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PORT MOLLER KING CRAB PROGRAM: 1989 RECONNAISSANCE STUDY

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FINAL REPORT

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ABSTRACT

A suite of biological sampling was undertaken to study the population status of king crab and other crustacean stocks in the Port Moller estuarine complex (Port Moller and Herendeen Bay) in the southeastern Bering Sea. Samples were collected between 17 August and 26 August 1989; methods included benthic trawling, zooplankton sampling, intertidal surveys, benthic grab samples, and side scan sonar surveys. In addition, zooplankton samples from a herring survey conducted in June 1989 were analyzed for crustacean larvae. Anomuran, brachyuran, and caridean larvae were found during the June and August sampling periods. Pandalid shrimp larvae were found in abundance throughout the estuary during both periods, while red king crab and Tanner crab larvae were found only in June, and only from a small area in inner Herendeen Bay. During benthic and intertidal sampling, pandalid shrimp were found to be numerous. Juveniles of both red and blue king crabs and tanner crab were found in small numbers. The late season and the limited sampling permitted no definite conclusions to be drawn regarding the status of crab stocks in the estuary, although the data suggest that there may be local reproduction of red king and tanner crabs in Herendeen Bay. Further sampling should focus on defining the reproductive status of these crab stocks and their relation with nearby stocks in Bristol Bay.

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INTRODUCTION

Abundance of king crabs (*Paralithodes* spp.) has varied tremendously in the southeastern Bering Sea over the last 20 years (Otto 1986). Current explanations of such fluctuations are tenuous because many aspects of the ecology and distribution of various life history stages are poorly studied. For both red (*P. camtschatica*) and blue (*P. platypus*) king crabs, research has focused on adult and sub-adult stages. The limited work on larvae and juvenile stages points to substantially different distributional patterns than for older animals. In particular, small juveniles of both species occur nearshore in benthic substrate, which provides refuge from predation (McMurray et al. 1984), while adults occur on more open substrates farther from shore.

Use of coastal lagoons and embayments by red king crab (RKC) has long been a question, and the Port Moller complex has been of particular interest. Commercial and subsistence crab fishing have occurred in Herendeen Bay, and both red and blue king crab are known to occur in the bay. Blue king crab (BKC) is of particular scientific interest because of its disjunct distribution, being known from the Pribilof, St. Matthew, and St. Lawrence Islands, and in deep bays of Kodiak Island and Southeast Alaska.

The Port Moller Complex (PMC) is a large lagoonal estuarine system within Bristol Bay (Figure 1). This region of Bristol Bay is near the North Aleutian Basin oil and gas lease area. This area is also thought to be of prime importance as a nursery to juvenile crabs (McMurray et al. 1984), which has prompted OCSEAP to fund research on crab populations in relation to oceanography in the PMC.

The principal objective of the 1989 field work was to survey the PMC (Port Moller and Herendeen Bay) for king crab larvae, juveniles, and adults. Additionally, experience was sought with different sampling techniques for locating the different life stages in various habitats. Finally, a preliminary description of habitat types and their distributions was obtained.

METHODS

Field work was conducted from 17 August to 26 August 1989. Of those 10 days, 6 were completed in the field, 2 lost to weather, and 2 spent on equipment installation and boat repair. A suite of sampling was conducted throughout the PMC, including zooplankton (bongo net), benthic trawling (beam and otter trawls), benthic grab samples (van Veen sampler), intertidal surveys for juvenile crab, and sidescan sonar surveys to describe bottom features. Figure 2 shows sample station locations; Tables 1 and 2 summarize sample dates and locations for each gear type. In addition to data collected during this survey period, we also analyzed zooplankton samples

obtained during larval herring surveys conducted in June 1989 (McGurk 1989). Station locations for the herring survey are shown in Table 3 and Figures 3-6.

Zooplankton sampling was conducted using a 60-cm diameter bongo net with 505- μm mesh on one side and 333- μm mesh on the other side. Samples were collected with standard, double-oblique tows from the surface to depths ranging from 5 to 48 m (depending on bottom depth). Distance towed was measured with a flow meter mounted on one side of the net. The meter was calibrated by towing it a fixed distance along a dock; an average of three replicate calibration tows gave a value of 0.0279 m per revolution of the meter, which corresponds to a volume filtered of 0.00789 m^3 per revolution. Samples were preserved in 10% buffered formalin in seawater, stored in 1-liter plastic jars, and shipped to the University of Washington for processing. A total of 14 bongo tows were made at 6 stations.

Trawling was conducted using a 3-m beam trawl designed to sample juvenile crab on soft bottoms (Gunderson and Ellis 1986) and a small otter trawl. Ten stations (Stations 1-4 and 7-12) were sampled with the beam trawl, with tow durations ranging from 2 to 4 min. One additional station (No. 13) was sampled with an otter trawl tow for 4.5 min. All crab and commercial shrimp caught were identified to species and counted; all crab and subsamples of shrimp were measured to the nearest mm carapace length. Additionally, fish and molluscs caught were saved from most tows and given to Rae Baxter for identification. Appendices A and B list the fish and mollusc species captured.

Benthic sediment samples were obtained with a small van Veen grab sampler, with an approximate sample area of 0.03 m^2 . Bottom type and macroinvertebrates in the samples were noted. Eleven samples were collected at six stations.

Surveys of intertidal and shallow subtidal habitats were conducted at two sites in Port Moller and at four sites in Herendeen Bay (Figure 2). These surveys were conducted by searching each site intensively for the presence of juvenile king crab. Particular attention was given to under-rock habitats by lifting moderate size rocks and searching underneath. Juvenile crab were identified to species, sexed, measured and returned alive to the beach. Additional shore work was conducted by walking along the high tide line and collecting king crab carapaces that had been washed ashore. These were identified to species and measured. Because of the rocky nature of the areas surveyed and the relatively low abundance of juvenile crab, no attempt was made to sample quantitatively.

Sidescan sonar surveys of the PMC were conducted by an independent contractor (Mike Kelley, EG&G Analytical Services, Inc.) using an EG&G 260 100/500 kHz unit with recorder and a 272 TD towfish towed approximately 10 m off the bottom. One survey in Port Moller covered the main channel from trawl station #1 to #4 (Figure 2). Surveys were also conducted along the lengths of Hague and Johnson channels, and along selected transects in Herendeen Bay near the

trawl stations. Records from these surveys were interpreted by EG&G personnel, who then provided us with a summary of their results.

Preserved plankton samples were sorted into major taxonomic groups. Important anomuran and brachyuran larvae were further sorted to species and larval stage. Samples containing large numbers of larvae were split using a Folsom plankton splitter before sorting; the fraction sorted ranged from 6.25 to 100% of the original sample. After counting, sorted larvae were preserved in 70% ethanol-5% glycerol. Finally, abundance of the various species was converted to numbers per 1000 m³ by the following formula:

$$D = \frac{1000 * N}{(V * F)},$$

where

D = density (no. per 1000 m³),

N = raw number of larvae sorted from the sample,

V = volume filtered during the tow, and

F = the fraction of the sample sorted.

In addition to samples from the August crab reconnaissance cruise, crustacean larvae were obtained from samples taken during the larval herring survey in June (M. McGurk, Triton Env. Cons.). These samples were processed in the same way.

RESULTS

PLANKTON

Anomuran, brachyuran and caridean larvae were found during both the June and August sampling periods (Tables 4 and 5). At both times, anomuran larvae consisted primarily of pagurids (hermit crabs), brachyurans included several families, and carideans were mainly pandalids and crangonids. Of the commercially important species, pandalid shrimp larvae were found in abundance during both cruises, but RKC and Tanner crab (*Chionoecetes bairdi*) larvae were present only in the June samples, and then only in low numbers at three stations in Herendeen Bay. No BKC larvae were found. Geographic distributions of the commercial species are shown in Figures 3-6.

TRAWL AND INTERTIDAL SURVEYS

Crustaceans caught in trawl samples included several taxonomic groups (Table 6). Crangonid shrimp were most numerous, followed by pandalid shrimp, with crabs least numerous.

Commercial crab species caught included RKC and Tanner crab. Intertidal sampling (Table 7) found live juveniles and cast shells of both RKC and BKC. Catches of all commercial species were low, probably because of the limited sampling schedule. Size distributions of all commercial crab species are shown in Figures 7-9.

Molluscs and fish caught in trawls and other sampling methods were identified by Rae Baxter; species captured are listed in Appendices A and B.

BENTHIC HABITATS

Observations of bottom type came from several sources: side scan sonar interpretation, van Veen grab samples taken at trawl stations, observations of benthic materials brought up by trawls, and observations during intertidal surveys. Coverage of the PMC was far from complete. Bottom type observations and their approximate locations are summarized in Figure 10. Observations from side scan sonar are summarized in Appendix C.

Habitat requirements for king crab change with age or size. Early juveniles are most commonly associated with gravel, rock, cobble or shell substrates, and are often associated with bryozoans, sea urchins or tube-building worms (McMurray et al. 1984; Armstrong et al. 1985). They tend to be absent from areas of rock with sand or mud in the interstices. Adults are less habitat specific, ranging over sand and mud bottom types, generally in deeper water than the juveniles. Most of the bottom area of the PMC appears to be suitable for adult king crab; intertidal juvenile habitat is fairly restricted. Areas of potential juvenile king crab habitat are indicated with shading in Figure 10. The extent of subtidal juvenile habitat is unknown at this time.

