4K90-29

# Development of Artificial Collectors for Late Larval Thru Early Benthic Stages of Red King and Tanner Crabs

By

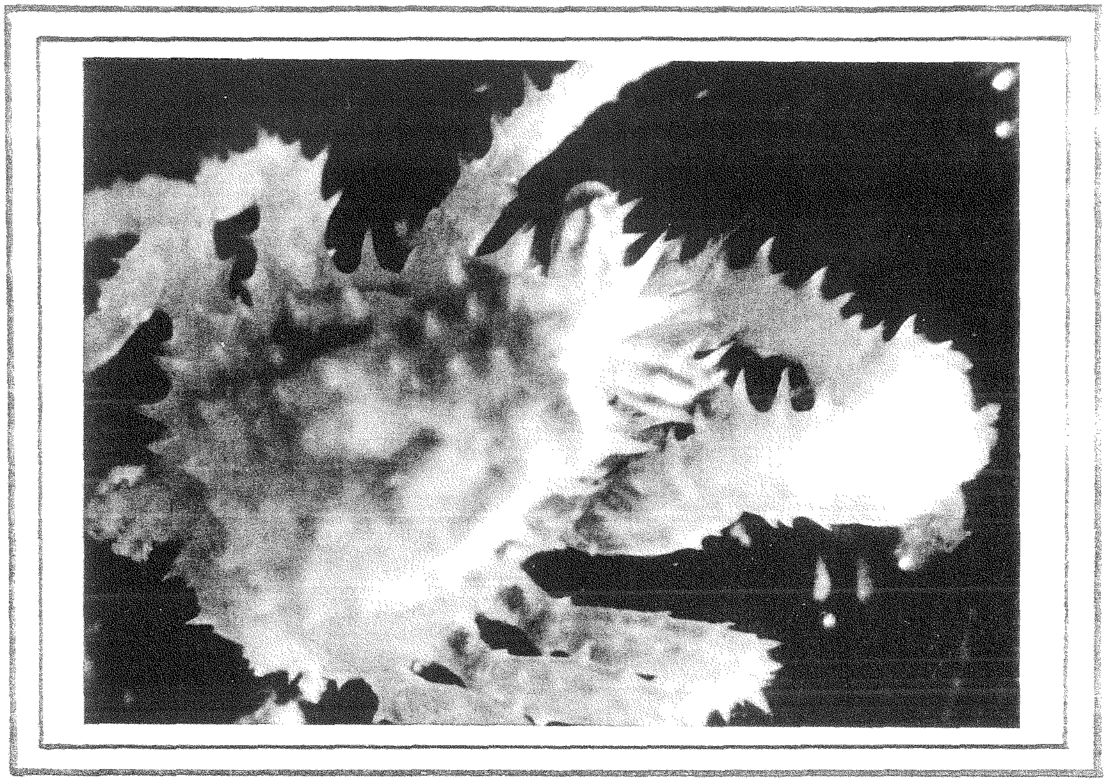
S. Forrest Blau
William E. Donaldson
and
Susan C. Byersdorfer

Regional Information Report[1] No. 4K90-29

Alaska Department of Fish and Game
Division of Commercial Fisheries
211 Mission Road
Kodiak, Alaska 99615

September 1990

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished division reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.



Early benthic stage red king crab, 2.4 mm carapace length.

**ACKNOWLEDGMENTS**

This project was initiated by Dr. Dana Schmidt, Westward Region Research Supervisor, Division of Commercial Fisheries, in the Alaska Department of Fish and Game (ADF&G). Dr. Gordon Kruse, Marine Fishery Scientist, in the same division of ADF&G in Juneau, provided the funding for this study. We thank them for their insight, direction and support.

We also express appreciation to the following ADF&G, Division of Commercial Fisheries, Kodiak personnel who assisted in various aspects of the field work. Tom Emerson and Ed Sampson skippered the Coho and helped deploy and retrieve gear. Morris Lambdin built and retrieved collector gear, dove on gear, and sorted organisms from the collectors. Ed Avery built the collector table and wash box, retrieved collector gear, sorted organisms and assisted in data summarization. Jim Blackburn, Larry Greer, Pat Holmes, Doug Pengilly and Dana Schmidt assisted in the retrieval of the collector gear including sorting and counting of marine organisms. Doug Pengilly also assisted in temperature data retrieval and summarization.

Special thanks to Dr. Thomas Shirley of University of Alaska, Juneau, who provided helpful editorial comments on the manuscript.

# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

**ABSTRACT**

Seven different types of experimental artificial collectors were built and tested by the Alaska Department of Fish and Game (ADF&G) in an attempt to collect last larval to early benthic stages of red king (Paralithodes camtschaticus) and Tanner (Chionoecetes bairdi) crabs. The goal of this study was to determine the collector best suited to passively collect small crabs of these species for future larger scale and longer period studies. These future studies would attempt to correlate the numbers of young crabs found in the collectors in a given year to the catches of crabs recruiting to legal size in ensuing years as found on annual ADF&G trawl surveys conducted in the same area. Two hundred and eighty-one collectors were deployed from April-June 1989, on the ocean floor in depths from 6-21 m below MLLW. Ten different sites were selected in inner Chiniak Bay, located on the northeast portion of Kodiak Island, Alaska, based on past records of crab occurrence. Bottom types ranged from mud to rock but were predominately soft (mud to sand).

Collectors were set and retrieved by scuba divers and vessel crew members. Two hundred and fifty-seven collectors were retrieved in October and November 1989, after being in the ocean four to six months. Each collector was rinsed thoroughly through a screen and organisms $\geq$1 mm were retained and counted. King and Tanner crabs were measured. There were 419 red king crabs collected, 99% were young of the year crabs (<13 mm CL) with sizes ranging from 3.5 to 7.0 mm CL. The remaining six king crabs were one year olds (13.0 to 24.4 mm CL). Red king crabs were present at each site with two collector types, "large pots" and "sausages," each accounting for 27 % of the total number collected. Of the 290 Tanner crabs collected, 45 were measured; their sizes ranged from 7 to 20 mm CW. Of those measured, 96% were young of the year, sizes <18 mm CW, and the remaining were one year olds. Tanner crabs were collected at half the sites and 91% were collected in one gear type, the "large pots." In addition >100 taxa of marine organisms were identified and enumerated from the collectors. The "sausage" collector was the highest ranked of the seven different collectors tested in this study based on their low production cost, ease of handling, and efficiency of collecting red king crabs on a per volume basis. Sausages were composed of tubular plastic netting with a stretch mesh of 16 mm and stuffed with used herring gillnet to a diameter of 26 cm and a length of 83 cm.

## INTRODUCTION

Research on the settlement of a wide variety of marine invertebrates on various artificial collectors has been conducted by numerous biologists around the world (Cairns 1982; Butman 1987). Only a few studies have been successful in relating settlement levels of commercial shellfish species to subsequent levels of recruitment in later years (Gwyther and Burgess 1987; Phillips 1986).

The goal of this project was to develop an artificial collector that would passively capture glaucothoe and early benthic stages of red king crabs (Paralithodes camtschaticus); and megalops to early benthic stages of Tanner crabs (Chionoecetes bairdi). If an artificial collector, hereafter termed "collector," could be developed to meet this goal then it was anticipated that the project would be expanded to at least a five year program to determine if future recruitments to these fisheries could be predicted based on the magnitude of settling events. If a strong correlation could be established between the abundance of young of the year crabs found in collectors in a given year and the abundance of recruit sized crabs from the same year class in later trawl surveys, then ADF&G shellfish managers, researchers, and the commercial crab industry would have an opportunity to plan farther ahead than can be done now based on changing levels of year class strength.

## METHODS

Guy Powell, retired ADF&G crab research biologist, was contracted to provide information on the distribution of juvenile and adult female red king crabs within the Kodiak Archipelago. In addition Powell provided data and photos from his scuba diving observations on one and two year old red king crabs in their natural habitats.

Three attempts have been made to develop collectors for red king crabs. Powell (ADF&G unpubl. memo 1969) suggested using webbed king crab pots fitted with polypropylene pieces to serve as a "filter" of postlarval red king crabs for enhancement purposes; but the project was never funded. Dr. Bradley Stevens of the National Marine Fisheries Service NMFS, Kodiak (pers. comm.) deployed two king crab pots each containing two smaller pots stuffed with trawl web, in the Bering Sea in 1987 in hopes of collecting juvenile red king crabs. None of the gear was recovered. Settling red king crabs were collected in Auke Bay, Alaska on five different collectors (Freese and Babcock 1990). These collectors consisted of wire frames filled with either plastic plants, plastic scouring pads or air filters; or plate collectors made from carpet or plastic screening. We decided not to use collectors similar to these because the number of crabs collected was small.

The following seven collector designs were developed for testing:

1) Minnow traps - 42x19 cm metal minnow traps (Gee's no. G-40, size 8 mesh) were attached every 2 m to a 26 m leadline to make a unit of gear (Figure 1). There were 10 traps per string of gear; half were stuffed with polyethylene blue plastic netting and the other half were stuffed with used herring gillnet. These two styles of traps were placed on the leadline in an alternating fashion. In addition each half of every minnow trap had a 0.4 kg lead weight tied inside to increase stability of the trap while it was deployed on the bottom.

2) Sausages - a 1.8 m section of tubular polyethylene blue plastic netting (used for scallop spat collecting in Japan) was stuffed loosely with used herring gillnet and secured with overhand knots in each end. Its stretch mesh was 16 mm. Average size per "sausage" style collector was 83x26 cm. There were two styles of sausages, one was termed "horizontal" and the other "vertical" since it had a underwater plover cork tied at one end. Five each of the two styles of sausages were attached to a leadline in alternating fashion by using halibut snaps (Figure 2).

3) Turfs - were composed of green plastic door mats with plastic grass 3 cm high, lashed onto angle iron frames 93x83 cm (Figure 3).

4) Brooms - consisted of 16 industrial push broom heads with plastic bristles 40x8.5x13.5 cm, screwed onto angle iron frames 93x83 cm (Figure 3). In addition two 10 kg sand bags were tied onto each broom frame to make the collector negatively buoyant.

5) Small pots - made of 1.5 cm diameter reinforcing steel welded into frames 93x93x60 cm and covered with nylon bags having 0.8 cm holes. These pots were stuffed with a variety of netting: used herring, trawl, etc.

6) Large pots - made of similar materials to small pots except larger frame size, 120x120x60 cm (Figure 4).

7) Shells - this collector consisted of perforated plastic trays filled predominately with butter clam (*Saxidomus giganteus*) shells. There were two styles of shell collectors, those consisting of two trays lashed together, 36x48x18 cm (Figure 5) or three trays stacked and lashed together, 36x48x10 cm.

Inner Chiniak Bay, on the northeast side of Kodiak Island was chosen as the crab collector pilot study area due to its ease of access to the Kodiak ADF&G office and its long history of commercial production of both red king and Tanner crabs. Ten sites were chosen within this area to place collectors. Three of these were selected within Trident Basin, just east of Near Island, based on Powell's prior observations of postlarval and juvenile red king crabs.

Deployment of collectors were made in the spring to early summer (March 31 to June 6) of 1989 using ADF&G vessels, the *Kazami* (7.5 m) or the *Coho* (12.8 m), with three or four person crews.

