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First-Year Indexing of Post-Larval Red King Crab Abundance by Use of Sausage-Shaped Artificial Collectors in Chiniak Bay, Alaska, 1990

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S. Forrest Blau

Susan C. Byersdorfer

Dana C. Schmidt

William E. Donaldson

and

B. Alan Johnson

State of Alaska Walter J. Hickel, Governor

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AUTHORS

S. Forrest Blau is a king crab research biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Region IV, 211 Mission Road, Kodiak, Alaska 99615-6399.

Susan C. Byersdorfer is a seasonal crab research biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Region IV, 211 Mission Road, Kodiak, Alaska 99615-6399.

William E. Donaldson is the crab research project leader for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Region IV, 211 Mission Road, Kodiak, Alaska 99615-6399.

Dr. Dana C. Schmidt was the regional research supervisor for the Alaska Department of Fish and Game, Division of Commercial Fisheries, Region IV, 211 Mission Road, Kodiak, Alaska 99615-6399. Currently he is the principal limnologist for the Alaska Department of Fish and Game, Fisheries Rehabilitation, Enhancement, and Development Division, 34828 Kalifornsky Beach Road, Soldotna, Alaska 99669-3150.

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ABSTRACT

The first year of a 5- to 10-year study to index abundance of postlarval red king crabs *Paralithodes camtschaticus* provided encouraging results. In the spring of 1990 sausage-shaped artificial collectors (SACs) were placed, using a systematic spatial sampling design, at 55 stations in Chiniak Bay, Kodiak Island, Alaska. At each station there were five horizontal and five vertically oriented SACs attached to a groundline on the bottom. One hundred and forty-three horizontal and 192 vertical SACs from 42 of the stations were recovered in the fall after soaking an average of 6 months. There were 1,393 red king crabs collected which were believed to be young of year, or age-0, based on their size; overall catch per unit of effort (CPUE) was 4.2 crabs per collector. The vertical collector CPUE was 5.3, and the horizontal collector CPUE was 2.6 crabs per collector. Mean carapace lengths of the age-0 crabs were 5.0 mm overall, 5.3 mm for the vertical SACs, and 4.1 mm from the horizontal SACs. We attributed greater CPUE and size of the age-0 crabs from the vertical SACs to hydroids on the vertical SACs which were absent on the horizontal SACs. CPUE of age-0 crabs on both collector types consistently increased by each decreasing depth group.

An index value of 5.18 (S.E. = 0.66) age-0 crabs was derived from the mean of the station means using vertical SACs only. This value will be compared to future abundances of adult red king crabs caught on Alaska Department of Fish and Game trawl surveys conducted in Chiniak Bay five or more years in the future to see if a correlation exits between settlement and adult abundances.

SACs were set at four additional sites to examine the time of settlement and rate of growth of the age-0 crabs. There were 59 glaucothoe larvae and 890 age-0 crabs collected from these SACs from June to December 1990. The majority of glaucothoe larval settlement occurred by the second week of June. The fifth instar was estimated to have a mean carapace length of 5.4 mm, which was close to the mean size of crabs collected from the vertical SACs during the index retrieval period of late September through October, indicating that the peak period of settlement may have been similar throughout Chiniak Bay.

KEY WORDS: Red king crabs, abundance indexing, artificial colectors, larvae, Kodiak, young of year

INTRODUCTION

In 1989 crab research biologists in the Division of Commercial Fisheries, Alaska Department of Fish and Game (ADF&G), in Kodiak built and tested seven different types of artificial collectors for their feasibility and cost effectiveness in collecting postlarval red king crabs *Paralithodes camtschaticus* and Tanner crabs *Chionoecetes bairdi*. After testing, the sausage-shaped artificial collectors (SACs)—so named because of their tubular shape and the fact that they contain stuffing—were chosen as the best all around collector to use future efforts to index postlarval crabs (Blau et al. 1990). Red king crabs settled on SACs, whereas thousands of age-0 Tanner crabs were observed by divers to occupy areas near the SACs at a site, but only one was taken in a SAC at that site (Blau et al. 1990).

After an effective artificial collector was developed for red king crabs, a long-term research plan was formulated: in 1990 SACs were set and retrieved in Chiniak Bay in the first of a 5-year study. An index value will be calculated each year. These values will be compared to the abundances of adult red king crabs caught on ADF&G trawl surveys in ensuing years. If a strong correlation is found, it could provide ADF&G and the commercial crab industry a longer period to plan and adjust to the fluctuating population levels. It could also enhance our understanding of factors affecting red king crab population abundance. Additional goals of this research were to (1) define the settling dates, growth increments, and molt frequencies of age-0 red king crabs; and (2) examine the crab collection efficiency of the horizontal versus vertical SACs.

METHODS

Chiniak Bay, located on the northeastern portion of Kodiak Island, Alaska, was selected as the study site (Figure 1) because commercial red king crab harvests have occurred there for more than 30 years. ADF&G has surveyed the bay annually for king and Tanner crabs using pots or trawls since 1971.

Collector and Gear Description

The outer "skin" of the SAC consisted of a 1.8-m long section of tubular polyethylene blue plastic netting having a stretch mesh of 16 mm. This netting is also made and used in Japan for artificial collectors used in collecting scallop spat (State Government of Alaska, Kodiak Area Native Association, and Overseas Fishery Cooperative Foundation of Japan 1989). Used herring gillnet was stuffed loosely into the "skin." One end was then tied with an overhand knot and the other was closed by a plastic reclosable pin. A tied piece of twine was fastened to a stainless steel longline snap and then looped through itself, on the stuffing side of the pin, to also keep the reopenable end of the SAC closed tight when deployed. The stuffed portion of the SACs averaged 83 cm long and 26 cm in diameter. Horizontal and vertical SACs were similar in design, except that a vertical SAC had an underwater float, a *plover* cork having 283 g of buoyancy, tied at one end and a snap on the other end. Horizontal SACs had no float, but a snap at each end. SACs were attached to a groundline by longline snaps.

A standard string of gear consisted of five vertical and five horizontal SACs in a row, each attached to a groundline at 2-m intervals (Figure 2). The 43-m long groundline was held to the bottom by a 18.2-kg Kedge anchor at each end, to which a buoy line trailed to the surface and connected to a 13x28-cm float. "ADF&G" was branded on the floats (Figure 2). Each buoy also had a reflective sticker attached which stated, "**Research Project** DON'T DISTURB THIS GEAR! NO CRAB POT ATTACHED *Alaska Dept. of Fish and Game* 486-4791."

In addition, most strings had a 38x14x18-cm plastic slotted tray filled 6 cm deep with butter clam *Saxidomus giganteus* shells. This type of artificial collector arrived too late in 1989 to be tested with the other experimental collectors so it was attached in the middle of the string of SACs and was tested for its usefulness as a postlarval crab collector. It also served as an additional weight at the mid point of the string. Two or three additional 1.5-kg weights were also attached to the groundline between the vertical SACs.

Sample Design

Juvenile red king crabs are known to settle in waters $\leq$27 m (Sundberg and Clausen 1979). The minimum depth that ADF&G's *RV/Resolution* (27 m long) could safely operate when working the collector gear was 6 m. Therefore, the southwestern portion of inner Chiniak Bay that conformed to the depth range of 6-27 m was identified as the study site. On nautical charts this area was marked off into a grid composed of squares 3/4 nmi per side. Potential indexing station locations were at the corner or midpoint of each square. A number of additional criteria existed for station placement: (1) there had to be at least one station per square; (2) selected squares had to be adjacent to each other, i.e., there could be no skipping of squares; and (3) areas of heavy vessel traffic or containing reefs were eliminated from possible station selection because of potential loss of gear. Using the above criteria, 55 permanent indexing stations were selected.

The first station was selected near the City of Kodiak; the remaining 54 stations were sequentially selected along inner Chiniak Bay proceeding in a southerly direction. These stations were divided into three geographic areas as follows: St. Paul Harbor (stations 1-12), Middle Bay (stations 13-32) and Kalsin Bay (stations 33-55; Figures 3, 4). In addition, four sites were selected for examining the time of settling of glaucothoe larvae and the growth of age-0 crabs (Figure 3). These four sites were given the following alpha designations: Sites A and B were within Trident Basin, Site C was outside the southern entrance to Trident Basin, and Site D was located to the south of the entrance to Gibson Cove (Figure 3). These sites were chosen for their easy access throughout the sampling period and their proximity to areas where collections of postlarval red king crabs were previously reported (Blau et al. 1990). Each site had 25 SACs on a goundline in a similar fashion as shown in Figure 2, except that the horizontal and vertical SACs were alternated.

Gear Placement

Strings of gear were set at the 59 stations from March 30 until April 25, 1990, using ADF&G's *RV/Coho*, *RV/Resolution*, and Kodiak High School's *K-Hi-C*. To assist in deploying the gear, each vessel carried at least three crewmen in addition to the skipper. Beginning with one end, each string of gear was deployed over the stern, as the vessel moved slowly forward. The opposite end of the string was held on deck to stretch the gear tight before releasing the remaining anchor overboard. Station locations were found by radar in conjunction with points of land (Figures 3, 4). Station locations were recorded by their distances from land reference points using radar (Appendix A).

Depths of the gear were initially measured with fathometers, and later modified, if necessary, by the depths recorded by scuba divers. All depths were adjusted to mean lower low water (MLLW).

A Ryan TempMentor[1] thermograph was placed 11 m below MLLW in Trident Basin to record ocean temperatures on an hourly basis. Bottom temperatures and salinities were recorded during most station visits using a YSI[1] model 33 S-C-T meter.

Scuba diving was used to observe as many indexing stations as possible. At each such station, the gear was inspected, and notes were taken on how it was fishing (i.e., gear as set, gear partially or wholly tangled, SACs off the bottom, etc.). Notes on the benthic habitat, substrate, predominant algae, and animals were also made. On nonrocky bottoms a sediment sample was taken in the middle of the gear by scooping or inserting a 250-ml jar into the surface layer of the bottom and capping it underwater. A few sediment samples were also obtained by using a LaMotte Chemical[1] bottom sample dredge which was deployed and retrieved from the surface.

Gear Retrieval

Scuba divers retrieved SACs from settling study sites. Two SACs, a vertical and horizontal, from each of the four settling study sites were retrieved biweekly from June to August; one SAC per site per sampling period was collected after that. The herring gillnet was removed from each retrieved SAC and washed in a 20-L container. Contents from the container were poured through a tray which had a 1-mm screen on its bottom. Red king crabs were either picked from the assorted marine life from a petri dish under a dissecting microscope when they were very small (<3 mm CL) or picked directly from the screen using tweezers if they were larger and easily seen. Carapace lengths of these king crabs were measured using an ocular micrometer in a dissecting scope.

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[1]Reference to trade names does not imply endorsement by ADF&G.

Gear from the indexing stations was retrieved from September 24 until October 30 using the *RV/Coho* and a crew of three to five people. Gear was retrieved with the assistance of hydraulics. Each string of gear at each indexing station was assigned one of the following station data quality codes:

0 = station string laid out on the ocean bottom as set; SACs spaced properly, and SAC bases ≤1 m off bottom (Figure 2); confirmed by divers; not tangled when retrieved;
1 = entire string of SACs when retrieved was as set but its condition on the bottom was not verified by divers;
2 = string had one or more SACs whose bases were ≥1 m off the bottom as observed by divers;
3 = all SACs tangled when retrieved, their number sequence when washed was arbitrary except that sequences 1-5 and 6-10 were assigned to either horizontal or vertical SAC style groups; one or more SACs may have their bases ≥1 m off the bottom;
4 = some SACs were tangled; others were fishing normally; one or more SACs in a string may also have had their bases ≥1 m off the bottom; and
5 = string of gear completely missing (not retrieved after repeated attempts to retrieve it) or due to technical difficulties, no useable data could be obtained from the string.

