokidis et al., 1985), suggesting no mixing of the populations. My findings do not directly refute these studies in that no seals were resighted anywhere but southern Oregon, which may indeed be a distinct population.

There were also variations in movement patterns during my study. Most of the twelve resighted seals were heard at only one place for a short duration. Although one seal was resighted at Pigeon Point after leaving the Umpqua for the entire length of the study. Three seals made trips back and forth between the Umpqua and another site. Many studies have also observed variations of movements between two or more sites (Divinyi, 1971; Pitcher and McAllister, 1981; Jeffries, 1985; Herder, 1986; Allen et al., 1987; Harvey, 1987; Yochem et al., 1987).

In all of these studies, including mine, movements and distances reported are truly minimum representations. The tracking of these animals is sporadic and information must be pieced together. Confounding factors include: transmitter problems, limited survey area and duration, and restricted effort. These factors could have contributed to my inability to resight the six other seals that left the

Umpqua.

There were some noticeable differences with regard to gender and age. I found that adult females stayed at the Umpqua until at least a month after the pupping season. Also, all four radio tagged pups which would later be resighted outside the Umpqua were regular residents there until between day 30 and 32 of the study, when all four pups permanently left the haul-out site. This suggests that mothers and pups utilize one site during the pupping season and that pups usually leave the site immediately after weaning.

Other studies have also supported the idea that mothers with pups do not travel great distances and tend to make use of the same areas until weaning (Slater, 1982; Lawson, 1983; Eliason, 1986; Allen et al., 1987; Allen 1988; Godsell, 1988; Stein, 1989). It is assumed that females with pups do not travel long distances in order to conserve the pups energy and reduce the opportunities of the pair becoming separated (Stein, 1989).

Although sample sizes were not large enough to permit statistical analysis, the data may suggest that females hauled out more and travelled greater distances on average than males. Pups on average hauled out much less than adults and moved more often.

King (1983) found that weaned pups feed on small crustaceans and fish which are less calorically rewarding

than larger prey items but are also easier to acquire. Consequently, it seems logical that radio-tagged pups in this study would be resighted less on land because they are learning to feed by feeding more often on smaller prey items. Pups may have moved more than adults in order to feed in areas where these special types of prey are in abundance.

The majority of tagging and telemetry studies have found that pups and juvenile seals travel great distances (Bonner and Witthames, 1974; Loughlin, 1974; Johnson, 1976; Hoover, 1983; Stein, 1989). However, other studies found no tendency for one gender to move further distances than another (Harvey, 1987; Allen et al., 1987).

Abundance Dynamics

Haul-out patterns and abundance of harbor seals at different sites along the eastern Pacific are extremely variable. Each site has a unique pattern to the magnitude and seasonality of abundances. Harbor seal observational peaks usually occur during the spring and summer months at sites along the North American coast. This is probably due to the gathering of seals on land in response to the pupping/breeding periods (Johnson and Jeffries, 1977; Harvey, 1987).

At the Cape Arago site, spring and summer harbor seal

numbers were noticeably higher than in the fall and winter months. Conversely, Pigeon Point did not exhibit a noticeable abundance peak and was also more variable over the study period.

Increases in harbor seals during spring and summer months have been repeatedly observed along the western coast of the United States (Everitt and Jeffries, 1979; Sullivan, 1979; Everitt et al., 1981; Graybill, 1981; Stewart, 1981; Fancher and Alcorn, 1982; Brown and Mate, 1983; Allen et al., 1984; Bayer, 1985; Herder, 1986; Stein, 1989).

Other reports in Oregon have found peaks in the fall and winter (Brown and Mate, 1983; Roffe and Mate, 1984; Sease, 1992). Different studies have reported bimodal peaks in the summer and winter (Wade, 1981; Bayer, 1985; Herder, 1986; Harvey, 1987). Winter peaks are usually reported as being in response to various fish spawning periods and may be a reason for high seal numbers in the fall at Pigeon Point.

The best time of the year to survey for maximum counts was found to be mid July at Cape Arago. At Pigeon Point, maximum counts were observed at the end of May in response to the accumulation of animals and newborns during the pupping season. The monthly maximum counts of total seals by Graybill (1981) found a peak at Cape Arago during July but did not find a peak at Pigeon Point in May.

