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Distribution and Abundance of Larvae of King Crab, *Paralithodes camtschatica*, and Pandalid Shrimp in the Kachemak Bay Area, Alaska, 1972 and 1976

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U.S. DEPARTMENT OF COMMERCE
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Distribution and Abundance of Larvae of King Crab, *Paralithodes camtschatica*, and Pandalid Shrimp in the Kachemak Bay Area, Alaska, 1972 and 1976

EVAN HAYNES[1]

ABSTRACT

Distribution and abundance of larvae of king crab, *Paralithodes camtschatica*, northern shrimp, *Pandalus borealis*, humpy shrimp, *P. goniurus*, coonstripe shrimp, *P. hypsinotus*, and sidestripe shrimp, *Pandalopsis dispar*, were studied in the Kachemak Bay area, Alaska, in 1972 and 1976. In both 1972 and 1976, larvae of king crab, northern shrimp, and humpy shrimp first appeared in outer Kachemak Bay; their abundance was greatest in the central portion of the outer bay. Two additional species were studied in 1972, coonstripe shrimp and sidestripe shrimp. In 1972, the center of abundance of sidestripe shrimp larvae was similar to that of larvae of king crab, northern shrimp, and humpy shrimp. Coonstripe shrimp larvae were most abundant in the inner bay and along the northern shore of the outer bay.

The direction in which larvae were transported out of outer Kachemak Bay was only in partial agreement with suspected water-current patterns and may have been influenced by behavior of the larvae. Continued abundance of larvae in outer Kachemak Bay may be caused by entrainment of the larvae in gyres.

Depending on species and area, pandalid shrimp larvae are released at different times and over different periods. For example, larvae of northern shrimp appeared in plankton catches earlier than larvae of humpy shrimp. Coonstripe shrimp had the longest release period of all the shrimp sampled.

From the percentage of glaucothoe in the samples, king crab larvae probably settle in the Bluff Point area in outer Kachemak Bay. Larvae of pandalid shrimp probably settle in outer Kachemak Bay and possibly lower Cook Inlet, but exact locations cannot be determined only by observing changes in morphology of the larvae.

Vertical depth distributions of larvae of king crab and pandalid shrimp were generally similar. Early-stage larvae of king crab, northern shrimp, and humpy shrimp migrated vertically in a diel cycle. A thermocline did not prevent migration to surface waters.

INTRODUCTION

Little is known about the larvae of king crab, *Paralithodes camtschatica* (Telesius), and pandalid shrimp in Alaska; most of the research has dealt with adults and immatures. The geographical distribution of zoeae of king crab in the southeastern Bering Sea has been studied (Takeuchi 1962, 1968; Rodin 1972; Haynes 1974), and the morphology of larvae of blue king crab, *P. platypus* (Brandt), described (Hoffman 1968). The larval morphology of coonstripe shrimp, *Pandalus hypsinotus* Brandt, humpy shrimp, *P. goniurus* Stimpson, northern shrimp, *P. borealis* Krøyer, and yellow-leg shrimp, *P. tridens* Rathbun, has also been described (Haynes 1976, 1978, 1979, 1980).

The National Marine Fisheries Service Auke Bay Laboratory began an investigation in 1971 of the early life history of king crab and pandalid shrimp in Kachemak Bay, Alaska, to answer an important question of fisheries managers—Do the larvae of king crab and pandalid shrimp found in Kachemak Bay originate and settle in Kachemak Bay?

The abundance and distribution of the larvae over time, area, and depth were determined by systematically sampling Kachemak Bay and lower Cook Inlet with plankton nets. In 1971, the sampling technique was standardized and seasonal occurrence of the larvae verified. In 1972, Kachemak Bay was determined to be a major release area for larvae of king crab and pandalid shrimp. In 1976, in a joint study between the National Marine Fisheries Service and the Alaska Department of Fish and Game, it was determined that some of the larvae released in Kachemak Bay were dispersed seaward into lower Cook Inlet.

This report documents outer Kachemak Bay as a major release and settling area for larvae of king crab and pandalid shrimp. The term "outer bay" refers to the area of Kachemak Bay from Homer Spit seaward to long. 152°00′W; "inner bay" refers to the area from Homer Spit to the head of the bay. Depth distribution, diel migration, and settling areas of the larvae are also discussed. Dispersal of the larvae is compared with water-current patterns.

METHODS

The sampling area in 1972 extended from the head of Kachemak Bay westward to a line extending from off Anchor Point to approximately Flat Island (long. 152°00′W) (Fig. 1A). Tows were made at 24 stations semimonthly from the latter half of March through June.

In 1976, the sampling area differed slightly from the sampling area in 1972 and included the area from near Homer Spit (long. 151°30′W) westward to long. 152°30′W (Fig. 1B). Tows were made at 47 stations during four sampling periods, 10–13 May, 1–3 June, 22–24 June, and 13–15 July.

In both years, the sampling stations were distributed somewhat evenly throughout the sampling area. Not all stations were sampled during each period because of inclement weather, especially at the beginning of the season. Locations of all tows, both those yielding and not yielding larvae, are indicated for each sampling period in the figures showing larval distributions.

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Sampling techniques were different in 1972 and 1976 because of different study objectives. In 1972, the objectives were to determine both geographical and vertical distributions of the larvae; whereas in 1976, the objective was to determine only geographical distribution.

Samples were collected in 1972 with four Miller high-speed samplers (Miller 1961) fished at different depths. These samplers, with nets of 0.571 mm mesh, retain their theoretical filtering capacity until they are three-fourths clogged and are efficient at speeds up to 10 kn (Miller 1961). Four samplers were towed simultaneously at each station at different depths on a single wire. Depths below 100 m were not sampled because of gear limitations. Sampled depths were estimated from wire profiles, which were determined by making repeated tows using time-depth recorders at various locations on the wire (for method, see Glover 1962). Each sampler sampled one-fourth of the water column in five step intervals of 2 min each, regardless of station depth. At depths of 100 m or less, the percentage of the tow taken outside the desired sampling depth was 6% or less (Miller 1961). In this analysis, it was assumed that each sample represented only its intended stratum. For discussion, portions of the water column sampled are referred to as strata A, B, C, and D, with stratum A nearest the surface and stratum D nearest the bottom. Circular tows were made to minimize effects of currents.

Diel vertical migration of larvae of king crab, northern shrimp, and humpy shrimp was studied over a 22-h period on 10–11 May 1972. Every 2 h, tows were made with Miller high-speed samplers fished in the usual manner. In addition, another Miller high-speed sampler was towed just under the surface at each 2-h interval from 2000 h, 10 May, to 0600 h, 11 May.

The water volume filtered during each tow was estimated from a Rigosha flowmeter. The flowmeter, enclosed in a polyvinylchloride housing fitted with stabilization fins, was attached with the sampler at the top wire stop. Adjustments for the amount of water filtered by the deeper samplers were obtained by making repeated tows at various depths with flowmeters attached at each sampler position. Once these adjustments were obtained, only the top flowmeter was used. Flowmeters were calibrated by towing them over a known distance at a sampling speed of 5–6 kn (2.6–3.1 m/s). The flowmeters performed consistently during the entire sampling period.

Plankton was collected in 1976 with two 61 cm bongo nets (Posgay et al. 1968) fished side-by-side from nearbottom to surface. Nets had 0.333 mm mesh, and cod-end jars had 0.571 mm mesh. Samples were taken by lowering the nets to about 1 m from the bottom and retrieving them vertically at a velocity of slightly less than 1 m/s. In 1972 and 1976, samples were washed from nets and preserved in a 5% solution of Formalin and seawater.

In the laboratory, samples containing about 400 larvae or less were examined in their entirety; samples containing >400 larvae were divided into equal portions using a splitter described by Cooney (1971). The splitter showed no significant differences ($P > 0.05$) among either individual or pooled aliquot counts.

One scale of abundance for all species and sampling periods tended to mask differences so larval abundance was arbitrarily subdivided into as many as five categories. To avoid masking the differences, power functions of X^i ($X = 3, 4, 5, 9$, or 10, and $i = 1, 2$, or 3) were used to delimit the abundance categories. The abundance categories used for each species and sampling period are indicated on the charts showing larval distributions (Figs. 2–10).

For each positive tow in 1972 and 1976, data are given on depth and location of each station and on stage of development and number of larvae of king crab and each species of pandalid shrimp captured (Appendix Tables 1–3). Data on larvae of pandalid shrimp in 1976 are given only for *P. borealis* and *P. goniurus*. Larvae of other species of pandalid shrimp were collected during the 1976 survey but only in negligible quantities.

Larvae of king crab were identified from descriptions by Marukawa (1933), Sato and Tanaka (1949), Sato (1958), and Kurata (1964). Larvae of pandalid shrimp were identified from descriptions by Berkeley [1930] and Haynes (1976, 1978, 1979, 1980).

RESULTS

Distribution and Dispersal of Larvae of King Crab and Pandalid Shrimp

Larvae of the species studied in both years, 1972 and 1976 (king crab, northern shrimp, and humpy shrimp), were found throughout all the areas sampled. Patterns of distribution and areas of greatest numbers of larvae were similar for each species in both years (Figs. 2–20). Samples from the central portion of outer Kachemak Bay had the most larvae of each species. Samples from the inner bay and lower Cook Inlet had fewer larvae than the central portion of outer Kachemak Bay. In addition to being abundant in outer Kachemak Bay in 1976, larvae of humpy shrimp were abundant along the outer transect of the stations in Cook Inlet (Figs. 14, 15).

Two additional species, coonstripe shrimp and sidestripe shrimp, were studied in 1972 in Kachemak Bay. The areas of greatest abundance of larvae of coonstripe shrimp were markedly different from those of larvae of king crab, northern shrimp, humpy shrimp, or sidestripe shrimp. Larvae of coonstripe shrimp were most numerous in samples collected along the northern shore of the outer bay, off Bluff Point, and in the inner bay near Homer Spit (Figs. 16–18). The distribution of larvae of sidestripe shrimp was similar to that of larvae of king crab, northern shrimp, and humpy shrimp, except sidestripe shrimp larvae were not caught in the inner bay (Figs. 19, 20).

In Kachemak Bay, dispersal of larvae of king crab, northern shrimp, humpy shrimp, and sidestripe shrimp was similar. Larvae of all four species were dispersed into the inner bay primarily along the southern shore and out of the bay southwestward toward Flat Island. Some larvae were also dispersed northeastward toward Anchor Point.

Dispersal of coonstripe shrimp larvae in outer Kachemak Bay off Bluff Point was southwestward, similar in direction to the dispersal of larvae of king crab, northern shrimp, humpy shrimp, and sidestripe shrimp. Dispersal of coonstripe shrimp larvae from the inner bay was probably seaward along the northern shore of the outer bay toward Bluff Point.

Relation Between Distribution of Larvae and Current Patterns

The following summary of water-current patterns in Cook Inlet and Kachemak Bay was extracted from Burbank (1977). Clear seawater enters Cook Inlet through Kennedy Entrance (Fig. 21); flows northward along the east side of Cook Inlet; eventually mixes with turbid, low-salinity waters from sediment-laden rivers in Cook Inlet; then flows southward along the western shore of the inlet, around Cape Douglas into Shelikof Strait.

Water circulation in outer Kachemak Bay is dominated by two large gyres: A counterclockwise gyre in the eastern half and a clockwise gyre in the western half. The two-gyre system is generally stable but can be altered by strong winds. Water in the gyres has a typical residence time of 1–2 wk, although longer residence times do occur. Water flowing northward enters the gyres along the southern peripheries of the gyres and leaves them along the northern peripheries. Net water transport in outer Kachemak Bay is northward, whether or not the gyres persist.

Water circulation in inner Kachemak Bay is dominated by two counterclockwise gyres: One gyre near Homer Spit, the other near the head of the bay. Surface waters, primarily derived from rivers at the head of the bay, flow westward into the outer bay. Water at depths below about 30 m flows from the outer bay into the inner bay primarily along the southern shore.

If current were the only factor affecting dispersal, most of the larvae released in outer Kachemak Bay would be carried northward out of the bay soon after hatching. Some would be incorporated into the outer gyre and dispersed southwestward before being carried northward. Larvae not released in the bay would move into outer Kachemak Bay from the south.

The observed dispersals of larvae of king crab and pandalid shrimp from the areas of greatest abundance in Kachemak Bay were only in partial accord with the water currents. Surprisingly, most of the larvae originating in Kachemak Bay were not quickly dispersed out of the bay but remained in outer Kachemak Bay throughout sampling. The clockwise movement of water in the western gyre seems inadequate to account for the extensive dispersal of larvae southwestward from outer Kachemak Bay. There was no evidence of recruitment of larvae into Kachemak Bay from the south either in patterns of dispersal or in differences in seasonal progression of larval stages.

Behavior of the larvae may influence the direction and extent of their dispersal. For instance, vertical diel migration of larvae may affect their horizontal dispersal if the direction and velocity of water currents vary with depth. The geographical distribution of larvae of many other Crustacea is known to be nonrandom. Larvae of oysters (*Crassostrea virginica*) are retained within the spawning estuary and often settle upstream from the major spawning populations by selectively swimming in synchrony with tidal cycles (see Wood and Hargis 1971 for review). Larvae of barnacles (*Balanus* spp.) move in groups that are maintained even in eddies (De Wolf 1973). Behavior of larvae of king crab and pandalid shrimp is essentially unknown, particularly whether the larvae can maintain their geographic position in spite of currents. Until details of the behavior of larvae of king crab and pandalid shrimp are known, the underlying causes of their distributions in Kachemak Bay cannot be determined.

Time and Location of Release of Larvae

Areas of high abundance of Stage I larvae were presumed to be release sites. Stage I larvae of king crab first appeared in outer Kachemak Bay in April 1972, and their high abundance in this area in May 1972 and 1976 (Figs. 3, 5) indicated that outer Kachemak Bay was a major release area. Ovigerous king crab congregate in outer Kachemak Bay off Bluff Point each spring and release larvae.[2] Stage I larvae of king crab also appeared in other parts of Kachemak Bay at this time; however, they were less abundant. Their low abundance and pattern of dispersal seem to indicate that the larvae were transported into these areas by currents rather than released there.

[2]Data on file at Alaska Department of Fish and Game, Homer, AK 99603. Unpaginated.

Kachemak Bay was trawled from 5 through 13 May 1972 to determine the distribution of female shrimp that were releasing larvae (Fig. 22). (The egg cases remain attached to the pleopods of the female for some time after the larvae have been released.) Stage I larvae of all four species of pandalid shrimp were most abundant in plankton samples collected from areas where females were releasing larvae. Northern shrimp released larvae in the central portion of outer Kachemak Bay; humpy shrimp released larvae somewhat farther seaward. Coonstripe shrimp released larvae primarily at the entrance of, and within, the inner bay. However, Stage I larvae of coonstripe shrimp were also abundant in plankton samples from the northern shore of the outer bay (no adults were sampled in this area). Female sidestripe shrimp released their larvae in the relatively deep (about 100 m) water of the inner portion of the outer bay.

Northern shrimp apparently released their larvae earlier in 1972 and 1976 than did humpy shrimp. In 1972, Stage I larvae of northern shrimp were first captured 3 April, and Stage I larvae of humpy shrimp were first captured 22 April. During the 10–13 May sampling period in 1976, 59% of the northern shrimp larvae were Stage II compared with only 16% of the humpy shrimp larvae. The percentage of later larval stages remained greater for northern shrimp than for humpy shrimp until the latter half of June 1972. In the latter half of June, the percentage of Stage V larvae of northern shrimp (39%) was somewhat lower, rather than higher, than the percentage of Stage V larvae of humpy shrimp (50%). The reason for this reversal is unknown. In 1976, the percentage of later stages remained higher throughout the sampling period for northern shrimp than for humpy shrimp.

Time of larval release may be related to the location of the release site. For example, in 1976, larvae of humpy shrimp may have been released later in the lower Cook Inlet area than in outer Kachemak Bay. Humpy shrimp larvae were most abundant in the 1–3 June collections in the lower Cook Inlet area but were most abundant in the 10–13 June collections in Kachemak Bay (Table 1). Also, in 1976, humpy shrimp larvae were consistently more developed (in later stages) in Kachemak Bay than in lower Cook inlet (Fig. 23). This difference in progression of larval stages in Kachemak Bay and lower Cook Inlet continued through the last sampling period (13–15 July).

Pandalid shrimp in British Columbia waters apparently begin and complete release of most of their larvae earlier than pandalid shrimp in Kachemak Bay. In waters off British Columbia, most of the larvae of northern shrimp were released between late March and early April; most larvae of coonstripe shrimp were released later than larvae of northern shrimp; and both species completed release of their larvae near the end of April (Berkeley 1930). Butler (1964) confirmed Berkeley's findings for northern shrimp and coonstripe shrimp. In addition, Butler showed that release of humpy shrimp larvae in waters near Vancouver, British Columbia,

Table 1.—Number of humpy shrimp larvae captured in the western portion of the lower Cook Inlet study area and in the outer bay of Kachemak Bay, 1976.

