ENVIRONMENTAL PROTECTION SERVICE
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ENVIRONMENTAL STUDIES IN ALICE ARM AND HASTINGS ARM

PART V - BASELINE AND INITIAL PRODUCTION PERIOD - AMAX/KITSAULT MINE - SUBMERSIBLE OBSERVATIONS AND OTTER TRAWLS, 1980-1982

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Abstract

Results of Otter trawls in Alice and Hastings Arms by the Environmental Protection Service during 1980 and 1981 are presented. Also 1982 observations from a submersible of biota, bottom conditions, and turbidity are given.

October 1981 was considered to be too early to determine the effects of tailing deposition on the biota with a trawl net. Observations from the Pisces submersible reveal a significant impact.

Résumé

Les résultats des prises au chalut Otter à Alice Arm et Hastings Arm effectuées en 1980 et 1981 par le service de la protection de l'environnement (SPE) sont présentés dans ce rapport. Les observations de la biota, des conditions du fond marin et de la turbidité prises en 1982 d'un submersible y sont aussi données.

Octobre 1981 fut considéré trop tôt pour déterminer à l'aide du chalut Otter les effets de la déposition des résidue sur la biota. Cependant, les observations du submersible "Pisces" montrent un impact significatif.

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1. INTRODUCTION

This report is one of a number currently being prepared to document conditions prior to and following the re- opening of the B.C. Molybdenum mine in April, 1981, which is now under the name, Kitsault Mine. These reports have been separated into a baseline or pre start-up period and an initial production period as follows:

ENVIRONMENTAL STUDIES IN ALICE ARM AND HASTINGS ARM, BRITISH COLUMBIA

Part I - Baseline Studies, Amax/Kitsault Mine - Sediment and Tissue Trace Metals from Two Abandoned Mine Sites - B.C. Molybdenum and Anyox. This report contains all sediment and tissue trace metal data collected prior to start-up of the Kitsault mine in Alice Arm, data obtained from several control areas along the B.C. coast, and data from the abandoned copper smelter site at Anyox in Hastings Arm.

Part II - Baseline Studies, Amax/Kitsault Mine - Transmissometry and Water Chemistry
This report contains transmissometer measurements and the organic/inorganic content of and trace metal concentrations in the natural suspended particulate in May and October 1980. Previously reported transmissometer data from June 1977 are also provided.

Part III - Initial Production Period, Amax/Kitsault Mine - Sediment and Tissue Trace Metals - 1981. This report contains sediment and tissue trace metal data from samples collected in May - June and October 1981, after start-up of the Amax/Kitsault mine.

Part IV - Initial Production Period, Amax/Kitsault Mine - Transmissometer and Water Chemistry, 1981 and 1982. This report contains transmissometer measurements and the organic/-inorganic content of and trace metal concentrations in

suspended particulate in Alice Arm in 1981 and 1982.

Part V - Baseline and Initial Production Period, Amax/Kitsault - Submersible Observations and Otter Trawls - 1980-1982. This report contains data on species abundance and distribution from 1980-1981 otter trawl surveys; along with observations of species distribution, bottom conditions, and the tailing turbidity field taken from the submersible Pisces IV in July 1982.

1.1 Study Area

The study area is located on the northern British Columbia coast approximately 144 km north of the city of Prince Rupert, B.C. (Figure 1). Alice Arm, site of the new Kitsault mine, is a glacially fed inlet about 18.5 km (10 nautical miles) in length and 1.4 km (0.8 nautical miles) in width, which along with Hastings Arm form 2 branches at the terminus of Observatory Inlet. Near the mouth of Alice Arm are several shallow sills The inner sill depth is approximately 42 metres. The maximum depth within Alice Arm is about 380 metres (1200 ft). Two main rivers, the Kitsault (the more dominant and glacial river) and the Illiance, flow into the head of Alice Arm (Figure 2). Two smaller creeks, Roundy Creek and Lime Creek, enter Alice Arm near the Kitsault townsite. The latter drains the mine operating area (Figure 2). Littlepage (1978) estimates the total annual discharges into Alice Arm to be $1.6 \times 10^9 m^3$ (1.3 million acre-feet).

Hastings Arm is slightly longer (22.2 km or 12 nautical miles) and shallower (max. 307 m) than Alice Arm and within certain limits can serve as a control inlet. Anyox, site of the abandoned copper smelter, is situated at the mouth of Hastings Arm in Granby Bay near the junction with Alice Arm (Figure 1).

1.2 Otter Trawls

The Environmental Protection Service (EPS) has conducted bottom trawls in the Alice Arm and Hastings Arm area since 1977. Purpose of the trawls was to assess the diversity and density of bottom fish and

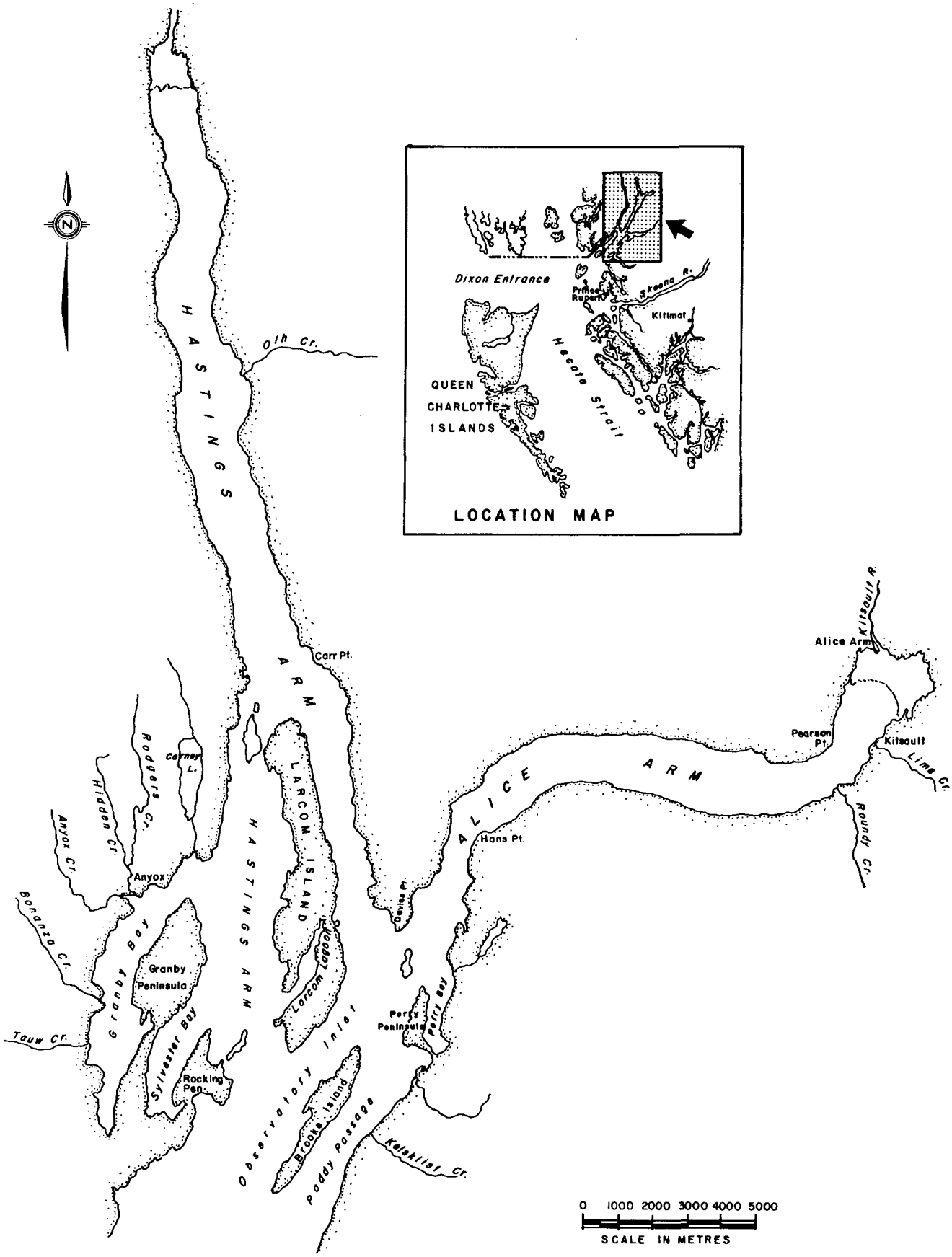

FIGURE 1 LOCATION MAP OF ALICE ARM AND HASTINGS ARM

macroinvertebrates in the area and to collect tissue samples for trace metal analysis. In this section trawl catches from 1980 and 1981 are recorded and comparisons are made to 1977 and 1978 trawls (Sullivan and Brothers 1979).

1.3 Pisces Dives

EPS personnel explored Alice and Hastings Arms aboard the Pisces IV submersible in October 1976 (Sullivan and Brothers 1979) and again in July 1982. The latter series of dives are reported herein. The dives provided a movie and still film record of bottom conditions plus a record of visual observations. In 1982 a CTD and transmissometer were also employed from the sub.

2. MATERIALS AND METHODS

2.1 Otter Trawls

Bottom trawls were conducted in May and October 1980 and May-June and October 1981 from the survey vessel CSS "Vector". Trawl locations and dates are listed in Appendix I and plotted in Figure 2. The trawling gear consisted of two otter doors attached to a net with a 5.8 metre throat and 3.8 cm mesh body. To alieviate clogging problems, the fine mesh cod end liner was removed from EPS trawl nets after 1978. Trawls were conducted with a 3 to 1 scope over a distance of about 0.7 nautical miles and at speeds averaging 3 knots. Trawl catches were sorted, identified, counted, and weighed aboard ship. Difficult specimens were preserved for later identification.

2.2 Pisces Dives

Ten dives were carried out aboard the Pisces IV submersible in July 1982. Dive locations are indicated in figure 3 and dates and coordinates listed in Appendix III. The submarine carried a pilot and two observers. Observations of water and bottom conditions and marine life were noted and a photographic record obtained on 16 mm cine film and 35 mm and 220 still film. A Plessy CTD and Sea Tech transmissometer were attached to the sub to determine the relationship between light transmittance in seawater and visual clarity. Photographs of a "target", attached to the sub, were also taken under conditions of varying transmittance.