Upon retrieval each SAC was unsnapped from the groundline, and a numbered tag (1-10) was sequentially attached to each SAC which was recorded when washed. SACs were individually placed into a plastic garbage sack prior to being washed to prevent the escape of crabs onto the deck. During retrieval, the SAC type, vertical or horizontal, and condition code was recorded for each SAC:

0 = SAC in good condition (no rips, tears; not bunched-up);
1 = SAC had a small rip or tear in outer skin and/or ≤25% herring gillnet missing;
2 = SAC was processed but data not useable because net loss too great (>25%), or the SAC was bunched up, tangled, and not fishing correctly, or divers observed it covered by sand;
3 = SAC was not processed because it was missing or ripped and the netting was mostly gone;
4 = horizontal SAC off bottom ≥1 m as observed by divers and in good condition; therefore fishing similar to a vertical SAC.

To clean the SACs sea water was pumped through a deck hose, and all SACs were washed on a wooden sorting table. The table was divided into three sections so that three SACs could be separated from each other and simultaneously washed. The herring gillnet or clam shells from the collectors were removed and washed thoroughly. Crabs and other marine life were washed from each collector, passing through a hole in the bottom of the table section onto a removable section drawer. The bottom of the drawers had a 1-mm square plastic screen stapled to them supported by an 8-mm square metal screen. Red king and Tanner crabs were picked from the assorted marine life collected on the drawers, measured with Vernier calipers to the nearest 0.1 mm, and recorded by individual collector. The thickness of the tips of the outside jaws on the calipers were ground down to fit between the narrow eye orbits of the age-0 red king crabs. Once measured the crabs were released overboard. Crabs were not sexed because it would have required examining them under a microscope. Carapace length (CL) of each king crab was measured from the rear of the right eye socket to the midpoint of the posterior margin of the carapace. Tanner crab carapace widths (CW) were measured laterally across the carapace at its point of greatest width.

Two SACs were selected from each string of indexing gear; the marine life from these were identified and counted by the lowest taxa possible.

Data Analysis

Guidelines for size-at-age data for red king crabs was taken from McCaughran and Powell (1977) and from Donaldson et al. (1981) for Tanner crabs.

Only strings of SACs that were known or assumed to have fished properly (stations having quality codes of 0 or 1) and SACs in good shape (condition codes 0 and 1) were used in hypothesis testing. Using a two-stage sample design (Cochran 1977) the strings of SACs at the indexing stations were the primary units and the SACs on the strings were the subunits. The 10 SACs were a linear arrangement of observations; a variance estimate for the second stage was used that performs better under these conditions (Wolter 1984). Mean squared error was used for the variance at the first stage.

Let:

n = number of primary units sampled,

m_i = number of subunits sampled in the ith primary unit,

y_{ij} = value obtained for the jth subunit in the ith primary unit,

$\bar{y}_i = \sum_{j=1}^{m_i} \frac{y_{ij}}{m_i}$ = sample mean per subunit in the ith primary unit,

$$s_1^2 = \sum_{i=1}^{n} \frac{(\bar{y}_i - \bar{\bar{y}})^2}{n-1} \quad \text{, and}$$

$$s_{2i}^2 = \sum_{j=2}^{m_i} \frac{(y_{ij} - y_{i,j-1})^2}{2(m_i - 1)} \quad .$$

An unbiased estimate of the overall mean was provided with

$$\bar{\bar{y}} = \sum_{i=1}^{n} \frac{\bar{y}_i}{n} \quad .$$

The variance of the overall mean was provided with

$$var(\bar{\bar{y}}) = \frac{1}{n} s_1^2 + \frac{1}{n} \sum_{i=1}^{n} \frac{s_{2i}^2}{n m_i} \quad .$$

To determine if one type of gear fished better than the other, we tested whether the mean counts were significantly different for vertical versus horizontal alignment.

RESULTS

We dove on and examined 36 of the 55 indexing stations (Appendix A). Based on diving and retrieval observations (Appendix A), 42 strings of gear out of 55 (76%) contributed data for analysis; 11 strings of gear were missing and 2 had technical problems resulting in no useable data (Table 1). Of the 42 strings, 18 were set and fished as intended (Figure 2); 5 strings when retrieved seemed to have been fished as intended, but the location of the SACs in relation to the bottom was not verified by divers. The remaining 19 strings of gear had either one or more SACs off the bottom (≥1 m), had one or more SACs tangled with adjacent ones, or both.

Of the 42 indexing strings retrieved, 335 SACs (80%) were in good condition or had only a small rip in them, codes 0 and 1 (Table 2; Appendix B). This group was used in most of the data analyses. The remaining 85 (20%) SACs from these strings were assigned condition codes 2-4, the largest these groups where SACs that were missing, code 4 (Table 2). SACs having quality codes of 2-4 were not used in data analysis.

Although we were interested in an overall test of gear performance for the total area sample, the estimates for mean, variance, and the *t*-statistic for each string of gear are provided in Table 3. These provide a picture of each string. The critical two-tailed *t*-value ($\alpha = 0.05$, $df = 8$) is 2.306 for strings that had no missing or damaged collectors. The *t*-statistic was not significant for all strings but a pattern does exist. All but four were negative because the mean count for vertical SACs was larger than for horizontal SACs. The test statistics do not take into account the two-stage sampling.

The estimate for the overall mean of age-0 crabs for horizontal SACs was 3.20 and 5.34 for vertical SACs from the 19 stations analyzed (Table 3).

The estimated standard error for horizontal SACs was 0.940 and for the vertical SACs, 1.013. The one-tailed *t*-statistic for the test of a larger mean for vertical SACs was 1.55, significant at $\alpha = 0.1$. Therefore, vertical SACs collected more age-0 crabs than horizontal SACs. Even though the variance estimates included the second-stage variance, there was a pattern of a significant difference in the gear.

There were 1,457 red king crabs collected from 344 SACs taken from the 42 indexing strings of gear (Tables 2, 4). Their carapace lengths ranged from 3.0 mm to 20.8 mm. We used the following size-age classes for red king crabs: age-0 crabs ≤7.5 mm CL; age-1 crabs >7.5 to <20.0 mm CL; and age-2 crabs ≥20.0 mm CL. There were 1,411 (97%) age-0 crabs; 45 (3%) age-1 crabs; and 1 age-2 crab (<1%; Table 5; Figure 5). The number of age-0 crabs collected per site varied from 2 at Station 32 to 141 at Station 4 (Table 5). Likewise, the number of age-1 crabs per site varied from 0 at 25 stations to 11 at Station 50. There was 1 age-2 red king crab collected at Station 45 and 1 age-0 Tanner crab collected at Station 44. The number of crabs collected by size-age groups, SAC type, and station is documented in Appendix B.

The number of age-0 red king crabs per SAC ranged from 0 to 36 (Table 6; Figure 6). Seventy-eight percent of the SACs contained one or more age-0 crabs, and 75% contained one to seven age-0 crabs.

Vertical SACs composed 57% or 192 of the 335 SACs retrieved, whereas the total number of age-0 red king crabs in these collectors was 73%, or 1,016 of the 1,393 total crabs collected (Table 7). The overall mean number of age-0 red king crabs from vertical SACs was 5.34, this was significantly ($\alpha = 0.1$) larger than the overall mean for the horizontal SACs of 3.20 from the 19 strings compared in Table 3.

Mean carapace length by station for age-0 crabs in the vertical SACs was greater at every station compared to those found in the horizontal SACs (Table 7). Mean carapace lengths for age-0 crabs at all stations by gear type were 4.1 mm for horizontal SACs, 5.3 mm for vertical SACs, and 5.0 mm for all SACs combined (Table 7).

The depths from which SACs were retrieved ranged from 7 to 27 m below MLLW (Table 8). The number of SACs fished at any particular 1-m interval ranged from 3 to 47; at 15 of the 19 depth-intervals, 10 or more SACs were fished (Table 8). We did not retrieve SACs from 8 m or 11 m. The number of age-0 red king crabs collected by 1-m depth intervals varied from 4 to 242; these numbers were effected by the number of SACs retrieved from a particular depth and their catch per unit of effort (CPUE) at each depth. CPUE ranged from 0.9 at 27 m to 11.7 at 12 m.

CPUE of age-0 red king crabs generally increased with decreasing depth (Table 8). CPUE of these crabs was summarized in three depth groups by SAC type (Table 9). The relation of increasing CPUE by decreasing depth held for both horizontal and vertical SACs and their combined CPUE means at each of the three depth groupings (Table 9). The overall CPUE for all depths was 2.6 crabs for the horizontal SACs, 5.3 for the vertical SACs, and 4.2 overall (Table 9). The number of SACs retrieved from the 7- to 12-m depth range represented 9% of the effort but accounted for 18% of the age-0 crabs. The SACs in the 13- to 20-m range composed 57% of the effort and 66% of the age-0 crabs. The deepest grouping, 21 to 27 m, accounted for 34% of the SACs retrieved but only 16% of the number of age-0 crabs (Table 9).

When the sampling area was divided into three adjacent geographic areas, St. Paul Harbor, Middle Bay, and Kalsin Bay, the same trend of increasing CPUE of age-0 red king crabs with decreasing depth by SAC type was generally maintained (Table 10). The percentage of SACs retrieved and percentage of age-0 crabs collected by area was, respectively, 21% and 23% in St. Paul Harbor, 37% and 23% in Middle Bay, and 41% and 53% in Kalsin Bay (Table 10). Therefore, the percentage of age-0 crabs was nearly proportional to the amount of gear retrieved in St. Paul Harbor, less in Middle Bay, and greatest in Kalsin Bay (Table 10). CPUE of age-0 crabs was 2.6 for Middle Bay, 4.5 for St. Paul Harbor, 5.4 for Kalsin Bay, and 4.2 overall.

SACs Used to Study Settling and Growth

Age-0 postlarval red king crabs were collected over 11 sampling periods from June 1 to December 4, 1990. There were 949 age-0 crabs collected, of which 59 (6%) were glaucothoe larvae and 891 (94%) were of various sized instars (Table 11). Glaucothoe larvae were present only in the June sampling periods; 92% were taken in the June 14 sample. Peak CPUE of the postlarval red king crabs occurred in July. The fifth instar was estimated to have a mean carapace length of 5.41 mm. Complete analysis of this growth data is found in Donaldson et al. (1992).

Unprocessed Data

Other data collected but not reported herein include bottom types, habitat descriptions, bottom water temperature and salinity readings taken during station visits, continuous water temperature records taken in Trident Basin, growth of postlarval crabs in SACs, and relative abundance of hydroids and miscellaneous species at each station. Other commercial species found in the SACs included pandalid shrimp, green sea urchins *Strongylocentrotus droebachiensis*, and pink scallops *Chlamys* spp.

DISCUSSION

The number of age-0 crabs collected in 1990 with the SACs exceeded the numbers caught by mechanical or artificial collectors in previous studies (Weber 1967; Sundberg and Clausen 1979; McMurray et al. 1981, 1984; Pearson, Woodruff, and Higgins 1984; Freese and Babcock 1990; Blau et al. 1990). SACs appear to be a good method to collect postlarval red king crabs but not Tanner crabs. No Tanner crabs *C. bairdi* were collected from 110 SACs in 1989 (Blau et al. 1990), and only one was collected from 338 SACs in 1990.

The 1990 index value will be used, as will future index values, to determine whether a correlation exits between the abundance of age-0 crabs and subsequent recruitment levels of mature red king crabs caught on annual ADF&G trawl surveys within Chiniak Bay. Commercial red king crab harvest has been closed in the Kodiak Management Area since 1982 because of the depressed population levels. Below-average recruitment of juvenile red king crabs ($\leq$94 mm CL) has occurred since 1978. Depressed populations of red king crabs may not yield high enough variation in annual index values to adequately test this method. There have been only a few successful studies that related year class settlement levels of commercial shellfish species to subsequent levels of recruitment (Sause et al. 1987; Phillips 1986).

