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U.S. NAVY HOMEPORT DISPOSAL SITE INVESTIGATIONS IN PORT GARDNER, WASHINGTON

Invertebrate Resource Assessments

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Paul A. Dinnel, David A. Armstrong, Robert R. Lauth,
Thomas C. Wainwright, Janet L. Armstrong and Karen Larsen

FINAL REPORT

to

Washington Sea Grant, U.S. Navy and U.S. Army Corps of Engineers

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Approved

Submitted 10-12-88

R. C. Francis
Director

ABSTRACT

As part of the Navy Homeport project in Everett, Washington, crab and shrimp resources were sampled in and around potential sites in Port Gardner to be used for confined disposal of clean and contaminated dredged sediments. Sampling was conducted at 2 - 3 month intervals during 1986 and 1987 with a 3-m beam trawl at up to 90 stations. Additional sampling during the winter of 1986-87 involved the use of SCUBA divers and the deep submersible PISCES IV to locate buried crab.

Female Dungeness crab (*Cancer magister*) were abundant in Port Gardner and generally aggregated along the nearshore slope at depths ranging from about 10 to 100 m depending on season. Gravid (egg-bearing) females were highly aggregated on the upper slope (10- to 40-m depths) during December and January and less aggregated during summer months when they tended to "spread out" to deeper (to 140 m) portions of Port Gardner. Male Dungeness and rock crabs constituted only minor portions of the catches.

Seven species of pandalid shrimp were caught in the samples but, with the exception of only several stations, were nowhere abundant in Port Gardner. Each of the seven shrimp species preferred slightly different habitats and depths with recruitment of juveniles evident during the summer months.

The initial Confined Aquatic Disposal (CAD) site selected by the Navy for dredged material disposal was found to be in conflict with preferred use of the site by gravid female Dungeness crab. This conflict led to the selection of a "Revised Application Deep Confined Aquatic Disposal" (RADCAD) site in deeper water. The sampling data showed that average crab densities were about 10 times less in the RADCAD site (as compared to the CAD site) and that pandalid shrimp abundances were about 5 times less.

A Water Quality Certification (WQC) permit issued to the Navy by the State of Washington stipulated that use of the RADCAD site during the second year of dredged material disposal would be negated if RADCAD female Dungeness crab densities exceeded 100 crab/hectare (ha) or 5% of the Port Gardner population on an average annual basis. Our sampling found that female crab densities in the RADCAD never exceeded 56 crab/ha for any single sample trip nor exceeded 21 crab/ha or 3.7% of the population on an average annual basis. Hence, disposal of dredged material at the RADCAD site should not violate the WQC permit stipulations regarding female Dungeness crab.

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LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

CAD	Confined Aquatic Disposal
CL	carapace length (shrimp)
COE	U.S. Army Corps of Engineers
CW	carapace width (crabs)
ha	hectare (100 m x 100 m)
km	kilometers
m	meters
mm	millimeters
MLLW	mean lower low water
n	sample size
NM	nautical mile
PSDDA	Puget Sound Dredge Disposal Analysis
QA/QC	Quality Assurance/Quality Control
RADCAD	Revised Application Deep Confined Aquatic Disposal
SCUBA	self-contained underwater breathing apparatus
T	transect
UW	University of Washington
WDF	Washington Department of Fisheries
WDOE	Washington Department of Ecology
WQC	Water Quality Certification
$>$	greater than
$<$	less than
$\geq$	greater than or equal to
$\leq$	less than or equal to
~	approximately

ACKNOWLEDGMENTS

This project was funded by the Washington Sea Grant Program (Grant Number NA86AA-D-SG044B) in cooperation with the Seattle District, U.S. Army Corps of Engineers and the U.S. Navy. Partial direct funding was also provided by a contract from the U.S. Navy (Contract Number N62474-87-R-D510). Valuable sponsor coordination of this project was provided by Louie Echols and Alan Krekel of Washington Sea Grant; John Malek, Tom Muller, Steve Martin and David Kendall of the Seattle District, U.S. Army Corps of Engineers; and Ed Lukjanowicz, J. E. Roth, and Rick Krochalis of the U.S. Navy.

As part of a joint scientific project coordinated by Glen Jamieson and Dwight Heritage of the Pacific Biological Station, Nanaimo, B.C., the PISCES IV submersible, support vessel *Pender* and crews for both vessels were loaned to the project at no cost by the Department of Fisheries and Oceans, Institute of Ocean Sciences, Sidney, British Columbia under the direction of John Davis. Frank Chambers, Chief Pilot for PISCES IV, and his crew provided smooth diving operations with their professional and expert services. The crew of the U.S. Navy tug Manhattan provided valuable towing services for the PISCES IV and Pender to and from Port Gardner.

Most trawling operations were conducted from the RV Kittiwake under the very capable and experienced guidance of Charles Eaton. Assistance with field and laboratory work and diving operations were provided by a multitude of people including Don Gunderson, Russ McMillan, Greg Jensen, George Williams, Brett Dumbauld, Anthony Whiley, Dan Doty, Karen Larsen, Lori Christiansen, John Stadler and Bob Pacunski. Maxine Davis, Abby Simpson, Marcus Duke and Roy Nakatani provided assistance with report preparation and editing.

INVERTEBRATE RESOURCE ASSESSMENTS

INTRODUCTION

The U.S. Navy has selected the Everett-Port Gardner region of Puget Sound as the location for a new carrier battle group homeport (Figure 1). A portion of the construction plans for this new homeport requires dredging of clean and contaminated sediments from the East Waterway of Everett Harbor and the subsequent disposal of those sediments at a deep water disposal site in Port Gardner (U.S. Navy 1985; U.S. Army Corps of Engineers (COE) 1986). Sediment disposal plans include construction a containment berm and capping the contaminated sediments with a layer of clean material to isolate contaminants from bottom-dwelling marine fauna and to prevent contaminants from remobilizing into the water column.

A portion of the associated environmental concerns involves possible effects of dredging and disposal on fishery resources, especially those resources residing within the East Waterway and the Port Gardner disposal site. Of special concern are possible impacts to Dungeness crab (*Cancer magister*), a known fisheries resource of both commercial and sports value in Port Gardner. Washington State Department of Fisheries (WDF) statistical reports indicate average annual commercial catches of Dungeness crab in the Port Gardner/Port Susan area of typically 20,000 to 40,000 crab (roughly 40,000 to 80,000 pounds) per year with historic peaks (1944 and 1946) of over 100,000 crab and historic lows (1959) of approximately 6,000 crab (WDF 1974). In addition to the commercial catch, a substantial sport effort for crab also exists in Port Gardner based on crab pots and rings, diving and wading during periods of low tide (Williams 1975).

In response to fishery concerns, the U.S. Navy conducted studies of the crab resources within and around the East Waterway and adjacent shallow areas in 1984-1985 (Weitkamp et al. 1986). In addition to the shallow-water crab survey, work to characterize the resources in and around several deep-water disposal site was initiated in February 1986 by the University of Washington (UW) School of Fisheries. The preliminary findings of the UW trawl surveys of the disposal site(s) have been reported in a series of ten individual Cruise Reports submitted by Dinnel et al. (1986-1988). This document is the project completion report covering all sampling for invertebrate resources (crab and shrimp) in and around three proposed deep-water disposal sites in Port Gardner. The results of otter trawl sampling for bottomfish resources are presented in Lauth et al. (1988).

METHODS

General

Invertebrate resource sampling in the deep-water areas of Port Gardner was conducted with a research-sized beam trawl deployed from the 16-m research vessel Kittiwake. Trawling was conducted five times per year in 1986 and 1987 at 2- to 3-month intervals. A list of the sampling dates is recorded in Table 1. Additional sampling of Dungeness crab was also carried out in shallow-water areas using the beam trawl fished from a 6-m Boston Whaler® modified for trawling, and by SCUBA diver sampling along underwater transect lines. One additional sampling effort in deep-water areas in January 1987 utilized the deep-diving submersible PISCES IV to examine the distributional pattern of gravid (egg-bearing) Dungeness crab.

Sample Sites

The original Confined Aquatic Disposal (CAD) site proposed by the Navy was located just offshore of the East Waterway at a depth of approximately 80 m (Figure 2). Because of the relatively high abundance of animals (especially gravid Dungeness crab) at the CAD site, the preferred disposal site (Revised Application Deep Confined Aquatic Disposal - RADCAD) was established southwest of the CAD site at depths ranging from approximately 90 to 120 m (Figure 2). In addition to the two Navy disposal sites, a third site selected as a proposed unconfined disposal site by the Puget Sound Dredge Disposal Analysis (PSDDA) Program was also sampled on the same schedule as the Navy sites (Figure 2).

Trawl Sample Design

The original plan for trawl sampling in Port Gardner consisted of three stations in each of the three proposed disposal sites (Note: a major portion of the RADCAD site was initially designated as an alternative PSDDA site. The PSDDA Program yielded to the Navy's needs for a site as close as possible to the East Waterway since the capping procedure requires pipeline application of the clean capping sediments). Additionally, five north-south transects (T1-T5) were established at approximately 1-nautical mile (NM) intervals and trawl stations selected at specific depth contours (e.g., 10, 20, 40, 80, 110, 130-m depths) (Figure 2). Transects 6 and 7 were added to the trawl survey design during the first sampling trip when it became evident that Dungeness crab resources were relatively rich in the inner harbor area around the Navy CAD site. Additional non-transect stations (A-J) were gradually added to the sample plan as alternative sites to the original CAD site were being explored. By December 1986, the RADCAD site had been identified as the preferred alternative CAD site; its boundaries encompassed seven trawl stations (1, 2, 3, A, E, I, J; Figure 2). At this time, 60-m stations were also added to each of the transect lines to better characterize the important depth interval between 40 and 80 m and to aid in calculating population estimates for adult female Dungeness crab as specified by the Water Quality Certification (WQC) permit issued by the State of Washington (WDOE 1987).

The WQC permit stipulated that female Dungeness crab in the RADCAD site could not exceed a given average annual density or exceed a certain percentage of the female crab population residing within a WQC-defined area (Figure 3). Since the

WQC population area included shallow areas of Everett Harbor that were not previously sampled, five Delta stations (1-5; Figure 4) were added to the sample plan in June 1987 and 22 stations (all stations noted in Figure 4) added in September 1987.

The sample plan for the last trawl period (December 1987) was reduced to only a subset of 23 stations (Figure 5), which served to assure that gravid female crab were located in areas away from the RADCAD site as suggested by the December 1986 samples.

As previously noted, otter trawl samples for bottomfish were collected only during the first year at a subset of the stations described above for the beam trawl. The descriptions of the otter trawl stations, gear and methods, and results are presented in Lauth et al. (1988). However, catches of invertebrate resources from the otter trawl sampling are discussed and tabulated in this report.

The exact locations, depths, trawl directions, wire out, etc. are recorded for each trawl station in Appendix Table 1.

Diver Transects

Because gravid female Dungeness crab bury in the substrate during the winter (typically November-January), the efficiency of the trawl sampling was much reduced during the December 1986 sample session. Hence, SCUBA divers were utilized to sample the shallow areas of Port Gardner at stations along inshore extensions of Transects 1 - 7 (Figure 6). Dungeness crab were collected and counted at each station by two divers swimming side-by-side along a weighted 50-m long transect line. The area covered by each diver was a double arms-length distance (approximately 1.75 m) on their respective side of the transect line.

PISCES IV Observations

Sampling for buried female crab with SCUBA divers during December 1986 was limited to depths of approximately 20 m or less. However, unquantified observations by the divers at depths >20 m suggested that the distribution of gravid females was deeper than SCUBA working limits. Hence, high abundance of gravid crab buried on the RADCAD site remained a possibility since trawls do not effectively capture buried crabs.

To better assess female crab utilization of the RADCAD site during this time, the PISCES IV submersible was utilized for direct observations of the RADCAD site and the nearshore slopes around the RADCAD site. Six transects were conducted across the inner portion of Port Gardner in and around the RADCAD site (Figure 7). Direct observations of the bottom were made by two observers through the port and starboard ports and the bottom along the transects recorded on video tape.

Sample Gear

Demersal invertebrate fauna were sampled with a 3-m beam trawl (Figure 8; Gunderson and Ellis 1986) previously used elsewhere in Puget Sound (Armstrong et al. 1987; Dinnel et al. 1985a, 1985b, 1986a, 1986b, 1987a, 1988; Weitkamp et al. 1986). The beam trawl was towed approximately 232 meters (1/8 NM) at a target ground speed of 2.5 km/hr (1.4 knots) which yielded an area swept by the net (opening = 2.3 m) of 534 m^2. All crabs (Dungeness and the rock crabs *Cancer productus* and *Cancer gracilis*) caught in the trawls were measured for carapace width (CW), sexed and assessed for molt condition (degree of shell softness) and reproductive condition (females with or without eggs), and returned to the water. Shrimp catches were sorted to species (pandalid shrimp only), counted, measured for carapace length (CL) and checked for reproductive condition. Bottomfish caught in the beam trawl were bagged and frozen for later processing in the laboratory as noted in Lauth et al. (1988) for the otter trawl sampling.

Quality Assurance/Quality Control (QA/QC)

The location of each trawl station was found using a combination of radar ranges to permanent features and fathometer readings. LORAN C coordinates were not used in Port Gardner owing to an unknown source of interference.

Once stations were located, the beam trawl was deployed at a target boat speed (relative to the bottom) of about 1.5 knots. Winch "wire out" at each station was set by precalculated ratios (varying from 3:1 to 10:1, wire out: depth) depending on depth and gear type. The beam trawl was towed at a target ground speed of 1.4 knots for 1/8 NM (232 m) following pre-specified depth contours (for slopes) or compass headings (for flat bottoms). Time elapsed for each tow was monitored and the tow discarded if the elapsed time was 25% more or less than expected (i.e., if speed was <1.05 or >1.75 knots). Tows were also discarded and repeated if any other significant discrepancies were noted (e.g., gear hang-ups, tangled gear, torn or unexpectedly empty net, etc.).

Data Analyses

All beam trawl catches of demersal invertebrates were converted to **estimated densities** based on our best estimates of area swept by the beam trawl. Our "best estimates" are based on previous underwater measurements of net openings, observations of net behavior and measurements of actual "net on bottom" times using sonic transducers on the nets during fishing (Gunderson, unpublished data).

Regardless of the accuracy in calculating "areas swept" by each trawl gear, no trawl is 100% **efficient** at catching the animals in its path, which means that the faunal densities are almost always underestimated, the degree of underestimation being dependent on animal species, their behavior, and bottom type. The term "density" or "estimated density" (e.g., crab/ha) as used in this report has been used with the assumption of a net capture efficiency of 100%. Therefore, "densities" reported herein specifically refer to an **index** of estimated densities, specific to gear type, which should provide the best **relative** measures of demersal resources present and trends in abundances between areas, between seasons, and between years.

WQC Crab Population Estimates

On 24 September 1987, the U.S. Army Corps of Engineers (COE) issued a Section 10/404 permit to the U.S. Navy to dredge the East Waterway and dispose of the dredged materials at the deep-water RADCAD disposal site (COE 1987). One of the special conditions of this permit was that "the permittee shall comply with all of the conditions of the Water Quality Certification granted by the State of Washington on 2 March 1987" (WDOE 1987). One of the specific requirements of the WQC is:

> "Approval of the boundaries for the second years disposal shall also be contingent upon a demonstration, based on two years data, that adult female crabs within the second year boundaries of the proposed disposal site have a mean annual density of less than 100 female adult crabs per hectare and such crabs are less than five percent of the total female adult crabs within the area bounded by 48.0 degrees north latitude and 122 degrees, 17.5 minutes west longitude, the 110 meter depth contour and the MLLW mark, and the disposal site greater than 110 meters deep."

Thus, the WQC requires estimates of adult female Dungeness crab densities within the RADCAD site **and** estimates of the RADCAD population relative to the defined WQC area within Port Gardner (Figure 3). Estimated **mean annual densities** for each year were calculated as:

$$\text{Mean annual density} = \frac{\sum_{i=1}^{N} \left[\frac{x_1 + x_2 + \ldots x_n}{n}\right]}{N},$$

where: x = estimated female crab densities calculated from each RADCAD station for a given cruise,

n = total number of trawls made within the RADCAD for a given cruise, and

N = number or cruises per year.

Estimated crab densities (x) for each individual RADCAD station were calculated as follows:

$$\text{Estimated crab density (crab/ha)} = \frac{(10{,}000\ m^2/\text{ha})(\text{No. of crab caught in the trawl})}{\text{No. } m^2 \text{ swept by the net}}$$

Thus, for trawls of 1/8 N.M. (= 232 m) using the beam trawl with a calculated opening of 2.3 m, the crab density formula reduces to

18.73 X No. of crab caught.

Percentages of female crab residing within the RADCAD site were based on population estimates calculated for both the RADCAD site and WQC area as a whole. The sampling plan, as indicated above (Figure 2), consisted of a basic grid of transects with beam trawl stations at preselected depths, supplemented by additional stations selected to provide better coverage in the central area near the probable disposal site(s). Independent of these stations, a set of stations were established within the RADCAD site. This sampling design allowed calculation of reliable estimates of background population levels (from the transect and supplemental stations) and statistically independent estimates for the RADCAD site.

The sampling design for surveying background population levels was a stratified design: the set of trawl stations at any of the predetermined depths can be thought of as representing the crab population in a certain depth zone (stratum). To the extent that stations within any of these strata were selected with no foreknowledge of the distribution of crab, these stations were effectively random. Thus, estimation techniques for a stratified random sampling design (e.g., Cochran 1963) are appropriate, and have been successfully applied in similar surveys (Gunderson et al. undated; Bakkala and Smith 1978).

The method for estimating the overall background (WQC area) crab population for each sampling date consisted of four steps:

1. Determining the area included within each stratum;
2. estimating the mean crab density in each stratum;
3. estimating the overall stratified mean crab density; and
4. expanding the overall density estimate to a population estimate.

To determine areas within depth strata, we first compiled a contour chart of the survey area at a 1:10,000 scale, showing depth contours at 5- or 10-m intervals. This was compiled from data in reports from the National Ocean Service (1984), Northern Technical Services, Inc. (undated), and U.S. Navy (1953) Hydrographic Office. From this chart, the areas within each depth stratum and within the RADCAD site were measured with a digital planimeter; these areas are given in Figure 9.

From the trawl sample data, mean densities for each stratum were calculated as follows: For each trawl sample in the stratum, the density of adult female crab (females larger than 90 mm CW) was calculated. Because many of the stations are on steep slopes, this raw density was multiplied by a slope correction factor (ranging from 1.00 to 1.12 for various stations) to provide density-per-unit of horizontal area. The mean and sample variance of this density were then calculated for each stratum.

From the mean density for each stratum, the overall mean density (number per hectare) for the WQC area was calculated as the sum of the stratum means multiplied by the stratum areas, divided by the total area

$$d = \left[\sum_{i=1}^{I} d_i A_i \right] / A,$$

where: d = overall mean density,

d_i = mean density for stratum i,

A_i = area in stratum i,

A = overall area, and

I = number of strata.

The sample variance of d was calculated using the appropriate stratified variance estimate (Cochran 1963, equation 5.11).

This overall density was then expanded to give a total population estimate (p) by multiplying by the total area:

$$p = d \times A$$

The formulae for variance estimates and confidence intervals given in Cochran (1963) were used. Density and population estimates for the RADCAD site were calculated as for the individual strata above.

The WQC area designated by WDOE (1987) for background population estimates included a substantial area (between 0- and 5-m depth, and in the harbor area) for which no sample data were available (except June and September 1987) and excluded a substantial area that had been sampled (compare station array of Figure 2 with WQC area of Figure 3). To provide population estimates up to MLLW, we made two provisions for the calculation. First, lacking any appropriate data, we assumed that adult female crab in the shallow unsampled areas of the WQC area occurred at densities similar to those estimated for the 6- to 15-m stratum (10-m stations; this area is indicated in Figure 3). This assumption provided a "best" estimate of the total female population for the entire designated WQC area. Second, to provide greater precision in estimates, we included all appropriate sampling stations in the stratum density estimates, whether or not the stations fell within the WQC boundaries designated by WDOE (e.g., Transect 5 stations). Assuming that these outlying stations are similar to other stations in the same strata, this will not affect the mean density or population estimates, but will reduce their variances.

RESULTS

Dungeness Crab

The "Standard Beam Trawl Survey" (hereinafter called standard surveys) of 55 (early 1986) to 73 (beginning December 1986) stations (Figure 2) was conducted in February, April, June, September, and December of 1986 and 1987 except that in December 1987 an abbreviated survey of only 23 stations was authorized (Figure 5). In addition, 5 shallow stations on the Snohomish Delta were sampled in June 1987 and 22 shallow Delta, River, East Waterway and 3-m south shore stations were sampled in September 1987 (Figure 4). Most of the following results and discussion will focus on the findings at the "standard survey" stations (all stations in the CAD, RADCAD, PSDDA sites; all Transect 1-7 stations and Stations A-J; n = 73 stations except not all of these stations were sampled prior to December 1986) with occasional reference to the additional shallow stations sampled in June and September 1987.

Geographic Distribution. The distributions of Dungeness crab in Port Gardner varied by sex and season. In all seasons and for both sexes, the highest crab densities were on the steep nearshore slope areas of Port Gardner from as shallow as 3 m down to about 100 m. Female Dungeness crab were consistently aggregated along the nearshore slope during winter and spring of each year and tended to "spread out" into the deeper, flatter central areas of Port Gardner during summer and early fall (Figures 10 (1986) and 11 (1987)). Sampling in the shallow areas of Port Gardner in June (Snohomish Delta only) and September 1987 showed that adult female crab also occur in substantial numbers on the Delta and in the Snohomish River mouth and East Waterway (Figure 11), as previously documented by Weitkamp et al. (1986).

Male Dungeness crab were much scarcer than females and accounted for only about 9% of the total Dungeness crab catch for the 2 years of combined data from the standard survey stations. Like the females, the males aggregated along the nearshore slope of Port Gardner and were rarely caught in the deeper central portion of Port Gardner (Figures 12 and 13 for 1986 and 1987, respectively). Shallow nearshore samples in June and September 1987 showed that males also occurred in relatively high numbers on the Delta and in the River and East Waterway (Figure 13).

Shallow Diver Transects. Dungeness crab were caught in the beam trawl at very few stations in December 1986 (Figures 10 and 12) and the crab that were caught were mostly gravid females with new eggs. Prior experience from North Puget Sound (Armstrong et al. 1987) suggested that the gravid females were buried in the sediments and, thus, were of limited availability to the trawl gear. As a result, the shallow areas of Port Gardner (2-, 4- and 6-m depths) were sampled along 26 diver transects at the ends of Transects 1-7 (Figure 6).

The average estimated density for all dive stations combined was 495 crab/ha, a substantially greater density than the beam trawl estimate for Port Gardner of 71 crab/ha in December 1986. The diver surveys showed that crab tended to aggregate in certain areas. Female crab were especially abundant at the north ends of Transects 2 and 7 (e.g., estimated female densities of 4,000 and 941/ha for the T2 and T7, 6-m stations, respectively) while the males were most abundant at the Transect 6-south 6-m station (765 males/ha) (Figure 14; Appendix Table 2). Indeed, catches of female crab outnumbered males by about 4:1 in the northern (Delta) area, while males outnumbered females by about 3:1 along the south shore. Overall, females outnumbered males in the diver catches by 2:1 and 74% of the females were gravid with new egg masses.

Although relatively few female crab were caught by divers along the south shore, deeper exploratory dives indicated that gravid females (buried in the substrate) were more abundant in the 15- to 20-m depth range than had been indicated by beam trawl catches at the 20-m stations. Hence, this was additional direct evidence that newly gravid female crab aggregate in high concentrations in specific areas and that a trawl is relatively ineffective in sampling these buried crab.

Deep PISCES IV Transects. Because the diving surveys affirmed the inefficiency of the trawl for catching buried crab, and because the female aggregations extended below 20 m, questions remained about the limits of distribution of the buried females, especially in regard to the RADCAD and PSDDA disposal sites. To solve this unknown, the Canadian submersible PISCES IV was used for visual surveys of the bottom at all depths in and around the RADCAD site during 6 to 9 January 1987.

Both active and buried Dungeness crab were easily observed from the PISCES IV including crab moving over the bottom as well as buried in the sediments. Buried crab were visible owing to protrusion of the antennae and, often, portions of the carapace extending above the surface of the sediments. Buried crab also left a telltale disturbance area at the site of burial and left a distinct pit upon departure (Dinnel et al. 1987a).

As illustrated in Figure 15 (and detailed in Appendix Table 3), Dungeness crab were found to be very scarce at depths >90 m (only 2% of all crab observed), and none of these crab were buried, nor were "burial pits" evident. Crab densities increased along the bottom half of the nearshore slope (50-90 m) and accounted for approximately 10% of all crab observed with only 10% of these crab (i.e., 1% overall) buried in the bottom sediments (Figure 15). Densities of crab were highest in the 10-50 m range with crab being especially abundant between the 20-40 m contours. Of all crab observed, 88% were in the 10-50 m range, with 85% of these buried in the bottom sediments. All buried crab dislodged by the PISCES IV mechanical arm (~10) were gravid females. Additionally, numerous "pits" suspected to have been produced by crab burial were observed at this upper depth range.

Crab Distributions North and South of Port Gardner. A few beam trawl tows were made north (June 1986) and south (September 1986) of Port Gardner to provide a better interpretation of the aggregations of Dungeness crab observed around the RADCAD site. There was a trend toward diminishing crab densities with distance away (to the north) of the Snohomish Delta based on tows at three stations north of the WQC area (Figure 16). Seven tows conducted south of Port Gardner between Mukilteo and Picnic Point indicated that very few crab were present in this area at that time (Figure 16). Hence, these limited data support the concept that the nearshore slope area of Port Gardner (from Mukilteo to the Snohomish Delta) is preferred habitat for females (and probably males) of this species.

Seasonal Crab Densities. The apparent densities of Dungeness crab varied seasonally in Port Gardner, probably as a combined result of natural mortality (or fishing mortality for large males), immigration and emigration, recruitment of juveniles to the adult stocks and efficiency of the trawl relative to crab behavior. The estimated average cruise densities (excluding December 1987) for all Port Gardner standard survey stations ranged from a low of 40 crab/ha in April 1987 to a high of 147 crab/ha in February 1987 (Table 2; Appendix Table 4). This apparent decrease in the number of crab in Port Gardner between February and April occurred each year, and may be due, in large part, to natural mortality of senescent females (Stevens and Armstrong 1981) and fishing pressure on the large males (Figure 17). Evidence to support the idea of female mortality comes from observations of dead crab in the April trawl catches in both 1986 and 1987. However, female molting and mating also takes place during the spring. Hence, the number of crab actually present in April may be under-estimated because of the reclusive (i.e., burial) nature of newly molted, soft-shelled females.

Again in each year, apparent crab densities increased between the April and June sampling (Figure 17). A significant portion of this increase was probably due to the immigration of 2-year old juveniles into the adult population (first age of mating for females). Evidence from crab studies in North Puget Sound (Dinnel et al. 1986b) suggests that subadult crab move out of shallow areas around June of each year to molt and join the adult (>90 mm CW) population in deeper waters. Hence, between February and June of each year is a time when the crab population levels are in flux, which is due to natural mortality and recruitment of sub-adult crab. Density estimates for June and September of each year were very similar, suggesting a cessation or a balance of mortality and recruitment during this period (Figure 17). Density estimates were substantially reduced in December because of poor fishing efficiency of the net for buried crab, and rebounded to higher levels in February as females with mature eggs emerged from burial. The reason for an apparent increase in crab density in February 1987 (over the June/September densities) is presently unknown but may simply be due to gear efficiency/crab behavior interactions and/or the high degree of variability inherent in this type of sampling (e.g., standard deviations of the mean densities typically range from 100 to 200%, even with a sample size of 55 to 73 stations; Table 2).

Disposal Site Crab Densities. The densities of Dungeness crab estimated to be within the three proposed disposal sites for each season are listed in Table 2 and illustrated in Figure 18. For all data combined (1986 and 1987), the approximate ratio of crab for each site was 20:2:1 for the CAD, RADCAD, and PSDDA sites, respectively, with the CAD site having roughly twice the average density as measured for Port Gardner as a whole.

The WQC permit (WDOE 1987) for the second year's disposal at the RADCAD site requires "...based on two years data, that adult female crabs within the second year boundaries of the proposed disposal site have a mean annual density of less than 100 female adult crabs per hectare..." The annual estimated female crab densities (± 95% confidence limits) within the RADCAD site were 9.5 ± 8.2 (n = 22) and 20.8 ± 9.2 (n = 35) crab/ha for 1986 and 1987, respectively. The average estimated female crab density for both years combined was 16.4 ± 6.4 (n = 57) crab/ha. These estimated densities for the RADCAD are well below the 100 crab/ha standard set by the WQC.

Population Estimates. The WQC permit for the second years disposal at the RADCAD site also requires, "...based on two years data, that adult female crabs within the second year boundaries...are less than 5% of the total female adult crabs within the [WQC] area..." Seasonal population estimates for Dungeness crab within the WQC area ranged between about 60,000 to 200,000 total crab, of which roughly 80% were females (Figure 19). The estimated populations of female crab ranged from a low of 51,300 ± 19,800 (95% confidence limits) in April 1987 to a high of 180,300 ± 85,000 in February 1987 (Table 3). Estimates of females in the RADCAD site varied from 0 ± 0 (December of each year) to 7,929 ± 4,520 crab (June 1987) (Table 3; Figure 20, top). On the basis of the calculations shown in Table 3, the seasonal percentages of females within the RADCAD site as compared to the WQC area ranged from 0 to 9.5% (Figure 20, bottom). The annual percentages for females in the RADCAD site, on which the WQC standard is based, were 1.5 and 3.7% for 1986 and 1987, respectively, and the 2-year average (1986 and 1987) was 2.6%. Thus, it is apparent that female crab percentages within the RADCAD site were below the 5% annual level specified by the WQC.

The seasonal population estimates for male, female and total Dungeness crab for each depth stratum are listed in Appendix Table 5.

Depth Distribution. The distribution of Dungeness crab by depth in Port Gardner varied by season and by sex. Males were always caught in greatest numbers in the shallowest depth stratum (0-15 m) and only occasionally were males caught at the deeper stations (Figure 21). Females were always concentrated along the near-shore slope (0-110 m depth range) but did occur in sparse numbers in the deeper central portion (>110 m) of Port Gardner during the summer months (Figure 21). Also, the majority of the females tended to be located along the deeper (50-110 m) portions of the slope during summer and then strongly concentrated at shallower depths (0-50 m) during the winter period of egg incubation.

Size Distribution. The Dungeness crab population in Port Gardner was unique because 0+ to 2+ age class crab (<100 mm CW) were almost totally absent from all samples. The primary exception to this was the capture of 12 young-of-the-year (0+) crab in tows at the Snohomish River and East Waterway in September 1987. These juvenile crab were probably about 2-6 weeks old and averaged 10.7 mm CW.

The size-frequency distributions for all male and female Dungeness crab caught by beam trawl in Port Gardner for all sampling cruises are shown in Figures 22 and 23. Males ranged in size from about 80 to 180 mm CW with average size-per-trip falling in the narrower range of 116 to 146 mm CW. Patterns of growth and age-class groupings are not readily apparent in the size-frequency graphs for males (Figure 22). The only information that is readily gleaned from male size histograms is that males <120 mm in February 1986 may have molted to the adult population later that year, but were completely lacking in the 1987 trawl catches.

Size-frequency patterns for females (Figure 23) are more apparent than for the males. Females <100 mm CW (i.e., ~2-years-old) were rare during all seasons, although the overall range in size of females was about 90 to 155 mm CW, with the mean size during most trips falling in the range of 119 to 127 mm CW. Again, little information on growth or age-class composition can be readily gleaned from the female size-frequency distributions, although crab between 100 to 140 mm CW are at least 2- to 4-years-old.

As noted above, the absence of juvenile crab underscores a unique feature of the population. Clearly, recruitment of subadults into the adult population takes place in

Port Gardner, but the source of the juveniles and their preferred habitats is presently unclear. It is probable that juveniles find refuge in the estuarine portions of the Snohomish River and Delta and may also come from the Port Susan area to the north.

Female Reproduction. As noted above, approximately 80% to 90% of all Dungeness crab caught by beam trawl in Port Gardner were females (Figure 24, top). Approximately 80% of all females caught in the December and February trawls were gravid. The bulk of the females caught in December had new (bright orange) egg masses that were probably extruded in either November or December. Few females carried new eggs in February; rather, the eggs ranged from medium age (brownish orange) to the point of active hatching (brown) or spent, empty egg masses. Only a rare female carried eggs during the April, June and September sample periods (Figure 24, middle).

Shell Condition. Crabs grow in discreet increments by molting the old shells and then gradually hardening a new expanded shell. Molting can take place year-round in some individuals, but the majority of molting takes place in specific seasons and is dependent on sex. Males showed peaks of molting activity (as indicated by elevated proportions of crabs with either "soft" or "very soft" shells) in February and April of each year with a slight additional peak in September (Figure 24, bottom). Females showed slight indications of molting activity in the period April to June of each year, although virtually no soft females were caught. Molting of females is also tied to mating activity since mating usually takes place between a hard-shell male and a soft-shell female (Butler 1967). The eggs are fertilized internally (from sperm stored in the spermatheca) when they are extruded from the ovary in the late fall.

Red Rock Crab

The red rock crab, *Cancer productus,* and the purple rock crab, *C. gracilis* , were caught in small numbers together with a few small *C. oregonensis* (not recorded). The estimated seasonal station densities are listed in Appendix Table 6 and the distribution of *C. productus* by depth intervals shown in Figure 25. Catches of *C. productus* were sparse in all seasons except September and occurred at all depths. The relatively large catch of *C. productus* in September 1987 was due to an influx of juveniles caught at the shallow Delta, River and East Waterway stations, which were added in September 1987, as well as at a variety of the standard survey stations. This recruitment of juveniles (which was not noted in the 1986 samples; Figure 26) accounted for roughly 40% of the *C. productus* caught in September 1987 (Figure 27, top). Gravid females were primarily caught in December (Figure 27, middle) and all egg masses were new (Figure 27, bottom).

Purple Rock Crab

Catches of the purple rock crab, *C. gracilis*, were only slightly greater than for *C. productus* (Appendix Table 6) with the highest catches generally being in shallow areas (i.e., <40 m) (Figure 28). The largest catches of *C. gracilis* were associated with newly settled juveniles caught in the September and December trawls each year (Figures 29 and 30, top). Male and female *C. gracilis* were generally caught in equal numbers, and no gravid females were observed (Figure 30).

Pandalid Shrimp

Seven species of pandalid shrimp were caught in Port Gardner: Spot prawn, *Pandalus platyceros;* coonstripe shrimp, *P. danae*; pink shrimp, *P. borealis;* smooth pink shrimp, *P. jordani*; humpback shrimp, *P. hypsinotus;* flexed shrimp, *P. goniurus;* and the sidestripe shrimp, *Pandalopsis dispar.* The estimated station densities by season and by species are recorded in Appendix Table 7.

For all pandalid species combined, the estimated overall shrimp densities in Port Gardner varied widely from a low of 10 ± 28 shrimp/ha (± 1 standard deviation) in April 1986 to a high of 640 ± 1,234 shrimp/ha in September 1987 (Table 4 and Figure 31).

On the basis of 2 years of data, a distinct cycle of shrimp densities seems evident: recruitment of juvenile shrimp of most species during summer with a gradual decline in density due to predation and/or natural mortality during the rest of the year to low population levels in early spring of each year (Figure 31).

Densities of shrimp in the disposal sites generally tracked with the overall Port Gardner densities, although this was more evident for the CAD site than for the RADCAD or PSDDA sites (Table 4). In general, for all species and seasons combined, the ratio of shrimp abundance was approximately 4:5:1:1 for Port Gardner: CAD:RADCAD:PSDDA, respectively, for the beam trawl catches (Figure 32).

The spatial distributions of shrimp in Port Gardner (all species combined) for all seasons are shown in Figures 33 (1986) and 34 (1987). These figures show that relatively low densities of shrimp occurred during the spring/early summer (especially for 1986) and then increased because of juvenile recruitment by September of each year (Figure 35). Generally, densities of shrimp were highest along the nearshore slope, although densities within the RADCAD site were occasionally higher (e.g., June 1987; Figure 34).

Average shrimp/ha for all species combined and for each species for each sample season are shown in Figure 35.

Spot Prawn. The spot prawn, *Pandalus platyceros*, was consistently common at one set of stations (Transect 5, 40-80 m) and generally caught in small numbers at moderate depths (40-80 m) along the southern nearshore slope (Figure 36). Small spot prawn were seasonally caught at shallower stations (10-20 m, often associated with large catches of the algae *Ulva*) during the settlement period around September of each year when a bimodal (1986) or trimodal (1987) length-frequency distribution was evident (Figure 37).

Sidestripe Shrimp. The sidestripe shrimp, *Pandalopsis dispar*, is a common inhabitant of deeper water areas (≥80 m depth; Figure 38). Size-frequency plots

(Figure 39) show that *P. dispar* recruited as juveniles by September of each year and that two age groups were evident during this time.

Coonstripe Shrimp. The coonstripe shrimp, *P. danae*, generally preferred the shallower half of the nearshore slope in Port Gardner as indicated by the depth-distribution graphs in Figure 40. Recruitment of juveniles of this species also was evident in the September samples of each year (Figure 41).

Smooth Pink Shrimp. The smooth pink shrimp, *P. jordani*, was caught in the 60-100 m range on the lower portion of the nearshore slope but was completely absent from all samples in April and June 1986 and scarce in June 1987 (Figure 42). Again, juvenile recruitment was evident by September of each year (Figure 43).

Pink Shrimp. The pink shrimp, *P. borealis*, was a common inhabitant of the deeper, outer portions of Port Gardner during all seasons (Figure 44). Recruitment of juveniles was evident by September of both years and the size-distributions for each season were distinctly bimodal, indicating the presence of two (or possibly more) year classes (Figure 45).

Flexed Shrimp. The flexed shrimp, *P. goniurus*, was very scarce in the Port Gardner samples, occurring in only April 1986 and September 1987 (Figure 46). Recruitment of juveniles was only apparent in September 1987 (Figure 47), although very slight.

Humpback Shrimp. The humpback shrimp, *P. hypsinotus*, was caught during all seasons, but densities were low in Port Gardner. Generally, its distribution was limited to the nearshore slope at moderate depths (20-80 m; Figure 48). Samples collected at the shallow River and East Waterway stations in September 1987 contained relatively high numbers of *P. hypsinotus*, where areas of bark debris were apparently favored habitat for juveniles of this species (as was also the case for *P. danae*). Recruitment of young shrimp was noted in September 1987 but was later (December) in 1986 (Figure 49).

Shrimp Reproductive Conditions

Mature females of six pandalid species were gravid during the winter to early spring (December-April; Figure 51). Gravid individuals of the seventh species, *P. goniurus*, were never caught, but its egg-bearing period has been reported by Butler (1980) to be the same as the other species. These species of pandalid shrimp are protandric hermaphrodites, which means that small shrimp are generally males which subsequently undergo a change of sex to females as they grow larger. Hence, it is the reproductive females that are targeted by both the sport and commercial shrimp fishery.

Otter Trawl Catches of Invertebrates

Crab and shrimp caught by otter trawl were not analyzed in detail for this report since the primary sampling tool for these resources was the beam trawl. However, the estimated otter trawl densities for each cruise and station for Dungeness crab (no rock crab were caught with the otter trawl) and pandalid shrimp are summarized in Appendix Tables 8 and 9, respectively.

While invertebrate data have not been compared in detail between the two trawl types, a general indication of their relative efficiency for sampling crab and shrimp can be gained by comparing their catches (estimated density calculations) at the three CAD stations for February, April, June, and September 1986 ($n = 12$ samples). The estimated average Dungeness crab densities ($\pm$ 1 standard deviation) for these 12 samples were 297 ± 190 and 20 ± 21 crab/ha for the beam and otter trawls, respectively. Thus, on the basis of these data, the beam trawl was about 10 times more efficient for sampling crab than was the otter trawl. Estimated average pandalid shrimp densities for the same set of 12 stations were 247 ± 382 and 316 ± 295 shrimp/ha for the beam and otter trawls, respectively. Hence, the otter trawl appears to be at least as efficient at sampling shrimp as the beam trawl, if not more so. Besides some indications that shrimp density estimates may differ between the two gear types, Figure 50 also suggests that the beam trawl may be more effective at catching small shrimp (illustrated for *P. borealis* in this case), while the otter trawl preferentially catches larger shrimp. Two factors may be important in this selectivity:

1. The beam trawl "tends bottom" better than the otter trawl, which means that smaller shrimp hiding or digging into the bottom would be better captured by the beam trawl.
2. The mesh size of the otter trawl is several times the size of the beam trawl mesh. This may allow smaller shrimp to avoid capture by escaping through the larger mesh that precedes the small mesh cod-end bag.

DISCUSSION

The dominant demersal invertebrate resources caught in Port Gardner during the 1986/1987 trawling were crabs (primarily Dungeness crab) and pandalid shrimp. Other invertebrate resources (e.g., sea cucumbers, scallops, etc.) were absent or very scarce.

Dungeness Crab

Puget Sound annual commercial Dungeness crab landings are generally in the range of one to two million pounds (Figure 52, top), of which roughly 50,000 pounds/year have been caught in the Port Gardner and Port Susan region of the Sound in recent years (Figure 52, bottom; WDF 1982 and WDF, unpublished). An additional unknown amount of crab are also taken in the sport fishery via pots, rings, diving and wading during periods of low tide.

Several past studies have shown the relative importance of Port Gardner for crab as compared to nearby areas of Possession Sound and Port Susan. Otter trawl sampling by Ames et al. (1975) in 1973/1974 showed that the highest numbers of crab occurred along the south shore of Port Gardner and off the Snohomish Delta as compared to stations near Gedney Island and the south end of Camano Island (Figure 53). The average 2-year estimated crab density from otter trawl catches (less effective crab sampler than a beam trawl) in Area 1 (south shore of Port Gardner; Figure 53) was 21.6 ± 20.9 (± 1 standard deviation) crab/ha with a strong suggestion of substantially different population levels between the 2 years (e.g., see Areas 1 and 2, Figure 53).

A similar trawl study using a rigid frame beam trawl was conducted by English (1976) in Port Gardner from June 1973 to May 1974. His summary data plots (Figure 54) also showed that the Port Gardner area (inner south shore) contained more crab than nearby areas off Mukilteo or Tulalip.

Weitkamp et al. (1986; 3-m beam trawl) estimated an average density of 50 crab/ha in the shallow areas of the Snohomish Delta, East Waterway and inner south shore of Port Gardner (8 stations, 13 cruises), with individual station averages ranging from 10 to 130 crab/ha. Other significant findings were that females outnumbered the males in the catches by more than a 2:1 ratio, females seemed to avoid the East Waterway (male: female ratio = 5:1), and gravid females were essentially absent from these shallow areas.

The present study was initiated by the U.S. Army Corps of Engineers/U.S. Navy to identify any possible significant resource conflicts relative to disposal of contaminated dredged materials at a deep-water CAD site offshore of the East Waterway in Port Gardner. The first trawl survey in February 1986 "raised a red flag" because of high abundances of gravid female crab (est. 225 females/ha) within the boundaries of the CAD site.

The subsequent trawl program in Port Gardner during 1986 and 1987 showed that seasonal crab densities (excluding December 1987) ranged from 40 to 147 crab/ha with an overall 2-year average density of 91 crab/ha (n = 620 samples). Comparison of this average density with estimated densities from other areas of Puget Sound (all sampled by the University of Washington using the same beam trawl; Dinnel et al. 1986a, 1988; Dinnel unpublished) showed that Port Gardner crab densities are roughly the same in magnitude as the north Puget Sound area and Bellingham Bay, and substantially greater than many other areas including the Strait of Juan De Fuca, Saratoga Passage, Elliott Bay, Commencement Bay and the Nisqually region (Table 5). Hence, it is very reasonable to conclude that Port Gardner (especially the near-shore slope and Delta areas) provides favored habitat and resources for this species.

Another significant factor discovered during this sampling was that 80-90% of the Dungeness crab caught in Port Gardner were females and that these females tended to aggregate in certain areas during certain seasons. Our sampling suggested the following pattern of movements and aggregation (Figure 55): During the winter (November-January), newly gravid females were highly aggregated (and buried) on the nearshore slope and Delta between depths of about 10 to 40 m. As the eggs matured to hatching (~February), females became more active and moved more broadly along the slope down to about 90 m. During the summer and early fall, females generally spread out (possibly foraging for food) and occurred in the deeper, central portions of Port Gardner at low densities until egg extrusion when they moved back inshore to the 10-40 m zone.

The relationship of female Dungeness crab movements to the three proposed disposal sites in Port Gardner is shown in Figure 55. Very few crab were found at the depths of these disposal sites during the egg incubation period (November - January). During February to May, large numbers of females moved into the area of the proposed CAD site but few were as deep as the RADCAD or PSDDA sites. In June to October, crab densities increased slightly in the PSDDA and RADCAD sites but were always substantially less than in the CAD site. Overall average densities (crab/ha) in these three sites for the 2-year sampling program were: CAD = 188, RADCAD = 19 and PSDDA = 9. Hence, the decision by the Navy to relocate from the CAD site to the RADCAD site for disposal of contaminated dredged materials should substantially reduce both direct (i.e., burial) and indirect (i.e., possible toxicant effects, especially to the externally carried eggs) effects to this species.

One important factor to note regarding Dungeness crab in Port Gardner (or, indeed, anywhere in their range) is that their population levels can vary dramatically from year to year. This fact is obvious from the fluctuations of the commercial crab landings (Figure 52) as well as implicit in sampling statistics, including Ames et al. (1975) (Figure 53) and this study (Table 2, Figure 17). The population level during a given year is composed of the integration of several year classes, each varying in year-class strength. Our sampling data in Port Gardner and in other areas of Puget Sound suggest that annual population levels undergo significant adjustments at specific times of the year. Figure 17 shows that there is an apparent reduction of population levels in April of each year followed by an increase in June. Elevated numbers of dead female crab (not molted shells) were caught in the April trawls of each year, suggesting that this is a period of natural mortality for senescent females. Hence, the population suffers a decline at this time.

In June of each year, the population level appears to increase following the period of female mortality. Sampling programs in north Puget Sound and Padilla Bay (Dinnel et al. 1986b and 1987b) have shown that juvenile crab of various sizes tend to move to deeper areas (1-year old crab from intertidal to shallow subtidal; 2-year old crab from shallow subtidal to deeper subtidal) in about June of each year following molting and mating of females in April and May. Of prime importance to note here is that the female population level in any given period of summer to fall is probably established during the spring following senescent female mortality and recruitment of young adult animals. The amount of population adjustment in any given year depends on the magnitudes of the female mortality and the recruitment of the young adults. These factors are, of course, dependent on the magnitude of year-class success of respective age classes. As a result, population levels in the summer of any given year can not be predicted (at this time) by population levels of the preceding year, nor can between-year population levels be directly compared as an index of short-term degradation or pollution.

This discussion is of importance relative to monitoring future crab density or populations in or around dredged material disposal sites. If a "before and after" analysis is desired, then it is imperative that the "after" density (or population) levels be compared to density estimates derived within that same year. The "after" estimates simply cannot be compared to previous year's estimates owing to the unknown extent of natural mortality and young adult recruitment that takes place in the spring of each year.

Also of significance in designing any future sampling plan is the fact that crab behavior also affects the density (population) estimates. Reliable density estimates of crab (especially females) during the early winter period of egg incubation is not possible because of crab burial behavior. Likewise, the efficiency of catching crab with a trawl appears to improve around February when the females apparently do not bury (since eggs are hatching) and subsequently the females may be less mobile (i.e., avoid the net less) (Figure 17 shows peak catchs in February of both years and Ames et al. (1975) observed the same pattern in February 1974 for Area 1 (Figure 53)).

<u>WQC and RADCAD Densities and Population Estimates</u>. As indicated previously, the State WQC permit for the second year's disposal at the RADCAD site is dependent on the demonstration, based on 2 years of data, that annual female Dungeness crab densities do not exceed 100 adult female crab/ha and that such crab are <5% of the population within the specified WQC area.