Date	Larvae in Kachemak Bay (no.)	Larvae in western portion lower Cook Inlet (no.)
10–13 May	21	1,639
1–3 June	55	796
23–24 June	23	11
13–15 July	9	30

probably also was completed by April. In my 1972 study, Stage I larvae of northern shrimp were not caught until the first half of April; Stage I larvae of humpy shrimp and coonstripe shrimp were not caught until the latter half of April. Stage I larvae of all three species of pandalid shrimp were most abundant several weeks after the first larvae were caught. In the western Atlantic Ocean, pandalid shrimp also released their larvae later in northern waters than in southern waters (Haynes and Wigley 1969).

As expected, the percentage of each larval stage of king crab and pandalid shrimp was related to the time of year. Only the four larval stages before the glaucothoe (settling) stage of king crab were represented in the 1972 samples; all larval stages, including the glaucothoe, were represented in the 1976 samples (Fig. 24). In 1972, all king crab larvae collected during the 15–30 April sampling period were Stage I. During the next sampling period, 1–15 May, some Stage II larvae were present. By the end of May, the percentage of Stage II larvae had increased, and 2% were Stage III. This progression of later stages continued until the last sampling period. A similar progression occurred in 1976, except the later stages became more abundant earlier in the year. The July 1976 samples contained only three specimens and may not reflect the true ratio of Stage IV to Stage V larvae.

Seasonal progression in abundance of later larval stages of pandalid shrimp (Fig. 25) varied with species. In lower Cook Inlet, the progression was slower for coonstripe shrimp and humpy shrimp than for northern shrimp. In 1972, release of larvae of coonstripe shrimp began during the latter half of April; by the latter half of June, 64% of the larvae were still only Stage II. The presence of Stage I larvae in plankton is partly dependent on how long females release larvae. From samples of ovigerous females collected over several years, coonstripe shrimp larvae have been observed to release over a longer period than other pandalid shrimp larvae in Kachemak Bay. The high percentage of Stage II larvae of coonstripe shrimp in the latter half of June was probably related to this extended period of larval release. In 1976, the slower progression in abundance of each larval stage of humpy shrimp in lower Cook Inlet compared with humpy shrimp in Kachemak Bay (Fig. 23) was probably related to later larval release in the lower Cook Inlet area.

Settling Areas of King Crab Glaucothoe

The presence of king crab glaucothoe in plankton collections is generally considered indicative of a settling area (Makarov 1967). The molt from Stage IV to glaucothoe is characterized by abrupt changes in morphology resulting in larvae that can swim (Sato 1958) but are characteristically bottom dwelling.

Areas of abundance of king crab glaucothoe in Kachemak Bay in 1976 (glaucothoe were not captured in samples in 1972) included most of the central and northern sectors of the outer bay. Glaucothoe were found in plankton samples across the mouth of Kachemak Bay from Anchor Point to Point Pogibshi and southwestward into lower Cook Inlet waters. The high abundance of glaucothoe in the area between Anchor Point and Bluff Point implies that this area is a major settling area. Sundberg and Clausen (1977) have shown that the area between Anchor Point and Bluff Point also has higher densities of juvenile king crab than the other areas sampled (Fig. 26).

Settling Areas of Late-Stage Larvae of Northern Shrimp and Humpy Shrimp

In both 1972 and 1976, Stage V and VI larvae of northern shrimp and humpy shrimp were most abundant in outer Kachemak Bay. Few late-stage larvae of either species were caught seaward of Kachemak Bay in 1976 except along the outer transect of stations.

Areas of abundance of late-stage larvae of pandalid shrimp may not always indicate settling areas because the transition from zoea to megalopa, which is characterized by only slight changes in morphology (Haynes 1978, 1979), would have negligible effect on swimming capability. Larvae of northern shrimp and humpy shrimp probably settle in outer Kachemak Bay; but settling may be dependent upon factors other than changes in morphology. Until these factors are known, designation of settling areas will be based on abundance of the late-stage larvae.

Depth Distribution of Larvae of King Crab, Northern Shrimp, and Humpy Shrimp

Very little is known about the depth distribution of king crab larvae and pandalid shrimp larvae. Takeuchi (1962) suggested that younger king crab larvae are more abundant nearer the surface, whereas older larvae are more abundant nearer the bottom, but his data were too meager to substantiate his suggestion. In Berkeley's (1930) study on the postembryonic development of *Pandalus danae* in British Columbia waters, she found that Stages I and II *P. danae* are somewhat evenly distributed with depth, except no larvae were caught at the surface. Later stages (Stages III-V) of *P. danae* seemed to be found progressively deeper that earlier stages.

To determine the depth distribution of larvae of king crab, northern shrimp, and humpy shrimp, I ranked the midpoints of depths where larvae were collected in 1972 and tabulated the percentage of each stage of each species in each 100 m^3 of water strained. These data were plotted and a line drawn through the points visually (Fig. 27). Data for glaucothoe of king crab and for larval Stage V and older of pandalid shrimp are not shown because too few larvae were in the samples.

Depth distributions of larvae of king crab, northern shrimp, and humpy shrimp were similar, but the number of larvae varied with depth. Few larvae were captured at or near the surface or deeper than 60 m; most were captured between 10 and 40 m. Below 70 m, however, Stage I larvae of northern shrimp were more abundant than Stage I larvae of king crab or humpy shrimp. This increase in abundance below about 70 m may reflect release of larvae at the deepwater stations.

Diel Vertical Migration

Early-stage larvae of king crab, northern shrimp, and humpy shrimp migrated vertically in a diel cycle. In the 22-h study of 10–11 May 1972, Stage I larvae of king crab and Stage I and II larvae of northern shrimp and humpy shrimp were more abundant in the surface 15 m between 1800 h and 0800 h, the hours of twilight and darkness, than during daylight hours (Figs. 28, 29A). In the 15–30 m stratum, the percentage of Stage I larvae of king crab and of Stage I and II larvae of northern shrimp and humpy shrimp was greatest during the hours with more light, 0800–1600 h. In the 30–60 m stratum, the percentage of early-stage larvae of king crab, northern shrimp, and humpy shrimp was lowest during the period of low light levels and highest during the period of high light levels (1000–1600 h). Too few of the other stages of king crab, northern shrimp, or humpy shrimp larvae were in the 22-h samples to determine their diel vertical distributions.

Temperature profiles in the study area were similar throughout the 22-h sampling period (Fig. 29B): A pronounced thermocline was present from the surface to 10 m, and water below 10 m was nearly isothermal. A thermocline may hinder or prevent vertical migration of some zooplankton (Vinogradov 1968; Mauchline and Fisher 1969); however, early-stage larvae of king crab, northern shrimp, and humpy shrimp migrated up and down, through the thermocline.

CONCLUDING REMARKS

The question of whether larvae of king crab and pandalid shrimp remain in or migrate from Kachemak Bay needs further study. Undoubtedly, some larvae are carried out of the bay, both to the north and southwest. Although most larvae remain in the bay, the portion that migrates needs to be determined. Abundance and direction of dispersal of the pandalid larvae in the western portion of the study area also need to be assessed. Both the distribution and annual variation of abundance of the larvae in this area are unknown.

Studies on the identification of larvae of pandalid shrimp and king crab in the study area have provided detailed descriptions of the morphology of each larval stage so that identification of these stages in plankton collections is no longer a problem. Studies on the life histories of these forms, however, have provided little more than estimates of time of larval release, abundance of larvae, and dispersal of the larvae in relation to major oceanographic events in the Kachemak Bay-lower Cook Inlet area.

This study emphasizes our limited knowledge of the physical and biological processes affecting abundance of larvae in the Kachemak Bay-lower Cook Inlet area, especially factors related to their geographical and vertical distributions and seasonal changes in abundance.

ACKNOWLEDGMENTS

I thank Robert Gunter for helping me collect the 1972 samples and Catherine W. Mecklenburg for sorting many of them. The Alaska Department of Fish and Game, Coastal Habitat Section, provided funding and vessel support for the 1976 study. Mike Treesch, temporary biologist with Alaska Department of Fish and Game, helped me collect the 1976 samples and sorted many of them.

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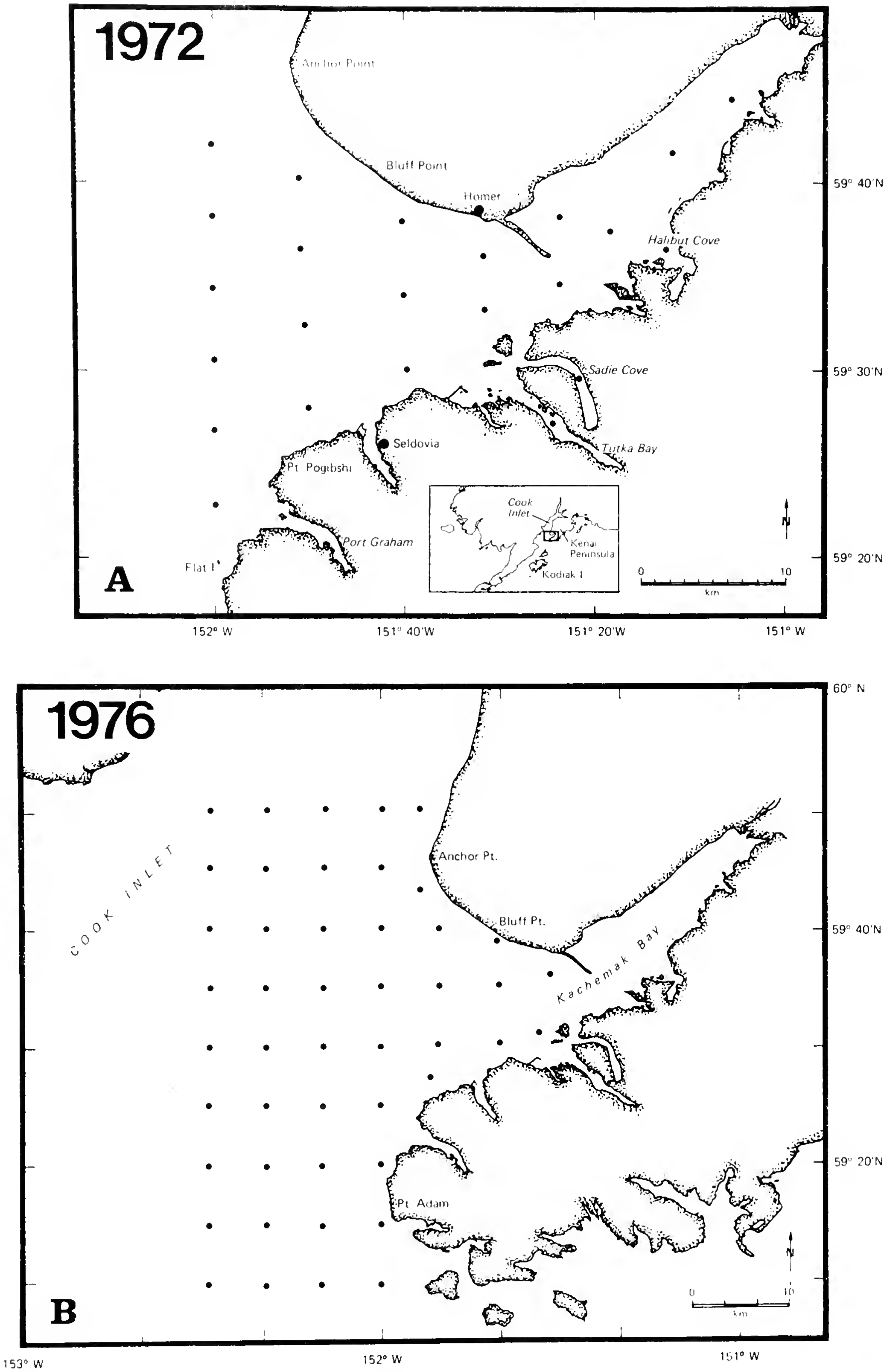


Figure 1.—Location of sampling stations used to determine relative abundance and distribution of larval king crab and pandalid shrimp in (A) Kachemak Bay, 1972, and (B) outer Kachemak Bay-lower Cook Inlet, 1976.

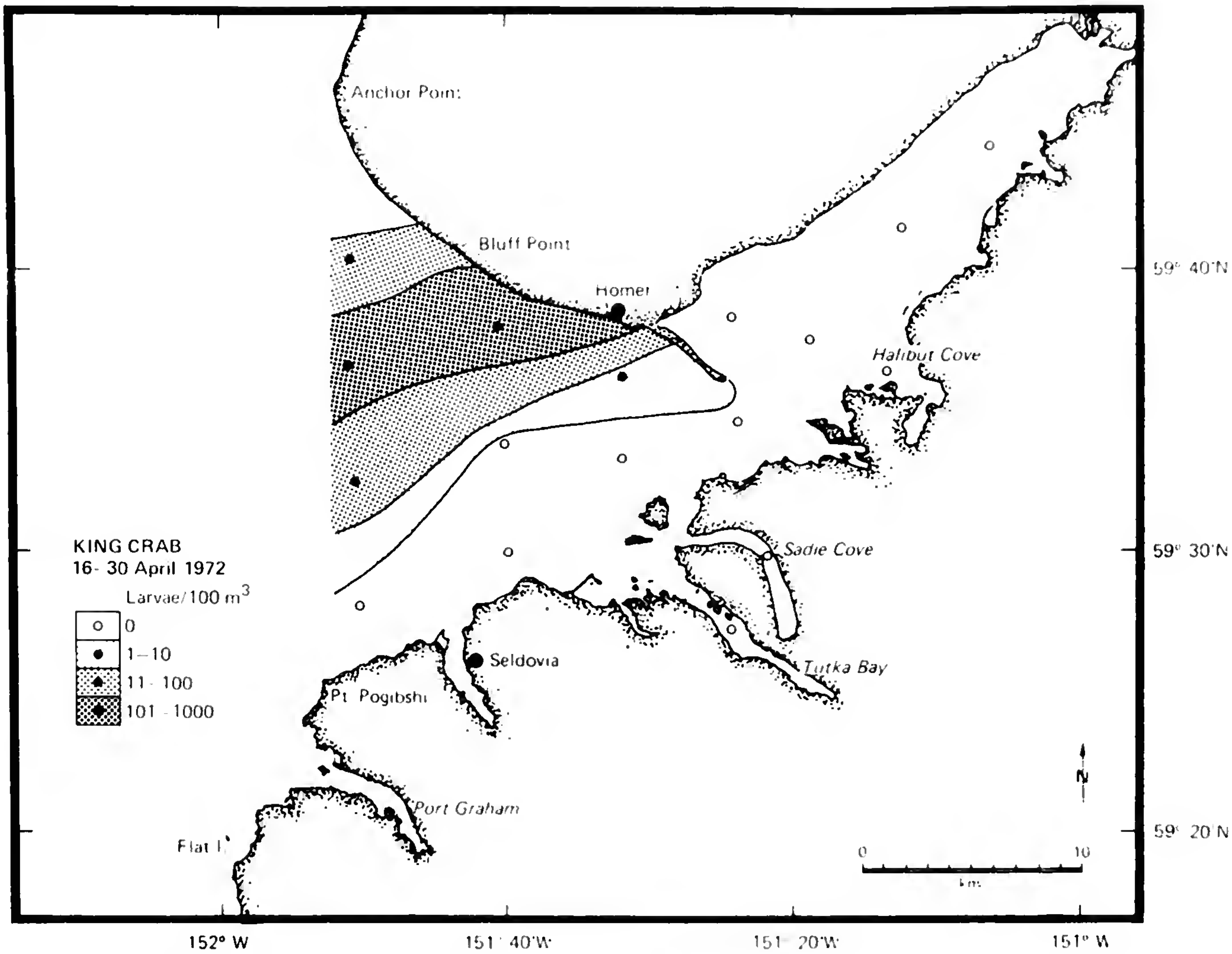
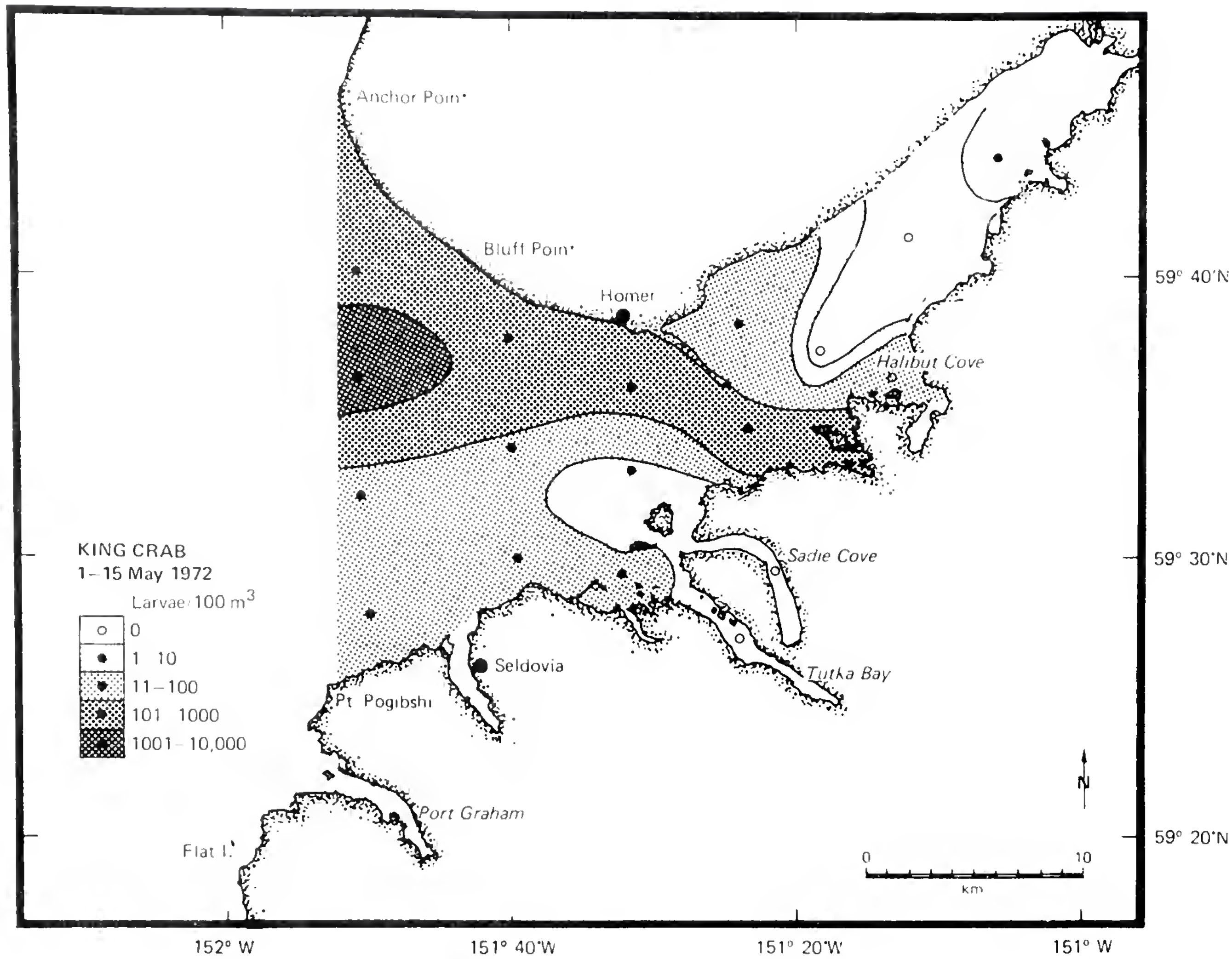


Figure 2.—Abundance and distribution of king crab larvae in Kachemak Bay, 16–30 April 1972.