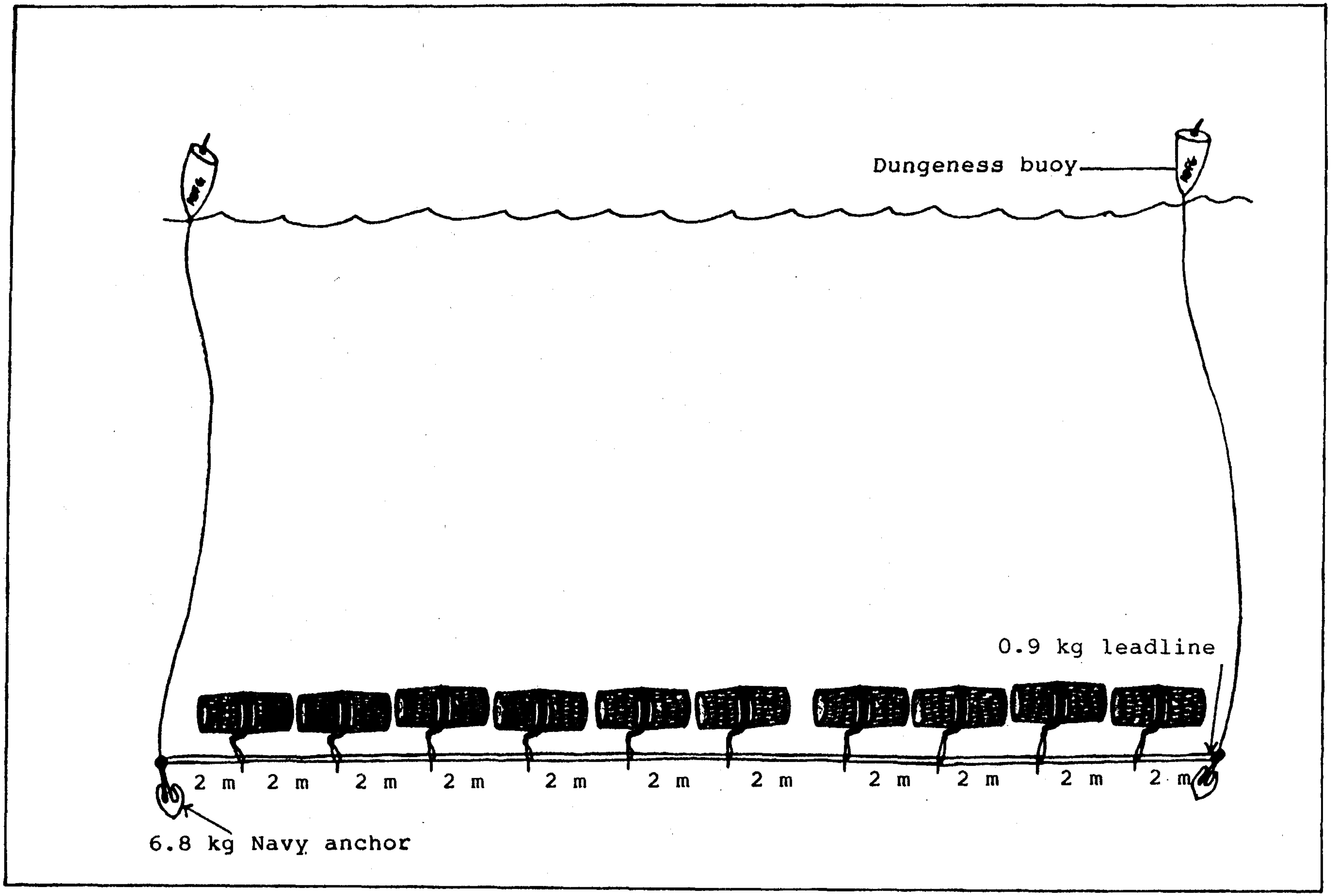



Figure 1. Schematic of string of "minnow trap" collectors.

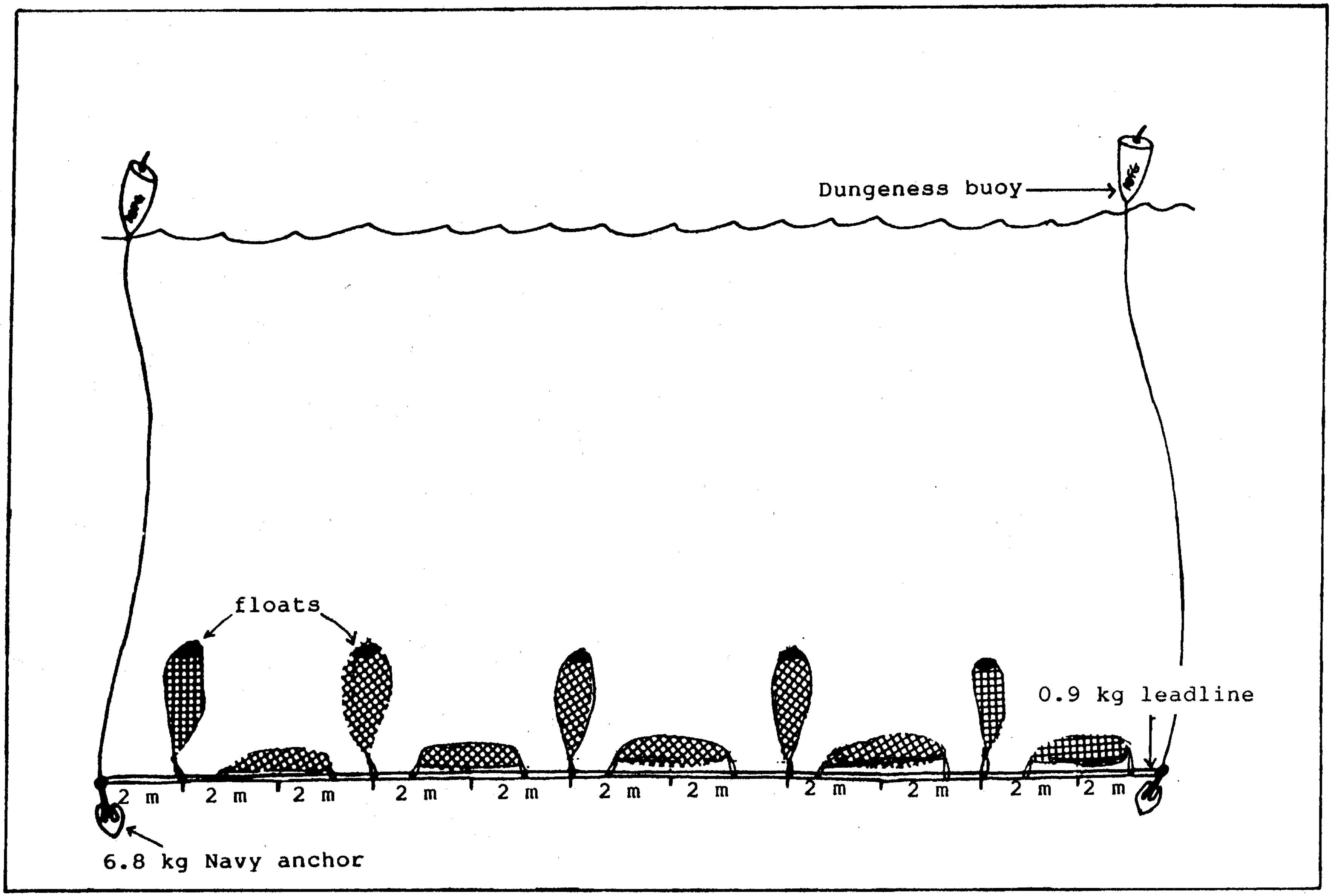



Figure 2. Schematic of string of "sausage" collectors, showing alternating pattern of vertical and horizontal "sausages".

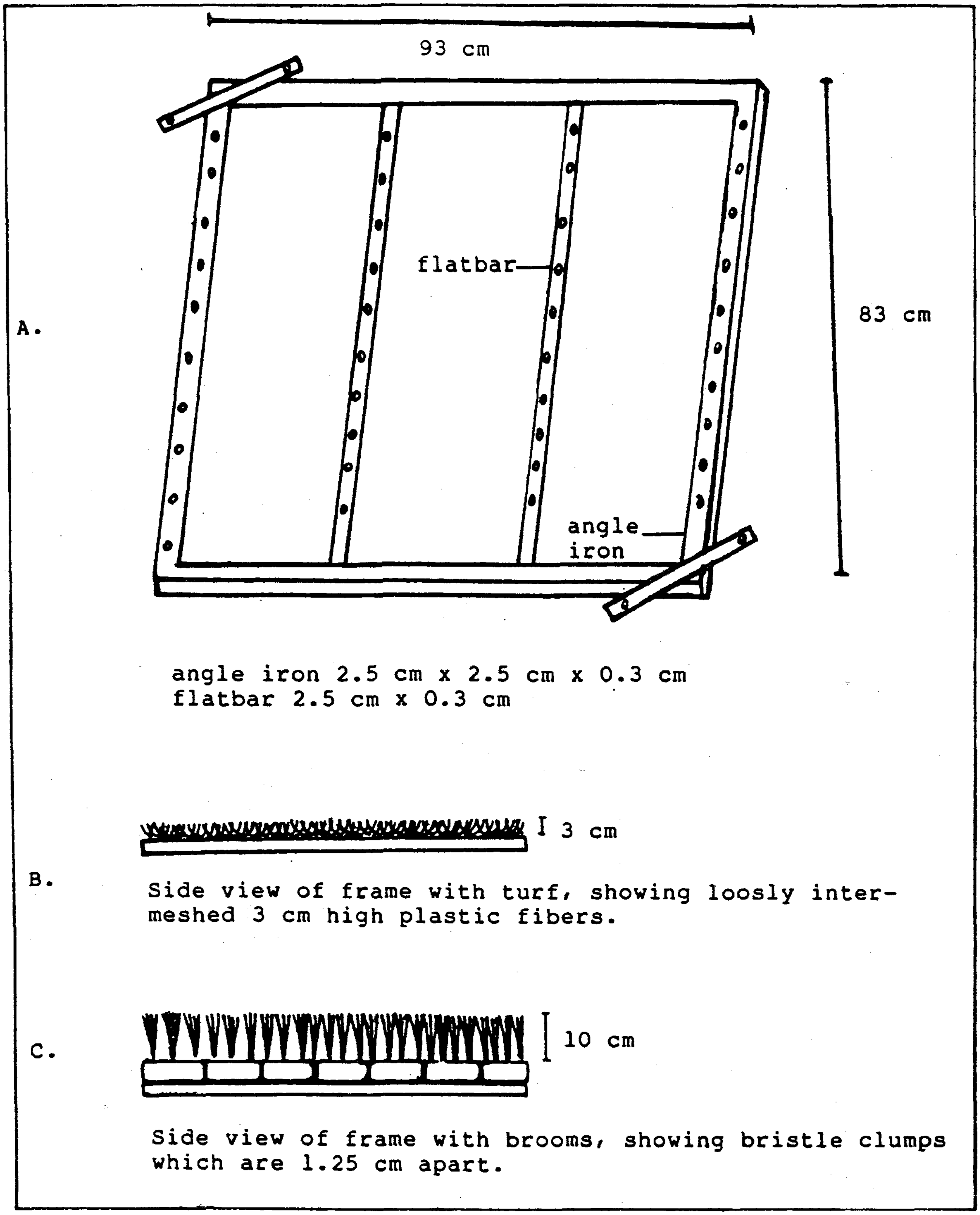



Figure 3. Frame for attachment of one turf or sixteen brooms (A), turf collector (B), and broom collector (C).