The seasonal average densities ranged from 0 to 56 crab/ha in the RADCAD with average densities of 9 and 21 crab/ha for 1986 and 1987, respectively. These seasonal and annual densities are substantially below the WQC standard.

For the annual 5% population restriction, the seasonal RADCAD percentages ranged from a low of 0% to a high of 9.5% (Table 3). However, the annual percentages were 1.5% and 3.7% for 1986 and 1987, respectively. Hence, the WQC percentage-based restriction has been met for these years.

Although the calculated RADCAD crab densities and percentages are below the WQC standards, the mechanics and assumptions inherent in these calculations must be clarified. First, the population estimates are based on the beam trawl catches and not on actual crab densities. While the beam trawl is the most efficient piece of trawl gear for sampling crabs, it rarely catches 100% of the crabs in its path because of avoidance and burial behavior. Second, the WQC area includes portions of the shallow Delta, River, East Waterway and South Shore (Figure 3), which were only sampled in September 1987. Thus, for seasons other than September 1987, population estimates in this stratum were based on female crab abundances measured at the 10-m stations. Third, sampling was not based on a random design but rather conducted along regularly spaced transects (plus selected deep stations not on transects) at specific depths to provide important spatial data. However, given the fact that (1) sampling biases were highly minimized by a complete lack of visualization of either crabs or the bottom type from the surface vessel, (2) trawl paths (relative to a fixed point) inherent in this type of sampling are not precise, and (3) the number of stations sampled was high, it is very reasonable to equate the sample design to a "stratified random sampling" plan for purposes of the WQC/RADCAD population estimates. Finally, we have made the statistical assumption that the estimated densities of crab follow a normal distribution within strata. Such an assumption rarely holds for this type of sampling (Elliott 1977) but is essential for determining confidence limits for a stratified sampling design. This assumption should not affect the population estimates themselves, but wide departures from normality would make the confidence intervals questionable.

Pandalid Shrimp

Puget Sound annual commercial shrimp landings have fluctuated widely during the last 50 years, ranging from 8,000 (1955) to 144,000 (1973) pounds with an annual catch averaging about 58,000 pounds (1935-1982; Figure 56) (WDF 1974, 1982, unpublished). Of this average catch, roughly 1/10 has been caught in the Port Susan/Port Gardner area of Puget Sound, and essentially 100% has come from the Port Susan statistical reporting area (Figure 57). The primary species in the Port Susan catches have been pink shrimp (a combination of *Pandalus borealis* and *P. jordani*), spot prawn and coonstripe shrimp.

Historically, the Port Susan area has been noted by WDF to be a significant commercial producer of pink shrimp and the outer portions of Port Gardner, Possession Sound and Saratoga Passage to be important for spot prawn. The inner portion of Port Gardner was not indicated to be a significant shrimp producer (Smith 1937).

Estimated pandalid shrimp densities within the RADCAD site during 1986 and 1987 ranged from a low of 0 shrimp/ha (June 1986) to a high of 142 ± 115 shrimp/ha, which was due to a relatively strong settlement of juvenile shrimp in June 1987. The average RADCAD shrimp density (all ten cruises combined) was approximately 50 shrimp/ha, an average density roughly ten times less than Bellingham Bay (a known shrimp-producing area), where an average density of about 600 shrimp/ha was estimated in 1987 by Dinnel et al. (1988). Hence, it is reasonable to conclude that the RADCAD site does not provide significant habitat for commercial shrimp production.

SUMMARY AND CONCLUSIONS

1. *Cancer* crabs and pandalid shrimp were sampled in February, April, June, September and December 1986 and 1987 by 3-m beam trawl at 55 to 95 stations around three proposed dredged material disposal sites (CAD, RADCAD, PSDDA) in Port Gardner, Washington. Additional crab and shrimp data were also collected

from a lower level of sampling (1986 only at about twenty stations) with a 7.6-m otter trawl.

2. Observations of gravid (egg-bearing) females and buried crabs were made in December 1986-January 1987 along transects using SCUBA divers and observations from the deep submersible, PISCES IV.
3. Geographic distributions of Dungeness crab in Port Gardner varied by sex and by season. In all cases, there was a very strong preference by Dungeness crab for the nearshore slope where depths ranged from 0 to 100 m.
4. Adult (≥100 mm CW) male Dungeness crab were relatively scarce in the beam trawl catches, comprising only 10-20% of the 2-year combined catches. The males were generally most abundant at the shallow (≤20 m) stations.
5. Female crab were plentiful in Port Gardner and tended to favor different depths depending on season. During winter, the females (roughly 80-90% carrying eggs) were highly aggregated in a depth zone between about 10-40 m. In February, when eggs were hatching, females moved down slope and were densest in the 40-80 m range. During summer and early fall, the females "spread out" to deeper portions of Port Gardner, possibly to forage for food.
6. An apparent period of female natural mortality was noted in April of each year when dead females were caught in the trawls and when the population estimates declined. Molting and mating of females took place around April and May of each year, with apparent recruitment of sub-adults to the adult population in June. An understanding of the timing and magnitudes of female mortality and recruitment are especially important for the interpretation of future monitoring studies. The recurring annual pattern of mortality and recruitment is probably consistent from year to year, but the magnitude of each, which is dependent on respective year-class strength, will vary between years. The best sampling times for annual population estimates are probably in summer following mortality/recruitment, or in

February when crabs (especially the females) seem to be most available (e.g., not buried) to the trawl gear.

7. For all beam trawl data combined (1986 and 1987 cruises), the approximate ratio of Dungeness crab (essentially all females) densities in the proposed disposal sites was 20:2:1 for the CAD, RADCAD and PSDDA sites, respectively. The annual estimated densities (± 95% confidence limits) of female crab within the boundaries of the RADCAD were 9.5 ± 8.2 (n = 22 samples) and 20.8 ± 9.2 (n = 35 samples) crab/ha for 1986 and 1987, respectively. These estimated densities are substantially less than the maximum standard of 100 crab/ha allowed by the State Water Quality Certification (WQC) permit for the second year's disposal of contaminated sediments.
8. Seasonal population estimates for female Dungeness crab ranged from about 50,000 to 180,000 within a specified WQC area and from 0 to 8,000 within the boundaries of the RADCAD site. As compared to the WQC area female population, females within the RADCAD site comprised from 0 to 9.5% of the WQC estimate on a seasonal basis. The annual percentages for 1986 and 1987 were 1.5 and 3.7%, respectively. Both of these annual percentages are less than the limit of 5% specified by the WQC permit for allowing the second year's disposal.
9. Seven species of pandalid shrimp were caught in Port Gardner. The most abundant of these species were the spot prawn, coonstripe shrimp, sidestripe shrimp and pink shrimp. Gravid female shrimp of most species occurred during the winter, and newly settled juvenile shrimp were caught in June and September trawls. None of these shrimp species occurred in commercially important densities in Port Gardner, but moderate commercial shrimp catches are made in Port Susan just to the north of Port Gardner.

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FIGURES AND TABLES

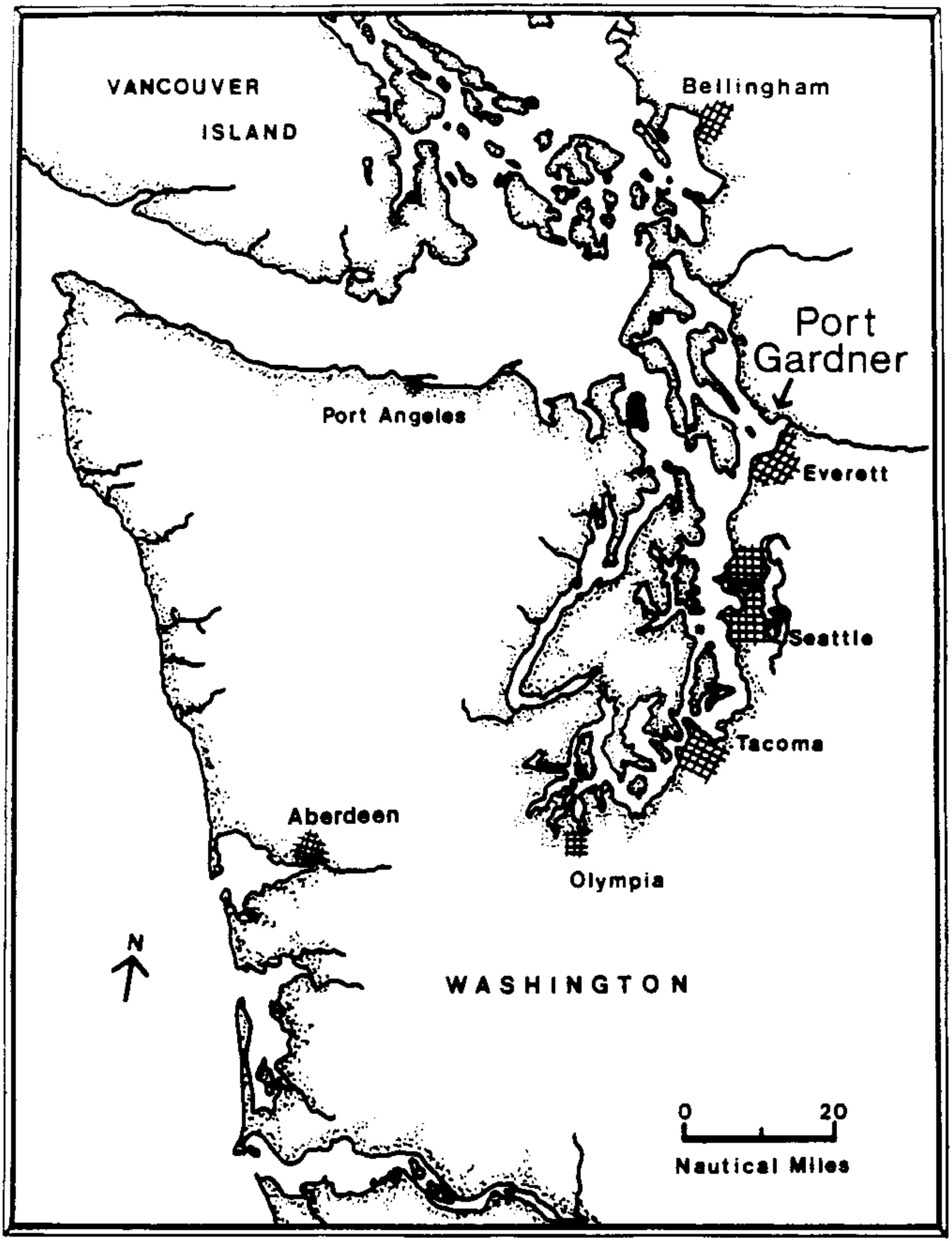


Figure 1. Map of Western Washington showing the location of Port Gardner.

Table 1. Summary of sampling seasons, dates, vessels, and gear associated with resource sampling in and around dredged materials disposal sites in Port Gardner during 1986 and 1987.

SEASON	VESSEL	GEAR	SAMPLE DATES
1986			
FEBRUARY	KITTIWAKE	Beam / Otter Trawl	FEB 4-7 / 12-13
APRIL	KITTIWAKE	Beam / Otter Trawl	APR 15-18 / 18-22
JUNE	KITTIWAKE	Beam / Otter Trawl	JUNE 4-9 / 30-2 JULY
SEPTEMBER	KITTIWAKE	Beam / Otter Trawl	SEPT 12-18 / 11-15
DECEMBER	KITTIWAKE	Beam Trawl	DEC 5-10
DECEMBER	20' WHALER	Diver Transects	DEC 16-18
1987			
JANUARY	KITTIWAKE	Otter Trawl	JAN 16
JANUARY	PISCES IV	Submersible	JAN 6-9
FEBRUARY	KITTIWAKE	Beam Trawl	FEB 2-6
APRIL	KITTIWAKE	Beam Trawl	APR 7-13
JUNE	KITTIWAKE	Beam Trawl	JUNE 1-5
SEPTEMBER	KITTIWAKE	Beam Trawl	SEPT 21-25
SEPTEMBER	20' WHALER	Beam Trawl	SEPT 30
DECEMBER	KITTIWAKE	Beam Trawl	DEC 30

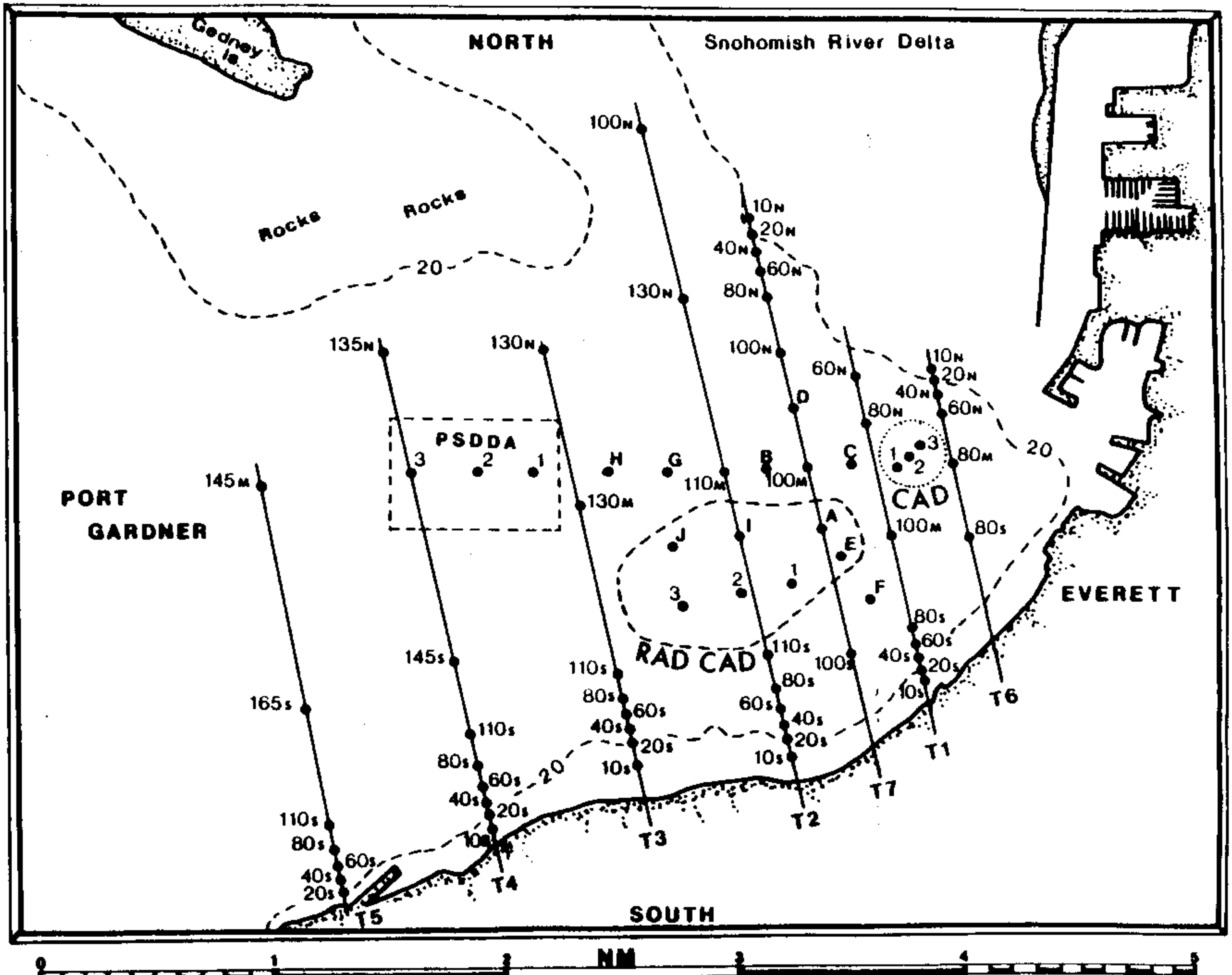


Figure 2. **Map of Port Gardner showing the locations** of the beam trawl sampling stations excluding the shallow Delta, River and East Waterway stations sampled during the latter part of 1987. Stations A-H and the 60 m stations were gradually added to the sampling plan. The station numbers indicate the

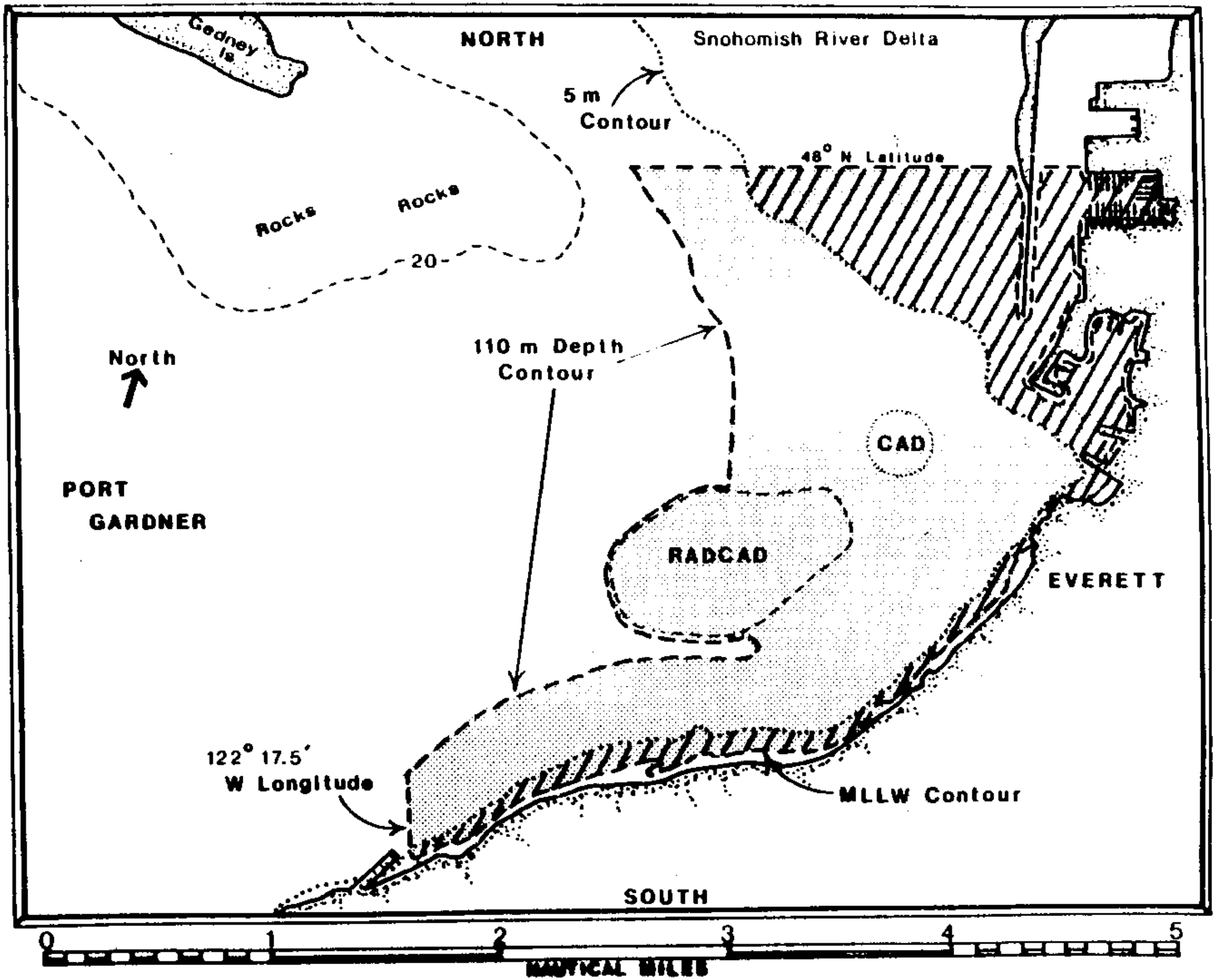


Figure 3. Map of Port Gardner showing the Washington Department of Ecology Water Quality Certification zone (stippled area) and the shallow areas within the WQC zone that were only sampled in the latter part of 1987 (hatched area).

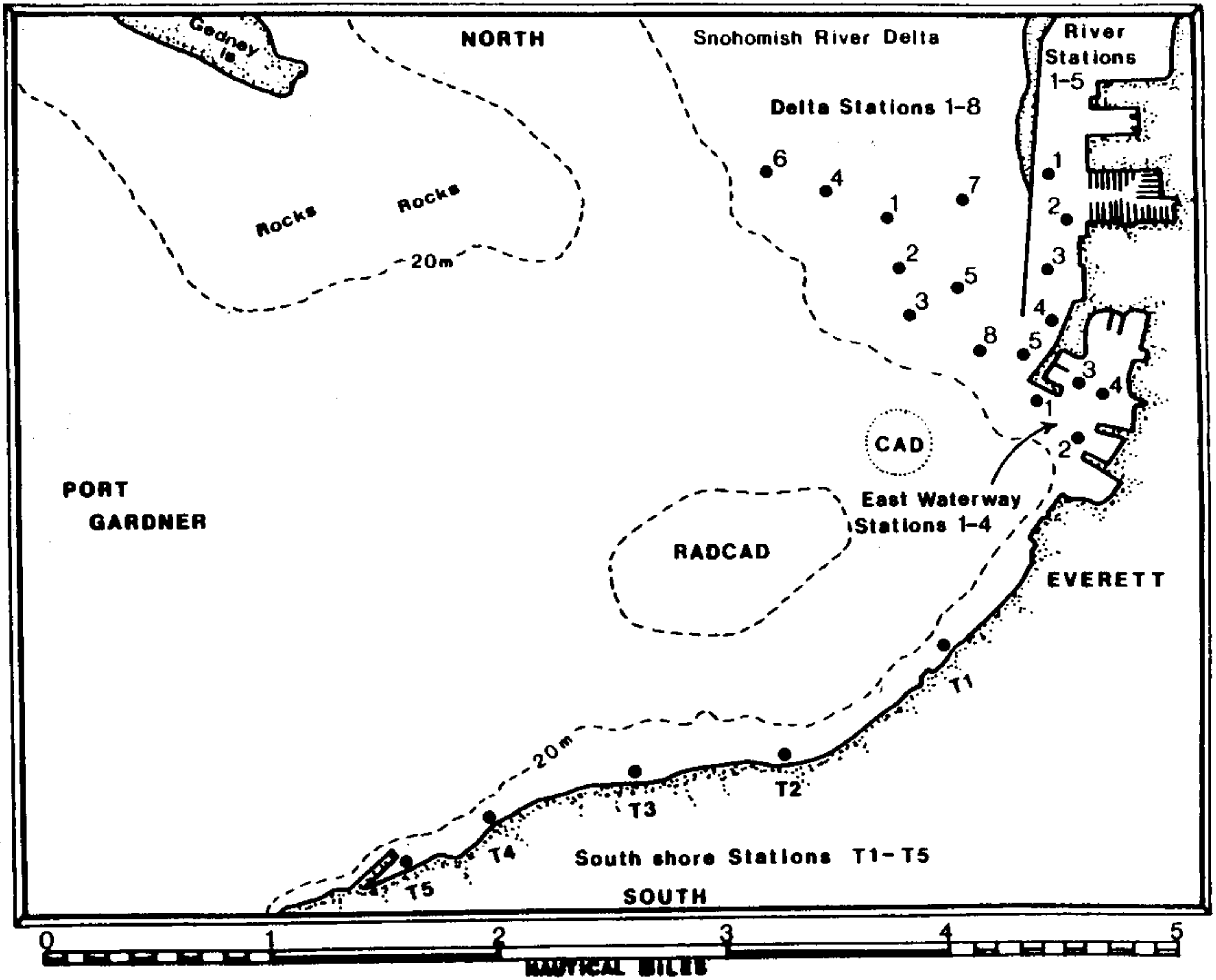


Figure 4. Map of Port Gardner showing the locations of the additional shallow stations (3-15m) sampled in June and September 1987. Only Delta Stations 1-5 were sampled in June while all stations were sampled in September.

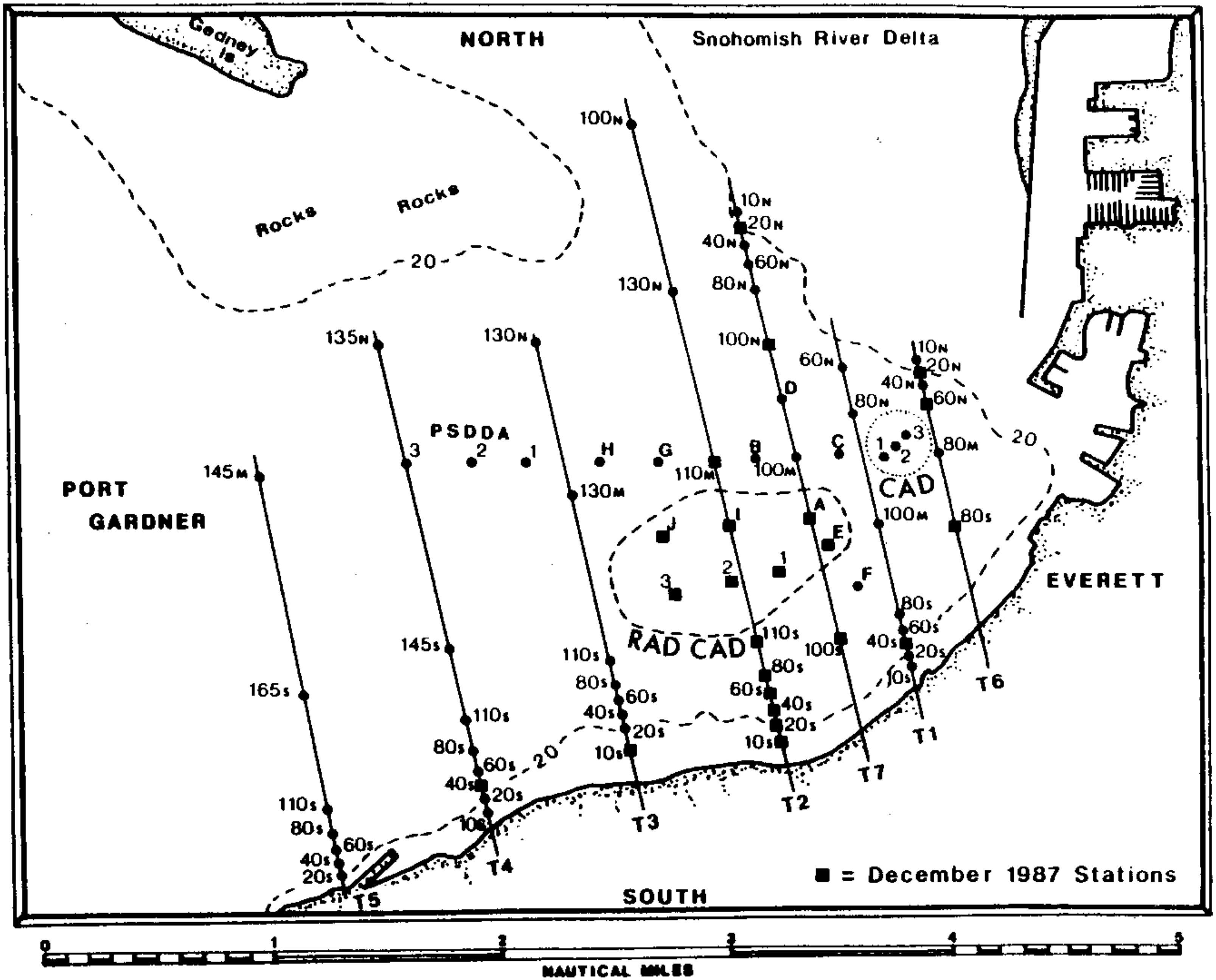


Figure 5. Map of Port Gardner showing the abbreviated set of 23 stations sampled by beam trawl in December 1987.

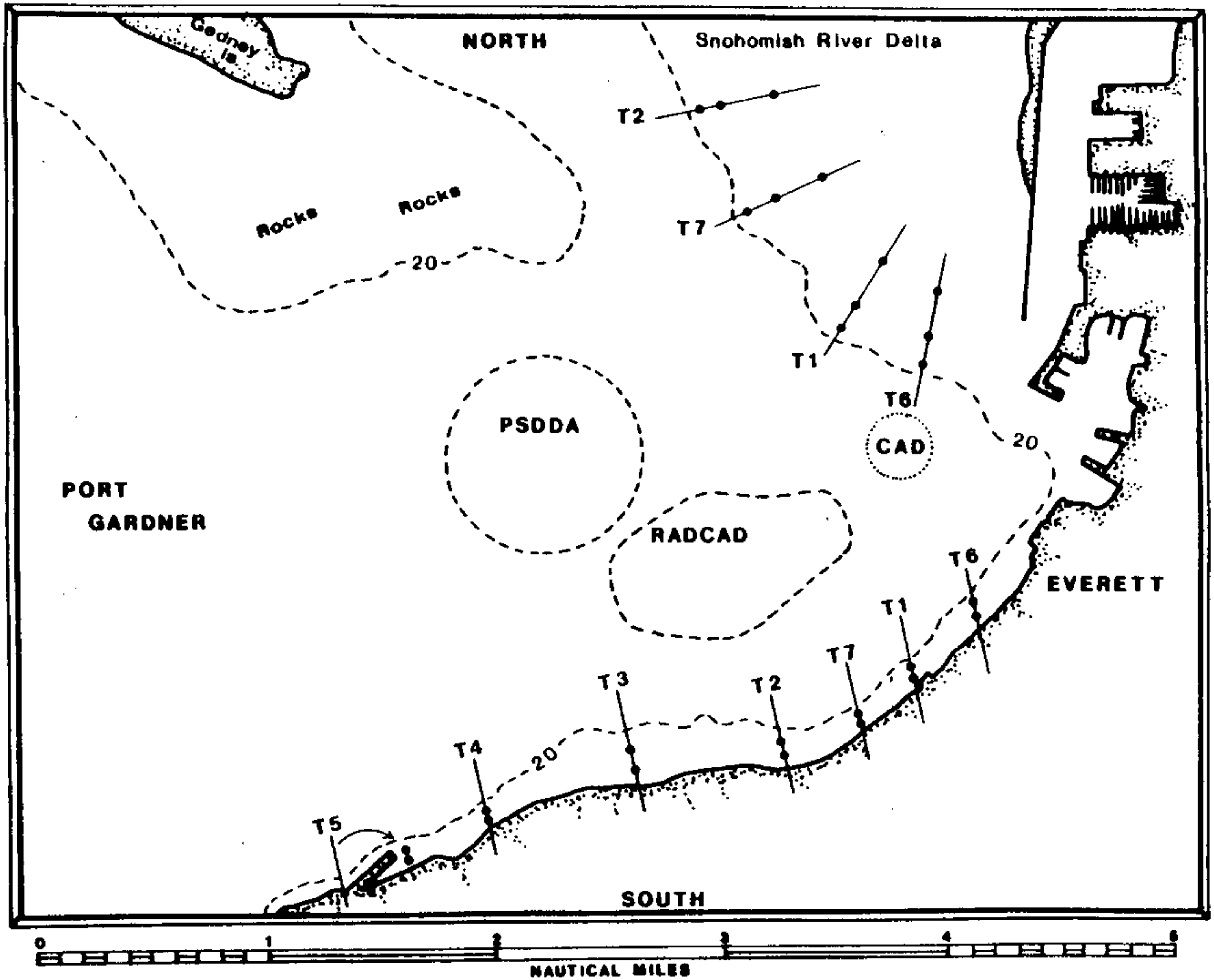


Figure 6. Map of Port Gardner showing the locations of the shallow dive transects sampled for Dungeness crab by SCUBA divers in December 1986.

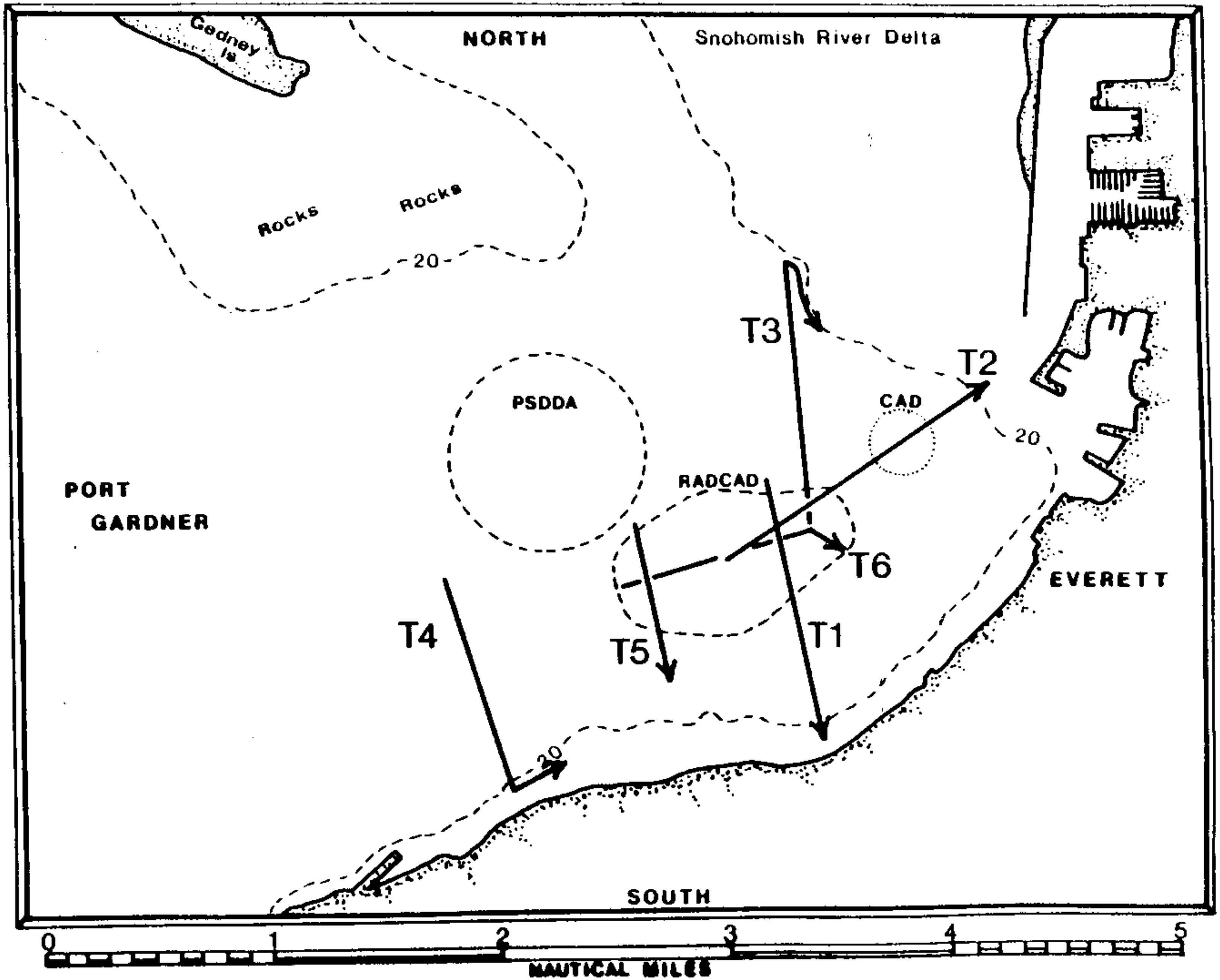


Figure 7. Map of Port Gardner showing the paths of the dive transects covered by the **Pisces IV submersible in January 1987.**

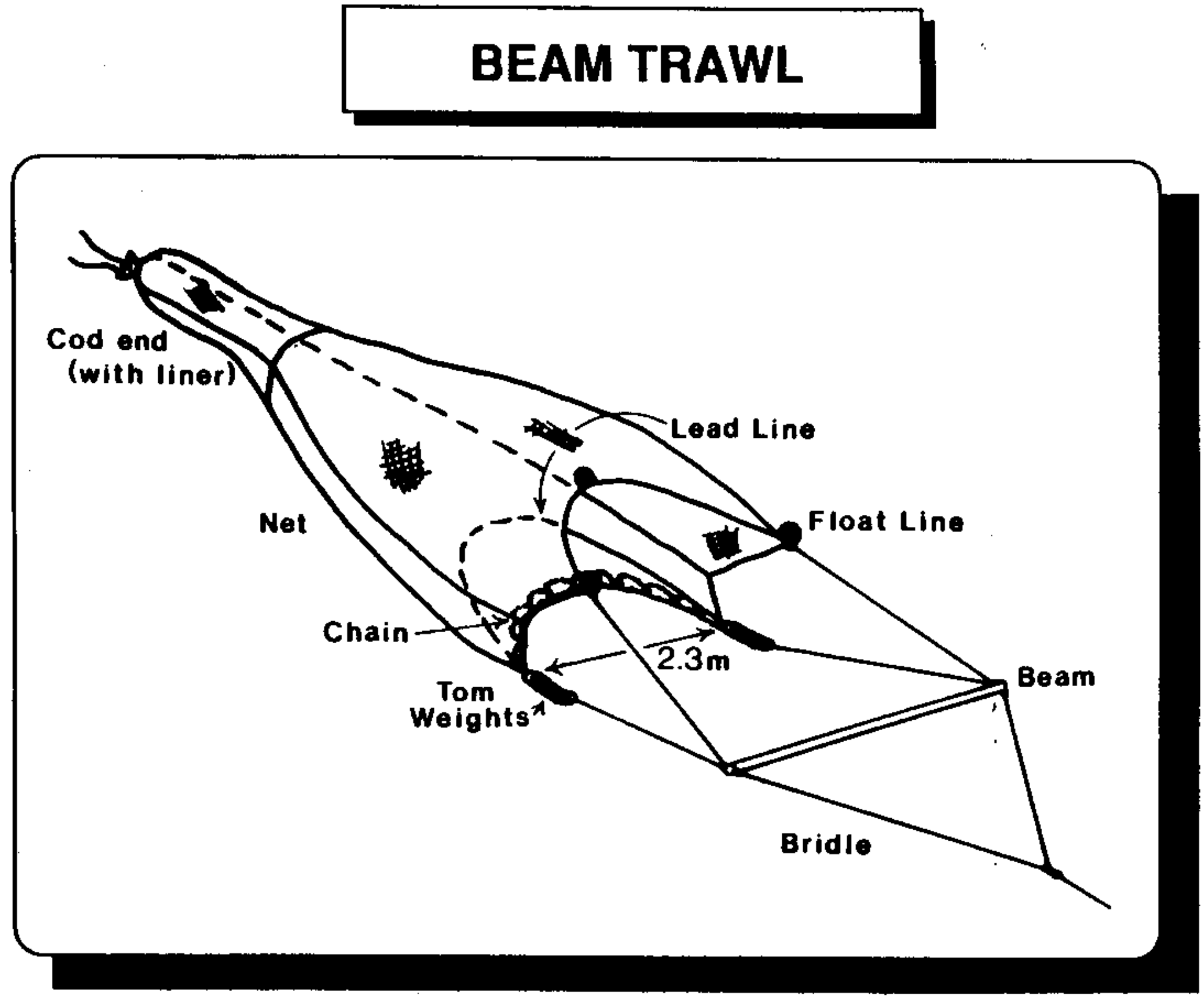
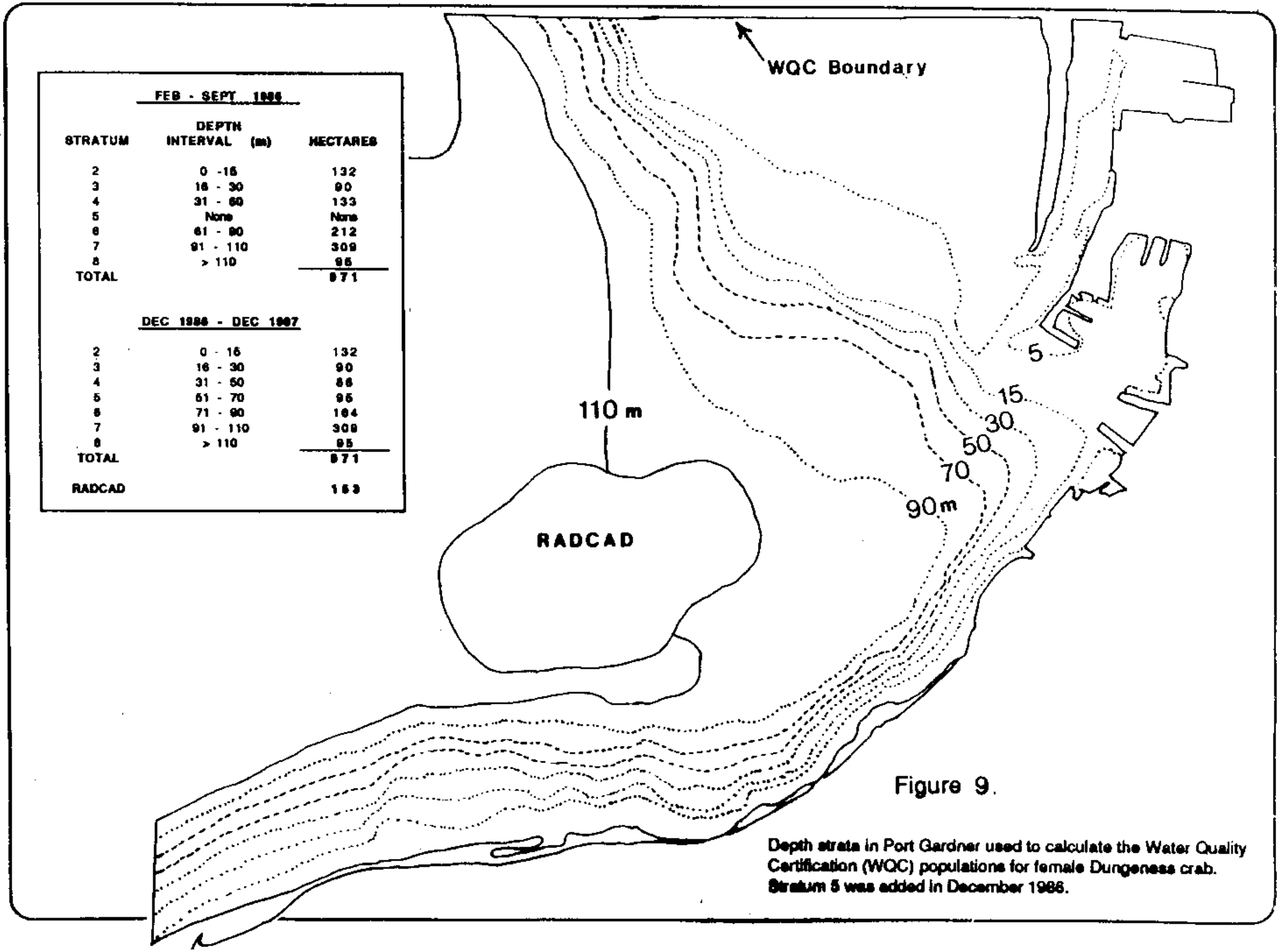


Figure 8. Diagram of the 3-m beam trawl used to sample invertebrate resources in Puget Sound. The trawl is as described by Gunderson and Ellis (1986) except that the beam was steel instead of aluminum.



STRATUM	DEPTH INTERVAL (m)	HECTARES
FEB - SEPT 1986		
2	0 - 15	132
3	16 - 30	90
4	31 - 60	133
5	None	None
6	61 - 90	212
7	91 - 110	309
8	> 110	95
TOTAL		971
DEC 1986 - DEC 1987		
2	0 - 15	132
3	16 - 30	90
4	31 - 50	86
5	51 - 70	95
6	71 - 90	164
7	91 - 110	309
8	> 110	95
TOTAL		971
RADCAD		163

Figure 9.

Depth strata in Port Gardner used to calculate the Water Quality Certification (WQC) populations for female Dungeness crab. Stratum 5 was added in December 1986.

FEMALE DUNGENESS CRAB 1986

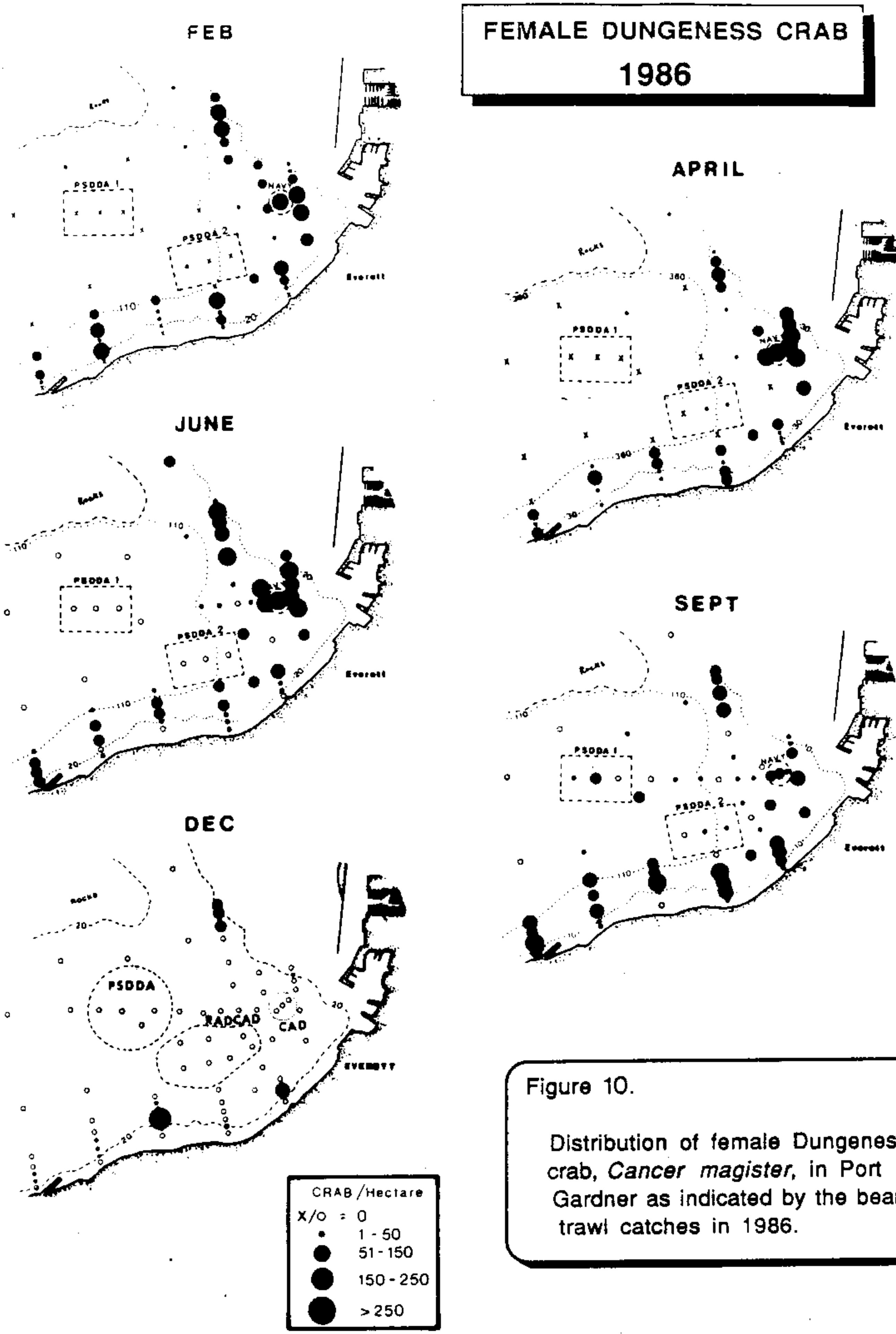


Figure 10.

Distribution of female Dungeness crab, *Cancer magister*, in Port Gardner as indicated by the beam trawl catches in 1986.