The presence and abundance of hydroids *Obelia* sp. on the gear had a large and unexpected affect on this study. Hydroids settled and grew only on vertical SACs and buoy lines. One reason for the number of age-0 crabs on the vertical SACs being twice that of the horizontal SACs we attributed to the presence of hydroids. Hydroids increased crab habitat on the vertical SACs and may have provided increased protection from cannibalism or predation. Hydroids also provide additional food sources for age-0 crabs, (Feder et al. 1980; Feder and Paul 1980; Feder and Jewett 1981; Pearson et al. 1984) and a habitat for those organisms (food sources) to live on. Hydroids probably settled on horizontal SACs but did not grow because the SACs rolled on the bottom and broke the hydroids off. In addition hydroids on the horizontal SACs were closer to benthic predators than were the hydroids living on the vertical SACs. Hydroids caused additional drag on the buoy lines causing them to bow and consequently many strings were not recovered because the buoys were continually submerged (Table 1, Appendix A). Based on visual observations the hydroid densities on the gear in Kalsin Bay were consistently greater than in either St. Paul Harbor or in Middle Bay (Figure 7). Compared to St. Paul Harbor or Middle Bay, Kalsin Bay had both the best return of age-0 crabs in relation to the amount of gear retrieved, and it had the highest CPUEs in the 13-27 m depth ranges (Table 9). These facts may be directly attributable to the higher densities of hydroids on the vertical SACs.

Scuba diving enabled us to verify much of the data collected for this report. In particular, it was indispensable for observing how SACs were fishing. Many vertical SACs were off the bottom ≥1m; this would not have been known otherwise. That information proved important in building the database which revealed the correlation between the CPUE of age-0 crabs and depth. Observations made while diving also revealed that horizontal SACs experienced higher losses than vertical SACs because of the greater contact and abrasion on rocky substrates that were often covered with barnacles. The amount of diving on the index stations is expected to decrease markedly in the future due to gear improvements and the amount of bottom habitat information gathered in 1990.

The 1990 results will effect several changes in the 1991 gear deployed, although the 55 indexing stations will remain the same. Because vertical SAC CPUE exceeded the horizontal SAC CPUE by approximately 2:1 for the age-0 red king crabs and fewer were destroyed by barnacles, the vertical SACs will be used exclusively, five per string, spaced 2 m apart. Each plover cork in the vertical SAC will be cut in half to reduce their underwater buoyancy, and a 1.4-kg lead weight will be attached to the groundline below each vertical SAC. This will allow these collectors to remain vertical but anchored slightly above the bottom. An additional larger buoy will be added on each buoy line for 1991 to counteract the additional drag on lines caused by hydroids. This should enable more strings of gear to be found and retrieved in 1991. In addition, several strings of ancillary gear will be deployed to test the collection rates of age-0 crabs in depths shallower and deeper than the standard indexing stations. Strings of some SACs used solely to determine growth of the postlarval crabs will be designed so that they can be retrieved without diving.

There are at least two design changes that might be worth testing in the future. Deploying gear in depths <7m could be attempted because a significant percentage of red king crab settlement may occur there. Also the size and shape of the SACs could be enlarged or changed because they are only confined in width by the size of the tubular outer skin netting. For example sections of this tubular netting many meters long could be stuffed with used herring gillnet as could much larger net bags. Larger SACs may provide additional numbers of crabs for indexing purposes. The successful indexing of western rock lobsters from settled larvae has occurred from 9 years data collected from one site containing six collectors (Phillips 1986).

In 1989, even though 101 SACs were retrieved, only age-0 crabs were taken in the gear (Blau et al. 1990). In 1990, although no SACs were retrieved prior to June because a boat was not available to get to the gear, Glaucothoe larval settlement in SACs was documented for the first time. In addition to settling on the SACs, these crabs continue to molt and grow in these collectors. Because information on age-0 crab growth was important, the collection rate of SACs was slowed and spread over a year from initial settlement, i.e., June 1990 - June 1991.

Red king crabs appeared to settle fairly uniformly, both temporally and spatially throughout the study area. At the settlement growth study sites most glaucothoe larvae were found on SACs in mid-June. By mid-October the instars at both the settlement growth sites and the indexing stations had mean carapace lengths within 1 mm of each other, indicating that the settlement and growth rates were probably similar throughout Chiniak Bay. From 335 SACs the coefficient of variation of catch rate (number of crabs/SAC) was 1.13 for age-0 crabs, indicating a fairly uniform distribution. By comparison, from nine tows made on the ADF&G crab survey in Chiniak Bay in 1990, the coefficient of variation of catch rate was 1.61 (crabs/nmi towed), indicating a more clumped distribution for the older (>age-4) red king crabs.

Index strings of vertical SACs are to be retrieved in future years when most of the age-0 crabs have developed to the fifth instar stage. In 1990 the mean size of the age-0 crabs from the vertical SACs was very close to the estimated size of the fifth instar stage. Known sources of interannual variation in the time when red king crab larvae reach a particular instar include hatch periods, density, synchrony of hatching with the spring phytoplankton bloom, length of time in the water column, and survival rates (McMurray et al. 1984; Shirley and Shirley 1989). Therefore, setting the 55 indexing stations by April of each year and pulling them in October may not be sufficient to ensure comparable index values from year to year. To meet this objective collectors deployed for examining growth will be used to indicate the timing of retrieval of the indexing gear based on the presence of the fifth instar as the predominate instar stage. Variation in index values may also be caused by gear improvements, deploying gear at slightly different depths at some indexing stations, and by differential losses of gear from storms, excessive hydroids, or vessel traffic.

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Table 1. Fishing condition of the 55 indexing strings of gear which used sausage-shaped artificial collectors to sample postlarval red king crabs in Chiniak Bay, Alaska, 1990.

Condition of String	Quality Code	Number of Strings	Percent
As Set Observed With Scuba	0	18	33
As Set Not Observed With Scuba	1	5	9
One or More SACs >1 m Off Bottom	2	8	14
All SACs Tangled	3	5	9
Some SACs Tangled	4	6	11
Missing/Lost	5	13	24
Totals		55	100

Table 2. Sausage-shaped artificial collector conditions from 42 strings of gear retrieved in the postlarval red king crab indexing study in Chiniak Bay, Alaska, 1990.

SAC Condition	Quality Code	Number of SACs Horizontal	Vertical	Total	Percent
Good	0	136	179	315	75
Small Rip	1	7	13	20	5
Not Useable	2	4	2	6	1
Missing	3	60	16	76	18
Horizontal Off Bottom	4	3	0	3	1
Totals		210	210	420	100

Table 3. Pair-wise test of difference in mean number of age-0 red king crabs between vertical and horizontal style sausage-shaped artificial collectors in Chiniak Bay, Alaska, 1990.

Index Station	t'	Horizonal			Vertical		
		$\bar{y}$	s_2^2	m_i	$\bar{y}$	s_2^2	m_i
2	-2.73	2.200	1.750	5	8.000	20.875	5
4	-0.77	12.000	7.750	5	16.200	140.125	5
5	-1.41	3.200	7.875	5	5.200	2.250	5
6	-2.50	1.000	2.000	2	3.750	0.833	4
7	-1.26	0.000	0.000	5	0.400	0.500	5
12	-4.55	1.400	1.875	5	5.000	1.250	5
21	-1.31	0.250	0.333	4	1.500	3.333	4
23A	-0.27	2.600	7.875	5	3.000	3.125	5
24	0.20	2.600	1.375	5	2.400	3.625	5
25	-7.41	0.400	0.375	5	6.600	3.125	5

Index Station	t'	Horizontal			Vertical		
		$\bar{y}$	s_2^2	m_i	$\bar{y}$	s_2^2	m_i
26	-3.77	0.250	0.333	4	3.000	2.250	5
29	-0.98	0.400	1.000	5	1.000	0.875	5
38	-1.68	2.200	3.375	5	4.400	5.250	5
43	0.26	12.500	112.500	2	10.400	45.750	5
44	-1.61	2.600	5.250	5	6.800	28.750	5
48	-4.09	4.200	4.500	5	12.400	15.625	5
50	1.06	4.400	7.375	5	3.000	1.375	5
52	0.74	6.800	12.500	5	5.333	4.250	3
55	-1.34	1.800	2.125	5	3.000	1.875	5

Table 4. Length frequency of all red king crabs collected from 42 strings of indexing gear, including all sausage-shaped artificial collectors regardless of condition, Chiniak Bay, Alaska, 9/24 to 10/30/91.

Carapace Lengths (mm)	No. Crabs	Carapace Lengths (mm)	No. Crabs	Carapace Lengths (mm)	No. Crabs
3.0	2	5.6	65	11.4	2
3.3	4	5.7	74	11.5	1
3.4	7	5.8	66	11.6	2
3.5	8	5.9	41	11.7	1
3.6	24	6.0	54	11.8	1
3.7	44	6.1	39	12.0	2
3.8	43	6.2	44	12.1	2
3.9	44	6.3	25	12.3	1
4.0	47	6.4	19	12.4	2
4.1	49	6.5	16	12.5	2
4.2	59	6.6	7	12.6	1
4.3	70	6.7	5	12.7	1
4.4	52	6.8	1	12.8	1
4.5	81	6.9	3	13.0	2
4.6	72	7.0	2	13.1	3
4.7	47	7.4	1	13.5	2
4.8	43	9.1	1	13.6	1
4.9	32	10.0	1	14.0	1
5.0	36	10.1	1	14.1	1
5.1	29	10.2	1	14.2	1
5.2	32	10.4	1	14.4	1
5.3	25	10.6	1	14.8	1
5.4	39	11.1	2	16.5	1
5.5	60	11.3	3	17.0	1
				20.8	1
				TOTAL =	1,457

Table 5. Age compostion of red king and Tanner crabs by station from all sausage-shaped artificial collectors retrieved from the first year of postlarval crab indexing in Chiniak Bay, Alaska, 9/24 to 10/30/90.

Station	Number of Crabs				Station	Number of Crabs			
	Red King			Tanner		Red King			Tanner
	Age: 0	1	2	0		Age: 0	1	2	0
2	51	0	0	0	27	41	4	0	0
3	11	0	0	0	28	35	1	0	0
4	141	0	0	0	29	7	1	0	0
5	42	5	0	0	30	4	0	0	0
6	17	0	0	0	32	2	0	0	0
7	2	0	0	0	33	9	1	0	0
9	11	0	0	0	34	15	0	0	0
10	4	0	0	0	35	36	0	0	0
11	12	0	0	0	38	33	1	0	0
12	32	0	0	0	39	38	0	0	0
14	20	0	0	0	41	23	3	0	0
17	36	0	0	0	42	84	4	0	0
18	4	1	0	0	43	85	0	0	0
19	3	1	0	0	44	47	2	0	1
20	48	2	0	0	45	61	0	1	0
21	7	0	0	0	46	38	4	0	0
22	12	0	0	0	48	83	1	0	0
23	28	2	0	0	50	37	11	0	0
24	25	0	0	0	52	50	0	0	0
25	35	0	0	0	53	102	1	0	0
26	16	0	0	0	55	24	0	0	0
					Totals:	1,411	45	1	1

Table 6. Frequency of occurrence of age-0 red king crabs in sausage-shaped artificial collectors from Chiniak Bay, Alaska, 9/24 to 10/30/90. Data was derived from 42 indexing strings using only collectors that had a condition code of 0 or 1.

No. Age-0 Crabs Per Collector	No. of Occurrences
0	76
1	51
2	27
3	32
4	26
5	24
6	34
7	12
8	10
9	9
10	2
11	6
12	2
13	6
15	5
16	3
17	3
18	1
19	2
20	1
22	1
23	1
36	1
	335

Table 7. Number of horizontal and vertical sausage-shaped artificial collectors having data condition codes of 0 or 1, number of red king crabs they collected, and mean carapace lengths of crabs.