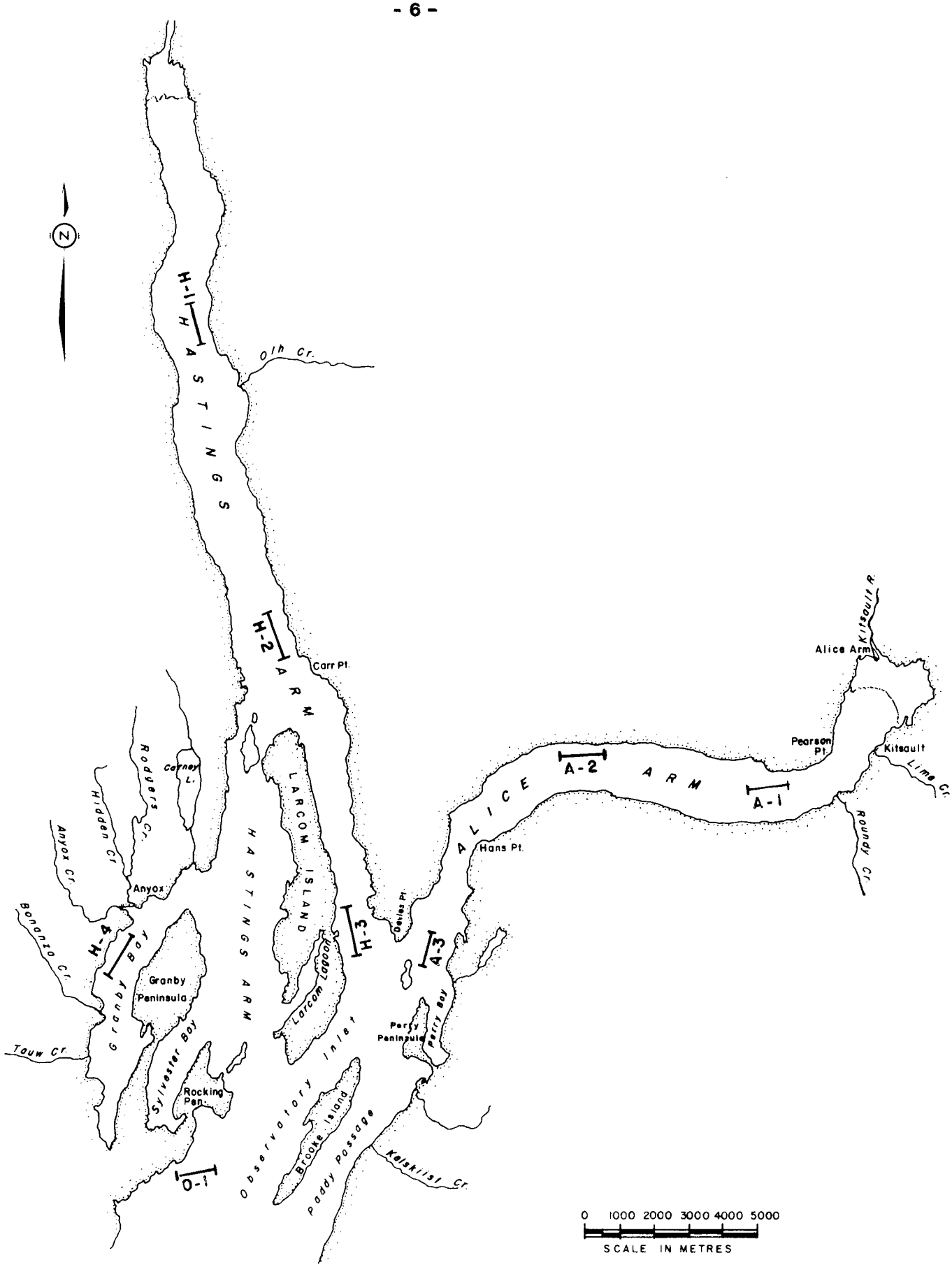

FIGURE 2 OTTER TRAWL STATIONS - ALICE AND HASTINGS ARM
1977 to 1981

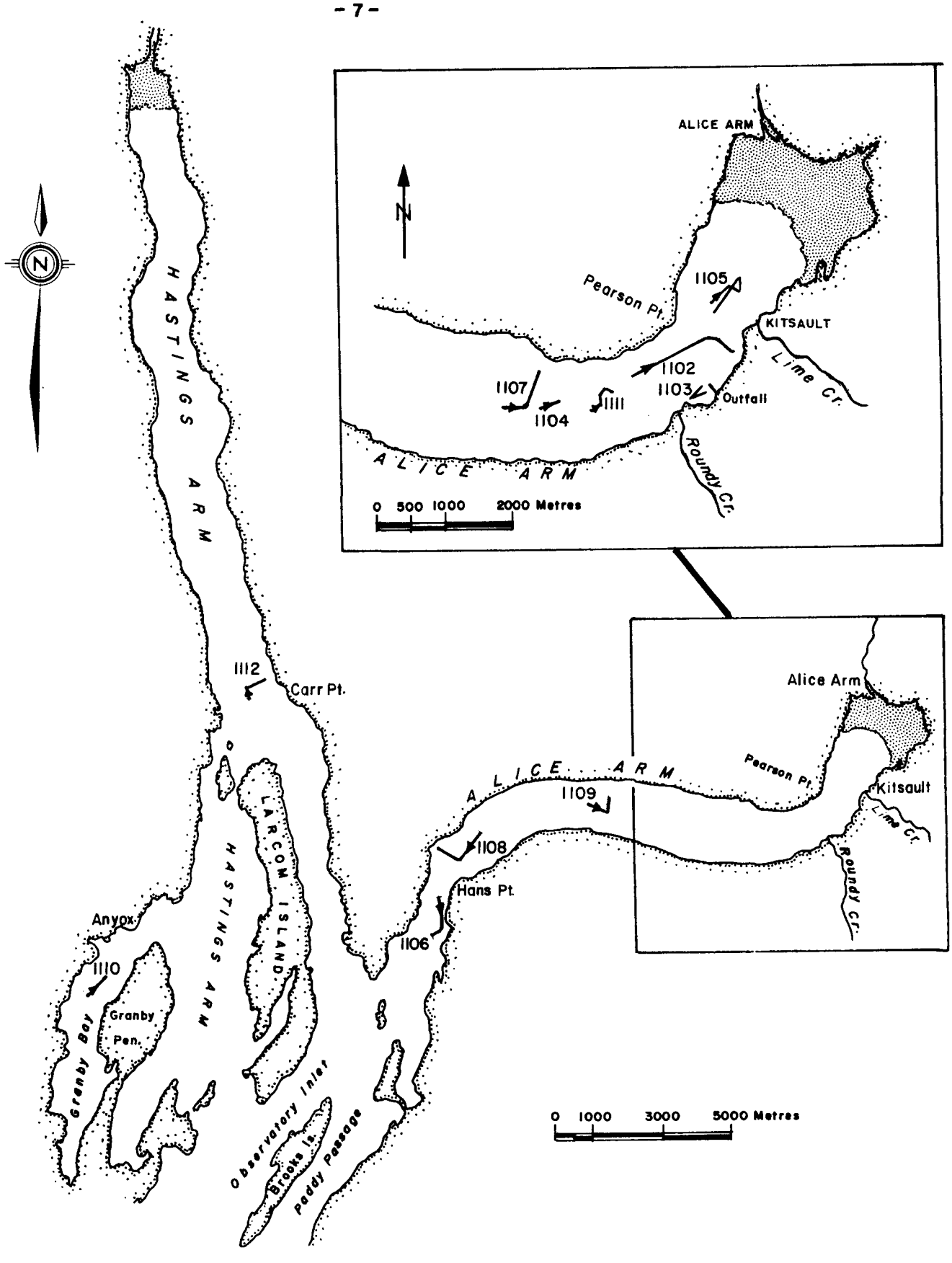

FIGURE 3 PISCES IV SUBMARINE DIVE SITES - ALICE ARM AND HASTINGS ARM - July, 1982

3. RESULTS AND DISCUSSIONS

3.1 Otter Trawls

Trawl catches for May 1980, October 1980, May-June 1981, and October 1981 surveys are presented in Appendix 1. Trawl statistics, including number of species collected, Shannon-Weaver diversity index, and evenness, are shown in Table 1.

When identifying trawl catches, most animals were identified to species but some such as brachiopods and sponges were not. Thus, the actual number of species collected would at times have been slightly higher than those listed in Table 1. Also some species were not always enumerated and hence were not included in the diversity index calculations. Chiridota (a sea cucumber), for example were often extremely numerous but due to their habit of lodging themselves in the net it was not practical to count or weigh them.

3.1.1 Alice Arm

Trawl A-1 was conducted in around 100 to 240 metres of water near the AMAX mine outfall. Between 1977 and 1981 the number of species collected per trawl varied from 11 to 40, the highest values being 39 and 40 in 1978. The slowest of 3 trawls in October 1981 had the next highest value of 25 species (it was also the most westerly trawl of that survey and hence not in an area of heavy fresh tailing deposition).

Yoldia thraciaeformis or montereyensis (clams), Chionocetes bairdi (Tanner crab), Pandalus borealis (pink shrimp), Crangon communis (a shrimp), and Ctenodiscus crispatus (a starfish) were present in most trawls at A-1. The starfish Ctenodiscus was found in low numbers until October 1980 and from then on was found in abundance. Conversely brittle stars disappeared from trawl catches after 1978 (Both of these occurences predate the resumption of tailing discharge into the inlet). A likely explanation for this disappearance and a lessening in numbers of species caught was the elimination of the fine mesh cod liner from EPS nets after 1978. The number of P. borealis caught was generally low except in the "boom year" of 1978 when 4259 and 2037 were caught in each of 2 trawls.

TABLE 1: TRAWL STATISTICS, 1977 - 81

STATION	DATE	NO. OF SPECIES	SHANNON-WEAVER DIVERSITY INDEX (LOG 2)	EVENNESS
A-1-I	14/06/77	18	2.72	0.70
-II	14/06/77	16	2.22	0.62
-III	14/06/77	21	3.11	0.76
-I	14/10/78	39	0.78	0.15
-II	14/10/78	40	1.49	0.29
-I	27/05/80	11	2.71	0.78
-II	27/05/80	18	2.81	0.72
	14/10/80	18	2.87	0.70
-I	31/05/81	10	2.36	0.84
-II	31/05/81	19	3.76	0.92
-III	02/06/81	19	2.70	0.69
-I	24/10/81	19	0.20	0.05
-II	24/10/81	25	3.39	0.75
-III	26/10/81	12	2.63	0.79
A-2-I	13/06/77	22	1.32	0.30
-II	13/06/77	23	1.47	0.33
-III	13/06/77	23	1.60	0.37
-I	13/10/78	16	2.74	0.74
-II	17/10/78	21	2.97	0.68
-III	17/10/78	14	2.75	0.80
-IV	17/10/78	20	1.85	0.43
-I	24/10/81	16	3.29	0.84
-II	25/10/81	21	2.96	0.70

TABLE 1: TRAWL STATISTICS, 1977 - 81
(Continued)