DISCUSSION

The main objectives of this study were met, although the late date of the cruise, small vessel size and very restricted field time limited both the scope of results and our ability to draw firm conclusions. Reports of both red and blue king crab in the PMC have been confirmed, but population status is still unknown. Trawls from a larger vessel and the use of crab pots would have greatly improved our ability to sample adult crab.

We found juveniles of both species of king crabs in intertidal and trawl samples and found Tanner crab in trawl samples, but we found neither live adults nor larvae of any of these species during the August survey. However, the presence of cast carapaces from adult size king crabs suggests that there may be reproductive populations in the PMC. Larvae of RKC and Tanner crab were found in samples from the June herring survey, and their restriction to inner Herendeen Bay suggests that they may be of local origin.

The distribution of larvae during the June survey may be compared with oceanographic information collected by EG&G during 1989. From these data, tentative conclusions regarding circulation and exchange in the estuary have been drawn (C. Greengrove, EG&G, pers. comm.). Estuarine circulation is largely driven by tides, with a low-frequency flow out of the estuary driven by large-scale wind forcing. Most of the estuary is well mixed by tidal currents, with the exception of deep Herendeen Bay, where the vertical temperature difference reaches 8°C in August, then decreases through the remainder of the summer. It is speculated that the deep water of Herendeen Bay forms during winter and mixes with surface water during the remainder of the year. King crab larvae exhibit diel migrations (Shirley and Shirley 1988), which in a stratified bay could lead to larval retention. Further description of the patterns of current with depth and behavior of king crab larvae with respect to currents and tide cycles is needed to draw any conclusions regarding this.

Several hypotheses are suggested for the origin of the crab stocks in the PMC. First, the estuary may serve as a nursery area for juveniles, which arrive either through larval drift or migration of young animals from nearshore areas and then migrate out of the estuary before maturing. At present, the data we have are consistent with this hypothesis, although the small size of juveniles encountered suggests that active immigration over long distances is unlikely. Second, the presence of king crab may be 'accidental,' resulting from adult crab discarded from fishing and processing vessels that frequent the PMC. Our finding of juveniles, but not adults, does not support this, but adult sampling effort was severely limited by vessel and gear availability. The low densities of juveniles found could result from occasional reproduction by such discards, although we suspect that few females are discarded. Third, the crab stocks in the PMC could be self-sustaining with or without substantial interchange with Bristol Bay stocks. The presence of juveniles and larvae in inner Herendeen Bay, but not in the outer estuary, suggests that this may be the case. However, at this time we have no evidence of reproductive adults in the estuary.

Obviously, there is much need for further work to better define the PMC crab stocks and their dynamics. Future work should be designed to overcome the shortcomings of this initial reconnaissance survey. In particular, future surveys should start in early May and extend through the summer (the expected larval period for the crab species) to allow analysis of larval dynamics. Sampling stations should be increased to about 25 throughout the estuary, and sampling should include areas of Bristol Bay immediately adjacent to the estuary. Further, a larger vessel should be available for trawling and pot sampling, both within and outside the estuary. A tentative sampling plan for further studies would include (1) weekly or biweekly plankton sampling using double-oblique bongo net tows from early May to late July; (2) two periods (early and late in the larval season) of more intensive plankton sampling using depth-stratified samples with an opening-and-closing net to characterize diel vertical migrations of larvae; and (3) two periods of intensive

sampling for juvenile and adult crab using trawls, intertidal surveys, and crab pots. Tagging of subadults and adults during these sampling periods could provide information on growth, movements, and population size.

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FIGURES

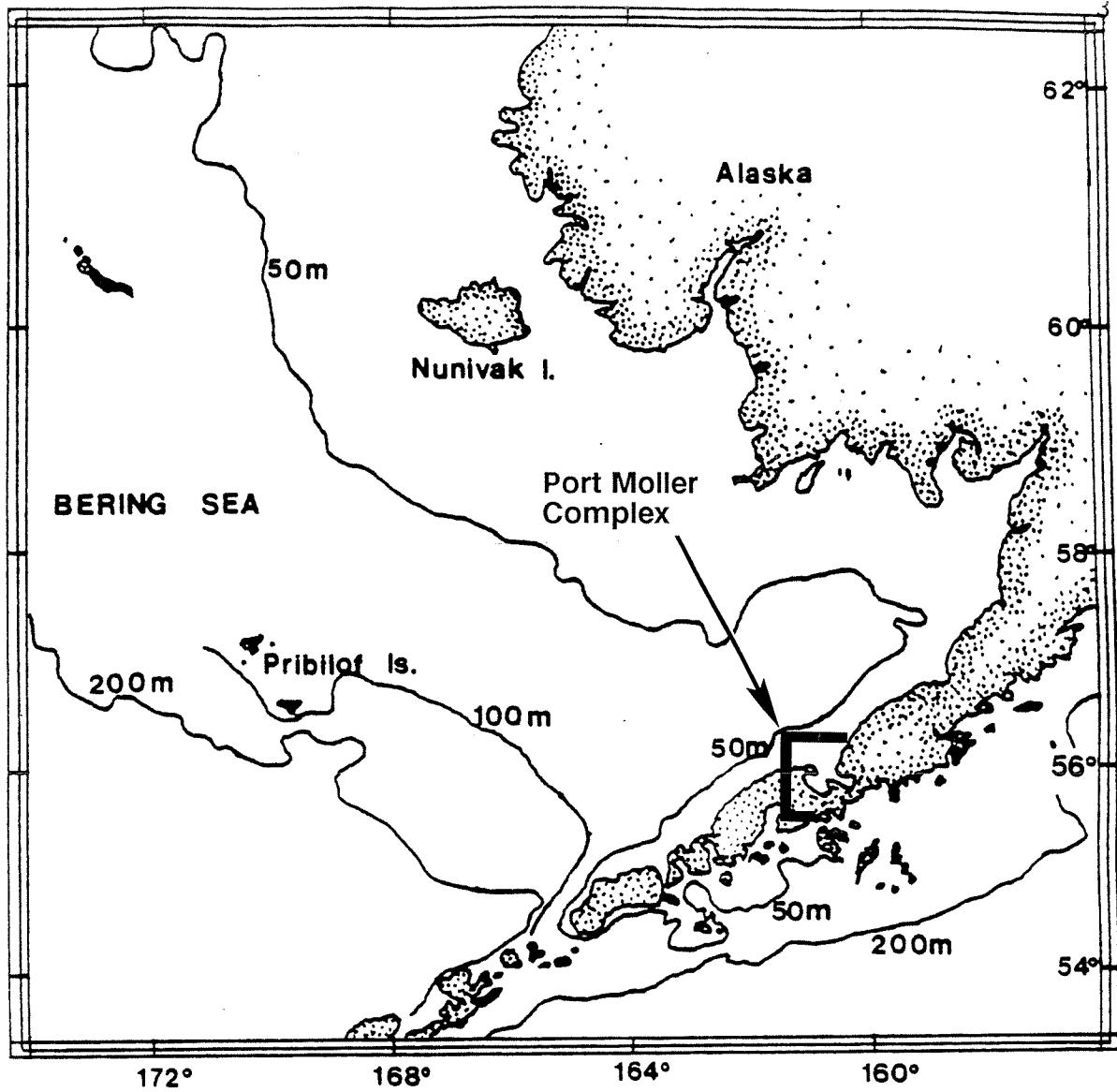


Figure 1. Chart of the southeast Bering sea showing the location of the Port Moller/Herendeen Bay estuarine complex.