FEMALE DUNGENESS CRAB 1987

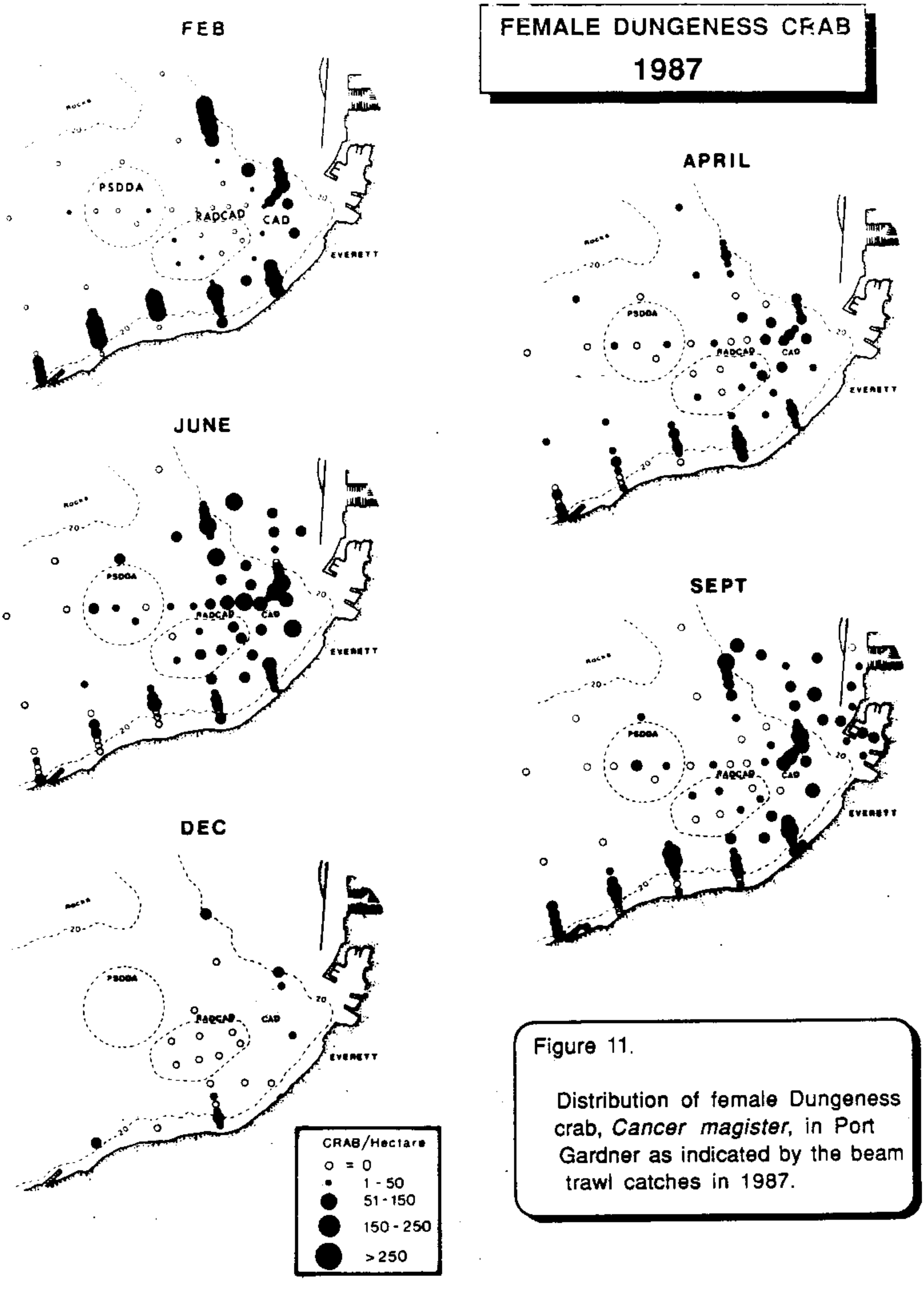


Figure 11.

Distribution of female Dungeness crab, *Cancer magister*, in Port Gardner as indicated by the beam trawl catches in 1987.

MALE DUNGENESS CRAB

1986

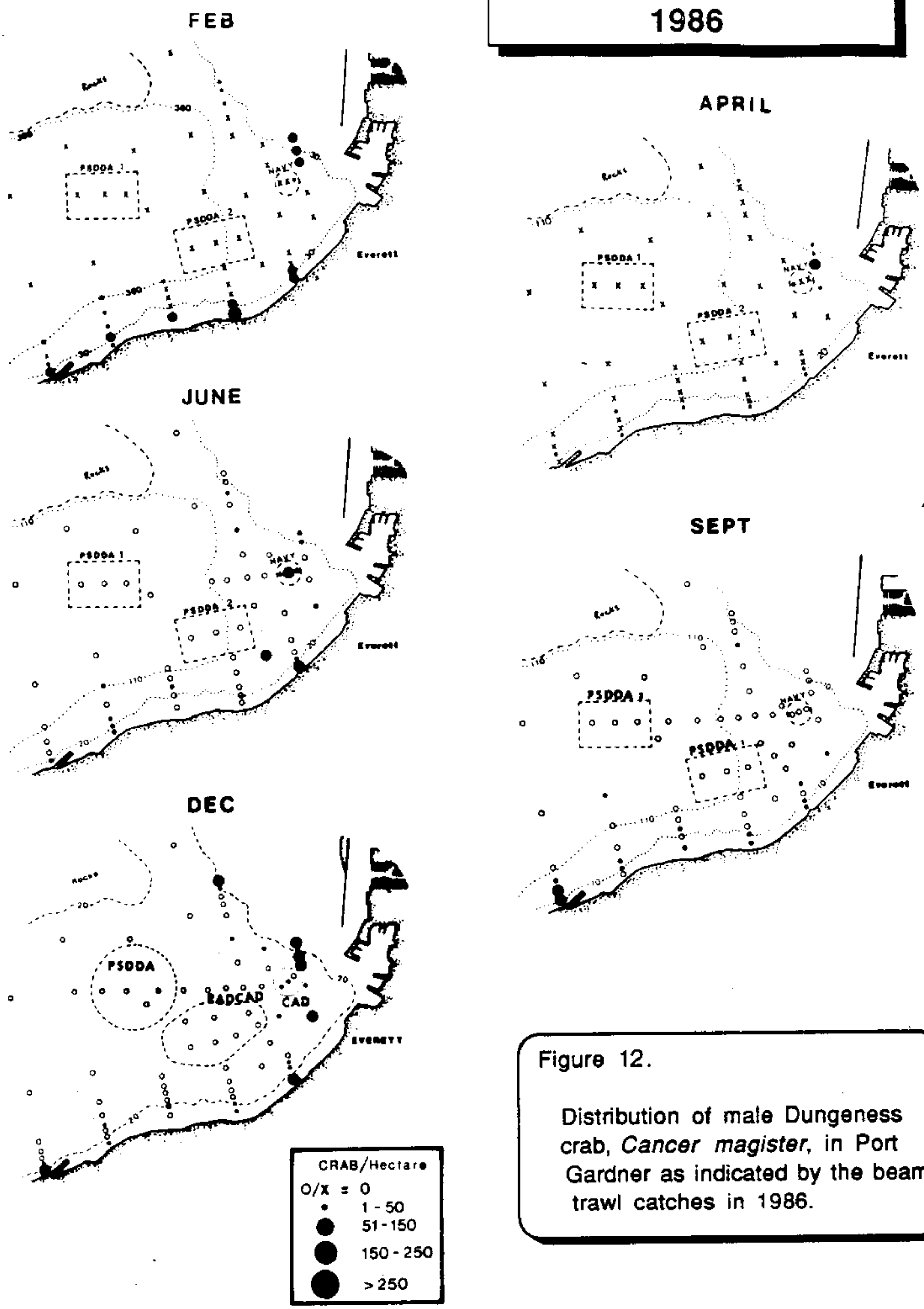


Figure 12.

Distribution of male Dungeness crab, *Cancer magister*, in Port Gardner as indicated by the beam trawl catches in 1986.

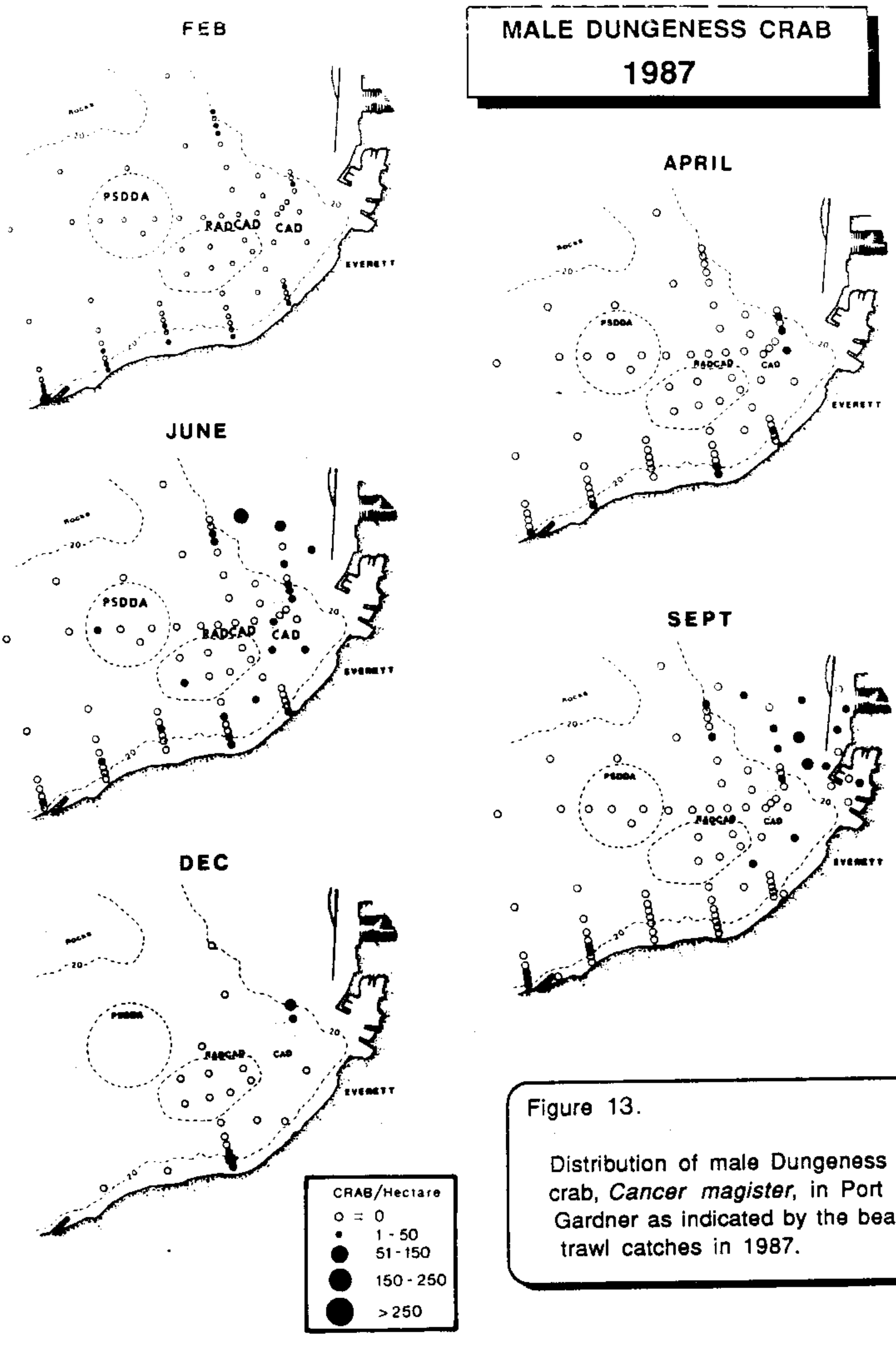


Figure 13.

Distribution of male Dungeness crab, *Cancer magister*, in Port Gardner as indicated by the beam trawl catches in 1987.

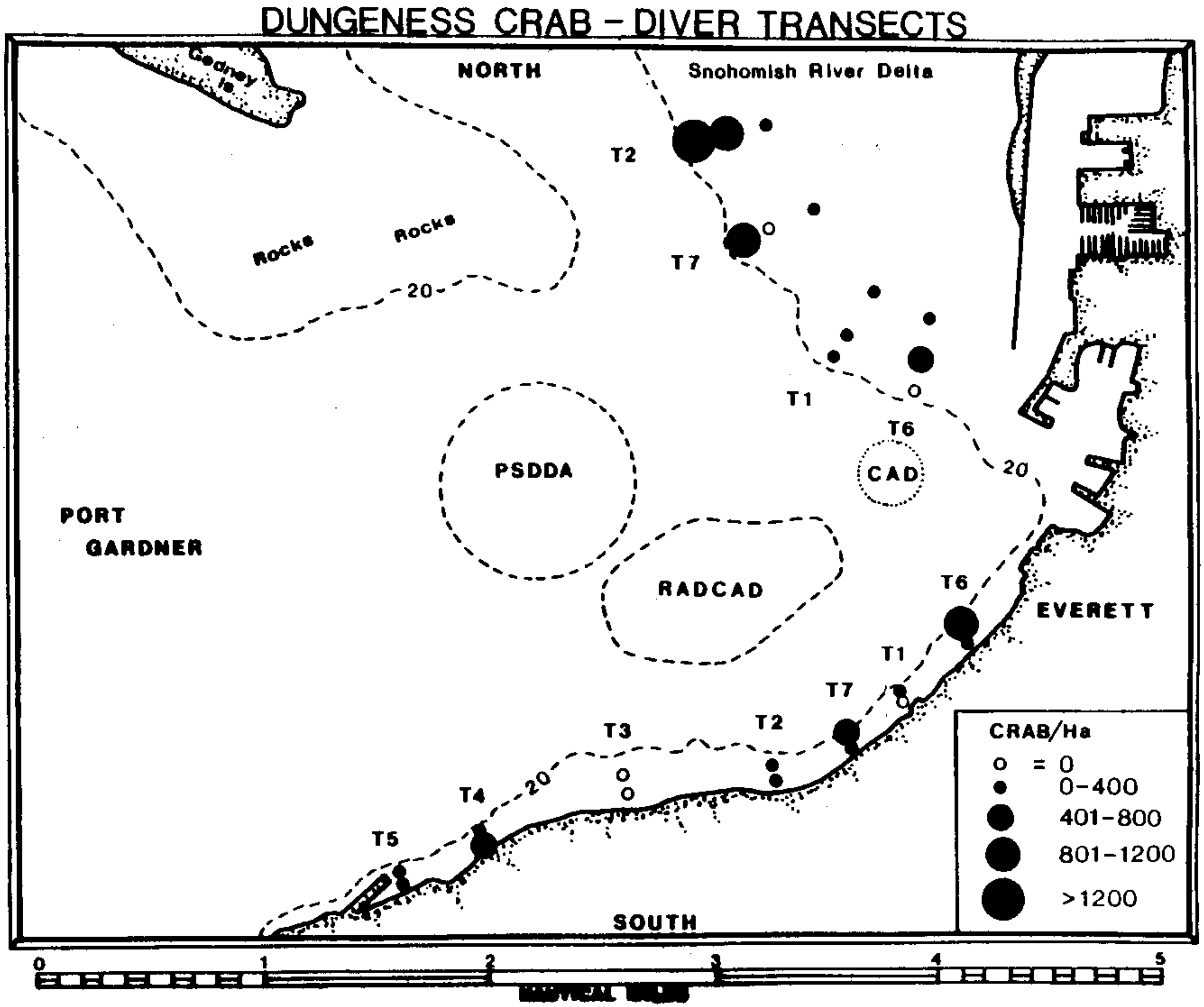


Figure 14. Map of Port Gardner showing the distribution of Dungeness crab as indicated by SCUBA diver catches along transect lines in December 1986.

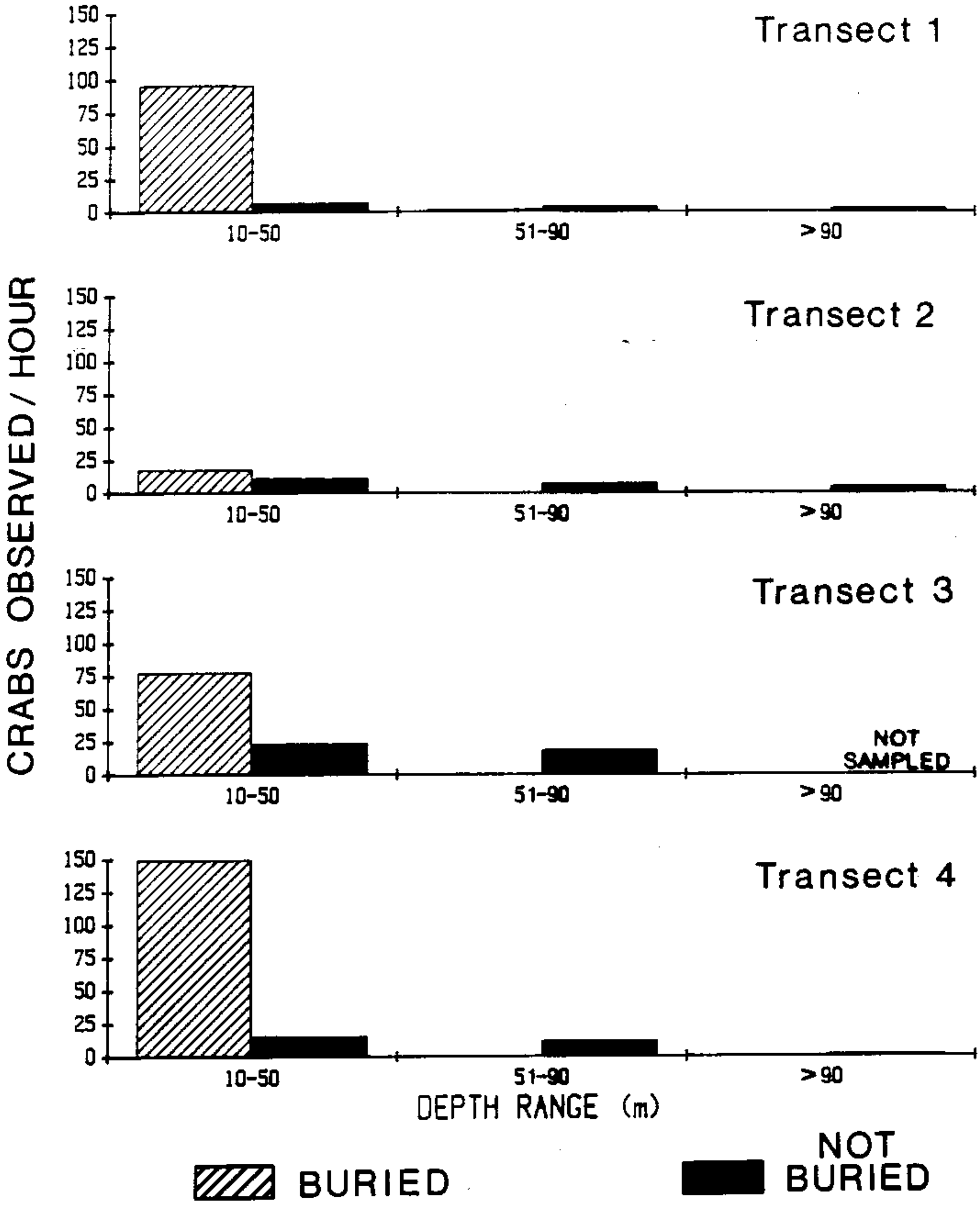


Figure 15. Number of Dungeness crab observed from the **Pisces IV** along four transects in Port Gardner during January 1987. See Figure 7 for the transect locations.

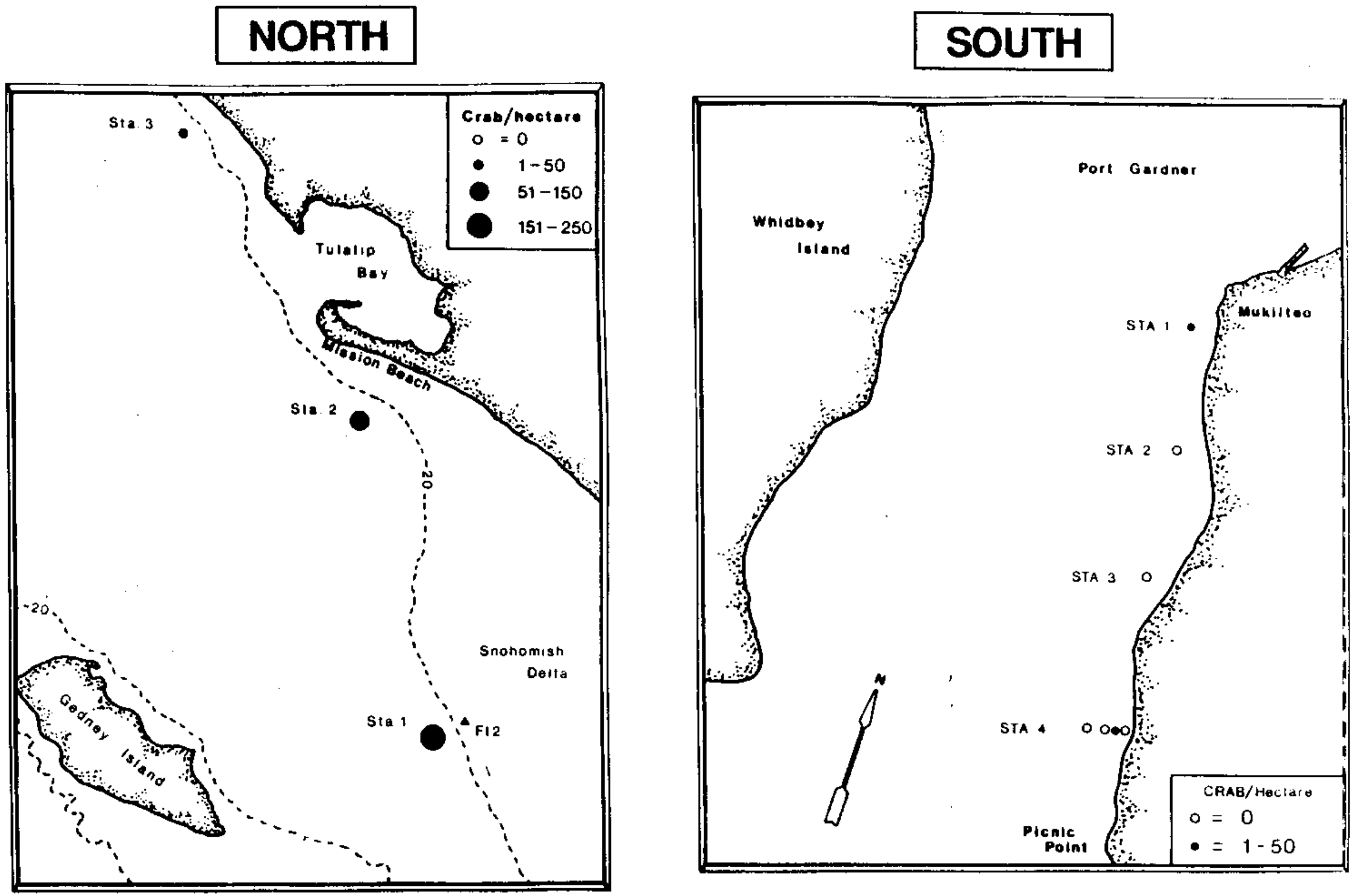


Figure 16. Estimated densities of Dungeness crab as indicated by beam trawl catches at 3 stations sampled north of Port Gardner in June 1986 (left) and at 7 stations sampled south of Port Gardner in September 1986 (right).

Table 2. Average estimated Dungeness crab density (crab/ha ± 1 standard deviation) in Port Gardner(all beam trawl samples combined; see Figure 2) and within each of the proposed disposal sites for all ten cruises during 1986 and 1987. The shallow Delta, River, and East Waterway stations are excluded (see Figure 4) NS = not sampled.

SEASON	# STATIONS SAMPLED	PORT GARDNER	CAD	RADCAD	PSDDA
FEBRUARY 1986	55	126 ± 150	225 ± 98	6 ± 11	0 ± 0
APRIL	55	85 ± 127	388 ± 141	19 ± 19	0 ± 0
JUNE	59	114 ± 178	502 ± 103	19 ± 32	0 ± 0
SEPTEMBER	63	100 ± 119	76 ± 51	11 ± 10	25 ± 29
DECEMBER	73	71 ± 313	25 ± 21	0 ± 0	0 ± 0
FEBRUARY 1987	73	147 ± 242	100 ± 54	16 ± 20	5 ± 10
APRIL	73	40 ± 43	44 ± 21	20 ± 21	10 ± 11
JUNE	73	85 ± 96	175 ± 121	56 ± 31	33 ± 32
SEPTEMBER	73	83 ± 110	156 ± 76	16 ± 17	9 ± 18
DECEMBER*	23	31 ± 53	NS	0 ± 0	NS

* Sampling at an abbreviated set of 23 stations only.

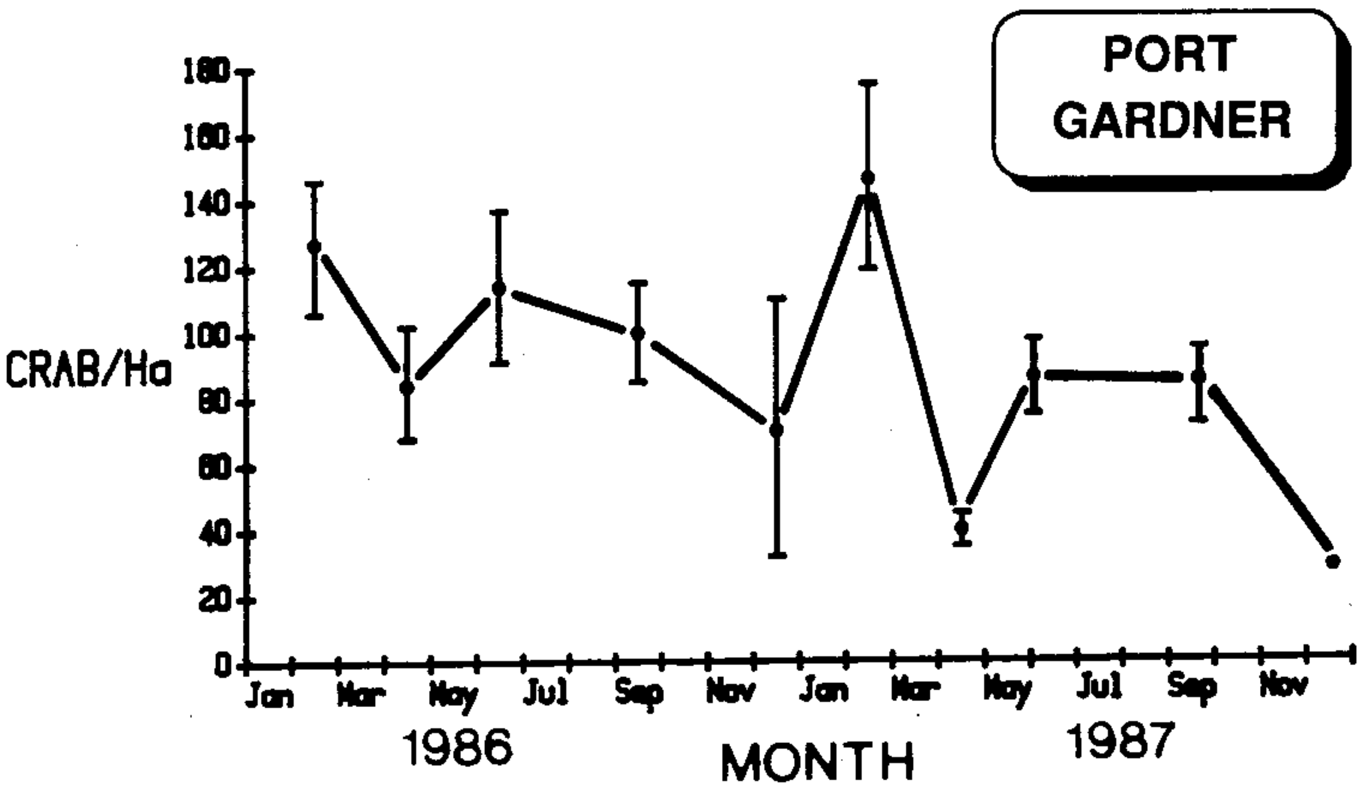


Figure 17. Average estimated densities of Dungeness crab in Port Gardner (all stations except the shallow Delta, River, and East Waterway stations) as indicated by beam trawl catches in 1986 and 1987. The bars are ± 1 standard error on the means.

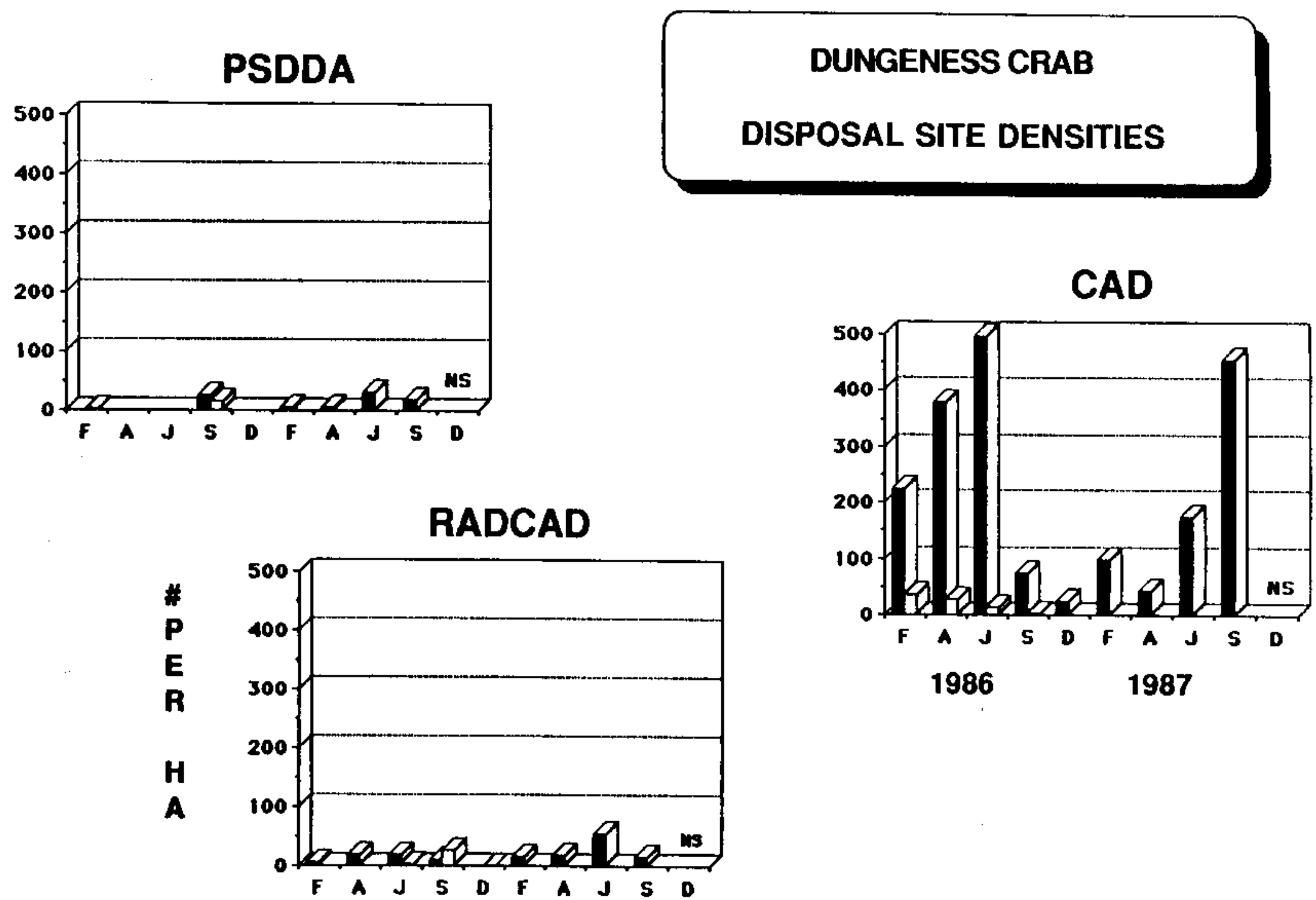


Figure 18. Seasonal densities of all Dungeness crab in the three proposed Port Gardner disposal sites as indicated by beam (■) and otter (□) trawl catches. Otter trawl sampling was conducted only in 1986. NS = not sampled.

Table 3. Mean population estimates and 95% confidence intervals of the means for female Dungeness crab in the Water Quality Certification (WQC) and RADCAD areas of Port Gardner during 1986 and 1987. Also included are estimates of the percent of females residing within the boundaries of the RADCAD relative to the WQC area.

MONTH		WQC POPULATION ESTIMATE (IN 1000'S OF CRAB)	95% CONFIDENCE INTERVAL (IN 1000'S OF CRAB)	RADCAD POPULATION ESTIMATE	95% CONFIDENCE INTERVAL	PERCENT FEMALES IN RADCAD
FEBRUARY	1986	138.7	± 51.0	925	± 11,754	0.7
APRIL		101.9	47.5	2,775	6,895	2.7
JUNE		111.7	43.7	2,775	8,831	2.5
SEPTEMBER		97.8	20.1	1,665	2,163	1.7
DECEMBER		71.5	83.1	0	0	0
FEBRUARY	1987	180.3	85.0	2,379	2,883	1.3
APRIL		51.3	19.8	2,775	2,964	5.4
JUNE		83.7	23.2	7,929	4,520	9.5
SEPTEMBER		104.0	25.8	2,379	2,426	2.3
DECEMBER		NOT CALCULATED	NOT CALCULATED	0	0	0
					AVERAGE % 1986 =	1.5
					AVERAGE % 1987 =	3.7
					TWO-YEAR AVERAGE =	2.6

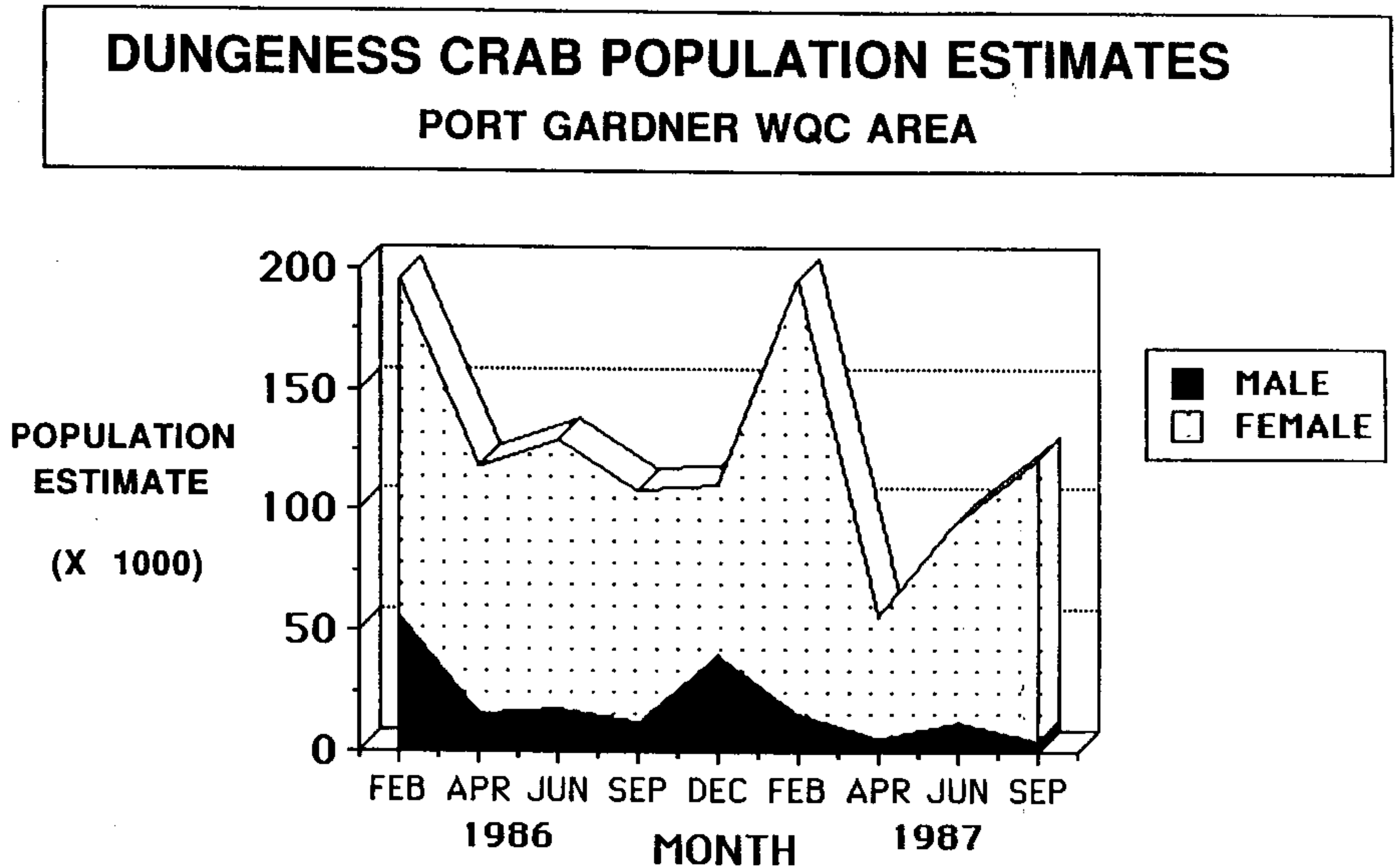
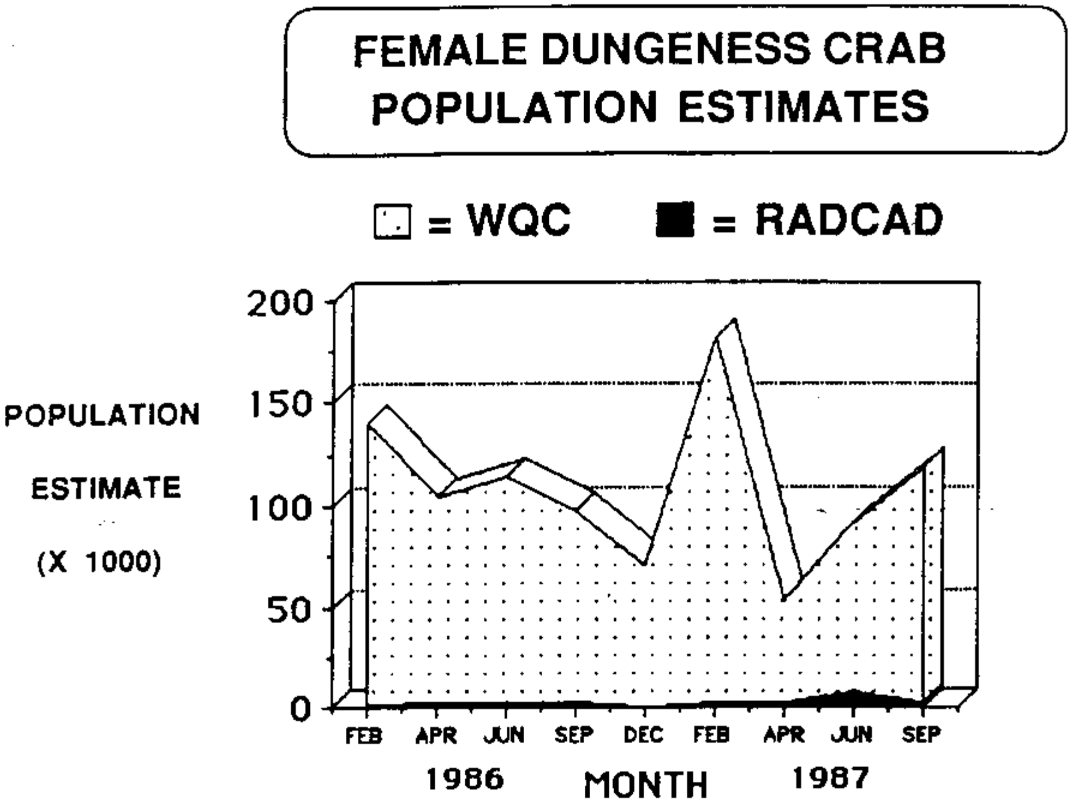


Figure 19. Seasonal population estimates of male and female Dungeness crab within the Water Quality Certification (WQC) area of Port Gardner. No estimates were calculated for the abbreviated December 1987 sampling.



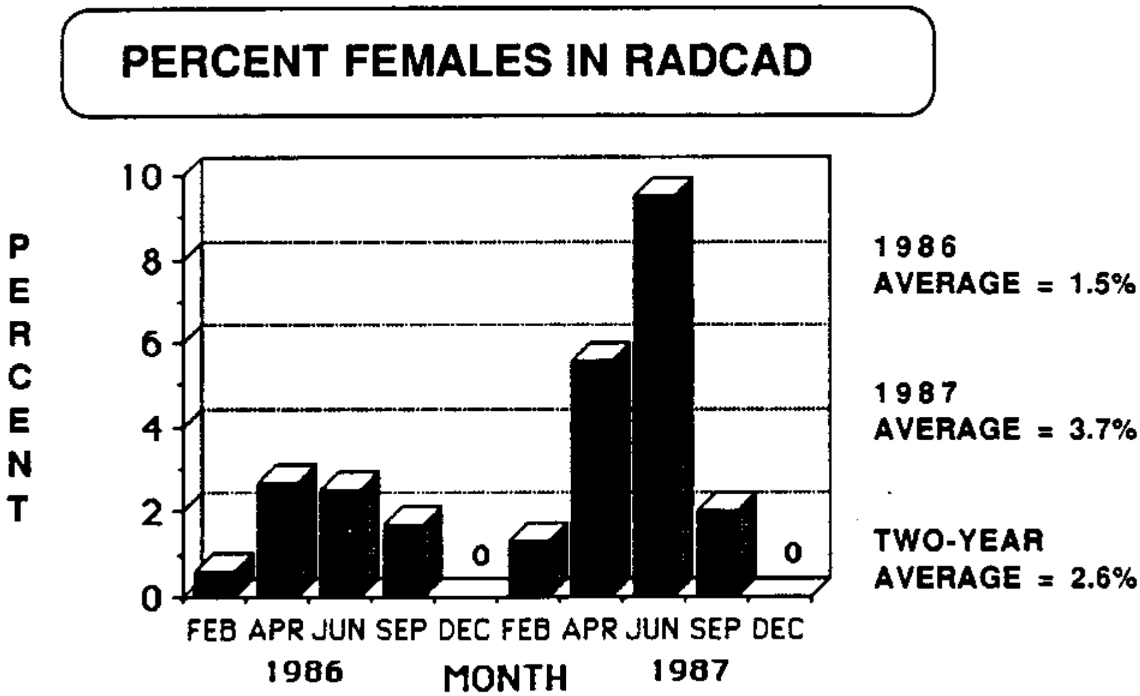


Figure 20. Seasonal female Dungeness crab population estimates for the Water Quality Certification (WQC) and RADCAD areas of Port Gardner (top) and the percent females estimated within the RADCAD site relative to the WQC populations.

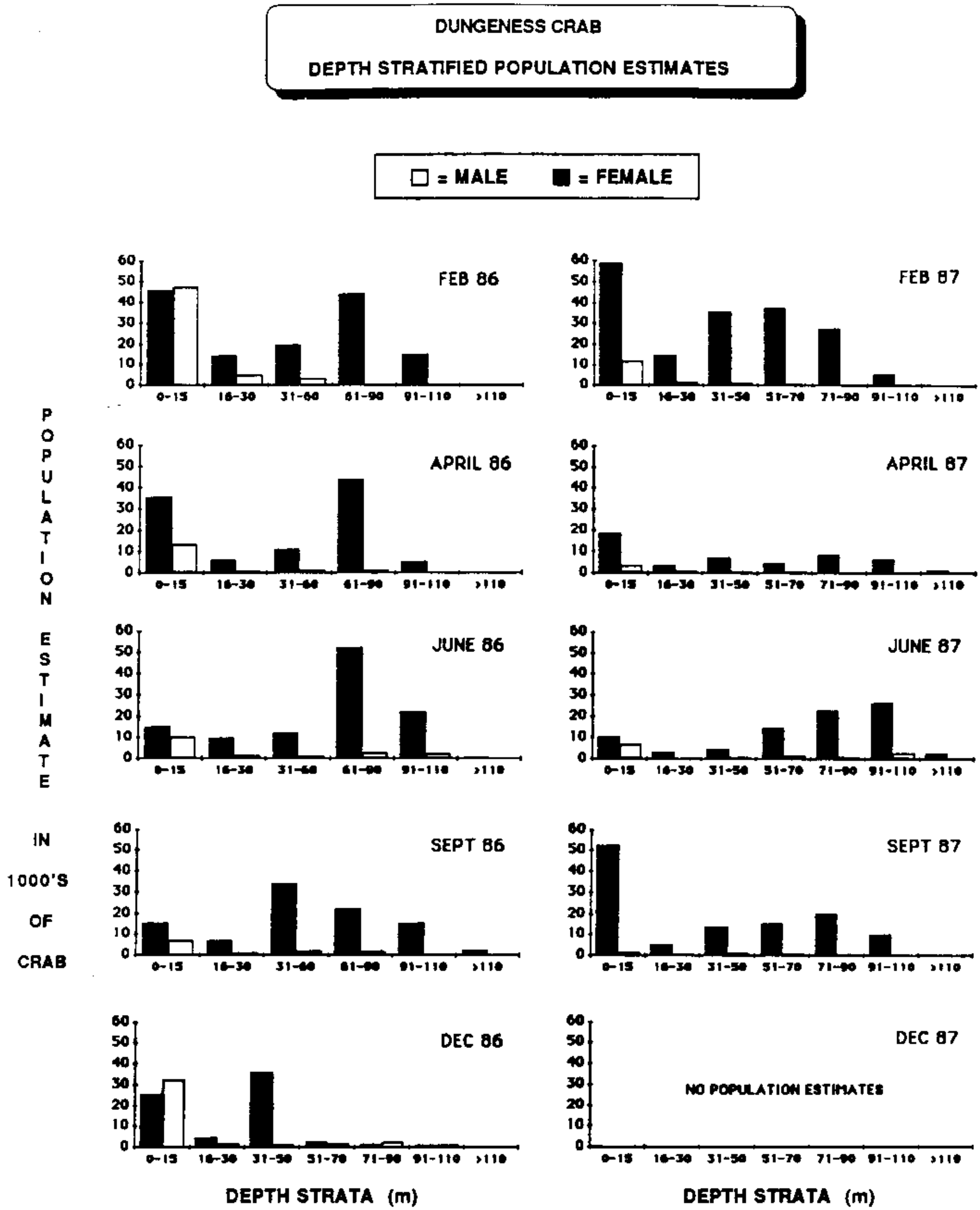


Figure 21. Seasonal population estimates of male and female Dungeness crab for all depth strata of the WDOE Water Quality Certification area of Port Gardner. No population estimates were calculated for December 1987 due to reduced sampling.

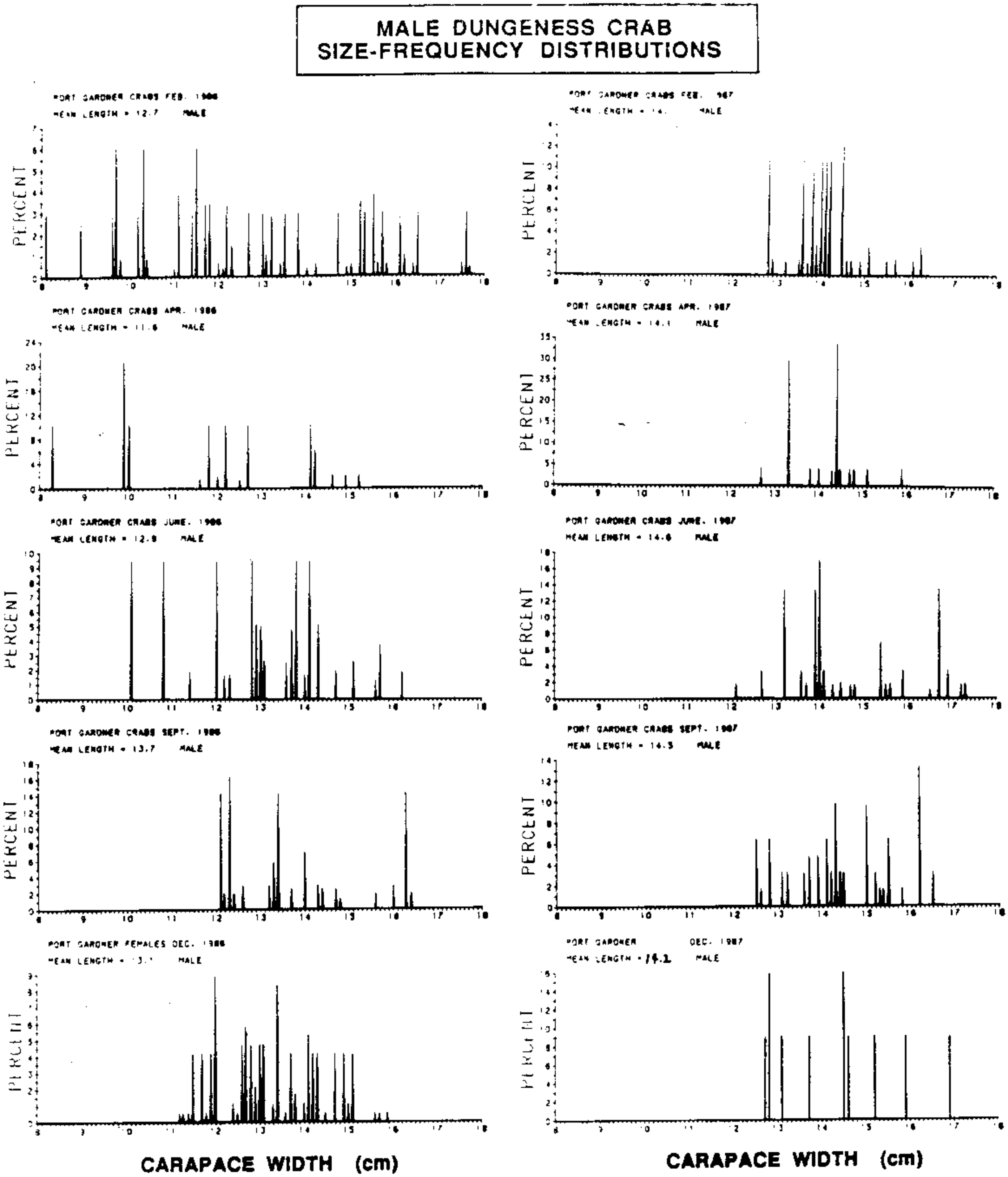


Figure 22. Seasonal size-frequency histograms for male Dungeness crab caught by beam trawl sampling in Port Gardner during 1986 and 1987. Note: Mean "length" = carapace width.