The pupping season at both sites begins and ends about

the same time and peaks on the same day (May 27). It is thought that pups are born at a calibrated time so that when they are weaned, prey items are in abundance (Bigg, 1973; Bigg and Fisher, 1975; Brown and Mate 1983).

The molting season is also similar at each site lasting from mid July to the end of August. I suspect the peak in total seals at Cape Arago may be in response to the beginning of the molting season because it occurs in mid July, a month and a half after the peak in pupping.

Peaks in response to the molt have been observed in other investigations (Everitt and Jeffries, 1979; Slater and Markowitz, 1983; Bayer, 1985). It has been suggested that warming the skin by hauling out during this stressful period may aid in the molting process (Geraci and Smith, 1976).

The proportion of pups compared to the total population during the peak of pupping at each site was 30.1% and 20.1% for Cape Arago and Pigeon Point respectively. This falls in the range reported by others (Calambokidis et al., 1978; Fancher and Alcorn, 1982; Brown and Mate, 1983; Stewart and Yochem, 1984).

It is notable that Cape Arago and Pigeon Point are only about 10 km apart and exhibit very different abundance pulses. Similar data has been gathered which demonstrates differences in abundance dynamics between other site pairs in close proximity (Fancher and Alcorn, 1982; Brown and Mate, 1983; Slater and Markowitz, 1983).

While variations in seal abundances were different between sites, the pupping and molting periods were comparable between the two. This pattern has also been observed in other studies of neighboring sites (Scheffer and Slipp, 1944; Boulva and McLaren, 1979; Brown and Mate, 1983; Slater and Markowitz, 1983).

Regions at both sites showed seasonal variations in usage. The most conspicuous was the abundance patterns on the Intertidal Rocks region at Cape Arago, which is used primarily as a nursery during pupping. Assuming the majority of pups were hauled out with females and there was a 1:1 gender ratio (Bishop, 1967; Boulva, 1971), mothers and pups represented at least 75% of the seals on Intertidal Rocks during the second week in May, 1992. This does not include pre-partum and juvenile females which could not be detected.

Northeast Rocks at Cape Arago also showed contrasting attendance. This region was only used by seals during the spring and summer months when pupping and molting take place.

Other researchers have also reported that harbor seals segregate into male herds and mother-pup herds during certain seasons (Fisher, 1952; Bishop, 1967; Newby, 1971; Knudtson, 1975; Slater and Markowitz, 1983). This non-random association of sexes implies some competition among males, leading to the exclusion of subordinate males from

females as they come into estrus. In addition, nursery herds could increase the likelihood that mother-pup pairs remain together until pups are weaned by having males compete in the water and not among the females.

Finally, Sullivan (1980) found differential use of some regions of an offshore rock complex with respect to age and season. Certain factors such as utilization of space by other pinnipeds, topography and accessibility were factors mentioned as possible reasons for seasonal preferences by age and gender classes.

In conclusion, my results have shown that, while harbor seals do not migrate en masse, variable movements do occur between sites which may be related to season. These data have also determined that seals use sites a considerable distance apart, and there may be movement trends with respect to gender and age.

Finally, my observations have established that there are seasonal variations in harbor seal numbers within sites and between sites, and have established concrete seasonal population parameters with regard to harbor seal abundances at two study areas.

APPENDIX A

TAG NUMBERS, RADIO FREQUENCIES, GENDERS, AGES AND MEASUREMENTS OF HARBOR SEALS TAGGED AT THE UMPQUA RIVER

Appendix A. Tag Numbers, Radio Frequencies, Genders, Ages and Measurements of Harbor Seals Tagged at the Umpqua River