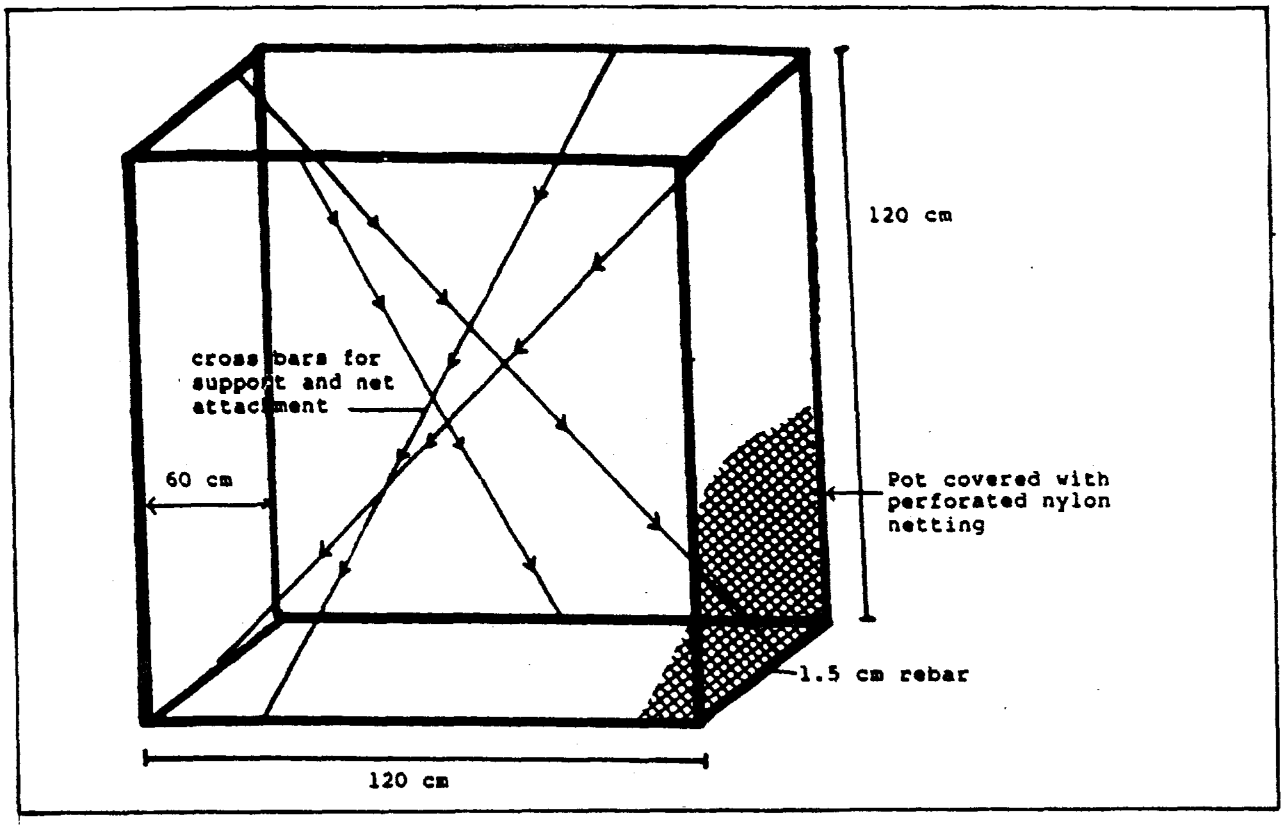



Figure 4. Large pot collector showing internal supports.

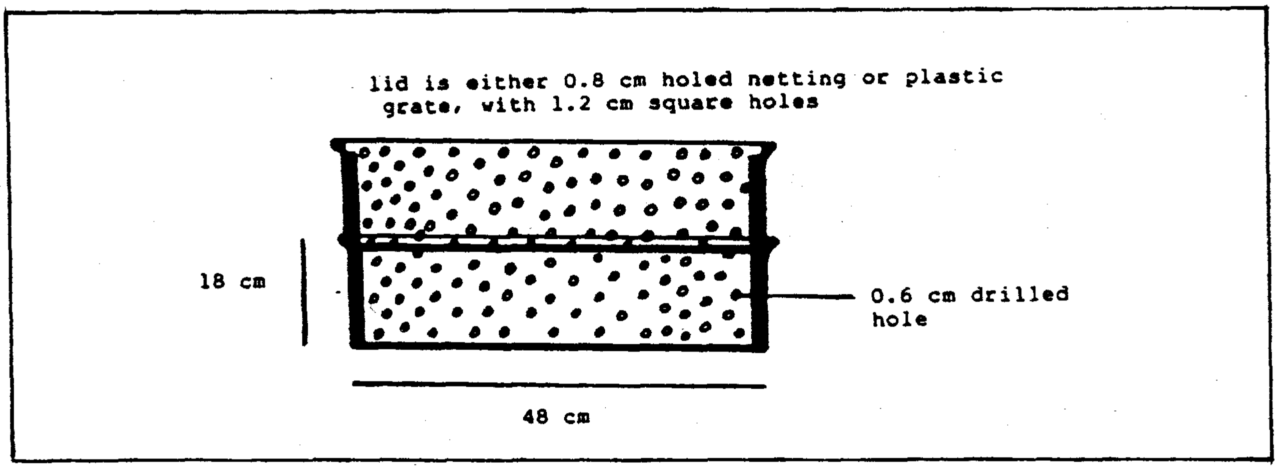



Figure 5. Shell collectors.

Deployment of the gear at each site was done generally as follows. Sites were picked with a variety of bottom substrates and within a depth range proven to have postlarval red king crabs (Sundberg and Clausen 1979). A string of 10 sausages was deployed slowly over the stern as the vessel moved forward. The end of the string was held on deck to stretch the gear tight before releasing the remaining anchor overboard. A string of 10 minnow traps was deployed in the same manner, 10-15 m distant and parallel to the string of sausages. In addition, three brooms, two turfs, three pots (combination of large and small) and a shell collector were connected together by a groundline every 2 m, in various combinations. Two or three strings of this gear were also released at each site in between the parallel strings of minnow traps and sausages. Deployment was followed by divers inspecting all gear at each site to insure proper orientation.

Collectors were retrieved in October and November 1989 using the Coho since it had a deck hose required for washing the gear. The Kazami was used once for extra people in a diving and filming effort. Crews on the Coho consisted of 4-5 people, which included diving biologists. Divers tied line with buoys to strings of turfs, brooms, pots and shell collectors which were then brought to the surface by the on deck crew. Divers also placed some turfs and broom collectors into large plastic woven bags, with mesh openings <0.5 mm, attempting to reduce crab loss from the collectors while they were being brought to the surface and to the deck of the boat. The different strings of gear were retrieved singly, with each collector washed separately.

A sorting table was divided into three sections by two widthwise dividers, and was used to wash all minnow, sausage, shell and pot collectors. Each section had a hole cut out of the bottom in which a removable drawer could be inserted. The drawer's bottom had a 1 mm square plastic screen stapled to it and was supported by a 8 mm square "hardware cloth" metal screen. All crabs and other marine life were then washed into the removable drawers. A wash box with a hole in the center of it covered with 1 mm square plastic and hardware cloth was also constructed specifically to wash the turf and broom collectors in.

All marine organisms retained were identified to the lowest taxon practicable and counted. When taxa had >150 individuals their numbers were estimated. Divers collected surface sediment sample at the collector sites using 1 L jars.

Red king and Tanner crabs were measured using Vernier calipers. King crab carapace lengths (CL) were measured to the nearest 0.1 mm, from the rear of the right eye socket, in a straight line to the midpoint of the posterior margin of the carapace. All king crabs were measured. Tanner crab carapace widths (CW) were measured to the nearest 1 mm across the lateral margins of the carapace (inside the spines) and perpendicular to the line bisecting the anterior and posterior ends of the carapace. Tanner crabs were measured and subsampled at a ratio of approximately 1:6.

Size at age data for red king and Tanner crabs were followed from McCaughran and Powell (1977) and Donaldson et al. (1981) respectively. Crabs were not sexed.

A Ryan TempMentor digital recording thermometer was placed 11 m below mean lower low water (MLLW) in Trident Basin, where three of the 10 sites were located. Temperatures were recorded every hour from which daily averages were calculated. Salinities were taken with a YSI model 33, S-C-T meter.

## RESULTS

Seven types of collectors were deployed at 10 different sites in inner Chiniak Bay from March 31 to June 26, 1989 (Table 1). About 29 individual collectors of seven different varieties were placed at each site in depths ranging from 6 to 21 m. Substrates at nine sites were predominately soft; composed of sand, silt or mud. One site in Middle Bay was composed of boulders. Most sites also were covered with varying amounts of kelps, other algae, polychaete tubes and clam shells. Two hundred and fifty-seven collectors were retrieved from October 3 to November 16, 1989; four to six months after being deployed. Twenty-four collectors were not found or were lost during retrieval.

Four hundred and nineteen red king and 290 Tanner crabs were collected in the gear (Tables 2 and 3). One or more red king crabs were found at every site (Table 2 and Figures 6-8), while Tanner crabs were collected at five (half) sites (Table 3 and Figures 6-8). The most king crabs at a site, 160, were collected at site 2 in Trident Basin and comprised 38% of the total for all sites. For Tanner crabs, site 3 near Gibson Cove was the most productive yielding 150 crabs, 52% of the total for all sites.

Of the 281 collectors deployed, 257 were retrieved, consisting of the following: sausages 101, minnow traps 76, brooms 25, turfs 20, large pots 17, small pots 10, shells 7, plus a buoy line which was covered with hydroids (Tables 2 and 3). Twenty-seven percent of the red king crabs came from the sausage and large pot collectors (Table 4). Catch per unit effort (CPUE) of king crabs was $\geq$1 for each collector type except the minnow traps (Table 2). CPUE $\geq$1 for Tanner crabs were attained in the small and large pots only (Table 3). The percentages of Tanner crabs collected by gear type was: large pots 91%, small pots 6%, minnow traps 6%, and sausages <1%. Turf, broom and shell collectors did not collect any Tanner crabs.

Carapace lengths of red king crabs ranged from 3.5 to 24.1 mm with a mode at 5.0 mm (Table 5 and Figure 9). Ninety-nine percent of these were young of the year (<13 mm CL). The remaining six crabs were one year olds, and ranged in size from 13.0 to 24.4 mm CL. Forty-five of 290 Tanner crabs collected were measured with their

Table 1. Location, site data, deployment and retrieval dates for 10 crab collector sites in Chiniak Bay, Alaska 1989.

| Site No. | Location | Depth, Meters Below MLLW | Substrate(s) Habitat | Collectors[a] | In Water Date | In Water $H_2O$ Temp. °C[b] | Out of Water Date | Out of Water $H_2O$ Temp. °C[b] | Out of Water Salinity o/oo |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Trident Basin, W. reef near thermograph site | 9 | Soft bottom, silty, shell hash, scattered kelp | 1, 2, 3, 4,6(2) | 3/31 | 2.8 | 10/03 | 8.9 | - |
| 2 | Trident Basin, N.W. side closest to Near Is. | 14 | Shell hash, small rocks | 1, 2, 3, 4, 6(3) | 5/30 | 5.8[c] | 10/3 | 8.9 | 30.0 |
| 3 | Gibson Cove, outside N. entrance | 14 | Soft mud bottom, worm tubes | 1, 2, 3, 4, 5(1), 6(2) | 5/30 | 5.8[c] | 10/26 | 5.9 | - |
| 4 | Trident Basin, W. side in deep hole | 15-21 | Mud, clam shells, some tube worms | 1, 2, 3, 4, 6(3) | 5/31 | 5.8[c] | 10/31 | 6.4 | 30.0 |
| 5 | St. Herman's Harbor, S. floating breakwater | 15 | Thick mud, <u>Owenia</u> tubes | 1, 2, 3, 4, 5(2), 6(1) | 6/1 | 5.9[c] | 10/27 | 6.0 | 29.3 |
| 6 | Holiday Island, cove on S.E. side | 6-9 | Shell hash and kelp | 1, 2, 3, 4, 5(3) | 6/14 | 6.6 | 11/1 | 6.4 | 29.7 |
| 7 | Holiday Island, cove on S.E. side | 12-14 | Soft mud bottom, worm tubes, kelps (<u>Alaria</u> <u>Agarum</u>, <u>Desmarestia</u>, & <u>Cyamathere</u>) | 1(6), 2, 3, 4(1), 6(3), 7(3) | 6/17 | 6.8 | 10/12 | 8.1 | - |
| 8 | Middle Bay, S.W. of Cliff Point | 9-14 | Boulders, rocks | 1, 2, 3, 4, 5(1), 6(2), 7(1) | 6/19 | 7.1 | 10/19 | 7.0 | - |
| 9 | Middle Bay, S. of Viesoki Is. | 15 | Fine sand | 1, 2, 3, 4, 5(2), 6(1),7(2) | 6/26 | 6.9 | 10/21 | 6.5 | - |
| 10 | Puffin Island, N. end | 17 | Soft bottom, silty | 1, 2(9), 3, 4, 6(3), 7(1) | 6/26 | 6.9 | 10/23 | 6.4 | - |

[a]Types of collectors used at each site are coded as follows: 1 = minnow traps (10/site), 2 = sausages (10/site), 3 = brooms (3/site), 4 = turfs (2/site), 5 = small pots, 6 = large pots, 7 = shell collectors. In parentheses are the numbers of a type of collector gear used at a site if different than previously mentioned.