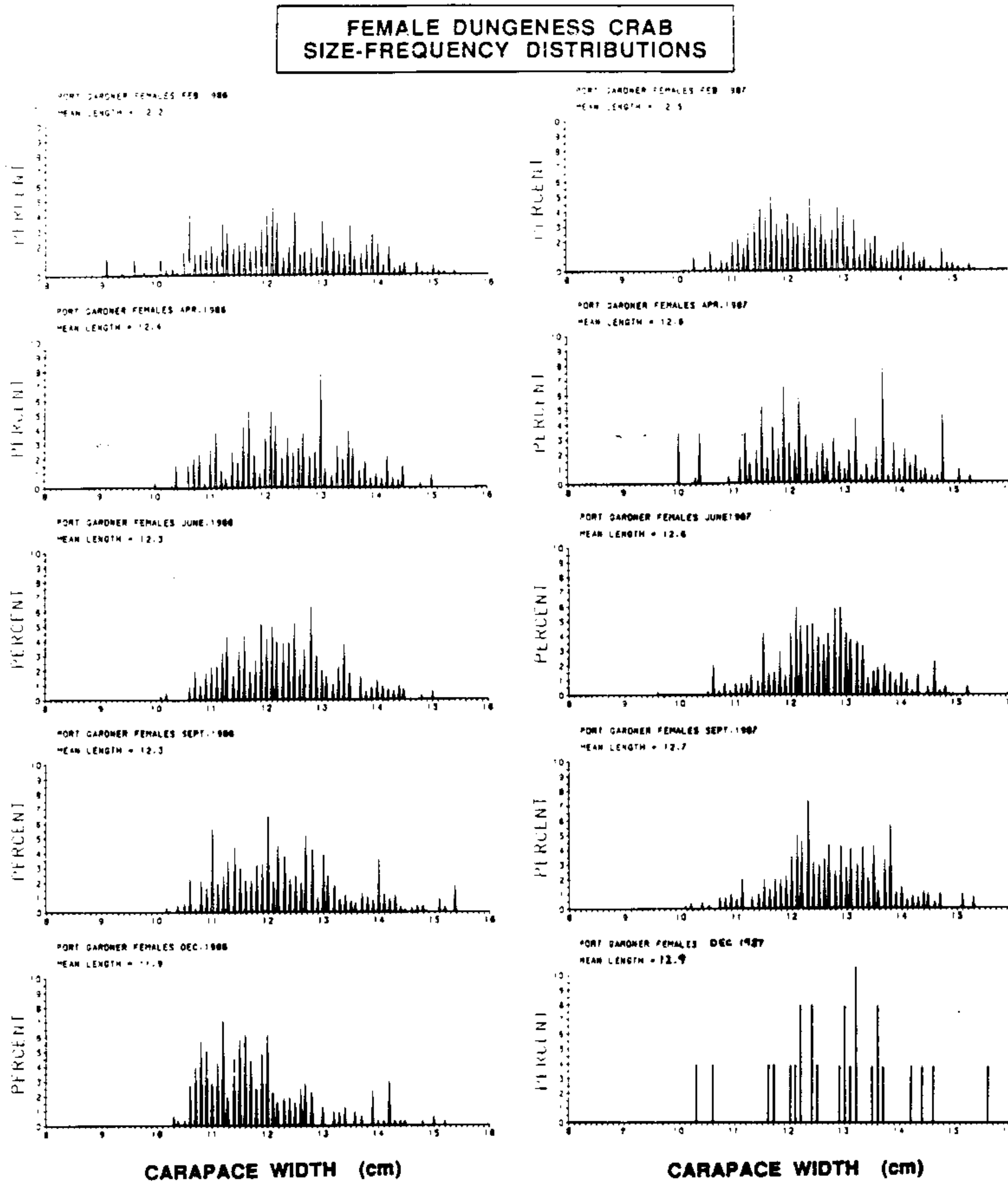


Figure 23. Seasonal size-frequency histograms for female Dungeness crab caught by beam trawl sampling in Port Gardner during 1986 and 1987. Note: Mean "length" = carapace width.

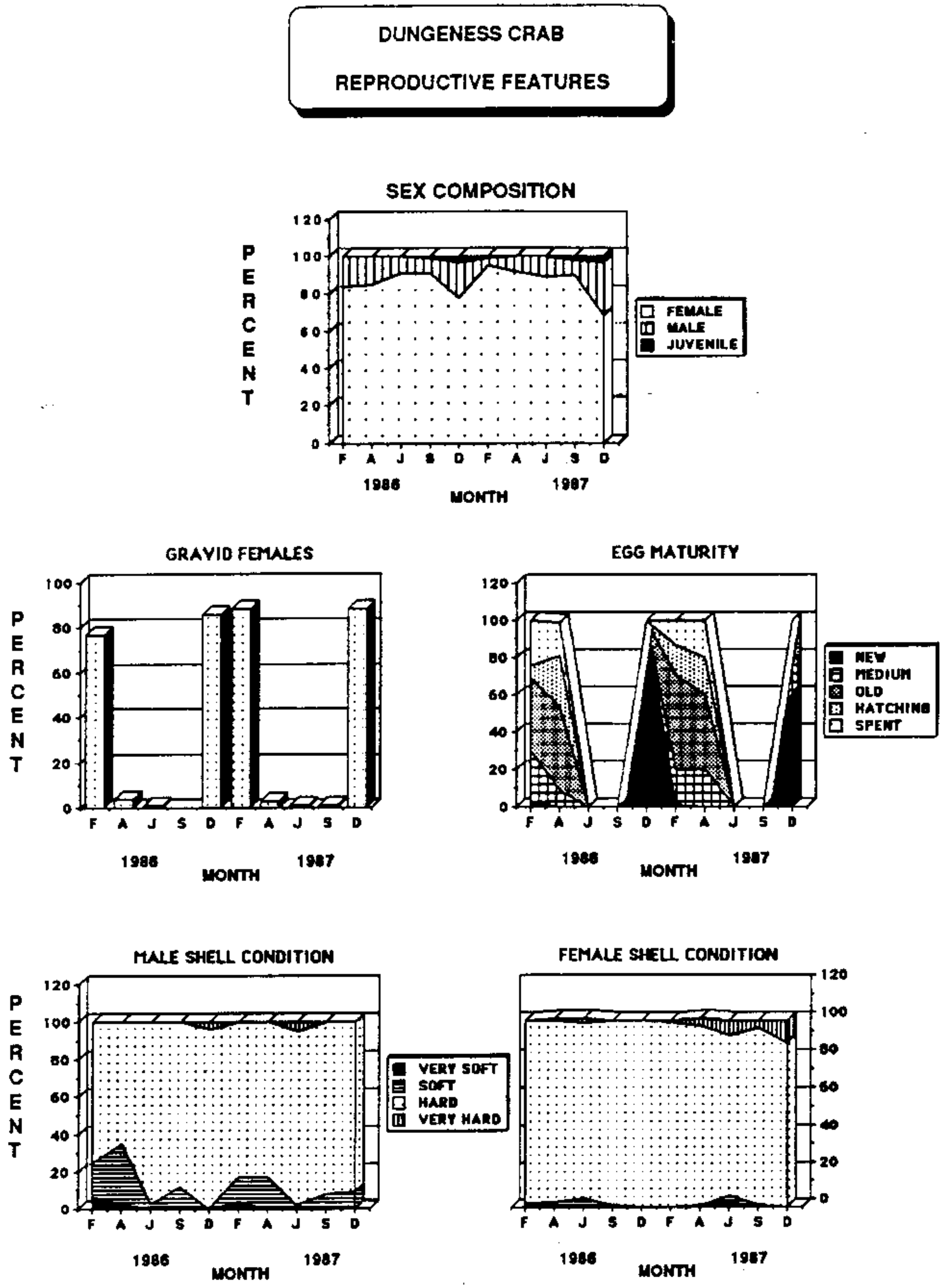


Figure 24. Summary of *Cancer magister* sex composition, female reproductive condition, egg maturity, and shell condition during each of five sampling periods in Port Gardner during 1986 and 1987.

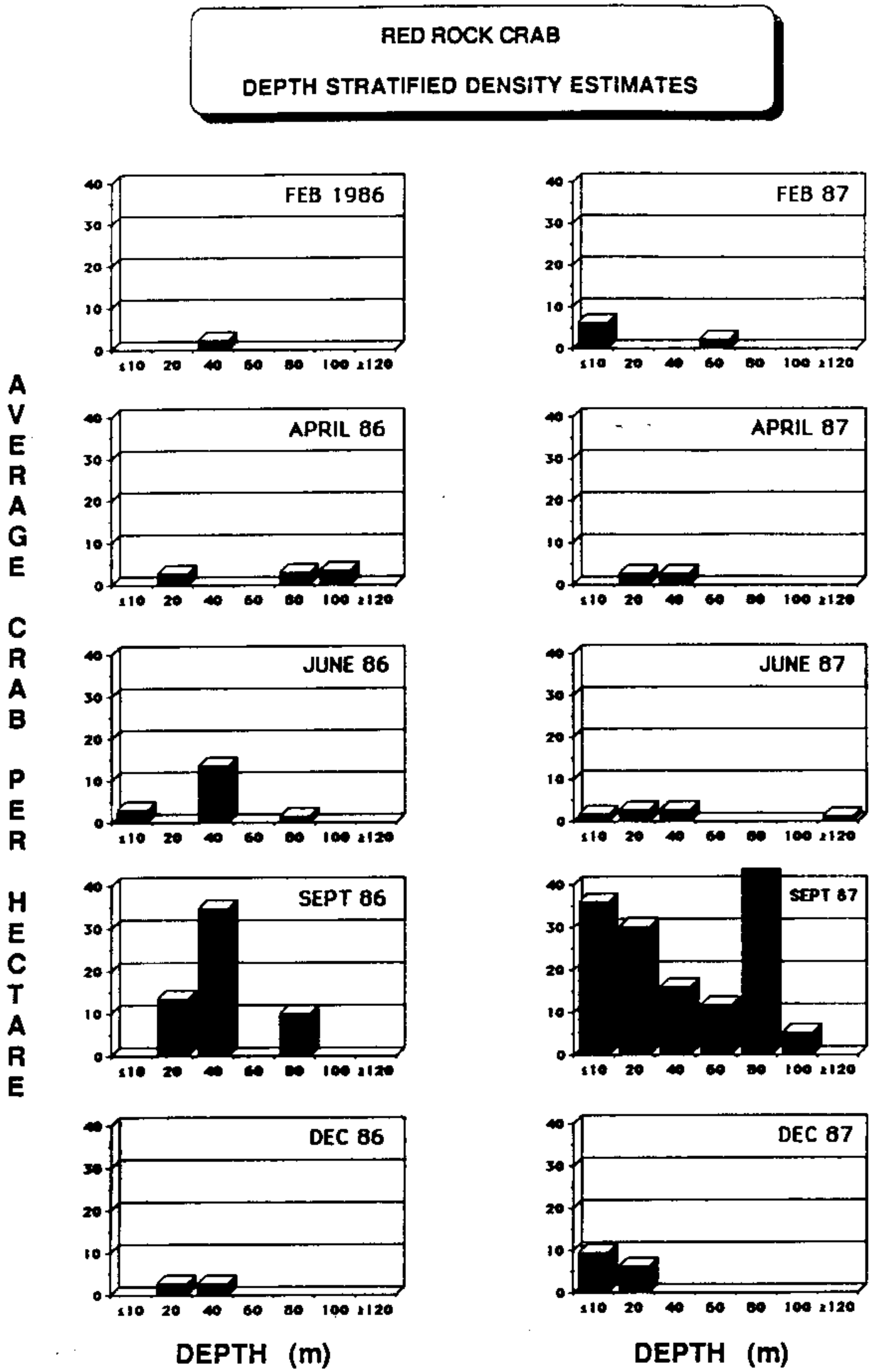


Figure 25. Distribution of red rock crab, *Cancer productus*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

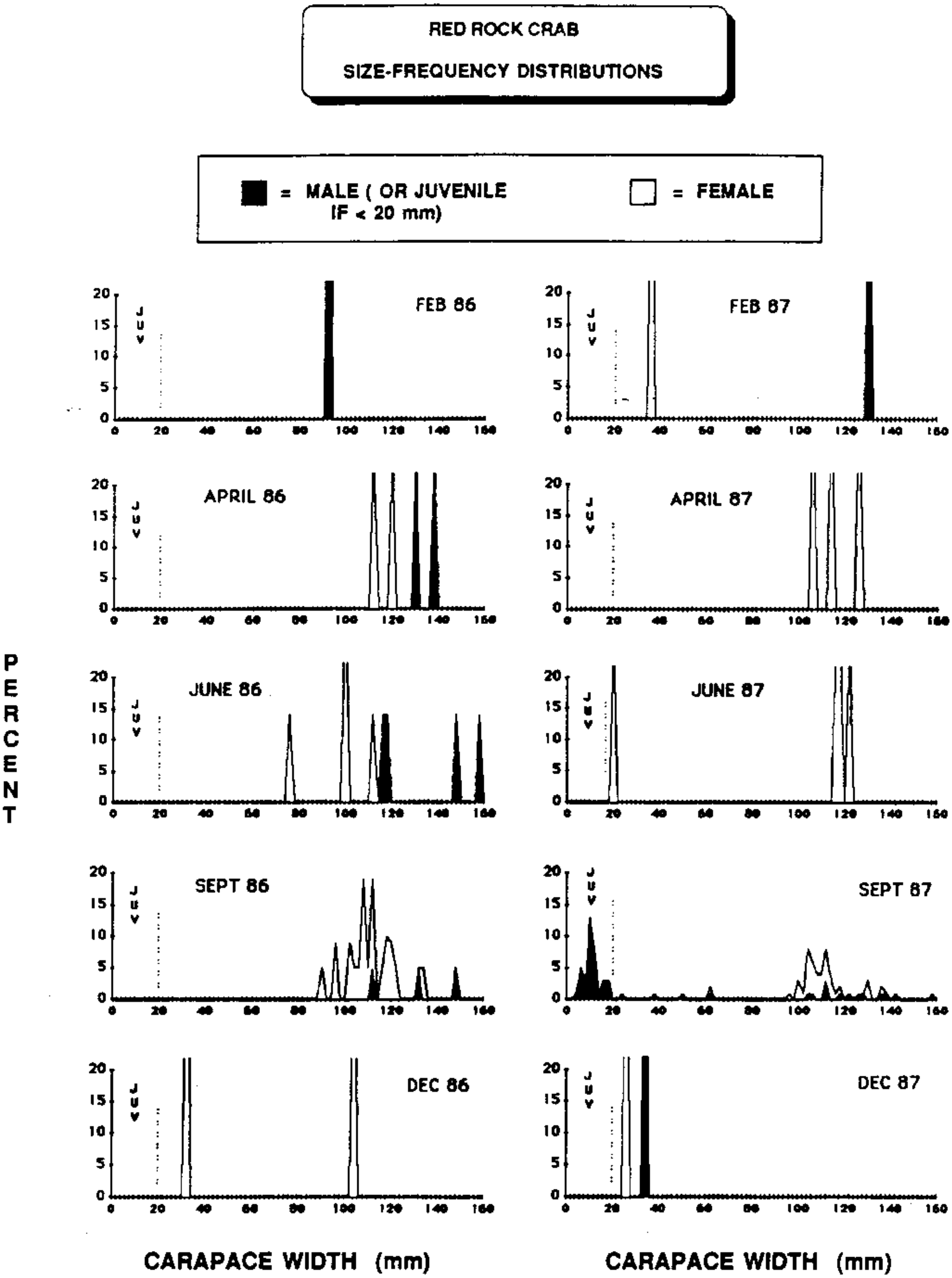


Figure 26. Summary of the red rock crab, *Cancer productus*, size-frequency distribution in the beam trawl catches for all sampling periods in Port Gardner during 1986 and 1987.

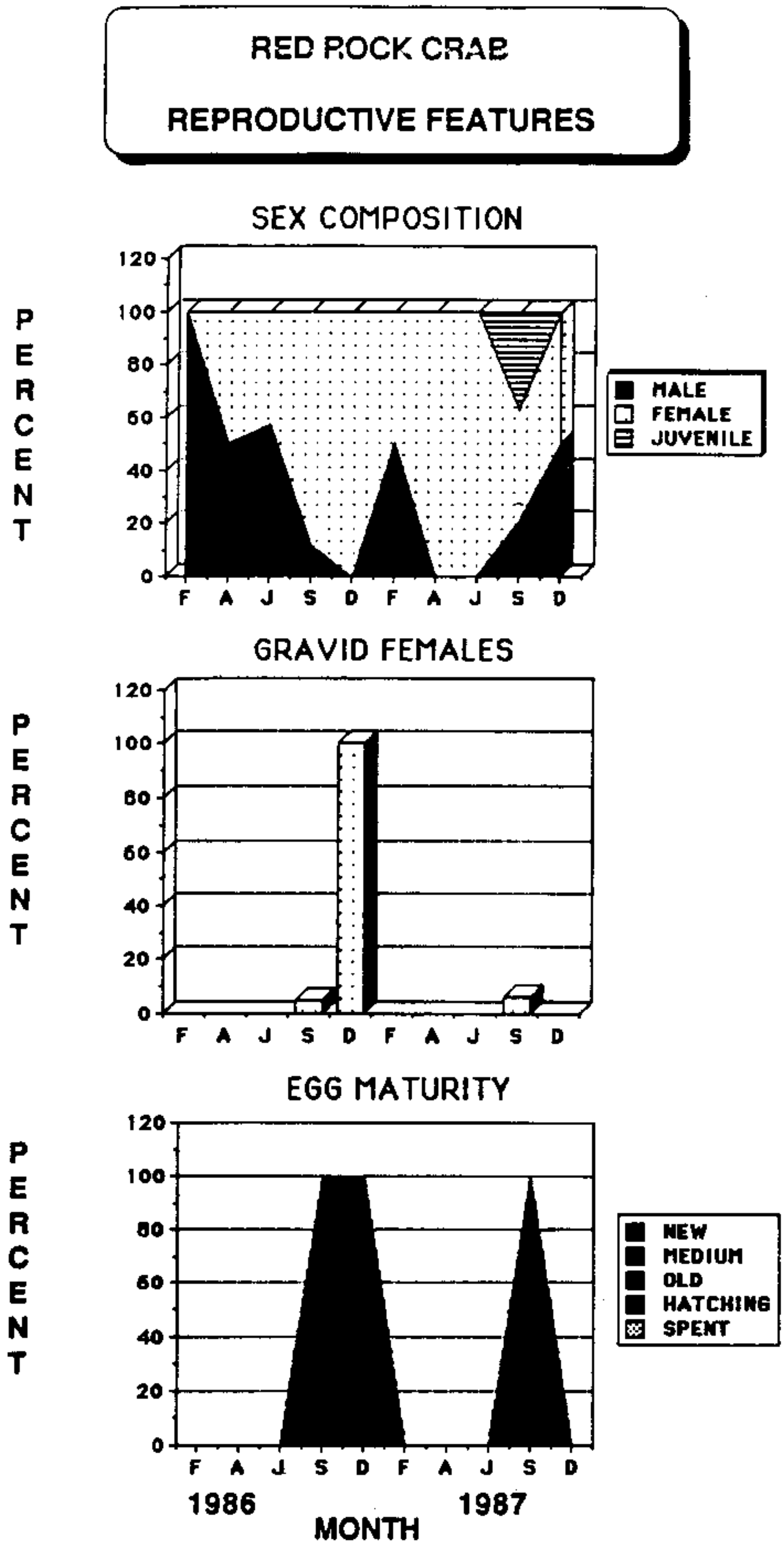


Figure 27. Summary of *Cancer productus* sex composition, reproductive condition, and egg maturity from beam trawl catches in Port Gardner for each of five sample periods in 1986 and 1987.

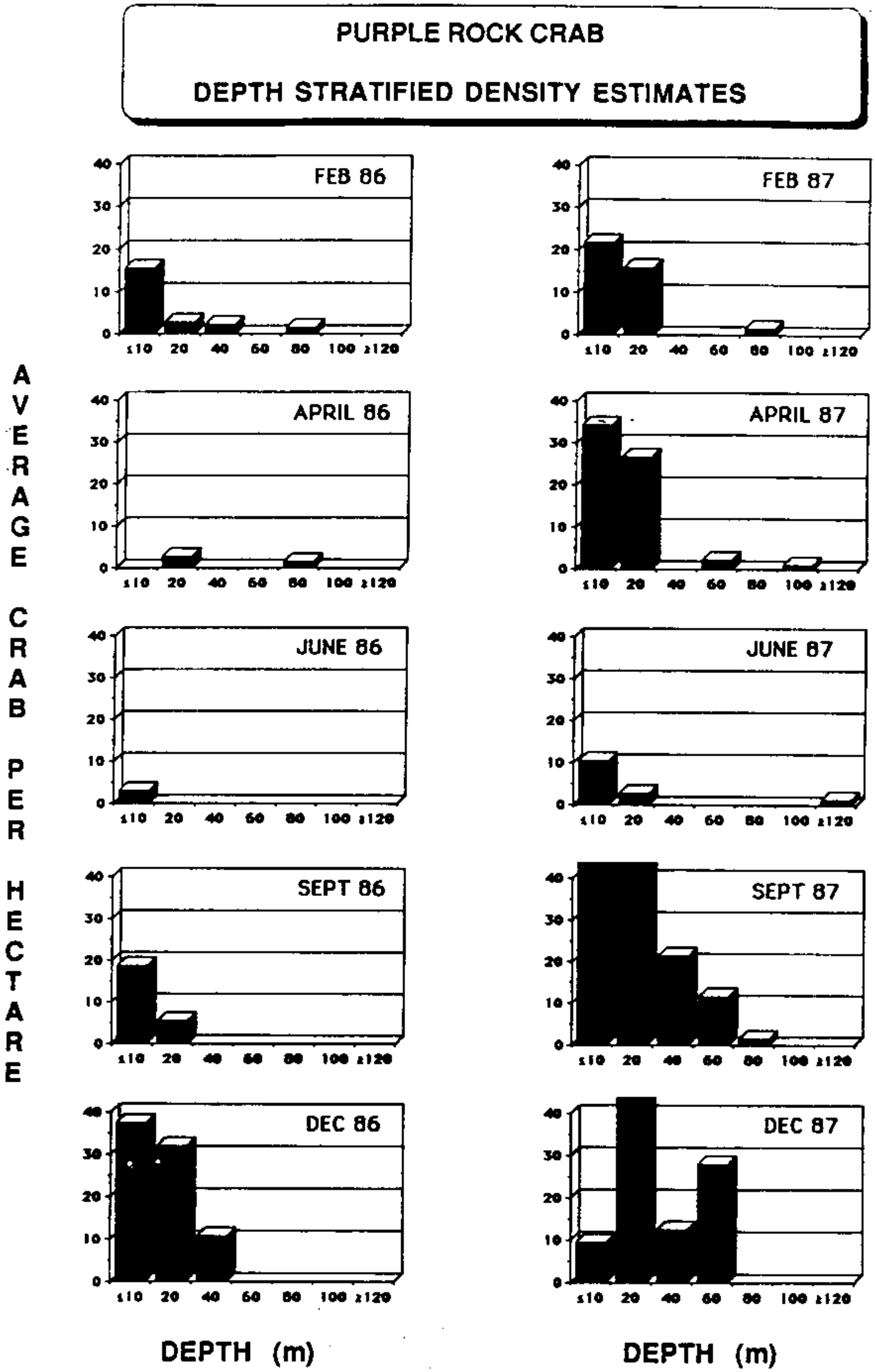


Figure 28. Distribution of purple rock crab, *Cancer gracilis*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

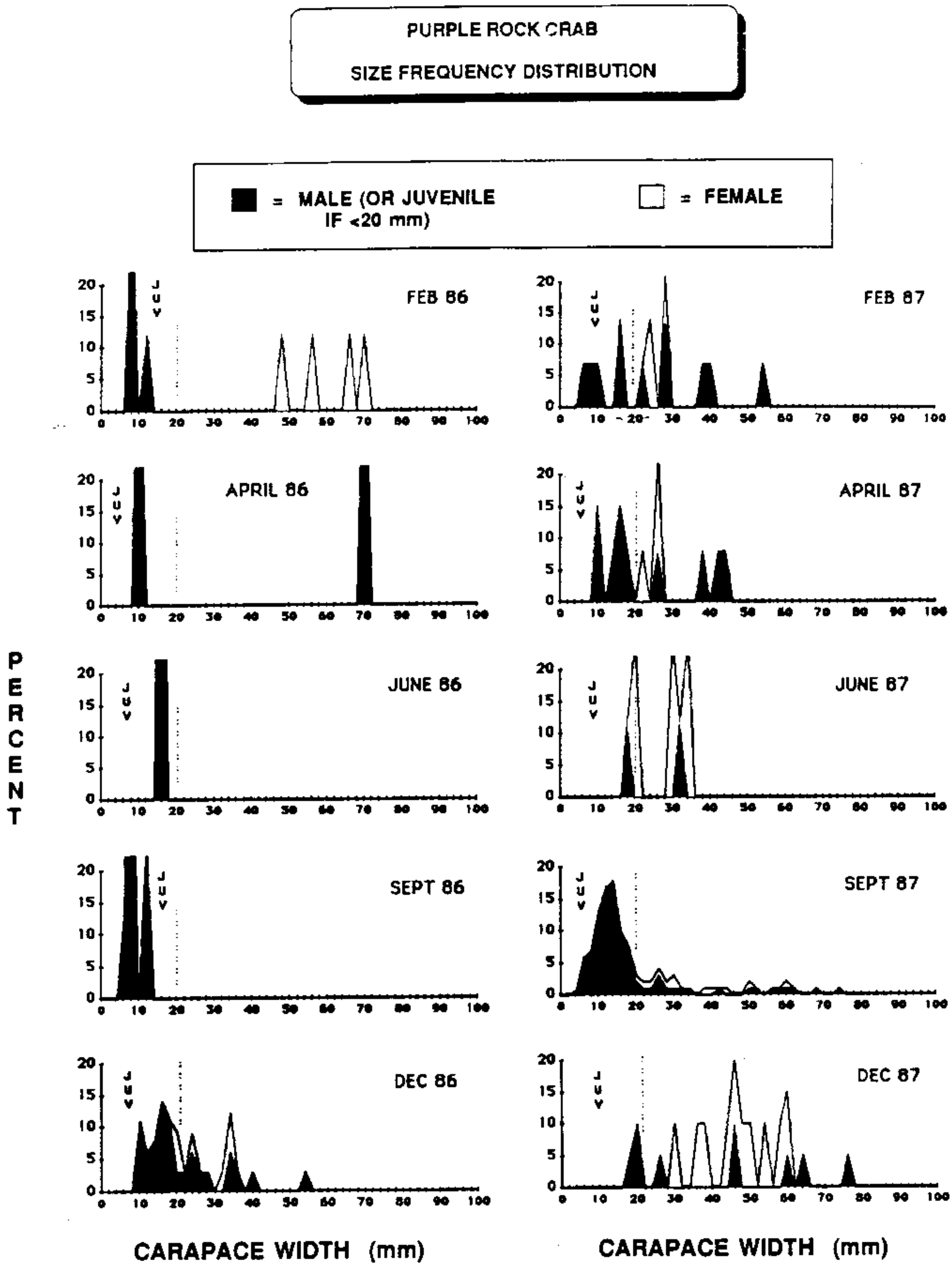


Figure 29. Summary of the purple rock crab, *Cancer gracilis*, size-frequency distribution in beam trawl catches from all sampling periods in Port Gardner during 1986 and 1987. Juv = juvenile (< 20 mm carapace width).

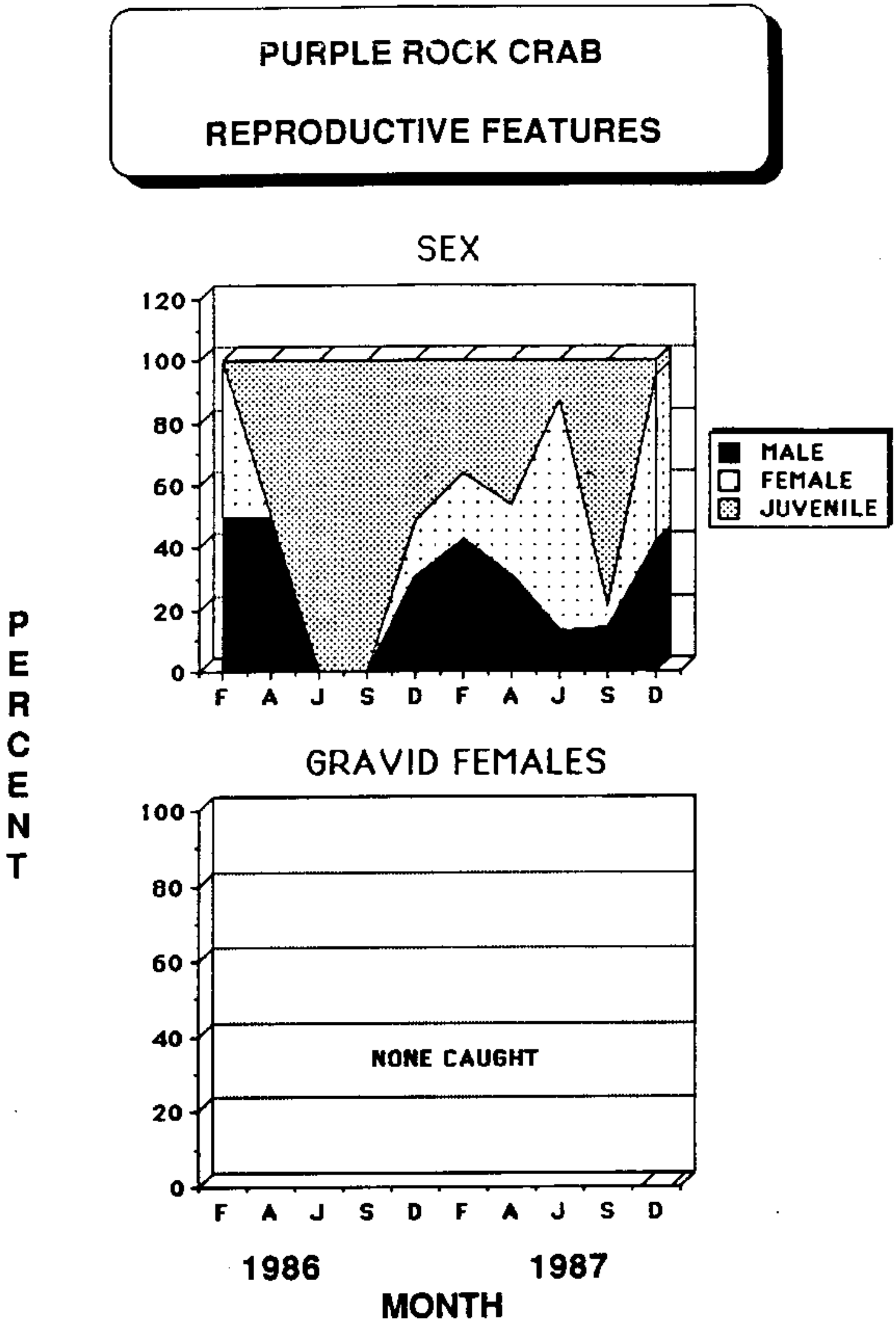


Figure 30. Summary of *Cancer gracilis* sex composition and female reproductive condition in Port Gardner for all five sample periods during 1986 and 1987.

Table 4 Average estimated pandalid shrimp density (No./ha ± 1 standard deviation) in Port Gardner (all beam trawl samples combined) and within each of the proposed disposal sites for all ten cruises during 1986 and 1987. The shallow Delta, River, and East Waterway stations are excluded. NS = not sampled.

SEASON	# STATIONS SAMPLED	PORT GARDNER	CAD	RADCAD	PSDDA
FEBRUARY 1986	55	123 ± 218	687 ± 518	81 ± 11	0 ± 0
APRIL	55	19 ± 28	0 ± 0	12 ± 11	56 ± 19
JUNE	59	30 ± 112	8 ± 13	0 ± 0	6 ± 11
SEPTEMBER	63	241 ± 498	293 ± 249	6 ± 11	31 ± 11
DECEMBER	73	161 ± 251	94 ± 117	53 ± 17	125 ± 47
FEBRUARY 1987	73	140 ± 246	125 ± 39	12 ± 18	52 ± 39
APRIL	73	128 ± 245	87 ± 21	16 ± 17	14 ± 18
JUNE	78	43 ± 77	12 ± 21	142 ± 115	0 ± 0
SEPTEMBER	95	640 ± 1,234	674 ± 471	29 ± 18	70 ± 32
DECEMBER*	23	151 ± 175	NS	142 ± 71	NS

* Sampling at a reduced set of 23 stations only.

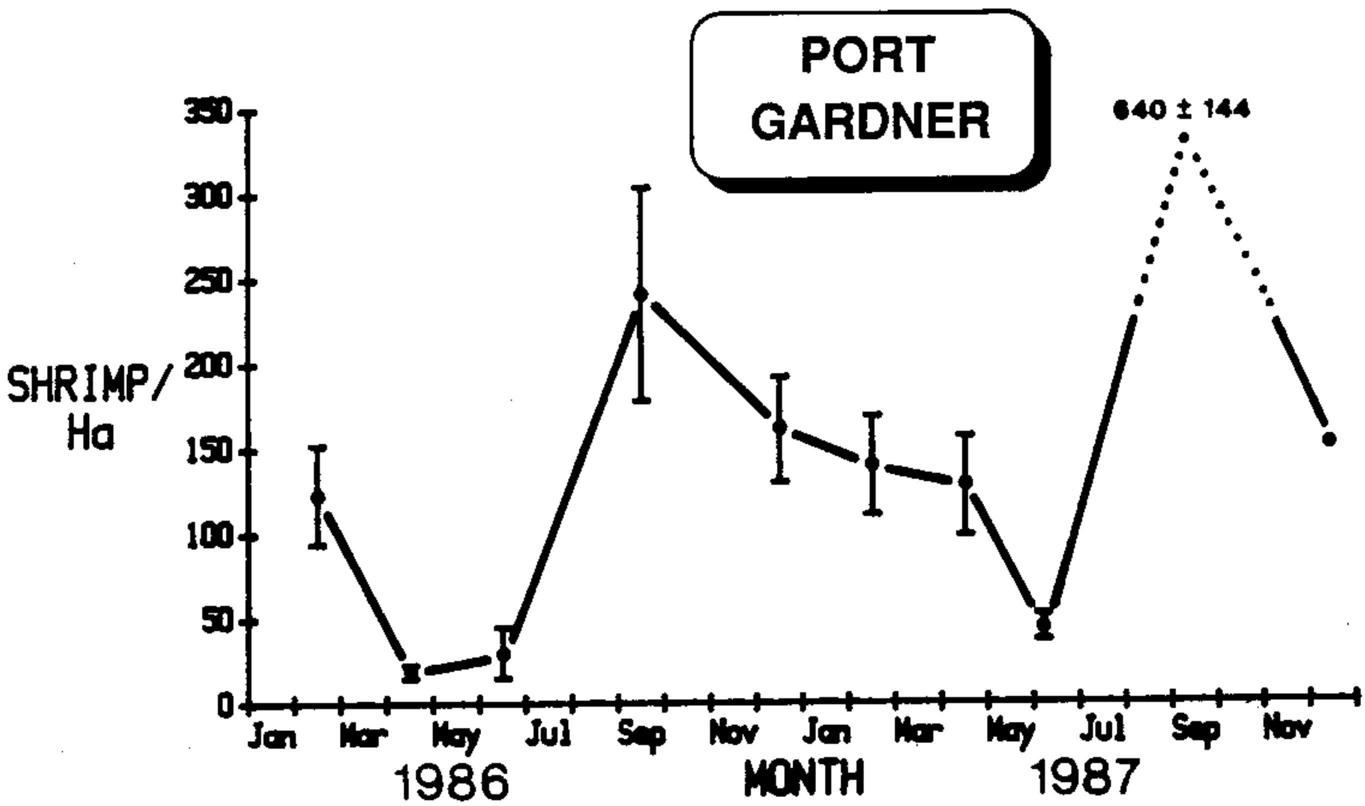


Figure 31. Average estimated densities of pandalid shrimp in Port Gardner (all stations except the shallow Delta, River, and East Waterway stations) as measured by beam trawl in 1986 and 1987. The bars are ± 1 standard error of the means.

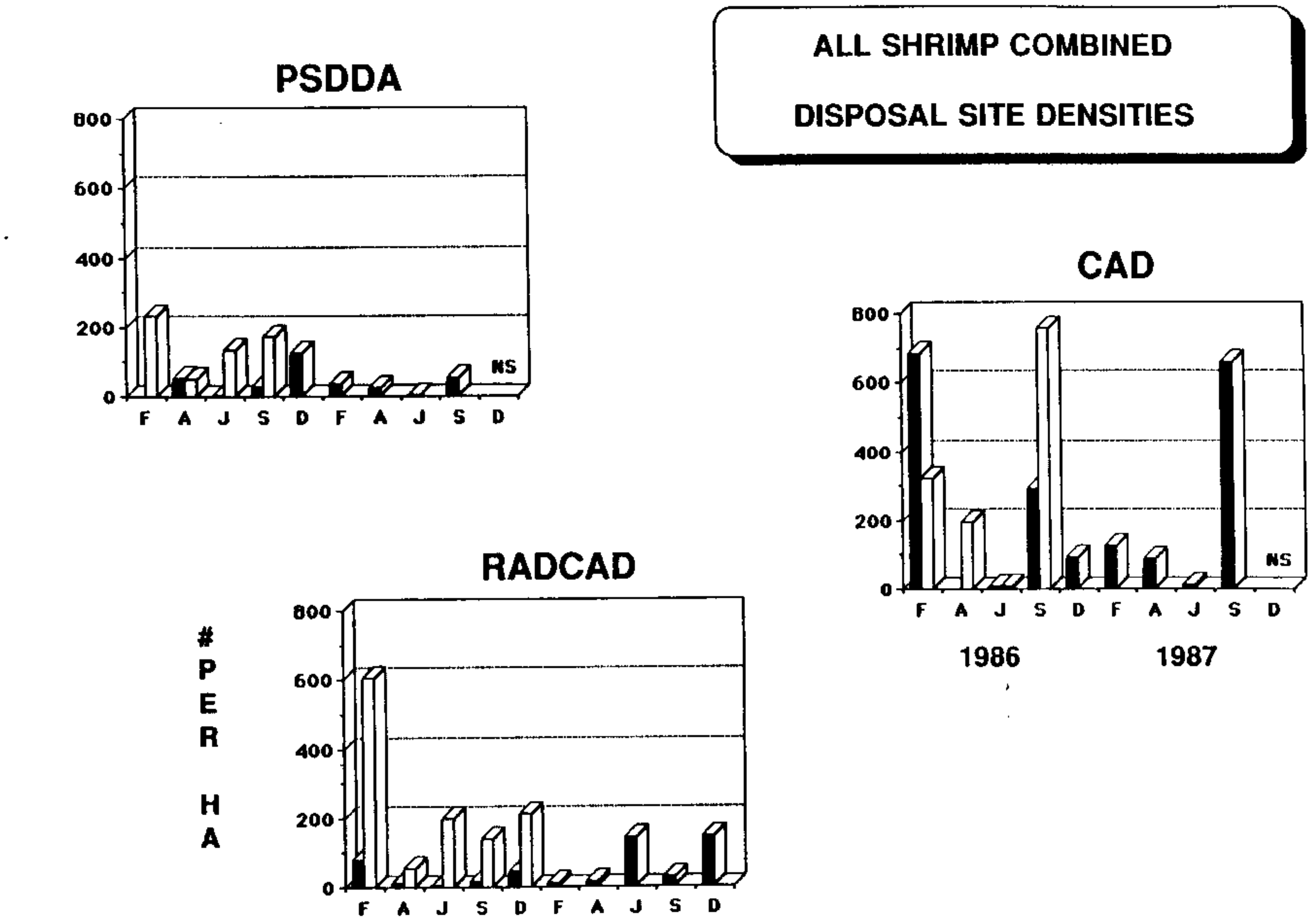


Figure 32. Seasonal distribution of pandalid shrimp (all species combined) in the proposed disposal sites in Port Gardner as indicated by the beam (■) and otter (□) trawl catches. Otter trawl sampling was conducted in 1986 only. NS = not sampled.

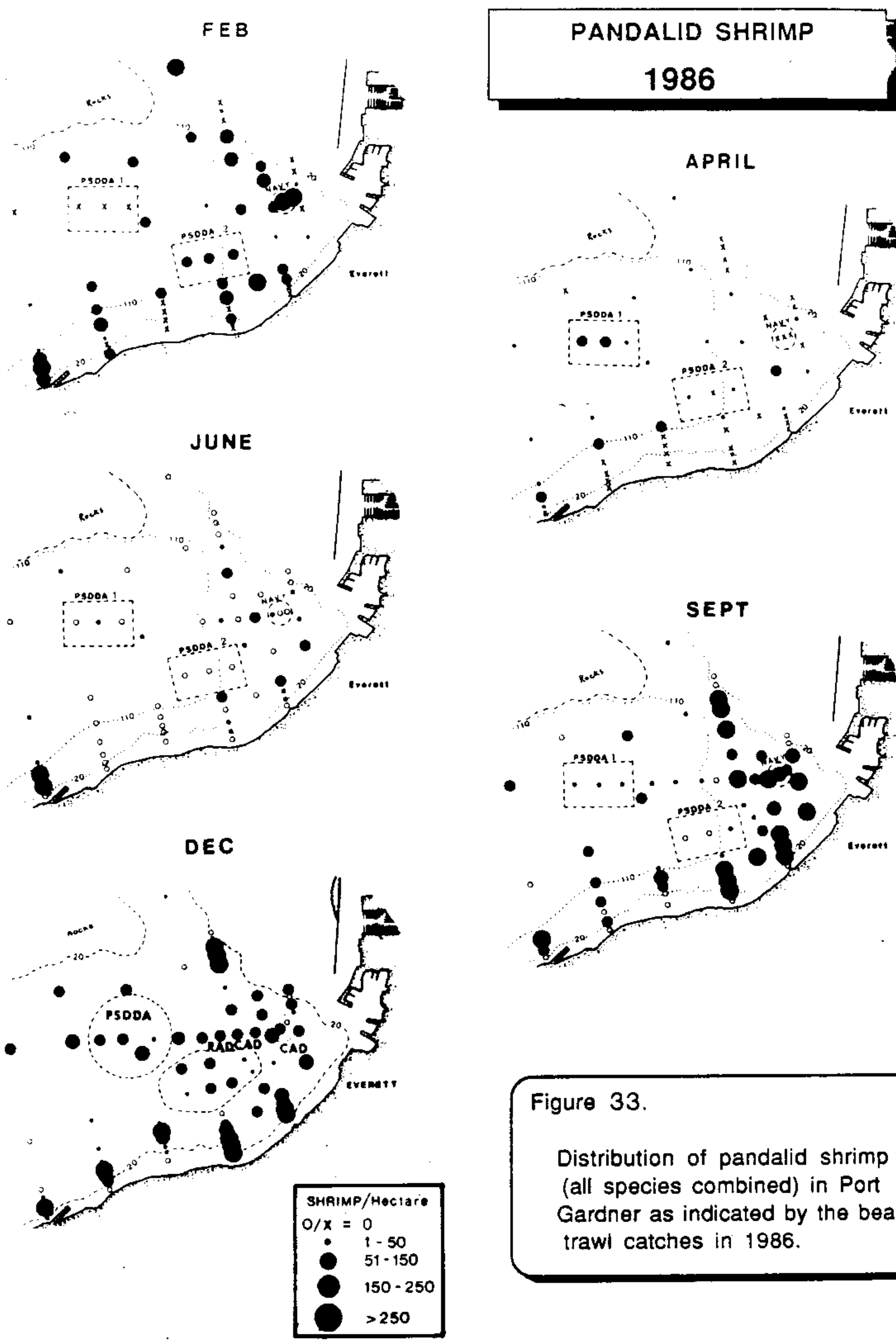
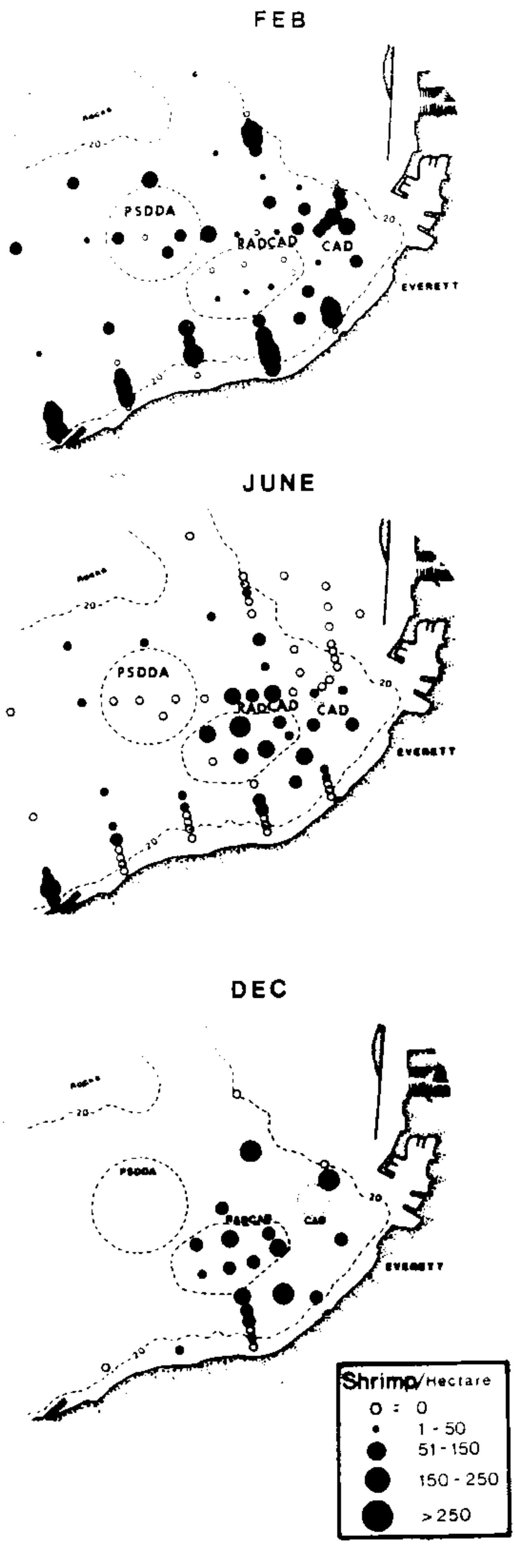


Figure 33.