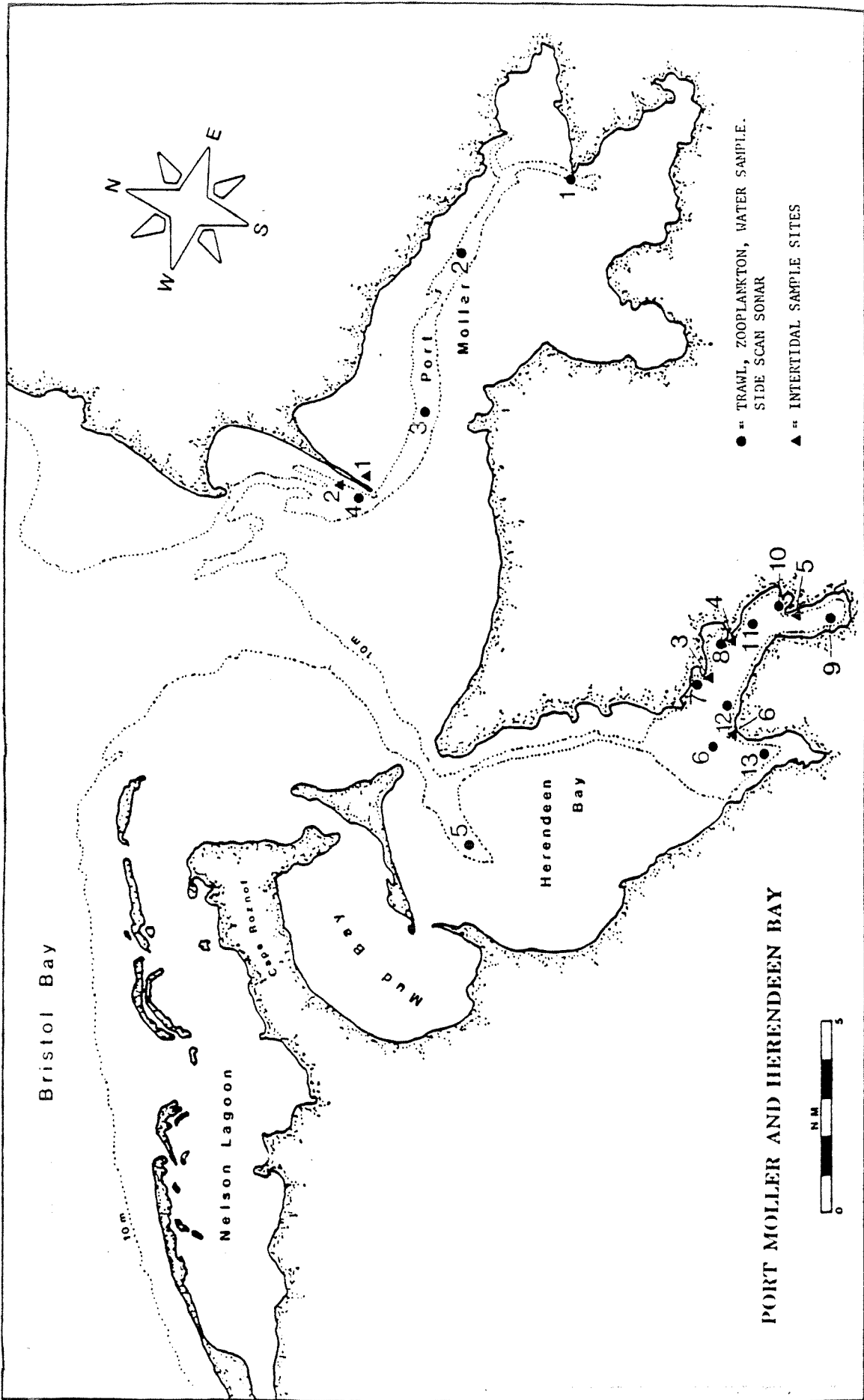


Figure 2. Locations of sample stations within the Port Moller Complex.

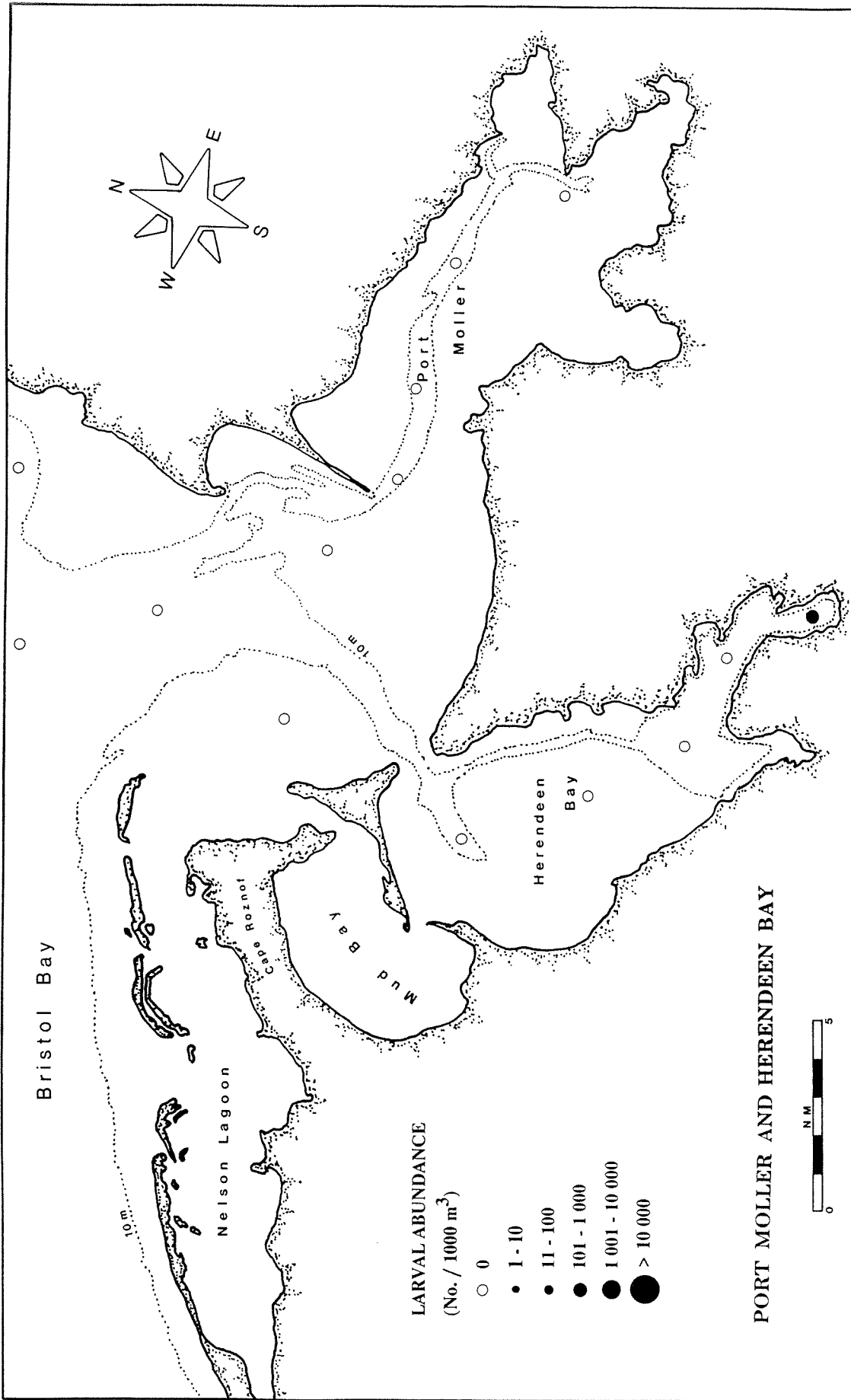


Figure 3. Relative abundance of red king crab larvae at sample stations during the herring survey, June 1989.

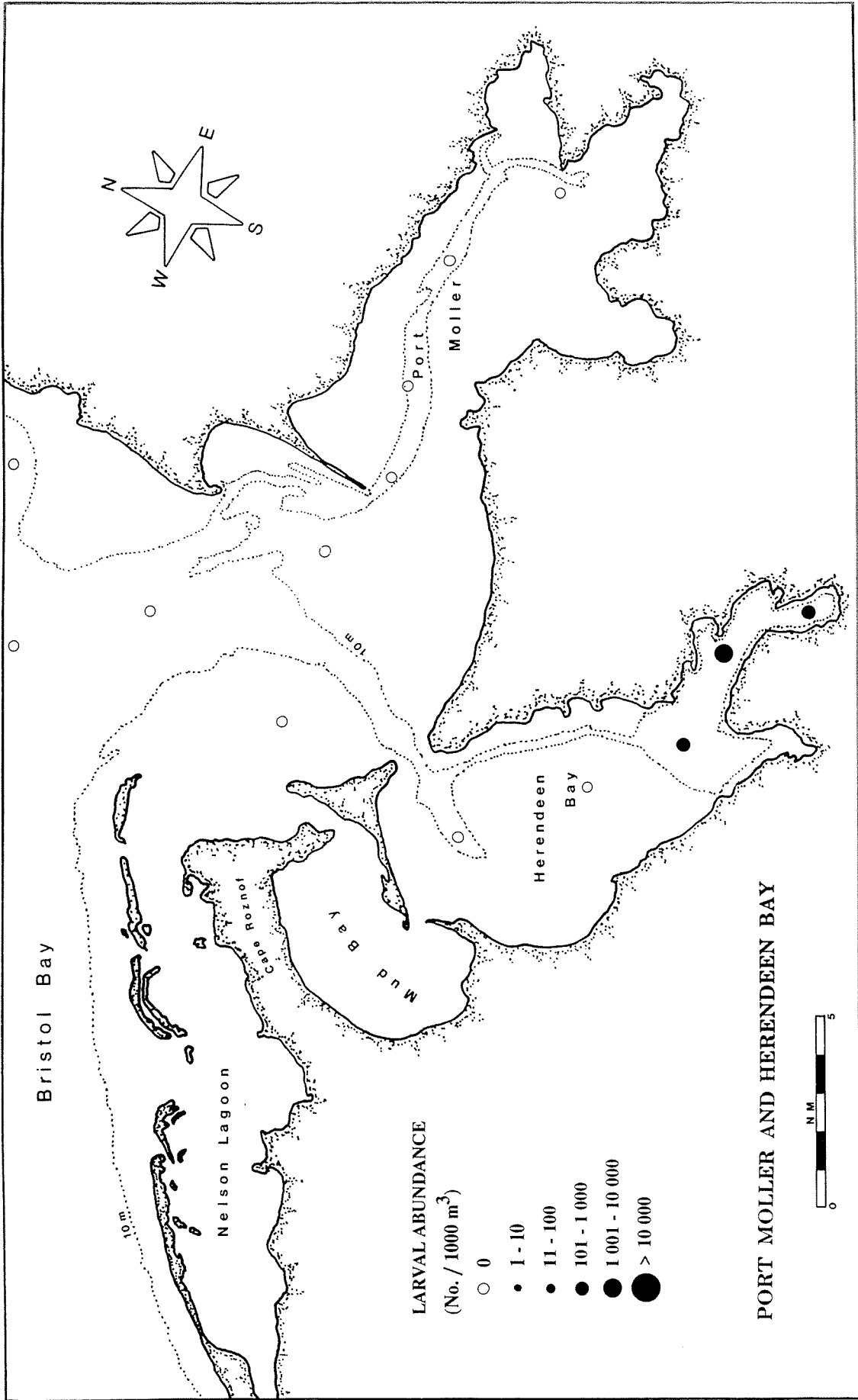


Figure 4. Relative abundance of Tanner crab larvae at sample stations during the herring survey, June 1989.