STATION	DATE	NO. OF SPECIES	SHANNON-WEAVER DIVERSITY INDEX (LOG 2)	EVENNESS
A-3-I	14/06/77	30	2.31	0.48
-II	14/06/77	32	2.10	0.43
-III	14/06/77	21	1.99	0.41
-I	14/10/78	42	1.33	0.25
-II	14/10/78	44	1.82	0.34
	25/05/80	22	2.64	0.59
-I	14/10/80	39	1.80	0.34
-II	14/10/80	19	1.90	0.45
	03/06/81	22	2.22	0.51
	25/10/81	24	3.57	0.80
H-1-I	16/10/78	10	1.85	0.56
-II	16/10/78	8	1.81	0.60
	25/10/81	12	1.34	0.37
H-2-I	13/06/77	12	2.36	0.68
-II	13/06/77	28	1.11	0.24
-III	13/06/77	25	1.17	0.25
-I	16/10/78	22	2.40	0.54
-II	16/10/78	28	2.18	0.46
	25/10/81	14	2.64	0.74
H-3-I	15/10/78	23	0.85	0.20
-II	16/10/78	21	2.36	0.58
-III	16/10/78	28	1.78	0.39

TABLE 1: TRAWL STATISTICS, 1977 - 81
(Continued)

STATION	DATE	NO. OF SPECIES	SHANNON-WEAVER DIVERSITY INDEX (LOG 2)	EVENNESS
H-4-I	16/10/78	11	1.26	0.38
-II	17/10/78	4	-	-
	26/05/80	10	0.42	0.13
O-1	14/06/77	23	2.90	0.65

In May-June and October 1981, P. borealis catches were variable ranging from 1 to 52. This may indicate spotty distribution rather than a decline. Lithodes aequispina (brown King crab) were found in 1978 (Sullivan and Brothers 1979), October 1980, and May-June and October 1981. Fish of various species were present in most trawl catches. None of the fish species recorded in 1977 (Sullivan and Brothers 1979) were found in October 1981. Fish common to more than one survey include Bathyagonus nigripinnis, Lumpenella longirostris, and Lycodes brevipes. O'Connell 1976 found only 5 species at their station 9 near A-1 in August 1976. No fish were found and shrimp numbers were very low. The trawl was slower and shorter than EPS trawls but the net was much larger and the mesh size smaller. Carmichael and Boutillier (1979) found larger numbers of Pandalopsis dispar and Theragra chalcogramma, but no Pandalus borealis at a station near A-1 in 1978. Their trawl was similar in speed and longer than EPS trawls. Their net was much larger than the EPS net but had the same mesh size.

Trawl station A-2, midway along Alice Arm, is deeper than A-1 (209 to 380 metres). The number of species collected varied little from survey to survey, ranging from 14 to 23. Common species to all surveys included Yoldia thraciaeformis or montereyensis, Pandalus borealis, Lithodes aequispina, Chionocetes bairdi, and Ctenodiscus crispatus. Crangon communis was not found in October 1981, but was present in 1977 and 1978 catches (Sullivan and Brothers 1979) in low numbers. Fish were commonly found, the most ubiquitous being Lumpenella longirostris. At O'Connell's (1976) nearby station 7, six invertebrate species were caught in August 1976. It was a shorter and slower trawl, no fish were caught, and shrimp numbers were low but comparable to some EPS trawls at A-2.

A-3, near the mouth of Alice Arm, is the shallowest station in Alice Arm (about 80 metres). The number of species per trawl varied from 19 to 44, the highest levels being in 1978 (as was the case at A-1). P. borealis was more abundant than at A-1 (except in 1978 [Sullivan and Brothers 1979]) and at A-2, with levels from 293 to 2455 individuals per trawl. Crangon communis was also more abundant (50 - 500). Paralithodes camtschatica (Alaskan King crab) was found once in 1977 at this station

(Sullivan and Brothers 1979). As at A-1, brittle stars were not found after 1978 (Sullivan and Brothers 1979). 14 species were found by O'Connell 1976 in August 1976 at their nearby station 6. Shrimp numbers were lower than trawls. Though shorter, this trawl was done at about the average speed EPS trawled at.

3.1.2 Hastings Arm. Trawl station H-1, at the head of Hastings Inlet (in around 250 meters of water) had comparatively low numbers of species present per trawl (namely 8-12). Numbers of individuals were low except for shrimp (P. borealis in 1978 - 57 and 83, in October 1981 - 256). In 1978 only fish and shrimp were collected, whereas in October 1981 crab, starfish, and sea cucumbers were also found. Shrimp were about 3 times as plentiful in 1981 catches compared to those in 1978 (Sullivan and Brothers 1979).

Trawl station H-2, midway along Hastings Arm, was about 290 metres deep. It is richer than H1, with 12 to 28 species per trawl. The number of species collected was lower for the most part in 1981 than in previous years (Table 1). Lithodes aequispina was found in 1977 and 1978 (Sullivan and Brothers 1979) but not in October 1981. Pandalopsis dispar was more abundant here than Pandalus borealis. Carmichael and Boutillier 1979 in November 1978 trawled larger numbers of Pandalus borealis and similar numbers of Pandalopsis dispar at this site. The trawl was similar in speed, much longer, and the net much larger.

H-3, 180 metres deep, was only done in 1978. It is near A-3, but twice as deep. The number of species caught ranged from 21 to 28, the highest number of species being associated with the slowest trawl. One trawl netted 1582 P. borealis. One Paralithodes camtschatica was trawled (Sullivan and Brothers 1979). In November 1978 Carmichael and Boutillier (1979) caught higher numbers of Pandalopsis dispar, no Pandalus borealis, and some ratfish and dogfish here. The trawl was similar in speed but longer than EPS trawls.

H-4 in Granby Bay is a shallower station (90 metres). The number of species collected during the time it was sampled was low (4-11). P. borealis was at times abundant in catches (710 and 4 in 1978 [Sullivan and Brothers 1979], 3242 in May 1980). High numbers of Macoma were collected in 1978 (1312 and 700 [Sullivan and Brothers 1979]) but no clams

were found in May 1980. The abandoned copper mine and smelter, Anyox, is located near this station.

O-1, in Observatory Inlet, was only trawled once by EPS in 1977, from 59 to 180 m in depth 23 species were found. No King crab were present. The number of Pandalopsis dispar exceeded the number of Pandalus borealis at this station.

3.1.3 General

The diversity indicies are not well correlated with the number of species collected (Table 1). Some of the trawl catches with many species present also had large numbers of individuals belonging to 1 or 2 species. This causes a reduction in the evenness value and a low diversity index (eg: trawl A-1-I - Oct. 78 and trawl A-1-I - Oct. 81 with diversity indicies of 0.78 and 0.20).

There are many variables in a trawl: the distance and speed; whether the net trawls up or down a slope; whether it encounters rocky areas, whether wood or debris clog the opening, whether locations are consistent from trawl to trawl, whether the net is torn; and whether it fills with mud. These must be remembered when comparing one trawl with another. Since the EPS net is smaller than most commercial nets it may fish quite differently. In fact it caught more species in comparable or higher numbers (over the same distance) than much larger trawls (O'Connell 1976, Carmichael and Boutillier 1978). Patchiness has been observed in the distribution of benthic animals from the Pisces. Also, motile organisms are sometime able to avoid the net and the degree to which they do so will vary depending on the bottom speed of the net, how full the net is, and the severity of the consequent shock wave.

Sponges, gorgonian corals, and brachiopods in the trawl catches usually indicate that rocks or a rocky outcrop were encountered during the trawl.

The longer trawls, as one might expect, usually had higher numbers of individuals and species. The slower EPS trawls generally resulted in catches with higher numbers of species and higher numbers of individuals for certain species of shrimp and fish.

October 1981 was too early to look for definite signs of effects from fresh mine tailing on trawl catches at A-1. From Pisces observations in 1982 (dive 1107) the trawl likely passed over both fresh tailing and fairly natural bottom. The second A-1 trawl in October 1981 was further west (further from the outfall) and had higher numbers of species and higher numbers of pinks than the other 2 trawls. However it was the slowest trawl and this may account for the difference. The number of species caught at A-1 was not appreciably different from earlier survey periods (except 1978).

3.2 Pisces Dives

Dive locations are shown in Figure 3, and detailed dive observations are in Appendix III. Common names of the animals observed may be found in the trawl data (Appendix II). Examples of photographs taken from the Pisces are shown in Plates 1-12. Plate 13 depicts the effects of turbidity on visibility. A presentation of the 16 mm movie film taken during the dives has been prepared and is available from EPS.

3.2.1 Alice Arm

On dive 1105 (at the head of Alice Arm) sediment was natural, with burrows and tracks caused by fish and invertebrates. *Pandalopsis dispar*, *Pandalus borealis*, *P. hypsinotus*, and other shrimp were seen. Sea whips were at times dense and the fish *Theragra chalcogramma* was observed.

Dive 1102 began seaward of the Amax outfall in 107 metres of water on a fresh tailing deposit (characterized by a rippled surface and light grey colouration). A sea whip and small shrimp were observed here. Nearer shore and further east natural sediment was encountered at 75 metres and shallower. The crab, *Chionocetes bairdi* and *Lithodes*

aequispina, the shrimp Pandalus borealis and P. hypsinotus, sea urchins, anemones, sole, and pricklebacks were seen in this section. The tailing plume was encounted at around 100 metres at the start of the dive. The latter part of the dive was shallower than 100 metres, hence above the plume.

Dive 1103 occurred around the Amax outfall. The substrate at around 35 metres, was natural in appearance, with infaunal burrows. The crab Hyas lyratus, Lithodes aequispina, and Chionocetes bairdi were seen as were shrimp and eelpouts.

Dive 1111, just west of dive 1102, solely consisted of transmissometry in mid water. Greatest turbidity encountered was at around 119 metres.

Tailing and lumps of clay (or tailing) were present on the bottom at 274 metres on dive 1104 (which occurred just west of dive 1111). Pandalus borealis, one prickleback, and nemertean worms were seen. Although not present near the bottom, the tailing plume was encountered at 269 metres and for an unspecified distance upward on ascent.

Dive 1107, just west of dive 1104, began at 342 metres on a natural burrow-ridden substrate, crossed an area of fresh tailing deposit where minor slumping was evident (Plates 9-12), and proceeded up the north slope until natural sediments were again encountered from 237 metres upward. Lithodes, shrimp, and the sea cucumber Molpadia were seen on the tailing. On the natural bottom, the starfish Ctenodiscus and Solaster, Chionocetes bairdi, Lithodes, eelpouts, hermit crabs, sea urchins, sea anemones, flatfish, small fish, skate, Theragra chalcogramma, and shrimp were observed. On the rocky face near shore were cloud sponge, brachiopods, anemones, and shrimp. Milkiness and murkiness were observed in the water column from 100 metres down to below 143 metres and also between 269 and 212 metres when travelling along the bottom.

Dive 1109, midway along Alice Arm (Plates 5,6), traversed a natural bottom, with burrows, from 362 metres to 169 metres. Pandalopsis borealis and some Pandalopsis dispar were seen. A rocky face with sea cucumbers attached was encountered at 299 metres.