Distribution of pandalid shrimp (all species combined) in Port Gardner as indicated by the beam trawl catches in 1986.

PANDALID SHRIMP
1987



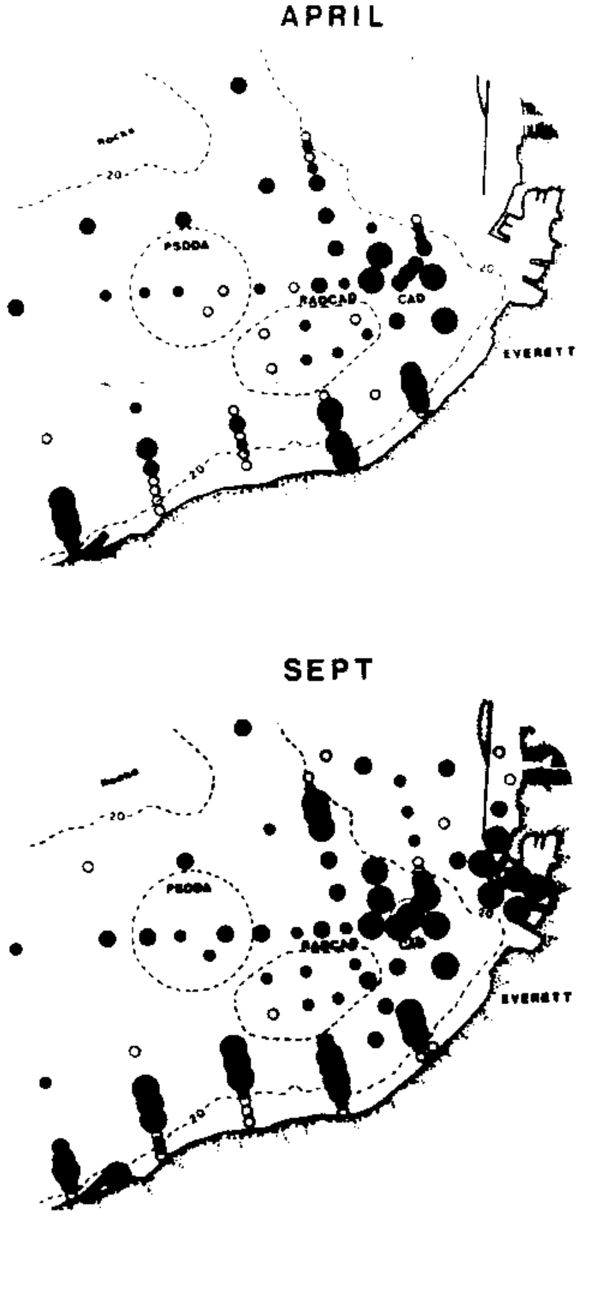


Figure 34.

Distribution of pandalid shrimp (all species combined) in Port Gardner as indicated by the beam trawl catches in 1987.

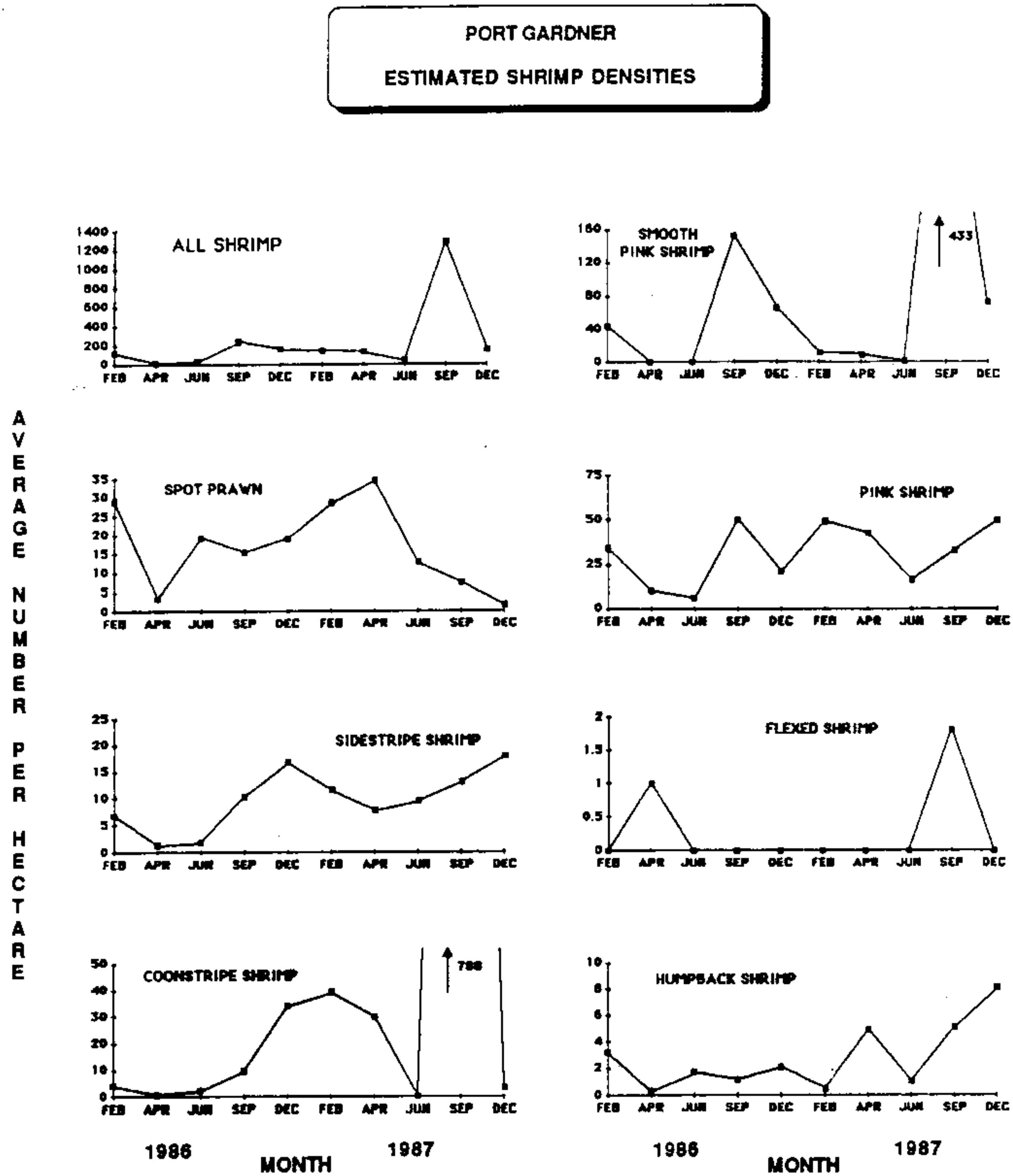


Figure 35. Beam trawl catches of seven species of pandalid shrimp in Port Gardner for all sample periods in 1986 and 1987. The number of stations sampled during each period ranged from 23 to 95.

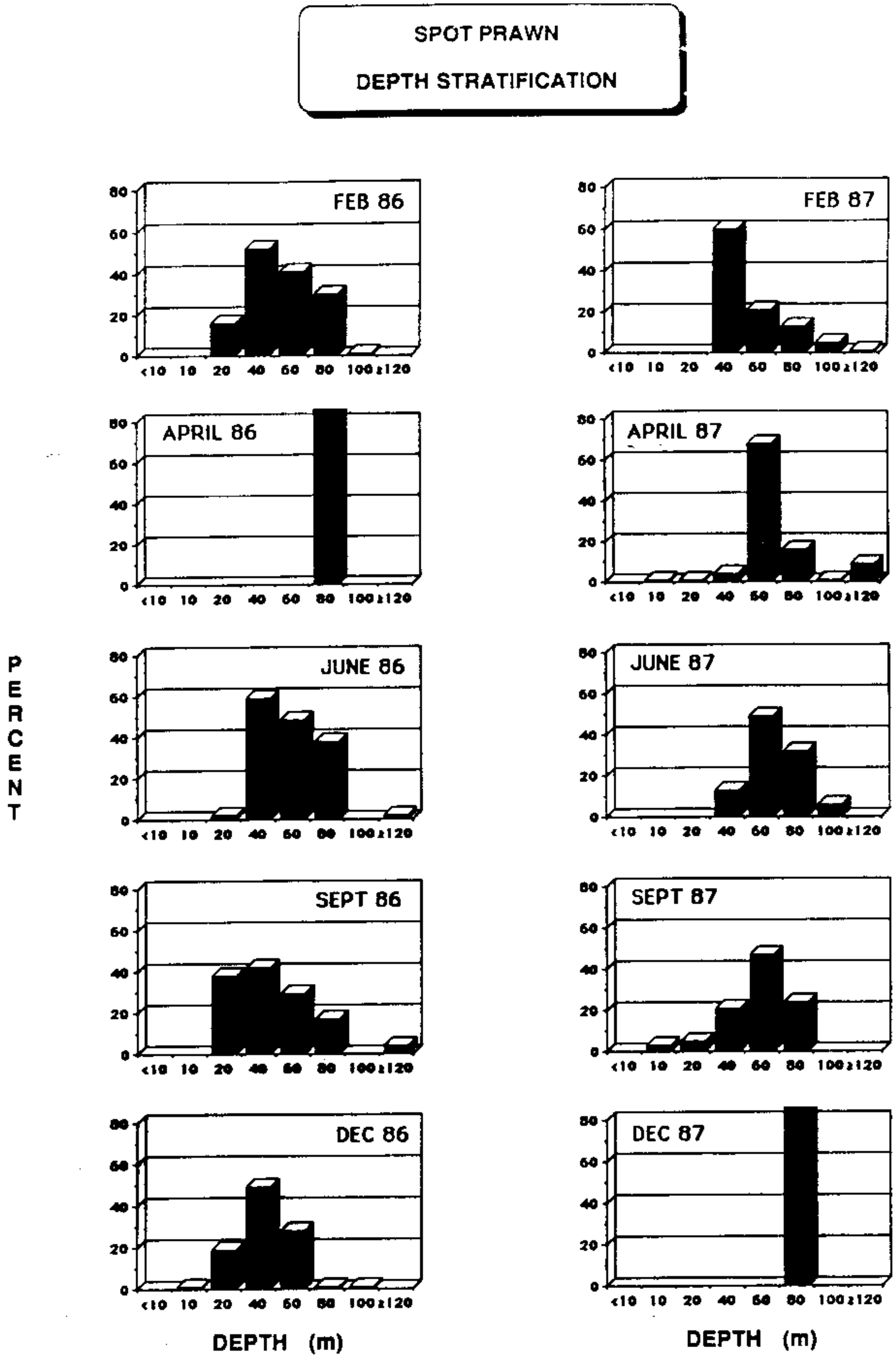


Figure 36. Distribution of spot prawn, *Pandalus platyceros*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

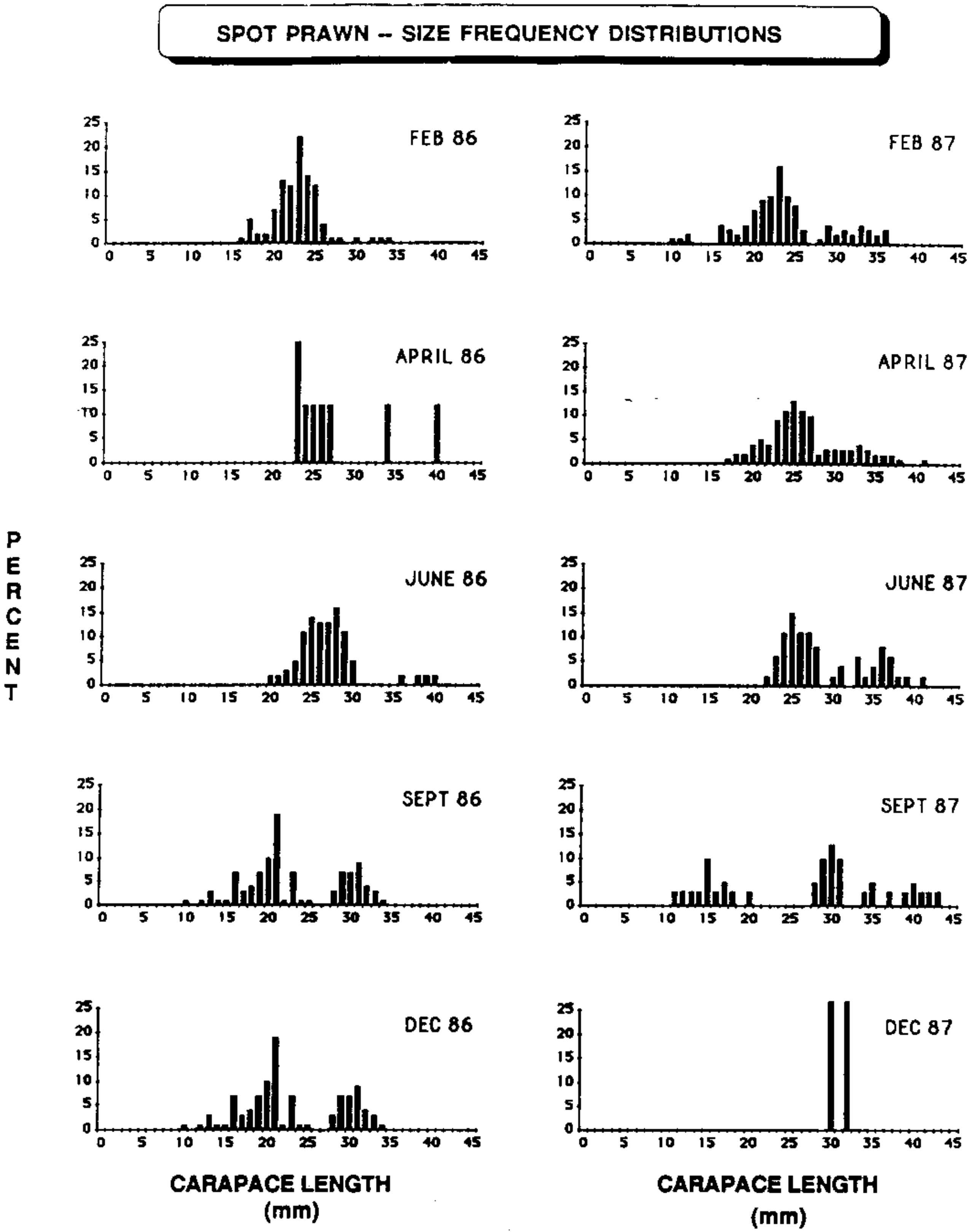


Figure 37. Carapace length-frequency plots for spot prawn, *Pandalus platyceros*, caught in Port Gardner by beam trawl (all stations combined) for each sample period in 1986 and 1987.

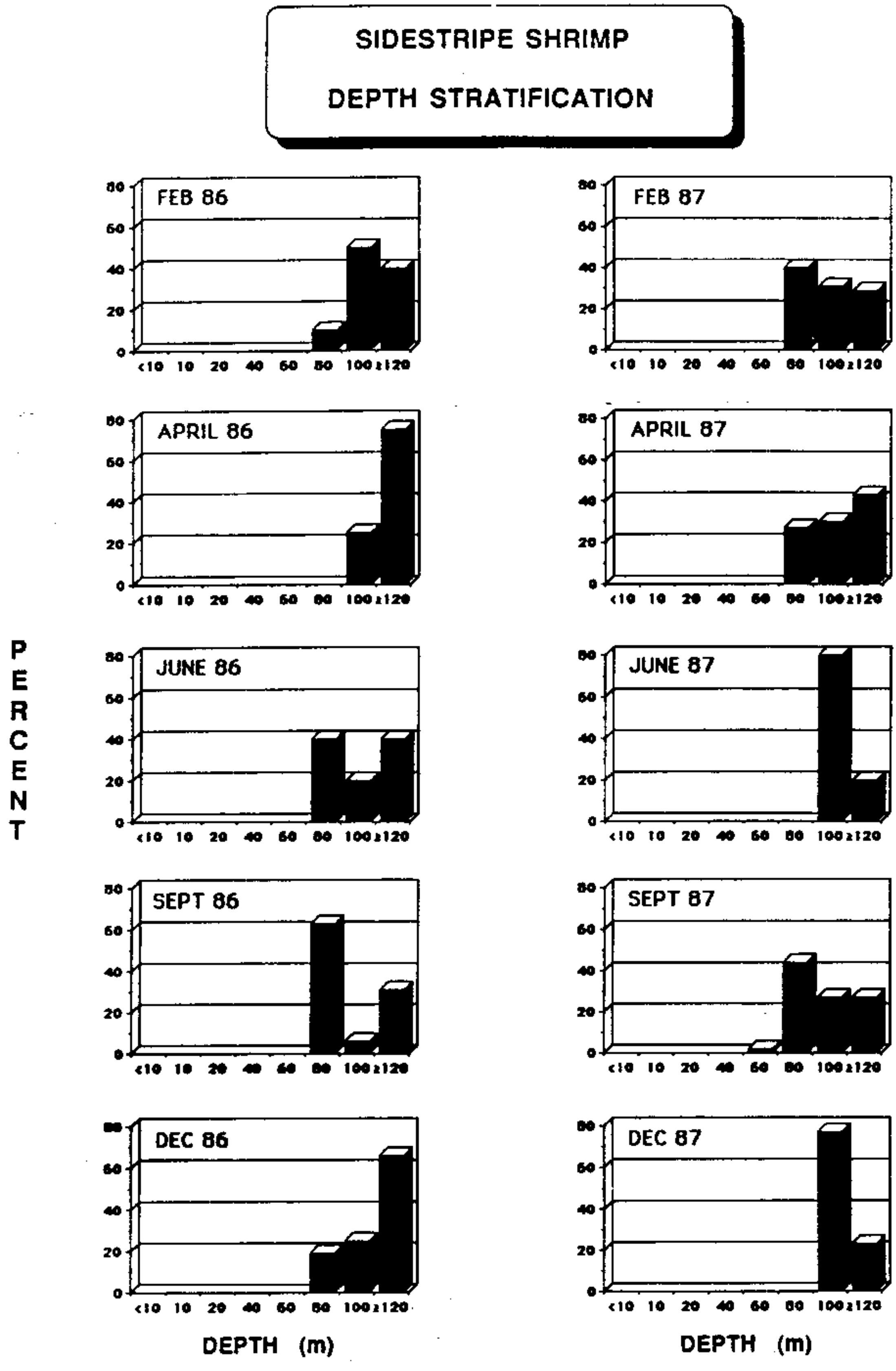


Figure 38. Distribution of sidestripe shrimp, *Pandalopsis dispar*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

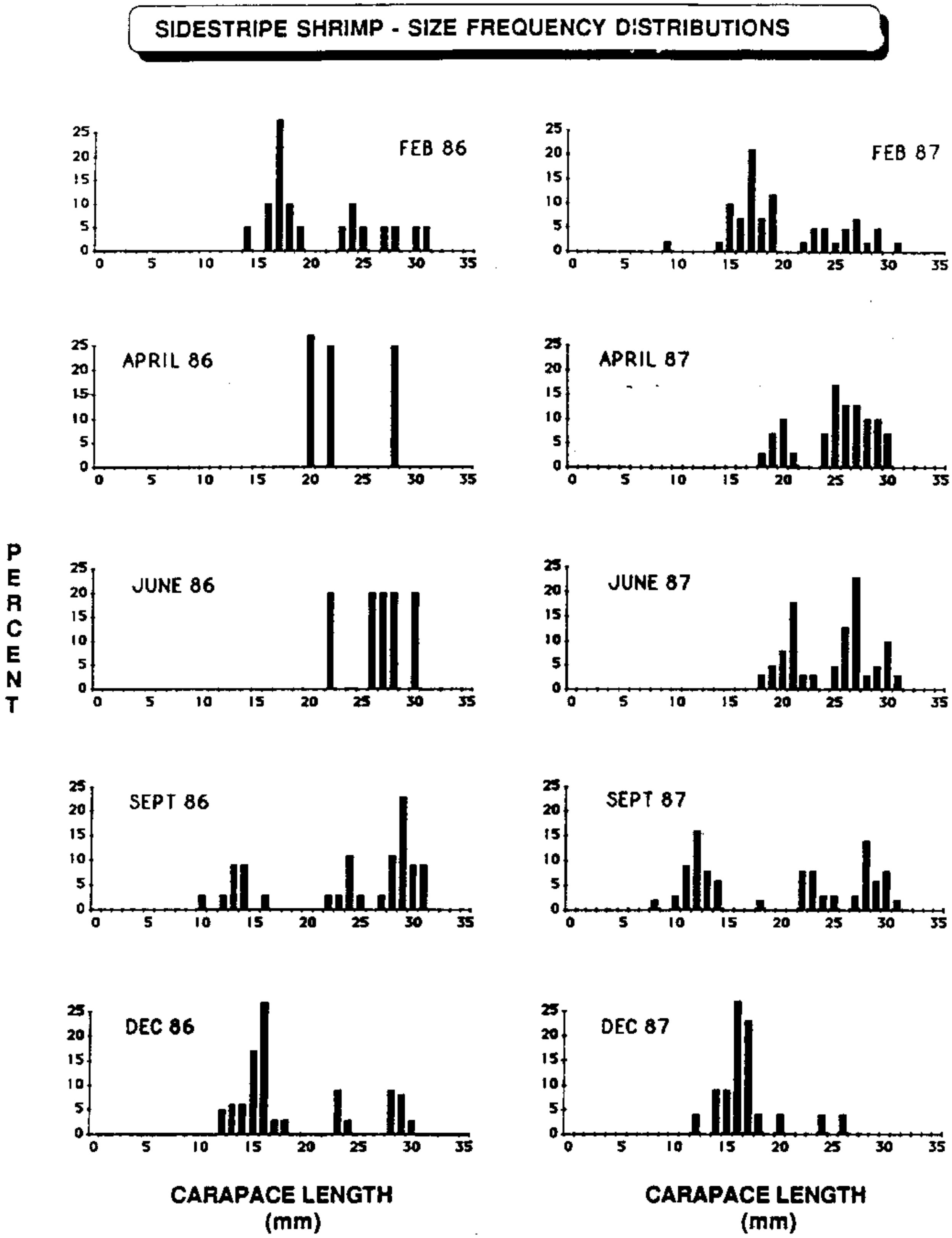


Figure 39. Carapace length-frequency plots for sidestripe shrimp, *Pandalopsis dispar*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

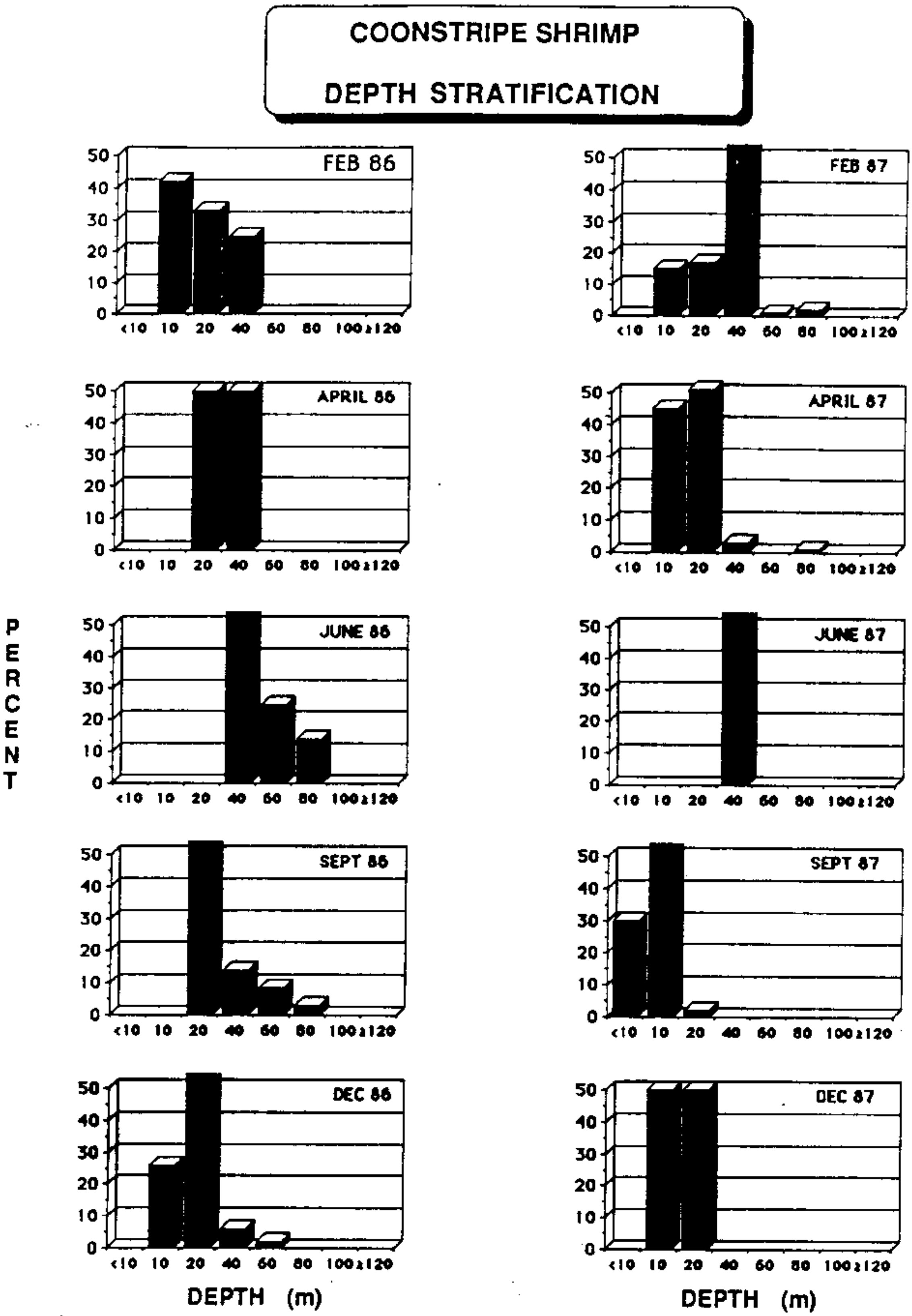


Figure 40. Distribution of coonstripe shrimp, *Pandalus danae*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

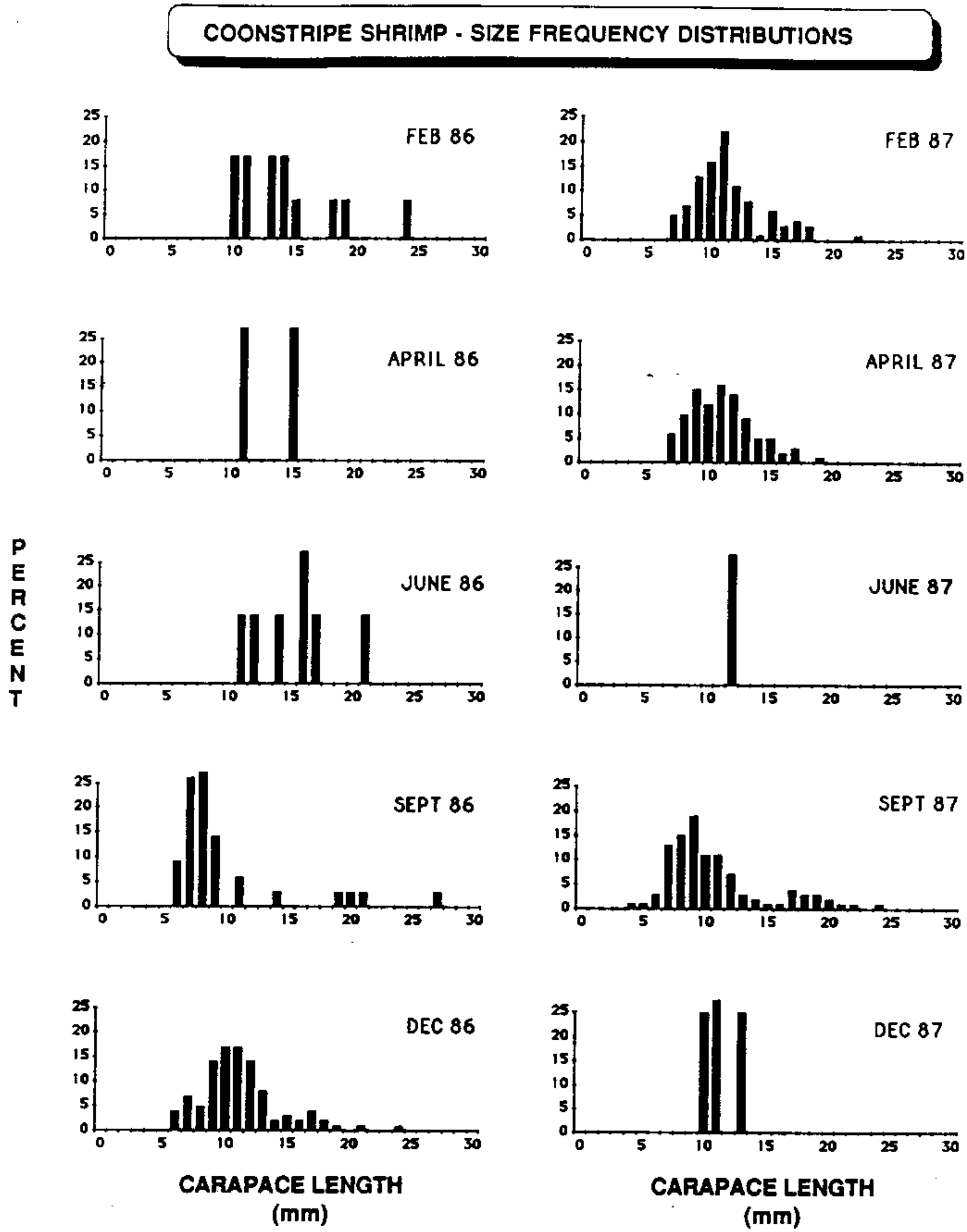


Figure 41. Carapace length-frequency plots for coonstripe shrimp, *Pandalus danae*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

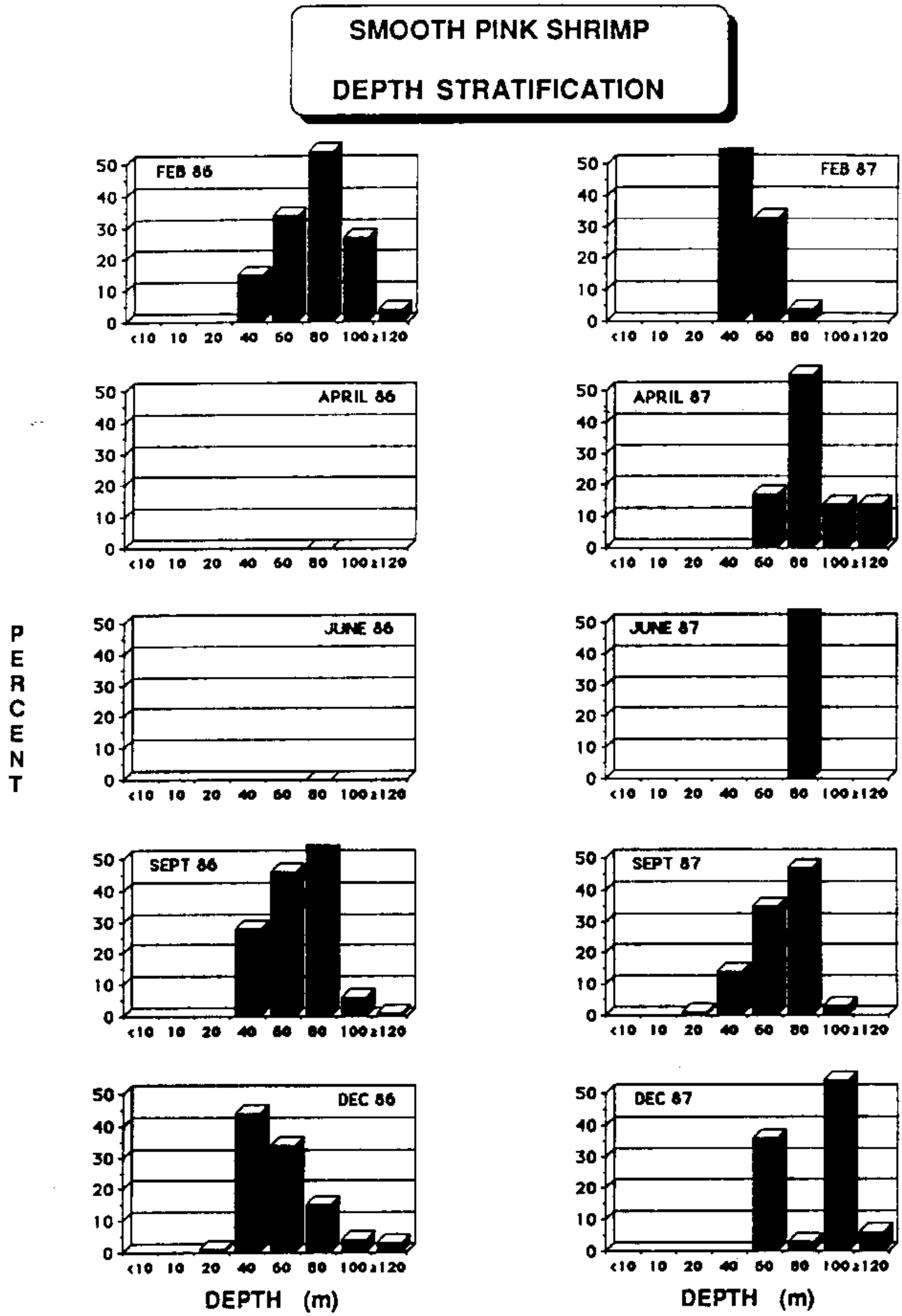


Figure 42. Distribution of smooth pink shrimp, *Pandalus jordani*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

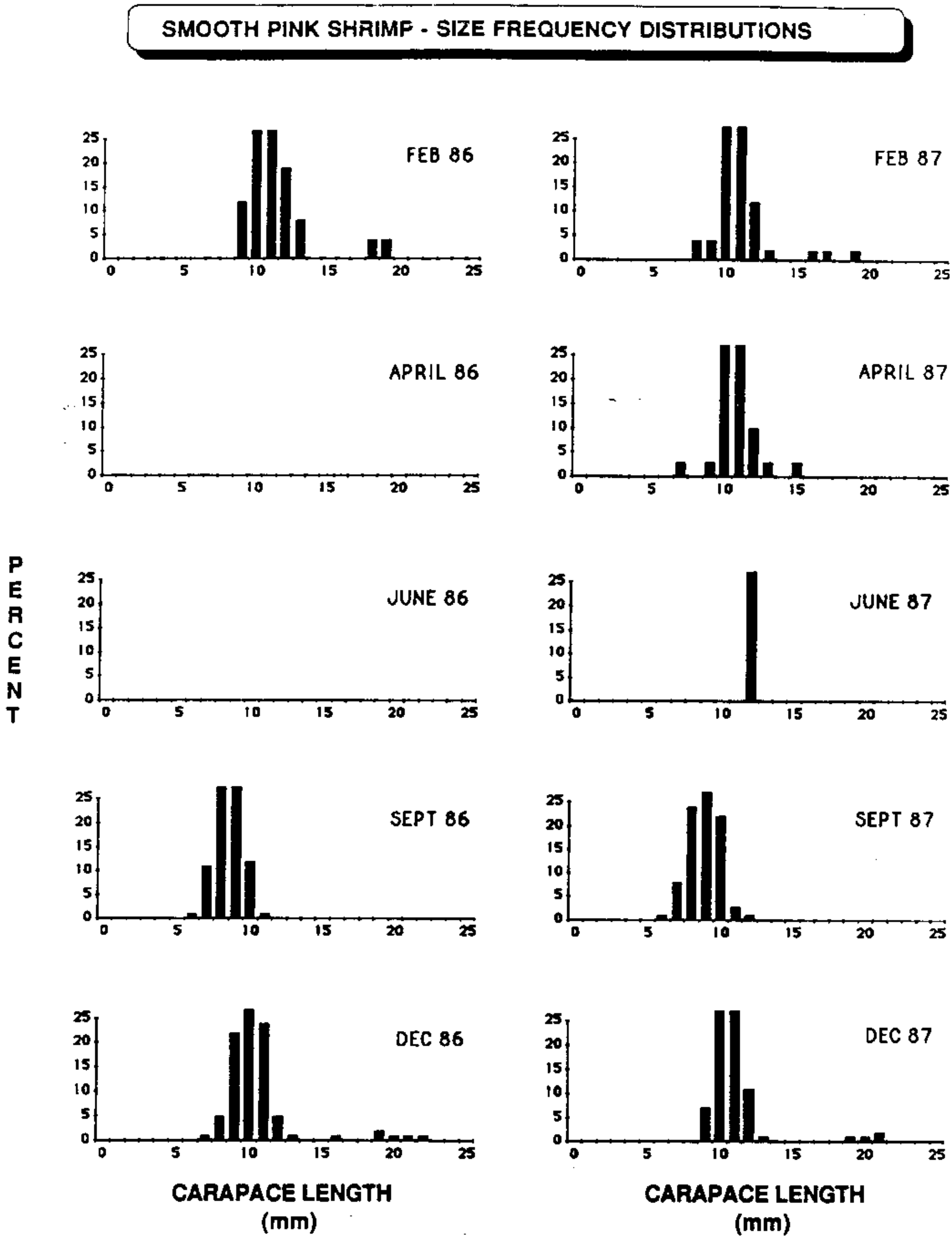


Figure 43. Carapace length-frequency plots for smooth pink shrimp, *Pandalus jordani*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

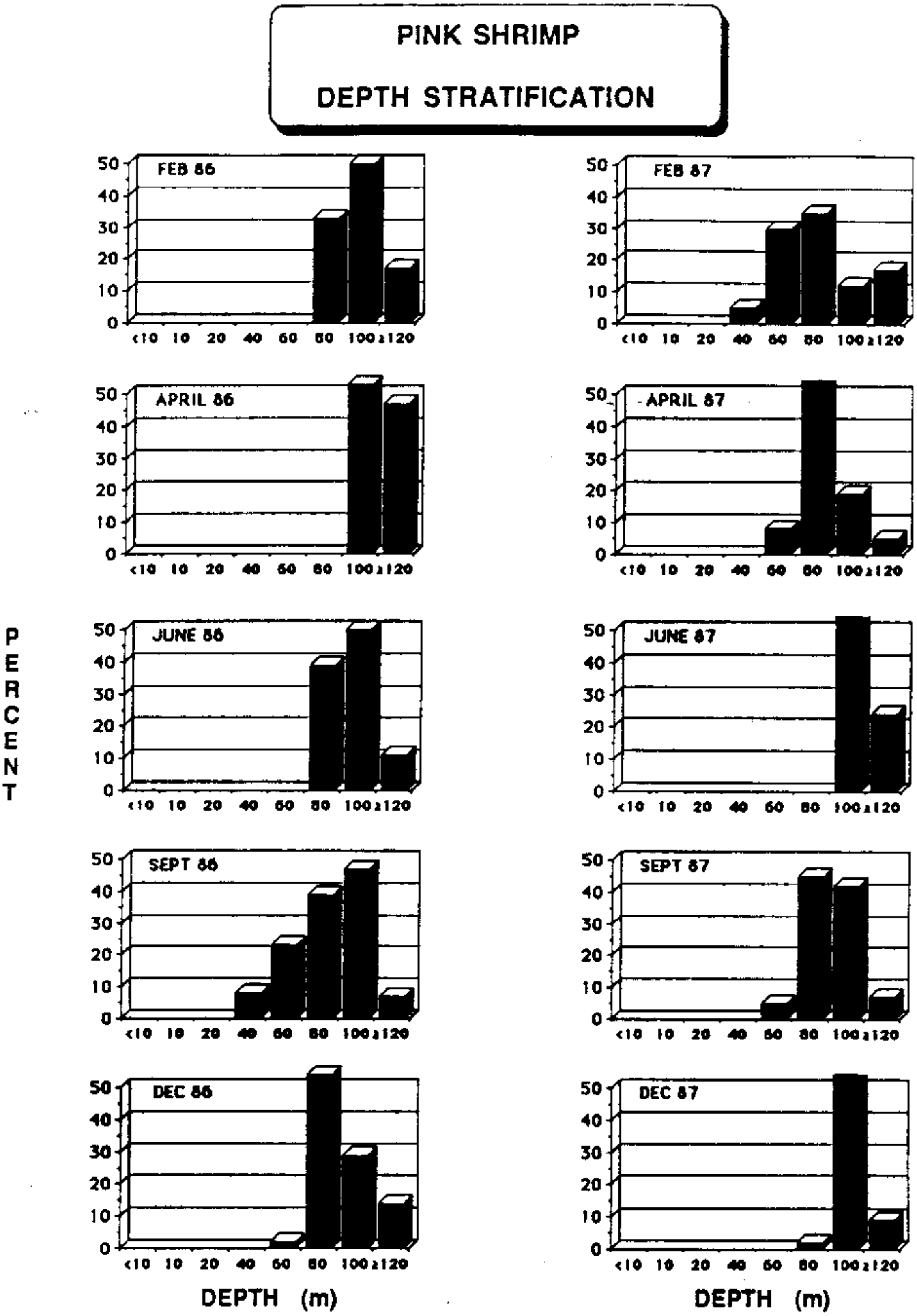


Figure 44. Distribution of pink shrimp, *Pandalus borealis*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

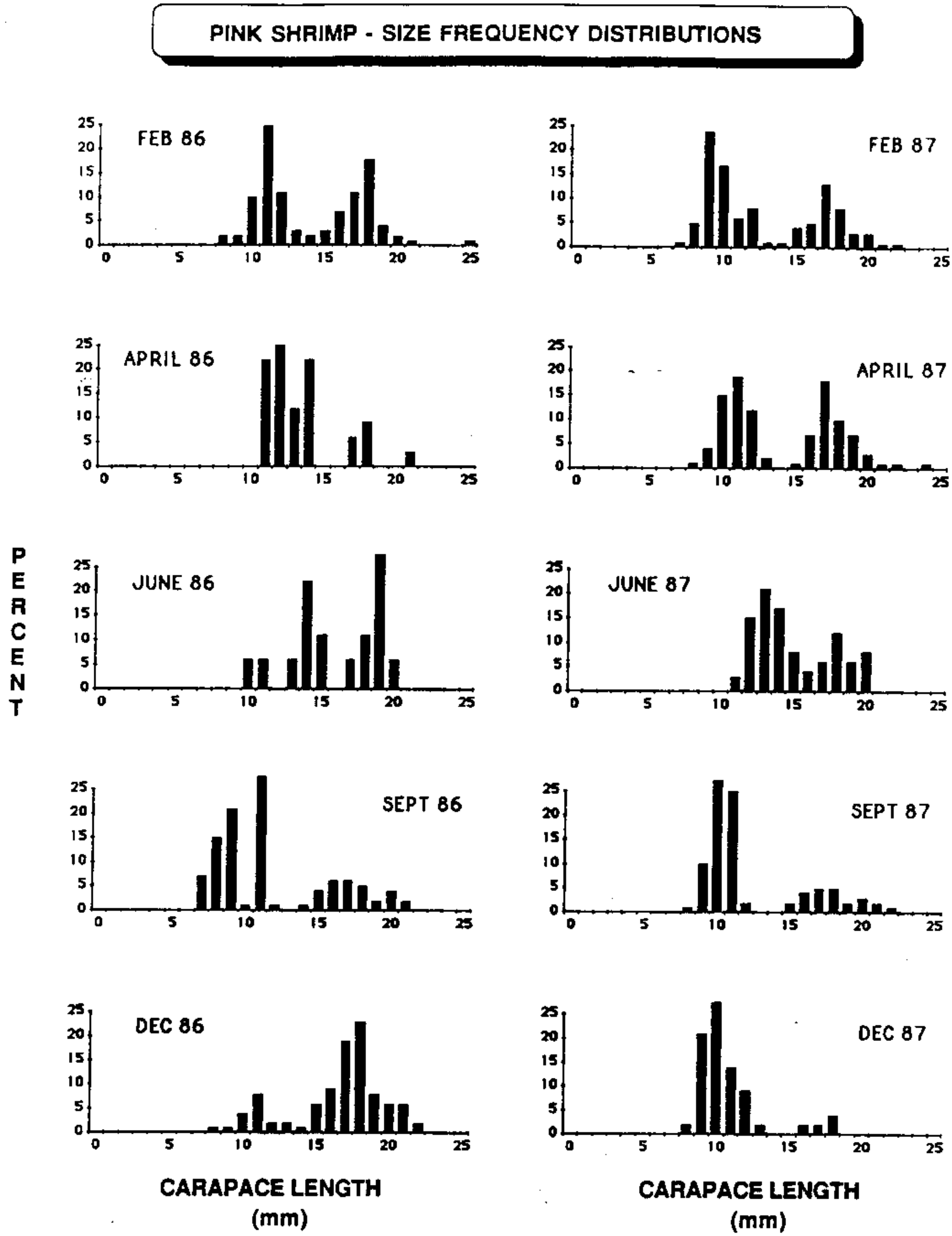


Figure 45. Carapace length-frequency plots for pink shrimp, *Pandalus borealis*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

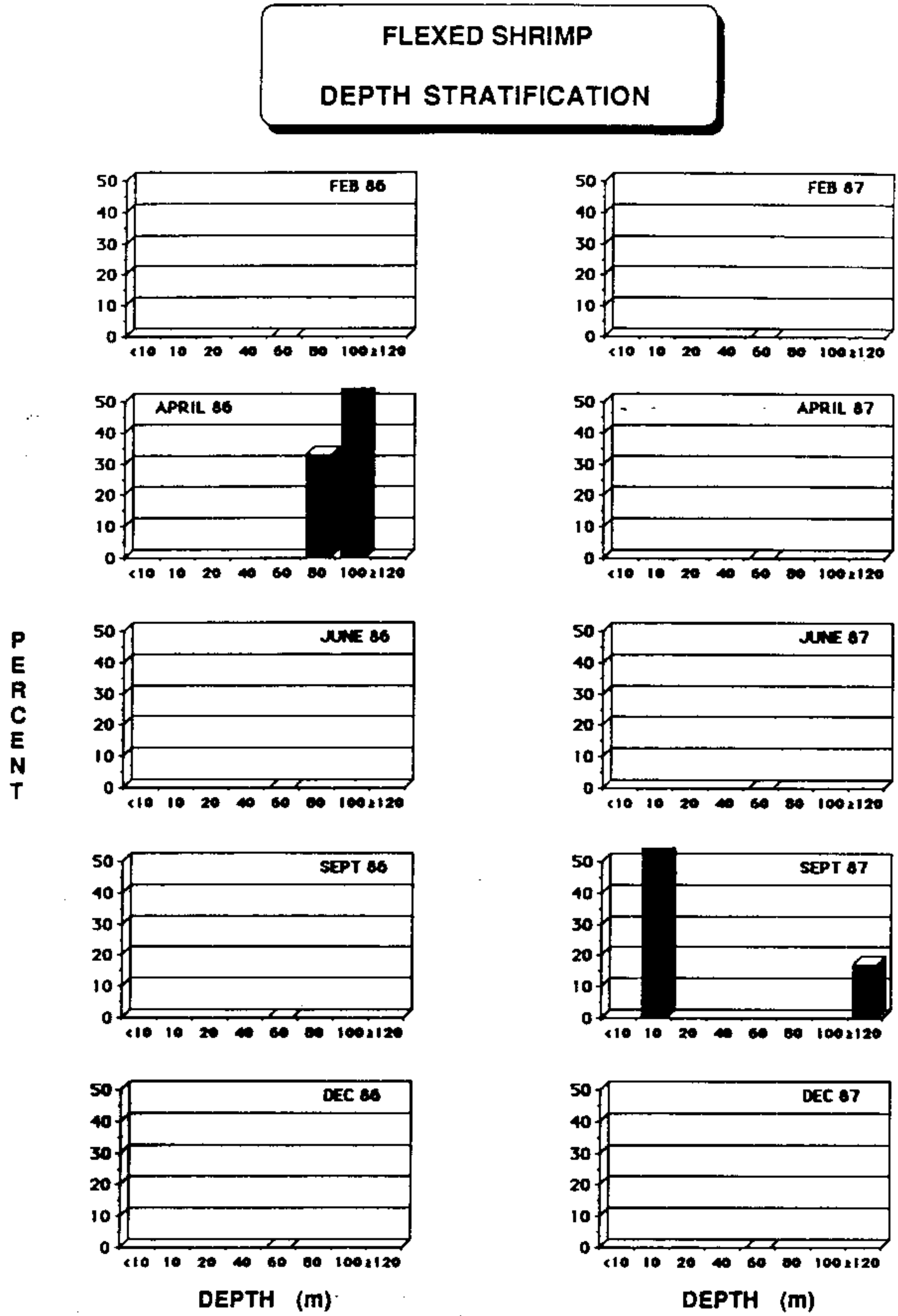


Figure 46. Distribution of flexed shrimp, *Pandalus goniurus*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