Seal Number	Frequency (mHz.)	Date Tagged	Sex	Tag Color	Age	Length (cm.)	Width (kg.)	Girth (cm.)
1	164.020	05/05/92	Female	Green	Yearling	95	25.5	76
2	164.034	05/06/92	Male	White	Pup	81	13.2	60
3	164.060	05/06/92	Male	White	Pup	75	10.6	56
4	164.080	05/05/92	Female	Green	Subadult	124	46	99
5	164.102	05/06/92	Male	White	Pup	91	20.7	75
6	164.120	05/06/92	Female	Green	Adult	142	78	103
7	164.140	05/05/92	Male	White	Adult	154	89	-0-
8	164.162	05/05/92	Female	Green	Adult	120	69	115
9	164.180	05/06/92	Female	Green	Adult	133	80	-0-
10	164.200	05/06/92	Female	Green	Adult	140	76	105
11	164.220	05/05/92	Female	Green	Subadult	110	33	81
12	164.240	05/05/92	Male	White	Adult	153	90	119
13	164.260	05/06/92	Male	White	Pup	83	13.2	59
14	164.282	05/06/92	Female	Green	Pup	81	16.2	67.5
15	164.300	05/05/92	Male	White	Adult	155	87	-0-
16	164.320	05/05/92	Male	White	Adult	147	92	-0-
17	164.342	05/05/92	Male	White	Adult	144	89.5	-0-
18	164.380	05/05/92	Female	Green	Subadult	107	30	84
19	164.425	05/06/92	Male	White	Pup	78	12.4	58
20	164.460	05/05/92	Female	Green	Adult	132	73	119
21	164.890	05/06/92	Female	Green	Adult	122	74	-0-

APPENDIX B

AIR TO GROUND COMPARISON OF THE NUMBER OF HARBOR SEAL AT CAPE ARAGO AND PIGEON POINT

Appendix B. Air to Ground Comparison of the Number of Harbor Seals at Cape Arago and Pigeon Point

Date	Time	Count Total(Pups)	% of Ground to Air Total Seals	% of Ground to Air Seal Pups
Cape Arago				
5/20/92 Air	10:35	517(110)	97.1%	96.4%
5/20/92 Ground	10:35	502(106)		
5/21/92 Air	10:56	742(184)	90.8%	89.7%
5/21/92 Ground	10:56	674(165)		
6/5/92 Air	11:42	679(111)	96.0%	93.7%
6/5/92 Ground	11:42	652(104)		
			x=94.6%	x=93.3%
Pigeon Point				
6/5/92 Air	10:49	82(16)	91.5%	87.5%
6/5/92 Ground	10:49	75(14)		
7/7/92 Air	11:41	113(3)	89.4%	100.0%
7/7/92 Ground	11:41	101(3)		
			x=90.5%	x=93.8%

APPENDIX C

TAG FREQUENCIES, MOVEMENTS CATEGORIES, DAY PRESENT AT THE UMPQUA RIVER SITE AND RESIGHTINGS OF 21 HARBOR SEALS

Appendix C. Tag Frequencies, Movement Categories, Days Present at the Umpqua River Site and Resightings of 21 Harbor Seals

Seal number	Radio tag frequency (MHz)	Movement (I-V)	Days Present at Umpqua study site	Resightings outside the Umpqua						
				North of UM			South of UM			
				AB (8)	FL (30)	SC (31)	PP (77)	CA (86)	BN (6)	CB (4)
1	164.018	IV	120	-	-	-	-	-	-	-
2	164.034	I	30	-	-	-	-	4	-	-
3	164.060	I	29	-	-	-	-	1	-	1
4	164.080	II	9	-	-	9	-	-	-	-
5	164.102	V	16	-	-	-	-	-	-	-
6	164.120	V	4	-	-	-	-	-	-	-
7	164.140	III	0	-	-	-	30	-	1	-
8	164.162	V	50	-	-	-	-	-	-	-
9	164.180	I	69	4	-	-	-	-	-	-
10	164.200	V	87	-	-	-	-	-	-	-
11	164.220	IV	82	-	-	-	-	-	-	-
12	164.240	I	54	-	8	-	-	-	-	-
13	164.260	V	26	-	-	-	-	-	-	-
14	164.282	II	30	-	-	-	-	5	-	-
15	164.300	I	76	-	5	-	-	-	-	-
16	164.320	I	14	-	1	-	-	-	-	-
17	164.342	II	9	-	-	7	-	-	-	-
18	164.380	V	64	-	-	-	-	-	-	-
19	164.425	I	30	-	1	-	-	-	-	-
20	164.460	IV	105	-	-	-	-	-	-	-
21	164.890	I	47	-	5	-	-	-	-	-

UM-Umpqua AB-Alsea Bay FL-Florence SC-Siltcoos
PP-Pigeon Point CA-Cape Arago BN-Bandon CB-Cape Blanco

* Numbers in ( ) are number of monitoring bouts at each site

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