The sediment on dive 1108, just inside the Alice Rock sill (Plates 3, 4), was at first natural soft mud with small tubes protruding. Near Hans Creek coarse rippled sand and smooth river stones were encountered, followed again by soft mud later in the dive. Near shore, rocky cliffs were encountered. Biota on the mud and the sand bottom included Pandalopsis dispar, small shrimp, Lithodes, Chionocetes, Theragra chalcogramma, eelpouts, pricklebacks, sculpins, starfish, sea cucumbers, anemones, snails, Munida (squat "lobster"), sea urchins, and scale worms. On the rocky cliffs were brachiopods, tube worms, sea anemones, corals, sponge, sea urchins, Cucumaria (sea cucumber), sculpins, hermit crab, and shimp.

Dive 1106 (Plate 1) traversed the sill near the mouth of Alice Arm. On the inner side of the sill the bottom consisted of small cobbles to large rocks. At 232 metres, at the start of the dive, the cobbles were covered with fine silt, whereas later in the dive, in shallower water, stones on the bottom were free of silt (an indication of stronger currents). Chionocetes bairdi, Lithodes aequispina, Pandalus borealis, Pandalopsis dispar, sea urchins, starfish, hermit crab, skate, sole, eelpouts, crinoids and corals were observed. The substrate on the outer side of the sill consisted of fine gravel at first, changing to smooth mud further from the sill. Shrimp, hermit crab, sole, sculpins, eelpouts, starfish, snails, Paralithodes, Chionocetes, sea whips, sea cucumbers, crinoids, sea urchins, and cup corals were seen here.

3.2.2 Hastings Arm Dive 1110 was carried out in Granby Bay near Anyox, in about 90 metres of water. The bottom was smooth mud with some burrows. Poor visibility hampered observations but very many Pandalus borealis and some Pandalopsis dispar were seen.

Dive 1112, off Carr Point (Plates 7,8), followed a muddy bottom with burrows and mounds. Rocky outcroppings and cliffs were encountered. Ctenodiscus crispatus (the mud star) was frequent on the mud bottom. Shrimp distribution was variable. Theragra chalcogramma, Anoplopoma fimbra (sablefish), Chionocetes, eelpouts, pricklebacks, burrowing anemones, and snails were also seen. In the rocky areas brachiopods predominated. Lithodes, starfish, snails, anemones, sea urchins, sea cucumbers, shrimp, and barnacles were observed.

3.2.3 General The photographs of the "target" (plate 13) illustrate the relationship between light transmittance and visibility. The lines on the target are 8 cm high. They were photographed at a distance of 120 cm with a 35 mm SLR camera (inside the sub) using a 50 mm lens. Indistinctness of the lines is obvious at 50% transmittance. The lines become impossible to see at 30% transmittance.

Pisces observations in 1982 clearly indicate a sparsity of marine life on deposits of fresh tailing. Some King crab, sea whips, shrimp, and sea cucumbers were seen in these areas, but burrows were for the most part not observed in the fresh tailing and the normal nutrient-rich brown coating of detritus was absent from the surface.

Shrimp seemed less abundant on dive 1112 than during a 1976 dive in the same area (dive 518) (D. Goyette, EPS - personal observation). Similarly trawl data from nearby H-2 indicate lower numbers of shrimp in October 1981 than in 1977. On dive 522 in 1976 20 Paralithodes camtschatica (Alaskan King crab) were observed. This is near dive 1106, during which one P. camtschatica was seen. None were observed at any other dive sites on either survey. P. camtaschatica was occasionally caught in trawls at stations A3 and H3 just seaward of these dive sites. In 1982 EPS caught this crab at A1 (unprepared data). Lithodes aesquispina (brown King crab) was observed at most dive sites both surveys. Most of them seen in 1982 were quite small. A commercial King crab fishery has been established in the area since 1976.

Hydrolagus collei (ratfish) and Squalus acanthias (dogfish) are uncommon in this area. Both were caught near H3 in 1978 by Carmichael and Boutillier (1979), and an H. collei was caught on a longline in Alice Arm in 1975, (O'Connell 1976). Neither of these species have been trawled by EPS nor have they been observed from the Pisces. O'Connell 1977 mentions the presence of large numbers of Merluccius productus (hake) in Alice Arm. This is not confirmed by trawl data from EPS, O'Connell 1976, or Carmichael and Boutillier 1979 or by Pisces observations by EPS. One M. productus was caught in a trawl net at station A2 in 1977 by EPS. Limanda aspera

(yellowfin sole) were commonly caught by Dobrocky Seatech (O'Connell 1976) in Alice Arm in trawls and crabtraps, but were never found by EPS until 1982 (unprepared data). They may frequent shallower water than that normally trawled by EPS. Pandalus platyceros (prawns) were seen in low numbers from the Pisces in 1976 but not in 1982. They were caught in a prawn trap off Randy Creek in Alice Arm by Cooper and Boutillier 1979 in 1978. None were trawled by EPS, O'Connell 1976, or Carmichael and Boutillier 1979.

4. CONCLUSIONS

4.1 Otter Trawls

The many variables of trawling preclude precise estimation of benthic populations. Comparability of these data to trawl studies by other groups in the Alice and Hastings area is fairly poor. Differences between trawl catches at the same station may be due to changes in trawl technique or equipment, or they may reflect patchiness, movement, or natural variation in the populations of benthic organisms.

Station A-3 is the richest station in this study area which may be a result of its shallower depth and its location at the mouth of Alice Arm. Stations H-2 and H-3 seem comparable to Alice Arm stations but H-1 and H-4 are decidedly poorer in numbers of species caught.

The area of heavy fresh tailing deposition in Alice Arm was not extensive enough in October 1981 to cover the entire area trawled at A-1, although light deposition measured by sediment chemistry was general throughout the area. Hence we would not expect, and in fact did not see, any significant indication of impact in the trawl catch data.

4.2 Pisces Dives

Observations from the Pisces IV submarine reveal an impacted epibenthic community and a severely reduced infaunal community (as indicated by the lack of burrows) in the area of heavy recent tailing deposition, though motile organisms occurred in this area (e.g. crab, shrimp, and fish).

Shrimp density appeared lower off Carr Point in Hastings Arm in 1982 compared with 1976. Also, throughout the area, King crab seemed fewer in number and smaller generally in 1982 perhaps as a result of commercial crab fishing.

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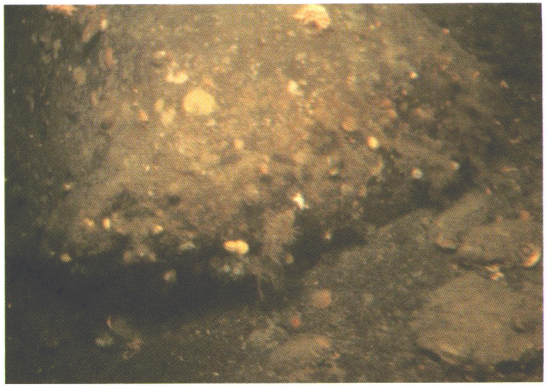


plate 1 Pisces dive 1106 - 70m.

plate 2 Pisces dive 1108 - 220m.-king crab

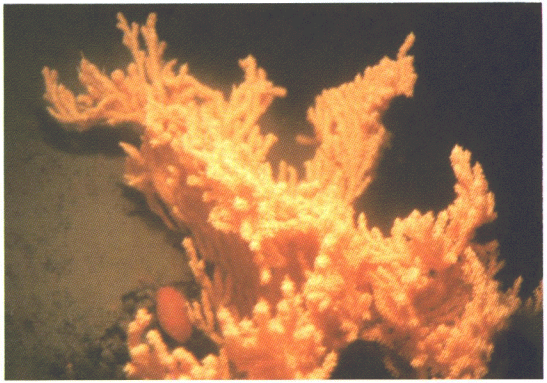


plate 3 Pisces dive 1108 - 108m. - Primnoa

plate 4 Pisces dive 1108 - 130m. - sculpin

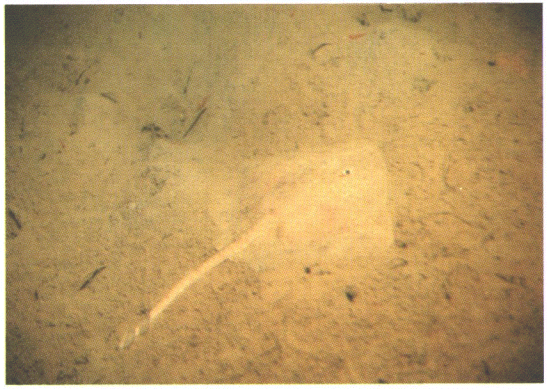


plate 5 Pisces dive 1109 - 210m. - skate

plate 6 Pisces dive 1109 - 237m. - shrimp

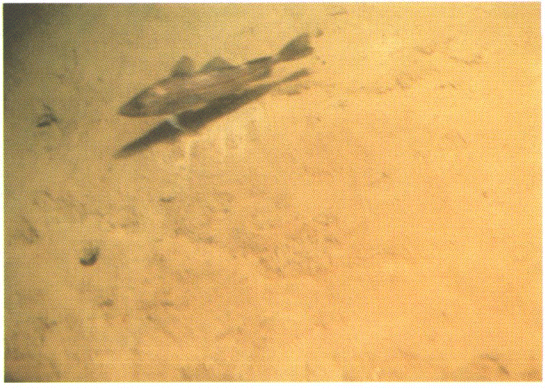


plate 7 Pisces dive 1112 - 290m. - pollock

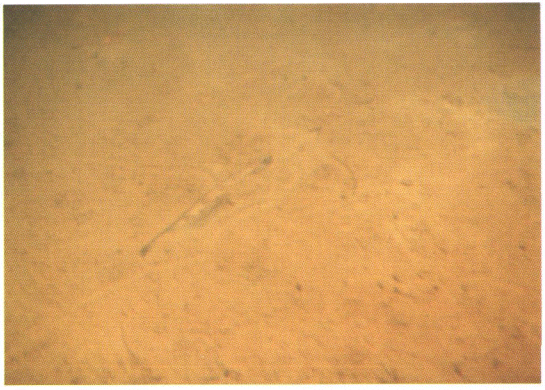


plate 8 Pisces dive 1112-290m. - prickleback

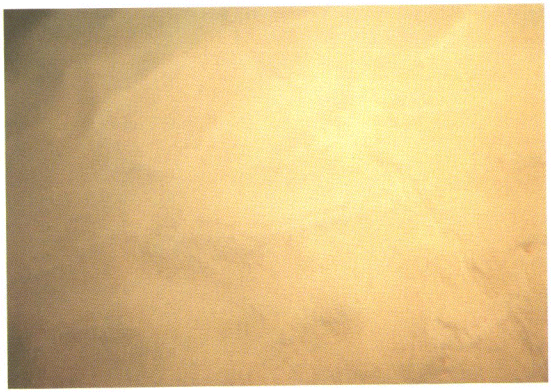


plate 9 Pisces dive 1107-315m.