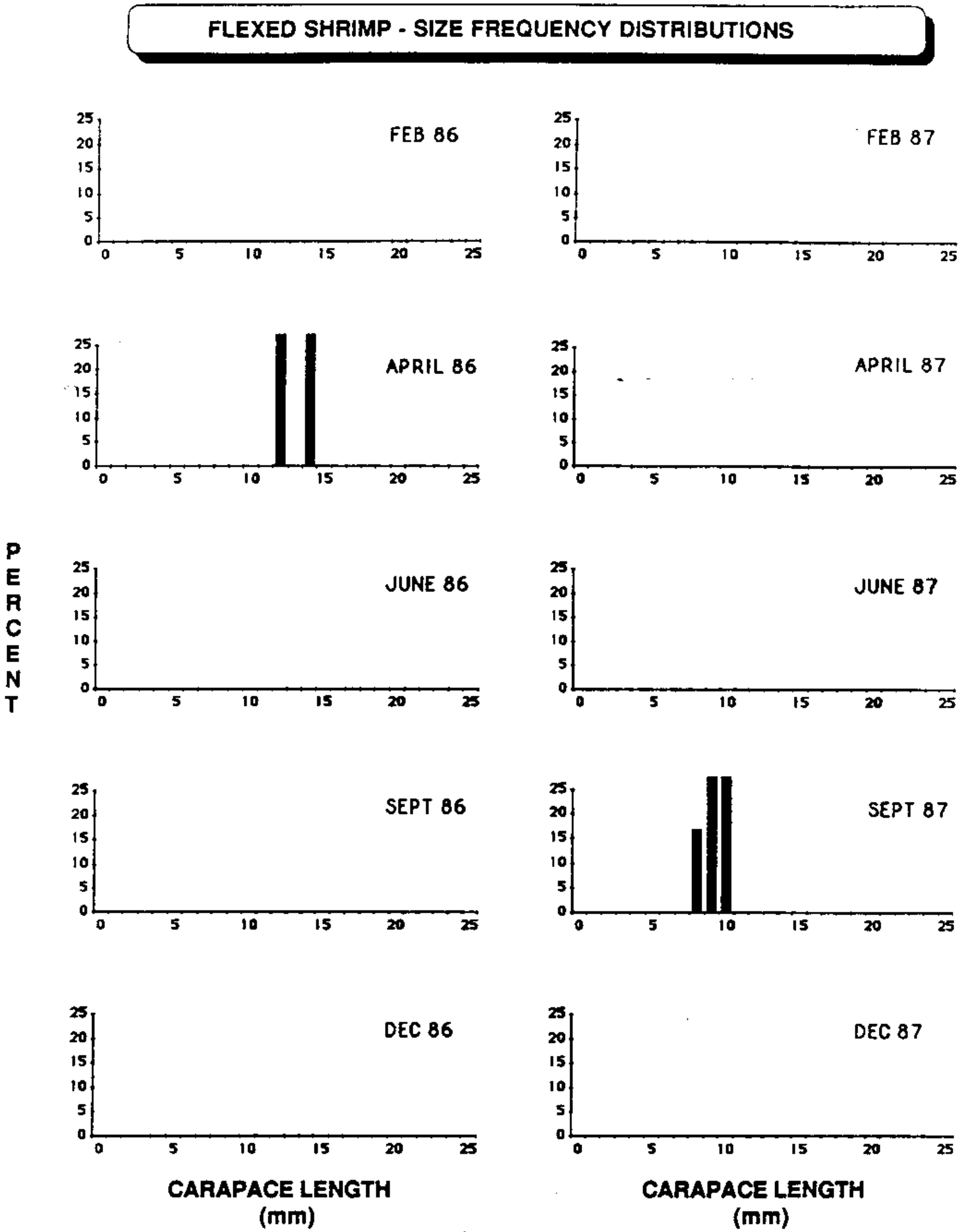


Figure 47. Carapace length-frequency plots for flexed shrimp, *Pandalus goniurus*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

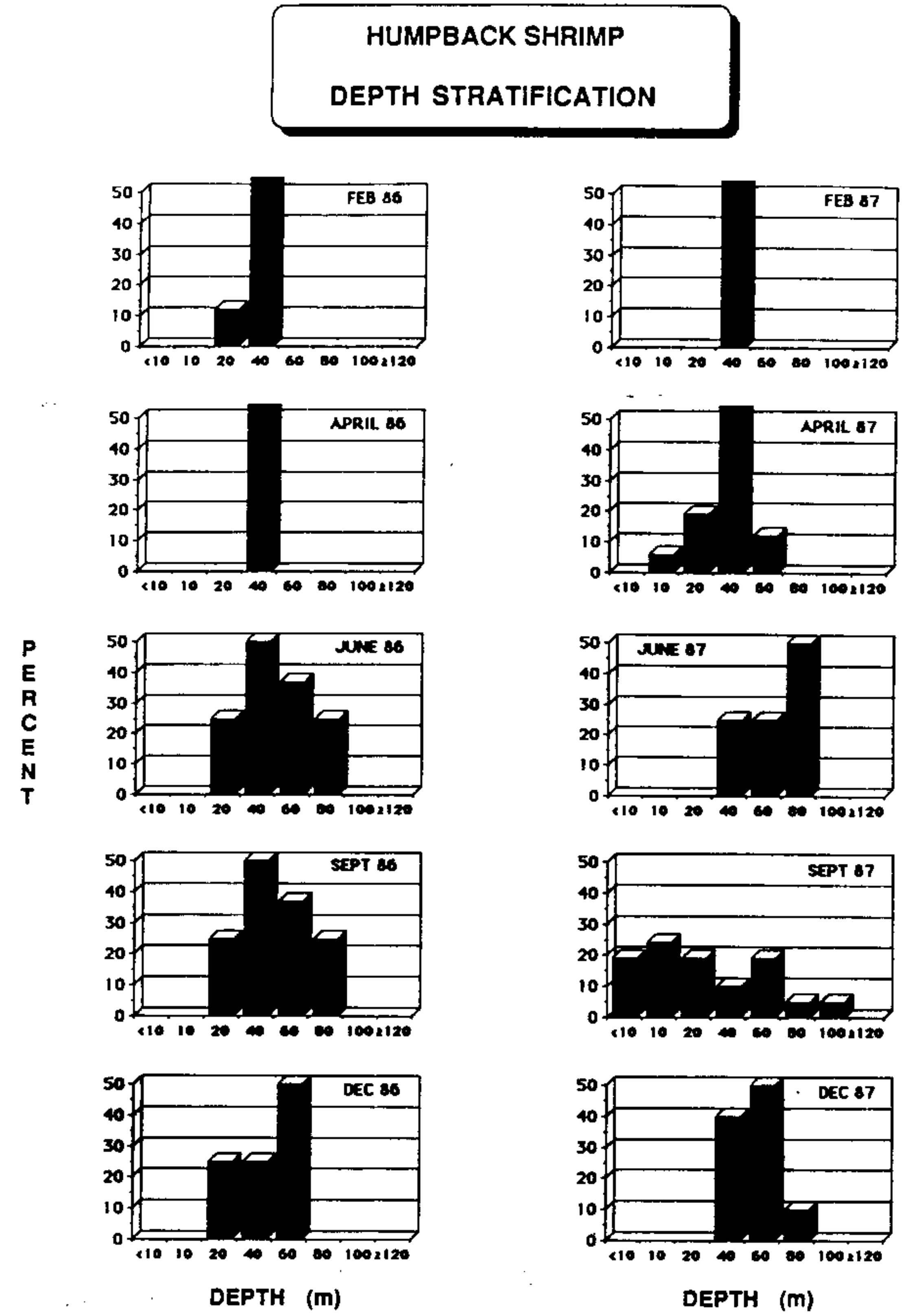


Figure 48. Distribution of humpback shrimp, *Pandalus hypsinotus*, in Port Gardner by depth intervals as indicated by beam trawl catches for all sample periods in 1986 and 1987.

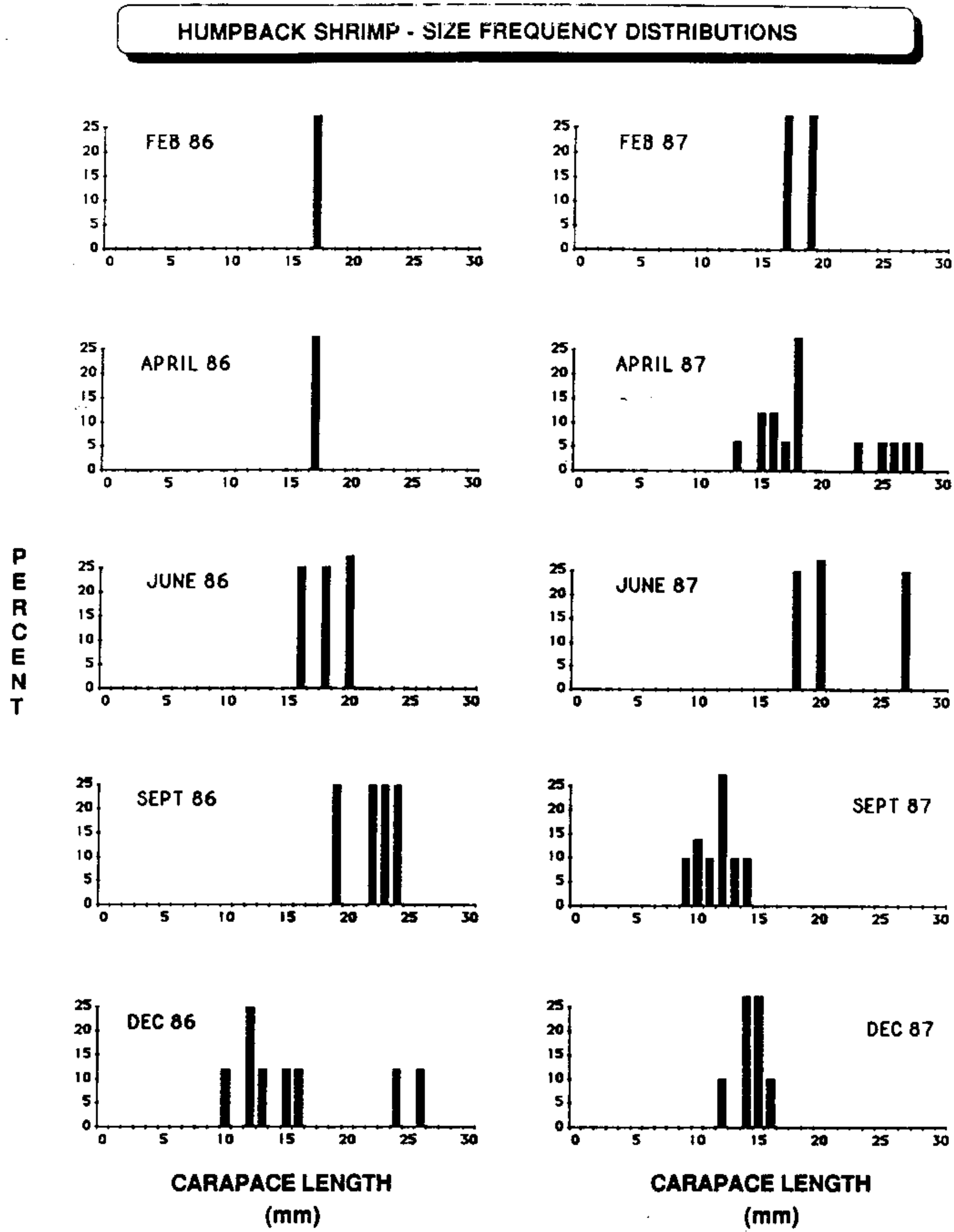


Figure 49. Carapace length-frequency plots for humpback shrimp, *Pandalus hypsinotus*, caught in Port Gardner beam trawls (all stations combined) for each sample period in 1986 and 1987.

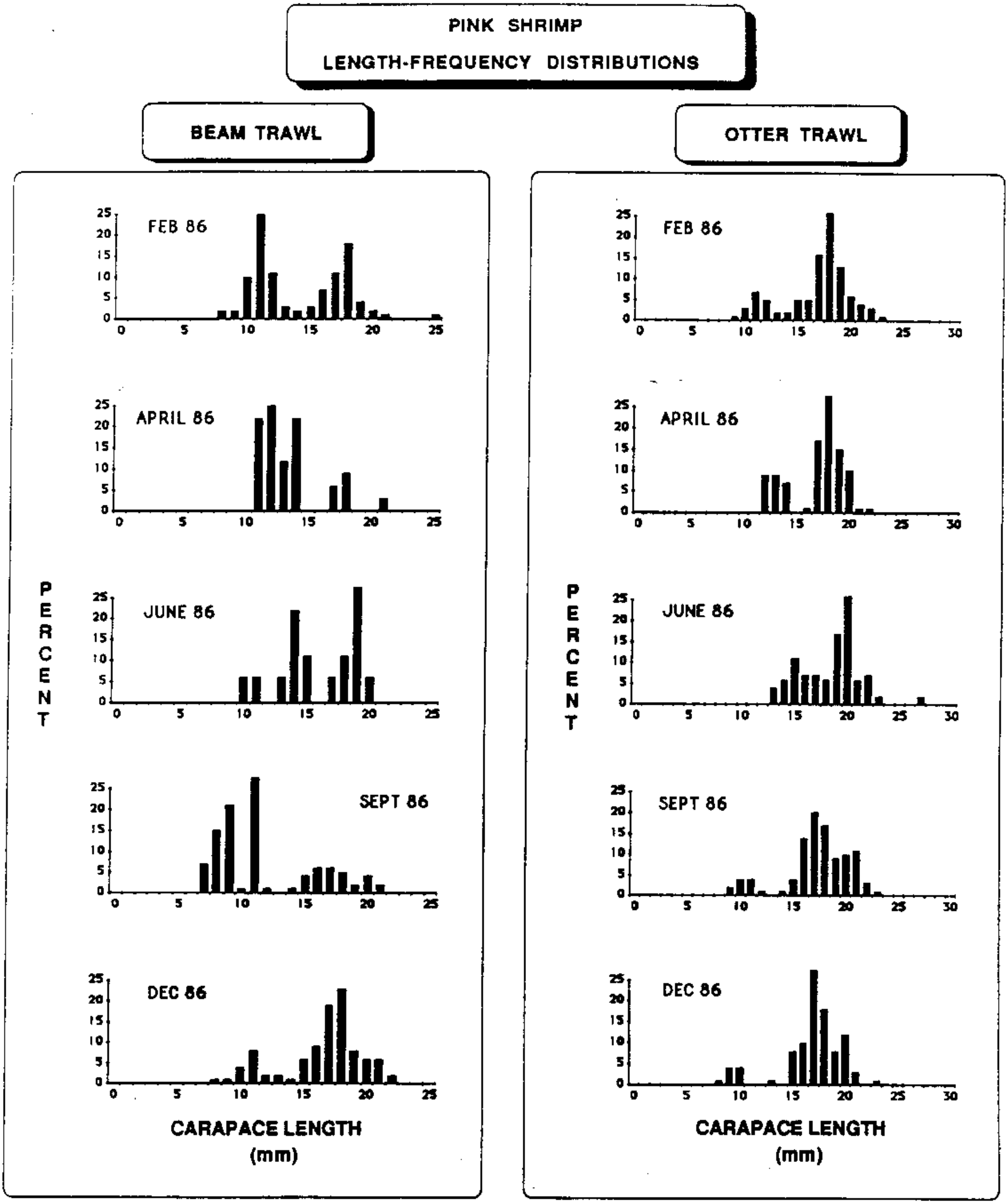


Figure 50. Comparison of length-frequency plots for pink shrimp, *Pandalus borealis*, caught in Port Gardner by beam trawl (left) and otter trawl (right) for each sample period in 1986 only.

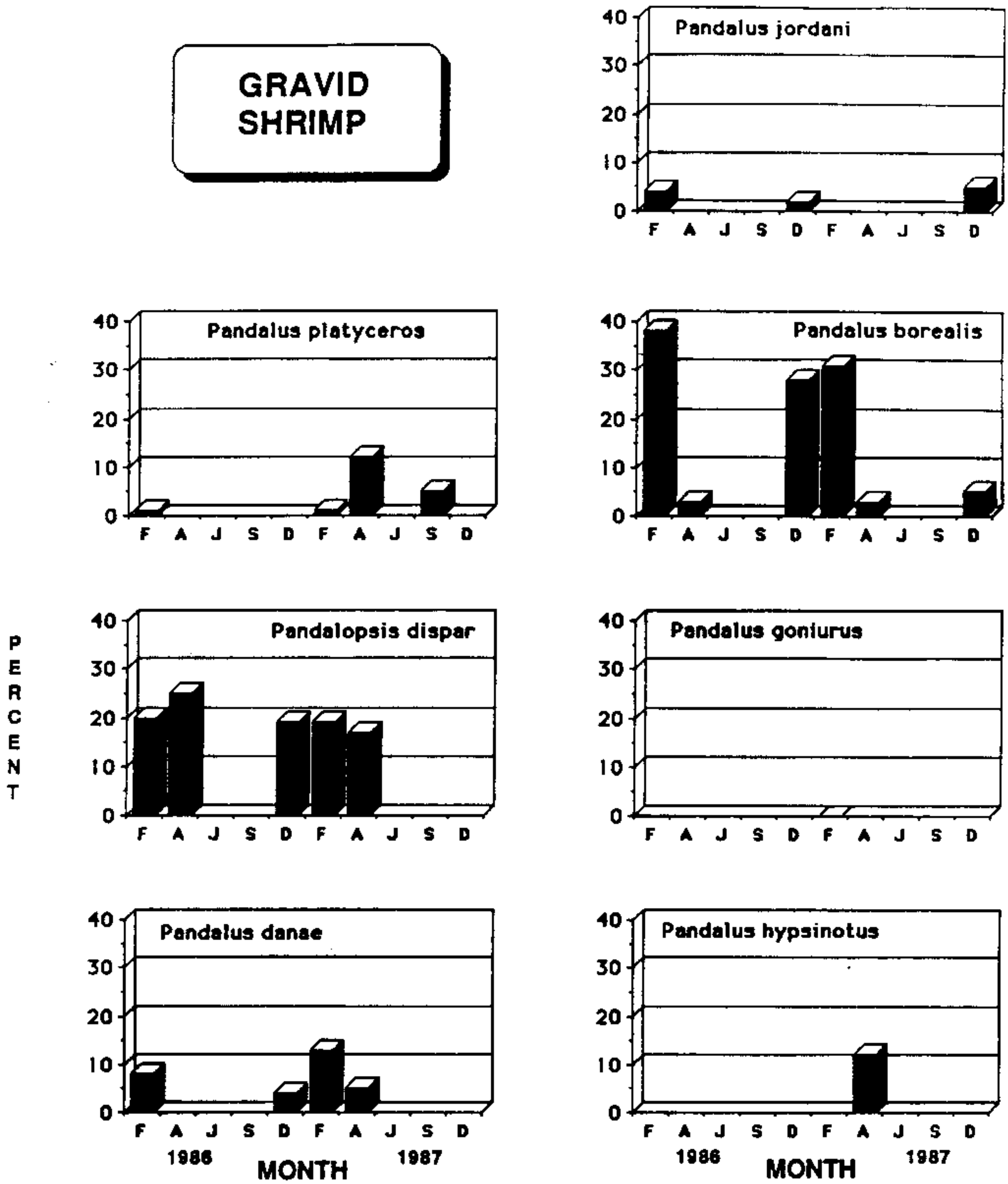
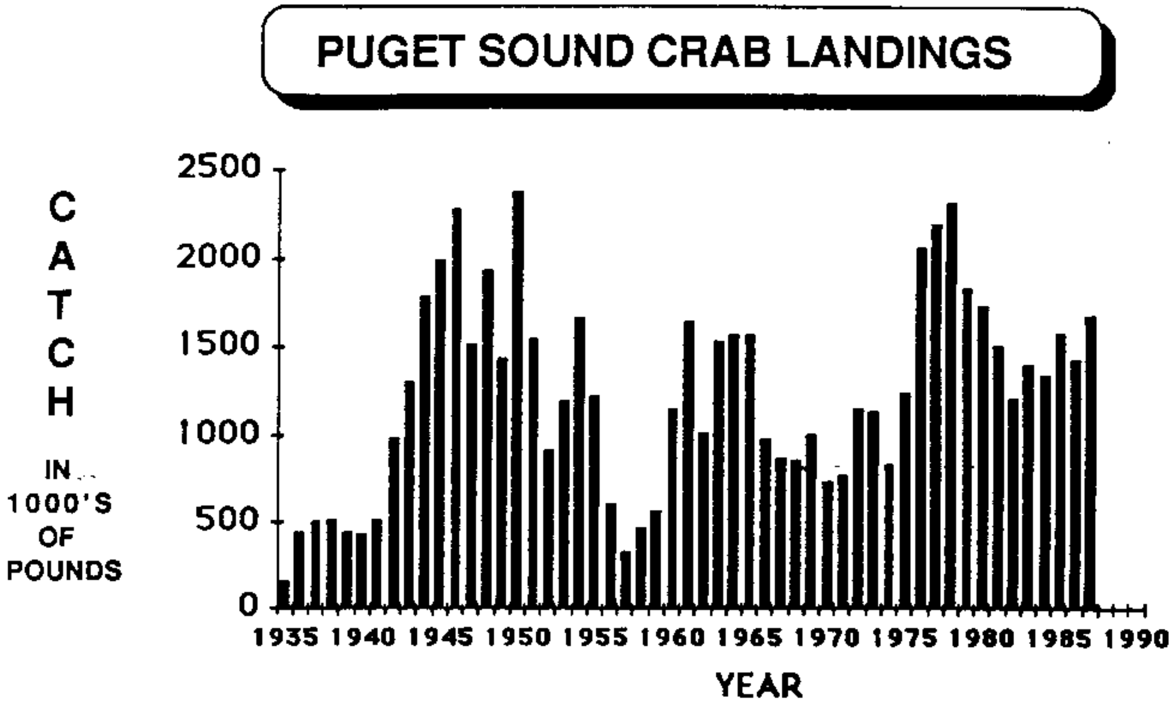


Figure 51. Percent of shrimp caught in the Port Gardner beam trawl samples which were carrying eggs during each sample period in 1986 and 1987.



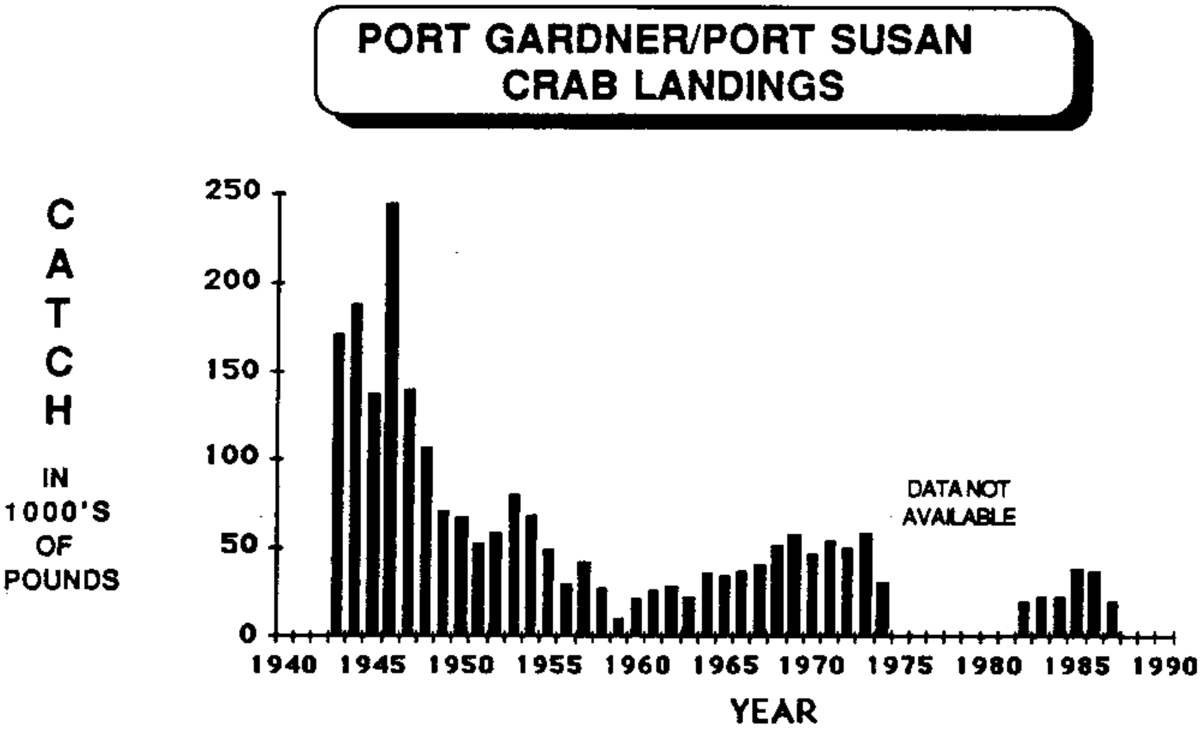
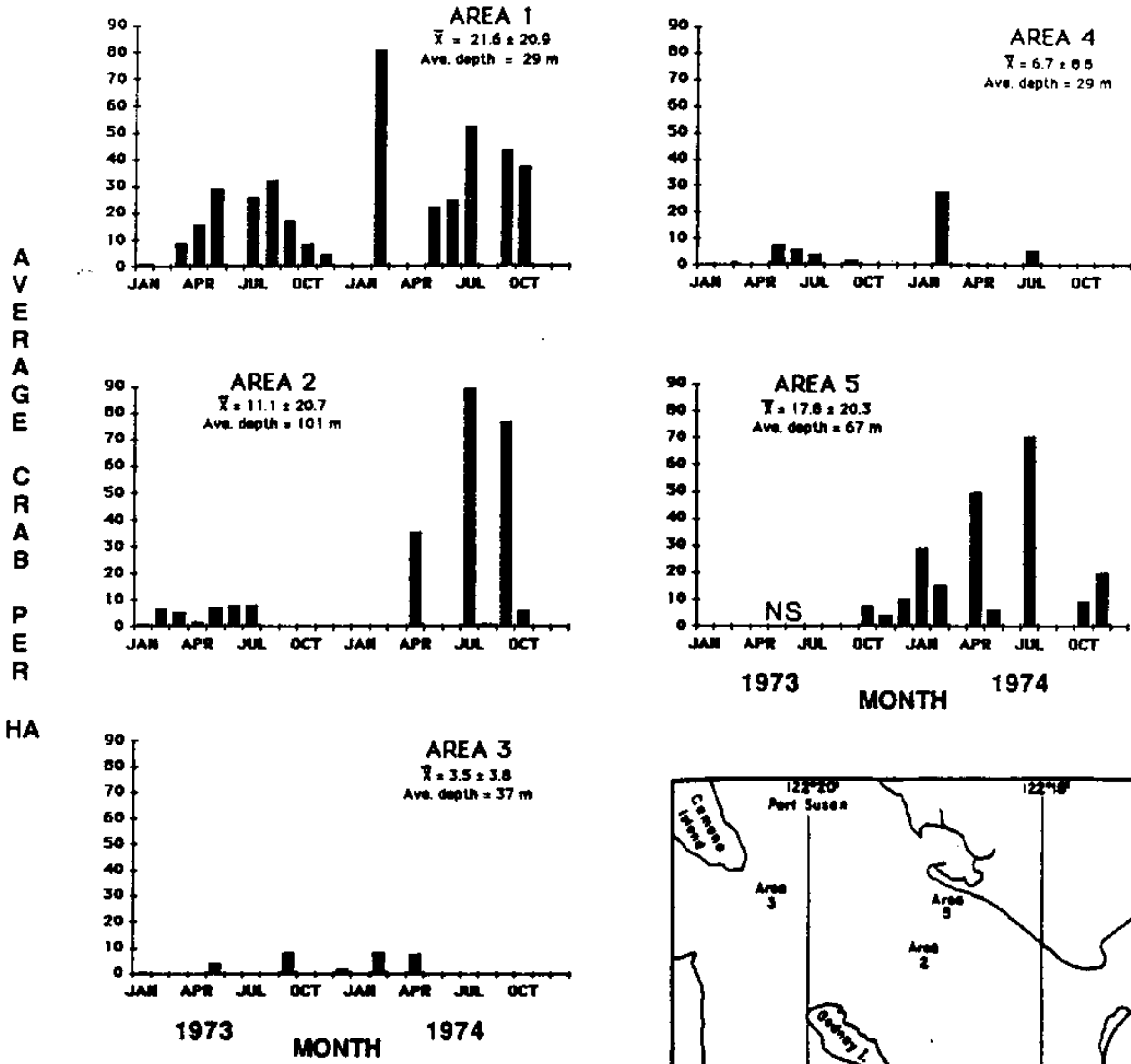


Figure 52. Commercial Dungeness crab landings in Puget Sound from 1935 to 1987 (top) and in the Port Gardner/Port Susan region from 1943 to 1987 (bottom). Source of data: WDF (1982, unpublished data).

PORT GARDNER -- 1973 / 1974 -- OTTER TRAWL



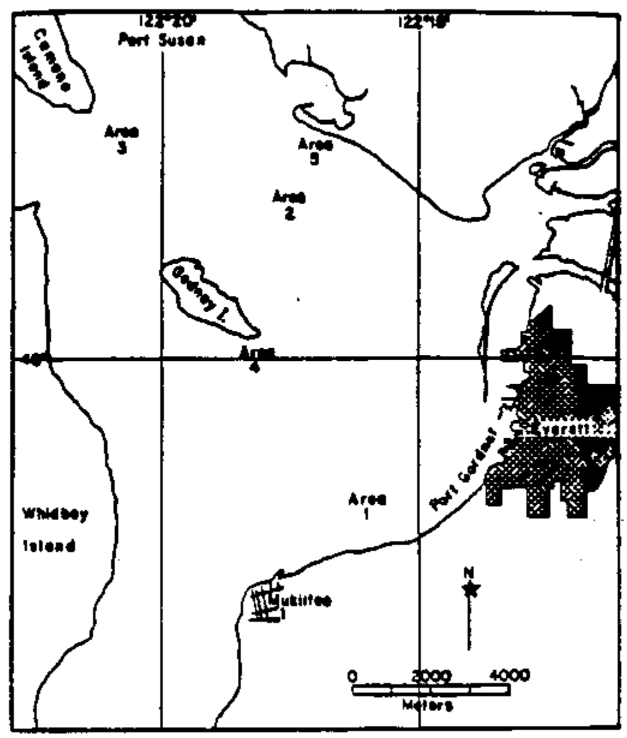


Figure 53.

Average estimated Dungeness crab densities in five areas of Port Gardner in 1973 and 1974 as indicated by monthly sampling with a research otter trawl. These estimates were calculated from data collected by Ames et al. (1975) and assumes a trawl fishing width of 3.5 meters.

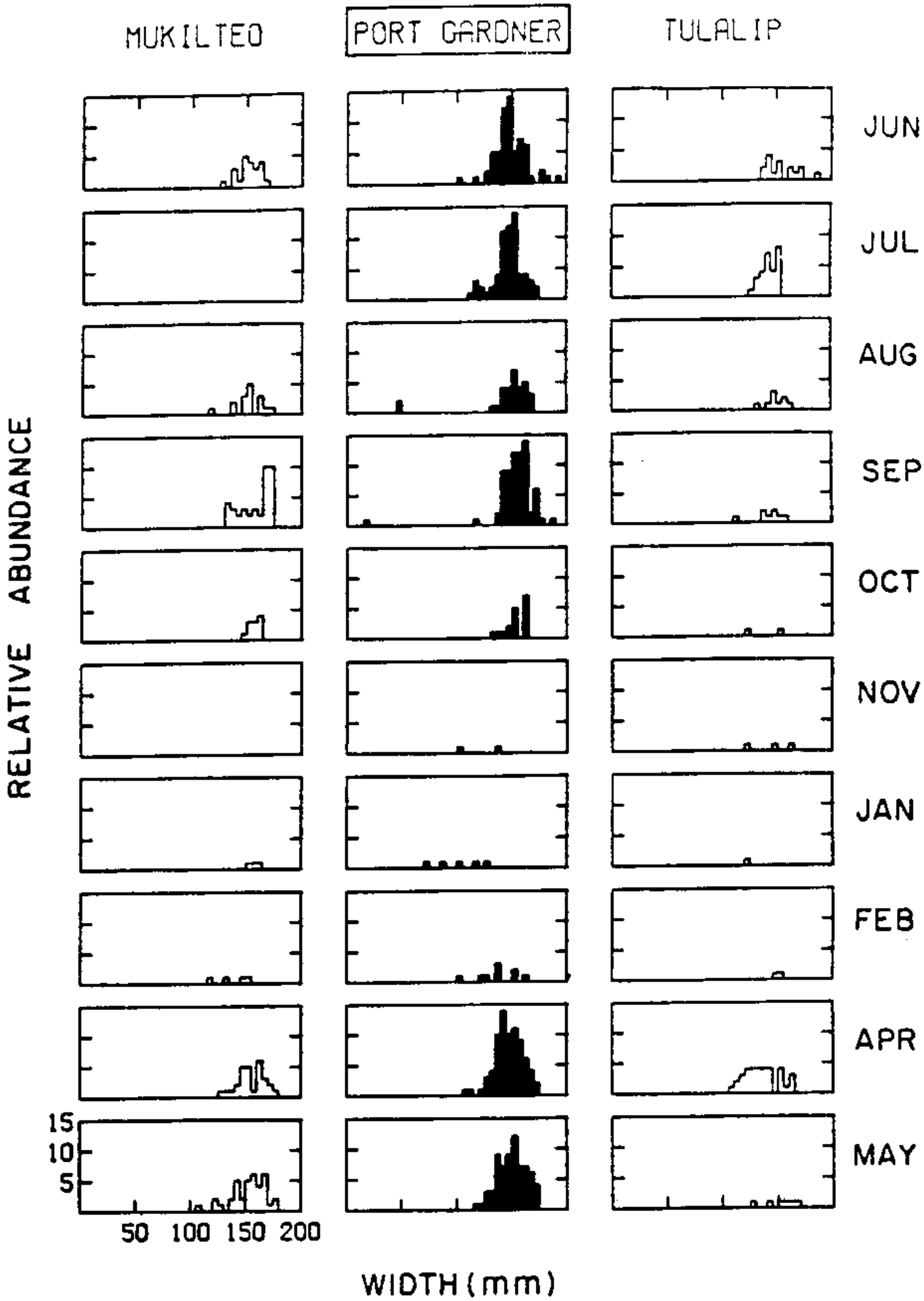


Figure 54. Carapace width-frequency distributions for female Dungeness crab caught at three locations over a ten month period in and around Port Gardner, June 1973 to May 1974. Graphs are from English (1976).

Table 5. Estimated average densities of Dungeness crab as calculated from University of Washington beam trawl catches in the inland waters of Washington.

AREA	DATE	NUMBER OF SAMPLES	ESTIMATED CRAB/Ha
PORT GARDNER:	FEB 1986	55	126
	APRIL	55	85
	JUNE	59	114
	SEPT	63	100
	DEC	73	71
	FEB 1987	73	147
	APRIL	73	40
	JUNE	73	85
	SEPT	73	83
	DEC	23	31
COMBINED AVERAGE =		**620**	**91**
NORTH PUGET SOUND:	AUGUST 1984	22	93
(PADILLA BAY TO THE	DEC	23	19
STRAIT OF GEORGIA)	MARCH 1985	23	148
	OCT	38	118
COMBINED AVERAGE =		**106**	**98**
STRAIT OF GEORGIA (PSDDA):	APRIL 1987	11	46
	OCT	11	17
COMBINED AVERAGE =		**22**	**32**
BELLINGHAM BAY:	FEB 1987	39	56
	MAY	39	108
	JULY	38	104
	OCT	39	65
COMBINED AVERAGE =		**155**	**83**

Table 5. (cont.)

AREA	DATE	NUMBER OF SAMPLES	ESTIMATED CRAB/Ha
PORT TOWNSEND (PSDDA):	APRIL 1987	3	0
	OCT	6	0
COMBINED AVERAGE =		9	0
PORT ANGELES (PSDDA):	APRIL 1987	6	0
	OCT	6	0
COMBINED AVERAGE =		12	0
SARATOGA PASS (PSDDA):	FEB 1986	11	1
	JUNE	14	43
COMBINED AVERAGE =		25	25
ELLIOTT BAY (PSDDA):	FEB 1986	11	0
	JUNE	13	3
	SEPT	15	3
COMBINED AVERAGE =		39	2
COMMENCEMENT BAY: (PSDDA)	FEB 1986	15	0
	JUNE	18	0
	SEPT	19	0
COMBINED AVERAGE =		52	0
NISQUALLY REGION (PSDDA):	FEB 1987	53	5
	MAY	53	3
	JULY	53	2
	OCT	53	1
COMBINED AVERAGE =		212	3

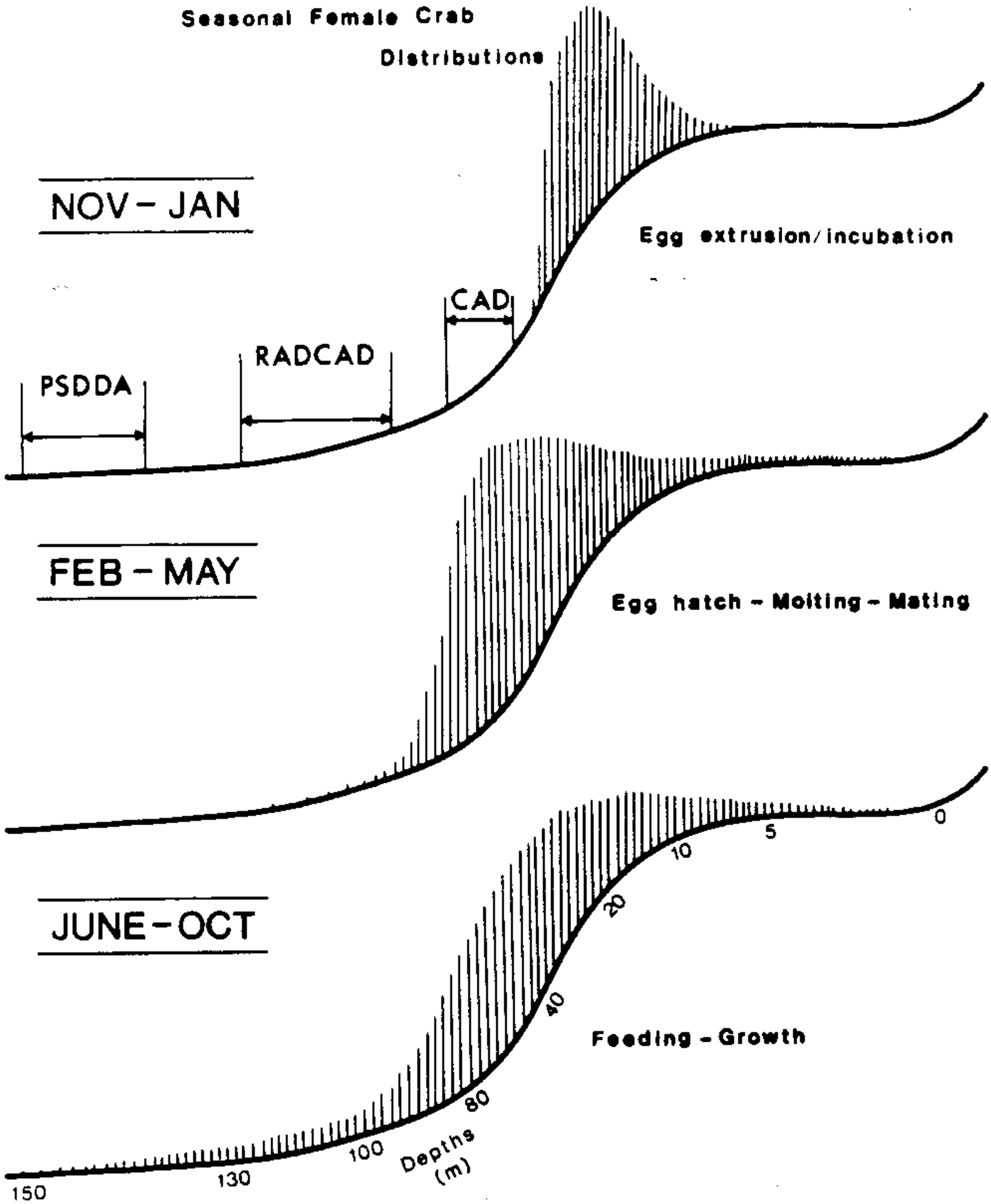


Figure 55. Schematic representation of the seasonal distribution of female Dungeness crab on and around the near-shore slope and in the proposed disposal sites in Port Gardner.

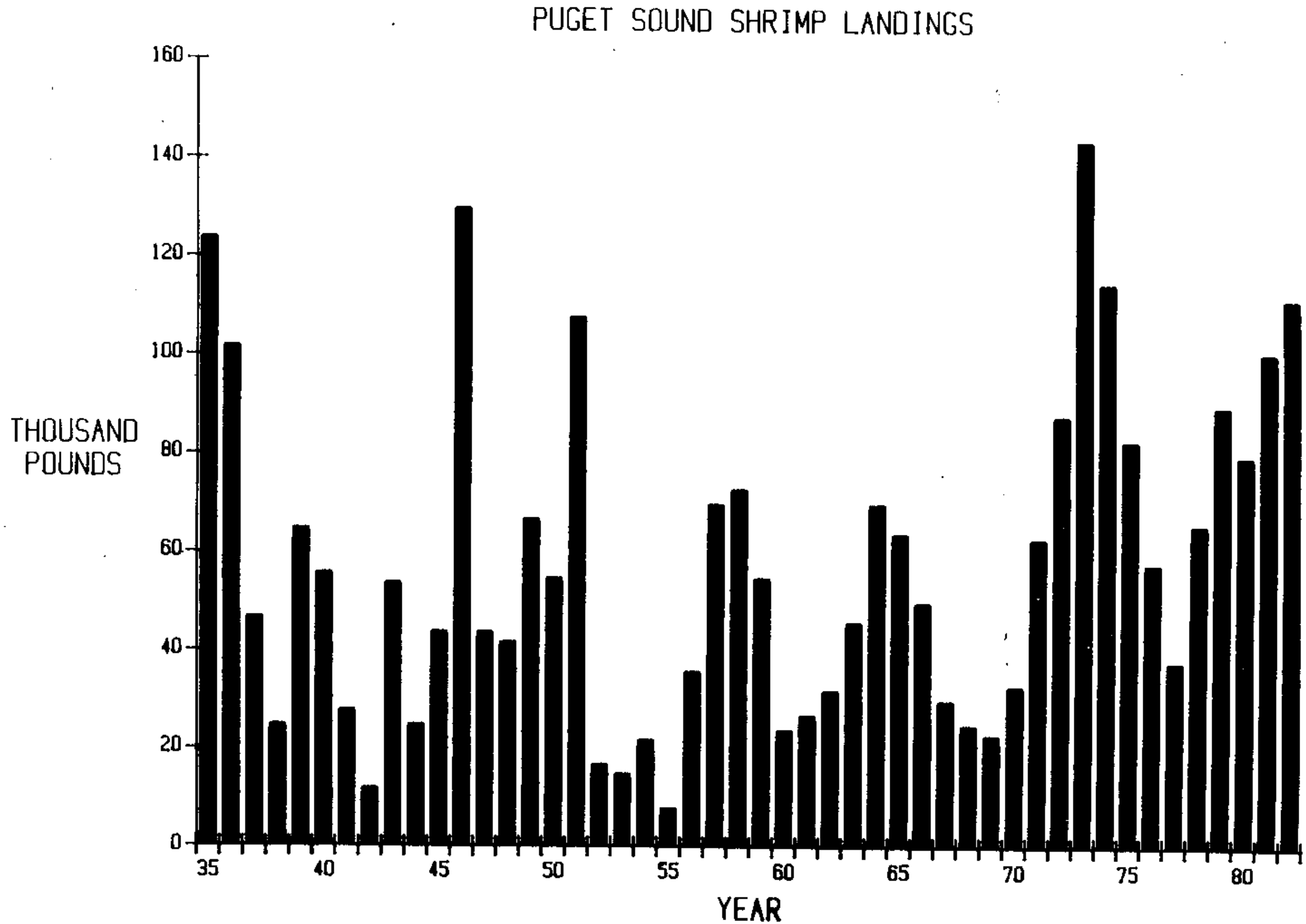


Figure 56. Annual commercial shrimp landings from Puget Sound (including Hood Canal) from 1935 to 1982. Data from WDF 1974 and 1982.

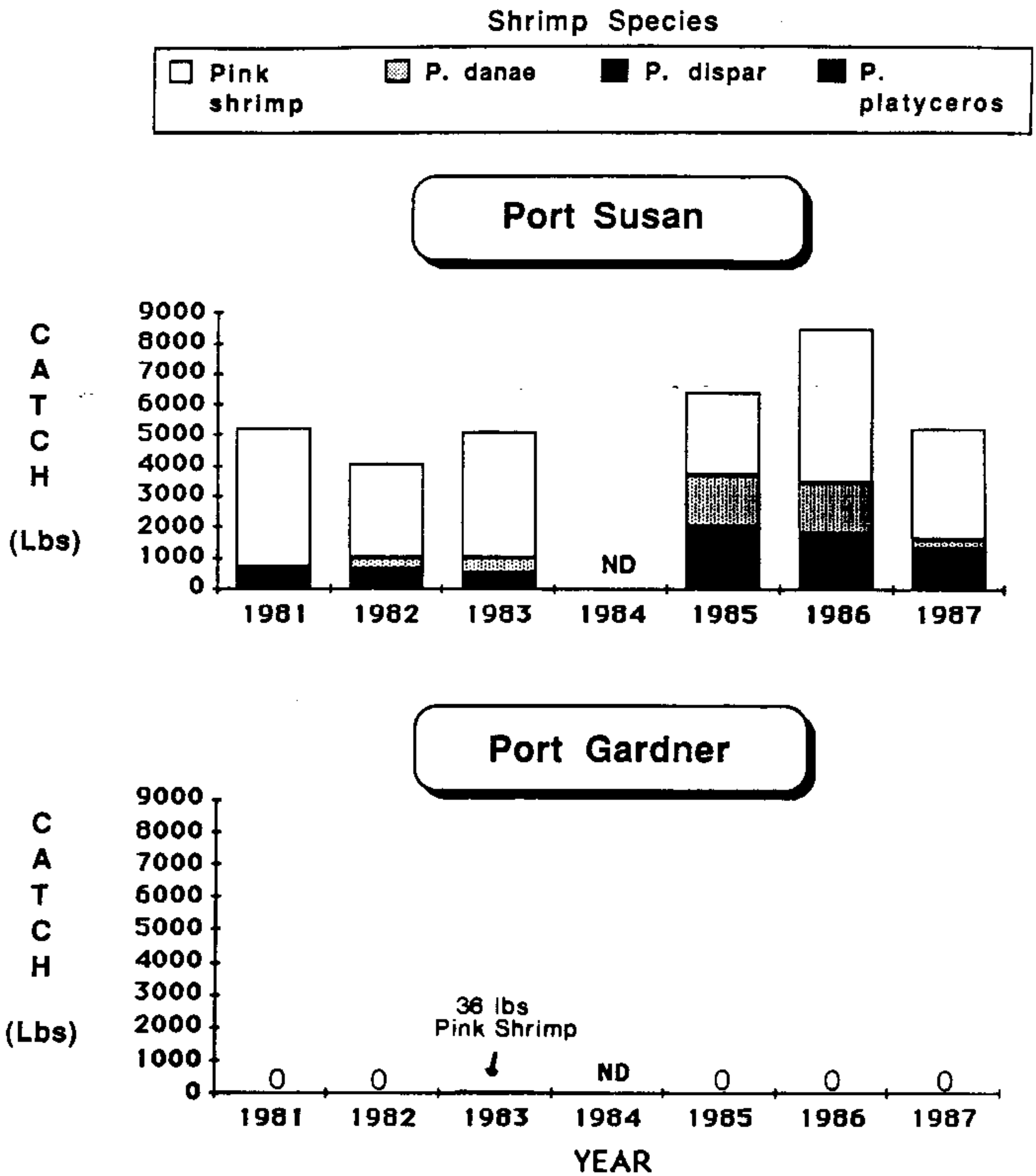


Figure 57. Commercial catches of pandalid shrimp in Port Susan and Port Gardner from 1981 to 1987. From Washington Department of Fisheries data (unpublished). ND = no data available.