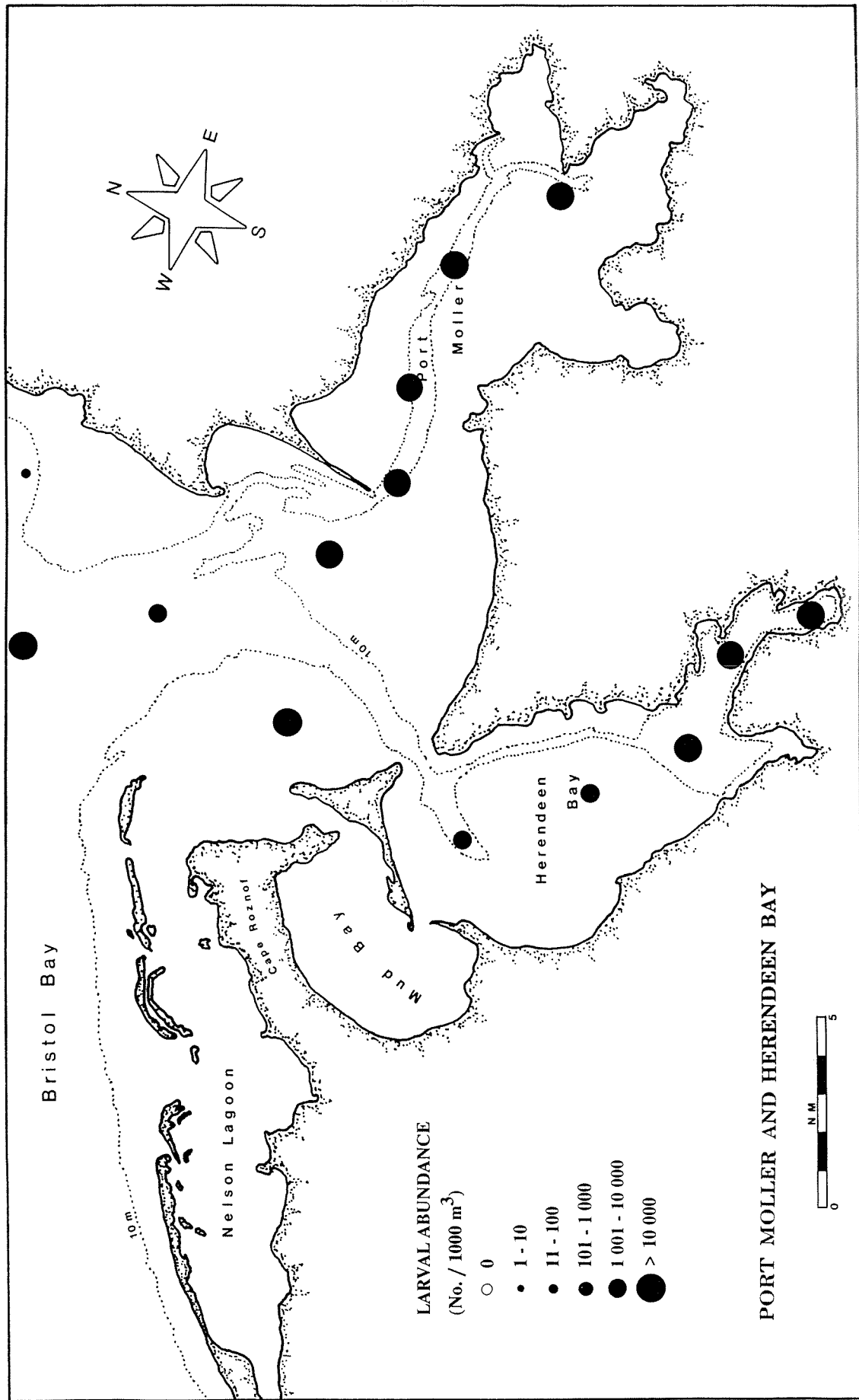


Figure 5. Relative abundance of pandalid shrimp larvae at sample stations during the herring survey, June 1989.

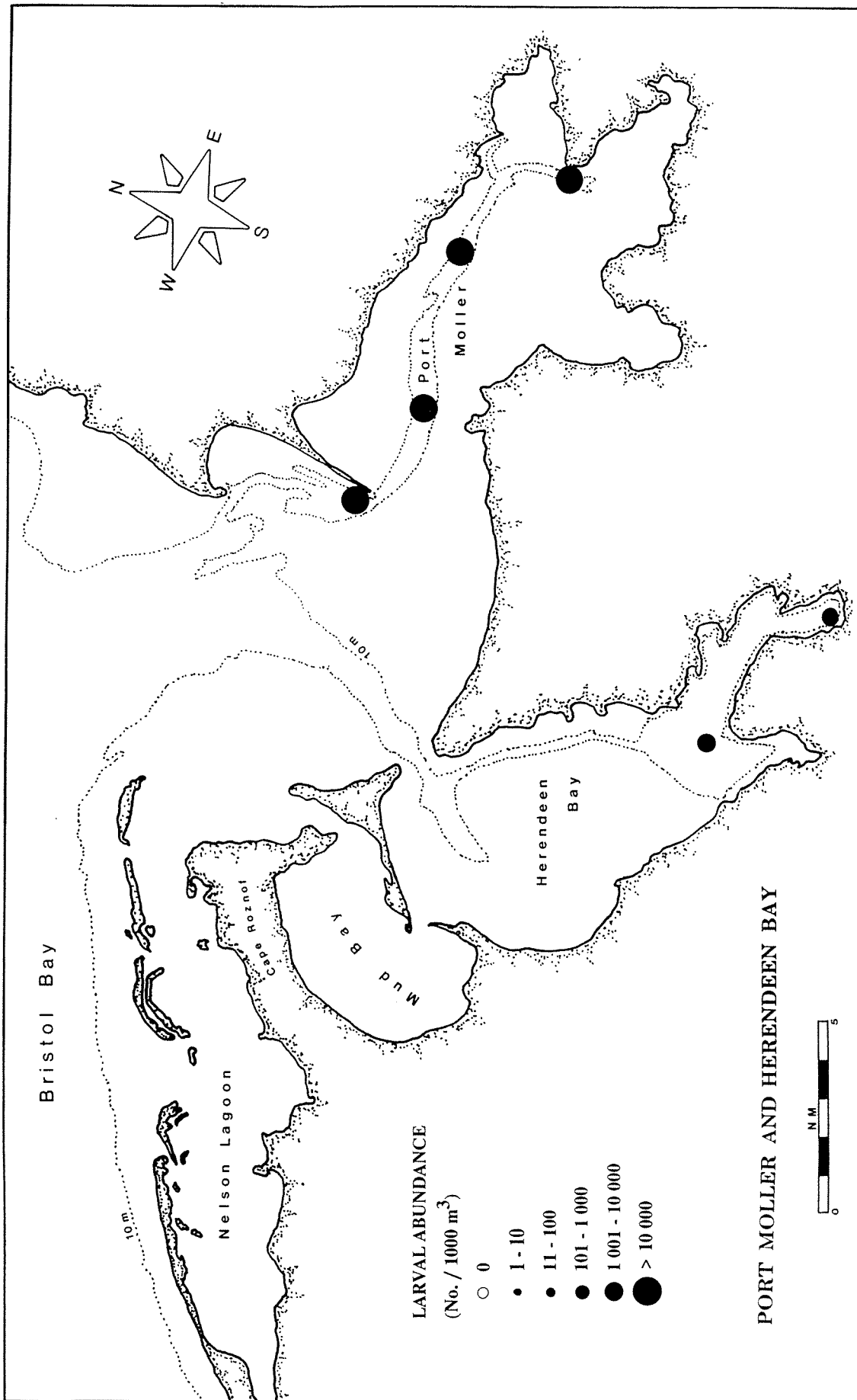


Figure 6. Relative abundance of pandalid shrimp larvae at sample stations during the crab survey, August 1989.