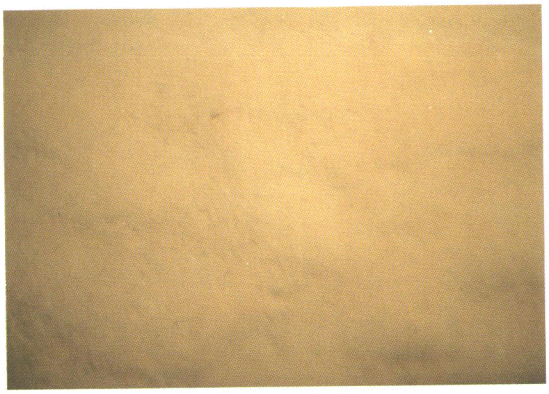


plate 10 Pisces dive 1107-315m.

plate 11 Pisces dive 1107-312m.

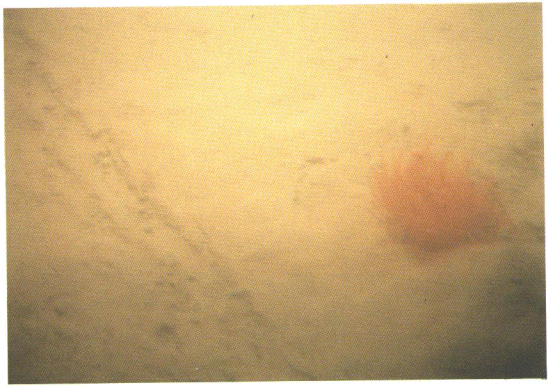
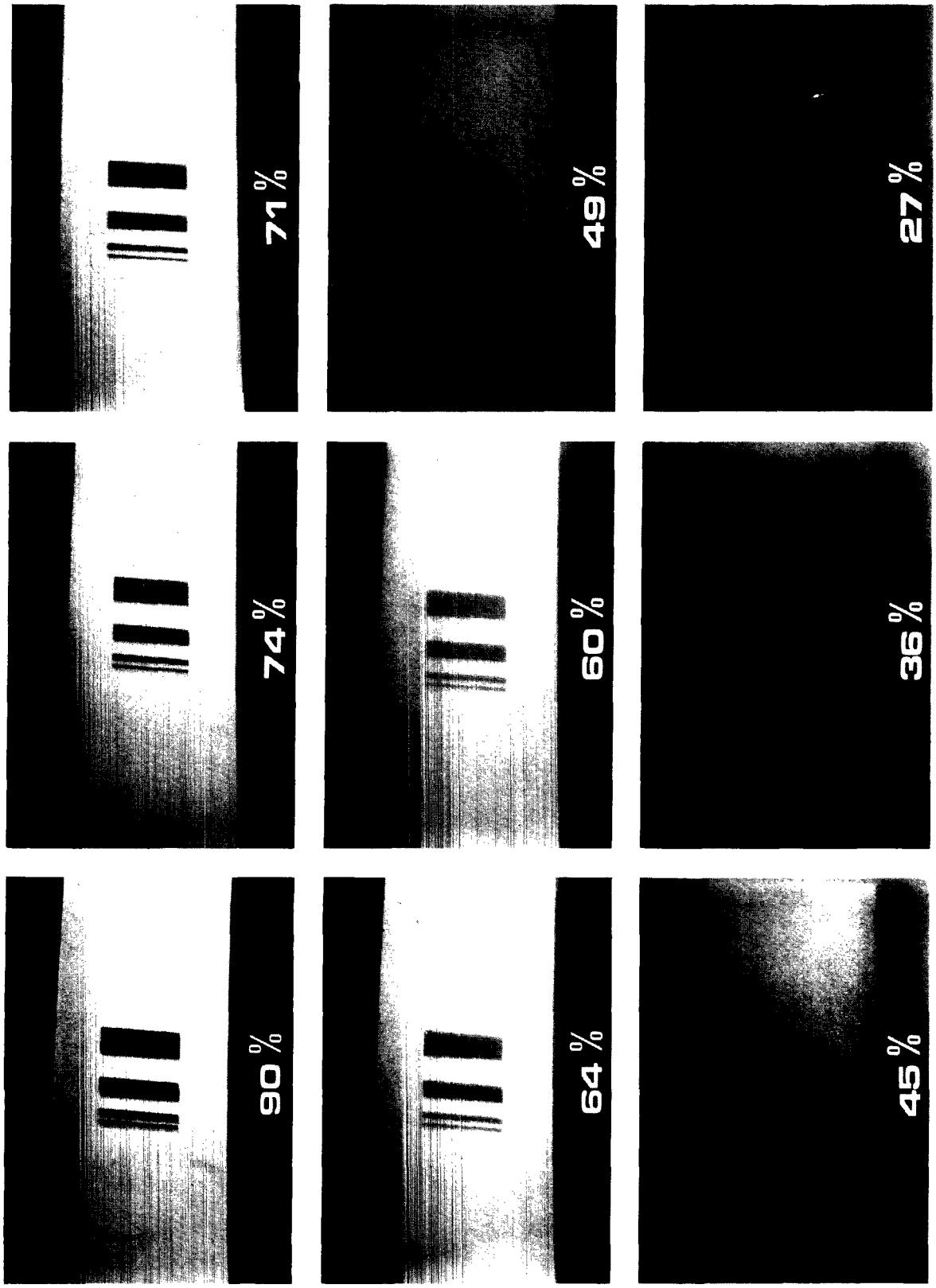


plate 12 Pisces dive 1107-280m.-anemone

Plate 13. Visibility from PISCES IV related to % Transmittance



APPENDIX I: TRAWL COORDINATES, 1980 - 81

APPENDIX I. TRAWL COORDINATES, 1980 - 81

TRAWL NO.	DATE	DEPTH (Meters)	LATITUDE	LONGITUDE
ALICE ARM A-1-I	27/05/80	START: 183	55° 27.00'N	129° 30.33'W
		FINISH: 110	55° 27.28'N	129° 29.66'W
-II	27/05/80	START: 155	55° 26.95'N	129° 30.46'W
		FINISH: 104	55° 27.23'N	129° 29.73'W
	14/10/80	START: -	-	-
		FINISH: -	-	-
-I	31/05/81	START: -	55° 26.68'N	129° 32.62'W
		FINISH: -	55° 26.68'N	129° 31.76'W
-II	31/05/81	START: -	-	-
		FINISH: -	-	-
-III	02/06/81	START: -	55° 26.70'N	129° 33.10'W
		FINISH: -	55° 26.73'N	129° 31.70'W
-I	24/10/81	START: 240	55° 26.78'N	129° 31.23'W
		FINISH: 192	55° 26.93'N	129° 30.43'W
-II	24/10/81	START: 220	55° 26.47'N	129° 32.58'W
		FINISH: 194	55° 26.50'N	129° 31.80'W
-III	26/10/81	START: 209	55° 26.85'N	129° 30.87'W
		FINISH: 161	55° 27.05'N	129° 30.10'W
A-2-I	24/10/81	START: 380	55° 27.10'N	129° 35.90'W
		FINISH: 273	55° 27.17'N	129° 35.05'W
-II	25/10/81	START: 377	55° 27.10'N	129° 36.10'W
		FINISH: -	55° 27.10'N	129° 36.92'W

APPENDIX I: TRAWL COORDINATES, 1980 - 81
(continued)

TRAWL NO.	DATE	DEPTH (Meters)	LATITUDE	LONGITUDE
A-3	25/05/80	START: 82	55° 24.70'N	129° 40.72'W
		FINISH: -	55° 24.25'N	129° 41.08'W
-I	14/10/80	START: -	-	-
		FINISH: -	-	-
-II	14/10/80	START: -	-	-
		FINISH: -	-	-
	03/06/81	START: -	55° 24.63'N	129° 40.80'W
		FINISH: -	55° 24.10'N	129° 41.00'W
	25/10/81	START: -	55° 24.60'N	129° 40.80'W
		FINISH: -	55° 24.15'N	129° 41.00'W
HASTINGS ARM				
H-1	25/10/81	START: 236	55° 35.10'N	129° 47.60'W
		FINISH: 251	55° 34.60'N	129° 47.70'W
H-2	25/10/81	START: 293	55° 29.50'N	129° 45.80'W
		FINISH: 285	55° 29.05'N	129° 45.50'W
H-4	26/05/80	START: 90	55° 23.72'N	129° 49.40'W
		FINISH: 91	55° 24.32'N	129° 49.40'W

APPENDIX II

TRAWL DATA - 1980-81

AREA ALICE ARM STATION A-1-I DATE 27/5/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	3		
Pandalus borealis	pink shrimp	16		
unknown shrimp		10		
ARTHROPODA - ANOMURA				
hermit crab		1		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		2		
CHORDATA - PISCES				
Atheresthes stomias	arrowtooth flounder	2		
Gadus macrocephalus	Pacific cod	1	3880	
Lumpenella longirostris	longsnout prickleback	2		
Lyopsetta exilis	slender sole	1		
Theragra chalcogramma	walleye pollock	3		

AREA ALICE ARM STATION A-1-II DATE 27/5/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
PORIFERA		much		
CNIDARIA - Anthozoa				
Stylatulidae	sea whips	3		
BRACHIOPODA		61	366	att. to lg. barnacles
ANNELIDA - Hirudinea				
Marsipobdella sacculata		sev.		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	1	2	
Pandalopsis dispar	sidestripe shrimp	4	67	
Pandalus borealis	pink shrimp	66	138	
unknown shrimp		34	37	
ARTHROPODA - ANOMURA				
Lithodes aequispina	brown King crab	2	4656	
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	4	1119	
ARTHROPODA - Cirripedia	barnacles - large	sev.		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	16		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		10		
Molpadia intermedia		12		
CHORDATA - PISCES				
Hippoglossoides ellasodon	flathead sole	2	549	
Lumpenella longirostris	longsnout prickleback	5	221	
Lycodes diapterus	black eelpout	1	65	
Theragra chalcogramma	walleye pollock	2	422	