Station	No. Collectors			No. Age-0 King Crabs			Mean CL (mm)		
	Hor.	Vert.	Total	Hor.	Vert.	Total	Hor.	Vert.	Total
2	5	5	10	11	40	51	4.2	5.2	5.0
3	0	4	4	0	11	11		5.9	5.9
4	5	5	10	60	81	141	4.3	5.0	4.7
5	5	5	10	16	26	42	3.9	4.5	4.3
6	2	4	6	2	15	17	4.3	5.2	5.1
7	5	5	10	0	2	2		4.4	4.4
9	0	5	5	0	11	11		4.7	4.7
10	0	4	4	0	4	4		5.9	5.9
11	0	3	3	0	12	12		6.1	6.1
12	5	5	10	7	25	32	5.0	5.3	5.2
14	0	3	3	0	20	20		5.5	5.5
17	0	5	5	0	36	36		5.8	5.8
18	5	5	10	0	4	4		4.8	4.8
19	5	3	8	2	1	3	4.8	6.1	5.2
20	4	5	9	2	46	48	4.3	5.4	5.4
21	4	4	8	1	6	7	3.7	5.4	5.2
22	0	5	5	0	12	12		5.9	5.9
23	5	5	10	13	15	28	4.6	5.7	5.2
24	5	5	10	13	12	25	4.0	5.8	4.9
25	5	5	10	2	33	35	4.2	5.7	5.6
26	4	5	9	1	15	16	4.3	5.4	5.4
27	4	5	9	22	19	41	3.8	5.3	4.5
28	5	5	10	2	33	35	4.9	5.5	5.5
29	5	5	10	2	5	7	3.9	5.3	4.9
30	4	5	9	0	4	4		4.3	4.3
33	5	5	10	1	8	9	5.0	5.9	5.8
34	0	4	4	0	15	15		5.9	5.9
35	1	5	6	0	32	32		6.1	6.1
38	5	5	10	11	22	33	4.1	5.4	4.9
39	0	5	5	0	38	38		5.5	5.5
41	4	5	9	5	18	23	4.7	5.2	5.1
42	4	5	9	19	61	80	4.0	5.4	5.1
43	2	5	7	25	52	77	4.2	5.2	4.9
44	5	5	10	13	34	47	3.7	4.7	4.4
45	5	5	10	28	33	61	4.2	5.9	5.1
46	5	5	10	10	28	38	3.8	5.3	4.9
48	5	5	10	21	62	83	4.2	5.2	4.9
50	5	5	10	22	15	37	4.3	5.0	4.6
52	5	3	8	34	16	50	3.9	4.5	4.1
53	5	5	10	23	79	102	4.1	4.7	4.5
55	5	5	10	9	15	24	4.0	5.7	5.1
Totals	143	192	335	377	1,016	1,393	4.1	5.3	5.0

Table 8. Numbers of sausage-shaped artificial collectors by depth, numbers of age-0 red king crabs collected, and the resulting CPUE. Data is from 42 strings of gear having condition codes for the collectors of 0 or 1, Chiniak Bay, Alaska, 9/24 to 10/30/91.

Depth (m)	No. Collectors	Age-0 Kings	CPUE
7	3	24	8.0
9	3	24	8.0
10	11	38	3.5
12	14	164	11.7
13	23	116	5.0
14	47	242	5.1
15	22	109	5.0
16	35	208	5.9
17	17	35	2.1
18	23	113	4.9
19	4	4	1.0
20	20	98	4.9
21	16	59	3.9
22	20	71	3.6
23	10	7	0.7
24	12	25	2.1
25	29	30	1.0
26	18	19	1.1
27	8	7	0.9
Totals	335	1,393	4.2

Table 9. CPUE of age-0 red king crabs, by depth groupings for vertical and horizontal sausage-shaped artificial collectors retrieved in the fall of 1990, Chiniak Bay, Alaska. Data is from 42 strings of gear retrieved having condition codes of 0 or 1.

Depth	CPUE of Age-0 Red King Crabs			% SACs	% Age-0 Red
Meters	Horizontal	Vertical	Mean	Retrieved	King Crabs
7 to 12	5.6	9.4	8.0	9	18
13 - 20	3.3	6.0	4.9	57	66
21 - 27	1.0	2.7	1.9	34	16
Totals	2.6	5.3	4.2	100	100

Table 10. Number and CPUE of age-0 red king crabs collected by vertical (V) and horizontal (H) sausage-shaped artificial collectors by location and depth group, Chiniak Bay, Alaska, 9/24 to 10/30/90. Data is from 42 strings of gear retrieved having condition codes for the collectors of 0 or 1.

Depth Meters	St. Paul Harbor		Middle Bay		Kalsin Bay		All Areas Combined		
	V	**H**	**V**	**H**	**V**	**H**	**V**	**H**	**Overall**
7 to 12									
Mean Age-0	16.2	12.0	6.8	0.4	7.3	0	9.4	5.6	8.0
SD	12.9	5.2	2.1	0.5	2.9	NA	7.5	6.9	
No. Collectors	5	5	6	5	9	1	20	11	31
13 - 20									
Mean Age-0	4.4	2.1	4.8	2.0	8.5	4.8	6.0	3.3	4.9
SD	3.2	2.1	4.2	2.2	6.1	4.5	5.0	3.7	
No. Collectors	30	17	42	27	39	36	111	80	191
21 - 27									
Mean Age-0	1.3	0	0.9	0.2	4.6	2.0	2.7	1.0	1.9
SD	1.3	0	1.1	0.5	2.5	2.0	2.6	1.7	
No. Collectors	10	5	22	23	29	24	61	52	113
All Depths									
Mean Age-0	5.0	3.6	3.7	1.1	6.9	3.6	5.3	2.6	4.2
SD	6.3	4.9	3.9	1.8	5.0	3.9	5.2	3.7	
No. Collectors	45	27	70	55	77	61	192	143	335
Summary by Location									
Mean CPUE:	**4.5**		**2.6**		**5.4**		**4.2**		
No. (%) Age-0 Crabs	**324 (23.2%)**		**325 (23.3%)**		**744 (53.4%)**		**1,393 (100%)**		
No. (%) Collectors	**72 (21.4%)**		**125 (37.3%)**		**138 (41.2%)**		**335 (100%)**		

Table 11. Numbers of red king crab glaucothoe larvae (G) and older instars (I) from sausage-shaped artificial collectors at Sites A through D, used to study the settlement period and growth of the crabs, inner Chiniak Bay, Alaska, 1990.

Retrieved[a]:	6/1	6/14	6/14	6/28	6/28	7/13	7/26	8/10	8/23	9/7	9/21	10/16[b]	12/4	TOTAL	
Crab Form:	G	G	I	G	I	I	I	I	I	I	I	I	I	G	I
No. Crab	4	60	34	1	77	165	217	116	98	46	32	49	51	59	891
Collectors	8	8	8	8	8	8	9	8	8	4	4	4	4	73	
CPUE	0.5	7.5	4.3	0.1	9.6	20.6	24.1	14.5	12.2	11.5	8.0	12.3	12.8	0.8	12.2

[a] From June 1 to August 23, 1990, one vertical and one horizontal SAC, were taken from Sites A-D; however, an extra vertical collector was also taken from Site D on July 26. One collector was retrieved per site from September 7 to October 16; however, on December 4 two collectors were retrieved from Site A and none from Site B.

[b] The 19 stations used in the calculation of the index value were retrieved from September 25 to October 29, 1990.

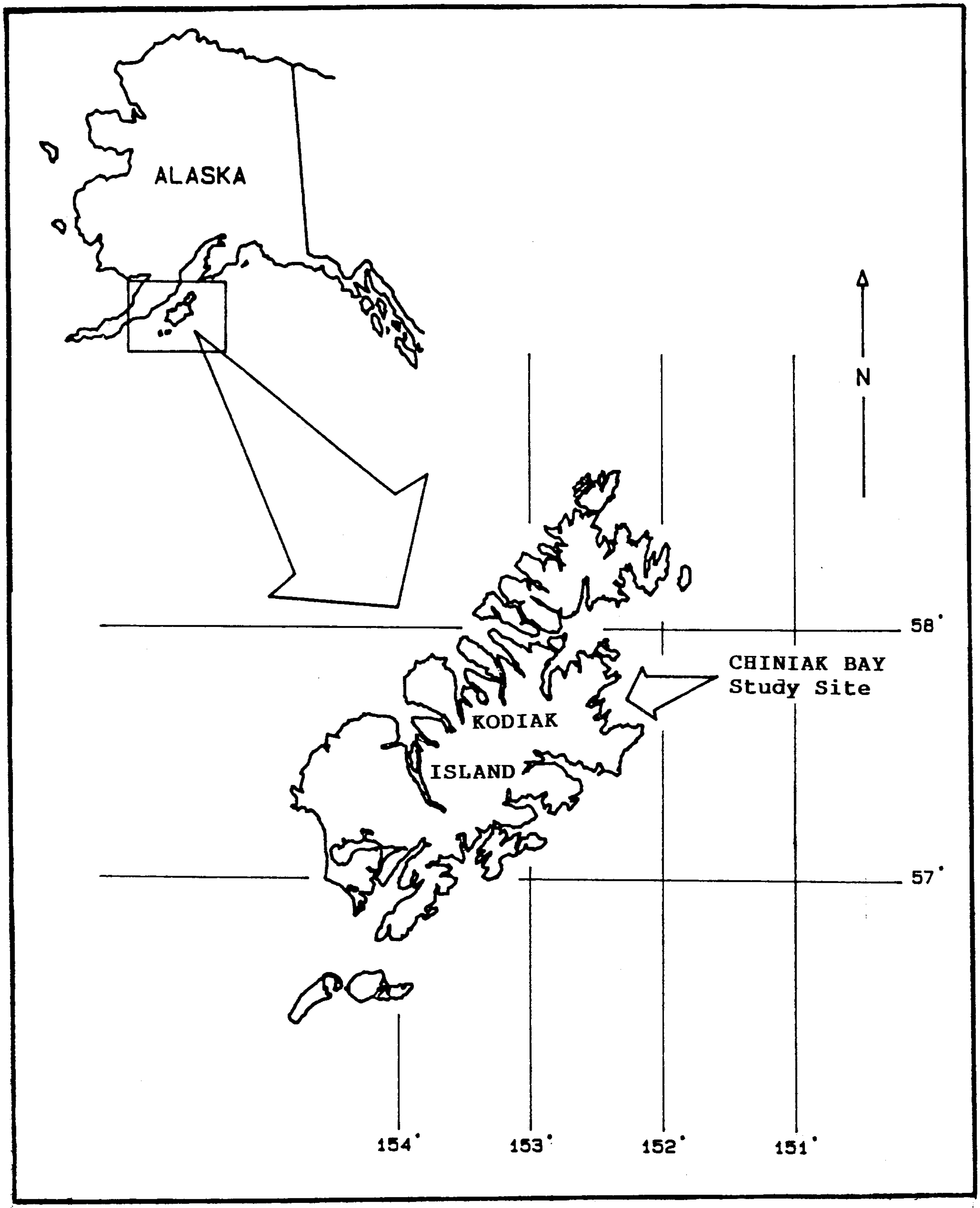

Figure 1. Chiniak Bay on the northeastern portion of Kodiak Island, the 1990 site of postlarval red king crab indexing by the Alaska Department of Fish and Game using sausage-shaped artificial collectors.