[b]Average daily temperature taken from 11 m below MLLW in Trident Basin by digital recording thermometer.

[c]Average daily temperatures estimated from adajcent temperatures taken by thermograph in Trident Basin.

Table 2. Young of the year red king crabs, <13 mm in carapace length, found in collectors, Chiniak Bay, fall 1989.

| Site Number: U = no. units, C = no. crabs: retrieved | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C |
| 1. **Minnow Traps** | | | | | | | | | | | | | | | | | | | | | | |
| blue (plastic liner) | 3 | 1 | 5 | 7 | 5 | 8 | 5 | 10 | -[a] | - | 5 | 1[b] | 4 | 1 | 5 | 0 | 3 | 0 | 4 | 0 | 39 | 28 |
| green (herring net) | 5 | 0 | 4 | 5 | 6 | 5 | 5 | 14 | - | - | 3 | 0 | 1 | 0 | 5 | 0 | 4 | 1 | 4 | 5 | 37 | 30 |
| 2. **Sausages** | | | | | | | | | | | | | | | | | | | | | | |
| horizontal | 5 | 5 | 4 | 17 | 5 | 8 | 10 | 8 | 5 | 0 | 5 | 0 | 5 | 12 | 5 | 0 | 4 | 0 | 5 | 2 | 53 | 52 |
| vertical | 3 | 2 | 5 | 23 | 5 | 16 | 7 | 7 | 4 | 1 | 5 | 3 | 5 | 4 | 5 | 1 | 5 | 0 | 4 | 1 | 48 | 58 |
| 3. **Turfs** | | | | | | | | | | | | | | | | | | | | | | |
| bagged | - | - | 2 | 13 | 2 | 0 | 1 | 3 | - | - | 2 | 0 | 1 | 1 | 2 | 0 | 2 | 0 | - | - | 12 | 22 |
| unbagged | 2 | 1 | - | - | - | - | 1 | 3 | 2 | 1 | - | - | 1 | 0 | - | - | - | - | 2 | 2 | 8 | 7 |
| 4. **Brooms** | | | | | | | | | | | | | | | | | | | | | | |
| bagged | - | - | 3 | 14 | 1 | 8 | - | - | - | - | - | - | 1 | 1 | 3 | 1 | 3 | 0 | - | - | 11 | 24 |
| unbagged | - | - | - | - | 2 | 4 | 3 | 6 | 3 | 1 | 3 | 2 | - | - | - | - | - | - | 3 | 2 | 14 | 25 |
| 5. **Small Pots** | - | - | - | - | 1 | 9 | 3 | 29 | 2 | 1 | 3 | 5 | - | - | 1 | 0 | - | - | - | - | 10 | 44 |
| 6. **Large Pots** | 2 | 8 | 3 | 81 | 2 | 9 | - | - | 1 | 1 | - | - | 3 | 12 | 2 | 0 | 1 | 0 | 3 | 3 | 17 | 114 |
| 7. **Shells** | | | | | | | | | | | | | | | | | | | | | | |
| two trays | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 8 | - | - | - | - | 1 | 0 | 4 | 8 |
| three trays | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0 | 2 | 0 | - | - | 3 | 0 |
| 8. **Other**[c] | 1 | 1 | | | | | | | | | | | | | | | | | | | 1 | 1 |
| Totals | 21 | 18 | 26 | 160 | 29 | 77 | 35 | 85 | 17 | 5 | 26 | 11 | 24 | 39 | 29 | 2 | 24 | 1 | 26 | 15 | 257 | 413[d] |

[a]Dash means gear either not fished or lost.

[b]A red king crab carapace was also found, but is not included in the catch.

[c]A red king crab was found in a mass of hydroids growing on a bouy line.

[d]Six one year old red king crabs (≥13 - < 33 mm CL) were also collected; two each at sites 1,2, and 4.

Table 3. Tanner crabs found in collectors in Chiniak Bay, fall 1989.

| Site Number: | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| U = no. units, C = no. crabs: | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C | U | C |
| 1. **Minnow Traps** | | | | | | | | | | | | | | | | | | | | | | |
| blue (plastic liner) | 3 | 0 | 5 | 0 | 5 | 12 | 5 | 0 | -[a] | - | 5 | 0 | 4 | 4 | 5 | 0 | 3 | 0 | 4 | 0 | 39 | 16 |
| green (herring net) | 5 | 0 | 4 | 0 | 6 | 0 | 5 | 0 | - | - | 3 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 4 | 0 | 37 | 0 |
| 2. **Sausages** | | | | | | | | | | | | | | | | | | | | | | |
| horizontal | 5 | 0 | 4 | 0 | 5 | 0 | 10 | 0 | 5 | 1 | 5 | 0 | 5 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 53 | 1 |
| vertical | 3 | 0 | 5 | 0 | 5 | 0 | 7 | 0 | 4 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 5 | 0 | 4 | 0 | 48 | 0 |
| 3. **Turfs** | | | | | | | | | | | | | | | | | | | | | | |
| bagged | - | - | 2 | 0 | 2 | 0 | 1 | 0 | - | - | 2 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | - | - | 12 | 0 |
| unbagged | 2 | 0 | - | - | - | - | 1 | 0 | 2 | 0 | - | - | 1 | 0 | - | - | - | - | 2 | 0 | 8 | 0 |
| 4. **Brooms** | | | | | | | | | | | | | | | | | | | | | | |
| bagged | - | - | 3 | 0 | 1 | 0 | - | - | - | - | - | - | 1 | 0 | 3 | 0 | 3 | 0 | - | - | 11 | 0 |
| unbagged | - | - | - | - | 2 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | - | - | - | - | - | - | 3 | 0 | 14 | 0 |
| 5. **Small Pots** | - | - | - | - | 1 | 10 | 3 | 0 | 2 | 0 | 3 | 0 | - | - | 1 | 0 | - | - | - | - | 10 | 10 |
| 6. **Large Pots** | 2 | 0 | 3 | 0 | 2 | 128 | - | - | 1 | 0 | - | - | 3 | 90 | 2 | 0 | 1 | 1 | 3 | 44 | 17 | 263 |
| 7. **Shells** | | | | | | | | | | | | | | | | | | | | | | |
| two trays | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0 | - | - | - | - | 1 | 0 | 4 | 0 |
| three trays | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0 | 2 | 0 | - | - | 3 | 0 |
| 8. **Other**[b] | 1 | 0 | | | | | | | | | | | | | | | | | | | 1 | 0 |
| Totals | 21 | 0 | 26 | 0 | 29 | 150 | 35 | 0 | 17 | 1 | 26 | 0 | 24 | 94 | 29 | 0 | 24 | 1 | 26 | 44 | 257 | 290 |

[a] Dash means gear either not fished or lost.

[b] A buoy line with masses of hydroids covering it was checked for postlarval crab.

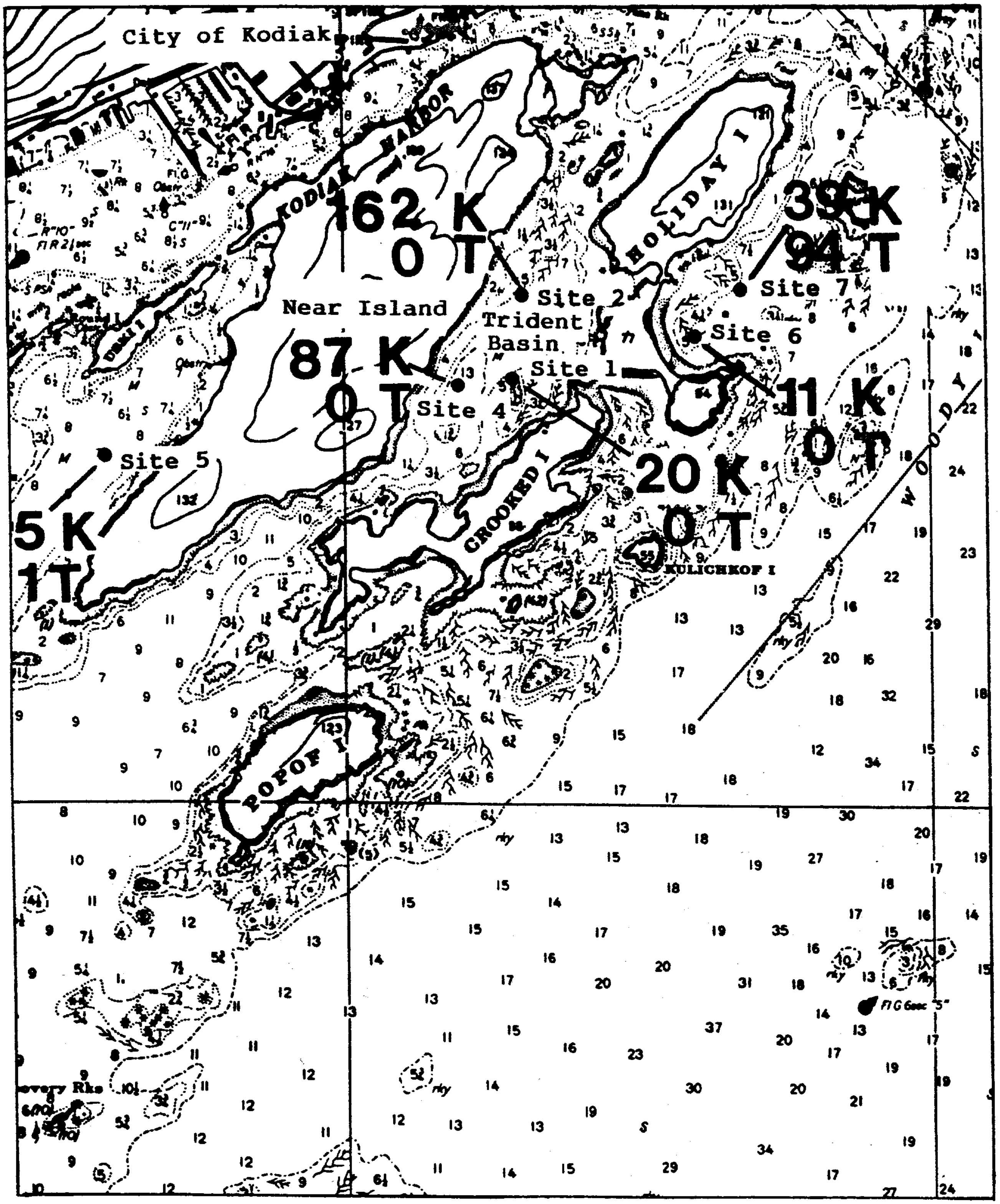



Figure 6. Number of postlarval red king (K) and Tanner (T) crabs found on collectors at six sites near the City of Kodiak, fall 1989.