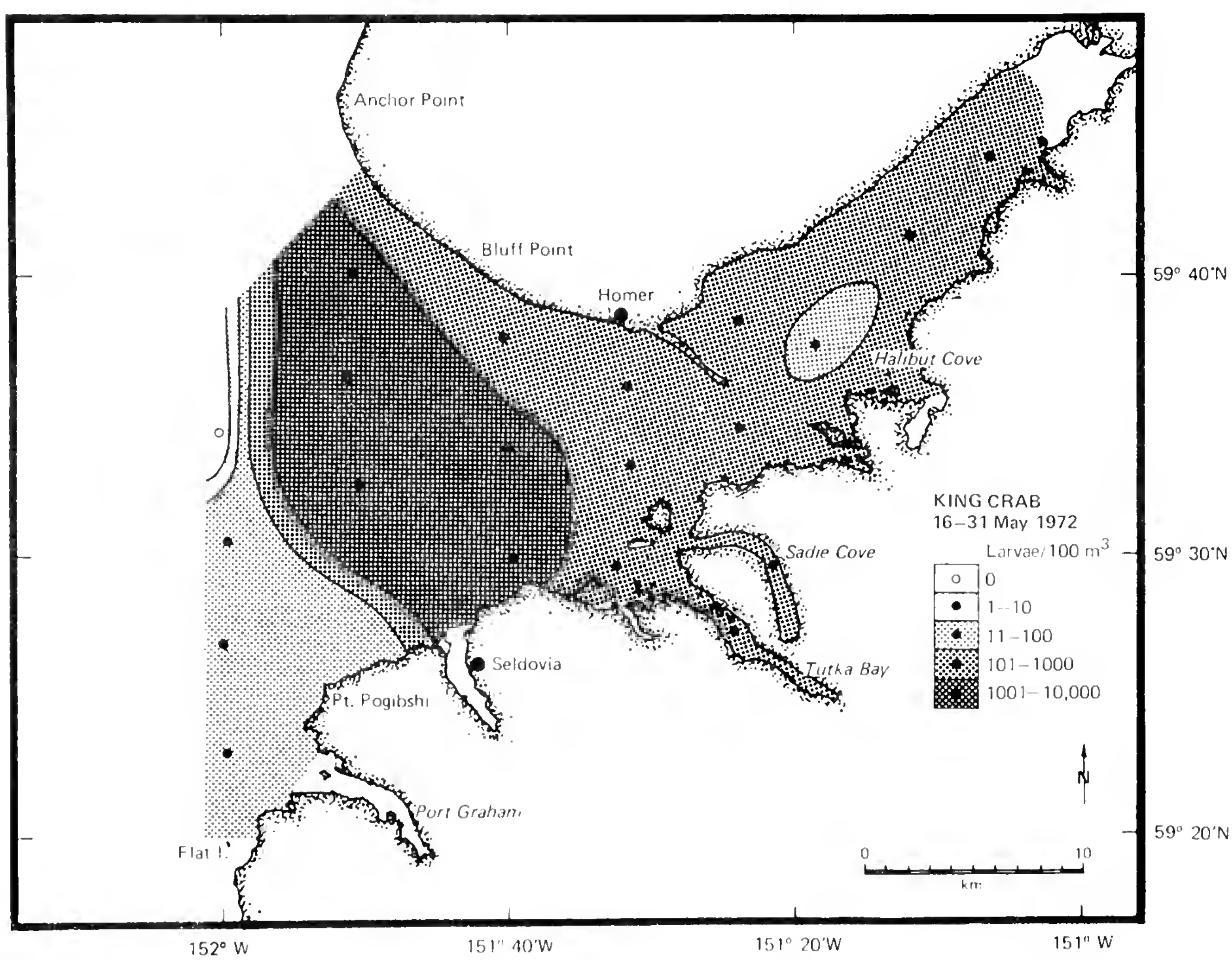


Figure 3.—Abundance and distribution of king crab larvae in Kachemak Bay, 1–15 and 16–31 May 1972.

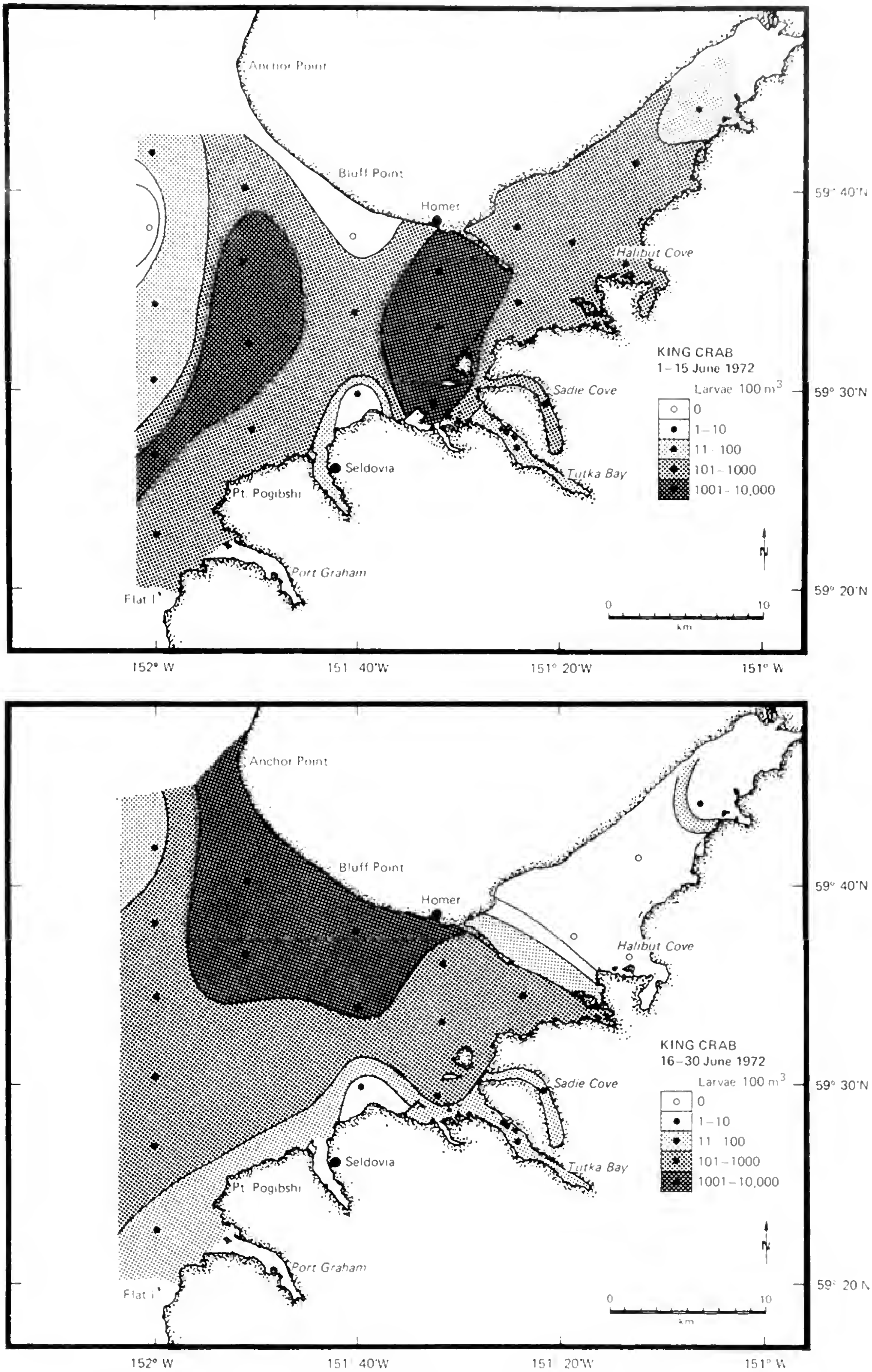


Figure 4.—Abundance and distribution of king crab larvae in Kachemak Bay, 1–15 and 16–30 June 1972.

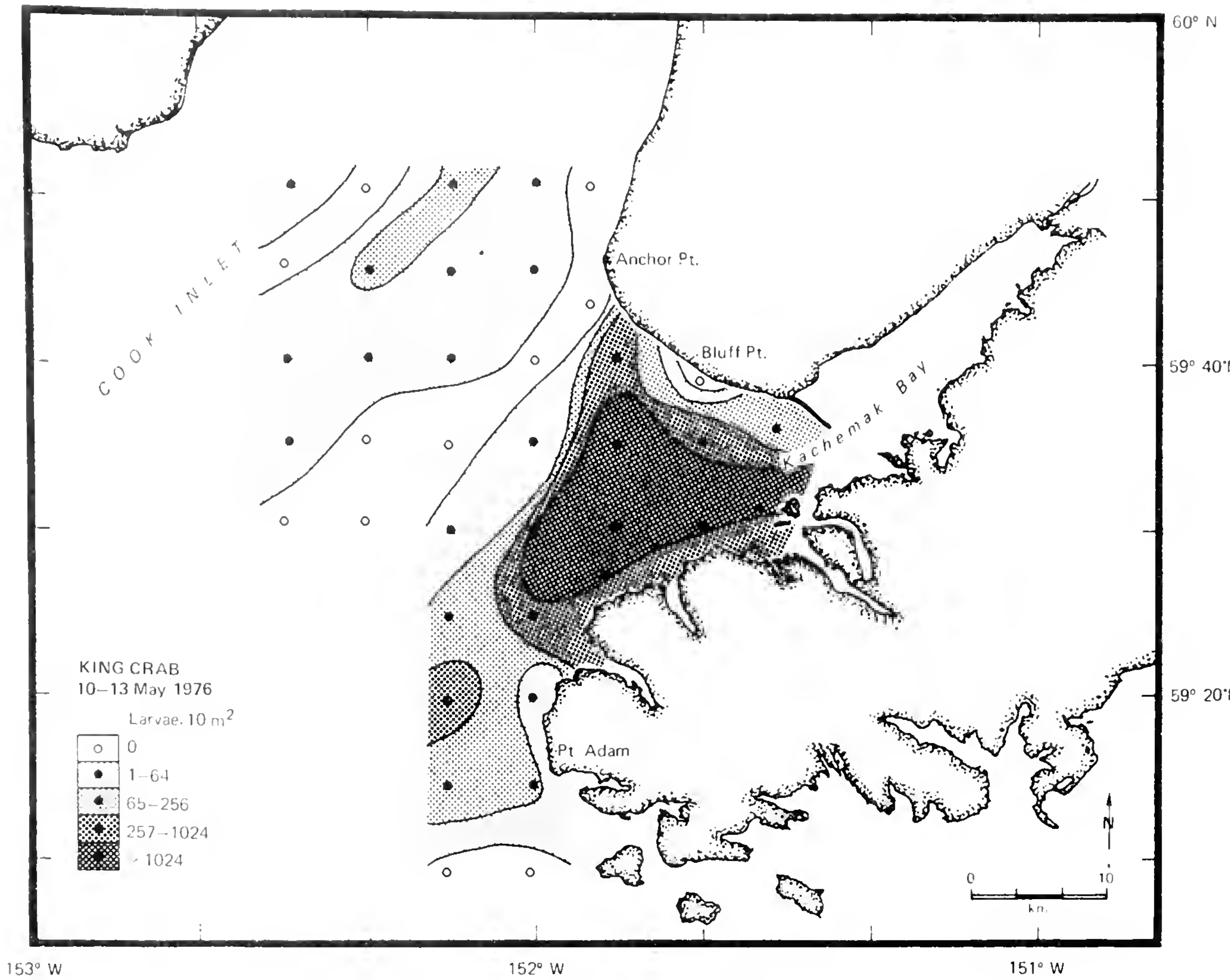


Figure 5.—Abundance and distribution of king crab larvae in Kachemak Bay, 10–13 May 1976.

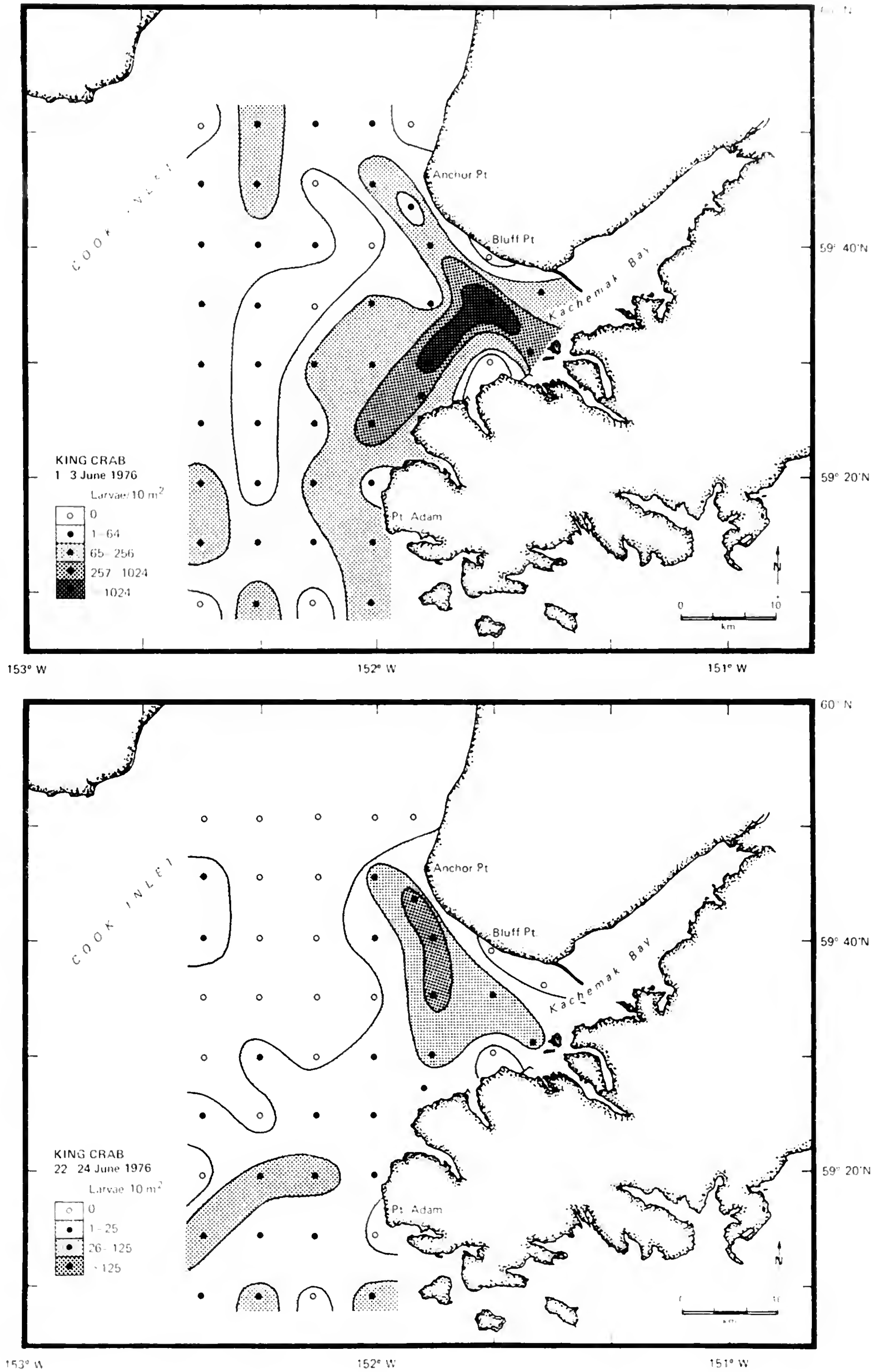


Figure 6.—Abundance and distribution of king crab larvae in outer Kachemak Bay-lower Cook Inlet, 1-3 and 22-24 June 1976.