AREA ALICE ARM STATION A-3 DATE 25/5/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	197	270	
Pandalus danae	coonstripe shrimp	3		
Pandalopsis dispar	sidestripe shrimp	178	1907	
Pandalus borealis	pink shrimp	299	770	
Pandalus hypsinotus	humpback shrimp	7	102	
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	5	1366	
ECHINODERMATA - ASTEROIDEA				
Crossaster paposis	rose star	1		
Ctenodiscus crispatus	mud star	1		
Solaster dawsoni		1		
ECHINODERMATA - OPHIUROIDEA				
Gorgonocephalus eucnemis	basket star	11		
ECHINODERMATA - HOLOTHUROIDEA				
Molpadia intermedia		1		
Parastichopus sp. ?		54		
ECHINODERMATA - ECHINOIDEA				
Strongylocentrotus pallidus	white sea urchin	18		
CHORDATA - PISCES				
Agonus acipenserinus	sturgeon poacher	2	92	
Hippoglossoides ellasodon	flathead sole	13	1837	
Lepidopsetta bilineata	rock sole	1	342	
Leptocottus armatus	staghorn sculpin	2		small
Lycodes brevipes	shortfin eelpout	9	413	
Microstomus pacificus	Dover sole	5	521	
Myoxocephalus polyacanthocephalus	great sculpin	2	2624	
Theragra chalcogramma	walleye pollock. juv.	51	1311	
	adult	2	512	

AREA HASTINGS ARM STATION H-4 DATE 26/5/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	7	8	
Pandalopsis dispar	sidestripe shrimp	22	58	
Pandalus borealis	pink shrimp	3242	10,116	
Pandalus hypsinotus	humpback shrimp	9	187	
Pandalid		10	22	small
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1	337	
CHORDATA - PISCES				
Bothrocara molle	soft eelpout	10	288	
Cymatogaster aggregata	shiner seaperch	1	23	
Microstomus pacificus	Dover sole	5	266	
Theragra chalcogramma	walleye pollock	134	1999	

AREA ALICE ARM STATION A-1 DATE 14/10/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
unidentified snail #1		8		
" #2		1		
" #3		1		
MOLLUSCA - PELECYPODA				
Yoldia thraciaeformis or montereyensis		26		
unidentified bivalve		1		
ANNELIDA - Hirudinea				
Marsipobdella sacculata		1		
ARTHROPODA - CARIDEA				
Eualus suckleyi	short-scaled eualid	7	12	
Pandalopsis dispar	sidestripe shrimp	35	391	
Pandalus borealis	pink shrimp	43	173	
ARTHROPODA - ANOMURA				
Lithodes aequispina	brown King crab	1	1186	
hermit crabs		10		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1	297	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	many	785	
CHORDATA - PISCES				
Lumpenella longirostris	longsnout prickleback	3	129	
Lycodes diapterus	black eelpout	1	52	
Microstomus pacificus	Dover sole	1	1084	
Nectoliparis pelagicus	tadpole snailfish	4	8	
Thaleichthys pacificus	eulachon	1		

AREA ALICE ARM STATION A-3-I DATE 14/10/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
CNIDARIA - Anthozoa				
Actiniaria		1		
BRACHIOPODA		4		
MOLLUSCA - GASTROPODA				
unidentified snail #4		1		
ANNELIDA - POLYCHAETA		1		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined Crangon	500	447	
Pandalopsis dispar	sidestripe shrimp	32	318	
Pandalus borealis	pink shrimp	1578	3773	2.39 g. each
Pandalus hypsinotus (?)	humpback shrimp	7	117	
Pasiphaea pacifica	glass shrimp	4		
Shrimp: unknown	shrimp #1	13		)
	shrimp #2	1		)
	shrimp #3	3		)
	shrimp #4	6		)
	shrimp #5	33		) specimens taken
	shrimp #6	4		)
	shrimp #7	1		)
	shrimp #8	1		)
	shrimp #9	1		)
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	4	934	
Hyas lyratus	lyre crab	17		
ECHINODERMATA - ASTEROIDEA				
Crossaster paposis	rose star	6		
Ctenodiscus crispatus	mud star	1		
Henricia sp.	blood star	3		
Pseudarchaster parelli		1		

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ECHINODERMATA - OPHIUROIDEA				
Gorgonocephalus eucnemis	basket star	2		
	brittle stars	7		
ECHINODERMATA - HOLOTHUROIDEA				
Parastichopus sp.		32		
ECHINODERMATA - ECHINOIDEA				
Strongylocentrotus sp.		12		
CHORDATA - PISCES				
Agonus acipenserinus	sturgeon poacher	21	310	
Hippoglossoides ellasodon	flathead sole	4	457	
Inopsetta ischyra	hybrid sole	1	118	
Lepidopsetta bilineata	rock sole	3	1152	
Lumpenus maculatus	daubed shanny	1		
Microstomus pacificus	Dover sole	1	65	
Nectoliparis pelagicus	tadpole snailfish	1	2	
Parophrys vetulus	English sole	21	2834	
Theragra chalcogramma	walleye pollock	44	2249	
unknown sculpin #1		14	320	
Myoxocephalus polyacanthocephalus		1	794	

AREA ALICE ARM STATION A-3-II DATE 14/10/80

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined Crangon	81	76	
Eualus suckleyi	short-scaled eualid	10		
Pandalopsis dispar	sidestripe shrimp	16		
Pandalus borealis	pink shrimp	340	1157	
Pandalus hypsinotus	humpback shrimp	2		
Pasiphaea pacifica	glass shrimp	10		
Shrimp: unidentified	shrimp #1	1		
	shrimp #4	3		
	shrimp #6	2		
	shrimp #8	1		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	6		
Pseudarchaster parelli		1		
ECHINODERMATA - OPHIUROIDEA				
Gorgonocephalus eucnemis	basket star	1		
ECHINODERMATA - HOLOTHUROIDEA				
Parastichopus sp.		17		
CHORDATA - PISCES				
Lycodes brevipes	shortfin eelpout	1	102	
Lyopsetta exilis	slender sole	6	1233	
Parophrys vetulus	English sole	1	271	
Theragra chalcogramma	walleye pollock	18	1034	
unknown sculpin		1		

AREA ALICE ARM STATION A-1-I DATE 31/5/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	3		
unknown snail A		1		
MOLLUSCA - PELECYPODA				
Yoldia thraciaeformis or montereyensis		6		
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	8	129	
Pandalus borealis	pink shrimp	2	8	
Pasiphaea pacifica	glass shrimp	sev.		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	sev.		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		num.		
Molpadia intermedia		1		
CHORDATA - PISCES				
Clupea harengus pallasi	Pacific herring	1		

AREA ALICE ARM STATION A-1-II DATE 31/5/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	1		
unknown snail A.		4		
MOLLUSCA - PELECYPODA				
Macoma sp.		3		
Nuculana pernula		2		
Yoldia thraciaeformis or montereyensis		1		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	2		
Pandalopsis dispar	sidestripe shrimp	2		
Pandalus borealis	pink shrimp	1		
Pasiphaea pacifica	glass shrimp	1		
ARTHROPODA - ANOMURA				
hermit crabs		7		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	3		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	num.		
Solaster dawsoni		1		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		num.		
Parastichopus sp.		2		
small *Molpadia*-like		1		
CHORDATA - PISCES				
Bathyagonus nigripinnis	blackfin poacher	1	22	
Lycodes brevipes	shortfin eelpout	1	67	
juvenile eelpout		1		

AREA ALICE ARM , STATION A-1-III DATE 2/6/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
CNIDARIA - Anthozoa				
Actiniaria		1		
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	23		
unknown snail A		1		
MOLLUSCA - PELECYPODA				
Nuculana pernula		1		
Yoldia scissurata		7		
Yoldia thraciaeformis or montereyensis		39		
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	37	522	
Pandalus borealis	pink shrimp	52	179	
Pasiphaea pacifica	glass shrimp	2		
ARTHROPODA - ANOMURA				
Lithodes aequispina	brown King crab	1		
hermit crab		1		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	14		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	num.		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		num.		
Molpadia intermedia		sev.		
Parastichopus sp.		num.		
CHORDATA - PISCES				
Lumpenella longirostris	longsnout prickleback	1	32	
Lycodes brevipes	shortfin eelpout	1	63	
Nectoliparis pelagicus	tadpole snailfish	1		

AREA ALICE ARM STATION A-3-I DATE 3/6/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
unknown snail		1		
MOLLUSCA - PELECYPODA				
unknown clam		1		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	84	100	
Pandalopsis dispar	sidestripe shrimp	10	180	
Pandalus borealis	pink shrimp	293	1172	
Pandalus hypsinotus	humpback shrimp	8	197	
unknown shrimp A		2		
unknown shrimp B		1		
ARTHROPODA - ANOMURA				
Munida quadrispina	squat lobster	3		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1		
Hyas lyratus	lyre crab	1		
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	4		
ECHINODERMATA - OPHIUROIDEA				
Gorgonocephalus eucnemis	basket star	8		
ECHINODERMATA - HOLOTHUROIDEA				
Parastichopus sp.		many		
ECHINODERMATA - ECHINOIDEA				
Strongylocentrotus pallidus	white sea urchin	4		
CHORDATA - PISCES				
Asterotheca alascana	gray starsnout	3		
Eopsetta jordani	Petrale sole	12	828	
Lycodes brevipes	shortfin eelpout	15	581	
Lyopsetta exilis	slender sole	1	23	
Parophrys vetulus	English sole	4	1003	
Theragra chalcogramma	walleye pollock	47	2687	
unknown sculpin		3		

AREA ALICE ARM STATION A-1-I DATE 24/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
CNIDARIA - Anthozoa				
Actiniaria		1	85	
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	85	553	
Neptunea lyrata	ridged whelk	28	695	
Neptunea sp.		5	139	
unknown snail A		1		nr. *Polinices* but smal
unknown snail B		1		" " " "
MOLLUSCA - PELECYPODA				
Macoma sp.		63	255	
Nuculana pernula		1	1	
Yoldia scissurata		6	19	
Yoldia thraciaeformis or montereyensis		222	480	
ANNELIDA - POLYCHAETA				
Nephthyidae		1		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined crangon	2	4	
Pandalopsis dispar	sidestripe shrimp	8	101	
Pandalus borealis	pink shrimp	1	6	
ARTHROPODA - ANOMURA				
hermit crab		4		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	(male)2	962	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	23898		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		many		
Molpadia intermedia		91	4633	
unknown white *Cucumaria*-like		1		

AREA ALICE ARM STATION A-1-111 DATE 26/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	10	68	
Neptunea lyrata	ridged whelk	2	19	
MOLLUSCA - PELECYPODA				
Macoma sp.		7	46	
Yoldia scissurata		15	38	
ARTHROPODA - CARIDEA				
Pandalus borealis	pink shrimp	1	3	
Pasiphaea pacifica	glass shrimp	1	1	
unknown shrimp A		1		
unknown shrimp B		1		
ARTHROPODA - ANOMURA				
Munida quadrispina	squat lobster	1	4	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	many	2343	
ECHINODERMATA - HOLOTHUROIDEA				
Molpadia intermedia		9	69	
CHORDATA - PISCES				
Bothrocara molle	soft eelpout	1	3	