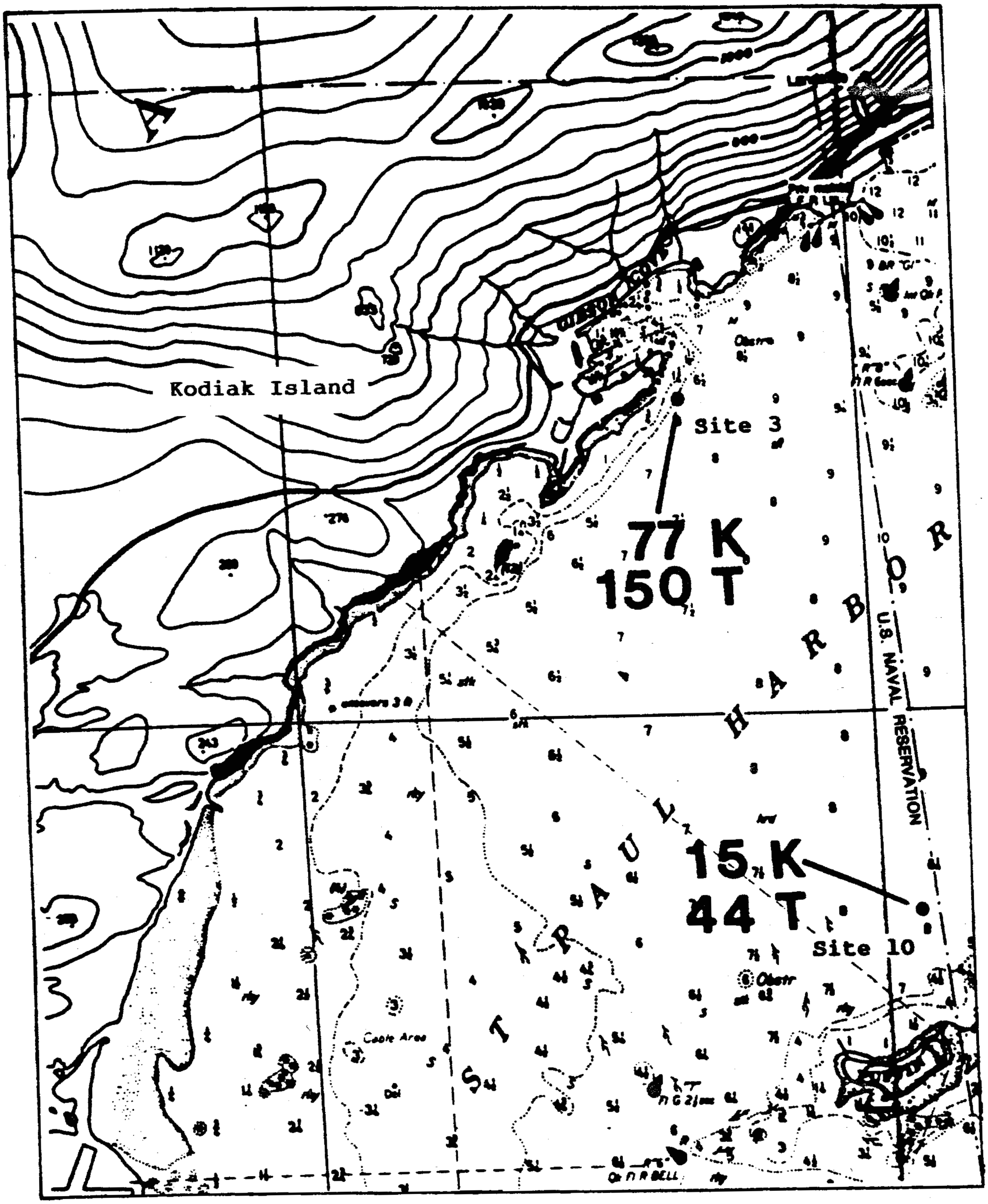



Figure 7. Number of postlarval red king (K) and Tanner (T) crabs found on collectors at two sites in St. Paul Harbor, fall, 1989.

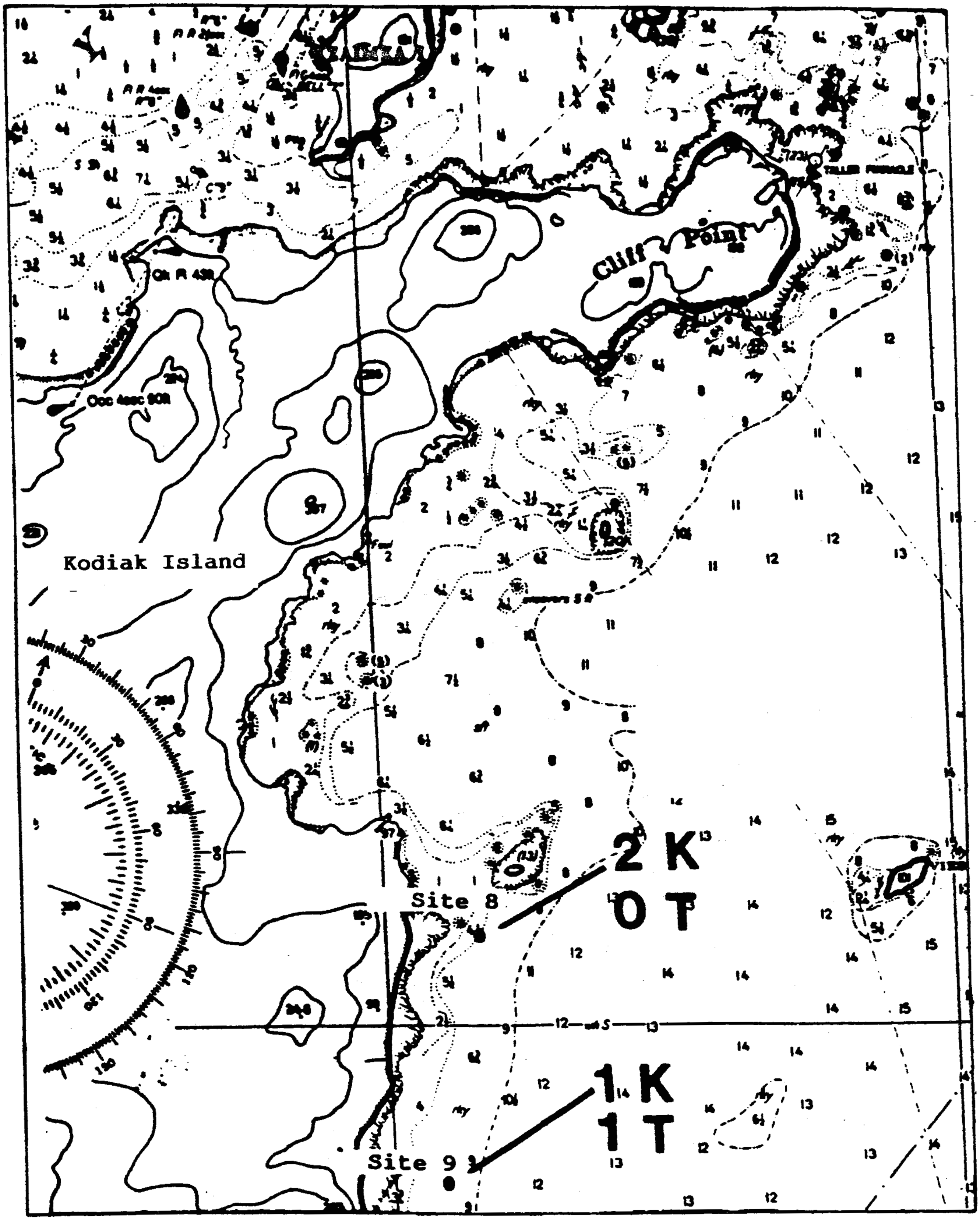



Figure 8. Number of postlarval red king (K) and Tanner (T) crabs found on collectors at two sites near the mouth of Middle Bay, fall 1989.

Table 4. Percentages of postlarval red king crabs, <13 mm in carapace length, found in collectors by gear type and site, Chiniak Bay, fall 1989.

| Gear Types | Site #1 % | Site #2 % | Site #3 % | Site #4 % | Site #5 % | Site #6 % | Site #7 % | Site #8 % | Site #9 % | Site #10 % | Totals Collected[a] % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Minnow traps:** | | | | | | | | | | | |
| blue (plastic liner) | 5 | 4 | 10 | 13 | - | 18 | 3 | 0 | 0 | 0 | 7 |
| green (herring net) | 0 | 3 | 6 | 18 | - | 0 | 0 | 0 | 100 | 35 | 7 |
| **2. Sausages:** | | | | | | | | | | | |
| horizontal | 28 | 10 | 10 | 10 | 0 | 0 | 30 | 0 | 0 | 14 | 13 |
| vertical | 11 | 15 | 21 | 9 | 20 | 27 | 10 | 50 | 0 | 7 | 14 |
| **3. Turfs:** | | | | | | | | | | | |
| bagged | 5 | 8 | 0 | 10 | - | 0 | 3 | 0 | 0 | - | 5 |
| unbagged | - | - | - | 4 | 20 | - | 0 | - | - | 7 | 1 |
| **4. Brooms:** | | | | | | | | | | | |
| bagged | - | 9 | 10 | - | - | - | 3 | 50 | 0 | - | 6 |
| unbagged | - | - | 18 | 8 | 20 | 18 | - | - | - | 14 | 6 |
| **5. Small Pots:** | - | - | 11 | 26 | 20 | 36 | - | 0 | - | - | 10 |
| **6. Large Pots:** | 44 | 50 | 11 | - | 20 | - | 30 | 0 | 0 | 21 | 27 |
| **7. Shells:** | | | | | | | | | | | |
| two trays | - | - | - | - | - | - | 21 | - | - | 0 | 2 |
| three trays | - | - | - | - | - | - | - | 0 | 0 | - | 0 |
| **8. Other:** | 5 | - | - | - | - | - | - | - | - | - | 0.2 |
| Totals:[b] | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

[a]Raw data only, the number of crabs collected are not adjusted for volume differences between gear type.

[b]Totals may not always equal 100 due to rounding.

Table 5. Size frequencies of all red king crabs found in collectors, Chiniak Bay, fall 1989.

| Carapace Lengths (mm) | No. |
|---|---|
| 3.5 | 2 |
| 3.7 | 6 |
| 3.9 | 3 |
| 4.0 | 11 |
| 4.1 | 6 |
| 4.2 | 12 |
| 4.3 | 7 |
| 4.4 | 11 |
| 4.5 | 21 |
| 4.6 | 14 |
| 4.7 | 19 |
| 4.8 | 22 |
| 4.9 | 29 |
| 5.0 | 89 |
| 5.1 | 27 |
| 5.2 | 29 |
| 5.3 | 25 |
| 5.4 | 15 |
| 5.5 | 18 |
| 5.6 | 8 |
| 5.7 | 9 |
| 5.8 | 5 |
| 5.9 | 4 |
| 6.0 | 11 |
| 6.1 | 0 |
| 6.2 | 2 |
| 6.3 | 0 |
| 6.4 | 0 |
| 6.5 | 2 |
| 6.6 | 1 |
| 6.7 | 2 |
| 6.8 | 0 |
| 6.9 | 2 |
| 7.0 | 1 |
| 13.0 | 1 |
| 18.0 | 1 |
| 18.8 | 1 |
| 18.9 | 1 |
| 20.7 | 1 |
| 24.1 | 1 |
| | 419 |