Red King Crab

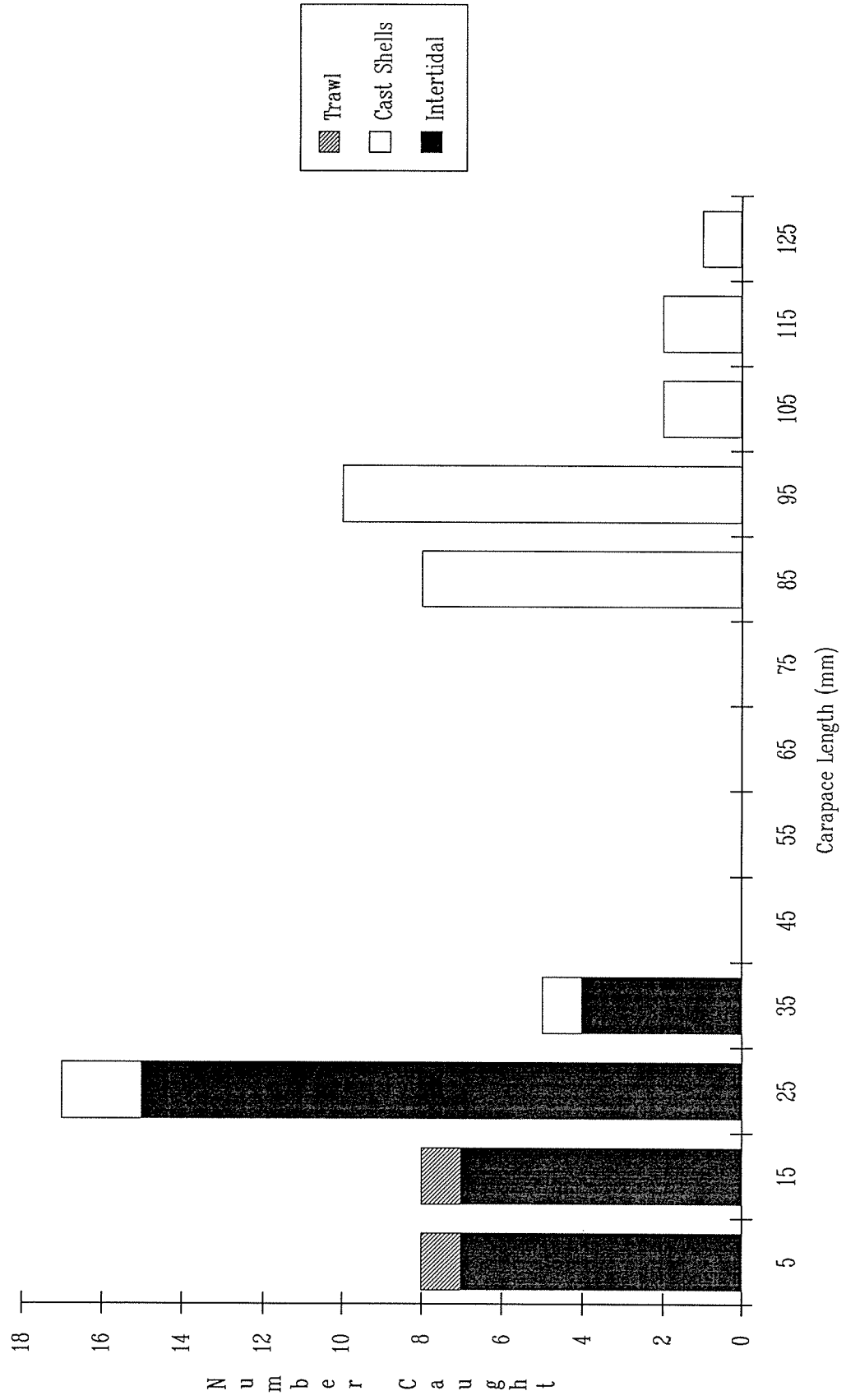


Figure 7. Size distribution of red king crab catch; numbers caught by 10 mm size classes.

Blue King Crab

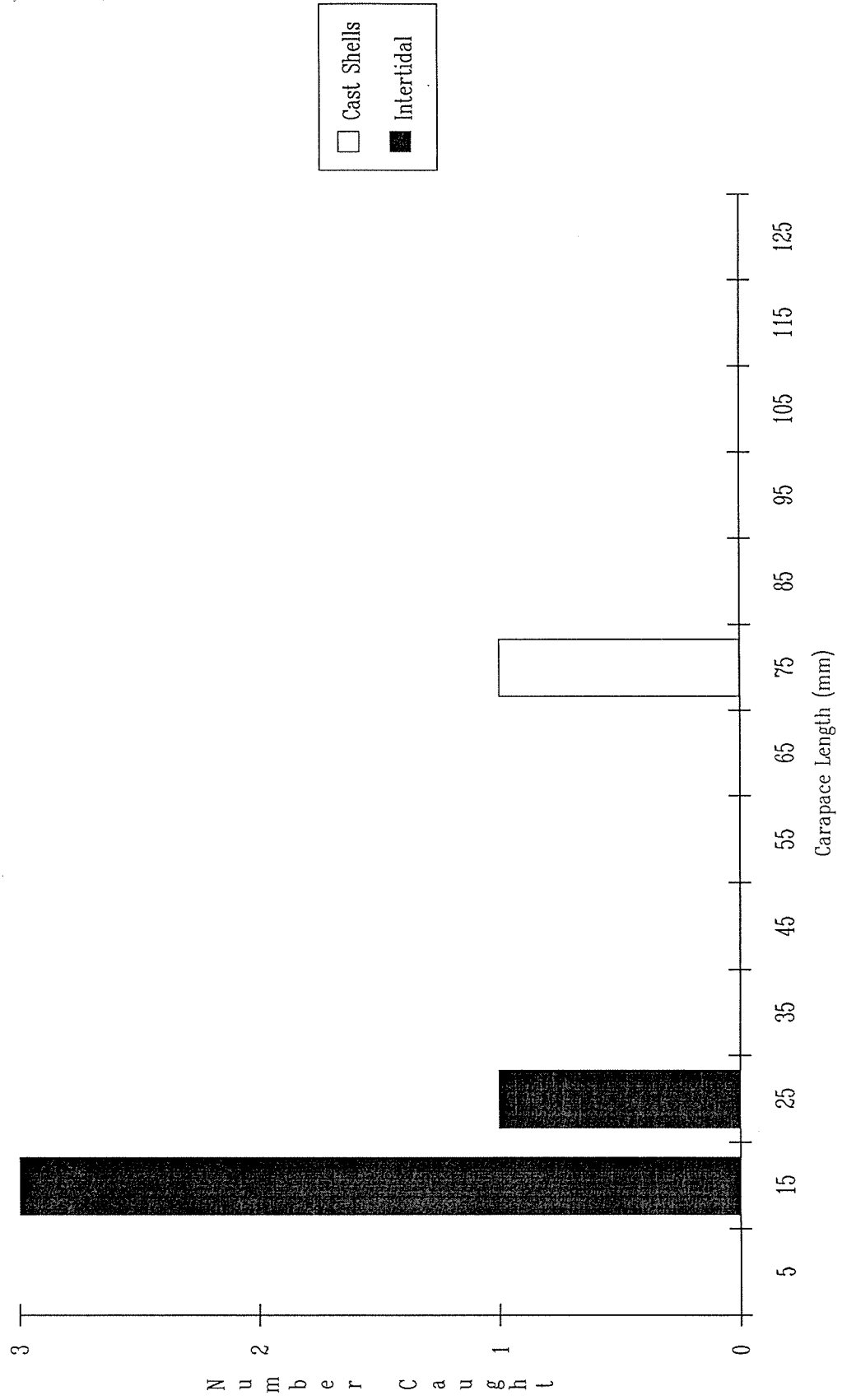


Figure 8. Size distribution of blue king crab catch; numbers caught by 10 mm size classes.