AREA ALICE ARM STATION A-2-I DATE 24/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	3	15	
unknown snail		1		
MOLLUSCA - PELECYPODA				
Yoldia scissurata		1	6	
Yoldia thraciaeformis or montereyensis		4	7	
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	12	168	3 with roe
Pandalus borealis	pink shrimp	5	15	
Pasiphaea pacifica	glass shrimp	3		
ARTHROPODA - ANOMURA				
Lithodes aequispina	brown King crab	1	1998	
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1	410	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	sev.	352	
ECHINODERMATA - HOLOTHUROIDEA				
Parastichopus sp.		9	296	
CHORDATA - PISCES				
Bathyagonus nigripinnis	blackfin poacher	1	13	
Lumpenella longirostris	longsnout prickleback	2	79	
Lycodes brevipes	shortfin eelpout	1	44	
Nectoliparis pelagicus	tadpole snailfish	1	5	
unknown fish		1		

AREA ALICE ARM STATION A-2-II DATE 25/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
BRACHIOPODA		4	19	
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	15	92	
unknown snail		5	15	
MOLLUSCA - PELECYPODA				
Yoldia scissurata		4	19	
Yoldia thraciaeformis or montereyensis		21	33	
ANNELIDA - POLYCHAETA				
Polynoidae		1		
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	64	606	
Pandalus borealis	pink shrimp	28	115	
Pasiphaea pacifica	glass shrimp	1		
unknown shrimp A		1		
unknown shrimp B		1		
unknown shrimp C		1		
ARTHROPODA - ANOMURA				
Lithodes aequispina	brown King crab	2	376	
hermit crab		9		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	1	46	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	num.	927	
ECHINODERMATA - HOLOTHUROIDEA				
Parastichopus sp.		sev.	989	
CHORDATA - PISCES				
Bothrocara molle	soft eelpout	1	15	
Hemitripterus bolini	bigmouth sculpin	1	491	
Lumpenella longirostris	longsnout prickleback	9	315	
Nectoliparis pelagicus	tadpole snailfish	1	9	

AREA ALICE ARM STATION A-3 DATE 25/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
CNIDARIA - Anthozoa				
Stylatulidae	sea whips	2		
ANNELIDA - POLYCHAETA				
Polynoidae		2		
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined Crangon	50		
Pandalopsis dispar	sidestripe shrimp	15	211	
Pandalus borealis	pink shrimp		1455	
Pasiphaea pacifica	glass shrimp	3		
unknown shrimp A		3		
unknown shrimp B		1		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	5	564	
Hyas lyratus	lyre crab	4	3	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	21	24	
near *Henricia* (but too pale)		1		
ECHINODERMATA - OPHIUROIDEA		3		
Gorgonocephalus eucnemis	basket star	5	360	
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		many		
Parastichopus sp.		31	2272	
ECHINODERMATA - ECHINOIDEA				
Strongylocentrotus droebachiensis	green sea urchin	2	69	
Strongylocentrotus pallidus	white sea urchin	22	736	
CHORDATA - PISCES				
Dasycottus setiger	spinyhead sculpin	3	104	
Eopsetta jordani	petrale sole	7	749	
Lycodes brevipes	shortfin eelpout	6	280	
Parophrys vetulus	English sole	5	726	
Theragra chalcogramma	walleye pollock	28	3343	
unknown fish		1		(small, smelt-like)
unknown poacher		1		

AREA HASTINGS ARM STATION H-1 DATE 25/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
ARTHROPODA - CARIDEA				
Crangon communis	common two-spined Crangon	6	8	
Pandalopsis dispar	sidestripe shrimp	179	1019	
Pandalus borealis	pink shrimp	256	872	
unknown shrimp A		1		
unknown shrimp B		2		
ARTHROPODA - ANOMURA				
hermit crab		2	6	
ARTHROPODA - BRACHYURA				
Hyas lyratus	lyre crab	1	137	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	3	12	
ECHINODERMATA - HOLOTHUROIDEA				
Molpadia intermedia		2	40	
CHORDATA - PISCES				
Bathyagonus nigripinnis	blackfin poacher	2	15	
Dasycottus setiger	spinyhead sculpin	1	18	
Nectoliparis pelagicus	tadpole snailfish	1	5	

AREA HASTINGS ARM STATION H-2 DATE 25/10/81

SPECIES	COMMON NAME	NO.	WT.(g)	REMARKS
MOLLUSCA - GASTROPODA				
Colus halli	Hall's colus	9	55	
Neptunea lyrata	ridged whelk	4	92	
MOLLUSCA - PELECYPODA				
Yolandia scissurata		1	7	
Yoldia thraciaeformis or montereyensis		21	56	
ARTHROPODA - CARIDEA				
Pandalopsis dispar	sidestripe shrimp	45	244	
Pandalus borealis	pink shrimp	11	45	
ARTHROPODA - ANOMURA				
hermit crabs		4		
ARTHROPODA - BRACHYURA				
Chionocetes bairdi	Tanner crab	12	2754	
ECHINODERMATA - ASTEROIDEA				
Ctenodiscus crispatus	mud star	many	5772	
near *Mediaster sp.*		2		
ECHINODERMATA - HOLOTHUROIDEA				
Chiridota sp.		many		
Molpadia intermedia		1		
CHORDATA - PISCES				
Bathyagonus nigripinnis	blackfin poacher	1	19	
Raja stellulata	starry skate	1	200	

APPENDIX III: PISCES IV DIVING OBSERVATIONS

APPENDIX III: PISCES IV DIVING OBSERVATIONS

DIVE 1102: 1030, 8 July 1982.

PILOT: R. Taylor

OBSERVERS: D. Goyette, R. Hinder

POSITIONS: start - 55°26.96'N, 129°30.63'W
55°27.30'N, 129°29.61'W
55°27.30'N, 129°29.43'W
finish - 55°27.19'N, 129°29.19'W

OBSERVATIONS:

- turbid at surface.

8.5 m - halocline - fine particles in suspension.

to 60 m - fine particles, ctenophores, chaetognaths, Cyanea, a few euphausids.

60 m - more ctenophores seen.

89 m - grey haze, visibility 4-5 ft.

100 m - very murky.

102 m - extremely murky.

107 m - reached bottom - steep slope - fresh tailing, amphipods in water column.

90 m - course 060° - sea whip in fresh tailing - ripples on surface.

61 m - some small shrimp - altered course to 090° (toward north shore).

97 m - sub frame clearly visible - water murky grey.

75 m - recontacted bottom.

90 m - again contacted bottom, visibility 8 ft.

75 m - bottom - old tailing or natural sediment - surface light brown, some burrows and animal tracks.

- Chionocetes bairdi, Lithodes aequispina, Pandalus hypsinotus and

Pandalus borealis.

- position - K 6.5.
- new bearing 100°.

39 m - sea urchins, occasional Lithodes aequispina, Pandalus borealis, sole, small Chionocetes bairdi, pricklebacks, pink and white sea anemones, small tubes protruding from substrate.

DIVE 1103: 1425, 8 July 1982.

PILOT: R. Taylor

OBSERVERS: D. Goyette, D. DeMill

POSITIONS: start - 55°26.92'N, 129°29.56'W
55°26.85'N, 129°29.63'W
finish - 55°26.92'N, 129°29.56'W

OBSERVATIONS:

- surface water murky.

38 m - bottom - visibility good.

- eelpout, Hyas lyratus, Lithodes aequispina, Chionocetes bairdi, pandalid shrimp.
- sediments - natural in appearance - burrows, light brown layer on surface.
- Ran west parallel to shore, found 6 inch pipe (centre of small bay west of outfall).
- Returned east to find outfall pipe at 35 m, edge of turbidity cloud encountered with billowing clouds.
- Dive cancelled due to potential hazard from ropes attached to the pipe anchors.

DIVE 1104: 0919, 9 July 1982.

PILOT: J. Oszust

OBSERVERS: D. Goyette, F. Hickey

POSITIONS: start - 55°26.70'N, 129°31.85'W
finish - 55°26.77'N, 129°31.58'W

OBSERVATIONS:

- water murky at surface.

13 m - water clear - fine suspended particles.

86 m - greyish-white appearance to water column, larger particles same as shallower.

104 m - strands in water.

155 m - large numbers of strands and particles, visibility about 10 feet, no further evidence of turbidity field.

250 m - murky.

272 m - occasional smelt-like fish, hyperid amphipods.

274 m - bottom - fresh tailings, surface rippled, featureless, no burrows, occasional chunks of clay.

- some Pandalus borealis, one prickleback, coiled brown/black nemertean worms on surface.
- visibility about 6 feet.
- left bottom.

269 m - becoming murky.

higher - extremely murky - visibility nil.

DIVE 1105 1325, 9 July 1982.

PILOT: R. Taylor

OBSERVERS: R. Hinder, L. McLeod

POSITIONS: start - 55°27.55'N, 129°29.52'W
- 55°27.65'N, 129°29.36'W
- 55°27.63'N, 129°29.26'W
- 55°27.73'N, 129°29.26'W
finish - 55°27.49'N, 129°29.52'W

OBSERVATIONS:

- murky at surface.

11 m - halocline.

40 m - larger white particles begin showing up.

70 m - odd ctenophore, particles as at 40 m.

99 m - bottom - course set at 040°.
- numerous burrows and tracks, similar to dive 1102, grey sediment with brown coating, sea whips (small).
- ctenophores in water.
- visibility about 5 feet.

97 m - some small logs and branches, loose Fucus.
- very few shrimp, some Chionocetes bairdi, and eelpouts.

94 m - King crab, sea whips very common, visibility 2 m.
larger burrows, more shrimp (mostly Pandalopsis dispar, some Pandalus hypsinotus, Pandalus borealis, and others).

78 m - changed course to 120°.

later - changed course to 0°.
- chaetognaths and euphausids in water.

79 m - 2 Theragra chalcogramma.
visibility improving.

92 m - changed course to 245°.
- sea whips dense, several Pandalopsis dispar.

98 m - encountered humps about 3 ft. high and 20 ft. apart.
- no shrimp, fewer sea whips than earlier.

DIVE 1106: 0915, 10 July 1982.

PILOT: R. Taylor

OBSERVERS: D. Goyette, D. DeMill.

POSITIONS: start - 55°25.71'N, 129°40.23'W
- 55°25.42'N, 129°40.13'W
- 55°25.13'N, 129°40.14'W
finish - 55°25.08'N, 129°40.45'W

OBSERVATIONS:

- some surface turbidity.
8 m - halocline.
lower - fine particles, strands (more than at head of inlet).
186 m - many suspended particles.
232 m - bottom - visibility about 5 m, cobbles covered with fine silt.
- small urchins.
- course 170°.
- light brown silt. Chionocetes bairdi, Pandalus borealis, numerous small shrimp and hermit crabs, skate, eelpouts, white Henricia-like starfish, Parastichopus, a few Pandalopsis dispar, Lithodes aequispina.