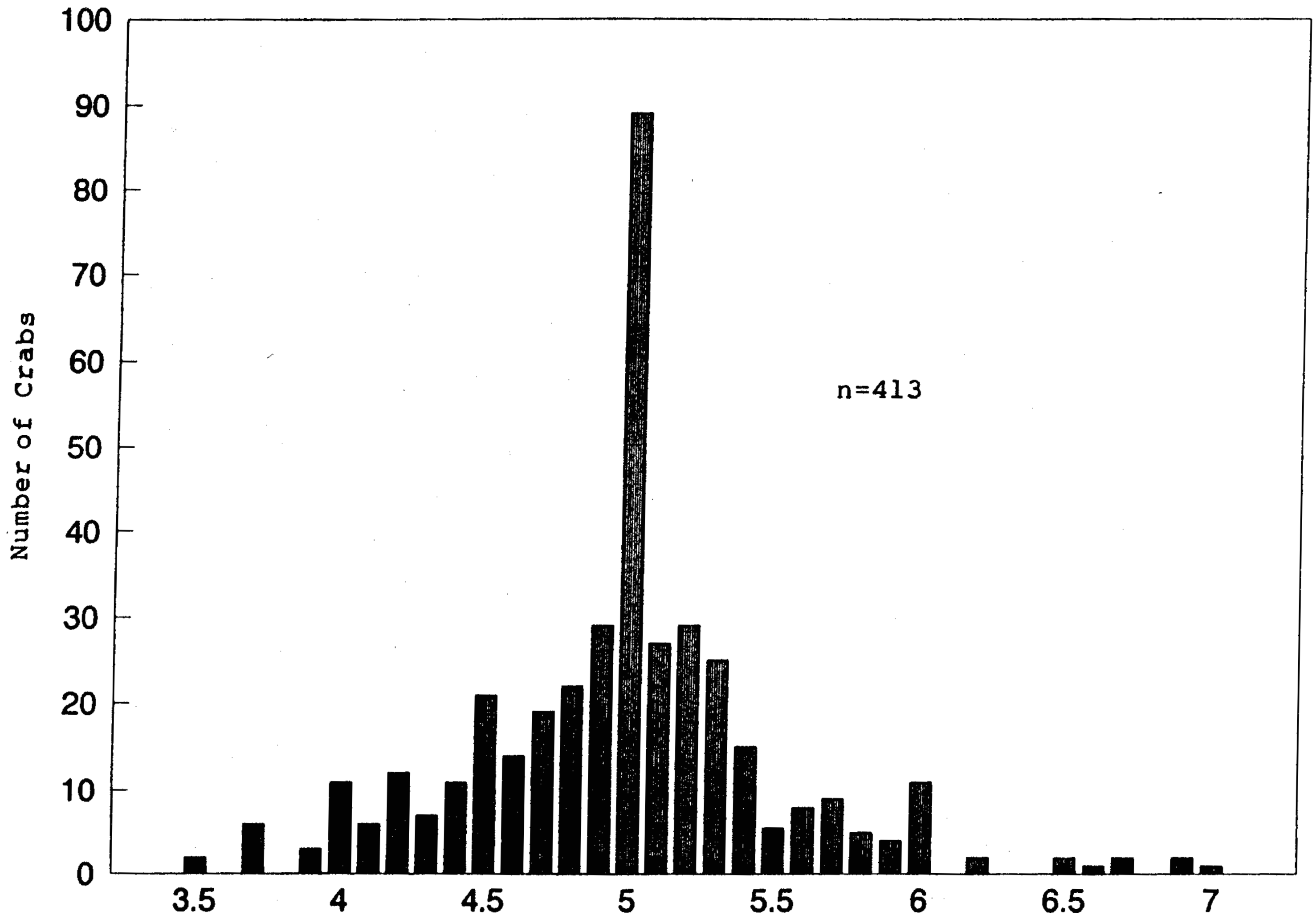



Figure 9. Length frequencies of young of the year red king crabs found in collectors, Chiniak Bay, fall 1989.

carapace widths ranging from 7 to 20 mm (Table 6 and Figure 10). Of those measured 96% were young of the year (<18mm CW) and the remaining were one year olds.

There were 111 taxa including 14 phyla of marine plants and animals identified from the collectors (Table 7). Arthropoda and Mollusca were the two most abundant phyla, containing 22,736 and 10,245 animals, respectively, at the nine sites enumerated (site 1 was the first site retrieved and only about half of the taxa were enumerated there). Shrimp composed 95% of the arthropods and snails composed 92% of the mollusks that were counted. The number of taxa varied from 30 to 50 per site (sites 5 and 2, respectively).

Daily average water temperatures were taken on the bottom at 11 m below MLLW in Trident Basin near site 1. Temperatures ranged from a low of 2.8 °C on March 31, the first day of deployment, to 10.3 °C on August 25 before starting their annual winter decline (Figure 11). The few salinity readings taken ranged between 29.3 to 30.0 o/oo.

## DISCUSSION

The number of postlarval young of year red king crabs (413) and Tanner crabs (estimated 279) found on the 256 collectors retrieved in this pilot study was greater than the number of this age of crabs collected in several other studies (Weber 1967; Sundberg and Clausen 1979; McMurray et al. 1981 and 1984; Pearson et al. 1984; Freese and Babcock 1990) including ADF&G trawl and pot surveys around the Kodiak Archipelago. When this study was initiated, it was uncertain whether a single larval or postlarval king or Tanner crab would occur on any of the collectors as the population levels of both species has been at depressed levels for several years. Whether the last larval stages of these crabs actually settled on the collectors was not determined by this study since the collectors were not pulled and examined until after settlement had occurred as evidenced by the crabs' postlarval sizes which were at a minimum several instars larger than their respective last larval stages. Having the collectors deployed over a four to six month period, as opposed to a shorter period of time, may have increased the occurrence of crabs the collectors, since fouling organisms are important to other settling organisms (Scheltema 1974; Little and Milano 1980). A study designed to collect data on the time period which settling larvae of king and Tanner crabs occur benthically would enable collectors to be placed in the water in sufficient time to assure fouling by marine organisms.

The fact that young of the year red king crabs occurred at all sites and in all collector types reveals their apparent nonspecificity to settling on the artificial substrates tried, unlike Tanner crabs which occurred on half the collector types.

Table 6. Size frequencies of Tanner crabs measured from collectors, Chiniak Bay, fall 1989.

| Carapace Widths (mm) | No. |
|---|---|
| 7 | 2 |
| 8 | 2 |
| 9 | 6 |
| 10 | 10 |
| 11 | 2 |
| 12 | 8 |
| 13 | 4 |
| 14 | 6 |
| 15 | 0 |
| 16 | 0 |
| 17 | 2 |
| 18 | 1 |
| 19 | 1 |
| 20 | 1 |
| | 45 |

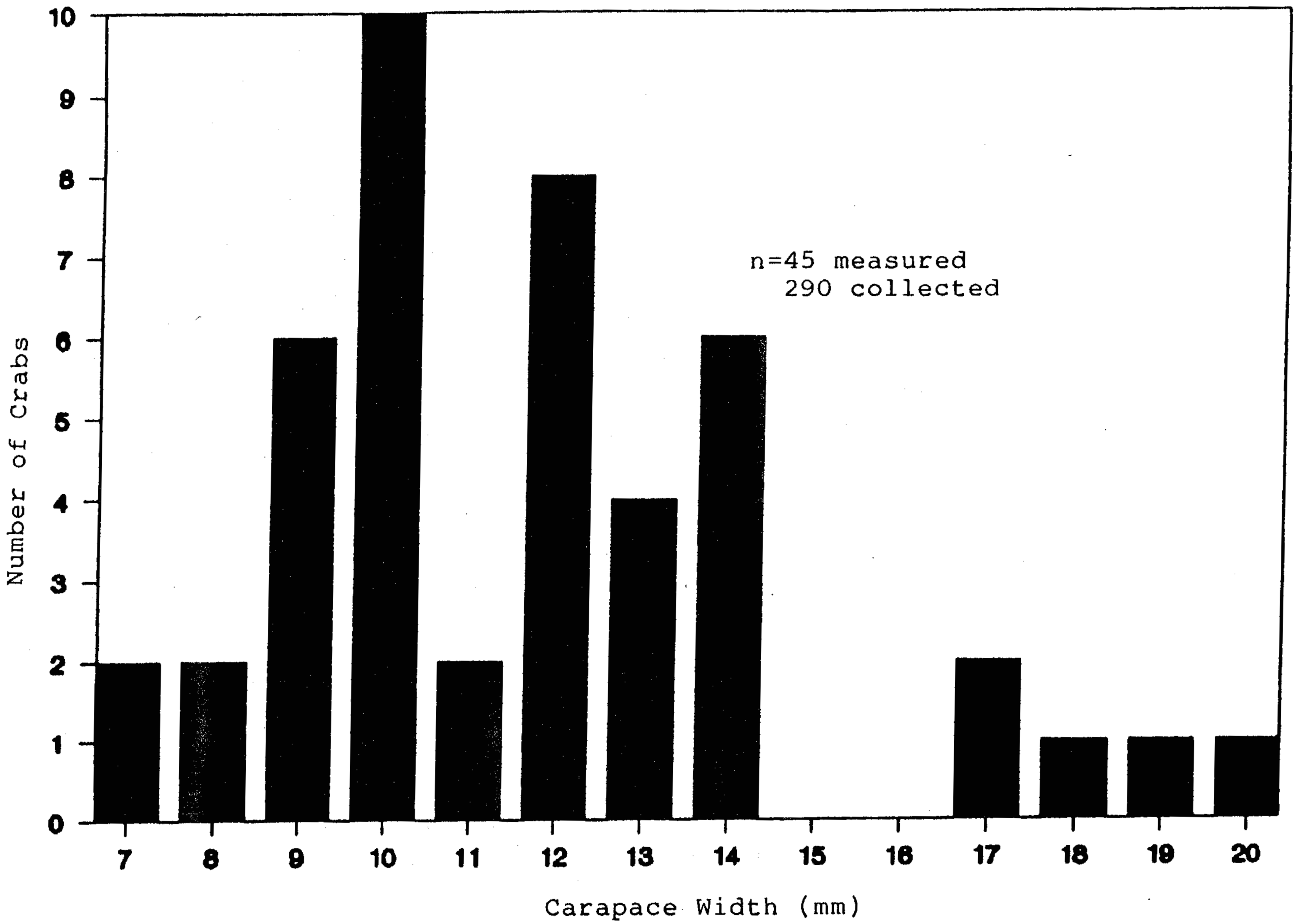



Figure 10. Width frequencies of young of the year Tanner crabs found in collectors, Chiniak Bay, fall 1989.