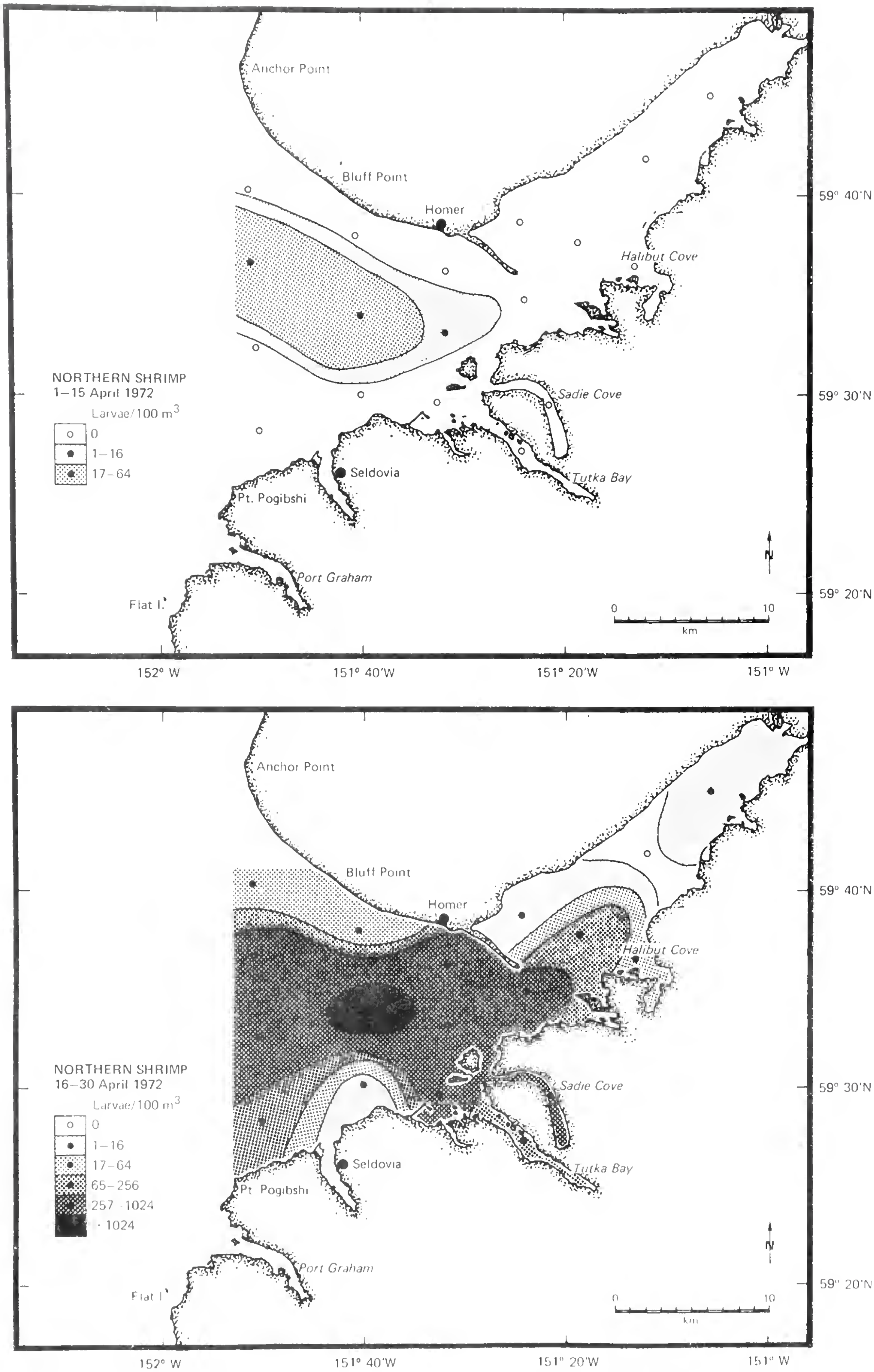
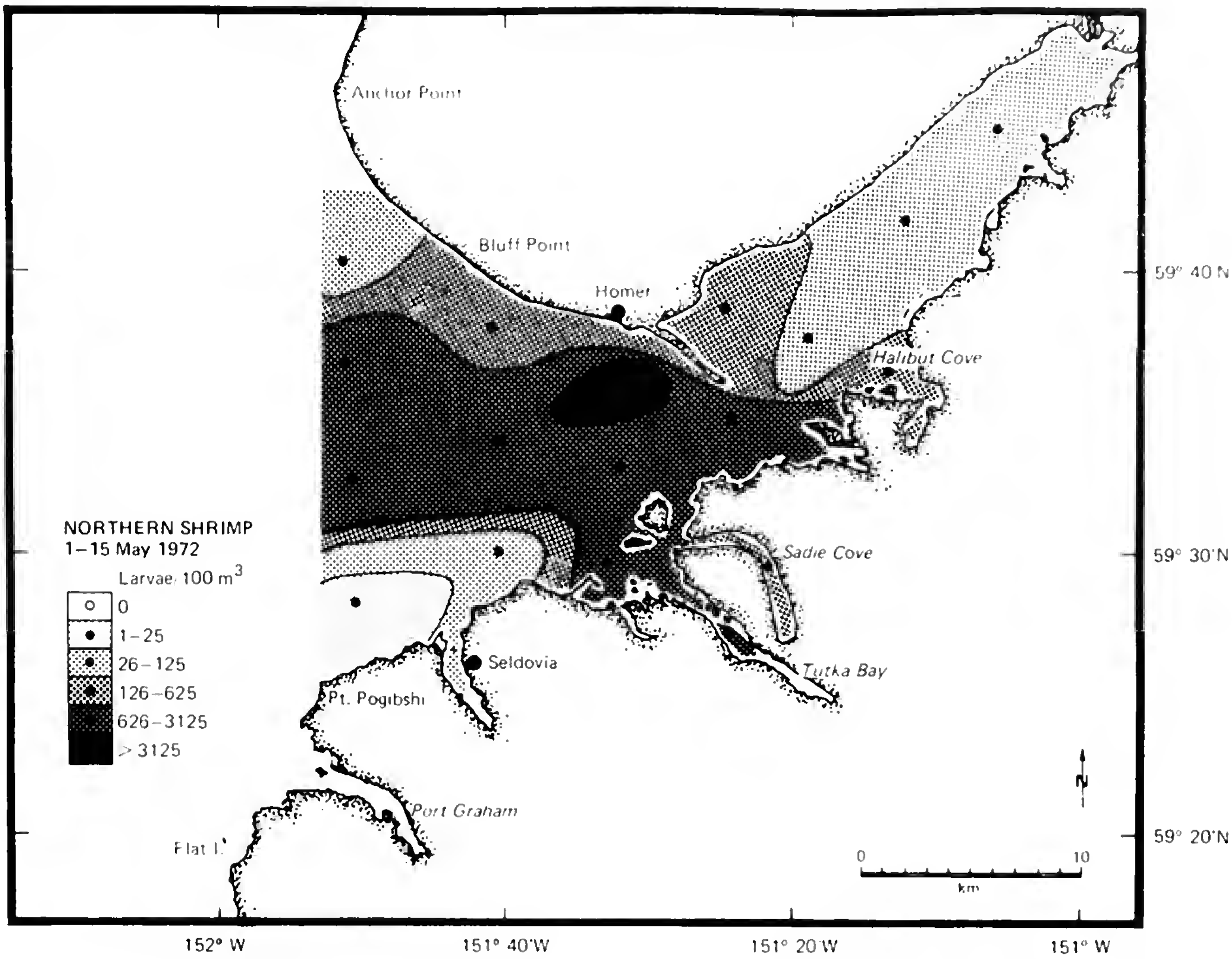


Figure 7.—Abundance and distribution of northern shrimp larvae in Kachemak Bay, 1–15 and 16–30 April 1972.



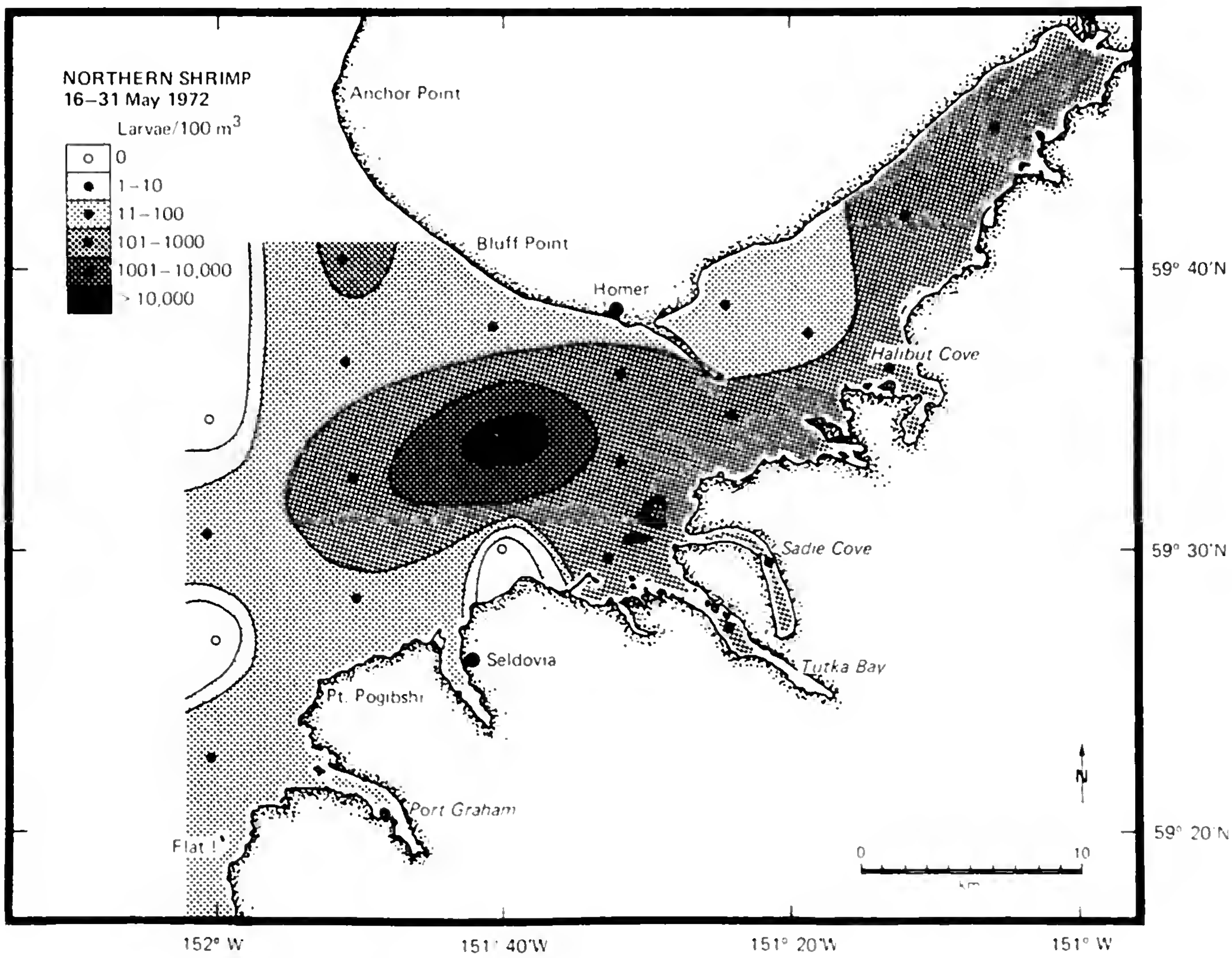


Figure 8.—Abundance and distribution of northern shrimp larvae in Kachemak Bay, 1–15 and 16–31 May 1972.

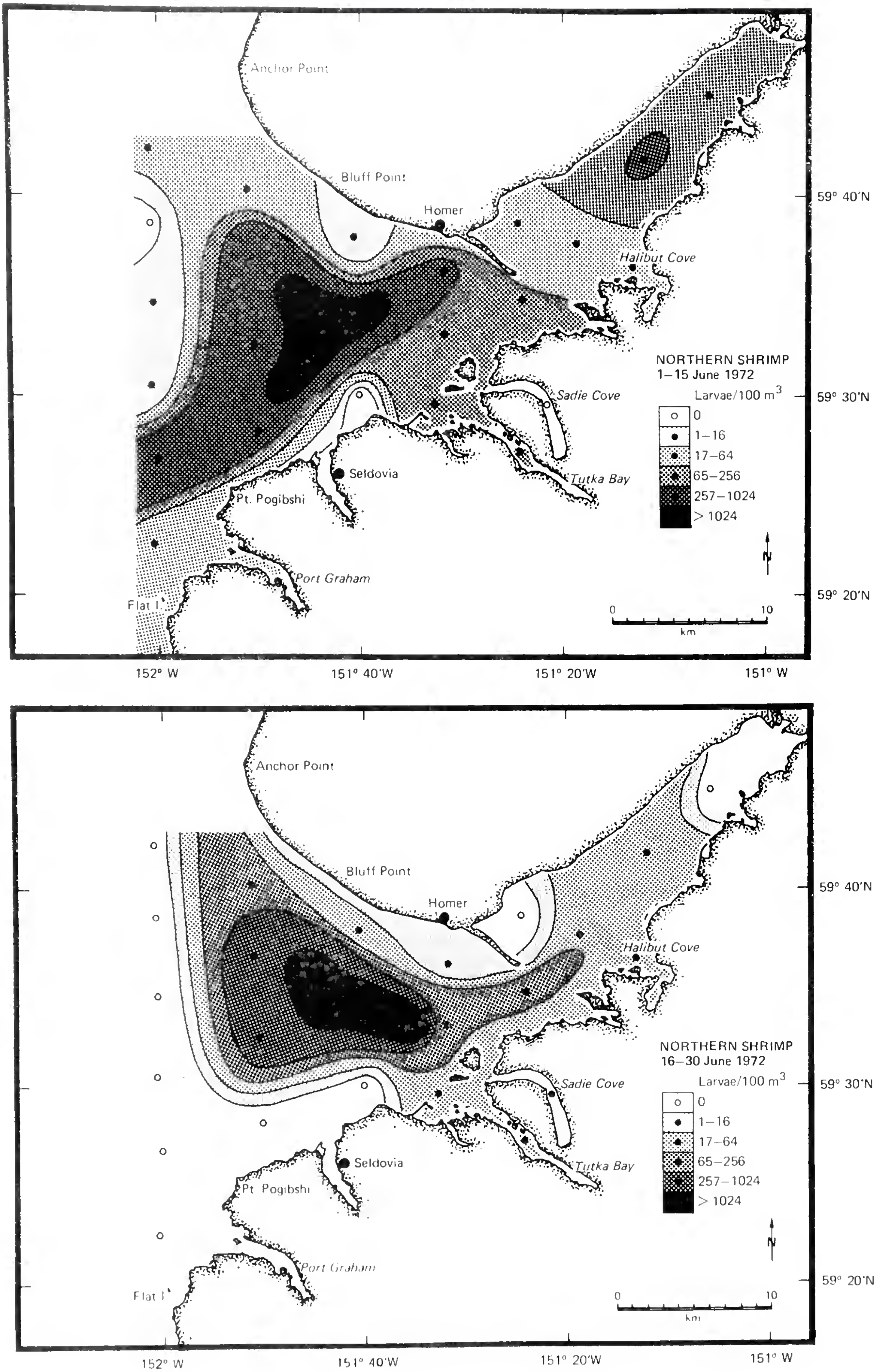


Figure 9.—Abundance and distribution of northern shrimp larvae in Kachemak Bay, 1–15 and 16–30 June 1972.