186 m - larger rocks, occasional Pandalus borealis and Pandalopsis dispar, Lithodes aequispina.
70 m - cobbles, boulders, small Paragorgia - white and pink, Theragra chalcogramma, Crossaster papposus, Cucumaria miniata, crinoids.
- very few shrimp, clean bottom.
- Pteraster, Munida, cup corals, many small Paragorgia.
42 m - fix at D_1 67.
- Strongylocentrotus pallidus, Crossaster, few crustaceans, crinoids dominant, basket stars, a few sole.
- outer slope of sill, fine gravel.
- slightly lower visibility.

52 m - gravel - hermit crabs, basket stars, sculpins, sole, Parastichopus, Colus.

58 m - cup coral, snails, hermit crab, occasional starfish.

- fix - between F_1 and G_1 - line 67.

64 m - mud, sea whips, sea cucumbers, sea urchins. no King crab on outer side of sill thus far.

67 m - visibility lowered to 4-6 ft. Soft, light brown, smooth mud, a few burrows and animal tracks, small Paralithodes, very few shrimp, eelpouts, basket stars, large sculpin, Chionocetes bairdi.

DIVE 1107: 1310, 10 July 1982.

PILOT: R. Taylor

OBSERVERS: D. Goyette, D. DeMill

POSITIONS: start - 55°26.70'N, 129°32.49'W
- 55°26.70'N, 129°32.04'W
finish - 55°26.98'N, 129°31.86'W

OBSERVATIONS:

(A pre-dive transmissometer profile revealed maximum trubidity at around 100 meters, elevated levels from 80-110 m)

100 m - water milky.
143 m - still murky and entering another layer.
342 m - bottom - natural appearing mud, craters, burrows, light brown layer - course 090°.
- Ctenodiscus, Chionocetes bairdi, numerous small sea cucumbers protruding from bottom (Chiridota?), occasional eelpout, a few Pandalus borealis, a few Pandalopsis dispar, 2 Lithodes -
- aequispina, hermit crab.
322 m - silty appearance, entering fringe of tailing deposit.
324 m - bottom smoother, Lithodes.
317 m - smoother bottom, fewer burrows, few shrimp.
- bottom appears striated due to ripples with light grey ridges and brown material in troughs.
- clay lumps, smooth bottom - fresh tailing.
- "moonscape" - barren and smooth, some animal tracks.
318 m - Molpadia, very few shrimp.
- ridges run N-S, about 1½ cm. high.
313 m - evidence of slumping, clay lumps.
317 m - turning to shore - course 030°.
307 m - silt, clay chunks, numbers of shrimp increasing.

290 m - steep slope.

269 m - poor visibility.

237 m - still poor visibility - soft mud, craters reappearing, sea urchins, occasional sea anemone (pink/white), Ctenodiscus, Crangon communis - common, Solaster, small fish.

212 m - silty, visibility poor. Natural sediments, steep mud slope.

171 m - Pandalus borealis - numbers increasing. Very few fish seen this dive, no sole, the odd skate, several Theragra chalcogramma, Chionocetes.

- bottom conditions similar to beginning of dive.

143 m - steep mud slope.

94 m - few flatfish.

67 m - visibility increasing, silty bottom.

- rock with cloud sponge, brachiopods, numerous anemones (pink/white), shrimp.

DIVE 1108: 0900, 11 July 1982.

PILOT: J. Oszust

OBSERVERS: D. DeMill, F. Hickley

POSITIONS: start - 55°26.68'N, 129°39.05'W
- 55°26.27'N, 129°39.52'W
finish - 55°26.48'N, 129°40.23'W

OBSERVATIONS:

78 m - large particles in water ½ to 1 inch apart.
- interstitial water clear.
- ctenophores, amphipods, copepods.

100 m - long strands begin to appear.

142 m - herring, eelpout-like fish.

200 m - chaetognaths, Cyanea.

306 m - bottom - visibility 3 m, soft mud bottom.
- course 235°.
- prickleback, Pandalopsis dispar, small pink sea cucumbers.
- bottom soft mud with many tiny tubes protruding, no burrows.
- white small Henricia-like starfish, a few small shrimp, small eelpouts, white sea urchins.
- a few burrows now.
- bottom finely dusted with light brown sediment and organic debris (bark, branches).
- Lithodes aequispina, Theragra chalcogramma, Chionocetes bairdi, small Colus, small burrowing anemones.
- occasional small burrows, many small tubes.

266 m - Munida, hermit crabs, tubes a little larger in diameter and protruding further from the bottom.
- getting into coarser sediment -appearance of rippled beach sand, firmer - the sub doesn't plough in as deep - no tubes.

253 m - smooth river stones up to 30 cm or more in diameter.

later - tubes reappear, anemones.
- softer sediment with burrows.
- small hermit crab, small shrimp, small tubes, one Marsipobdella sacculata (leech) on own - others on Lithodes.
- small eelpout.
- sediment light grey with brown organic coating. A lot of organic debris.
- Pandalopsis dispar, small sculpin, Theragra chalcogramma.

216 m - new heading 270°
- pink anemone, Strongylocetrotus pallidus, Lithodes aequispina, several small shrimp, sponge, brittle star.
- tubes still plentiful, occasional shallow burrow.
- many small sea cucumbers.

later - have reached station U64, still heading 270°.
- shallow burrows, cucumber castings, large snail.
- visibility 3-5 metres.

216 m - slope rising.
- sediment light grey beneath brown coating.
- small hermit crab, small shrimp, eelpout, scale worms.
- large rock.
- steep rock cliff - hermit crab, brachiopods, anemones, brittle stars, large Primnoa, starfish, anemones in tubes, small white Paragorgia.
- brown sediment on rock - brachiopods, tube worms, anemones in tubes, white Cucumaria, white Henricia-like starfish.
- seawhip, sponge, large sculpin, many Strongylocentrotus pallidus.
- smooth sediment covering part of slope - with a few burrows, small shrimp, small eelpouts, Munida, cup corals.

70 m - rock cliff again - brachiopods, cup corals, shrimp.

DIVE 1109: 1420, 11 July 1982.

PILOT: J. Oszust

OBSERVERS: R. Hinder, L. McLeod

POSITIONS: start - 55°27.10'N, 129°36.07'W
- 55°26.98'N, 129°35.48'W
finish - 55°27.27'N, 129°35.40'W

OBSERVATIONS:

water column
- long mucous strands, eelpout-like fish.

362 m - visibility 2/3 metre.
- sediment gray with light brown dusting.
- large and small burrows, some animal trails, a few shrimp.

355 m - Lithodes aequispina.

340 m - visibility 1 m.
- 2 shrimp every second, at one knot speed. Mostly Pandalopsis dispar, some Pandalus borealis, and others.
- several eelpouts and pricklebacks.

299 m - rock face, sea cucumbers.

287 m - equal amounts Pandalopsis dispar and Pandalus borealis (about 6 in view at one time).

225 m - visibility 3-4 m.
- more Pandalus borealis than Pandalopsis dispar and shrimp more abundant overall (10-15 in view at one time).
- some grey patches where the brown coating has been cleared from the substrate.

210 m - some large burrows - up to 15 cm across.

175 m - sea anemone.

169 m - smaller burrows. Even numbers of Pandalopsis dispar and Pandalus borealis plus smaller shrimp.

surfaced - many long mucous-like strands in water column.

DIVE 1110: 0908, 12 July 1982.

PILOT: F. Chambers

OBSERVERS: D. Goyette, D. DeMill.

POSITIONS: start - 55°24.18'N, 129°49.30'W
finish - 55°24.48'N, 129°48.90'W

OBSERVATIONS:

- turbid at surface.

90 m - at bottom - fairly smooth, occasional burrows.

- surface sediment brownish.
- visibility 1 m.
- very many shrimp - mainly Pandalus borealis, some Pandalopsis dispar.

later - visibility improved to 1½ m.

DIVE 1111: 1031, 13 July 1982.

PILOT: J. Oszust

OBSERVERS: D. Goyette, R. Hinder

POSITIONS: start - 55°26.70'N, 129°31.13'W
- 55°26.76'N, 129°31.04'W
- 55°26.80'N, 129°31.04'W
- 55°26.87'N, 129°30.97'W
finish - 55°26.84'N, 129°30.89'W

OBSERVATIONS:

(Consists solely of transmissometry in mid-water).

229 m - getting fairly turbid - starting horizontal run-course 045°.
- (bottom 240 m).

general - a few Cyanea (jellyfish) have been seen.

218 m - changed course to 000°.

145 m - fairly turbid.

118 m - still turbid.
- changed course to 030°.

119 m - changed course to 120°.
- very turbid. As course continued turbidity increased at first, then cleared somewhat.

DIVE 1112: 1410, 13 July 1982.

PILOT: J. Oszust

OBSERVERS: D. Goyette, D. DeMill.

POSITIONS: start - 55°28.82'N, 129°45.32'W
- 55°29.00'N, 129°45.46'W
finish - 55°29.12'N, 129°44.92'W

OBSERVATIONS:

24 m - many particles, interstitial water clear.
- little zooplankton.
later - less large white particles near the bottom.
- occasional smelt-like fish. Fish not common.
296 m - bottom - silty, surface light brown, mounds greyish.
- many small burrows and craters.
- Ctenodiscus crispatus frequent, occasional Pandalus borealis, one Theragra chalcogramma, triton (snail), Pandalopsis dispar, animal tracks.
- visibility 1-2 m, fine suspended particles.
- shrimp spaced about 1 m - apart.
- octopus.
- sediment around burrows grey.
- shrimp distribution patchy - some areas none.
- very few eelpouts, no flatfish, one Pandalopsis dispar.
283 m - large craters common, no rippling.
- Ctenodiscus crispatus frequent - some buried.
- occasional burrowing anemones, Pandalopsis dispar.
- shrimp do not seem as abundant as in 1976 dives.
- prickleback.
- no hermit crabs.
270 m - steep rock face.
- brachiopod shells at base.

- rock face covered in brachiopods.
- anemones, white Henricia-like starfish, Balanus nubilis, one Lithodes aequispina.

241 m - occasional pandalid shrimp - fair distance between individuals.

216 m - gradual incline.
- occasional eelpout, one Anoplopoma fimbria (sablefish).
- a few small shrimp, poacher, snailfish.

200 m - shrimp a little more abundant - Pandalopsis dispar, pandalids, a few spirontocarids.
- Ctenodiscus, Chionocetes bairdi, another Anoplopoma fimbria.

183 m - steep muddy slope - uneven surface, some burrows.
- many shrimp.

136 m - base of cliff, nearly vertical.
- light dusting of silt on ledges.
- brachiopods, cloud sponges, small white Henricia-like starfish.

138 m - some Parastichopus, a triton, occasional Munida and Stronglocentrotus pallidus, some sea cucumbers.

100 m - very few shrimp.
- surfaced.