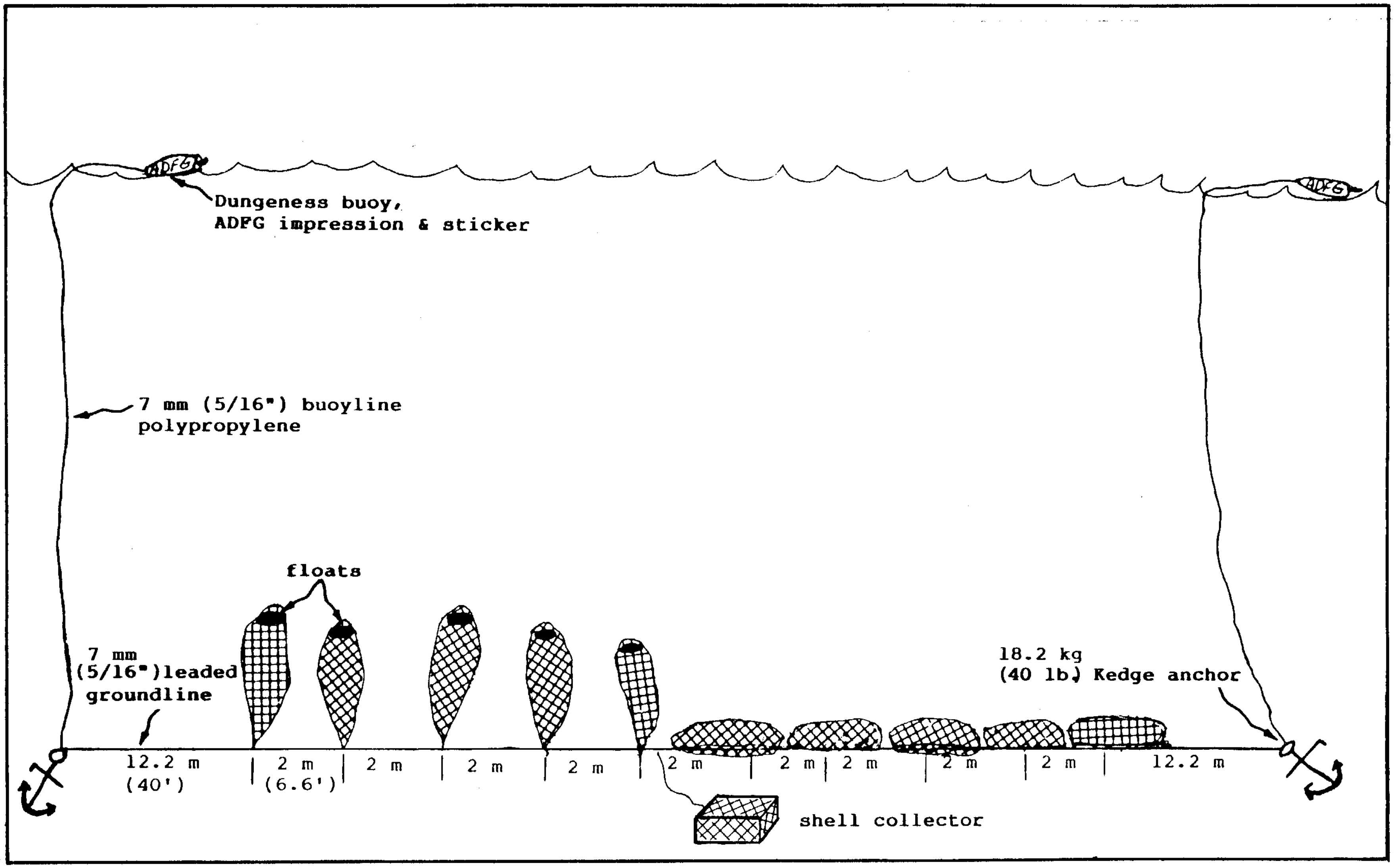

Figure 2. Gear deployment at a postlarval red king crab indexing station in Chiniak Bay, Kodiak Island, Alaska in 1990. Five vertical sausage-shaped artificial collectors are followed by five horizontal collectors; a shell collector is between them.

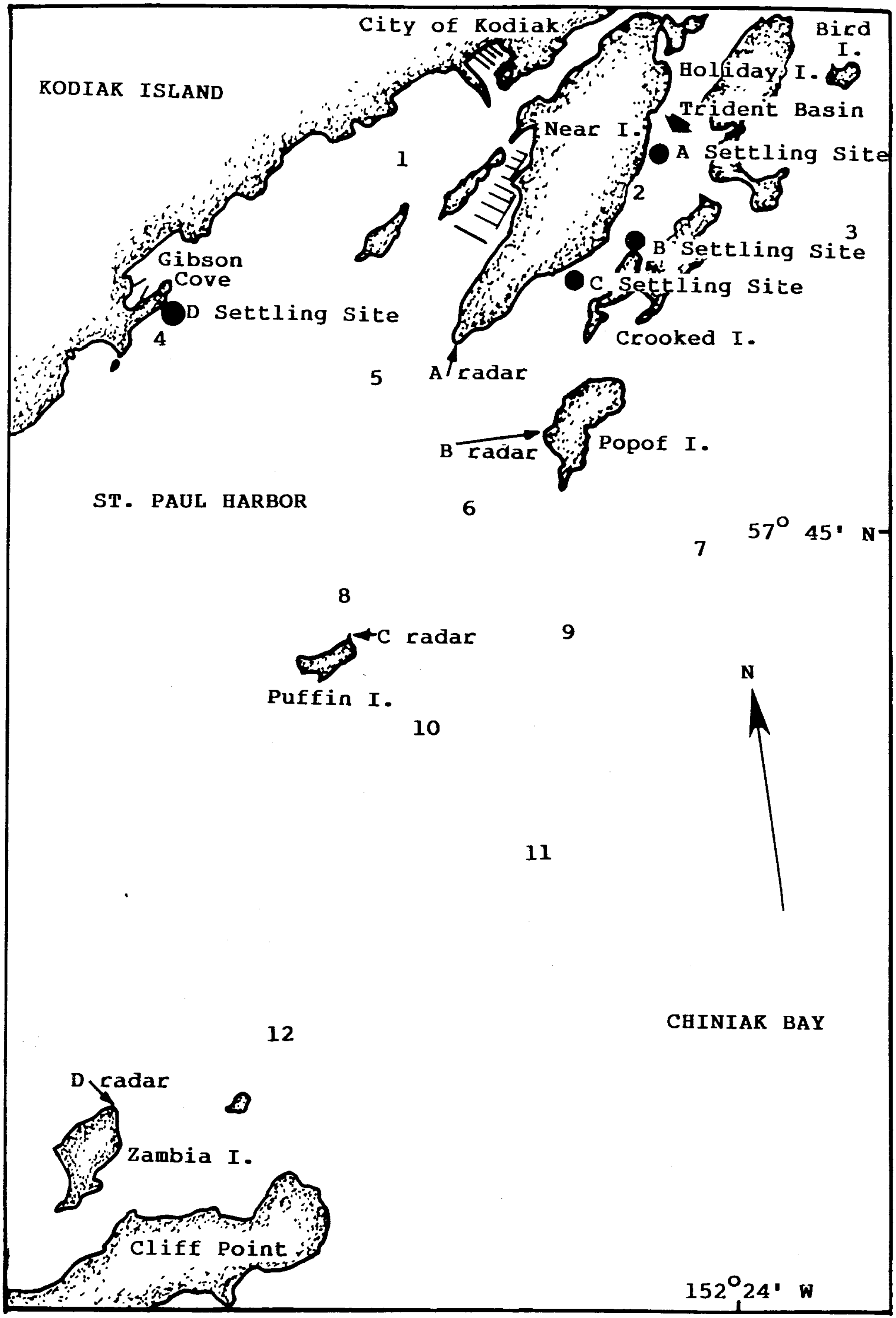

Figure 3. Red king crab postlarval indexing stations #1-12, settling collector sites A-D and radar reference points A-D used in St. Paul Harbor, Kodiak Island, Alaska in 1990.

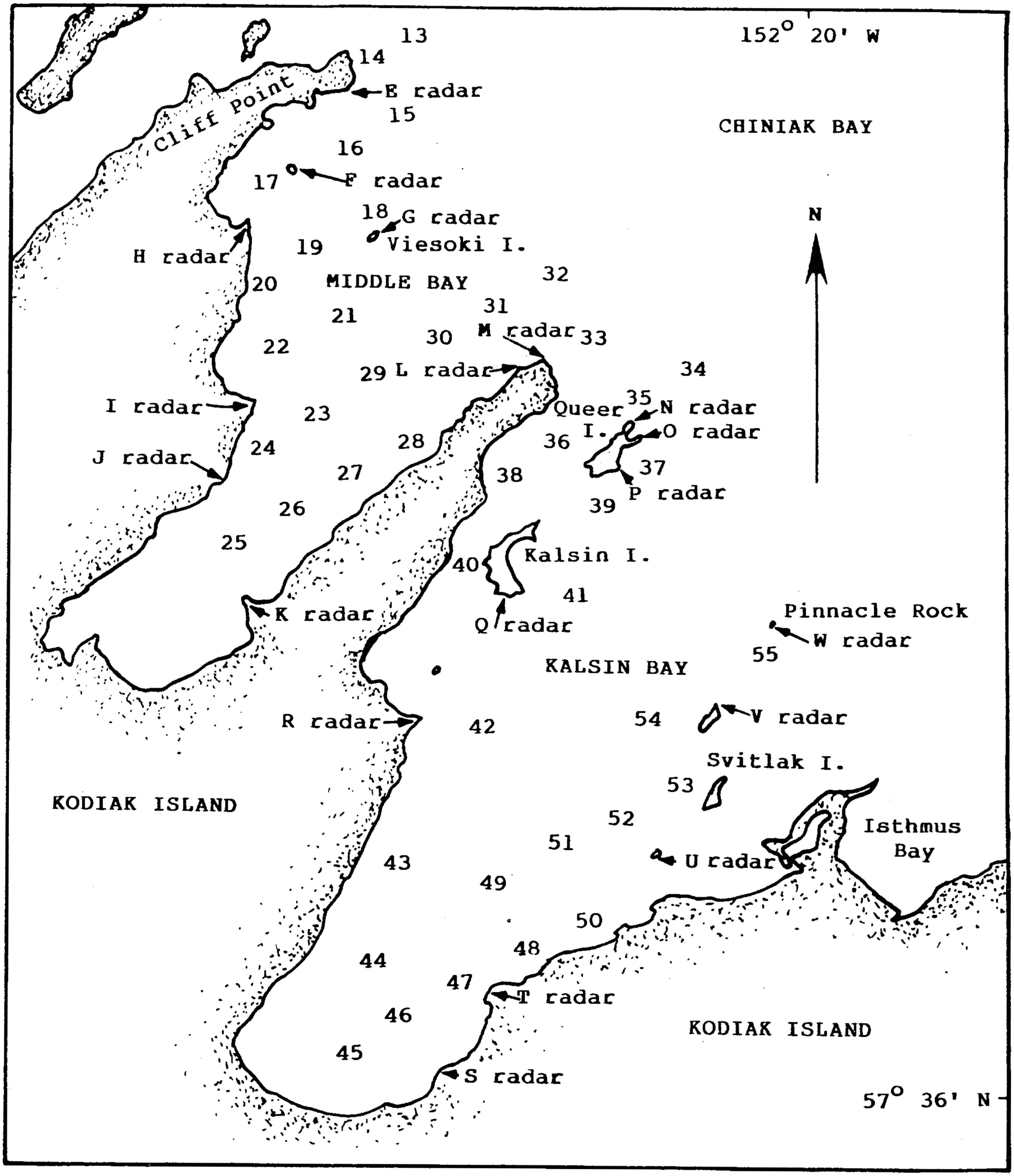

Figure 4. Red king crab postlarval indexing stations in Middle Bay (#13-32) and Kalsin Bay (#33-55) and radar reference points E-W used in 1990, Kodiak Island, Alaska.