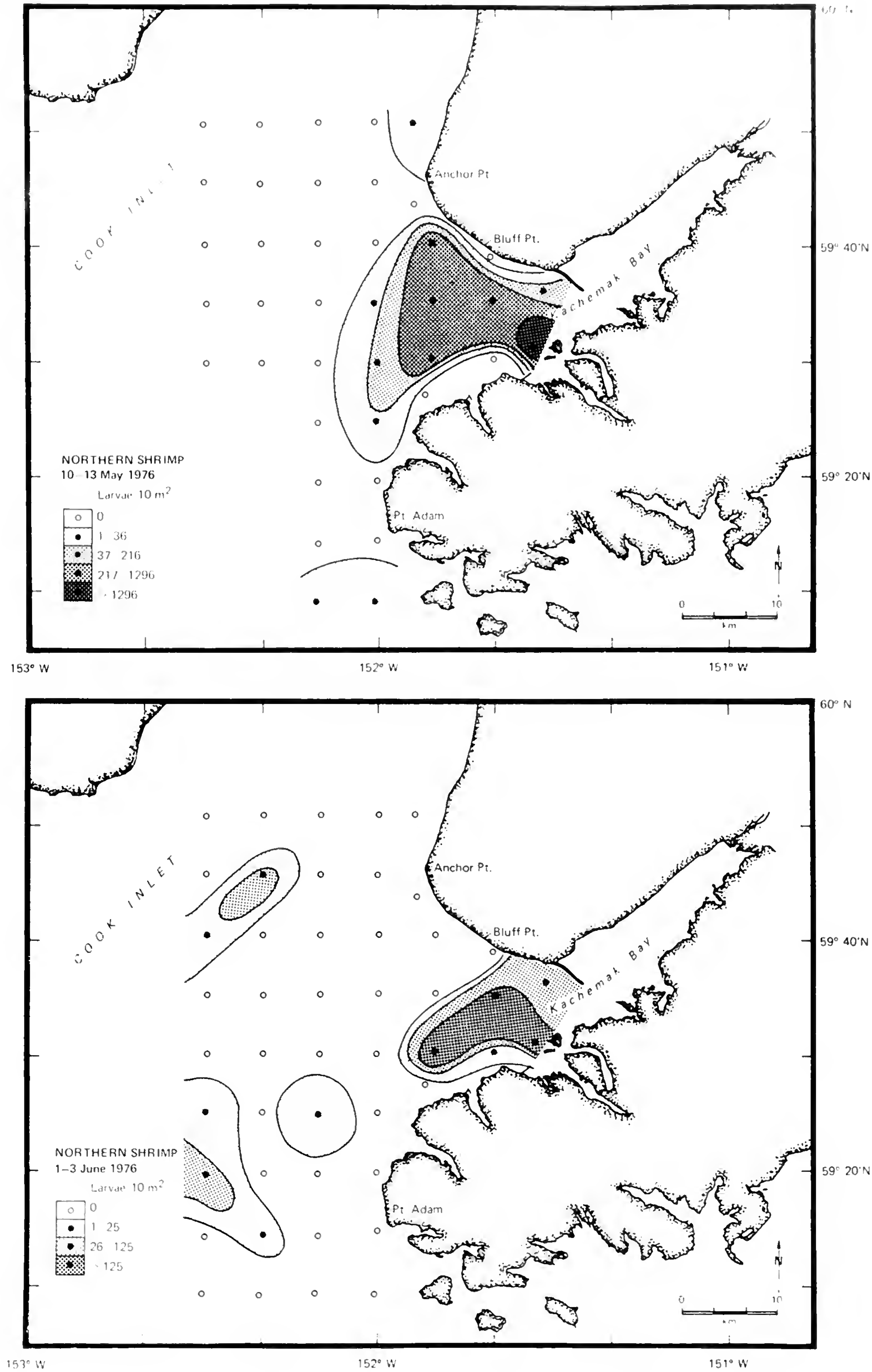


Figure 10.—Abundance and distribution of northern shrimp larvae in outer Kachemak Bay-lower Cook Inlet, 10–13 May and 1–3 June 1976.

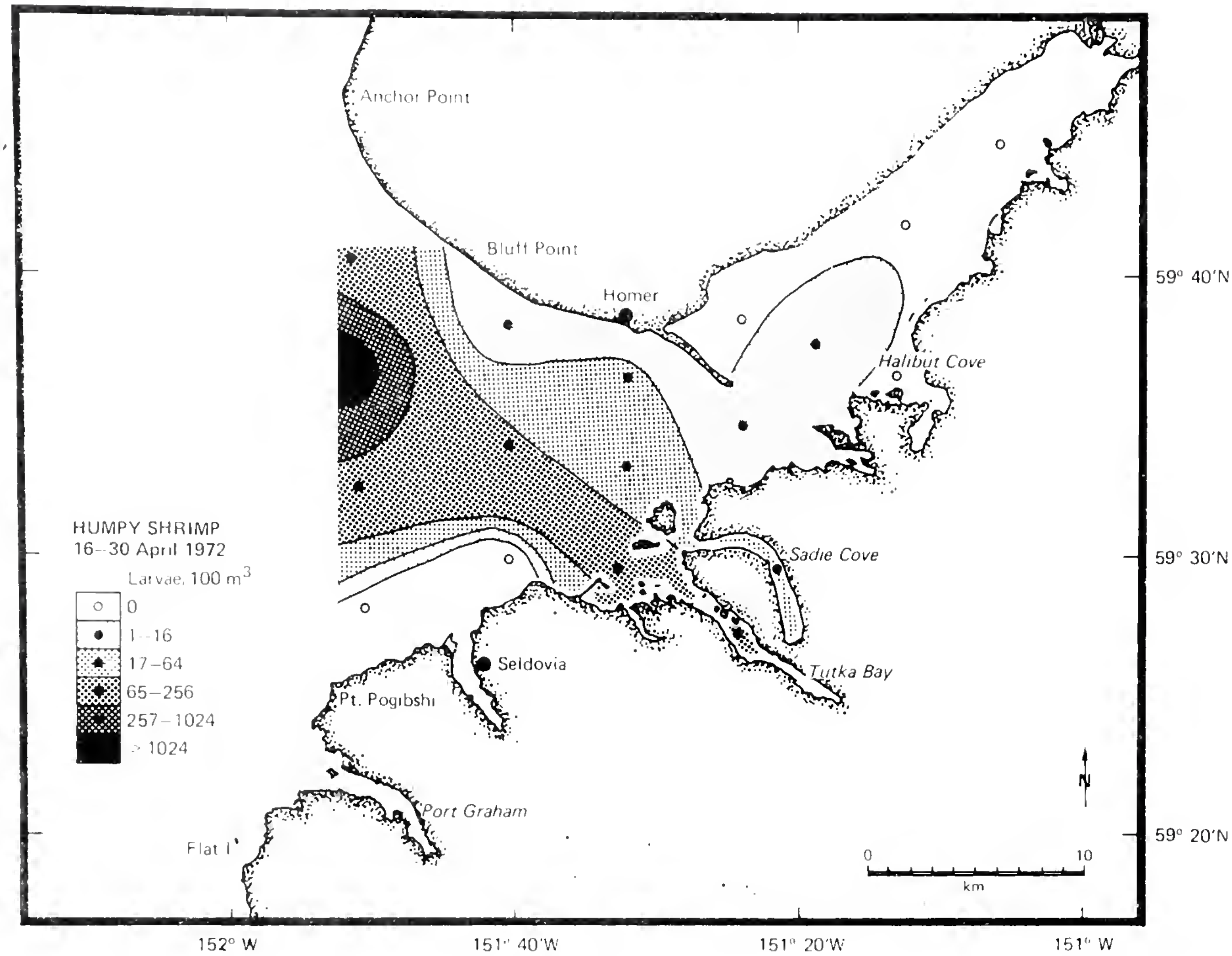
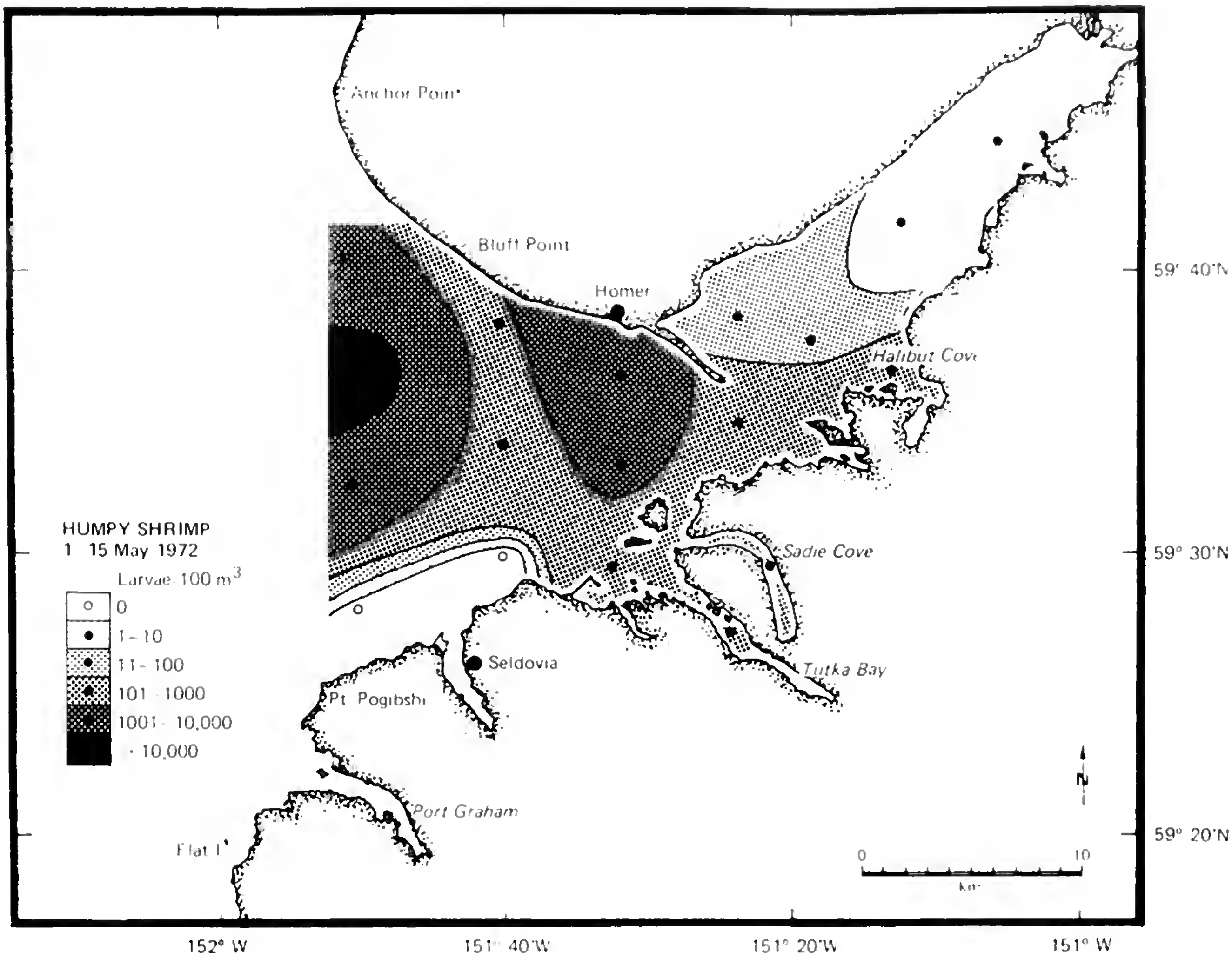


Figure 11.—Abundance and distribution of humpy shrimp larvae in Kachemak Bay, 16–30 April 1972.



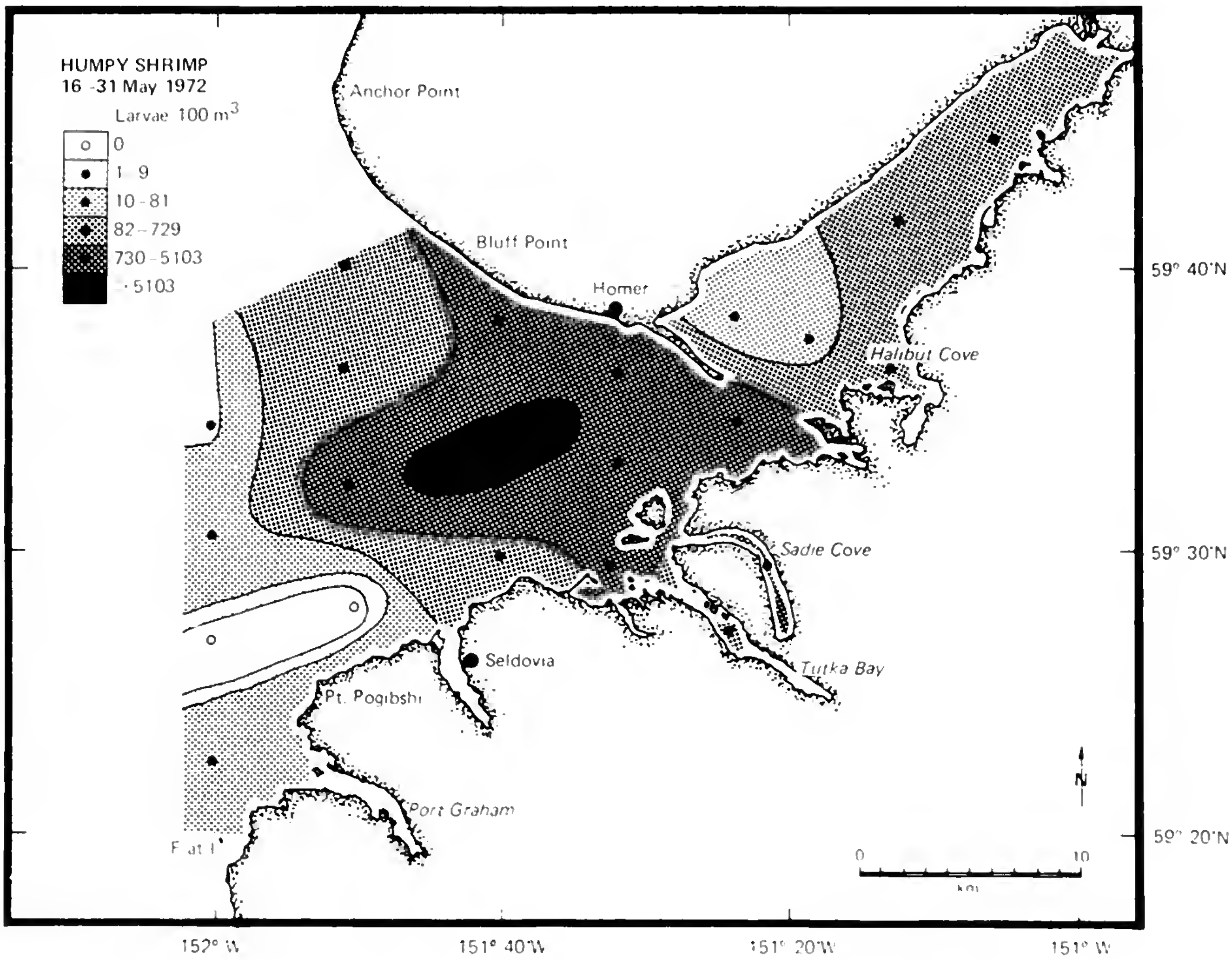
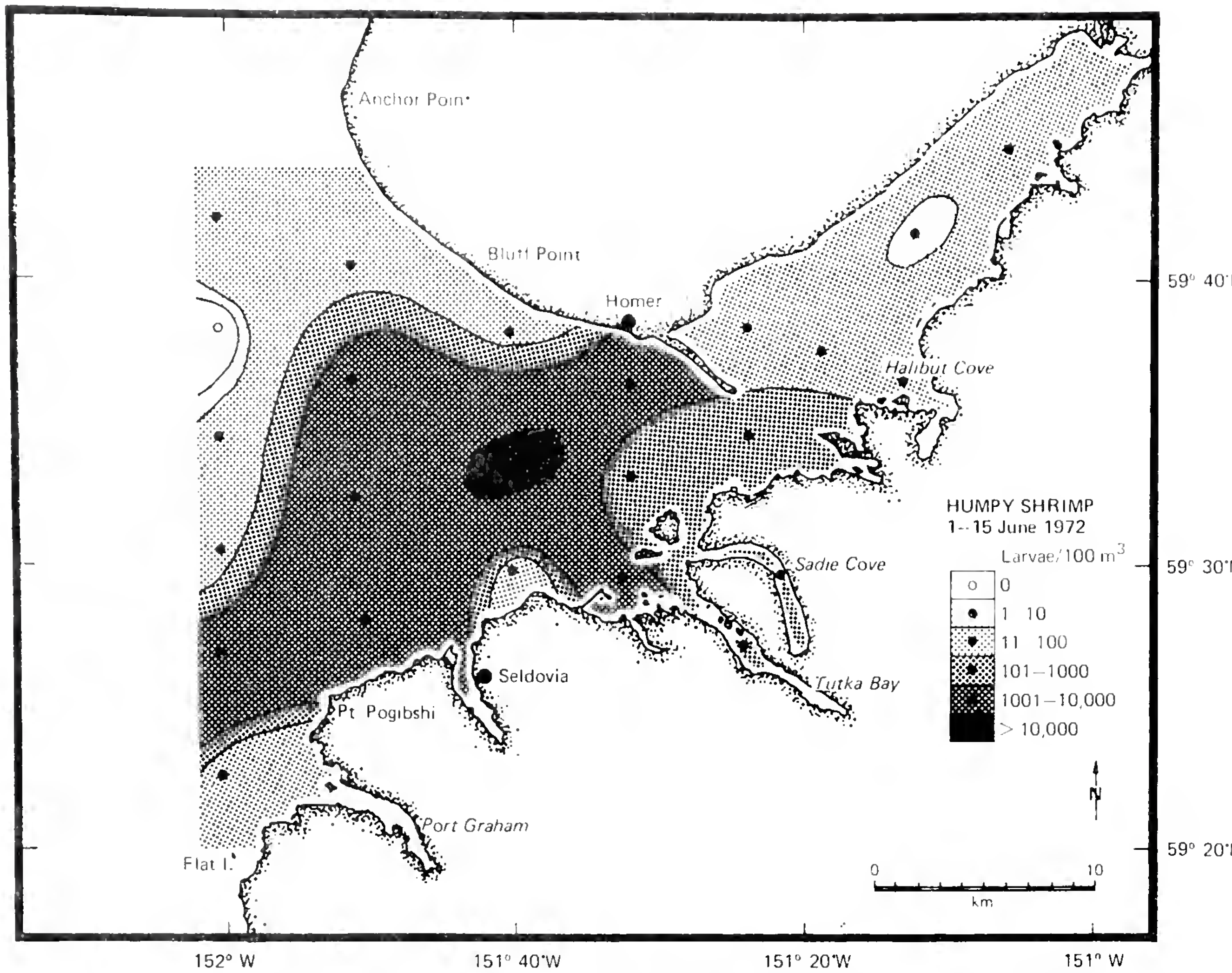


Figure 12.—Abundance and distribution of humpy shrimp larvae in Kachemak Bay, 1-15 and 16-31 May 1972.