APPENDIX TABLES

Appendix Table 1. Physical descriptions of the trawl sampling stations in Port Gardner.

Station #	Depth (m) Start set of net	Depth (m) Start tow	Depth (m) End tow	Range markers and distance (NM) (at start of net set)	Compass heading (degrees magnetic)	Approximate wire out (ft.)
Navy CAD Site (80m):						
Station 1	84	80	80	0.65 marker 4/0.72 SW. corner S. Pier	110	1100
Station 2	82	80	85	0.60 marker 4/0.72 SW. corner S. Pier	115	1100
Station 3	81	75	83	0.54 marker 4/0.70 SW. corner S. Pier	130	1100
NAVY RAD CAD Site (110m):						
Station 1	105	110	112	0.9 notch W. Pier/1.0 edge S. Pier	145	1150
Station 2	113	117	118	0.92 notch W. of S. Pier/1.25 SW. corner S. Pier	145	1150
Station 3	124	127	116	0.85 bump W. of shore notch/1.5 SW. corner S. Pier	145	1200
Station 4 (A)	105	108	110	0.92 SW. corner S. Pier/0.75 shore	305	1150
Station 5 (E)	103	105	107	0.85 SW. corner S. Pier/0.75 nob on shore	135	1100
Station 6 (I)	110	122	129	1.25 SW. corner S. Pier/1.15 shore at notch	305	1200
Station 7 (J)	119	114	115	1.40 SW. corner S. Pier/1.25 shore at notch	140	1150
PSDDA Site (130m):						
Station 1	128	130	133	2.10 Marker 4/1.50 Edgewater	145	1350
Station 2	133	134	135	2.30 Marker 4/1.50 Edgewater	145	1350
Station 3	136	139	140	2.50 Marker 4/1.50 Edgewater	145	1380
Transect #1:						
10S	12	12	12	0.50 SW. corner S. Pier	200	250
20S	21	23	22	0.70 SW. corner S. Pier	40	350
40S	41	45	42	0.80 SW. corner S. Pier	35	600
60S	60	62	60	0.82 SW. corner S. Pier	35	800
80S	83	82	78	0.88 SW. corner S. Pier	40	1000
100M	101	102	103	0.83 Marker 4/0.45 SW. corner S. Pier	250	1100
80N	82	80	76	0.94 Marker 4/1.50 Darlington	80	1050
60N	62	60	60	0.92 Marker 4/1.64 Darlington	75	800

Appendix Table 1. (Continued)

Station #	Depth (m) Start set of net	Start tow	End tow	Range markers and distance (NM) (at start of net set)	Compass heading (degrees magnetic)	Approximate wire out (ft.)
Transect #6:						
80S	74	84	64	0.33 SW. tip S. Pier	165	1050
80M	80	80	71	0.50 Marker 4/0.50 SW. corner S. Pier	280	1050
60N	63	61	56	0.40 Marker 4	260	800
40N	40	42	42	0.35 Marker 4/0.70 SW. corner S. Pier	260	600
20N	21	21	21	0.37 Marker 4	250	350
10N	12	11	11	0.35 Marker 4	260	250
Transect #7:						
100S	102	98	89	0.80 SW. corner S. Pier	220	1100
100M	101	102	105	1.20 Marker 4/1.26 SW. corner S. Pier	145	1100
100N	102	101	101	1.72 "RBN"/0.33 Marker 3	155	1100
80N	80	81	64	1.5 "RBN"/0.53 Marker 3	120	1050
60N	56	62	69	1.45 "RBN"	130	800
40N	42	43	33	1.5 Marker 4/1.55 "RBN"	320	600
20N	22	29	16	1.60 "RBN"	300	350
10N	11	14	12	1.60 "RBN"	310	250
Non-Transect Stations:						
B	105	106	114	1.25 Marker 4/1.10 nearest shore E. of notch	310	1100
C	92	91	92	1.00 SW. corner S. Pier/1.34 shore Darlington	80	1050
D	104	103	101	1.30 SW. corner S. Pier/1.46 Darlington	335	1100
F	110	109	113	0.65 SW. corner S. Pier/0.40 shore at Transect 1	250	1100
G	138	128	127	1.70 Marker 4/1.50 shore at Edgewater	145	1350
H	130	128	128	1.90 Marker 4/1.50 shore at Edgewater	145	1300
Delta Stations						
Station 1	4.2	4.4	4.6	2.50 SE Gedney/1.50 SW S. Pier	260	200
Station 2	5.0	5.0	5.8	2.50 SE Gedney/1.35 SW S. Pier	260	200
Station 3	6.3	6.2	6.9	2.50 SE Gedney/2.05 T2 Notch	260	225
Station 4	4.5	4.7	4.5	2.20 SE Gedney/2.50 Darlington	260	200
Station 5	4.4	4.8	5.6	0.50 West Side Everett Terminal/2.20 T2 Notch	160	200
Station 6	5.3	4.9	4.6	1.85 SE Gedney/2.50 Darlington	70	200
Station 7	4.1	4.2	3.9	0.5 West Side Everett Terminal/2.50 T2 Notch	155	200
Station 8	6.2	6.8	6.5	0.20 Breakwater/0.35 Marker 4	145	225

Appendix Table 1. (Continued)

Station #	Depth (m) Start set of net	Start tow	End tow	Range markers and distance (NM) (at start of net set)	Compass heading (degrees magnetic)	Approximate wire out (ft.)
Transect #2:						
10S	11	12	12	1.25 SW. corner S. Pier	260	250
20S	22	20	40	1.25 SW. corner S. Pier	250	350
40S	40	40	52	1.20 SW. corner S. Pier	250	600
60S	62	65	70	1.20 SW. corner S. Pier	250	800
80S	82	81	80	1.10 SW. corner S. Pier	240	1000
110S	112	110	110	1.14 SW. corner S. Pier	230	1150
110M	111	110	111	1.35 Marker 4/1.38 Darlington	155	1150
130N	136	134	125	3.5 Randall/1.6 SE. Gedney/2.0 NW S. Pier	120	1300
100N	102	95	84	1.35 Gedney/2.0 Marker 4/1.0 "RBN" Marker	110	1050
Transect #3:						
10S	12	12	10	1.88 S. edge S. Pier	65	250
20S	23	22	21	1.87 SW. corner S. Pier	70	350
40S	41	42	46	1.85 S. edge S. Pier	75	600
60S	61	60	67	1.89 SW. corner S. Pier	70	800
80S	80	82	82	1.86 SW. corner S. Pier	75	1050
110S	112	116	116	1.88 S. edge S. Pier	65	1200
130M	129	132	134	2.09 Marker 4/1.35 Edgewater	145	1300
130N	137	131	130	2.08 Marker 4/2.08 Edgewater	145	1350
Transect #4:						
10S	11	12	11	2.57 SW. corner S. Pier	40	250
20S	22	22	21	2.57 SW. corner S. Pier	40	350
40S	41	41	42	2.63 SW. corner S. Pier	35	600
60S	62	58	62	2.65 SW. corner S. Pier	35	800
80S	79	85	83	2.68 SW. corner S. Pier	40	1050
110S	113	112	123	2.70 SW. corner S. Pier	45	1175
145S	145	147	145	2.45 SW. corner S. Pier	210	1350
135N	140	138	139	2.26 Randall Pt./2.20 Edgewater/0.85 "RBN"	140	1500
Transect #5:						
20S	21	24	22	At tip of fuel dock	60	350
40S	42	38	52	3.11 SW. corner S. Pier	40	600
60S	61	64	43	3.13 SW. corner S. Pier	45	800
80S	81	80	82	3.12 SW. corner S. Pier	45	1050
110S	119	118	106	3.19 SW. corner S. Pier/0.39 tip fuel dock	45	1200
165S	171	169	170	1.92 nearest shore Whidbey/0.63 tip fuel dock	280	1600
145M	151	152	151	1.83 Edgewater/1.83 shore Clinton Dock	125	1500

Appendix Table 1. (Continued)

Station #	Depth (m) Start set of net	Start tow	End tow	Range markers and distance (NM) (at start of net set)	Compass heading (degrees magnetic)	Approximate wire out (ft.)
River Stations						
Station 9	7.0	7.4	7.5	0.13 Marina Entrance/0.9 West of Marina Breakwater	175	225
Station 10	8.9	10	11	0.14 W. Side Channel/ Abeam S. End Marina Breakwater	170	250
Station 11	10	10	13	Abeam Pier S. of Marina/ 0.09 West Side Waterway	180	250
Station 12	11	13	10	0.20 Marker 5/0.05 East Shore	15	250
Station 13	10	7.9	13	0.36 P.O.E. Pier One/0.16 Marker 4	5	250
East Waterway Stations						
Station 14	9.8	8.8	12	0.09 S. of Breakwater (Land)/0.25 W. of Pier 1	260	250
Station 15	14	16	20	0.09 Abeam Pier 2/0.29 NW Corner S. Pier	190	300
Station 16	12	15	19	0.14 W. End Pier 2/0.34 NW Corner S. Pier		300
Station 17	12	12	12	0.17 N. of NW Corner Pier 2/0.08 W. of Scott Dock	180	250
South Shore 3-m Stations						
All 3-m stations trawled from 20' whaler. Hence, locations were only approximated visually from shore topography.						

Appendix Table 2. Catches (crab/hectare) of Dungeness crab by divers along sampling transects at 26 shallow subtidal stations (2, 4 or 6 meters below MLLW). Transects at each station covered 170 m^2 (50 m long by 3.4 m wide). NS = not sampled, Average = mean ± 1 S.D. The columns marked "Unknown" refer to crabs which were sighted within the sample area but which evaded capture.

	2 Meter Stations				4 Meter Stations				6 Meter Stations			
Transect	♂	♀	(Gravid ♀)	Unknown	♂	♀	(Gravid ♀)	Unknown	♂	♀	(Gravid ♀)	Unknown
T1 - South	0	0		0	NS	NS		NS	59	0		0
T1 - North	176	118		0	59	176		0	59	176	(118)	0
T2 - South	235	59		0	NS	NS		NS	59	59		0
T2 - North	59	176		0	176	882	(765)	59	176	4,000	(3,588)	941
T3 - South	0	0		0	NS	NS		NS	0	0		0
T4 - South	412	0		0	NS	NS		NS	0	0		59
T5 - South	118	235		0	NS	NS		NS	235	0		59
T6 - South	118	59		59	NS	NS		NS	765	59	(59)	118
T6 - North	118	59		176	471	59	(59)	0	0	0		0
T7 - South	59	0		0	NS	NS		NS	118	235	(235)	176
T7 - North	59	176		0	0	0		0	235	941	(588)	0
Average	123 ± 113	62 ± 64	(0)	21 ± 52	176 ± 181	279 ± 354	(206 ± 324)	15 ± 26	155 ± 210	497 ± 1,139	(417 ± 1,017)	123 ± 265
Average by Depth	225 ± 137				470 ± 418				775 ± 1,423			

Appendix

Table 3. Number of exposed and buried Dungeness crab observed at three depth ranges from the **Pisces IV** in January 1987 in Port Gardner. See Figure 7 for the transect locations.

Location/depth range	Duration (min)	No. crabs observed/hr Exposed	Buried
Transect 1:			
10-50 m	60	7	96
50-90 m	30	4	2
>90 m	60	3	0
Transect 2:			
10-50 m	26	12	18
50-90 m	56	8	0
>90 m	50	5	0
Transect 3:			
10-50 m	89	24	78
50-90 m	45	19	2
>90 m	Not sampled		
Transect 4:			
10-50 m	46	16	150
50-90 m	15	12	0
>90 m	65	1	0
Transect 5:			
10-50 m	Not sampled		
50-90 m	Not sampled		
>90 m	40	3	0
Transect 6:			
10-50 m	Not sampled		
50-90 m	Not sampled		
>90 m	90	1	0
All transects combined:			
10-50 m	221	16.0	91.0
50-90 m	146	10.7	1.2
>90 m	305	2.4	0.0

Appendix Table 4.

Estimated densities (crab/ha) of Dungeness crab for all Port Gardner beam trawl samples collected during ten cruises in 1986 and 1987. The tabulation is broken down for all Dungeness crab combined, by male only, and by female only. NS = not sampled.

ALL CANCER MAGISTER (MALE + FEMALE + JUVENILE --ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
CAD SITE										
1 (80 m)	112	496	421	95	37	37	56	225	169	NS
2 (80 m)	281	439	618	115	37	131	56	37	225	NS
3 (80 m)	281	229	468	19	0	131	19	262	75	NS
AVERAGE ± 1 SD	225 ± 98	388 ±141	502 ± 103	76 ± 51	25 ± 21	100 ± 54	44 ± 21	175 ± 121	156 ± 76	- - -
RADCAD SITE										
1 (110 m)	0	38	0	19	0	0	37	75	37	0
2 (115 m)	0	19	0	19	0	37	0	94	0	0
3 (120 m)	19	0	0	0	0	37	19	56	0	0
A (110 m)	NS	NS	75	19	0	0	19	56	0	0
E (105 m)	NS	NS	NS	0	0	0	56	75	37	0
I (120 m)	NS	NS	NS	NS	0	0	0	37	19	0
J (115 m)	NS	NS	NS	NS	0	37	0	0	19	0
AVERAGE ± 1 SD	6 ± 11	19 ± 19	19 ± 38	11 ± 10	0 ± 0	16 ± 20	20 ± 21	56 ± 31	16 ± 17	0 ± 0
PSDDA SITE										
1 (130 m)	0	0	0	0	0	0	0	19	56	NS
2 (135 m)	0	0	0	57	0	0	19	75	0	NS
3 (140 m)	0	0	0	19	0	19	0	0	0	NS
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	25 ± 29	0 ± 0	6 ± 11	6 ± 11	31 ± 39	19 ± 32	- - -
TRANSECT # 1										
3S	NS	NS	NS	NS	NS	NS	NS	NS	9	NS
10S	150	76	56	57	169	206	19	56	56	NS
20S	75	38	56	76	37	94	37	19	37	NS
40S	150	19	19	191	262	318	131	94	131	0
60S	NS	NS	NS	NS	56	225	75	112	318	NS
80S	206	95	169	267	0	190	19	206	169	NS
100M	19	0	0	95	56	19	56	150	0	NS
80N	94	57	918	0	0	19	56	56	37	NS
60N	NS	NS	NS	NS	56	243	0	131	0	NS

Appendix Table 4. (cont.)

All	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
TRANSECT # 2										
3S	NS	NS	NS	NS	NS	NS	NS	NS	17	NS
10S	300	76	19	38	38	93	131	94	0	75
20S	168	57	19	249	57	0	94	0	75	206
40S	19	38	19	153	0	75	187	56	112	37
60S	NS	NS	NS	NS	0	131	94	56	112	0
80S	355	76	94	305	0	487	19	56	19	19
110S	0	0	112	0	0	19	19	75	75	0
110M	0	0	19	38	0	0	19	19	19	0
130N	19	0	37	38	0	0	19	131	0	NS
100N	19	19	56	0	0	0	19	0	0	NS
TRANSECT # 3										
3S	NS	NS	NS	NS	NS	NS	NS	NS	16	NS
10S	112	57	0	19	19	19	0	19	0	0
20S	19	38	37	38	0	19	19	0	37	NS
40S	37	115	75	572	2659	1236	150	37	75	NS
60S	NS	NS	NS	NS	19	861	37	224	318	NS
80S	75	95	56	95	19	375	56	112	337	NS
110S	150	0	37	57	0	19	37	37	37	NS
130M	0	0	0	76	0	0	0	37	0	NS
130N	0	19	0	19	0	0	0	56	19	NS
TRANSECT # 4										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	19	57	56	19	37	19	37	0	0	NS
20S	543	0	37	76	75	56	0	0	0	NS
40S	38	19	75	210	37	318	0	0	169	94
60S	NS	NS	NS	NS	74	749	37	150	243	NS
80S	188	210	75	115	0	337	94	56	75	NS
110S	56	19	56	153	0	56	19	0	37	NS
145S	0	0	0	57	0	0	37	19	0	NS
135N	19	0	0	0	0	0	37	0	0	NS
TRANSECT # 5										
3S	NS	NS	NS	NS	NS	NS	NS	NS	12	NS
20S	75	57	131	133	56	244	131	94	149	NS
40S	56	38	75	553	38	113	94	19	187	NS
60S	NS	NS	NS	NS	19	131	0	0	187	NS
80S	75	115	56	114	0	94	94	19	150	NS
110S	112	0	19	153	0	0	0	0	56	NS
165S	0	0	0	0	0	0	19	0	0	NS
145M	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 6										
80S	274	191	75	95	113	131	37	299	262	19
80M	487	592	282	191	56	150	131	187	56	NS
60N	NS	NS	NS	NS	75	208	149	281	169	56

Appendix Table 4. (cont.)

All	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
40N	337	305	206	76	75	262	19	112	506	NS
20N	93	229	300	19	75	75	56	75	75	112
10N	206	248	131	38	93	75	56	0	37	NS
TRANSECT # 7										
100S	94	57	156	76	0	56	19	131	75	0
100M	19	38	0	38	0	0	0	169	0	NS
100N	56	38	468	0	38	19	0	356	37	0
80N	85	76	206	229	56	169	19	19	94	NS
60N	NS	NS	NS	NS	75	731	19	412	75	NS
40N	599	153	244	229	112	786	56	94	56	NS
20N	525	112	337	95	206	824	37	75	94	94
10N	225	38	19	76	319	394	19	19	506	NS
NON-TRANSECT STA.										
B (110 m)	NS	NS	37	0	0	0	0	94	0	NS
C (90 m)	NS	NS	37	38	0	0	56	393	19	NS
D (105 m)	NS	NS	19	38	19	0	56	112	0	NS
F (110 m)	NS	NS	NS	38	0	37	37	131	113	NS
G (130 m)	NS	NS	NS	19	0	0	0	19	0	NS
H (130 m)	NS	NS	NS	0	0	19	19	0	37	NS
DELTA STATIONS										
1 (2 m)	NS	NS	NS	NS	NS	NS	NS	131	37	NS
2 (3 m)	NS	NS	NS	NS	NS	NS	NS	94	131	NS
3 (4 m)	NS	NS	NS	NS	NS	NS	NS	37	131	NS
4 (2 m)	NS	NS	NS	NS	NS	NS	NS	468	113	NS
5 (2 m)	NS	NS	NS	NS	NS	NS	NS	131	299	NS
6 (3 m)	NS	NS	NS	NS	NS	NS	NS	NS	187	NS
7 (2 m)	NS	NS	NS	NS	NS	NS	NS	NS	113	NS
8 (4 m)	NS	NS	NS	NS	NS	NS	NS	NS	169	NS
RIVER STATIONS										
9 (5 m)	NS	NS	NS	NS	NS	NS	NS	NS	131	NS
10 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	38	NS
11 (8 m)	NS	NS	NS	NS	NS	NS	NS	NS	169	NS
12 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	37	NS
13 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	93	NS
EAST WATERWAY STA.										
14 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	29	NS
15 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	29	NS
16 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	78	NS
17 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	156	NS
NUMBER STA. SAMPLED	55	55	59	63	73	73	73	78	95	23
GRAND AVERAGE ± 1 SD	124 ± 152	85 ± 127	109 ± 172	89 ± 115	71 ± 313	152 ± 247	40 ± 43	90 ± 103	85 ± 103	28 ± 52

Appendix Table 4. (cont.)

MALE CANCER MAGISTER (ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
CAD SITE										
1 (80 m)	0	19	47	0	37	0	0	19	0	NS
2 (80 m)	0	0	75	0	37	0	0	0	0	NS
3 (80 m)	19	0	37	0	0	0	0	0	0	NS
AVERAGE ± 1 SD	6 ± 11	6 ± 11	53 ± 20	0 ± 0	25 ± 21	0 ± 0	0 ± 0	6 ± 11	0 ± 0	- - -
RADCAD SITE										
1 (110 m)	0	0	0	0	0	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	19	0	0
A (110 m)	NS	NS	0	0	0	0	0	0	0	0
E (105 m)	NS	NS	NS	0	0	0	0	0	0	0
I (120 m)	NS	NS	NS	NS	0	0	0	0	0	0
J (115 m)	NS	NS	NS	NS	0	0	0	0	0	0
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	3 ± 7	0 ± 0	0 ± 0
PSDDA SITE										
1 (130 m)	0	0	0	0	0	0	0	0	0	0
2 (135 m)	0	0	0	0	0	0	0	19	0	0
3 (140 m)	0	0	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	6 ± 11	0 ± 0	- - -
TRANSECT # 1										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	131	38	56	38	150	37	0	37	0	NS
20S	56	19	37	19	0	0	0	0	0	NS
40S	0	0	0	0	19	0	37	0	0	0
60S	NS	NS	NS	NS	19	19	0	0	0	NS
80S	0	0	0	19	0	0	0	0	0	NS
100M	0	0	0	0	37	0	0	19	0	NS
80N	0	0	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	19	0	0	0	0	NS
TRANSECT # 2										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	206	19	0	19	19	37	19	37	0	37

Appendix Table 4. (cont.)

MALE CANCER MAGISTER (ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	**FEB**	**APRIL**	**JUNE**	**SEPT**	**DEC**	**FEB**	**APRIL**	**JUNE**	**SEPT**	**DEC**
20S	56	0	0	19	19	0	37	0	0	56
40S	0	0	0	0	0	0	0	0	0	19
60S	NS	NS	NS	NS	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	19	0	0
110S	0	0	0	0	0	0	0	0	0	0
110M	0	0	0	0	0	0	0	0	0	0
130N	0	0	0	0	0	0	0	0	0	NS
100N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 3										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	75	19	0	19	0	19	0	0	0	0
20S	0	0	0	0	0	0	0	0	0	NS
40S	0	0	19	19	0	37	0	0	0	NS
60S	NS	NS	NS	NS	0	0	0	37	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
110S	19	0	0	0	0	0	0	0	0	NS
130M	0	0	0	0	0	0	0	0	0	NS
130N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 4										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	19	38	37	0	37	19	19	0	0	NS
20S	131	0	37	38	0	37	0	0	0	NS
40S	19	0	19	38	0	0	0	0	19	0
60S	NS	NS	NS	NS	37	19	0	37	37	NS
80S	19	19	0	0	0	0	0	0	0	NS
110S	0	0	19	0	0	0	0	0	0	NS
145S	0	0	0	19	0	0	0	0	0	NS
135N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 5										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
20S	56	0	37	57	56	94	37	0	37	NS
40S	37	19	0	57	19	19	0	19	37	NS
60S	NS	NS	NS	NS	0	19	0	0	37	NS
80S	0	0	0	19	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
165S	0	0	0	0	0	0	0	0	0	NS
145M	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 6										
80S	0	0	19	19	94	0	0	37	19	0
80M	0	19	0	0	37	0	19	0	0	NS
60N	NS	NS	NS	NS	56	0	37	19	0	37
40N	94	57	0	0	56	19	0	19	19	NS
20N	56	19	19	0	19	0	19	19	0	56
10N	75	19	19	0	56	0	0	0	0	NS

Appendix Table 4. (cont.)

MALE CANCER MAGISTER (ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
TRANSECT # 7										
100S	0	0	52	0	0	0	0	37	0	0
100M	0	0	0	0	0	0	0	0	0	NS
100N	0	0	19	0	19	0	0	0	0	0
80N	0	0	0	19	0	0	0	0	19	NS
60N	NS	NS	NS	NS	0	19	0	19	0	NS
40N	19	0	19	0	0	37	0	19	0	NS
20N	19	0	0	0	37	0	0	0	0	0
10N	19	19	0	0	94	19	0	0	19	NS
NON-TRANSECT STA.										
B (110 m)	NS	NS	0	0	0	0	0	0	0	NS
C (90 m)	NS	NS	0	0	0	0	0	0	0	NS
D (105 m)	NS	NS	0	0	0	0	0	0	0	NS
F (110 m)	NS	NS	NS	0	0	0	0	0	19	NS
G (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
H (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
DELTA STATIONS										
1 (2 m)	NS	NS	NS	NS	NS	NS	NS	56	0	NS
2 (3 m)	NS	NS	NS	NS	NS	NS	NS	0	37	NS
3 (4 m)	NS	NS	NS	NS	NS	NS	NS	19	19	NS
4 (2 m)	NS	NS	NS	NS	NS	NS	NS	187	19	NS
5 (2 m)	NS	NS	NS	NS	NS	NS	NS	19	112	NS
6 (3 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
7 (2 m)	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
8 (4 m)	NS	NS	NS	NS	NS	NS	NS	NS	94	NS
RIVER STATIONS										
9 (5 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
11 (8 m)	NS	NS	NS	NS	NS	NS	NS	NS	37	NS
12 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
13 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	37	NS
EAST WATERWAY STA.										
14 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
15 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
16 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
17 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	39	NS
NUMBER STA. SAMPLED	55	55	59	63	73	73	73	78	95	23
GRAND AVERAGE ± 1 SD	20 ± 41	6 ± 12	11 ± 18	6 ± 14	13 ± 30	8 ± 15	3 ± 9	9 ± 24	7 ± 18	9 ±19

Appendix Table 4. (cont.)

FEMALE CANCER MAGISTER (ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
CAD SITE										
1 (80 m)	112	477	375	95	0	37	56	206	169	NS
2 (80 m)	281	439	543	115	0	131	56	37	225	NS
3 (80 m)	262	229	431	19	0	131	19	262	75	NS
AVERAGE ± 1 SD	218 ± 93	383 ± 134	450 ± 86	76 ± 51	0 ± 0	100 ± 54	44 ± 21	168 ± 117	156 ± 76	- - -
RADCAD SITE										
1 (110 m)	0	38	0	19	0	0	37	75	37	0
2 (115 m)	0	19	0	19	0	37	0	94	0	0
3 (120 m)	19	0	0	0	0	37	19	37	0	0
A (110 m)	NS	NS	75	19	0	0	19	56	0	0
E (105 m)	NS	NS	NS	0	0	0	56	75	37	0
I (120 m)	NS	NS	NS	NS	0	0	0	37	19	0
J (115 m)	NS	NS	NS	NS	0	37	0	0	19	0
AVERAGE ± 1 SD	6 ± 11	19 ± 19	19 ± 38	11 ± 10	0 ± 0	16 ± 20	20 ± 21	53 ± 32	16 ± 17	0 ± 0
PSDDA SITE										
1 (130 m)	0	0	0	0	0	0	0	19	56	NS
2 (135 m)	0	0	0	57	0	0	19	56	0	NS
3 (140 m)	0	0	0	19	0	19	0	0	0	NS
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	25 ± 29	0 ± 0	6 ± 11	6 ± 11	25 ± 28	19 ± 32	- - -
TRANSECT # 1										
3S	NS	NS	NS	NS	NS	NS	NS	NS	9	NS
10S	19	38	0	19	19	169	19	19	56	NS
20S	19	19	19	57	37	94	37	19	37	NS
40S	149	19	19	191	243	318	94	94	131	0
60S	NS	NS	NS	NS	37	206	75	112	318	NS
80S	206	95	169	248	0	190	19	206	169	NS
100M	19	0	0	95	19	19	56	131	0	NS
80N	94	57	918	0	0	19	56	56	37	NS
60N	NS	NS	NS	NS	37	243	0	131	0	NS
TRANSECT # 2										
3S	NS	NS	NS	NS	NS	NS	NS	NS	17	NS
10S	94	57	19	19	0	56	112	56	0	37
20S	112	57	19	210	19	0	56	0	75	131
40S	19	38	19	153	0	75	187	56	112	19
60S	NS	NS	NS	NS	0	131	94	56	112	0
80S	355	76	94	305	0	487	19	37	19	19

Appendix Table 4. (cont.)

FEMALE CANCER MAGISTER (ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
110S	0	0	112	0	0	19	19	75	75	0
110M	0	0	19	38	0	0	19	19	19	0
130N	19	0	37	38	0	0	19	131	0	NS
100N	19	19	56	0	0	0	19	0	0	NS
TRANSECT # 3										
3S	NS	NS	NS	NS	NS	NS	NS	NS	16	NS
10S	37	38	0	0	0	0	0	19	0	0
20S	19	38	37	38	0	19	19	0	37	NS
40S	37	115	56	553	2659	1119	150	37	75	NS
60S	NS	NS	NS	NS	19	861	37	187	318	NS
80S	75	95	56	95	19	375	56	112	337	NS
110S	131	0	37	57	0	19	37	37	37	NS
130M	0	0	0	76	0	0	0	37	0	NS
130N	0	19	0	19	0	0	0	56	19	NS
TRANSECT # 4										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	19	19	19	0	0	19	0	0	NS
20S	412	0	0	38	75	19	0	0	0	NS
40S	19	19	56	172	37	318	0	0	150	94
60S	NS	NS	NS	NS	37	730	37	112	206	NS
80S	169	191	75	115	0	337	94	56	75	NS
110S	56	19	37	153	0	56	19	0	37	NS
145S	0	0	0	38	0	0	37	19	0	NS
135N	19	0	0	0	0	0	37	0	0	NS
TRANSECT # 5										
3S	NS	NS	NS	NS	NS	NS	NS	NS	12	NS
20S	19	57	94	76	0	150	94	94	112	NS
40S	19	19	75	496	19	94	94	0	150	NS
60S	NS	NS	NS	NS	19	112	0	0	150	NS
80S	75	115	56	95	0	94	94	19	150	NS
110S	112	0	19	153	0	0	0	0	56	NS
165S	0	0	0	0	0	0	19	0	0	NS
145M	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 6										
80S	374	191	56	76	19	131	37	262	243	19
80M	487	573	262	191	19	150	112	187	56	NS
60N	NS	NS	NS	NS	19	206	112	262	169	19
40N	243	248	206	76	19	243	19	94	487	NS
20N	37	210	281	19	56	75	37	56	75	56
10N	131	229	112	38	37	75	56	0	37	NS
TRANSECT # 7										
100S	94	57	104	76	0	56	19	94	75	0
100M	19	38	0	38	0	0	0	169	0	NS
100N	56	38	449	0	19	19	0	356	37	0

Appendix Table 4. (cont.)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
80N	85	76	206	210	56	169	19	19	75	NS
60N	NS	NS	NS	NS	75	712	19	393	75	NS
40N	580	153	225	229	37	749	56	75	56	NS
20N	506	114	337	95	169	824	37	75	94	94
10N	206	19	19	76	225	375	19	19	487	NS
NON-TRANSECT STA.										
B (110 m)	NS	NS	37	0	0	0	0	94	0	NS
C (90 m)	NS	NS	37	38	0	0	56	393	19	NS
D (105 m)	NS	NS	19	38	19	0	56	112	0	NS
F (110 m)	NS	NS	NS	38	0	37	37	131	94	NS
G (130 m)	NS	NS	NS	19	0	0	0	19	0	NS
H (130 m)	NS	NS	NS	0	0	19	19	0	37	NS
DELTA STATIONS										
1 (2 m)	NS	NS	NS	NS	NS	NS	NS	75	37	NS
2 (3 m)	NS	NS	NS	NS	NS	NS	NS	94	94	NS
3 (4 m)	NS	NS	NS	NS	NS	NS	NS	19	112	NS
4 (2 m)	NS	NS	NS	NS	NS	NS	NS	281	94	NS
5 (2 m)	NS	NS	NS	NS	NS	NS	NS	112	187	NS
6 (3 m)	NS	NS	NS	NS	NS	NS	NS	NS	187	NS
7 (2 m)	NS	NS	NS	NS	NS	NS	NS	NS	94	NS
8 (4 m)	NS	NS	NS	NS	NS	NS	NS	NS	75	NS
RIVER STATIONS										
9 (5 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
11 (8 m)	NS	NS	NS	NS	NS	NS	NS	NS	112	NS
12 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
13 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	56	NS
EAST WATERWAY STA.										
14 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	29	NS
15 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	29	NS
16 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	78	NS
17 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	117	NS
NUMBER STA. SAMPLED	55	55	59	63	73	73	73	78	95	23
GRAND AVERAGE ± 1 SD	106 ± 144	79 ± 122	100 ± 166	82 ± 108	56 ± 312	147 ± 242	38 ± 39	83 ± 93	76 ± 97	21 ± 37

Appendix Table 5. Seasonal population estimates for male, female, and total Dungeness crab within the boundaries of the Water Quality Certification (WQC) area of Port Gardner during 1986 and 1987 (in 1000's of crabs).

1986

	FEBRUARY			APRIL			JUNE			SEPTEMBER				DECEMBER		
DEPTH (m)	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	DEPTH (m)	FEMALE	MALE	TOTAL
0-15	45.6	47.3	92.9	35.5	13.5	49	15.2	10.2	25.4	15.2	6.8	22	0-15	25.3	32.1	57.4
16-30	14	4.7	18.7	6.3	0.5	6.8	9.8	1.6	11.4	7	1.2	8.2	16-30	4.8	1.6	6.4
31-60	19.6	3.1	22.7	11	1.4	12.4	12.1	1	13.1	33.8	2.1	35.9	31-50	35.8	1.1	36.9
61-90	44.1	0.7	44.8	43.9	1	44.9	52	2.8	54.8	24.3	1.7	26	51-70	2.8	1.5	4.3
91-110	15.1	0.6	15.7	5	0	5	22.3	2.3	24.6	15.5	0	15.5	71-90	1.4	2.5	3.9
>110	0.3	0	0.3	0.2	0	0.2	0.3	0	0.3	2	0.1	2.1	91-110	1.3	1.3	2.6
													>110	0	0	0
TOTAL	138.7	56.4	195.2	101.9	16.4	118.3	111.7	17.9	129.6	97.8	11.9	109.7		71.5	40	111.5

1987

	FEBRUARY			APRIL			JUNE			SEPTEMBER			DECEMBER		
DEPTH (m)	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL	FEMALE	MALE	TOTAL
0-15	59.1	11.8	70.9	20.3	3.4	23.7	10.1	6.7	16.8	38.4	8.8	47.2			
16-30	14.7	1.6	16.3	3.5	1.2	4.7	3	0.3	3.3	5.4	0.5	5.9			
31-50	35.7	1.3	37	7.1	0.5	7.6	4.2	0.7	4.9	13.8	0.9	14.7	NO POPULATION ESTIMATES		
51-70	37.7	0.9	38.6	4.3	0.4	4.7	14.4	1.3	15.7	15.5	0.9	16.4			
71-90	27.6	0	27.6	8.5	0.2	8.7	22.8	1	23.8	20.1	0.5	20.6			
91-110	5.2	0	5.2	6.5	0	6.5	26.7	2.6	29.3	9.9	0.4	10.3			
>110	0.3	0	0.3	1.1	0	1.1	2.6	0.1	2.7	0.9	0	0.9			
TOTAL	180.3	15.6	195.9	51.3	5.7	57	83.7	12.7	96.4	104	11.9	115.9			

Appendix Table 6.

Estimated densities (crab/ha) of Red and Purple Rock crab for all Port Gardner beam trawl samples collected during ten cruises in 1986 and 1987. The tabulation is broken down for all Dungeness crab combined, by male only, and by female only. NS = not sampled.

ALL CANCER PRODUCTUS (MALE + FEMALE + JUVENILE --ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
CAD SITE										
1 (80 m)	0	0	0	0	0	0	0	0	0	NS
2 (80 m)	0	0	0	0	0	0	0	0	0	NS
3 (80 m)	0	0	0	0	0	0	0	0	0	NS
AVERAGE ± 1 SD										
RADCAD SITE										
1 (110 m)	0	19	0	0	0	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	0	0	0
A (110 m)	NS	NS	0	0	0	0	0	0	0	0
E (105 m)	NS	NS	NS	0	0	0	0	0	0	0
I (120 m)	NS	NS	NS	NS	0	0	0	0	0	0
J (115 m)	NS	NS	NS	NS	0	0	0	0	0	0
AVERAGE ± 1 SD										
PSDDA SITE										
1 (130 m)	0	0	0	0	0	0	0	0	0	NS
2 (135 m)	0	0	0	0	0	0	0	0	0	NS
3 (140 m)	0	0	0	0	0	0	0	0	0	NS
AVERAGE ± 1 SD										
TRANSECT # 1										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	0	0	0	0	0	0	0	0	NS
20S	0	0	0	0	0	0	0	0	0	NS
40S	0	0	0	19	0	0	0	0	0	0
60S	NS	NS	NS	NS	0	0	0	0	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
100M	0	19	0	0	0	0	0	0	0	NS
80N	0	37	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	0	0	0	0	0	NS
TRANSECT # 2										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	0	0	0	0	0	0	0	0	0

Appendix Table 6. (cont.)

ALL CANCER PRODUCTUS (MALE + FEMALE + JUVENILE --ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
20S	0	0	0	19	19	0	19	0	19	0
40S	0	0	0	0	0	0	0	0	0	0
60S	NS	NS	NS	NS	0	0	0	0	19	0
80S	0	0	0	0	0	0	0	0	0	0
110S	0	0	0	0	0	0	0	0	0	0
110M	0	0	0	0	0	0	0	0	0	0
130N	0	0	0	0	0	0	0	0	0	NS
100N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 3										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	0	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0	19	NS
40S	19	0	0	0	0	0	0	0	0	NS
60S	NS	NS	NS	NS	0	0	0	0	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
130M	0	0	0	0	0	0	0	0	0	NS
130N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 4										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	0	19	0	0	37	0	19	19	NS
20S	0	0	0	0	0	0	0	19	0	NS
40S	0	0	0	0	0	0	0	0	0	0
60S	NS	NS	NS	NS	0	0	0	0	0	NS
80S	0	0	19	0	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
145S	0	0	0	0	0	0	0	0	0	NS
135N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 5										
3S	NS	NS	NS	NS	NS	NS	NS	NS	50	NS
20S	0	19	0	56	0	0	0	0	0	NS
40S	0	0	94	243	19	0	19	19	112	NS
60S	NS	NS	NS	NS	0	19	0	0	75	NS
80S	0	0	0	131	0	0	0	0	112	NS
110S	0	0	0	0	0	0	0	0	75	NS
165S	0	0	0	0	0	0	0	0	0	NS
145M	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 6										
80S	0	0	0	0	0	0	0	0	0	0
80M	0	0	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	0	0	0	0	0	0
40N	0	0	0	0	0	0	0	0	0	NS
20N	0	0	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0	0	NS

Appendix Table 6. (cont.)

ALL CANCER PRODUCTUS (MALE + FEMALE + JUVENILE --ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
TRANSECT # 7										
100S	0	0	0	0	0	0	0	0	0	0
100M	0	0	0	0	0	0	0	0	0	NS
100N	0	0	0	0	0	0	0	0	0	0
80N	0	0	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	0	0	0	0	0	NS
40N	0	0	0	0	0	0	0	0	0	NS
20N	0	0	0	0	0	0	0	0	0	19
10N	0	0	0	0	0	0	0	0	0	NS
NON-TRANSECT STA.										
B (110 m)	NS	NS	0	0	0	0	0	0	0	NS
C (90 m)	NS	NS	0	0	0	0	0	0	0	NS
D (105 m)	NS	NS	0	0	0	0	0	0	0	NS
F (110 m)	NS	NS	NS	0	0	0	0	0	19	NS
G (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
H (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
DELTA STATIONS										
1 (2 m)	NS	NS	NS	NS	NS	NS	NS	0	0	NS
2 (3 m)	NS	NS	NS	NS	NS	NS	NS	0	0	NS
3 (4 m)	NS	NS	NS	NS	NS	NS	NS	0	0	NS
4 (2 m)	NS	NS	NS	NS	NS	NS	NS	0	0	NS
5 (2 m)	NS	NS	NS	NS	NS	NS	NS	0	19	NS
6 (3 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
7 (2 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
8 (4 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
RIVER STATIONS										
9 (5 m)	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
11 (8 m)	NS	NS	NS	NS	NS	NS	NS	NS	37	NS
12 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	187	NS
13 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	281	NS
EAST WATERWAY STA.										
14 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	206	NS
15 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	118	NS
16 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	118	NS
17 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	118	NS
NUMBER STA. SAMPLED	55	55	59	63	73	73	73	78	95	23
GRAND AVERAGE ± 1 SD	0.3 ± 2.6	1.7 ± 6.5	2.2 ± 12.6	7.4 ± 35.1	0.5 ± 3.1	0.7 ± 4.8	0.5 ± 3.1	1.0 ± 4.2	17.1 ± 47.6	0.8 ± 4.0

Appendix Table 6. (cont.)

ALL CANCER GRACILIS(MALE + FEMALE + JUVENILE --- ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
CAD SITE										
1 (80 m)	0	0	0	0	0	0	0	0	0	NS
2 (80 m)	19	0	0	0	0	0	0	0	0	NS
3 (80 m)	0	0	0	0	0	0	0	0	0	NS
AVERAGE ± 1 SD										
RADCAD SITE										
1 (110 m)	0	0	0	0	0	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	0	0	0
A (110 m)	NS	NS	0	0	0	0	0	0	0	0
E (105 m)	NS	NS	NS	0	0	0	0	0	0	0
I (120 m)	NS	NS	NS	NS	0	0	0	0	0	0
J (115 m)	NS	NS	NS	NS	0	0	0	0	0	0
AVERAGE ± 1 SD										
PSDDA SITE										
1 (130 m)	0	0	0	0	0	0	0	0	0	NS
2 (135 m)	0	0	0	0	0	0	0	0	0	NS
3 (140 m)	0	0	0	0	0	0	0	0	0	NS
AVERAGE ± 1 SD										
TRANSECT # 1										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	37	0	0	19	37	0	56	56	19	NS
20S	0	19	0	0	0	94	0	0	0	NS
40S	0	0	0	0	19	0	0	0	19	0
60S	NS	NS	NS	NS	0	0	0	0	37	NS
80S	0	0	0	0	0	0	0	0	0	NS
100M	0	0	0	0	0	0	0	0	0	NS
80N	0	0	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	0	0	0	0	0	NS
TRANSECT # 2										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	0	0	0	37	75	37	94	0	0	0
20S	0	0	0	19	0	19	168	0	131	75
40S	0	0	0	0	19	0	0	0	0	37
60S	NS	NS	NS	NS	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0	0	0

Appendix Table 6. (cont.)

ALL CANCER GRACILIS(MALE + FEMALE + JUVENILE --- ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
110S	0	0	0	0	0	0	0	0	0	0
110M	0	0	0	0	0	0	0	0	0	0
130N	0	0	0	0	0	0	0	19	0	NS
100N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 3										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
10S	37	0	19	0	94	75	56	0	75	19
20S	0	0	0	19	131	0	19	0	37	NS
40S	0	0	0	0	0	0	0	0	0	NS
60S	NS	NS	NS	NS	0	0	19	0	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
130M	0	0	0	0	0	0	0	0	0	NS
130N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 4										
3S	NS	NS	NS	NS	NS	NS	NS	NS	19	NS
10S	0	0	0	0	0	0	0	0	0	NS
20S	0	0	0	0	19	0	0	0	0	NS
40S	0	0	0	0	19	0	0	0	0	0
60S	NS	NS	NS	NS	0	0	0	0	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
145S	0	0	0	0	0	0	0	0	0	NS
135N	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 5										
3S	NS	NS	NS	NS	NS	NS	NS	NS	0	NS
20S	0	0	0	0	19	0	0	19	37	NS
40S	0	0	0	0	0	0	0	0	19	NS
60S	NS	NS	NS	NS	0	0	0	0	0	NS
80S	0	0	0	0	0	0	0	0	0	NS
110S	0	0	0	0	0	0	0	0	0	NS
165S	0	0	0	0	0	0	0	0	0	NS
145M	0	0	0	0	0	0	0	0	0	NS
TRANSECT # 6										
80S	0	0	0	0	0	0	0	0	0	0
80M	0	19	0	0	0	19	0	0	19	NS
60N	NS	NS	NS	NS	0	0	0	0	0	56
40N	19	0	0	0	0	0	0	0	19	NS
20N	19	0	0	0	56	0	0	0	56	150
10N	19	0	0	0	0	19	0	0	0	NS
TRANSECT # 7										
100S	0	0	0	0	0	0	19	0	0	0
100M	0	0	0	0	0	0	0	0	0	NS
100N	0	0	0	0	0	0	0	0	0	0

Appendix Table 6. (cont.)

ALL CANCER GRACILIS(MALE + FEMALE + JUVENILE --- ESTIMATED #/HA--BEAM TRAWL)

	1986					1987				
STATION	FEB	APRIL	JUNE	SEPT	DEC	FEB	APRIL	JUNE	SEPT	DEC
80N	0	0	0	0	0	0	0	0	0	NS
60N	NS	NS	NS	NS	0	0	0	0	0	NS
40N	0	0	0	0	19	0	0	0	94	NS
20N	0	0	0	0	0	0	0	0	243	19
10N	0	0	0	56	19	0	0	19	56	NS
NON-TRANSECT STA.										
B (110 m)	NS	NS	0	0	0	0	0	0	0	NS
C (90 m)	NS	NS	0	0	0	0	0	0	0	NS
D (105 m)	NS	NS	0	0	0	0	0	0	0	NS
F (110 m)	NS	NS	NS	0	0	0	0	0	0	NS
G (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
H (130 m)	NS	NS	NS	0	0	0	0	0	0	NS
DELTA STATIONS										
1 (2 m)	NS	NS	NS	NS	NS	NS	NS	0	0	NS
2 (3 m)	NS	NS	NS	NS	NS	NS	NS	0	19	NS
3 (4 m)	NS	NS	NS	NS	NS	NS	NS	0	19	NS
4 (2 m)	NS	NS	NS	NS	NS	NS	NS	0	94	NS
5 (2 m)	NS	NS	NS	NS	NS	NS	NS	37	581	NS
6 (3 m)	NS	NS	NS	NS	NS	NS	NS	NS	112	NS
7 (2 m)	NS	NS	NS	NS	NS	NS	NS	NS	94	NS
8 (4 m)	NS	NS	NS	NS	NS	NS	NS	NS	37	NS
RIVER STATIONS										
9 (5 m)	NS	NS	NS	NS	NS	NS	NS	NS	206	NS
10 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	337	NS
11 (8 m)	NS	NS	NS	NS	NS	NS	NS	NS	899	NS
12 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	318	NS
13 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	262	NS
EAST WATERWAY STA.										
14 (7 m)	NS	NS	NS	NS	NS	NS	NS	NS	176	NS
15 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	59	NS
16 (15 m)	NS	NS	NS	NS	NS	NS	NS	NS	157	NS
17 (10 m)	NS	NS	NS	NS	NS	NS	NS	NS	353	NS
NUMBER STA. SAMPLED	55	55	59	63	73	73	73	78	95	23
GRAND AVERAGE ± 1 SD	2.7 ± 8.4	0.7 ± 3.6	0.3 ± 2.5	2.4 ± 9.2	7.2 ± 22.0	3.6 ± 14.9	5.9 ± 24.2	1.9 ± 8.3	49.0 ± 129.0	15.5 ± 35.6

Appendix Table 7.

Estimated densities (shrimp/ha) of pandalid shrimp for all Port Gardner beam trawl samples collected during ten cruises in 1986 and 1987. NS = not sampled.