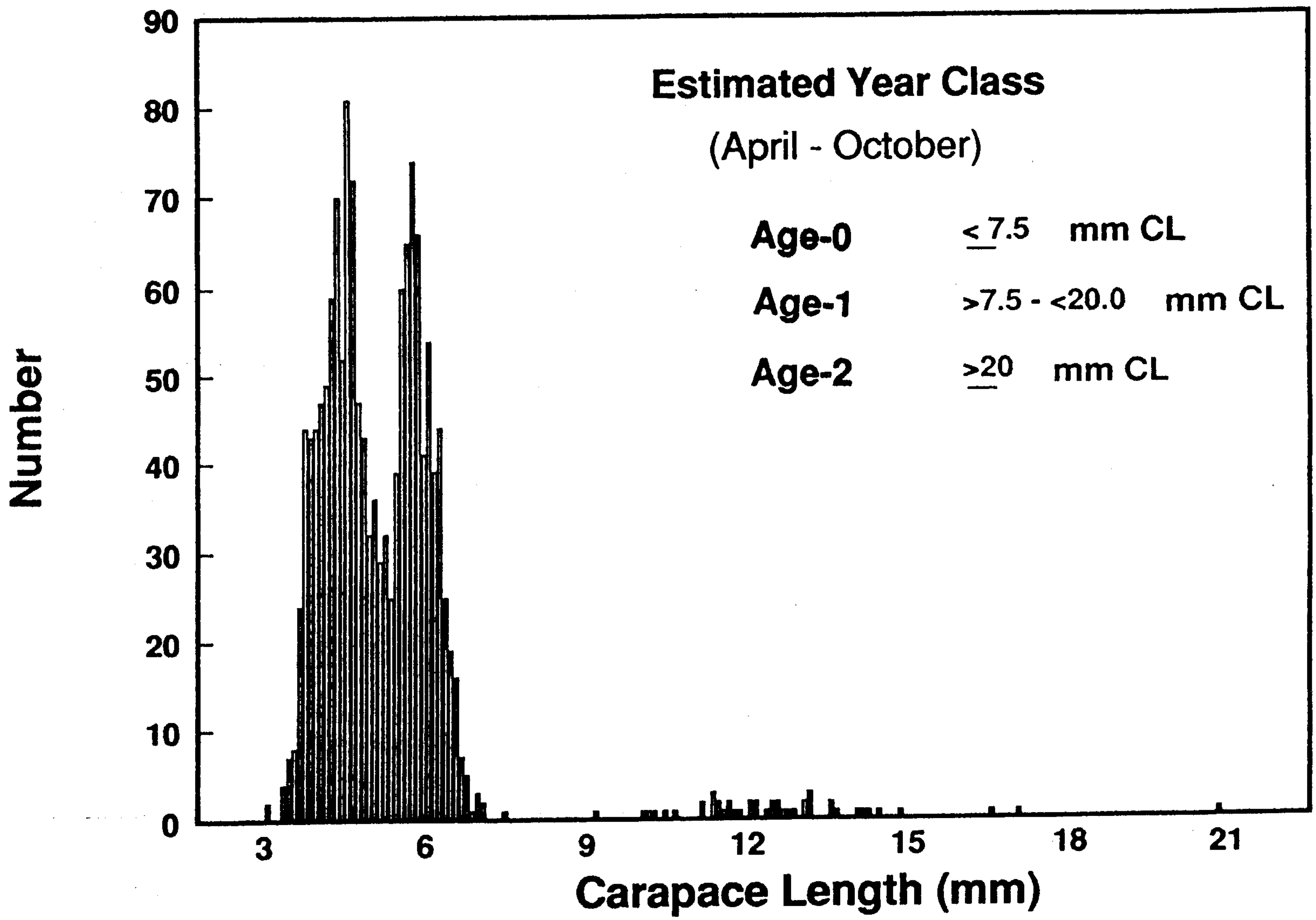

Figure 5. Length frequency of all red king crabs collected (n = 1,457) by estimated size-age classes from all sausage-shaped artificial collectors retrieved (n = 344) in the fall of 1990 from Chiniak Bay, Alaska.

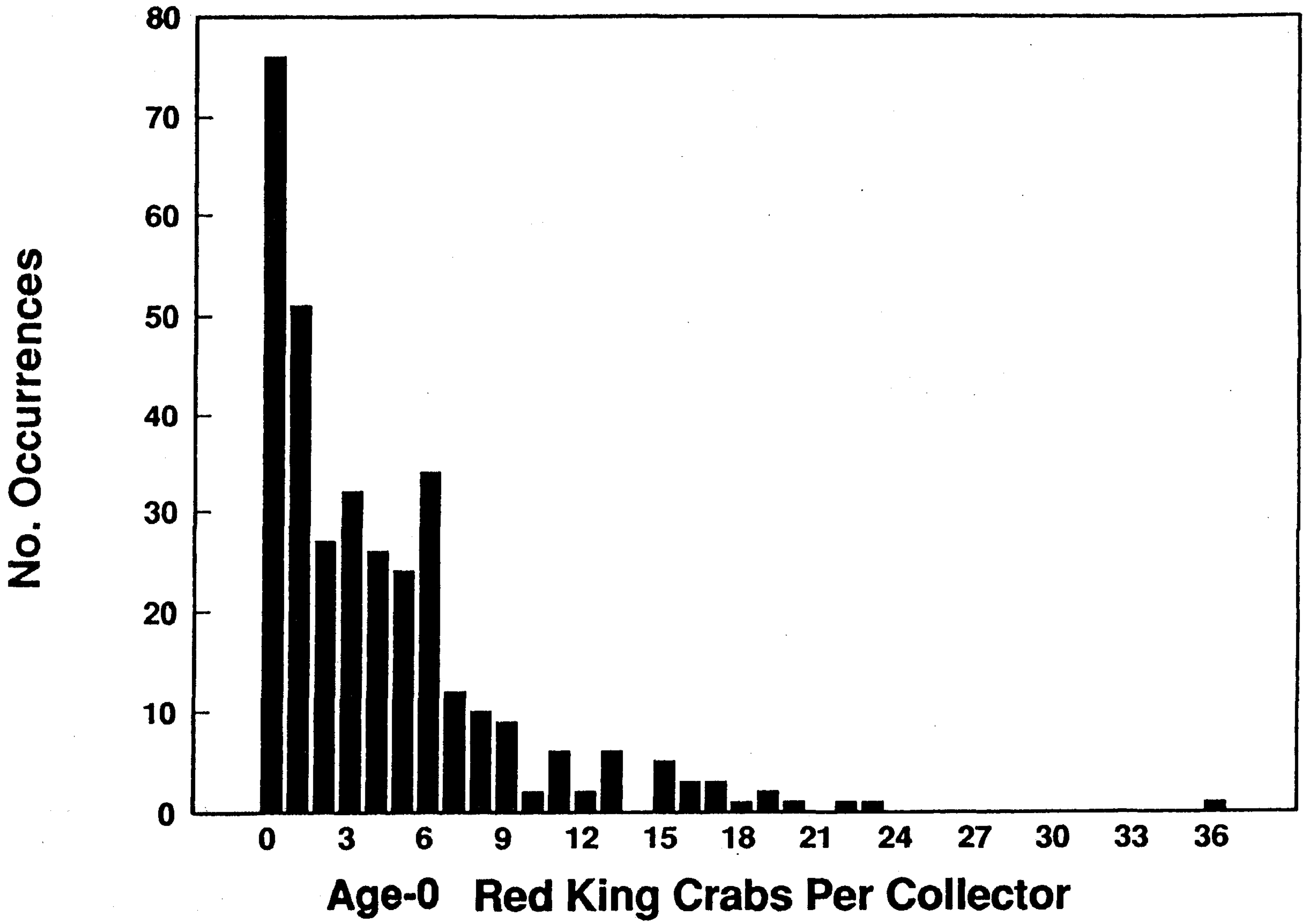

Figure 6. Frequency of occurrence of the number of age-0 red king crabs per collector from 335 sausage-shaped artificial collectors (with data quality codes of 0 or 1) retrieved in the fall of 1990 from Chiniak Bay, Alaska.

Figure 7. Morris Lambdin, Alaska Department of Fish and Game technician, holds a horizontal (left) and vertical (right) sausage-shaped artificial collectors from the same indexing string of gear retrieved from Kalsin Bay, Alaska in October of 1990. Note the abundance of hydroids on the vertical collector.

APPENDIX

Appendix A. Postlarval red king crab station locations and depths, set and retrieval dates, station data quality codes, and whether stations were dove on or had shell collectors attached to them, Chiniak Bay, Alaska, 1990.

Station	Set	Depth Set[1] (fm) MLLW	Radar Reference Points (nmi)[2] 1	2	3	Retrieved	Data Qual.[3]	Dove On[4]	Shell Collectors Y[4]	Shell Collectors King Crab CL
Index Stations 1 - 55										
1	4/03	6					5	Y		
2	4/03	7				9/27	0	Y	Y	5.1
3	4/25	8				10/09	2	Y	Y	
4	4/03	8				9/27	0	Y	Y	4.9, 4.6, 6.5, 4.0, 4.3, 3.7
5	4/03	9	A .2	B .53		9/27	0	Y	Y	
6	4/03	8-9	A .62	B .28	C .62	9/27	0	Y		
7	4/04	12-15	B .52	C 1.22		10/01	1	Y		
8	4/03	8					5	Y		
9	4/04	12	B .58	C .7		10/01	0	Y		
10	4/04	9	B .92	C .4		10/02	0	Y		
			B .92	C .411						
	4/04	11	C .92	E .32		9/28	0	Y		
12	4/04	8	D .59	G .34		10/02	0	Y		
13	4/04	15	D 1.3	E .72	G 1.7		5	N		
14	4/04	8	E .11			10/01	2	Y	Y[5]	
15	4/04	15	E .59	F .96	G .91		5	N		
16	4/04	14	E .45	F .31	G .6		5	N		
17	4/04	10	H .26	F .26		10/02	3	Y	Y	
18	4/04	14	G .1	H 1.0		10/01	3	N	Y	
19A[6]	4/04	13	H .4	I 1.2		10/02	4	Y	Y	
19		14	H .61	I 1.36	G .33					
20	4/04	9	I .82	beach .1		10/02	2	Y	Y	5.5
21	4/04	13	I 1.0	H 1.1	beach .87	10/25	1	N	Y	
22	4/04	10	I .5	beach .5		10/02	2	Y	Y	3.8
23A[6]		8	G 1.4	I .5		10/29	0	Y	Y	17.4 & 14.5 CW Tanner
	4/04	10	G 1.38	I.28						
24	4/05	8	I .3	J .4	beach 1.5	10/03	0	Y	Y	5.7, 4.3
25	4/05	6	K .5	north beach .3		10/03	0	Y	Y	5.9, 3.5
26	4/05	8	J .5	K .8		10/03	0	Y	Y	
27	4/10	7	G 1.84	I .95		10/03	4	Y	Y	4.2, 4.3
28	4/10	10	G 1.54	I 1.15		10/03	4	Y	Y	
29	4/10	12	G .97	I 1.03		10/03	0	Y	Y	
30	4/10	14	G 1.0	L .6		10/03	2	Y	Y	
31	4/10	13	G 1.1	L .46			5	N		
32	4/24	10	G 1.45	M .67		10/29	3	N	Y[5]	
33	4/11	17	M .32	N .69		10/29	3	N	Y	
34	4/11	14	M 1.0	N .52		10/05	1	N	N	
35	4/11	7	M .65	N .15		9/28	2	Y	Y[5]	
36	4/05	15					5	N		

-Continued-

Appendix A. (page 2 of 3)

Station	Set	Depth Set[1] (fm) MLLW	Radar Reference Points (nmi)[2] 1	2	3	Retrieved	Data Qual.[3]	Dove On[4]	Shell Collectors Y[4]	King Crab CL
37	4/11	12	P .24	O .24			5	Y		
38	4/05	12				10/17	1	N		
39	4/05	9	P .15	O .34	Q .54	10/01	2	Y	Y	
40	4/05	6	R 1.0	Q .43			5	Y		
41	4/05	13	Q .18	R 1.26	P 1.1	10/17	3	N	Y	
42	4/05	9	R .1	Q 1.04		9/24	4	Y	Y	3.8, 3.7., 3.5, 3.5, 4.1
43	4/05	10	R 1.0	T 1.29		9/28	0	Y	Y	4.0
44	4/05	12	S 1.2	T 1.1		9/28	0	Y	Y	11.7, 23.0
45	4/05	11	S .86	T 1.17		10/05	4	N	Y	4.7, 5.0
46	4/05	12	S .6	T .6		10/05	4	N	Y	4.0
47	3/30	12	R 1.75	T .43	U 1.75		5	N		
48	3/30	7	R 1.86	T .25	U 1.39	9/25	0	Y		
49	3/30	17	R 1.2	T .95	U 1.2		5	N		
50	3/30	11	R 1.8	T .84	U .72	10/24	1	N		
51	3/30	15	Q 2.0	R 1.27	U 1.01		5	N		
52	3/30	6	Q 1.68	R 1.38	U .61	9/25	0	Y		
53	3/30	6	Q 1.7	R 11.74	U .63	9/25	2	Y		
54	3/30	15	Q 1.23	R 1.48	U 1.1		5	N		
55	3/30	11	Q 1.72	V .5	W .12	10/15	0	Y		

Setting & Growth Study Stations A - D

Station	Set	Depth	Location
A	4/18	11	Placed in Trident Basin, NW portion near UA Fish Tech Center
B	4/18	6	" " " " , near cove on SW side of Crooked Is.
C	4/18	5-7	" outside SE entrance to Trident Basin.
D	4/18	6-7	" " Gibson Cove, near notch, N of station 4.