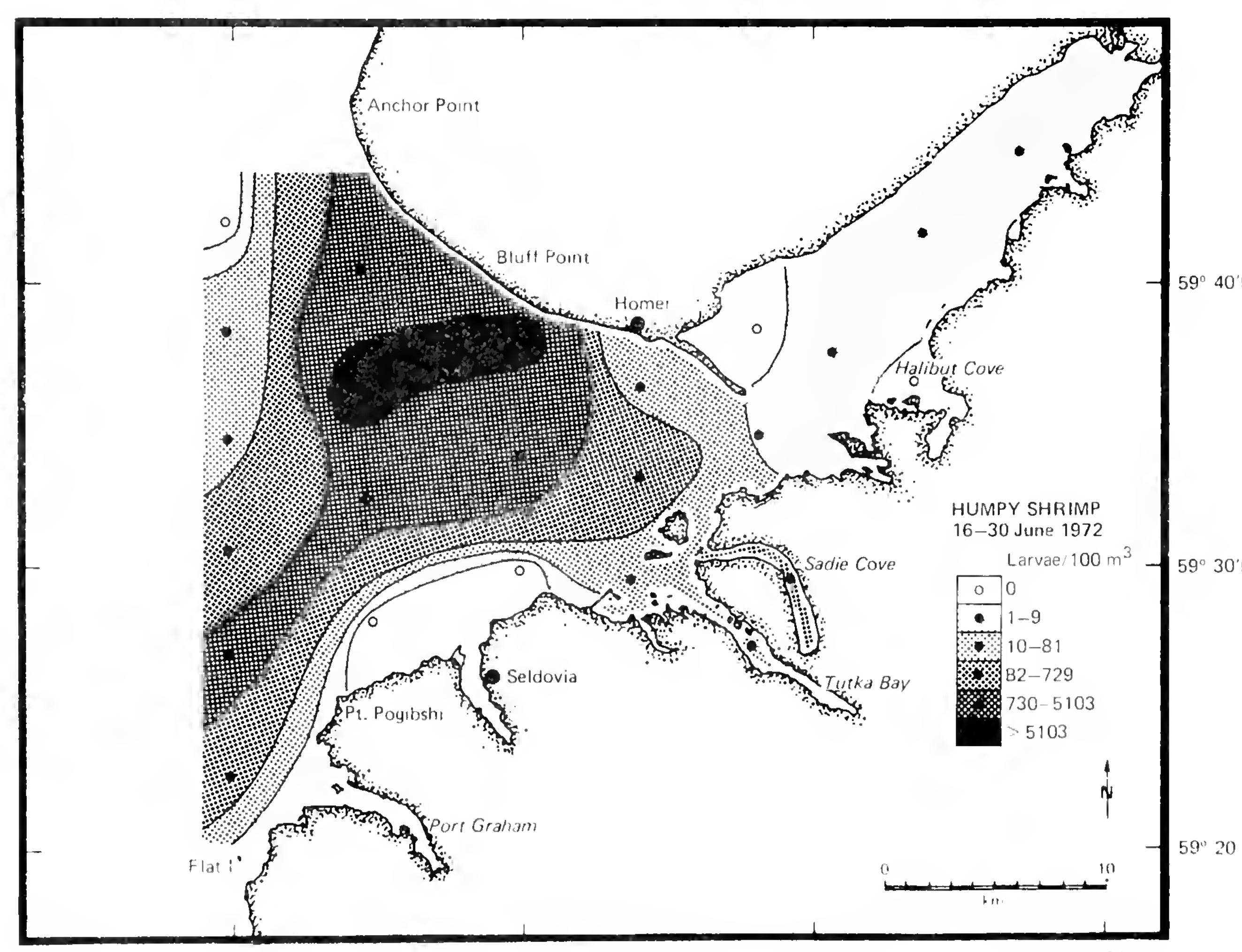


Figure 13.—Abundance and distribution of humpy shrimp larvae in Kachemak Bay, 1–15 and 16–30 June 1972.

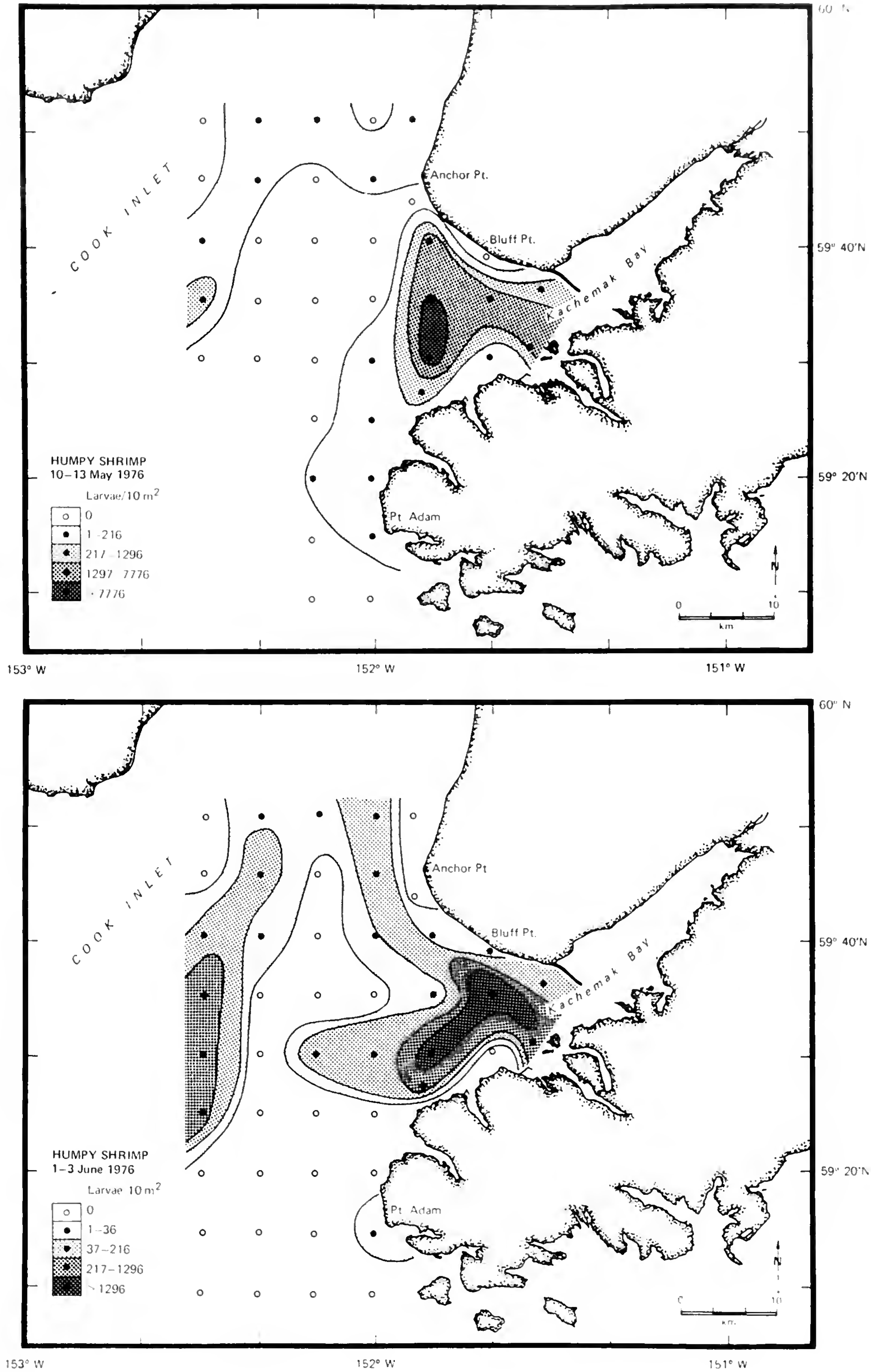


Figure 14.—Abundance and distribution of humpy shrimp larvae in outer Kachemak Bay-lower Cook Inlet, 10–13 May and 1–3 June 1976.

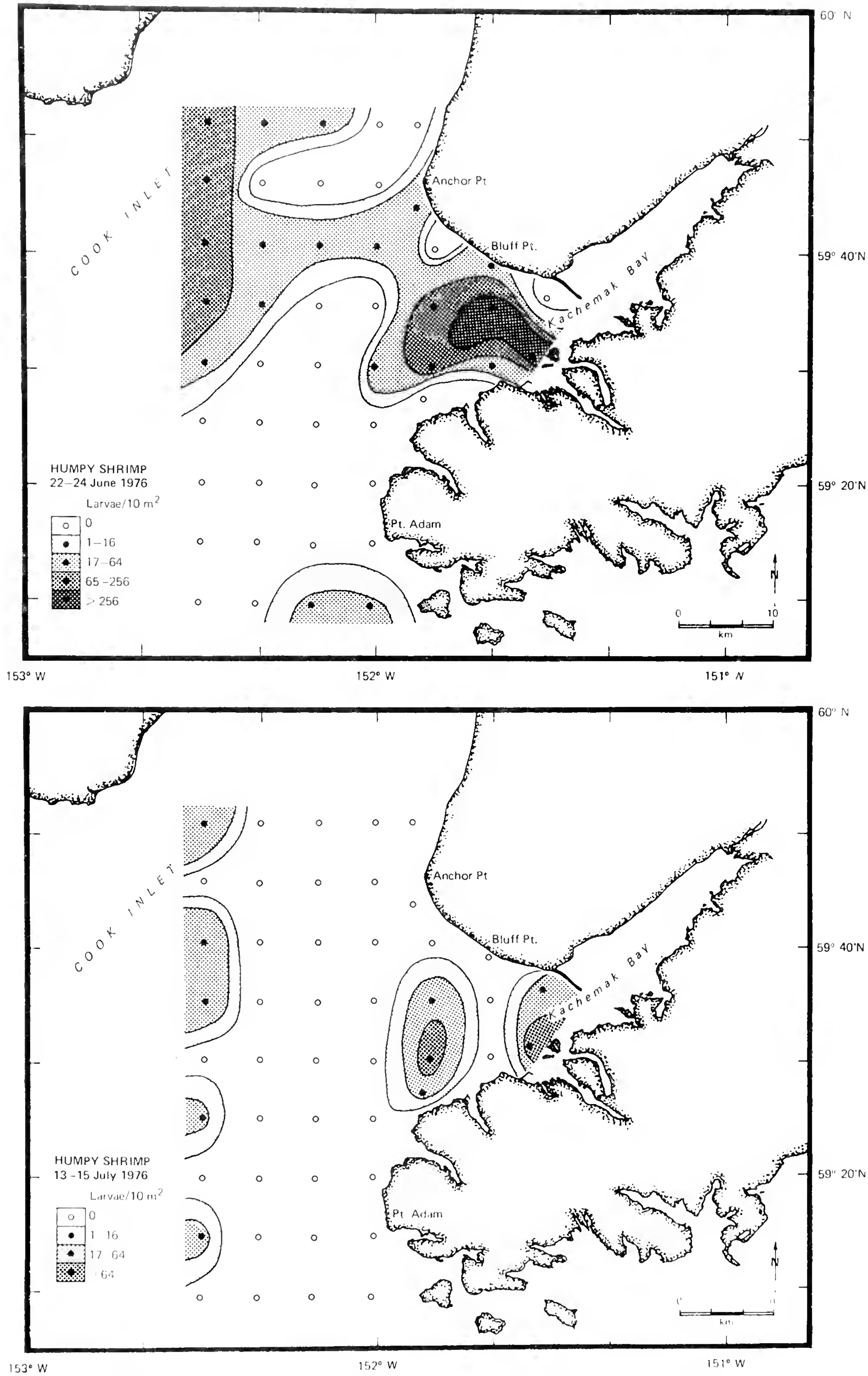


Figure 15.—Abundance and distribution of humpy shrimp larvae in outer Kachemak Bay-lower Cook Inlet, 22–24 June and 13–15 July 1976.

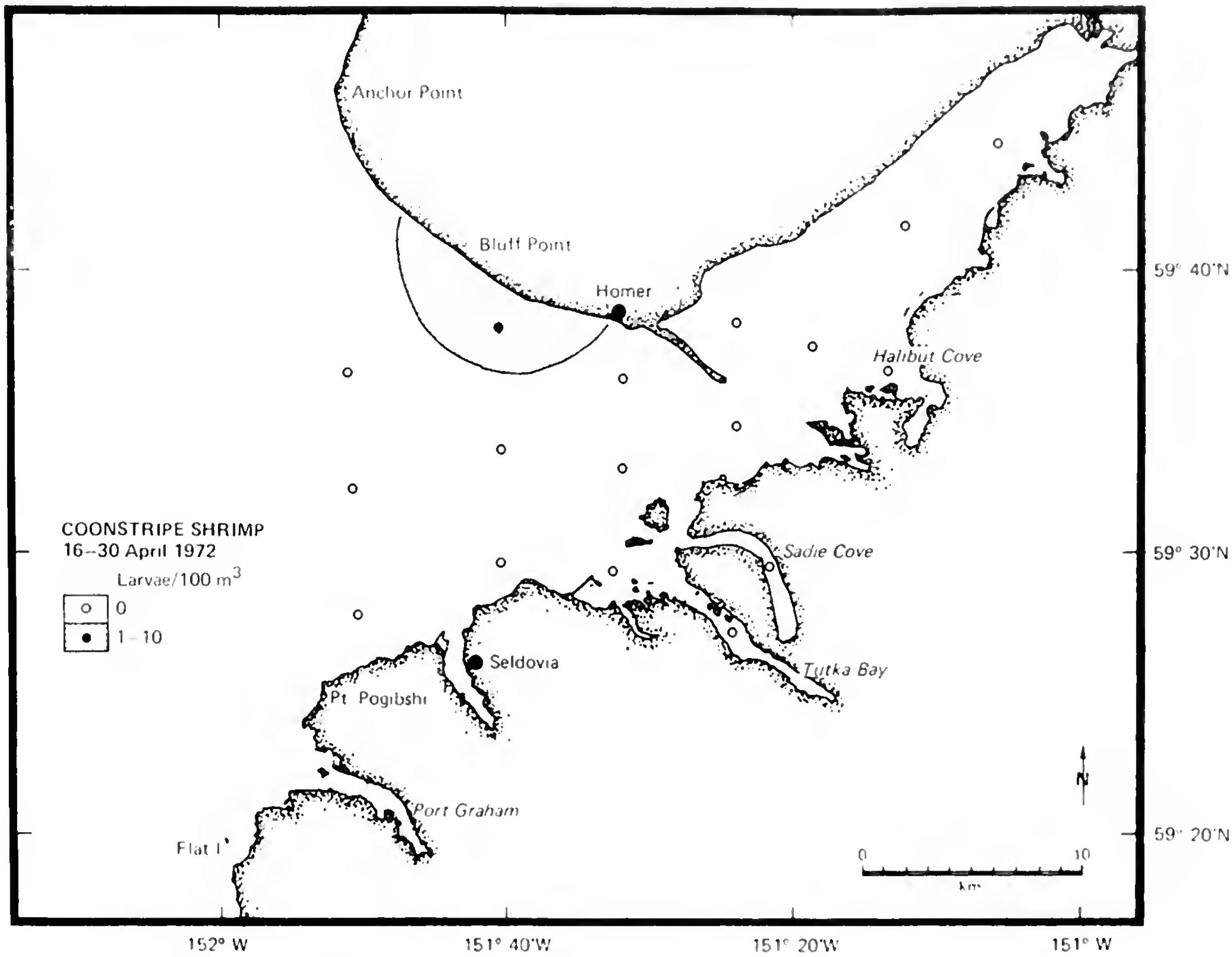
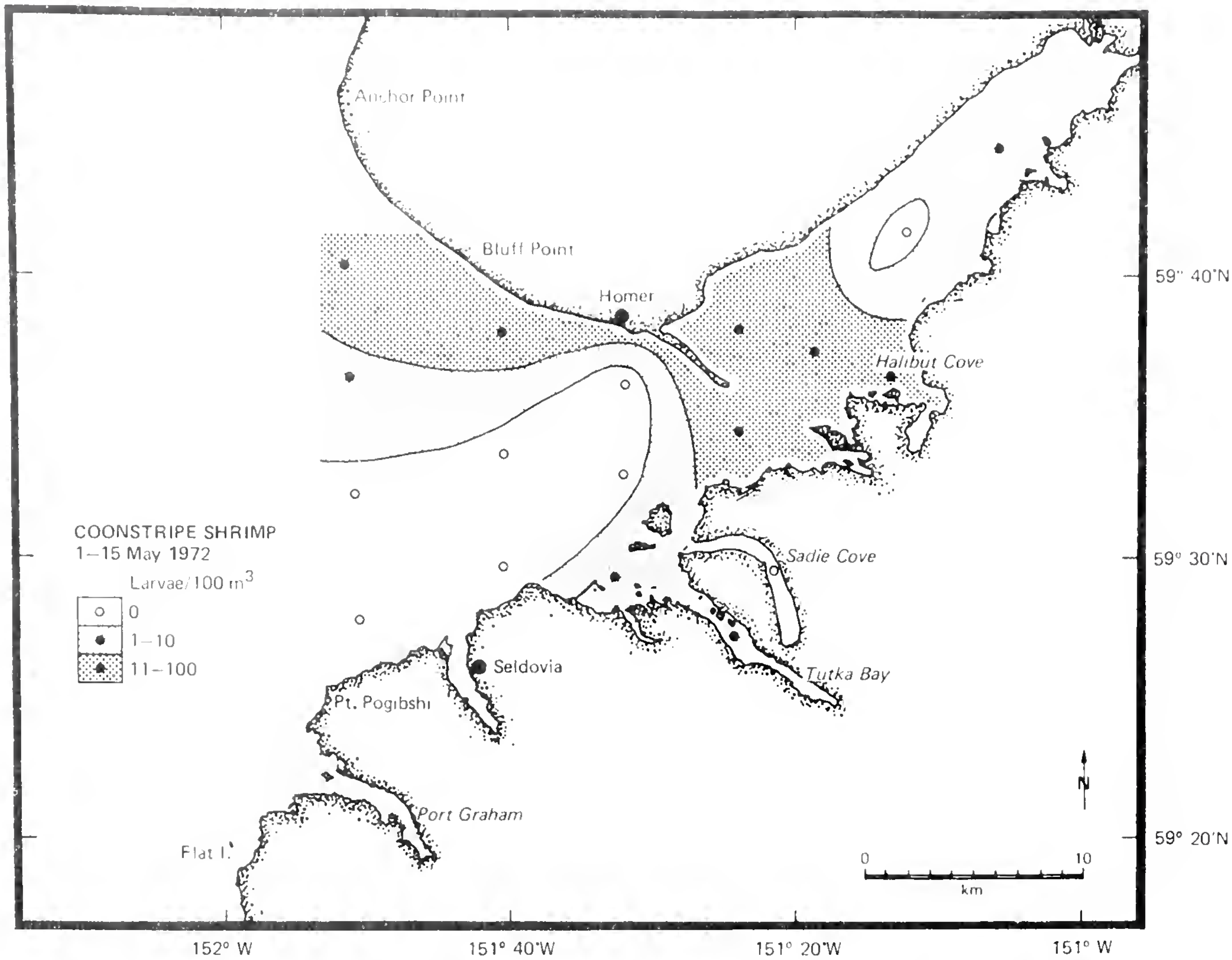