Tanner Crab

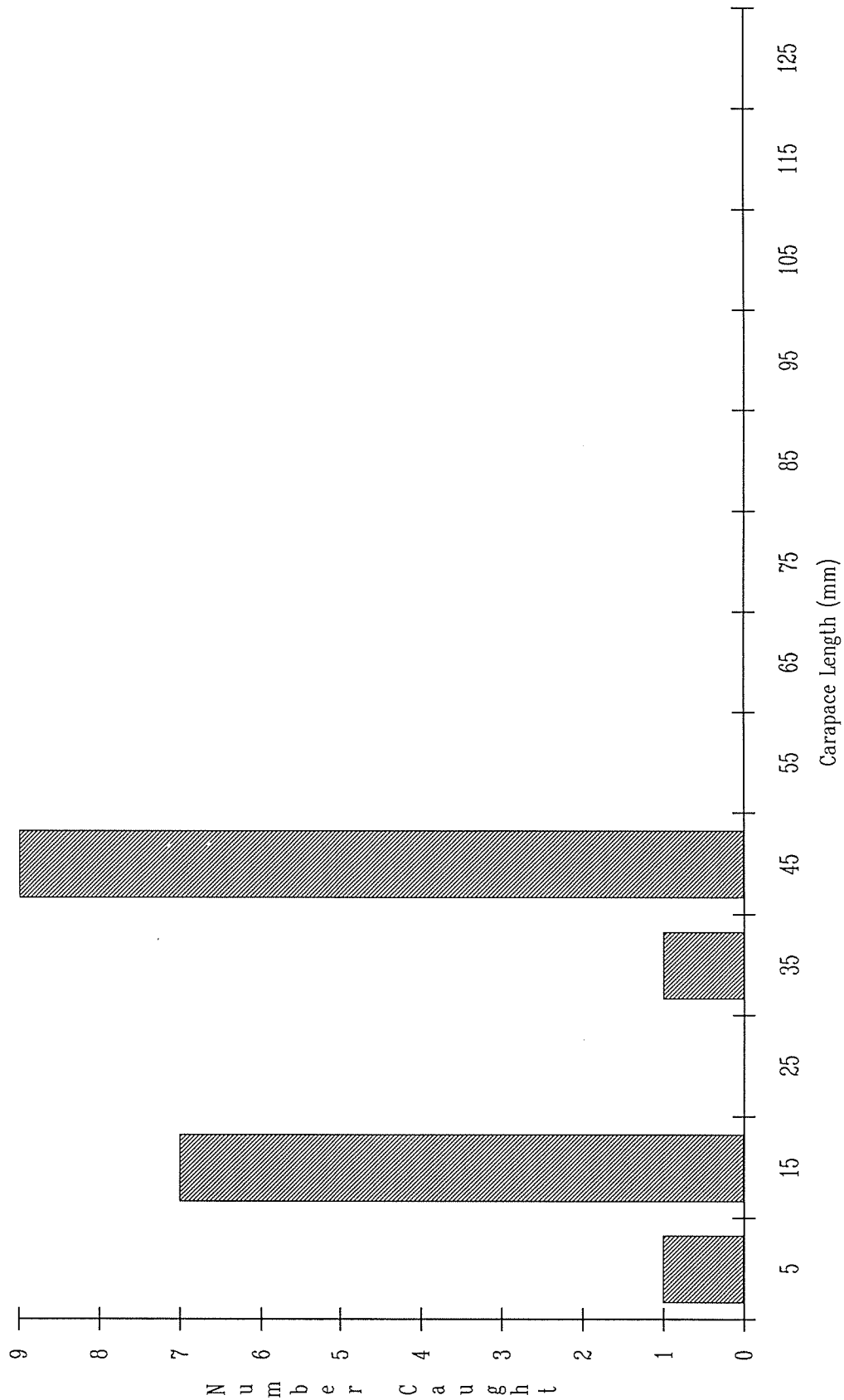


Figure 9. Size distribution of Tanner crab catch; numbers caught by 10 mm size classes.

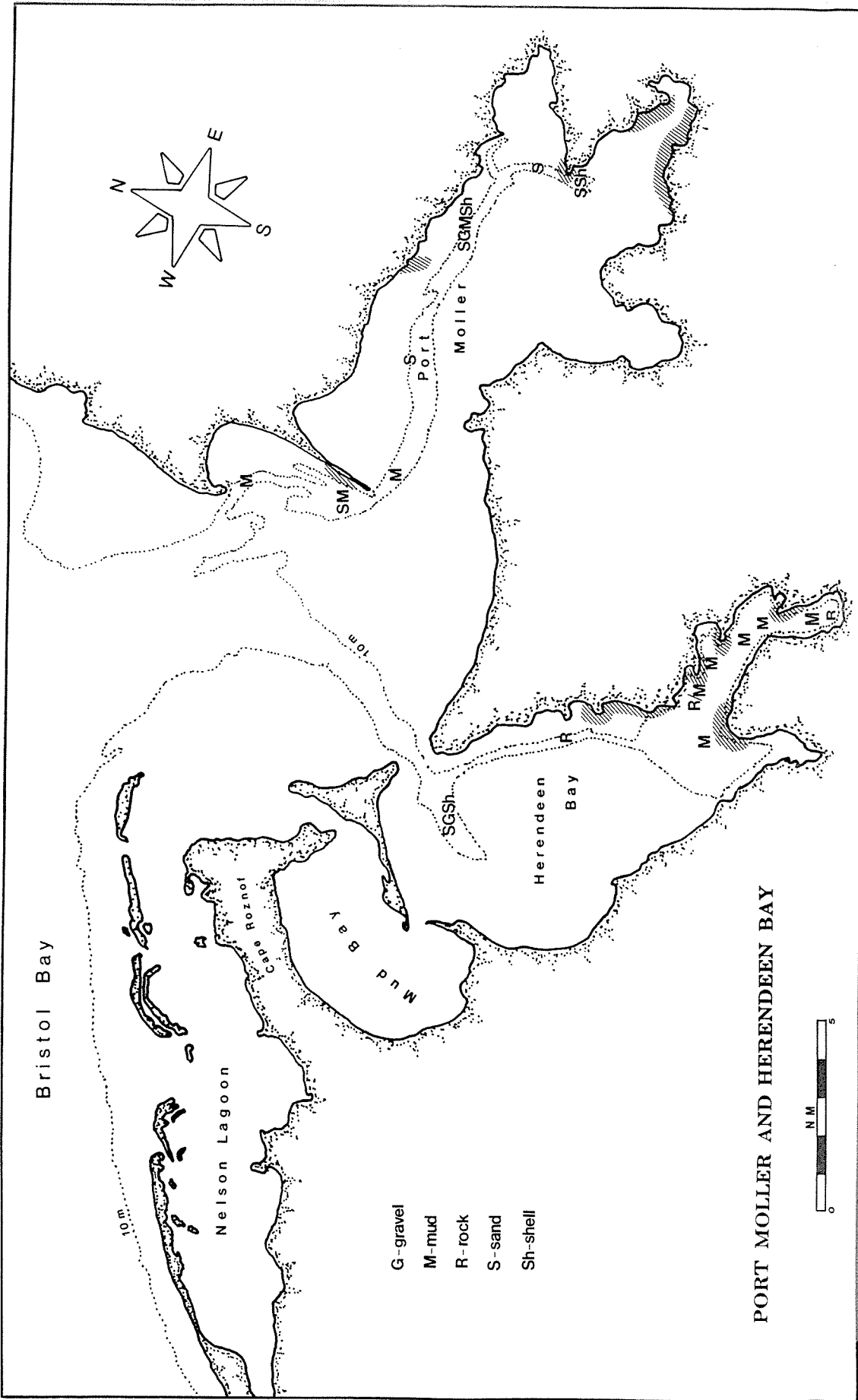


Figure 10. Chart of bottom type observations for the Port Moller Complex. Shading indicates potential juvenile king crab habitat.

TABLES

Table 1. Summary of samples collected in Port Moller, 17-26 August 1989.

Method	Sample	Station	Date
Beam Trawl	1	2	18 Aug
	2	4	19 Aug
	3	1	21 Aug
	4	3	21 Aug
	5	7	24 Aug
	6	8	25 Aug
	7	9	25 Aug
	8	10	25 Aug
	9	11	25 Aug
	10	12	26 Aug
Otter Trawl Bongo Net	11	13	26 Aug
	1	1	17 Aug
	2	1	17 Aug
	3	1	17 Aug
	4	2	18 Aug
	5	2	18 Aug
	6	2	18 Aug
	7	4	18 Aug
	8	4	18 Aug
	9	4	18 Aug
	10	3	19 Aug
	11	6	24 Aug
	12	6	24 Aug
	13	6	24 Aug
	14	9	25 Aug
van Veen Grab	1	1	17 Aug
	2	1	17 Aug
	3	1	17 Aug
	4	2	18 Aug
	5	2	18 Aug
	6	2	18 Aug
	7	4	18 Aug
	8	4	18 Aug
	9	4	18 Aug
	10	5	19 Aug
	11	6	24 Aug
Intertidal	1	IT-1	16 Aug
	2	IT-2	22 Aug
	3	IT-3	24 Aug
	4	IT-4	25 Aug
	5	IT-5	25 Aug
	6	IT-6	26 Aug

Table 2. Station locations for the crab survey, 17-26 August 1989.

Station	Average depth (m)	N Latitude		W Longitude	
		Deg.	Min.	Deg.	Min.
1	15	55	50.24	160	19.93
2	21	55	51.80	160	22.36
3	22	55	53.68	160	31.48
4	20	55	55.85	160	35.02
5	30	55		160	
6	25	55	46.36	160	46.58
7	20	55	46.29	160	43.90
8	15	55		160	
9	60	55	41.34	160	41.32
10	40	55		160	
11	40	55	44.77	160	41.15
12	40	55	45.18	160	44.89
13	20	55	44.89	160	48.31

Table 3. Station locations for the herring survey, 11-14 June 1989.

Station	Average depth (m)	N Latitude		W Longitude	
		Deg.	Min.	Deg.	Min.
A	4.4	55	50.25	160	19.17
B	6.0	55	52.75	160	24.25
C	5.6	55	53.47	160	29.25
D	6.4	55	54.33	160	34.33
E	6.1	55	56.97	160	35.33
F	8.2	55	59.36	160	37.13
G	17.2	56	5.42	160	42.57
H	8.0	56	3.77	160	31.82
I	9.6	56	9.75	160	27.00
J	5.6	55	56.05	160	42.07
K	6.0	55	52.78	160	50.30
L	3.8	55	49.75	160	46.87
M	16.4	55	46.70	160	46.22
N	45.4	55	44.47	160	40.60
O	33.9	55	43.00	160	41.13

Table 4. Larval abundances during June 1989.