Table 7. Marine organisms collected from 256 artifical collectors, of seven styles, after being submerged four-six months in Chiniak Bay, spring-fall 1989.

| Taxa Site No.: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MARINE INVERTEBRATES | | | | | | | | | |
| **Porifera** | 0 | + | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 2 sites |
| **Cnidarians** | + | + | 2+ | 1+ | 1+ | + | 0 | + | + | + | 9 sites |
| Hydroids | + | + | + | + | + | + | 0 | + | + | + | 9 sites |
| Sea Anemone-unident. | 0 | 0 | 0 | 1 | 0 | 0 | 0 | .0 | 0 | 0 | 1 |
| Metridium senile | + | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3+ |
| **Platyhelminthes** | 0 | 4 | 7 | + | 0 | 0 | 0 | 4 | 0 | 0 | 15+ |
| **Nemertea** | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 1 | 1 | 1 | 11 |
| **Nematoda** | 0 | 41 | 14 | 6 | 57 | 328 | 8+ | 0 | 15 | 9 | 478+ |
| **Annelida** | + | 96 | 299 | 164 | 171 | 149 | 124 | 49 | 217 | 131 | 1,400+ |
| Polychaeta unident | + | 6 | 205 | 12 | 41 | 57 | 26 | 0 | 35 | 33 | 415+ |
| Scaleworms | + | 90 | 91 | 152 | 129 | 92 | 97 | 49 | 30 | 98 | 828+ |
| Sabellid worms | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + |
| Nereis sp. | + | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4+ |
| Owenia fusiformis | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| Serpulid worms unident. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Spirobis sp. | 0 | 0 | 0 | + | 0 | 0 | + | + | 150+ | 0 | 150+ |
| **Mollusca** | + | 1606 | 474 | 1102 | 73 | 4920 | 440 | 1312 | 72 | 246 | 10,245 |
| Gastropoda | + | 1446 | 150 | 1040 | 11 | 4918 | 384 | 1294 | 61 | 73 | 9,377 |
| Snails-unident. | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| Alia sp. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Amphissa columbiana | 0 | 3 | 0 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 12 |
| Boreotrophon sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Crepidula sp. | 0 | 2 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Fusitriton oregonensis | 0 | 7 | 0 | 21 | 0 | 1 | 2 | 12 | 0 | 0 | 53 |
| Lacuna sp. | + | 2 | 2 | 19 | 0 | 3819 | 142 | 121 | 0 | 7 | 4,112+ |
| Littorina sitkana | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 3 |
| Margarites pupillus | + | 1380 | 11 | 942 | 7 | 1062 | 237 | 1141 | 10 | 60 | 4,850+ |
| Nucella emarginata | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1+ |
| Nucella lamellosa | + | 32 | 1 | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 44+ |
| Neptunea sp. | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + |
| Ocenebra sp. | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + |
| Olivella sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 1 | 20 |
| Searlesia dira | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 18 | 0 | 0 | 19 |
| Trichotropis cancellata | 0 | 11 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 |
| Limpets-unident. | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Nudibranch unident. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Dorids | 0 | 4 | 5 | 2 | 0 | 3 | 0 | 0 | 27 | 2 | 43 |
| Eolids | + | 82 | 9 | 37 | 4 | 10 | 1 | 0 | 2 | 2 | 147+ |
| Amphineura | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| Chitons-unident. | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 |
| Bivalvia | + | 72 | 442 | 63 | 62 | 15 | 57 | 17 | 11 | 173 | 912 |
| Clams-unident | + | 12 | 10 | 11 | 5 | 3 | 52 | 7 | 2 | 171 | 273+ |
| Clinocardium sp. | + | 2 | 1 | 4 | 0 | 0 | 1 | 0 | 1 | 2 | 11+ |
| Hiatella sp. | + | 47 | 5 | 24 | 14 | 5 | 1 | 6 | 0 | 0 | 102+ |
| Macoma spp. | 0 | 1 | 1 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 9 |
| Protothaeca staminea | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| Psephidia/Transenennella | 0 | 0 | 424 | 0 | 36 | 6 | 0 | 0 | 0 | 0 | 466 |
| Yoldia spp. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Scallops | | | | | | | | | | | |
| Chlamys sp. | + | 7 | 0 | 20 | 0 | 0 | 2 | 0 | 0 | 0 | 29+ |
| Pecten caurinus | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + |
| Mussels-unident. | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 2 | 3 | 0 | 9 |
| Mytilus edulis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| Cephalopoda | | | | | | | | | | | |
| Octopus dofleini | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 7 |

(continued)

Table 7. (p. 2 of 2)

| Taxa | Site No.: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Arthropoda** | 19+ | 1611 | 3602 | 2023 | 3038 | 4609 | 2035 | 1561 | 1103 | 3135 | 22,736 |
| Crabs-unident. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Cancer oregonensis | 0 | 6 | 1 | 0 | 1 | 5 | 1 | 8 | 0 | 4 | 26 |
| Chionoecetes bairdi | 0 | 0 | 150 | 0 | 1 | 0 | 94 | 0 | 1 | 44 | 290 |
| Haplogaster mertensii | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 29 |
| Hyas lyratus | 0 | 39 | 4 | 15 | 4 | 15 | 16 | 1 | 31 | 44 | 169 |
| Oregonia gracillis | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 167 | 0 | 0 | 167 |
| Paralithodes camtschaticus | 20 | 161 | 77 | 87 | 5 | 12 | 39 | 2 | 1 | 15 | 419 |
| Pinnixia sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Placetron wosnesenskii | + | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 4+ |
| Pugettia gracilis | + | 6 | 23 | 0 | 0 | 9 | 4 | 0 | 14 | 21 | 77+ |
| Telmessus cheiragonus | + | 161 | 368 | 130 | 48 | 218 | 172 | 97 | 12 | 249 | 1,455+ |
| Hermit crabs-unident. | + | 46 | 4 | 9 | 0 | 8 | 1 | 641 | 21 | 28 | 758+ |
| Amphipods-unident. | + | 2 | 0 | 4 | 6 | 26 | 3 | 82 | 47 | 21 | 191+ |
| Caprellids | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 18 | 0 | 23 |
| Cumaceans | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Isopods-unident | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Barnacles-Balanus spp. | 0 | 4 | 6 | 0 | 15 | 11 | 20 | 3 | 91 | 1 | 151 |
| Shrimp-unident. | 3400+ | 1101+ | 2956 | 1774 | 2958 | 4300 | 1684 | 130 | 863 | 2449 | 21,615+ |
| Hippolytids | + | 75 | 0 | 0 | 0 | 0 | 0 | 399 | 0 | 200 | 674+ |
| Pandalids | 0 | 43 | 4 | 5 | 0 | 0 | 0 | 0 | 4 | 58 | 114 |
| **Echiura** | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| **Echinodermata** | 0 | 22 | 0 | 23 | 0 | 9 | 4 | 42 | 1 | 10 | 111 |
| Strongylocentrotus droebachiensis | 0 | 5 | 0 | 0 | 0 | 7 | 1 | 12 | 1 | 8 | 34 |
| Brittle stars-unident. | + | 12 | 0 | 19 | 0 | 0 | 3 | 24 | 0 | 1 | 59+ |
| Sea stars-unident. | 0 | 4 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| Evasterias sp. | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Henricia sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Pycnopodia helianthoides | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| Sea cucumbers-unident. | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Sand dollar-unident | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Chordata** | + | 141 | 5 | 1343 | 7 | 1 | 2 | 0 | 0 | 5 | 1,504+ |
| Tunicates-colonial unident. | + | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2+ |
| Tunicates-solitary unident. | + | 0 | 0 | 1343 | 0 | 0 | 0 | 0 | 0 | 0 | 1343+ |
| Tunicates-unident. | + | 141 | 4 | 0 | 7 | 1 | 2 | 0 | 0 | 4 | 159 |
| | | | | MARINE FISH | | | | | | | |
| Osteichthyes | + | 34 | 52 | 42 | 24 | 153 | 50 | 121 | 10 | 106 | 592+ |
| Gunnels | + | 27 | 25 | 20 | 4 | 111 | 28 | 95 | 3 | 15 | 328+ |
| Lumpfish | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 8 |
| Poacher | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 4 |
| Hexagrammous spp. | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 10 | 0 | 0 | 13 |
| Stichaeus punctatus | 0 | 0 | 0 | 5 | 0 | 27 | 0 | 0 | 0 | 0 | 32 |
| Sculpins-unident. | + | 7 | 25 | 14 | 19 | 9 | 22 | 11 | 6 | 87 | 200+ |
| Nautichthys sp. | + | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 7+ |
| | | | | MARINE PLANTS | | | | | | | |
| **Rhodophyta** | + | + | + | 0 | + | + | + | + | + | 0 | 8 sites |
| Filamentous reds-unident. | + | + | + | 0 | + | + | + | + | + | 0 | 8 sites |
| Callophyllis flabellulata | 0 | + | 0 | 0 | 0 | + | + | 0 | 0 | 0 | 3 sites |
| Corallina sp. | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 1 site |
| Iridea sp. | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 site |
| Odonthalia floccosa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 1 site |
| Ptilota/Neoptilota | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 site |
| Rhodymenia sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | + | 0 | 1 site |
| **Phaeophyta** | + | 0 | + | 0 | 0 | + | + | + | 0 | 0 | 5 sites |
| Desmarestia sp. | + | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 2 sites |
| Kelp-unident. | 0 | 0 | 0 | 0 | 0 | + | 0 | 0 | 0 | 0 | 1 site |
| Agarum sp. | 0 | 0 | 0 | 0 | 0 | 0 | + | + | 0 | 0 | 2 sites |
| **Chlorophyta** | + | 0 | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 sites |
| Filamentous greens-unident. | + | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 site |

+ Indicates organisms present but not counted.

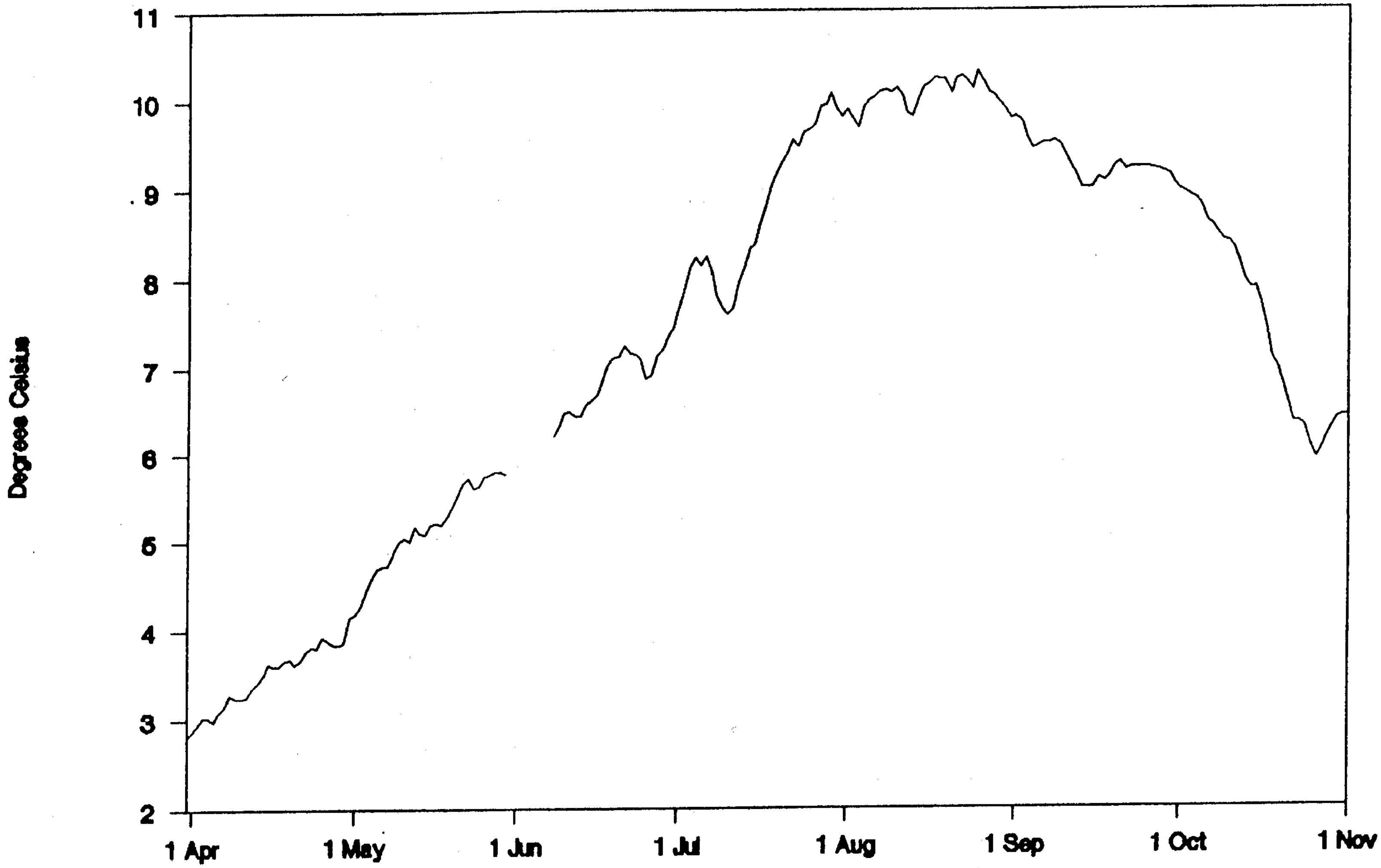



Figure 11. Daily average ocean temperatures while collectors were in the water from March 31 - November 1, 1989. Temperatures were taken in Trident Basin, 11 m below MLLW. (Data gap from May 30 - June 7 occurred while thermographs were being switched.)