Figure 16.—Abundance and distribution of coonstripe shrimp larvae in Kachemak Bay, 16–30 April 1972.



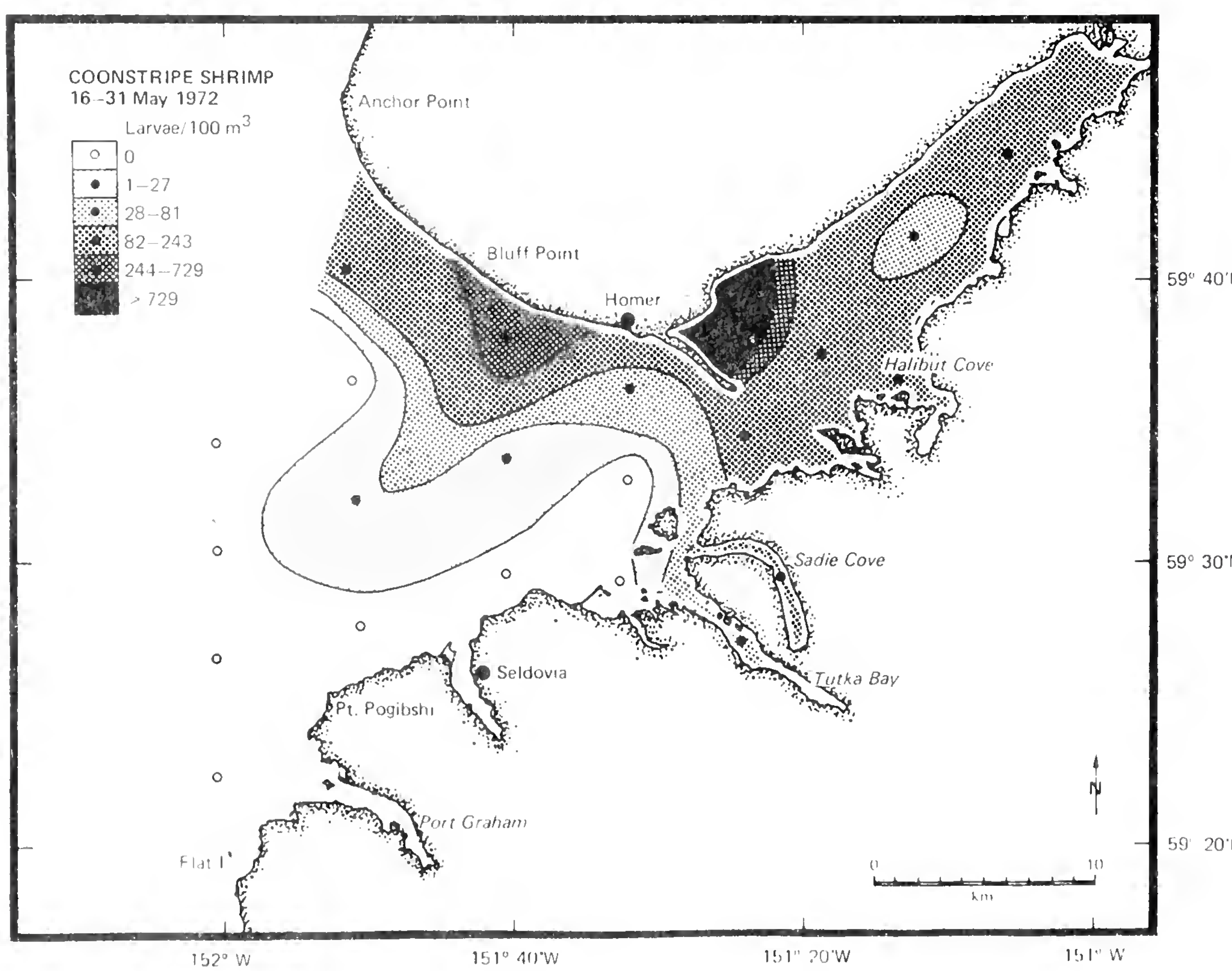


Figure 17.—Abundance and distribution of coonstripe shrimp larvae in Kachemak Bay, 1–15 and 16–31 May 1972.

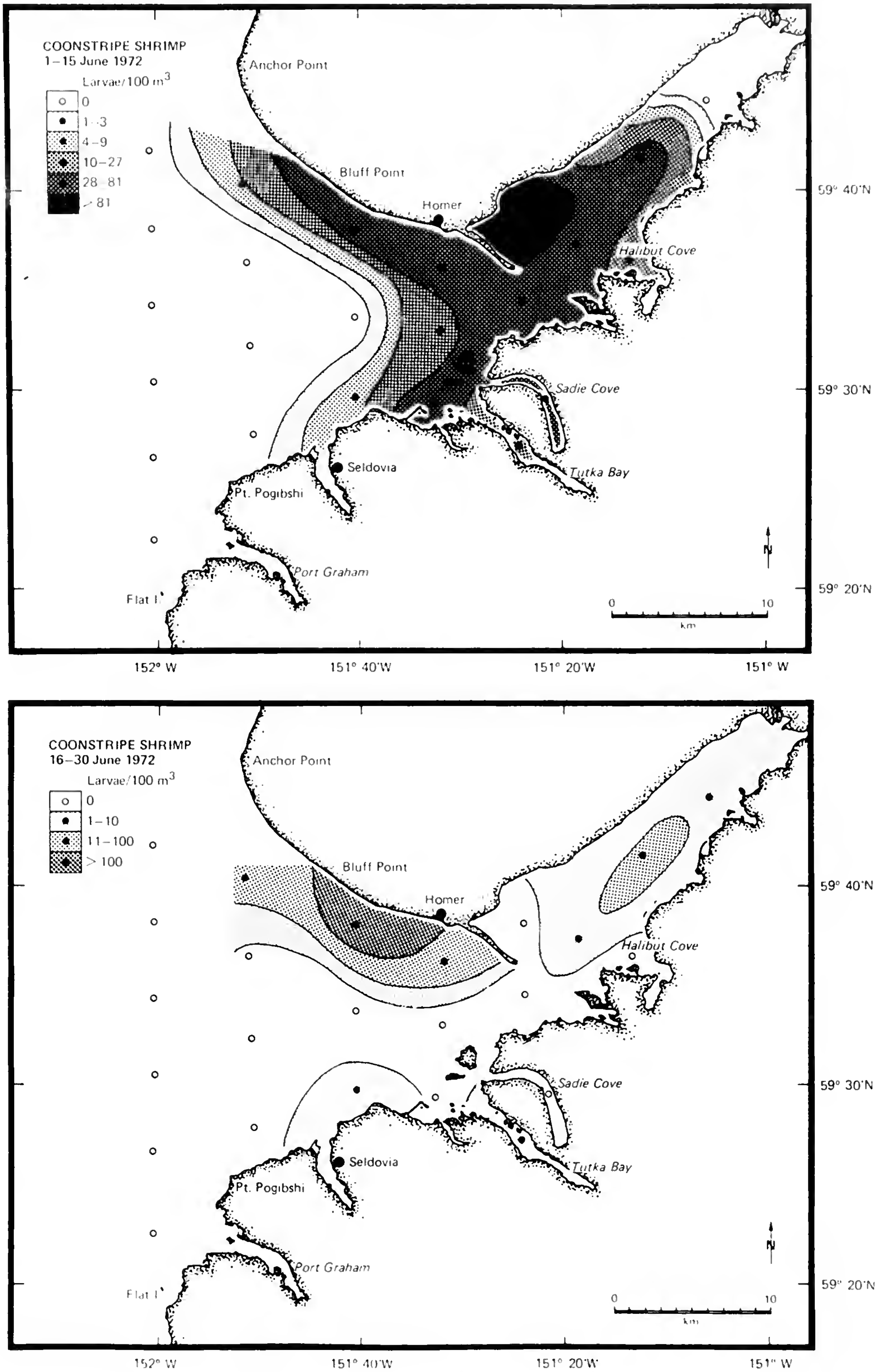


Figure 18.—Abundance and distribution of coonstripe shrimp larvae in Kachemak Bay, 1–15 and 16–30 June 1972.

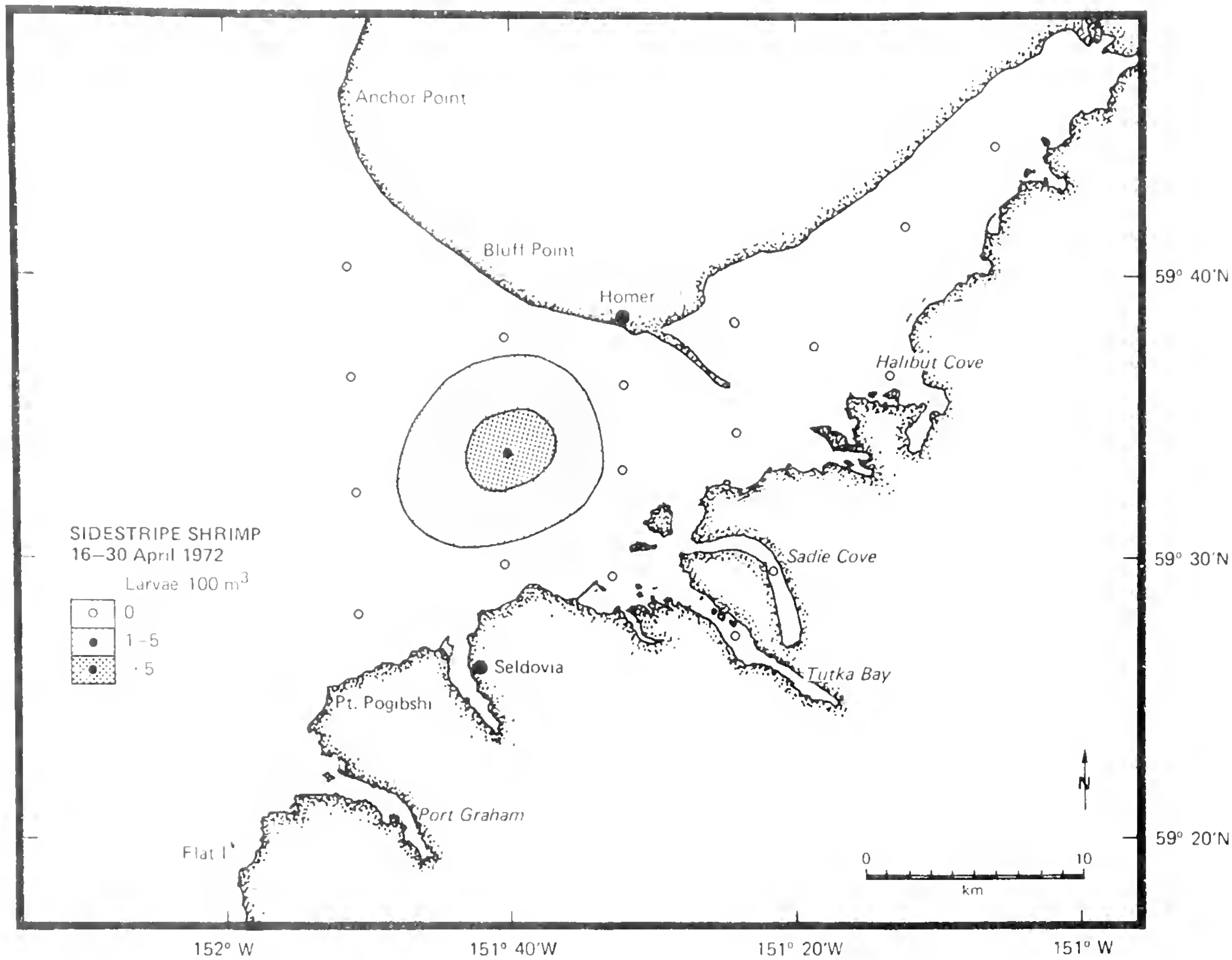


Figure 19.—Abundance and distribution of sidestripe shrimp larvae in Kachemak Bay, 16–30 April 1972.

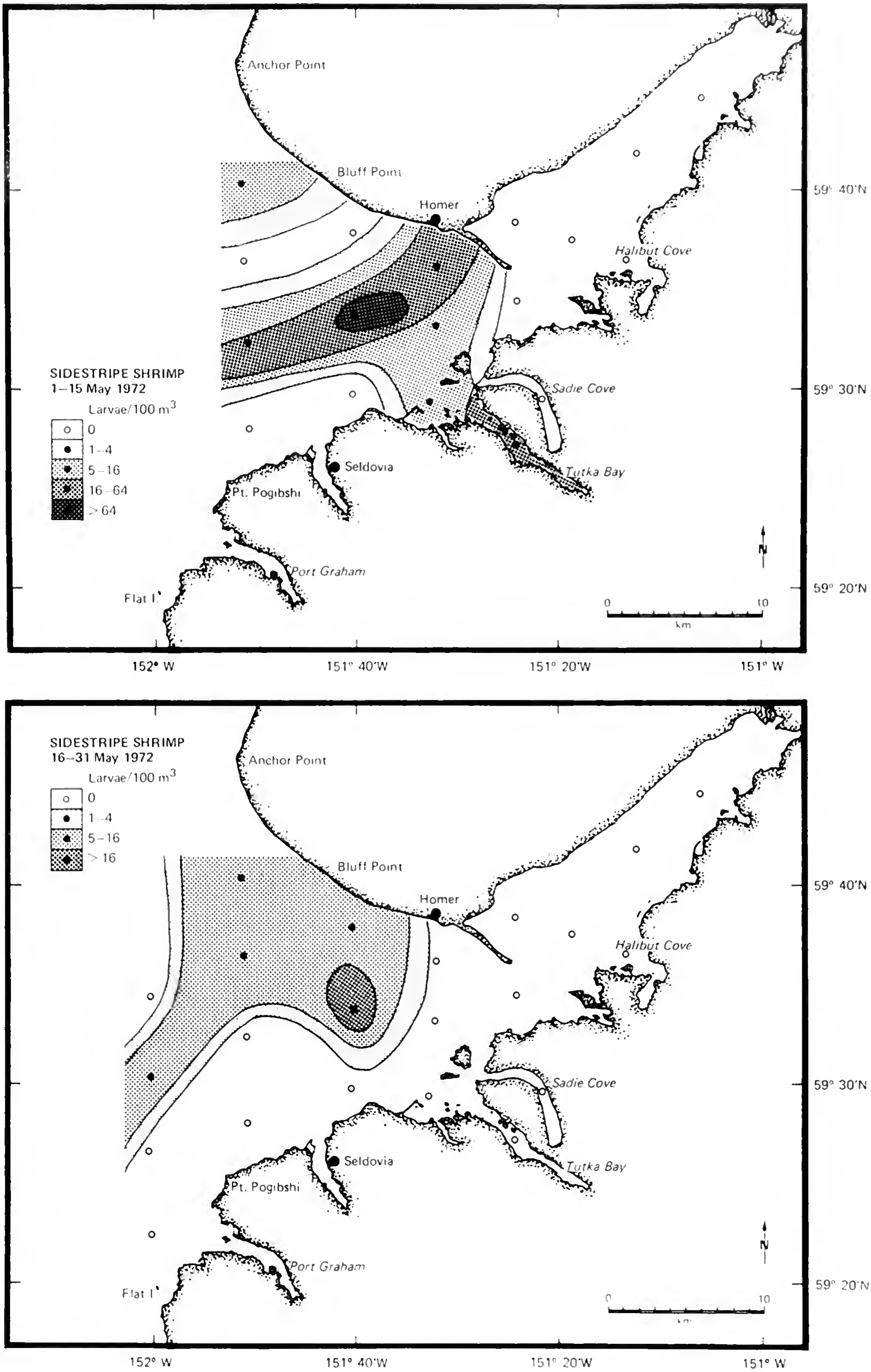


Figure 20.—Abundance and distribution of sidestripe shrimp larvae in Kachemak Bay, 1–15 and 16–31 May 1972.