[1] The depths which the sausage-shaped artificial collectors were retrieved from are listed in Appendix B.

[2] Station locations and alphabet letters used to designate radar reference points can be found on Figures 2 and 3.

[3] Each station was given a data quality code on the following basis: **0** = station string laid out on the ocean bottom as set (Figure 1); confirmed by divers and was not tangled when retrieved; **1** = string of SACs when retrieved was as set but its condition on the bottom was not verified by divers; **2** = string had one or more SACs whose bases were ≥1 m off the bottom as observed by divers; **3** = all SACs tangled when retrieved, their number sequence when washed was arbitrary except that

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sequences 1-5 & 6-10 were assigned to either horizontal or vertical SAC groups. One or more SACs may have their bases $\geq$1 m off the bottom; **4** = <u>some</u> SACs are <u>tangled</u>; others are fishing normally. One or more SACs may be $\geq$1 m off the bottom. **5** = string of gear completely missing (not retrieved after repeated attempts to retrieve it) or due to technical difficulties no useable data could be obtained from the string (e.g. stations 8, 40).

[4] Y = Yes, station dove on; N = station not dove on. Y = Yes, shell collector present on the string of gear set at the station indicated under the "shell collector" column.

[5] Shell collector set at station, but all shells were shaken out of the collector prior to retrieval, hence no opportunity for crabs to settle in these collectors.

[6] The letter A (for ancillary) was added to this station number to denote that the station was set in its proper index station position but when it was retrieved it had moved.

Appendix B. Number of crabs collected by age group and data by individual collector fished spring-fall 1990 in Chiniak Bay, Alaska.

Sta- tion	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs Red King Crabs-Age Classes[c] 0	1	2	Tanner
2	1	v	13	2	0	3	0	0	0
2	2	v	13	2	0	6	0	0	0
2	3	v	13	2	0	16	0	0	0
2	4	v	13	2	0	9	0	0	0
2	5	v	13	2	0	6	0	0	0
2	6	h	13	2	0	3	0	0	0
2	7	h	13	2	0	0	0	0	0
2	8	h	13	2	0	2	0	0	0
2	9	h	13	2	0	3	0	0	0
2	10	h	13	2	0	3	0	0	0
3	1	v	14	2	0	1	0	0	0
3	2	v	16	2	0	5	0	0	0
3	3	v	15	2	0	4	0	0	0
3	4	v	14	2	0	1	0	0	0
3	5	v	15	2	3	0	0	0	0
3	6	h	15	2	3	0	0	0	0
3	7	h	15	2	3	0	0	0	0
3	8	h	15	2	3	0	0	0	0
3	9	h	15	2	3	0	0	0	0
3	10	h	15	2	3	0	0	0	0
4	1	v	12	2	0	22	0	0	0
4	2	v	12	2	0	36	0	0	0
4	3	v	12	2	1	6	0	0	0
4	4	v	12	2	1	6	0	0	0
4	5	v	12	2	1	11	0	0	0
4	6	h	12	2	0	17	0	0	0
4	7	h	12	2	0	15	0	0	0
4	8	h	12	2	0	15	0	0	0
4	9	h	12	2	0	8	0	0	0
4	10	h	12	2	0	5	0	0	0
5	1	v	16	2	0	8	0	0	0
5	2	v	16	2	0	7	0	0	0
5	3	v	16	2	0	3	0	0	0
5	4	v	16	2	0	4	0	0	0
5	5	v	16	2	0	4	0	0	0
5	6	h	16	2	0	9	2	0	0
5	7	h	16	2	0	2	1	0	0
5	8	h	16	2	0	0	1	0	0
5	9	h	16	2	0	3	0	0	0
5	10	h	16	2	0	2	1	0	0
6	1	h	16	2	3	0	0	0	0
6	2	h	15	2	0	2	0	0	0
6	3	h	15	2	3	0	0	0	0
6	4	h	15	2	0	0	0	0	0
6	5	h	15	2	3	0	0	0	0
6	6	v	14	2	3	0	0	0	0
6	7	v	14	2	0	4	0	0	0
6	8	v	14	2	0	5	0	0	0
6	9	v	14	2	0	3	0	0	0
6	10	v	14	2	0	3	0	0	0
7	1	v	25	1	0	0	0	0	0
7	2	v	25	1	0	1	0	0	0
7	3	v	25	1	0	0	0	0	0
7	4	v	25	1	0	1	0	0	0
7	5	v	25	1	0	0	0	0	0
7	6	h	25	1	0	0	0	0	0
7	7	h	25	1	0	0	0	0	0
7	8	h	25	1	0	0	0	0	0

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Sta- tion	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs Red King Crabs-Age Classes[c] 0	1	2	Tanner
7	9	h	25	1	0	0	0	0	0
7	10	h	25	1	0	0	0	0	0
9	1	v	21	2	0	3	0	0	0
9	2	v	21	2	0	1	0	0	0
9	3	v	21	2	0	3	0	0	0
9	4	v	21	2	0	3	0	0	0
9	5	v	21	2	0	1	0	0	0
9	6	h	21	2	3	0	0	0	0
9	7	h	21	2	3	0	0	0	0
9	8	h	21	2	3	0	0	0	0
9	9	h	21	2	3	0	0	0	0
9	10	h	21	2	3	0	0	0	0
10	1	v	19	2	3	0	0	0	0
10	2	v	19	2	0	1	0	0	0
10	3	v	19	2	0	0	0	0	0
10	4	v	19	2	0	1	0	0	0
10	5	v	19	2	0	2	0	0	0
10	6	h	19	2	3	0	0	0	0
10	7	h	19	2	3	0	0	0	0
10	8	h	19	2	3	0	0	0	0
10	9	h	19	2	3	0	0	0	0
10	10	h	19	2	3	0	0	0	0
11	1	v	14	2	0	6	0	0	0
11	2	v	14	2	3	0	0	0	0
11	3	v	14	2	0	0	0	0	0
11	4	v	14	2	0	6	0	0	0
11	5	v	18	2	3	0	0	0	0
11	6	h	18	2	3	0	0	0	0
11	7	h	18	2	3	0	0	0	0
11	8	h	18	2	3	0	0	0	0
11	9	h	18	2	3	0	0	0	0
11	10	h	18	2	3	0	0	0	0
12	1	v	14	2	0	4	0	0	0
12	2	v	14	2	0	3	0	0	0
12	3	v	14	2	0	6	0	0	0
12	4	v	14	2	0	6	0	0	0
12	5	v	14	2	0	6	0	0	0
12	6	h	14	2	0	1	0	0	0
12	7	h	14	2	0	2	0	0	0
12	8	h	14	2	0	1	0	0	0
12	9	h	14	2	0	3	0	0	0
12	10	h	14	2	0	0	0	0	0
14	1	v	13	2	0	4	0	0	0
14	2	v	13	2	1	7	0	0	0
14	3	v	13	2	3	0	0	0	0
14	4	v	13	2	3	0	0	0	0
14	5	v	13	2	0	9	0	0	0
14	6	h	13	2	3	0	0	0	0
14	7	h	13	2	3	0	0	0	0
14	8	h	13	2	3	0	0	0	0
14	9	h	13	2	3	0	0	0	0
14	10	h	13	2	3	0	0	0	0
17	1	h	18	2	3	0	0	0	0
17	2	h	18	2	3	0	0	0	0
17	3	h	18	2	3	0	0	0	0
17	4	h	18	2	3	0	0	0	0
17	5	h	18	2	3	0	0	0	0
17	6	v	16	2	0	6	0	0	0
17	7	v	16	2	0	16	0	0	0
17	8	v	16	2	0	2	0	0	0

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Sta- tion	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs Red King Crabs-Age Classes[c] 0	1	2	Tanner
17	9	v	16	2	0	7	0	0	0
17	10	v	16	2	0	5	0	0	0
18	1	v	26	1	0	2	0	0	0
18	2	v	26	1	0	0	0	0	0
18	3	v	26	1	0	0	0	0	0
18	4	v	26	1	0	1	0	0	0
18	5	v	26	1	0	1	0	0	0
18	6	h	26	1	0	0	0	0	0
18	7	h	26	1	0	0	0	0	0
18	8	h	26	1	1	0	0	0	0
18	9	h	26	1	0	0	0	0	0
18	10	h	26	1	1	0	1	0	0
19	1	v	21	2	0	1	0	0	0
19	2	v	22	2	3	0	0	0	0
19	3	v	23	2	3	0	0	0	0
19	4	v	24	2	0	0	0	0	0
19	5	v	25	2	0	0	0	0	0
19	6	h	25	2	0	1	0	0	0
19	7	h	25	2	0	1	0	0	0
19	8	h	25	2	0	0	1	0	0
19	9	h	25	2	0	0	0	0	0
19	10	h	25	2	0	0	0	0	0
20	1	v	16	2	0	4	0	0	0
20	2	v	12	2	0	8	0	0	0
20	3	v	16	2	0	13	0	0	0
20	4	v	16	2	0	8	0	0	0
20	5	v	16	2	0	13	0	0	0
20	6	h	16	2	0	1	0	0	0
20	7	h	16	2	0	0	1	0	0
20	8	h	16	2	0	1	0	0	0
20	9	h	16	2	0	0	1	0	0
20	10	h	16	2	3	0	0	0	0
21	1	h	27	1	0	0	0	0	0
21	2	h	27	1	0	0	0	0	0
21	3	h	27	1	0	1	0	0	0
21	4	h	27	1	0	0	0	0	0
21	5	h	27	1	3	0	0	0	0
21	6	v	27	1	0	4	0	0	0
21	7	v	27	1	0	0	0	0	0
21	8	v	27	1	0	0	0	0	0
21	9	v	27	1	0	2	0	0	0
21	10	v	27	1	3	0	0	0	0
22	1	h	17	2	3	0	0	0	0
22	2	h	17	2	3	0	0	0	0
22	3	h	17	2	3	0	0	0	0
22	4	h	17	2	3	0	0	0	0
22	5	h	17	2	3	0	0	0	0
22	6	v	14	2	0	1	0	0	0
22	7	v	14	2	0	6	0	0	0
22	8	v	16	2	0	5	0	0	0
22	9	v	17	2	0	0	0	0	0
22	10	v	17	2	0	0	0	0	0
23	1	h	18	2	0	0	2	0	0
23	2	h	18	2	0	5	0	0	0
23	3	h	18	2	0	3	0	0	0
23	4	h	18	2	0	0	0	0	0
23	5	h	18	2	0	5	0	0	0
23	6	v	18	2	0	3	0	0	0
23	7	v	18	2	0	5	0	0	0
23	8	v	18	2	0	1	0	0	0