ESTIMATED SHRIMP DENSITIES (#/HA) -- FEBRUARY 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	94	0	19	0	0	75	0	0
2 (80 m)	918	19	19	0	880	0	0	0
3 (80 m)	1049	37	0	0	1011	0	0	0
AVERAGE ± 1 SD	687 ± 518	19 ± 19	13 ± 11	0 ± 0	630 ± 550	25 ± 43	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	75	19	0	0	0	56	0	0
2 (115 m)	75	0	19	0	0	56	0	0
3 (120 m)	94	0	0	0	0	94	0	0
AVERAGE ± 1 SD	81 ± 11	6 ± 11	6 ± 11	0 ± 0	0 ± 0	69 ± 22	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	0	0	0	0	0	0	0	0
2 (135 m)	0	0	0	0	0	0	0	0
3 (140 m)	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	56	0	0	0	19	0	0	37
80S	56	0	0	0	19	37	0	0
100M	19	0	0	0	19	0	0	0
80N	243	0	0	0	75	150	0	19
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	94	37	0	56	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	225	225	0	0	0	0	0	0
110S	56	0	0	0	0	56	0	0
110M	37	0	19	0	0	19	0	0
130N	75	0	0	0	0	75	0	0
100N	262	0	0	0	37	225	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	131	0	19	0	0	112	0	0
130M	75	0	19	0	0	56	0	0
130N	56	0	37	0	19	0	0	0
TRANSECT # 4								
10S	94	0	0	94	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	19	19	0	0	0	0	0	0
80S	187	0	0	0	0	187	0	0
110S	112	0	0	0	0	112	0	0
145S	75	0	56	0	0	19	0	0
135N	94	0	19	0	0	75	0	0
TRANSECT # 5								
20S	225	225	0	0	0	0	0	0
40S	880	824	0	56	0	0	0	0
80S	150	150	0	0	0	0	0	0
110S	37	0	19	0	0	19	0	0

Appendix Table 7 (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- FEBRUARY 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
165S	37	0	19	0	0	19	0	0
145M	0	0	0	0	0	0	0	0
TRANSECT # 6								
80S	56	0	0	0	0	56	0	0
80M	169	0	0	0	150	19	0	0
40N	75	0	0	0	19	0	0	56
20N	19	0	0	19	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	262	0	0	0	56	206	0	0
100M	56	0	19	0	0	37	0	0
100N	206	0	94	0	56	56	0	0
80N	0	0	0	0	0	0	0	0
40N	169	56	0	0	19	94	0	0
20N	19	0	0	0	0	0	0	19
10N	0	0	0	0	0	0	0	0
NUMBER STA. SAMPLED	55	55	55	55	55	55	55	55
GRAND AVERAGE ± 1 SD	119 ± 216	29 ± 119	7 ± 16	4 ± 16	43 ± 179	35 ± 56	0 ± 0	3 ± 10

ESTIMATED SHRIMP DENSITIES (#/HA) -- APRIL 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	0	0	0	0	0	0	0	0
2 (80 m)	0	0	0	0	0	0	0	0
3 (80 m)	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	19	0	19	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0
3 (120 m)	19	0	19	0	0	0	0	0
AVERAGE ± 1 SD	13 ± 11	0 ± 0	13 ± 11	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	37	0	0	0	0	37	0	0
2 (135 m)	75	0	0	0	0	75	0	0
3 (140 m)	56	0	0	0	0	56	0	0
AVERAGE ± 1 SD	56 ± 19	0 ± 0	0 ± 0	0 ± 0	0 ± 0	56 ± 19	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	537	19	0	0	0	0	19	0
100M	56	0	0	0	0	56	0	0
80N	0	0	0	0	0	0	0	0
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	19	0	0	19	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	19	0	0	0	0	19	0	0
110M	19	0	0	0	0	19	0	0
130N	19	0	19	0	0	0	0	0
100N	19	0	0	0	0	0	19	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- APRIL 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	56	0	0	0	0	37	19	0
130M	19	0	0	0	0	19	0	0
130N	19	0	0	0	0	19	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	112	0	0	0	0	112	0	0
145S	37	0	0	0	0	37	0	0
135N	0	0	0	0	0	0	0	0
TRANSECT # 5								
20S	0	0	0	0	0	0	0	0
40S	37	37	0	0	0	0	0	0
80S	112	112	0	0	0	0	0	0
110S	29	0	0	0	0	29	0	0
165S	19	0	19	0	0	0	0	0
145M	37	0	0	0	0	37	0	0
TRANSECT # 6								
80S	37	19	0	19	0	0	0	0
80M	0	0	0	0	0	0	0	0
40N	19	0	0	0	0	0	0	19
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	0	0	0	0	0	0	0	0
100M	19	0	0	0	0	19	0	0
100N	37	0	0	0	0	37	0	0
80N	0	0	0	0	0	0	0	0
40N	0	0	0	0	0	0	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
NUMBER STA. SAMPLED	55	55	55	55	55	55	55	55
GRAND AVERAGE ± 1 SD	18 ± 26	3 ± 16	1 ± 5	0.6 ± 4	0 ± 0	11 ± 22	1 ± 4	0.3 ± 3

ESTIMATED SHRIMP DENSITIES (#/HA) -- JUNE 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	23	0	0	0	0	0	0	0
2 (80 m)	0	0	0	0	0	0	0	0
3 (80 m)	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	8 ± 13	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	0	0	0	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	0
A(110 m)	19	0	0	0	0	19	0	0
AVERAGE ± 1 SD	5 ± 10	0 ± 0	0 ± 0	0 ± 0	0 ± 0	5 ± 10	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	0	0	0	0	0	0	0	0
2 (135 m)	19	0	19	0	0	0	0	0
3 (140 m)	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	6 ± 1	0 ± 0	6 ± 11	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- JUNE 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	19	0	0	0	0	0	0	19
40S	19	0	0	0	0	0	0	19
80S	75	56	0	0	0	19	0	0
100M	0	0	0	0	0	0	0	0
80N	0	0	0	0	0	0	0	0
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	19	0	0	0	0	0	0	19
40S	19	0	0	0	0	0	0	19
80S	0	0	0	0	0	0	0	0
110S	75	0	0	0	0	75	0	0
110M	0	0	0	0	0	0	0	0
130N	0	0	0	0	0	0	0	0
100N	0	0	0	0	0	0	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	0	0	0	0	0	0	0	0
130M	19	0	0	0	0	19	0	0
130N	0	0	0	0	0	0	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
80S	0	0	0	0	0	0	0	0
110S	0	0	0	0	0	0	0	0
145S	0	0	0	0	0	0	0	0
135N	37	0	19	0	0	19	0	0
TRANSECT # 5								
20S	0	0	0	0	0	0	0	0
40S	787	693	0	94	0	0	0	0
80S	281	281	0	0	0	0	0	0
110S	19	0	0	0	0	19	0	0
165S	19	0	19	0	0	0	0	0
145M	0	0	0	0	0	0	0	0
TRANSECT # 6								
80S	112	94	0	19	0	0	0	0
80M	19	0	19	0	0	0	0	0
40N	19	0	0	19	0	0	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	0	0	0	0	0	0	0	0
100M	0	0	0	0	0	0	0	0
100N	56	0	0	0	0	56	0	0
80N	19	19	0	0	0	0	0	0
40N	0	0	0	0	0	0	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	19	0	19	0	0	0	0	0
C (90 m)	131	0	19	0	0	112	0	0
D (105 m)	0	0	0	0	0	0	0	0
NUMBER STA. SAMPLED	59	59	59	59	59	59	59	59
GRAND AVERAGE ± 1 SD	36 ± 118	19 ± 97	2 ± 6	2 ± 13	0 ± 0	6 ± 19	0 ± 0	1 ± 5

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- SEPTEMBER 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	581	0	94	0	375	112	0	0
2 (80 m)	169	0	0	0	0	169	0	0
3 (80 m)	131	0	56	0	0	56	0	19
AVERAGE ±1 SD	294 ± 250	0 ± 0	50 ± 47	0 ± 0	125 ± 317	112 ± 57	0 ± 0	6 ± 11
RADCAD SITE								
1 (110 m)	19	0	19	0	0	0	0	0
2 (115 m)	0	0	0	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	0
A (110 m)	19	0	0	0	0	19	0	0
E (105 m)	37	0	0	0	0	37	0	0
AVERAGE ±1 SD	15 ± 16	0 ± 0	4 ± 8	0 ± 0	0 ± 0	11 ± 17	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	19	0	19	0	0	0	0	0
2 (135 m)	37	0	0	0	0	37	0	0
3 (140 m)	37	0	37	0	0	0	0	0
AVERAGE ±1 SD	31 ± 10	0 ± 0	19 ± 19	0 ± 0	0 ± 0	12 ± 21	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	375	94	0	262	0	0	0	19
40S	1760	75	0	19	0	0	0	37
80S	375	19	0	0	0	169	0	0
100M	187	0	19	0	0	169	0	0
80N	131	0	37	0	0	94	0	0
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	300	75	0	225	0	0	0	0
40S	356	0	0	0	356	0	0	0
80S	730	0	0	0	730	0	0	0
110S	37	0	0	0	0	37	0	0
110M	19	0	0	0	0	19	0	0
130N	37	0	19	0	0	19	0	0
100N	37	0	0	0	0	37	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	131	0	0	0	131	0	0	0
80S	206	19	0	0	0	187	0	0
110S	37	0	0	0	0	37	0	0
130M	75	0	19	0	0	56	0	0
130N	56	0	56	0	0	0	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	56	0	0	56	0	0	0	0
40S	0	0	0	0	1629	0	0	0
80S	75	0	0	0	187	75	0	0
110S	56	0	0	0	0	56	0	0
145S	56	19	0	0	0	37	0	0
135N	0	0	0	0	0	0	0	0
TRANSECT # 5								
20S	0	0	0	0	0	0	0	0
40S	150	0	0	37	0	0	0	0
80S	936	112	0	19	393	0	0	0
110S	131	524	0	0	0	131	0	0
165S	0	0	0	0	0	0	0	0
145M	75	0	0	0	0	37	0	0
TRANSECT # 6								
80S	655	37	0	0	599	19	0	0

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- SEPTEMBER 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
80M	1292	0	150	0	1049	94	0	0
40N	243	0	0	0	0	243	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	262	0	0	0	112	150	0	0
100M	411	0	0	0	0	412	0	0
100N	393	0	0	0	187	206	0	0
80N	1049	0	75	0	712	262	0	0
40N	3127	0	0	0	3127	0	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	0	0	0	0	0	0	0	0
C (90 m)	94	0	0	0	94	0	0	0
D (105 m)	75	0	0	0	0	75	0	0
F (110 m)	94	0	0	0	0	94	0	0
G (130 m)	37	0	19	0	0	19	0	0
H (130 m)	19	0	0	0	19	0	0	0
NUMBER STA. SAMPLED	63	63	63	63	63	63	63	63
GRAND AVERAGE ± 1 SD	241 ± 498	17 ± 69	10 ± 26	10 ± 44	154 ± 475	50 ± 82	0 ± 0	1 ± 6

ESTIMATED SHRIMP DENSITIES (#/HA) -- DECEMBER 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	225	0	19	0	131	75	0	0
2 (80 m)	56	0	0	0	19	37	0	0
3 (80 m)	0	0	0	0	0	0	0	0
AVERAGE ±1 SD	94 ± 117	0 ± 0	6 ± 11	0 ± 0	50 ± 71	37 ± 38	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	75	0	19	0	19	37	0	0
2 (115 m)	75	0	56	0	0	19	0	0
3 (120 m)	37	0	19	0	19	0	0	0
A (110 m)	37	0	0	0	37	0	0	0
E (105 m)	37	0	0	0	0	37	0	0
I (120 m)	19	0	0	0	19	0	0	0
J (115 m)	56	0	37	0	19	0	0	0
AVERAGE ±1 SD	48 ± 21	0 ± 0	19 ± 19	0 ± 0	16 ± 13	13 ± 18	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	75	0	56	0	19	0	0	0
2 (135 m)	131	0	75	0	0	56	0	0
3 (140 m)	169	0	150	0	0	19	0	0
AVERAGE ±1 SD	125 ± 47	0 ± 0	94 ± 50	0 ± 0	6 ± 11	25 ± 28	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	599	56	0	524	0	0	0	19
40S	375	37	0	112	187	0	0	37
60S	206	56	0	37	94	0	0	19
80S	206	0	0	0	112	94	0	0
100M	37	0	0	0	0	37	0	0
80N	131	19	19	0	0	94	0	0
60N	112	19	0	0	37	0	0	19
TRANSECT # 2								
10S	524	19	0	506	0	0	0	0
20S	1217	206	0	1011	0	0	0	0
40S	749	0	0	19	730	0	0	0

Appendix Table 7 (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- DECEMBER 1986 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
60S	225	0	0	0	225	0	0	0
80S	56	0	0	0	37	19	0	0
110S	0	0	0	0	0	0	0	0
110M	75	0	37	0	19	19	0	0
130N	94	0	75	0	0	19	0	0
100N	19	19	0	0	0	0	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	37	0	0	37	0	0	0	0
40S	19	0	0	0	19	0	0	0
60S	169	112	0	0	56	0	0	0
80S	262	0	0	0	94	169	0	0
110S	19	0	19	0	0	0	0	0
130M	225	0	169	0	19	37	0	0
130N	0	0	0	0	0	0	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	75	0	0	37	19	0	0	19
40S	243	37	0	19	187	0	0	0
60S	281	206	0	0	37	0	0	37
80S	37	0	0	0	0	37	0	0
110S	37	0	19	0	0	19	0	0
145S	19	0	19	0	0	0	0	0
135N	94	0	75	0	0	19	0	0
TRANSECT # 5								
20S	37	0	0	37	0	0	0	0
40S	581	581	0	0	0	0	0	0
60S	0	0	0	0	0	0	0	0
80S	19	0	0	0	19	0	0	0
110S	0	0	0	0	0	0	0	0
165S	0	0	0	0	0	0	0	0
145M	75	0	19	0	0	56	0	0
TRANSECT # 6								
80S	225	0	94	0	56	75	0	0
80M	112	0	19	0	19	75	0	0
60N	19	0	0	0	19	0	0	0
40N	150	0	0	0	150	0	0	0
20N	0	0	0	0	0	0	0	0
10N	131	0	0	131	0	0	0	0
TRANSECT # 7								
100S	112	0	19	0	0	94	0	0
100M	75	0	19	0	0	56	0	0
100N	37	0	0	0	19	19	0	0
80N	356	0	37	0	243	75	0	0
60N	1142	0	0	0	1142	0	0	0
40N	899	37	0	0	861	0	0	0
20N	19	0	0	19	0	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	56	0	37	0	19	0	0	0
C (90 m)	94	0	37	0	0	56	0	0
D (105 m)	150	0	19	0	75	56	0	0
F (110 m)	56	0	19	0	0	37	0	0
G (130 m)	94	0	19	0	37	37	0	0
H (130 m)	19	0	19	0	0	0	0	0
NUMBER STA. SAMPLED	73	73	73	73	73	73	73	73
GRAND AVERAGE ± 1 SD	262 ± 897	19 ± 16	16 ± 32	34 ± 145	68 ± 188	20 ± 33	0 ± 0	2 ± 7

Appendix Table 7 (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- FEBRUARY 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	94	0	37	0	0	56	0	0
2 (80 m)	112	0	56	0	37	19	0	0
3 (80 m)	169	131	0	0	0	37	0	0
AVERAGE ±1 SD	125 ± 39	44 ± 76	31 ± 28	0 ± 0	12 ± 21	37 ± 19	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	37	37	0	0	0	0	0	0
2 (115 m)	37	0	0	0	0	37	0	0
3 (120 m)	19	0	0	0	0	19	0	0
A (110 m)	0	0	0	0	0	0	0	0
E (105 m)	0	0	0	0	0	0	0	0
I (120 m)	0	0	0	0	0	0	0	0
J (115 m)	0	0	0	0	0	0	0	0
AVERAGE ±1 SD	13 ± 18	5 ± 14	0 ± 0	0 ± 0	0 ± 0	8 ± 15	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	0	0	0	0	0	0	0	0
2 (135 m)	94	0	37	0	0	56	0	0
3 (140 m)	19	0	19	0	0	0	0	0
AVERAGE ±1 SD	38 ± 50	0 ± 0	19 ± 19	0 ± 0	0 ± 0	19 ± 24	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	524	187	0	0	206	94	0	37
60S	524	262	0	0	56	206	0	0
80S	73	0	0	0	0	73	0	0
100M	37	0	37	0	0	0	0	0
80N	75	0	37	19	0	19	0	0
60N	47	0	0	0	0	47	0	0
TRANSECT # 2								
10S	187	0	0	187	0	0	0	0
20S	281	0	0	281	0	0	0	0
40S	337	56	0	37	225	19	0	0
60S	187	37	0	0	75	75	0	0
80S	243	19	0	0	0	225	0	0
110S	75	37	37	0	0	0	0	0
110M	19	0	0	0	0	19	0	0
130N	19	0	0	0	0	19	0	0
100N	19	0	0	0	0	19	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	1798	187	0	1610	0	0	0	0
60S	37	19	0	0	0	19	0	0
80S	131	19	0	0	0	112	0	0
110S	169	0	56	0	0	112	0	0
130M	56	0	19	0	0	37	0	0
130N	243	0	0	243	0	0	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	187	0	0	187	0	0	0	0
40S	187	75	0	112	0	0	0	0
60S	187	0	0	0	187	0	0	0
80S	112	0	0	19	0	94	0	0
110S	0	0	0	0	0	0	0	0
145S	94	0	0	0	0	94	0	0
135N	131	0	37	0	0	94	0	0
TRANSECT # 5								
20S	19	0	0	19	0	0	0	0
40S	749	674	0	56	19	0	0	0

Appendix Table 7 (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- FEBRUARY 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
60S	206	131	0	19	0	56	0	0
80S	375	94	0	19	0	262	0	0
110S	56	0	19	0	0	37	0	0
165S	37	0	0	0	0	37	0	0
145M	75	0	75	0	0	0	0	0
TRANSECT # 6								
80S	56	0	37	0	0	19	0	0
80M	169	0	94	0	0	75	0	0
60N	112	0	0	0	0	112	0	0
40N	56	0	0	0	0	56	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	56	0	19	0	0	37	0	0
100M	37	0	37	0	0	0	0	0
100N	37	0	0	0	0	37	0	0
80N	112	19	19	0	0	75	0	0
60N	487	0	0	19	0	468	0	0
40N	468	94	0	19	0	356	0	0
20N	19	0	0	19	0	0	0	0
10N	0	0		0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	0	0	0	0	0	0	0	0
C (90 m)	94	0	37	0	0	56	0	0
D (105 m)	75	0	37	0	0	37	0	0
F (110 m)	94	0	37	0	0	56	0	0
G (130 m)	206	0	37	0	0	169	0	0
H (130 m)	56	0	19	0	0	37	0	0
NUMBER STA. SAMPLED	73	73	73	73	73	73	73	73
GRAND AVERAGE ± 1 SD	141 ± 246	28 ± 91	11 ± 20	39 ± 194	11 ± 42	49 ± 83	0 ± 0	0.5 ± 4

ESTIMATED SHRIMP DENSITIES (#/HA) -- APRIL 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	75	0	19	0	19	37	0	0
2 (80 m)	75	0	0	0	19	56	0	0
3 (80 m)	112	0	19	0	0	94	0	0
AVERAGE ± 1 SD	87 ± 21	0 ± 0	13 ± 11	0 ± 0	13 ± 11	62 ± 29	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	37	0	37	0	0	0	0	0
2 (115 m)	19	0	19	0	0	0	0	0
3 (120 m)	0	0	0	0	0	0	0	0
A (110 m)	0	0	0	0	0	0	0	0
E (105 m)	19	0	19	0	0	0	0	0
I (120 m)	37	0	19	0	0	19	0	0
J (115 m)	0	0	0	0	0	0	0	0
AVERAGE ± 1 SD	16 ± 17	0 ± 0	13 ± 14	0 ± 0	0 ± 0	3 ± 7	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	37	0	37	0	0	0	0	0
2 (135 m)	19	0	19	0	0	0	0	0
3 (140 m)	19	0	0	0	19	0	0	0
AVERAGE ± 1 SD	25 ± 10	0 ± 0	19 ± 19	0 ± 0	6 ± 11	0 ± 0	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	169	0	0	150	0	0	0	19
40S	225	75	0	19	0	0	0	131

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- APRIL 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
60S	1011	805	0	0	131	19	0	56
80S	187	19	0	0	37	131	0	0
100M	75	19	19	0	0	37	0	0
80N	262	0	56	0	19	187	0	0
60N	37	0	0	0	0	0	0	37
TRANSECT # 2								
10S	1273	19	0	1236	0	0	0	19
20S	730	19	0	693	0	0	0	19
40S	19	0	0	19	0	0	0	0
60S	94	19	0	0	75	0	0	0
80S	393	75	0	0	94	225	0	0
110S	0	0	0	0	0	0	0	0
110M	0	0	0	0	0	0	0	0
130N	56	0	0	0	0	56	0	0
100N	112	0	0	0	37	75	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	19	19	0	0	0	0	0	0
60S	0	0	0	0	0	0	0	0
80S	112	0	0	19	0	94	0	0
110S	0	0	0	0	0	0	0	0
130M	0	0	0	0	0	0	0	0
130N	56	0	0	0	0	56	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	0	0	0	0	0	0	0	0
80S	56	37	0	0	0	19	0	0
110S	243	0	0	0	0	243	0	0
145S	37	0	19	0	19	0	0	0
135N	131	0	94	0	37	0	0	0
TRANSECT # 5								
20S	0	0	0	0	0	0	0	0
40S	56	19	0	19	0	0	0	19
60S	1011	880	0	0	0	131	0	0
80S	262	243	0	0	0	19	0	0
110S	262	225	19	0	0	19	0	0
165S	0	0	0	0	0	0	0	0
145M	56	0	37	0	0	19	0	0
TRANSECT # 6								
80S	637	37	0	0	19	581	0	0
80M	262	0	19	0	0	243	0	0
60N	112	0	0	0	0	112	0	0
40N	37	0	0	0	0	0	0	37
20N	19	0	0	0	0	0	0	19
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	0	0	0	0	0	0	0	0
100M	19	0	0	0	19	0	0	0
100N	94	0	0	0	0	94	0	0
80N	56	0	0	0	19	37	0	0
60N	19	0	0	0	19	0	0	0
40N	0	0	0	0	0	0	0	0
20N	37	0	0	37	0	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	112	0	19	0	19	75	0	0
C (90 m)	449	0	37	0	56	356	0	0
D (105 m)	56	0	19	0	0	37	0	0
F (110 m)	37	0	19	0	0	19	0	0
G (130 m)	19	0	19	0	0	0	0	0
H (130 m)	0	0	0	0	0	0	0	0
NUMBER STA. SAMPLED	73	73	73	73	73	73	73	73
GRAND AVERAGE ± 1 SD	128 ± 246	34 ± 143	8 ± 16	30 ± 165	9 ± 23	42 ± 94	0 ± 0	5 ± 18

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- JUNE 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	0	0	0	0	0	0	0	0
2 (80 m)	0	0	0	0	0	0	0	0
3 (80 m)	37	0	0	0	0	0	0	37
AVERAGE ±1 SD	12 ± 21	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	12 ± 21
RADCAD SITE				0	0			
1 (110 m)	169	0	75	0	0	94	0	0
2 (115 m)	94	0	0	0	0	94	0	0
3 (120 m)	0	0	0	0	0	0	0	0
A (110 m)	150	0	75	0	0	75	0	0
E (105 m)	19	0	0	0	0	19	0	0
I (120 m)	318	0	94	0	0	225	0	0
J (115 m)	243	0	75			169	0	0
AVERAGE ±1 SD	142 ± 115	0 ± 0	46 ± 43	0 ± 0	0 ± 0	97 ± 79	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	0	0	0	0	0	0	0	0
2 (135 m)	0	0	0	0	0	0	0	0
3 (140 m)	19	0	19	0	0	0	0	0
AVERAGE ±1 SD	6 ± 11	0 ± 0	6 ± 11	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0
TRANSECT # 1								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	37	19	0	0	0	0	0	19
80S	19	19	0	0	0	0	0	0
100M	75	0	75	0	0	0	0	0
80N	0	0	0	0	0	0	0	0
60N	0	0	0	0	0	0	0	0
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	75	75	0	0	0	0	0	0
80S	75	56	0	0	19	0	0	0
110S	0	0	0	0	0	0	0	0
110M	169	0	112	0	0	56	0	0
130N	19	0	0	0	0	19	0	0
100N	0	0	0	0	0	0	0	0
TRANSECT # 3								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	0	0	0	0	0	0	0	0
80S	19	19	0	0	0	0	0	0
110S	19	0	0	0	0	19	0	0
130M	0	0	0	0	0	0	0	0
130N	19	0	0	0	0	19	0	0
TRANSECT # 4								
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	0	75	0	0	0	0	0	0
60S	0	0	0	0	0	0	0	0
80S	75	0	0	0	0	0	0	0
110S	37	0	0	0	0	37	0	0
145S	37	0	0	0	0	37	0	0
135N	37	0	37	0	0	0	0	0

Appendix Table 7 (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- JUNE 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
TRANSECT # 5								
20S	0	0	0	0	0	0	0	0
40S	150	131	0	19	0	0	0	0
60S	393	393	0	0	0	0	0	0
80S	75	75	0	0	0	0	0	0
110S	19	0	0	0	0	19	0	0
165S	0	0	0	0	0	0	0	0
145M	0	0	0	0	0	0	0	0
TRANSECT # 6								
80S	56	56	0	0	0	0	0	0
80M	19	19	0	0	0	0	0	0
60N	0	0	0	0	0	0	0	0
40N	0	0	0	0	0	0	0	0
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	75	37	0	0	0	37	0	0
100M	169	0	112	0	0	56	0	0
100N	56	19	0	0	0	37	0	0
80N	0	0	0	0	0	0	0	0
60N	0	0	0	0	0	0	0	0
40N	19	0	0	0	0	0	0	19
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	75	0	19	0	0	56	0	0
C (90 m)	0	0	0	0	0	0	0	0
D (105 m)	37	0	0	0	0	37	0	0
F (110 m)	225	0	56	0	0	169	0	0
G (130 m)	0	0	0	0	0	0	0	0
H (130 m)	0	0	0	0	0	0	0	0
NUMBER STA. SAMPLED	73	73	73	73	73	73	73	73
GRAND AVERAGE ± 1 SD	43 ± 77	14 ± 51	10 ± 27	0.3 ± 2	0.3 ± 2	17 ± 42	0 ± 0	1 ± 5
DELTA STATIONS								
1 (2 m)	0	0	0	0	0	0	0	0
2 (3 m)	0	0	0	0	0	0	0	0
3 (4 m)	0	0	0	0	0	0	0	0
4 (2 m)	0	0	0	0	0	0	0	0
5 (2 m)	0	0	0	0	0	0	0	0

ESTIMATED SHRIMP DENSITIES (#/HA) -- SEPTEMBER 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	974	0	187	0	749	37	0	0
2 (80 m)	880	0	94	0	693	94	0	0
3 (80 m)	131	0	56	0	19	56	0	0
AVERAGE ± 1 SD	662 ± 462	0 ± 0	112 ± 67	0 ± 0	487 ± 406	62 ± 29	0 ± 0	0 ± 0
RADCAD SITE								
1 (110 m)	37	0	19	0	19	0	0	0
2 (115 m)	37	0	0	0	0	37	0	0
3 (120 m)	0	0	0	0	0	0	0	0
A (110 m)	37	0	0	0	0	37	0	0
E (105 m)	56	0	37	0	0	19	0	0
I (120 m)	19	0	19	0	0	0	0	0
J (115 m)	19	0	19	0	0	0	0	0
AVERAGE ± 1 SD	29 ± 13	0 ± 0	13 ± 14	0 ± 0	0 ± 0	13 ± 18	0 ± 0	0 ± 0

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- SEPTEMBER 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
PSDDA SITE								
1 (130 m)	37	0	19	0	0	19	0	0
2 (135 m)	75	0	75	0	0	0	0	0
3 (140 m)	56	0	37	0	0	0	19	0
AVERAGE ± 1 SD	56 ± 19	0 ± 0	44 ± 29	0 ± 0	0 ± 0	6 ± 11	6 ± 11	0 ± 0
TRANSECT # 1								
3S	0	0	0	0	0	0	0	0
10S	0	0	0	0	0	0	0	0
20S	19	0	0	19	0	0	0	0
40S	4176	37	0	0	4139	0	0	0
60S	3033	56	0	0	2978	0	0	0
80S	599	0	0	0	412	187	0	0
100M	75	0	0	0	19	56	0	0
80N	955	0	94	0	749	112	0	0
60N	2266	0	0	0	2266	0	0	0
TRANSECT # 2								
3S	0	0	0	0	0	0	0	0
10S	37	0	0	37	0	0	0	0
20S	169	37	0	56	0	0	0	75
40S	1891	0	0	0	1891	0	0	0
60S	2734	112	0	0	2584	0	0	37
80S	918	56	0	0	711	131	0	19
110S	131	0	37	0	19	75	0	0
110M	37	0	0	0	0	37	0	0
130N	19	0	0	0	0	19	0	0
100N	94	0	0	0	56	37	0	0
TRANSECT # 3								
3S	0	0	0	0	0	0	0	0
10S	0	0	0	0	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	19	0	0	0	4363	0	0	19
60S	4494	131	0	0	655	0	0	0
80S	918	0	0	0	112	262	0	0
110S	412	0	94	0	0	206	0	0
130M	37	0	19	0	0	19	0	0
130N	94	0	56	0	0	37	0	0
TRANSECT # 4								
3S	0	0	0	0	0	0	0	0
10S	19	0	0	19	0	0	0	0
20S	19	0	0	19	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	3614	0	0	0	3614	0	0	0
80S	1011	19	0	0	974	19	0	0
110S	393	0	0	0	37	356	0	0
145S	0	0	0	0	0	0	0	0
135N	0	0	0	0	0	0	0	0
TRANSECT # 5								
3S	1975	0	0	1975	0	0	0	0
20S	0	0	0	0	0	0	0	0
40S	112	112	0	0	0	0	0	0
60S	1554	19	0	0	1517	0	0	19
80S	187	56	0	0	131	0	0	0
110S	150	0	0	0	19	112	0	19
165S	37	0	0	0	0	37	0	0
145M	19	0	19	0	0	0	0	0
TRANSECT # 6								
80S	431	37	37	0	243	112	0	0
80M	880	0	56	0	674	150	0	0
60N	2509	0	19	0	2360	131	0	0
40N	187	0	0	0	169	0	0	19
20N	0	0	0	0	0	0	0	0
10N	0	0	0	0	0	0	0	0
TRANSECT # 7								
100S	56	0	0	0	0	56	0	0
100M	37	0	0	0	19	19	0	0
100N	150	0	37	0	37	75	0	0

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- SEPTEMBER 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
80N	1236	0	0	0	1086	150	0	0
60N	6704	19	0	0	6667	19	0	0
40N	655	0	0	0	655	0	0	0
20N	37	0	0	0	37	0	0	0
10N	0	0	0	0	0	0	0	0
NON-TRANSECT STA.								
B (110 m)	112	0	37	0	37	37	0	0
C (90 m)	599	0	37	0	431	131	0	0
D (105 m)	169	0	19	0	19	131	0	0
F (110 m)	56	0	19	0	0	37	0	0
G (130 m)	94	0	75	0	0	19	0	0
H (130 m)	112	0	37	0	0	75	0	0
NUMBER STA. SAMPLED	73	73	73	73	73	73	73	73
GRAND AVERAGE ± 1 SD	639 ± 1234	9 ± 26	17 ± 32	2 ± 9	554 ± 1230	43 ± 69	0.3 ± 2	3 ± 11
DELTA STATIONS								
1 (2 m)	19	0	0	19	0	0	0	0
2 (3 m)	0	0	0	0	0	0	0	0
3 (4 m)	37	0	0	37	0	0	0	0
4 (2 m)	75	0	0	75	0	0	0	0
5 (2 m)	0	0	0	0	0	0	0	0
6 (3 m)	0	0	0	0	0	0	0	0
7 (2 m)	75	0	0	75	0	0	0	0
8 (4 m)	56	0	0	56	0	0	0	0
RIVER STATIONS								
9 (5 m)	0	0	0	0	0	0	0	0
10 (7 m)	0	0	0	0	0	0	0	0
11 (8 m)	56	0	0	56	0	0	0	0
12 (10 m)	8015	19	0	7996	0	0	0	0
13 (10 m)	1835	0	0	1835	0	0	0	0
EAST WATERWAY STA.								
14 (7 m)	9353	0	0	9235	0	0	0	118
15 (15 m)	7794	0	0	7559	0	0	118	118
16 (15 m)	9529	0	0	9451	0	0	39	39
17 (10 m)	36353	0	0	36353	0	0	0	0

ESTIMATED SHRIMP DENSITIES (#/HA) -- DECEMBER 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
CAD SITE								
1 (80 m)	NS	NS	NS	NS	NS	NS	NS	NS
2 (80 m)	NS	NS	NS	NS	NS	NS	NS	NS
3 (80 m)	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ±1 SD	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
RADCAD SITE								
1 (110 m)	112	0	56	0	37	19	0	0
2 (115 m)	169	0	37	0	75	56	0	0
3 (120 m)	19	0	0	0	0	19	0	0
A (110 m)	150	0	112	0	19	19	0	0
E (105 m)	225	0	75	0	56	94	0	0
I (120 m)	243	0	94	0	56	94	0	0
J (115 m)	131	0	0	0	19	112	0	0
AVERAGE ±1 SD	150 ± 75	0 ± 0	53 ± 44	0 ± 0	37 ± 26	59 ± 41	0 ± 0	0 ± 0
PSDDA SITE								
1 (130 m)	NS	NS	NS	NS	NS	NS	NS	NS
2 (135 m)	NS	NS	NS	NS	NS	NS	NS	NS
3 (140 m)	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ±1 SD	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Appendix Table 7. (cont.)

ESTIMATED SHRIMP DENSITIES (#/HA) -- DECEMBER 1987 -- BEAM TRAWL

STATION	ALL SHRIMP	PANDALUS PLATYCEROS	PANDALOPSIS DISPAR	PANDALUS DANAE	PANDALUS JORDANI	PANDALUS BOREALIS	PANDALUS GONIURUS	PANDALUS HYPSINOTUS
TRANSECT # 1								
10S	NS	NS	NS	NS	NS	NS	NS	NS
20S	NS	NS	NS	NS	NS	NS	NS	NS
40S	17	0	0	0	0	0	0	75
60S	NS	NS	NS	NS	NS	NS	NS	NS
80S	NS	NS	NS	NS	NS	NS	NS	NS
100M	NS	NS	NS	NS	NS	NS	NS	NS
80N	NS	NS	NS	NS	NS	NS	NS	NS
60N	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 2								
10S	0	0	0	0	0	0	0	0
20S	37	0	0	37	0	0	0	0
40S	0	0	0	0	0	0	0	0
60S	56	0	0	0	19	0	0	0
80S	131	37	0	0	58	19	0	19
110S	337	0	0	0	56	281	0	0
110M	150	0	19	0	75	58	0	0
130N	NS	NS	NS	NS	NS	NS	NS	NS
100N	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 3								
10S	37	0	0	37	0	0	0	0
20S	NS	NS	NS	NS	NS	NS	NS	NS
40S	NS	NS	NS	NS	NS	NS	NS	NS
60S	NS	NS	NS	NS	NS	NS	NS	NS
80S	NS	NS	NS	NS	NS	NS	NS	NS
110S	NS	NS	NS	NS	NS	NS	NS	NS
130M	NS	NS	NS	NS	NS	NS	NS	NS
130N	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 4								
10S	NS	NS	NS	NS	NS	NS	NS	NS
20S	NS	NS	NS	NS	NS	NS	NS	NS
40S	0	0	0	0	0	0	0	0
60S	NS	NS	NS	NS	NS	NS	NS	NS
80S	NS	NS	NS	NS	NS	NS	NS	NS
110S	NS	NS	NS	NS	NS	NS	NS	NS
145S	NS	NS	NS	NS	NS	NS	NS	NS
135N	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 5								
20S	NS	NS	NS	NS	NS	NS	NS	NS
40S	NS	NS	NS	NS	NS	NS	NS	NS
60S	NS	NS	NS	NS	NS	NS	NS	NS
80S	NS	NS	NS	NS	NS	NS	NS	NS
110S	NS	NS	NS	NS	NS	NS	NS	NS
165S	NS	NS	NS	NS	NS	NS	NS	NS
145M	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 6								
80S	56	0	0	0	56	0	0	0
80M	NS	NS	NS	NS	NS	NS	NS	NS
60N	637	0	0	0	581	0	0	0
40N	NS	NS	NS	NS	NS	NS	NS	NS
20N	0	0	0	0	0	0	0	0
10N	NS	NS	NS	NS	NS	NS	NS	NS
TRANSECT # 7								
100S	487	0	0	0	169	318	0	0
100M	NS	NS	NS	NS	NS	NS	NS	NS
100N	487	0	19	0	412	56	0	0
80N	NS	NS	NS	NS	NS	NS	NS	NS
60N	NS	NS	NS	NS	NS	NS	NS	NS
40N	NS	NS	NS	NS	NS	NS	NS	NS
20N	0	0	0	0	0	0	0	0
10N	NS	NS	NS	NS	NS	NS	NS	NS
NUMBER STA. SAMPLED	23	23	23	23	23	23	23	23
GRAND AVERAGE ± 1 SD	151 ± 179	2 ± 8	18 ± 34	4 ± 12	73 ± 142	50 ± 88	0 ± 0	5 ± 17

Appendix Table 8.

Estimated densities (crab/ha) of Dungeness crab at Port Gardner sampling stations as indicated by the **otter trawl** catches from February 1986 to January 1987. NS = not sampled.

	CRUISE				
STATION	**FEB**	**APRIL**	**JUNE**	**SEPT**	**JAN 1987**
CAD:					
1	46	0	15	8	NS
2	15	23	31	0	NS
3	46	62	0	0	NS
AVERAGE ± 1SD	36 ± 18	28 ± 31	15 ± 16	3 ± 5	- - -
RADCAD:					
1	0	0	8	24	0
2	0	0	0	31	0
3	0	0	0	46	8
A	NS	NS	NS	NS	NS
E	NS	NS	NS	8	0
I	NS	NS	NS	NS	0
J	NS	NS	NS	NS	0
AVERAGE ± 1SD	0 ± 0	0 ± 0	3 ± 5	27 ± 16	1 ± 3
PSDDA:					
1	8	0	0	15	NS
2	0	0	0	23	NS
3	0	0	0	8	NS
AVERAGE ± 1SD	3 ± 5	0 ± 0	0 ± 0	15 ± 8	- - -
TRANSECT 1:					
20 m South	8	15	0	0	NS
40 m South	31	0	8	15	NS
100 m Middle	15	8	39	0	0
TRANSECT 2:					
20 m South	31	0	0	31	NS
40 m South	31	8	8	31	NS
110 m South	0	15	23	8	NS
TRANSECT 4:					
20 m South	15	0	0	15	NS
40 m South	8	15	0	8	NS
145 m South	15	0	0	0	NS
# OF SAMPLES	18	18	18	19	7
GRAND AVERAGE ± 1SD	15 ± 16	8 ± 15	7 ± 12	14 ± 13	1 ± 3

Appendix Table 9.

Estimated densities (shrimp/ha) of pandalid shrimp at Port Gardner sampling stations as indicated by the **otter trawl** catches from February 1986 to January 1987. NS = not sampled.

FEBRUARY 1986

	SHRIMP SPECIES							
STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL SPECIES COMBINED
CAD:								
1	0	8	0	31	371	0	0	409
2	15	0	0	0	139	31	0	185
3	46	23	0	85	208	0	8	371
AVERAGE ± 1 SD	20 ± 23	10 ± 12	0 ± 0	39 ± 43	239 ± 119	10 ± 18	3 ± 5	322 ± 120
RADCAD:								
1	0	456	0	0	409	0	0	865
2	0	471	0	0	216	15	0	703
3	0	193	0	0	62	0	0	254
A	NS	NS	NS	NS	NS	NS	NS	NS
E	NS	NS	NS	NS	NS	NS	NS	NS
I	NS	NS	NS	NS	NS	NS	NS	NS
J	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	0 ± 0	373 ± 156	0 ± 0	0 ± 0	229 ± 174	5 ± 9	0 ± 0	607 ± 317
PSDDA:								
1	0	93	0	0	54	0	0	147
2	0	224	0	0	54	0	0	278
3	0	193	0	0	77	0	0	270
AVERAGE ± 1 SD	0 ± 0	170 ± 68	0 ± 0	0 ± 0	62 ± 13	0 ± 0	0 ± 0	232 ± 73
TRANSECT 1:								
20 m South	0	0	0	0	0	0	0	0
40 m South	46	0	0	0	0	0	46	93
100 m Middle	0	332	0	0	425	0	0	757

Appendix Table 9. (cont.)

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL SPECIES COMBINED
TRANSECT 2:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
110 m South	8	85	0	0	77	0	0	170
TRANSECT 4:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
145 m South	0	216	0	0	170	0	0	386
# OF SAMPLES	18	18	18	18	18	18	18	18
GRAND AVERAGE + 1 SD	6 ± 15	127 ± 160	0 ± 0	6 ± 21	126 ± 146	3 ± 8	3 ± 11	272 ± 271

APRIL 1986

	SHRIMP SPECIES							
STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
CAD:								
1	0	8	0	0	147	0	0	154
2	0	93	0	0	124	8	0	224
3	0	62	0	8	131	0	0	201
AVERAGE ± 1 SD	0 ± 0	54 ± 43	0 ± 0	3 ± 5	134 ± 12	3 ± 5	0 ± 0	193 ± 36
RADCAD:								
1	0	15	0	0	54	15	0	85
2	0	15	0	0	46	0	0	62

Appendix Table 9. (cont.)

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
3	0	0	0	0	15	0	0	15
A	NS	NS	NS	NS	NS	NS	NS	NS
E	NS	NS	NS	NS	NS	NS	NS	NS
I	NS	NS	NS	NS	NS	NS	NS	NS
J	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	0 ± 0	10 ± 9	0 ± 0	0 ± 0	38 ± 21	5 ± 9	0 ± 0	54 ± 36
PSDDA:								
1	0	54	0	0	8	0	0	62
2	0	46	0	0	0	0	0	46
3	0	15	0	0	23	8	0	46
AVERAGE ± 1 SD	0 ± 0	38 ± 21	0 ± 0	0 ± 0	10 ± 12	3 ± 5	0 ± 0	51 ± 29
TRANSECT 1:								
20 m South	0	0	0	0	0	0	8	8
40 m South	0	0	0	0	0	0	0	0
100 m Middle	0	15	0	0	31	0	0	46
TRANSECT 2:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
110 m South	0	8	0	0	39	0	0	46
TRANSECT 4:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
145 m South	0	23	0	0	8	0	0	31
# OF SAMPLES	18	18	18	18	18	18	18	18
GRAND AVERAGE + 1 SD	0 ± 0	20 ± 27	0 ± 0	0 ± 0	35 ± 49	2 ± 4	1 ± 2	57 ± 69

Appendix Table 9. (cont.)

JUNE 1986

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
	SHRIMP SPECIES							
CAD:								
1	8	8	0	0	0	0	0	15
2	0	0	0	0	0	0	0	0
3	0	8	0	0	0	0	0	8
AVERAGE ± 1 SD	3 ± 5	5 ± 5	0 ± 0	0 ± 0	0 ± 0	0 ± 0	0 ± 0	8 ± 8
RADCAD:								
1	0	432	0	0	62	0	0	494
2	0	39	0	0	31	0	0	69
3	0	39	0	0	0	0	0	39
A	NS	NS	NS	NS	NS	NS	NS	NS
E	NS	NS	NS	NS	NS	NS	NS	NS
I	NS	NS	NS	NS	NS	NS	NS	NS
J	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	0 ± 0	170 ± 227	0 ± 0	0 ± 0	31 ± 31	0 ± 0	0 ± 0	201 ± 254
PSDDA:								
1	0	154	0	0	69	0	0	224
2	0	69	0	0	31	0	0	100
3	0	62	0	0	23	0	0	85
AVERAGE ± 1 SD	0 ± 0	95 ± 51	0 ± 0	0 ± 0	41 ± 25	0 ± 0	0 ± 0	136 ± 76
TRANSECT 1:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
100 m Middle	0	224	0	0	147	0	0	378

Appendix Table 9. (cont.)

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
TRANSECT 2:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
110 m South	0	15	0	0	31	0	0	46
TRANSECT 4:								
20 m South	0	0	0	0	0	0	0	0
40 m South	8	0	0	0	0	0	0	8
145 m South	0	39	0	0	23	0	0	62
# OF SAMPLES	18	18	18	18	18	18	18	18
GRAND AVERAGE + 1 SD	1 ± 3	60 ± 111	0 ± 0	0 ± 0	23 ± 38	0 ± 0	0 ± 0	85 ± 141

SEPTEMBER 1986

	SHRIMP SPECIES							
STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
CAD:								
1	31	309	0	8	317	0	0	664
2	0	703	0	0	216	0	0	919
3	0	463	0	31	201	0	0	645
AVERAGE ± 1 SD	10 ± 18	492 ± 199	0 ± 0	13 ± 16	245 ± 63	0 ± 0	0 ± 0	759 ± 139
RADCAD:								
1	0	39	0	0	93	0	0	131
2	0	77	0	0	46	0	0	124

Appendix Table 9. (cont.)

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
3	0	162	0	0	23	0	0	185
A	NS	NS	NS	NS	NS	NS	NS	NS
E	0	31	0	0	85	0	0	116
I	NS	NS	NS	NS	NS	NS	NS	NS
J	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	0 ± 0	77 ± 66	0 ± 0	0 ± 0	62 ± 33	0 ± 0	0 ± 0	139 ± 31
PSDDA:								
1	0	93	0	0	46	0	0	139
2	0	147	0	0	31	0	0	178
3	0	170	0	0	31	0	0	201
AVERAGE ± 1 SD	0 ± 0	137 ± 40	0 ± 0	0 ± 0	36 ± 9	0 ± 0	0 ± 0	173 ± 31
TRANSECT 1:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	8	0	0	8
100 m Middle	0	93	0	0	247	0	0	340
TRANSECT 2:								
20 m South	0	0	0	0	0	0	0	0
40 m South	0	0	0	0	0	0	0	0
110 m South	0	8	8	0	100	0	0	116
TRANSECT 4:								
20 m South	0	0	0	0	0	0	0	0
40 m South	8	0	0	0	0	0	0	8
145 m South	0	31	0	0	46	0	0	77
# OF SAMPLES	19	19	19	19	19	19	19	19
GRAND AVERAGE + 1 SD	2 ± 7	122 ± 186	1 ± 2	2 ± 7	78 ± 96	0 ± 0	0 ± 0	205 ± 266

Appendix Table 9. (cont.)

JANUARY 1987

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
	SHRIMP SPECIES							
CAD:								
1	NS	NS	NS	NS	NS	NS	NS	NS
2	NS	NS	NS	NS	NS	NS	NS	NS
3	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
RADCAD:								
1	0	239	0	8	31	0	0	278
2	0	77	0	0	31	0	0	108
3	0	31	0	0	23	0	0	54
A	NS	NS	NS	NS	NS	NS	NS	NS
E	0	286	0	23	77	0	0	386
I	0	170	0	0	31	0	0	201
J	8	193	0	0	31	0	0	232
AVERAGE ± 1 SD	1 ± 3	166 ± 97	0 ± 0	5 ± 9	37 ± 20	0 ± 0	0 ± 0	210 ± 119
PSDDA:								
1	NS	NS	NS	NS	NS	NS	NS	NS
2	NS	NS	NS	NS	NS	NS	NS	NS
3	NS	NS	NS	NS	NS	NS	NS	NS
AVERAGE ± 1 SD	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
TRANSECT 1:								
20 m South	NS	NS	NS	NS	NS	NS	NS	NS
40 m South	NS	NS	NS	NS	NS	NS	NS	NS
100 m Middle	NS	NS	NS	NS	NS	NS	NS	NS

Appendix Table 9. (cont.)

STATION	P. PLATYCEROS	P. DISPAR	P. DANAE	P. JORDANI	P. BOREALIS	P. GONIURUS	P. HYPSINOTUS	ALL COMBINED
TRANSECT 2:								
20 m South	NS	NS	NS	NS	NS	NS	NS	NS
40 m South	NS	NS	NS	NS	NS	NS	NS	NS
110 m South	0	386	0	0	347	0	0	733
TRANSECT 4:								
20 m South	NS	NS	NS	NS	NS	NS	NS	NS
40 m South	NS	NS	NS	NS	NS	NS	NS	NS
145 m South	NS	NS	NS	NS	NS	NS	NS	NS
# OF SAMPLES	7	7	7	7	7	7	7	7
GRAND AVERAGE + 1 SD	1 ± 3	197 ± 121	0 ± 0	4 ± 9	82 ± 118	0 ± 0	0 ± 0	285 ± 226