Station	Sample	Anomura	Brachyura	Pandalid shrimp	Red king crab	Tanner crab
D	1	1,309	0	45,232	0	0
D	2	4,823	0	155,622	0	0
A	3	1,382	0	113,530	0	0
F	4	0	0	5,975	0	0
H	5	0	0	33	0	0
I	6	4	4	31	0	0
G	7	62	31	14,776	0	0
K	8	59	117	2,042	0	0
O	9	290	4,476	19,099	109	725
M	10	162	1,052	12,985	0	324
D	11	4,347	0	68,232	0	0
C	12	6,093	0	125,966	0	0
A	13	38	0	24,885	0	0
C	14	3,071	0	119,840	0	0
F	15	5	0	78	0	0
J	16	68	0	89,685	0	0
E	17	80	0	44,365	0	0
N	18	61	3,243	12,790	0	1,010
M	19	153	994	48,703	0	0
L	20	0	0	5,552	0	0
K	21	1,349	92	59,631	0	0
A	22	0	0	30,392	0	0
B	23	3,251	0	147,864	0	0
C	24	105	10	17,028	0	0
D	25	12,140	0	61,507	0	0

Table 5. Larval abundances during August 1989, per 1000 m³.

Station	Sample	Anomura	Brachyura	Pandalid shrimp	Red king crab	Tanner crab
1	1	3,565	0	11,906	0	0
1	2	1,944	0	15,912	0	0
1	3	2,047	0	12,574	0	0
2	4	4,044	0	11,998	0	0
2	5	3,459	15	13,385	0	0
2	6	4,498	0	18,869	0	0
4	7	3,751	68	16,641	0	0
4	8	5,363	0	16,031	0	0
4	9	1,143	0	4,636	0	0
3	10	4,307	14	16,338	0	0
6	11	219	0	7,800	0	0
6	12	340	0	6,286	0	0
6	13	150	0	5,710	0	0
9	14	2,263	0	1,710	0	0

Table 6. Trawl catch of crustacean species.

Sample	Taxon	Number caught*
1	<i>Pandalus danae</i>	2
	Crangonidae	98
	Majidae	2
	Misc. Caridea	3
2	<i>Paralithodes camtschatica</i>	1
	<i>Pandalus danae</i>	1
	<i>Telmessus cheiragonus</i>	2
	Crangonidae	1000
3	Crangonidae	36
4	<i>Paralithodes camtschatica</i>	1
	<i>Pandalus danae</i>	n.c.
	Crangonidae	n.c.
	Misc. Caridea	n.c.
5	<i>Telmessus cheiragonus</i>	1
	<i>Pandalus goniurus</i>	19
	<i>Pandalus hypsinotus</i>	3
	Crangonidae	n.c.
	Majidae	n.c.
6	<i>Chionoecetes bairdi</i>	10
7	<i>Pandalus hypsinotus</i>	n.c.
	<i>Pandalus goniurus</i>	n.c.
	<i>Pandalopsis dispar</i>	n.c.
	Misc. Caridea	n.c.
8	<i>Chionoecetes bairdi</i>	8
9	<i>Pandalus hypsinotus</i>	n.c.
	Misc. Caridea	n.c.
10	<i>Pandalus hypsinotus</i>	n.c.
	Misc. Caridea	n.c.
11	(no crustaceans caught)	

*n.c.: not counted.

Table 7. Intertidal king crab catch.

Sample	Taxon	Number caught
IT-1	(no king crab found)	
IT-2	(no king crab found)	
IT-3	<i>Paralithodes</i> sp.	1
	<i>P. camtschatica</i>	25
	<i>P. c.</i> carapace	17
	<i>P. platypus</i>	1
IT-4	(no king crab found)	
IT-5	<i>P. camtschatica</i>	7
	<i>P. platypus</i>	3
	<i>P. p.</i> carapace	1
IT-6	<i>P. camtschatica</i>	1
	<i>P. c.</i> carapace	7

APPENDIX A
MOLLUSCS COLLECTED

MOLLUSKS OF PORT MOLLER, ALASKA

Collected and identified by Rae Baxter June and August, 1989.

Class: BIVALVIA

Order: NUCULOIDA

Family: NUCULIDAE

Nucula tenuis (Montagu, 1808)

Family: NUCULANIDAE

Nuculana fossa (Baird, 1863)

Family: YOLDIIDAE

Yoldia amygdalea Valenciennes, 1846

Yoldia hyperborea Torell, 1859

Yoldia myalis (Couthouy, 1838)

Order: MYTILOIDA

Family: MYTILIDAE

Modiolus modiolus (Linnaeus, 1758)

Musculus discors (Linnaeus, 1767)

Mytilus edulis (Linnaeus, 1758)

Order: OSTREOIDA

Family: ANOMIIDAE

Pododesma machrochisma (Deshayes, 1839)

Order: VENEROIDA

Family: THYASIRIDAE

Axinopida serricata (Carpenter, 1864)

Thyasira gouldi (Philippi, 1845)

Family: MONTACUTIDAE

Mysella tumida (Carpenter, 1864)

Nearomya compressa (Dall, 1899)

Family: CARDITIDAE

Crassocardia crassidens (Broderip & Sowerby, 1829)*Cyclocardia crebricostatus* (Krause, 1885)

Family: ASTARTIDAE

Tridonta rollandi Bernardi, 1858

Family: CARDIIDAE

Clinocardium californiense (Deshayes, 1841)*Clinocardium ciliatum* (Fabricius, 1780)*Clinocardium nuttalli* (Conrad, 1837)*Serripes groenlandicus* (Brugiere, 1789)*Serripes laperousi* (Deshayes, 1839)

Family: MATRACEA

Spisula polynyma (Stimpson, 1860)

Family: CULTELLIDAE

Siliqua alta (Broderip & Sowerby, 1829)*Siliqua patula* (Dixon, 1789)

Family: TELLINIDAE

Macoma balthica (Linnaeus, 1758)*Macoma brota* Dall, 1916*Macoma calcarea* (Gmelin, 1791)*Macoma expansa* Carpenter, 1864*Macoma inquinata* (Deshayes, 1855)*Macoma lama* Bartsch, 1929*Macoma middendorffi* Dall, 1884*Macoma obliqua* (Sowerby, 1817)*Tellina lutea* Wood, 1828

Family: VENERIDAE

Psephidia lordi (Baird, 1863)*Saxidomus giganteus* (Deshayes, 1836)

Order: MAOIDAE

Family: MYIDAE

Mya arenaria Linnaeus, 1758*Mya profundior* Grant & Gale, 1931*Mya truncata* Linnaeus, 1758*Mya uzenensis* Nomura & Zimbo, 1937

Family: HIATELLIDAE

Hiatella arctica Linnaeus, 1767

Family: PHOLADIDAE

Penitella sp.*Zirfaea pilsbryi* Lowe, 1931

Order: PHOLADOMYOIDA

Family: LYONSIIDAE

Lyonsia arenosa (Moller, 1842)

Class: GASTROPODA

Order: ARCHAEOGASTROPODA

Family: LOTTIIDAE

Lottia borealis (Lindberg, 1982)*Tectura fenestrata* (Reeve, 1855)*Tectura persona* (Rathke, 1833)*Tectura scutum* (Rathke, 1833)*Tectura testudinalis* (Muller, 1776)

Family: LEPETIDAE

Cryptobranchia concentrica (Middendorff, 1847)

Family: TROCHIDAE

Margarites argentatus (Gould, 1841)*Margarites hickmanae* McLean, 1984*Margarites pupillus* (Gould, 1849)

Order: MESOGASTROPODA

Family: LITTORINIDAE

Littorina sitkana Philippi, 1846

Family: LACUNIDAE

Lacuna vincta (Montagu, 1803)

Family: FISSOIDAE

Alvinia compacta (Carpenter, 1864)

Family: CERITHIIDAE

Cerithiopsis stejnergeri Dall, 1884

Family: TURRITELLIDAE

Tachyrhynchus erosus (Couthouy, 1838)

Family: TRICHOTROPIDIDAE

Trichotropis cancellatus Hinds, 1843*Trichotropis insignis* Middendorff, 1849

Family: NATICIDAE

Natica aleutica Dall, 1919*Natica* cf. *clausa* Broderip & Sowerby, 1829

Family: VELUTINIDAE

Velutina plicatilis (Muller, 1776)*Velutina undata* Brown, 1839*Velutina velutina* (Muller, 1776)

Order: NEOGASTROPODA

Family: THAIDIDAE

Nucella lima (Martyn, 1784)

Family: NEPTUNEIDAE

Beringius behringi (Middendorff, 1848)*Neptunea lyrata* (Gmelin, 1791)

Family: CANCELLARIIDAE

"Cancellaria" middendorffiana (Dall, 1884)

Family: TURRIDAE

Oenopota bicarinata (Couthouy, 1839)

Oenopota pavlova (Dall, 1919)

Oenopota turricula (Montagu, 1803)

Order: PYRAMIDELLOIDA

Family: PYRAMIDELLIDAE

Odostomia nunivakensis Dall & Bartsch, 1909

Order: BULLACEA

Family: DIAPHANIDAE

Diaphana minuta (Brown, 1827)

Order: SCAPHANDRACEA

Family: SCAPHANDRIDAE

Cyclichna oculata (Michaels, 1841)

Order: NUDIBRANCHIA

Family: ONCHIDORIDIDAE

Acanthodoris sp.