-Continued-

Station	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs: Red King Crabs-Age Classes[c] 0	1	2	Tanner
23	9	v	18	2	0	2	0	0	0
23	10	v	18	2	0	4	0	0	0
24	1	h	14	2	0	2	0	0	0
24	2	h	14	2	0	1	0	0	0
24	3	h	14	2	0	1	0	0	0
24	4	h	14	2	0	4	0	0	0
24	5	h	14	2	0	5	0	0	0
24	6	v	14	2	0	3	0	0	0
24	7	v	14	2	0	1	0	0	0
24	8	v	14	2	0	1	0	0	0
24	9	v	14	2	0	1	0	0	0
24	10	v	14	2	0	6	0	0	0
25	1	h	10	2	0	0	0	0	0
25	2	h	10	2	0	0	0	0	0
25	3	h	10	2	0	1	0	0	0
25	4	h	10	2	0	0	0	0	0
25	5	h	10	2	0	1	0	0	0
25	6	v	10	2	0	6	0	0	0
25	7	v	10	2	0	8	0	0	0
25	8	v	10	2	0	9	0	0	0
25	9	v	10	2	0	7	0	0	0
25	10	v	10	2	0	3	0	0	0
26	1	h	15	2	3	0	0	0	0
26	2	h	15	2	0	0	0	0	0
26	3	h	15	2	0	0	0	0	0
26	4	h	15	2	0	1	0	0	0
26	5	h	15	2	0	0	0	0	0
26	6	v	15	2	0	2	0	0	0
26	7	v	15	2	0	2	0	0	0
26	8	v	15	2	0	3	0	0	0
26	9	v	15	2	0	2	0	0	0
26	10	v	15	2	0	6	0	0	0
27	1	v	13	2	0	0	0	0	0
27	2	v	13	2	0	0	0	0	0
27	3	v	13	2	0	0	0	0	0
27	4	v	13	2	0	2	0	0	0
27	5	v	13	2	0	17	0	0	0
27	6	h	13	2	3	0	0	0	0
27	7	h	13	2	0	6	1	0	0
27	8	h	13	2	0	6	1	0	0
27	9	h	13	2	0	5	2	0	0
27	10	h	13	2	0	5	0	0	0
28	1	h	18	2	0	0	0	0	0
28	2	h	18	2	0	0	0	0	0
28	3	h	18	2	0	1	0	0	0
28	4	h	18	2	0	1	1	0	0
28	5	h	18	2	0	0	0	0	0
28	6	v	18	2	0	6	0	0	0
28	7	v	17	2	0	7	0	0	0
28	8	v	16	2	0	5	0	0	0
28	9	v	14	2	0	5	0	0	0
28	10	v	14	2	0	10	0	0	0
29	1	h	23	2	0	0	1	0	0
29	2	h	23	2	0	0	0	0	0
29	3	h	23	2	0	2	0	0	0
29	4	h	23	2	0	0	0	0	0
29	5	h	23	2	0	0	0	0	0
29	6	v	23	2	0	0	0	0	0
29	7	v	23	2	0	1	0	0	0
29	8	v	23	2	0	0	0	0	0

-Continued-

Sta-tion	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs: Red King Crabs-Age Classes[c] 0	1	2	Tanner
29	9	v	23	2	0	1	0	0	0
29	10	v	23	2	0	3	0	0	0
30	1	h	26	2	0	0	0	0	0
30	2	h	26	2	0	0	0	0	0
30	3	h	26	2	0	0	0	0	0
30	4	h	26	2	0	0	0	0	0
30	5	h	25	2	4	0	0	0	0
30	6	v	24	2	0	0	0	0	0
30	7	v	25	2	0	1	0	0	0
30	8	v	24	2	0	2	0	0	0
30	9	v	25	2	0	0	0	0	0
30	10	v	25	2	0	1	0	0	0
32	1	v	18	1	2	2	0	0	0
32	2	v	18	1	2	0	0	0	0
32	3	v	18	1	3	0	0	0	0
32	4	v	18	1	3	0	0	0	0
32	5	v	18	1	3	0	0	0	0
32	6	h	18	1	3	0	0	0	0
32	7	h	18	1	3	0	0	0	0
32	8	h	18	1	3	0	0	0	0
32	9	h	18	1	3	0	0	0	0
32	10	h	18	1	3	0	0	0	0
33	1	v	17	1	0	1	0	0	0
33	2	v	17	1	0	2	0	0	0
33	3	v	17	1	0	3	0	0	0
33	4	v	17	1	0	2	0	0	0
33	5	v	17	1	0	0	0	0	0
33	6	h	17	1	0	0	0	0	0
33	7	h	17	1	0	1	0	0	0
33	8	h	17	1	0	0	0	0	0
33	9	h	17	1	0	0	1	0	0
33	10	h	17	1	0	0	0	0	0
34	1	v	26	1	1	4	0	0	0
34	2	v	26	1	1	4	0	0	0
34	3	v	26	1	0	3	0	0	0
34	4	v	26	1	1	4	0	0	0
34	5	v	26	1	3	0	0	0	0
34	6	h	26	1	3	0	0	0	0
34	7	h	26	1	3	0	0	0	0
34	8	h	26	1	3	0	0	0	0
34	9	h	26	1	3	0	0	0	0
34	10	h	26	1	3	0	0	0	0
35	1	v	7	2	0	9	0	0	0
35	2	v	7	2	0	9	0	0	0
35	3	v	7	2	0	6	0	0	0
35	4	v	9	2	0	5	0	0	0
35	5	v	10	2	0	3	0	0	0
35	6	h	10	2	4	3	0	0	0
35	7	h	11	2	4	1	0	0	0
35	8	h	12	2	3	0	0	0	0
35	9	h	12	2	3	0	0	0	0
35	10	h	12	2	0	0	0	0	0
38	1	v	22	1	0	3	0	0	0
38	2	v	22	1	0	6	0	0	0
38	3	v	22	1	0	2	0	0	0
38	4	v	22	1	0	6	0	0	0
38	5	v	22	1	0	5	0	0	0
38	6	h	22	1	0	4	0	0	0
38	7	h	22	1	0	1	1	0	0
38	8	h	22	1	0	0	0	0	0

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Station	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs: Red King Crabs-Age Classes[c] 0	1	2	Tanner
38	9	h	22	1	0	1	0	0	0
38	10	h	22	1	0	5	0	0	0
39	1	v	13	2	0	4	0	0	0
39	2	v	12	2	0	8	0	0	0
39	3	v	9	2	0	13	0	0	0
39	4	v	9	2	0	6	0	0	0
39	5	v	12	2	0	7	0	0	0
39	6	h	12	2	3	0	0	0	0
39	7	h	12	2	3	0	0	0	0
39	8	h	12	2	3	0	0	0	0
39	9	h	12	2	3	0	0	0	0
39	10	h	12	2	3	0	0	0	0
41	1	v	24	1	0	5	0	0	0
41	2	v	24	1	0	3	0	0	0
41	3	v	24	1	0	5	0	0	0
41	4	v	24	1	0	4	0	0	0
41	5	v	24	1	0	1	0	0	0
41	6	h	24	1	0	1	1	0	0
41	7	h	24	1	0	0	1	0	0
41	8	h	24	1	0	0	1	0	0
41	9	h	24	1	0	4	0	0	0
41	10	h	24	1	3	0	0	0	0
42	1	h	17	2	0	8	0	0	0
42	2	h	17	2	0	0	1	0	0
42	3	h	17	2	0	10	0	0	0
42	4	h	17	2	0	1	2	0	0
42	5	h	16	2	2	4	1	0	0
42	6	v	15	2	0	6	0	0	0
42	7	v	14	2	0	15	0	0	0
42	8	v	14	2	0	12	0	0	0
42	9	v	14	2	0	17	0	0	0
42	10	v	14	2	0	11	0	0	0
43	1	h	18	2	2	5	0	0	0
43	2	h	18	2	2	0	0	0	0
43	3	h	18	2	2	3	0	0	0
43	4	h	18	2	0	5	0	0	0
43	5	h	18	2	0	20	0	0	0
43	6	v	18	2	0	5	0	0	0
43	7	v	18	2	0	4	0	0	0
43	8	v	18	2	0	9	0	0	0
43	9	v	18	2	0	23	0	0	0
43	10	v	18	2	0	11	0	0	0
44	1	h	21	2	0	7	0	0	0
44	2	h	21	2	0	1	0	0	0
44	3	h	21	2	0	0	0	0	1
44	4	h	21	2	0	2	0	0	0
44	5	h	21	2	0	3	1	0	0
44	6	v	21	2	0	6	0	0	0
44	7	v	21	2	0	0	0	0	0
44	8	v	21	2	0	13	1	0	0
44	9	v	21	2	0	9	0	0	0
44	10	v	21	2	0	6	0	0	0
45	1	v	20	1	0	13	0	0	0
45	2	v	20	1	0	6	0	0	0
45	3	v	20	1	0	4	0	0	0
45	4	v	20	1	0	7	0	0	0
45	5	v	20	1	1	3	0	1	0
45	6	h	20	1	0	13	0	0	0
45	7	h	20	1	0	2	0	0	0
45	8	h	20	1	0	1	0	0	0

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Station	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[a]	Quality of Data[b]	Number of Crabs: Red King Crabs-Age Classes[c] 0	1	2	Tanner
45	9	h	20	1	0	11	0	0	0
45	10	h	20	1	0	1	0	0	0
46	1	h	22	1	0	1	1	0	0
46	2	h	22	1	0	1	1	0	0
46	3	h	22	1	0	1	1	0	0
46	4	h	22	1	0	6	1	0	0
46	5	h	22	1	0	1	0	0	0
46	6	v	22	1	0	5	0	0	0
46	7	v	22	1	0	5	0	0	0
46	8	v	22	1	0	6	0	0	0
46	9	v	22	1	0	8	0	0	0
46	10	v	22	1	0	4	0	0	0
48	1	v	15	2	0	8	0	0	0
48	2	v	16	2	0	11	0	0	0
48	3	v	16	2	0	19	0	0	0
48	4	v	16	2	0	15	0	0	0
48	5	v	16	2	0	9	0	0	0
48	6	h	16	2	0	7	0	0	0
48	7	h	16	2	0	6	0	0	0
48	8	h	16	2	0	5	0	0	0
48	9	h	16	2	0	0	0	0	0
48	10	h	16	2	0	3	1	0	0
50	1	h	20	1	0	7	0	0	0
50	2	h	20	1	0	2	1	0	0
50	3	h	20	1	0	5	0	0	0
50	4	h	20	1	0	2	3	0	0
50	5	h	20	1	0	6	3	0	0
50	6	v	20	1	0	6	2	0	0
50	7	v	20	1	0	3	2	0	0
50	8	v	20	1	0	3	0	0	0
50	9	v	20	1	0	2	0	0	0
50	10	v	20	1	0	1	0	0	0
52	1	v	14	2	3	0	0	0	0
52	2	v	14	2	3	0	0	0	0
52	3	v	14	2	0	3	0	0	0
52	4	v	14	2	0	7	0	0	0
52	5	v	14	2	0	6	0	0	0
52	6	h	14	2	0	4	0	0	0
52	7	h	14	2	0	8	0	0	0
52	8	h	14	2	0	12	0	0	0
52	9	h	14	2	0	4	0	0	0
52	10	h	14	2	0	6	0	0	0
53	1	h	15	2	0	6	0	0	0
53	2	h	15	2	0	7	0	0	0
53	3	h	15	2	0	4	0	0	0
53	4	h	15	2	0	6	0	0	0
53	5	h	15	2	0	0	1	0	0
53	6	v	15	2	0	16	0	0	0
53	7	v	15	2	0	19	0	0	0
53	8	v	14	2	0	11	0	0	0
53	9	v	14	2	0	18	0	0	0
53	10	v	15	2	0	15	0	0	0
55	1	h	25	2	1	0	0	0	0
55	2	h	25	2	1	2	0	0	0
55	3	h	25	2	1	2	0	0	0
55	4	h	25	2	1	4	0	0	0
55	5	h	25	2	1	1	0	0	0
55	6	v	25	2	1	3	0	0	0
55	7	v	25	2	1	4	0	0	0
55	8	v	25	2	1	1	0	0	0

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Appendix B. (page 8 of 8)

Station	Collector Sequence	V=Vertical H=Horizontal	Depth (fm)	Depth Method[1]	Quality of Data[2]	Number of Crabs: Red King Crabs-Age Classes[3] 0	1	2	Tanner
55	9	v	25	2	1	3	0	0	0
55	10	v	25	2	1	4	0	0	0
Totals						1,411	45	1	1

[a] Method of recording depth: **1** = fathometer, **2** = diver.

[b] Quality of data; collector condition: **0** = collector in good condition (no rips, tears, or bunched-up); **1** = SAC had some problem (small tear, rip, some herring gillnet missing ≤25%); **2** = SAC not useable (processed but net lost too great, >25%, or SAC bunched-up, tangled, and not fishing correctly, or divers observed it covered by sand; **3** = SAC was not processed because it was missing or ripped and the netting was mostly gone; **4** = horizontal SAC off bottom ≥1 m as observed by divers and in good condition; therefore fishing similar to a vertical SAC.

[c] Red king crab age classes for this paper are estimated as follows: age-0 = crabs ≤7.5mm CL; age-1 = crabs >7.5-<20.0 mm CL and age-2 crabs ≥20 mm (there was only one age-2 crab 20.8 mm CL).