Tanner crabs were collected primarily from three sites, all of which had silty or muddy bottoms. At site 7 near Holiday Island, also a mud bottom, thousands of Tanner crabs young of the year were observed in situ adjacent to the collector gear set there, yet only 94 Tanner crabs were found in the 24 collectors retrieved from this site. We believe that the collectors used in this study may not be optimal for assessing Tanner crab settling.

The type of benthic habitat, depth, and associated organisms in the collectors are not the sole determining factors of the abundance of red king and Tanner crabs to be found in the collectors. Ninety-nine percent of the Tanner crabs were from three sites and 86% of the king crabs were from four sites. Each of these sites had silty or muddy bottoms with varying degrees of shell hash, infaunal polychaete worm tubes, benthic macroscopic algae and associated assemblages of marine organisms. Conversely there were similar sites, which had few to no king or Tanner crabs present. When habitats are similar, other conditions such as winds, currents, and tides may play a major role in larval dispersement (Hebard 1959; Markov 1969; Haynes 1974; Kinder and Schumaker 1981; and Incze 1983). Sites 8 and 9, both in Middle Bay, were the only sites which had rocky and fine sand habitats. These sites yielded the least numbers of king and Tanner crabs. Sites 8 and 9 also produced the least number of taxa and organisms in the collectors, when compared to other sites. Too few sandy or rocky habitats were sampled to make conclusions on their usefulness as sampling sites. The depth range the collectors were placed in was fairly narrow, 6 to 21 m below MLLW. Most of the crabs were from collectors 14 to 21 m deep, yet a particular depth did not guarantee a certain abundance level of crabs. Young of the year red king crabs are known to occur in both shallower and deeper depths compared to those depths fished in this study (Powell and Nickerson 1965). In order to better define major settling depths, collectors could be placed both shallower and deeper than they were in this study. A correlation matrix could also be applied to the settlement of young of the year crabs with the various marine organisms found and other environmental data gathered to better understand any relationships which may exist as was done by McMurray et al. 1984, for juvenile red king crabs in Bristol Bay.

Longlining collector gear was easier and more efficient than deploying smaller number of collectors unmarked by buoys. Some gear was lost because it could not be located since they were not marked by buoys. Both the turf and broom collectors needed diver assistance; in both the deployment phase, to aright the collectors which landed on the bottom upside down; and in the retrieval phase to add a line and buoy for retrieval. Also, about half the turf and broom collectors were enclosed in large plastic woven bags on the bottom by divers to see if the number of crabs retained would be increased, but not enough sites had both bag and unbagged comparisons to ascertain the effectiveness of this method (Table 2). Having a larger number of collectors deployed, like the minnow traps or sausages, is advantageous for an increased area sampled and for more precise parameter estimation.

The collectors used in this study appear to be better suited to the settlement and collection of red king crab young of the year than Tanner crabs. In order to select a collector type for future studies aimed at predicting recruitments based on annual red king crab settlement, several factors besides numbers of crabs were evaluated including: volume of each collector type; cost and time to make each collector; and ease of handling, including time involved in the deployment and retrieval of the various collector types. On a per volume basis, minnow traps were the most efficient collector, with 7.4 to 8.1 young of the year red king crabs per $cm^3x10^{-5}$ (Table 8). They were two to four times more efficient than the other collectors and an order of magnitude greater than the pot collectors in this regard. Minnow traps also took the least time to procure; were one of the three fastest collectors to assemble; second lowest in cost and fastest collector to deploy, retrieve and wash, compared to the other collectors (Table 9). Minnow traps had several major drawbacks; most were not reusable due to excessive corrosion, and overall volume was too small. Plastic minnow traps would solve the metal traps corrosion problem but would not increase their small volume. Sausage collectors cost the least to construct and equaled the minnow traps in overall performance (Table 9); although they were only one third to one quarter as effective in the number of red king crabs they collected by volume (Table 8). The broom, turf, shell and pot collectors proved more expensive and time consuming to deploy and retrieve than the minnow traps and sausages. Also they were generally less productive in their collection of red king crabs on a per volume basis than the minnow traps and sausages. The pot collectors were the most efficient collector of Tanner crabs and may have greater application in an expanded study of the young for that species. Due to their overall high performance compared to the other collector types, and their reusability, the sausage collectors were selected as the best collector type to use in future settlement studies on red king crabs.

Table 8. Numbers of young of the year red king crabs $\leq$ 13 mm in carapace length found in collectors, and in relation to volume of collectors fished, Chiniak Bay, fall 1989.

| Gear Types | Volume/Unit cm$^3$ | Total Number of Units | Total Volume Fished (cm$^3$) | Total Crabs Collected | No./Volume (Crabs/cm$^3$x10$^{-5}$) |
|---|---|---|---|---|---|
| 1. **Minnow Traps:** | | | | | |
| blue netting | 10,000 | 39 | 390,000 | 29 | 7.43 |
| green netting | 10,000 | 37 | 370,000 | 30 | 8.10 |
| 2. **Sausages:** | | | | | |
| horizontal | 44,100 | 53 | 2,337,300 | 52 | 2.22 |
| vertical | 44,100 | 48 | 2,116,800 | 58 | 2.73 |
| 3. **Brooms** | 83,664 | 25 | 2,091,600 | 49 | 2.34 |
| 4. **Turfs** | 38,595 | 20 | 771,900 | 29 | 3.75 |
| 5. **Shells:** | | | | | |
| two trays | 62,208 | 4 | 248,832 | 8 | 3.21 |
| three trays | 51,840 | 3 | 155,520 | 0 | 0.00 |
| 6. **Small Pots** | 518,940 | 10 | 5,189,400 | 43 | 0.82 |
| 7. **Large Pots** | 864,000 | 17 | 14,688,000 | 114 | 0.77 |

Table 9. Estimated costs in time and money per individual crab collector used in Chiniak Bay, spring - fall 1989.

| Collector Type | Time to Procure Materials (min.) | Time to Make (min.) | Cost of Materials[a] ($) | Deployment, Retrieval & Sorting Time (min.) |
|---|---|---|---|---|
| 1. **Sausage** | 49 | 30-35 | 8 | 10 |
| 2. **Minnow Trap** | 30 | 30-40 | 20 | 7 |
| 3. **Shell** | 65 | 20-40 | 40 | 20 |
| 4. **Turf** | 80 | 75 | 63 | 45 |
| 5. **Pots** (small & large) | 105 | 180 | 109 | 25 |
| 6. **Broom** | 80 | 75 | 125 | 60 |

[a]Cost of labor is not included in this figure; but see the procurement time column from which labor costs could be calculated.

## LITERATURE CITED


Butman, C.A. 1987. Larval settlement of soft-sediment invertebrates: the spatial scales of pattern explained by active habitat selection and the emerging role of hydrodynamical processes. Oceanogr. Mar. Biol. Ann. Rev. 25:113-165.

Cairns, J. Jr. (ed.) 1982. Artificial substrates. Ann Arbor Sci. 279p.

Donaldson, W.E., R.T. Cooney and J.R. Hilsinger. 1981. Growth, age and size at maturity of Tanner crab, Chionoecetes bairdi M.J. Rathbun, in the northern Gulf of Alaska (Decapoda, Bachyura). Crustaceana 40(3):286-302.

Freese, L. and M. Babcock. 1990. The utility of artificial substrate collection devices to determine time and location of red king crab (Paralithodes camtschatica) glaucothoe settling in Auke Bay, Alaska. Pages 119-130 in Proc. Intl. King and Tanner Crab Symp., U. Alaska, Alaska Sea Grant Rpt. 90-014.

Gwyther, B.L. and D. Burgess. 1987. Larval settlement, juvenile growth and the potential use of spatfall indices to predict recruitment of the scallop Pecten alba Tate in Port Phillip Bay, Victoria, Australia.

Haynes, E.B. 1974. Distribution and relative abundance of larvae of king crab, Paralithodes camtschatica, in the southeastern Bering Sea, 1969-70. Fish. Bull. 732(3):804-812.

Hebard, J.F. 1959. Currents in southeastern Bering Sea and possible effects upon king crab larvae. U.S. Fish Wild. Serv., Spec. Sci. Rpt. Fish., No. 293.

Incze, L.S. 1983. Larval life history of Tanner crabs, Chionoecetes bairdi and C. opilio, in the southeastern Bering Sea and relationships to regional oceanography. Ph.D. diss., U. Wash.

Kinder, T.H. and J.A. Schmacher. 1981. Hydrographic structure over the continental shelf of the southeastern Bering Sea. Pages 53-76 in D.W. Hood and J.S. Calder, eds. The eastern Bering Sea shelf: oceanography and resources. U. Wash. Press, Seattle.

Little, E.J. and G.R. Milano. 1980. Techniques to monitor recruitment of postlarval spiny lobsters, Panulirus argus, to the Florida Keys. Florida Mar. Res. Publ. 37.

Markov, R.R. 1969. Transport and distribution of decapod larvae in the plankton of the western Kamtchatka shelf. Oceanology 9(12):251-261.

McCaughran, D.A. and G.C. Powell. 1977. Growth model for Alaska king crab (Paralithodes camtschatica). J. Fish. Res. Bd. Canada 34(7):989-995.

McMurray, G., A.H. Vogel, P.A. Fishman, D.A. Armstrong. 1981. Distribution of larval and juvenile red king crabs (Paralithodes camtschatica) in Bristol Bay. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 53(1986):267-477.

McMurray, G., A.H. Vogel, P. A. Fishman, D.A. Armstrong, and S. C. Jewett. 1984. Distribution of larval and juvenile red king crabs (Paralithodes camtschatica) in Bristol Bay. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 53(1986):479-878.

Pearson, W.H., D.L. Woodruff, and B.J. Higgins. 1984. Feeding ecology of juvenile king and Tanner crab in the southeastern Bering Sea. U.S. Dep, Commer., NOAA, OCSEAP Final Rep. 53(1986):155-265.

Phillips, B.F. 1986. Prediction of commercial catches of the western rock lobster Panulirus cygnus. Can. J. Fish. Aquat.Sci. 43:2126-2130.

Powell, G.C. and R.B. Nickerson. 1965. Aggregations among juvenile king crabs (Paralithodes camtschatica, Tilesius) Kodiak, Alaska. Animal Behav. 13,2-3:374-380.

Scheltema, R.S. 1974. Biological interactions determining larval settlement of marine species. Thalassia jugosl. 10:263-296.

Sundberg, K. and D. Clausen. 1979. Post-larval king crab (Paralithodes camtschatica) distribution and abundance in Kachemak Bay, Lower Cook Inlet, Alaska, 1976. Pages 747-766 in Proc. 29th Alaska Science Conference, Alaska Fisheries:200 Years and 200 miles of Change, B.R. Melteff (ed.) Sea Grant Rpt. 79-6.

Weber, D.D. 1967. Growth of the immature king crab Paralithodes camtshcatica (Tilesius). Intl. N. Pac. Fish. Comm., Bull. 21:21-53.

The Alaska Department of Fish and Game administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information please write to ADF&G, P.O. Box 25526, Juneau, AK 99802-5526; U.S. Fish and Wildlife Service, 4040 N. Fairfax Drive, Suite 300 Webb, Arlington, VA 22203 or O.E.O., U.S. Department of the Interior, Washington DC 20240.

For information on alternative formats for this and other department publications, please contact the department ADA Coordinator at (voice) 907-465-6077, (TDD) 907-465-3646, or (FAX) 907-465-6078.