Family: CADLINIDAE

Cadlina marginata MacFarland, 1905

Family: DISCODORIDIDAE

Discodoris sandiegensis (Cooper, 1863)

Family: AEOLIDIIDAE

Aeolidia papillosa (Linnaeus, 1761)

Class: POLYPLACOPHORA

Order: NEOLORICATA

Family: LEPIDOCHITONIDAE

Schizoplax brandti (Middendorff, 1847)

Tonicella granulata Yakovleva, 1952

Tonicella lineata (Woods, 1815)

Family: LEPIDOPLEURIDAE

Leptochiton rugatus (Pilsbry, 1892)

APPENDIX B
FISH COLLECTED

**PORT MOLLER - MOLLER BAY & HERENDEEN BAY
FISH COLLECTED JUNE & AUGUST, 1989**

Fish as identified by Rae Baxter

CLUPEIDAE

Clupea harengus pallasii Valenciennes, 1847 - Pacific herring

OSMERIDAE

Mallotus villosus (Muller, 1777) - capelin

Osmerus eperlanus (Linnaeus, 1758) - Boreal smelt

SALMONIDAE

Oncorhynchus gorbuscha (Walbaum, 1792) - pink salmon

Oncorhynchus keta (Walbaum, 1792) - chum salmon

Oncorhynchus kisutch (Walbaum, 1792) - coho salmon

Oncorhynchus nerka (Walbaum, 1792) - red salmon

Oncorhynchus tshawytscha (Walbaum, 1792) - king salmon

Salvelinus alpinus (Linnaeus, 1758) - charr

GADIDAE

Gadus macrocephalus Tilesius, 1810 - Pacific cod

HEXAGRAMMIDAE

Hexagrammos stelleri Tilesius, 1810 - whitespotted greenling

COTTIDAE

Artedius fenestralis (Jordan & Gilbert, 1883) - padded sculpin

Gymnocanthus pistillinger (Pallas, 1814) - threaded sculpin

Leptocottus armatus Girard, 1854 - Pacific staghorn sculpin

Microcottus sellaris (Gilbert, 1896) - brightbelly sculpin

Myoxocephalus jaok (Cuvier & Valenciennes, 1829) - plain sculpin

Myoxocephalus polyacanthocephalus (Pallas, 1811) - great sculpin

AGONIDAE

- Agonus acipenserinus* Tilesius, 1811 - sturgeon poacher
Ocella dodecaedron (Tilesius, 1810) - Bering poacher
Pallasina barbata (Steindachner, 1876) - tubenose poacher

LIPARIDAE

- Liparis cf. cyclopus* Gunther, 1861 - ribbon liparid
Liparis cf. dennyi Jordan & Starks, 1895 - marbled liparid

ZOARCIDAE

- Lycodes brevipes* Bean, 1890 - shortfin eelpout

STICHAEIDAE

- Alectridium aurantiacum* Gilbert & Burke, 1912 - lesser prickleback
Lumpenus mackayi Gilbert, 1896 - pighead prickleback
Lumpenus maculatus (Fries, 1837) - daubed shanny

PHOLIDIDAE

- Pholis laeta* (Cope, 1873) - crescent gunnel

AMMODYTIDAE

- Ammodytes hexapterus* Pallas, 1811 - Pacific sand lance

PLEURONECTIDAE

- Hippoglossus stenolepis* Schmidt, 1904 - Pacific halibut
Hippoglossoides elassodon Jordan & Gilbert, 1881 - flathead sole
Lepidopsetta bilineata (Ayres, 1854) - rock sole
Limanda aspera (Pallas, 1814) - yellowfin sole
Platichthys stellatus (Pallas, 1787) - starry flounder

APPENDIX C

SIDE SCAN SONAR SUMMARY

Analysis of side scan sonar lines, provided by EG&G Oceanographic Services Department, Waltham, MA.

PORT MOLLER CRAB SIDE-SCAN ANALYSIS

<u>WYPT#</u>	<u>LAT NORTH</u>	<u>LONG WEST</u>	<u>LORAN TD'S</u>	
01	55 58.70'	160 35.10'	33669	46325
02	55 58.00'	160 34.00'	33670	46318
03	55 54.70'	160 35.20'	33686	46327
04	55 53.30'	160 31.10'	33682	46301
05	55 53.00'	160 24.70'	33668	46259
06	55 50.90'	160 19.40'	33665	46226
07	55 49.10'	160 20.00'	33673	46231
08	55 58.80'	160 38.30'	33677	46346
09	55 56.00'	160 42.10'	33697	46372
10	55 53.10'	160 48.80'	33726	46417
11	55 51.92'	160 46.82'	33741	46405
12	55 50.80'	160 47.30'	33731	46408
13	55 48.80'	160 46.90'	33738.5	46406.7
14	55 47.20'	160 47.40'	33746.2	46410.7
15	55 44.10'	160 47.50'	33758.8	46412.8
16	55 45.20'	160 43.90'	33745.7	46388.9
17	55 44.60'	160 41.60'	33742.6	46374.2
18	55 42.08'	160 40.80'	33750.7	46370.2

PORT MOLLER CRAB STUDY: SIDE-SCAN DATA ANALYSIS

<u>DATE</u>	<u>LINE</u>
8/21	003 SAND WAVES NEAR END OF LINE #003 WAYPOINT #5 02:00:00 = 55 53.02'N 160 25.51'W LARGER SAND WAVES 01:50:00 55 53.11'N 160 26.64'W SANDWAVES BETWEEN 02:00 AND 01:50
8/21	SOL #003 WAYPOINT #4 55 53.30'N 01:10:00 TRAWL STN #3 160 31.10'W MUD (SOFT) BETWEEN 01:50 AND 01:10
8/21	LINE #001 TRAWL STN #4 WAYPOINT #2 TO 3 55 58.00'N 160 34.00'W SOFT (MUD) BOTTOM CONTINUES TO SANDWAVES 00:00:00 TO 00:12:00
8/21	LINE #002 WAYPOINT #3 TO 4 POSSIBLE TRAWL SITE 55 53.83'N 160 34.10'W
8/21	004 WAYPOINTS 5 TO 6 TRAWL STN #02 55 51.80'N 160 22.36'W
8/21	005 WAYPOINTS 6 TO 7 TRAWL STN #01 55 50.24'N 160 19.93'W

PORT MOLLER CRAB SIDE-SCAN ANALYSIS

<u>DATE</u>	<u>LINE</u>
8/22	SOL #001 SURVEY FROM WAYPOINT #9 TO #10. 00:16:00 55 55.60'N POSSIBLE TRAWL SITE 160 43.84'W
	00:54:00 55 53.30'N DEEP HOLE Z > 100 M 160 49.92'W APPROX. 500 M LONG & 50 M WIDE
8/22	SOL #002 JOHNSONS CHANNEL TRAVELLING NORTH TO SOUTH 02:14:00 "EAGLE" ROCK 55 49.73'N 160 47.61'W
8/22	SOL #003 SURVEY FROM WAYPOINT #14 TO #15 S. END OF JOHNSON'S CHANNEL SOFT (MUD) BOTTOM
8/22	SOL #004 APPROX. 10 M CONTOUR AROUND BALD BLUFF PT. AND ACROSS TO SHINGLE POINT SOFT (MUD) BOTTOM

PORT MOLLER CRAB SIDE-SCAN ANALYSIS

<u>DATE</u>	<u>LINE</u>
8/24	001: OFF BLUFF POINT TRAVELLING TO BLUFF POINT 55 46.38'N 160 44.93'W SEMI-CIRCULAR GROUP OF ROCKS
	002: DRIFTING OFF BLUFF POINT EOL = 55 46.42'N 160 44.43'W
	003: LOOKING FOR "SOMETHING" (GROUP OF ROCKS) NEAR BLUFF PT. 00:28:00 HEADING FROM BLUFF PT TO CROW REEF 00:42:00 CROW REEF COMING UP 00:48:00 PAST CROW REEF HEADING TO WAYPOINT #17 00:52:00 SOFT (MUD) BOTTOM 01:04:00 PICK UP "TRACE" OF SOMETHING - SOFT (MUD) BOTTOM CONT. POSSIBLE DIFFERENT SEDIMENT LAYER 01:48:00 OFF GRAVEL POINT; TURNING DOWN TO WAYPOINT #18 - SOFT (MUD) BOTTOM CONT. 02:04:00 MORE (RELIC) TRACES - BOTTOM STILL SOFT 02:20:00 ROCK LEDGE 55 42.92'N 160 41.69'W 02:34:00 EOL 003 - PORT SIDE COMING UP FAST

Port Moller Side-Scan Data Analysis

<u>DATE</u>	<u>LINE</u>	
8/25	001	Approximate 10 meter - depth contour around Bluff Point. 00:10:00 Off cabin on north side 00:22:00 EOL #001
	002	Shallow fish and slow speed around inside (north) of reef.
	003	Along north side of Crow Point.
	004	Going down north side of Gull Point towards Grass Valley.

PORT MOLLER CRAB SIDE-SCAN ANALYSIS

<u>DATE</u>	<u>LINE</u>
8/26	001: OFF BOLD BLUFF PT. CONTOUR AROUND EAST SIDE TRAVELLING TO OLD CANNERY POSSIBLE TRAWL SITE: 55 45.09'N 160 44.52'W