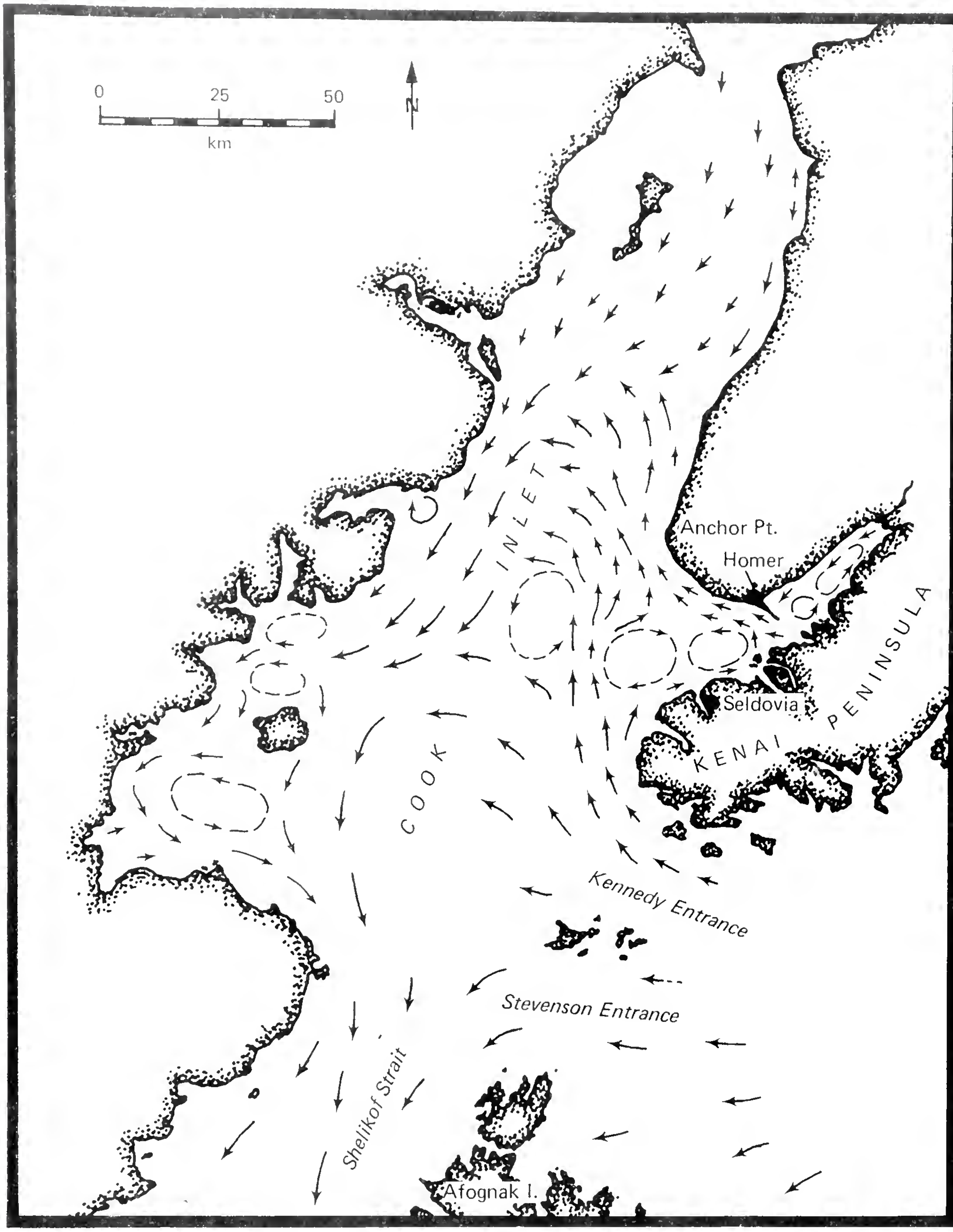
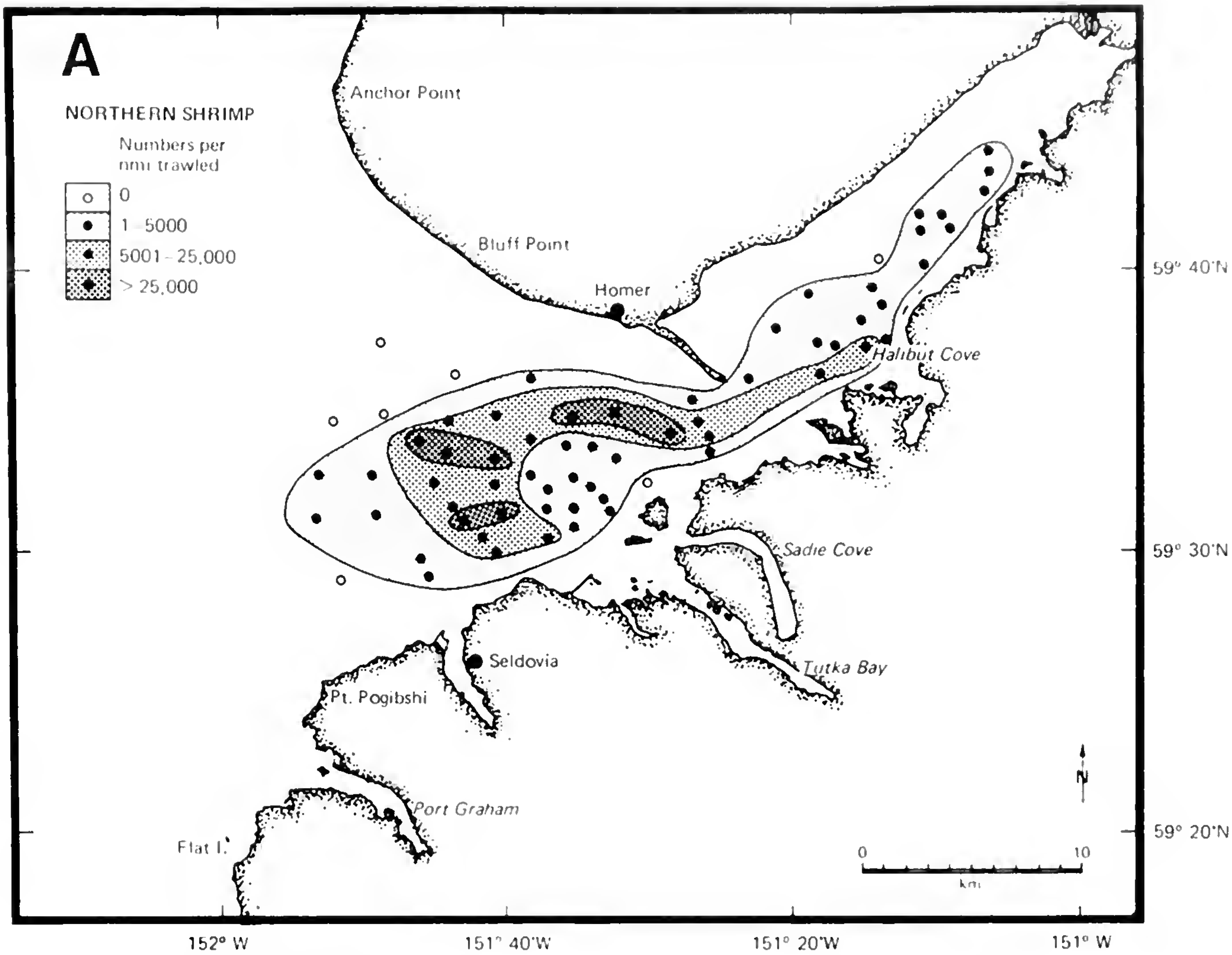


Figure 21.—Net circulation of surface water in Kachemak Bay-lower Cook Inlet area. Data collected during the spring and summer seasons (adapted from Burbank 1977).



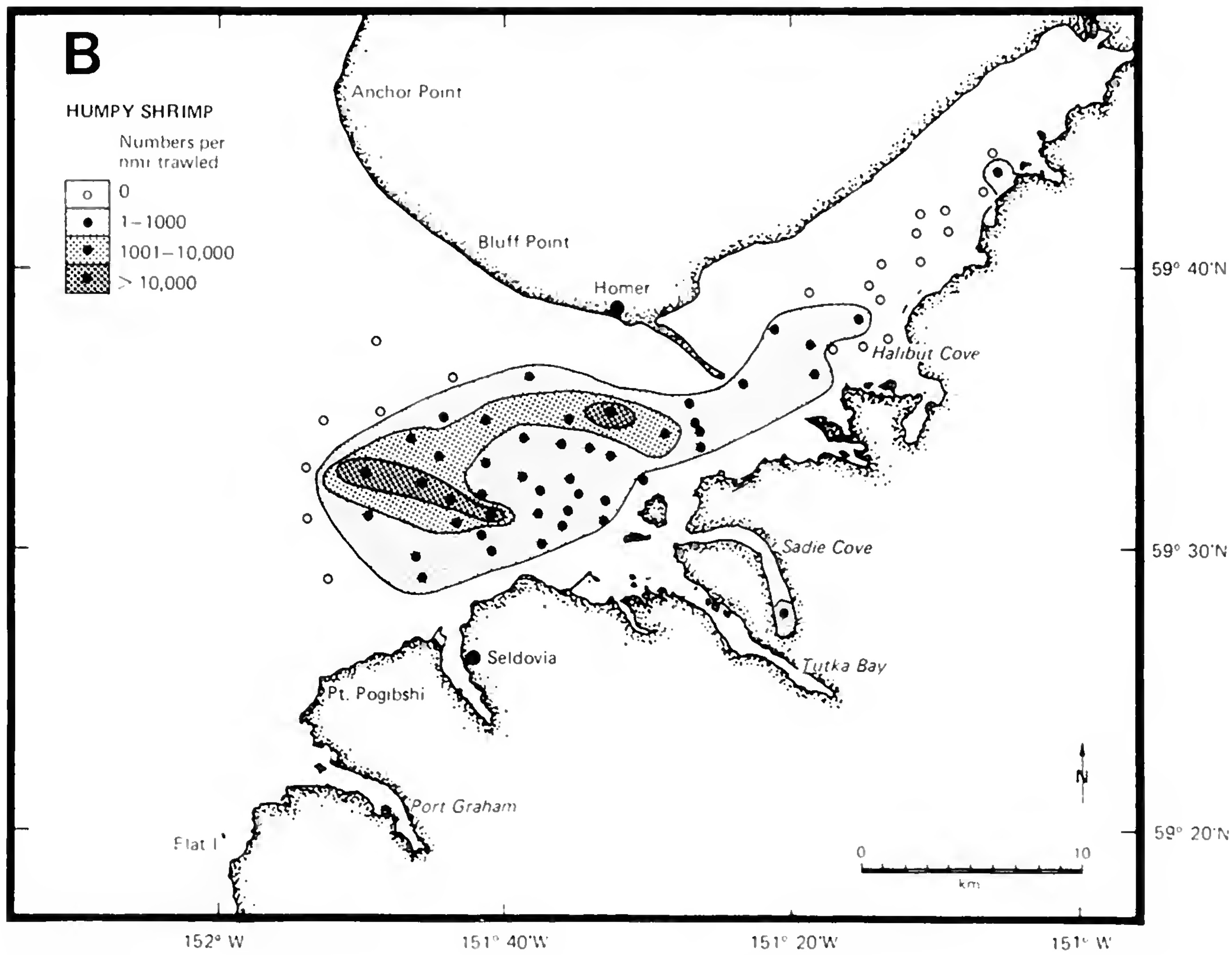


Figure 22.—Distribution of northern shrimp (A), humpy shrimp (B), coonstripe shrimp (C), and sidestripe shrimp (D) in Kachemak Bay, 5–13 May 1972.

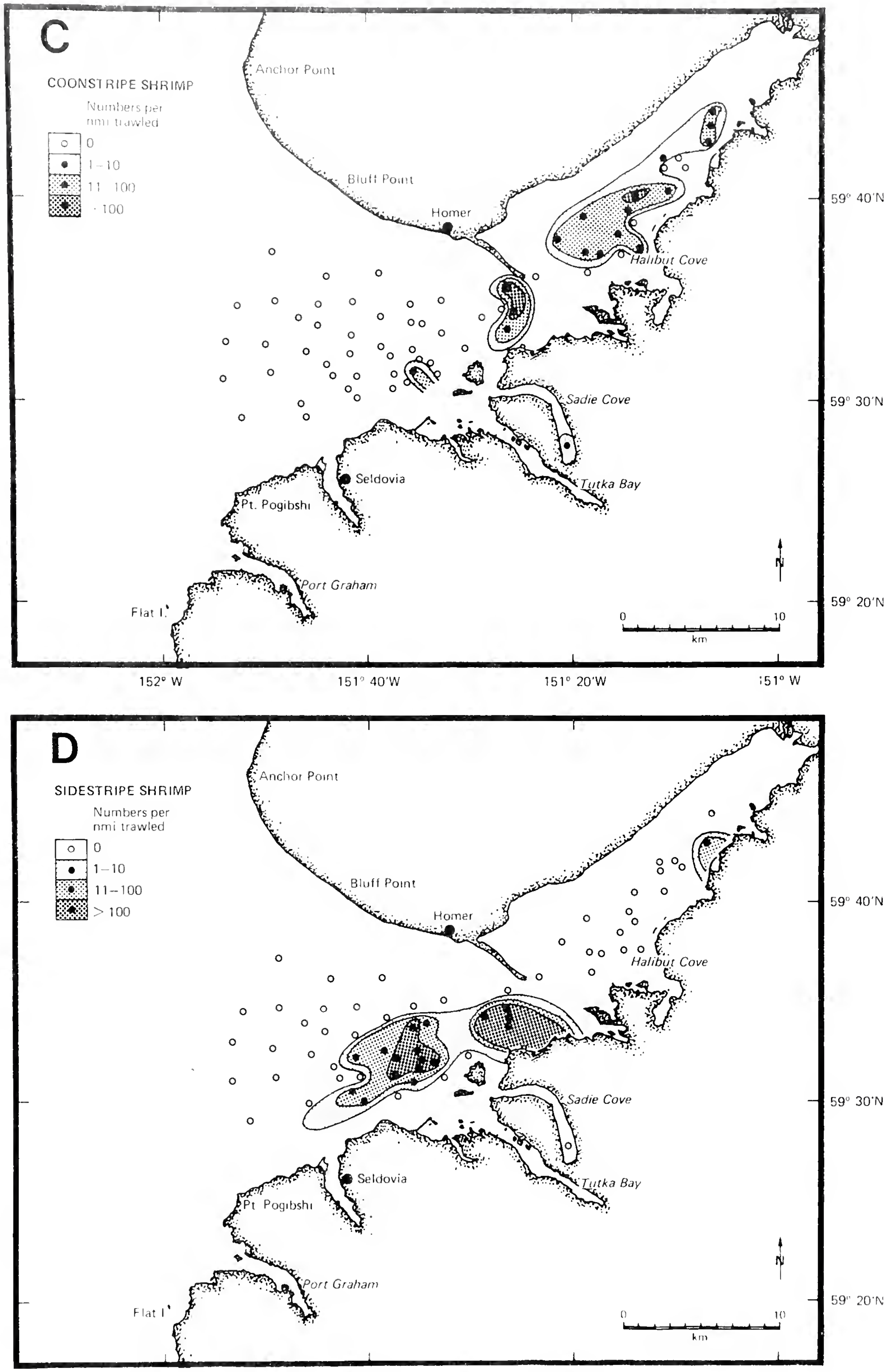


Figure 22.—*Continued.*

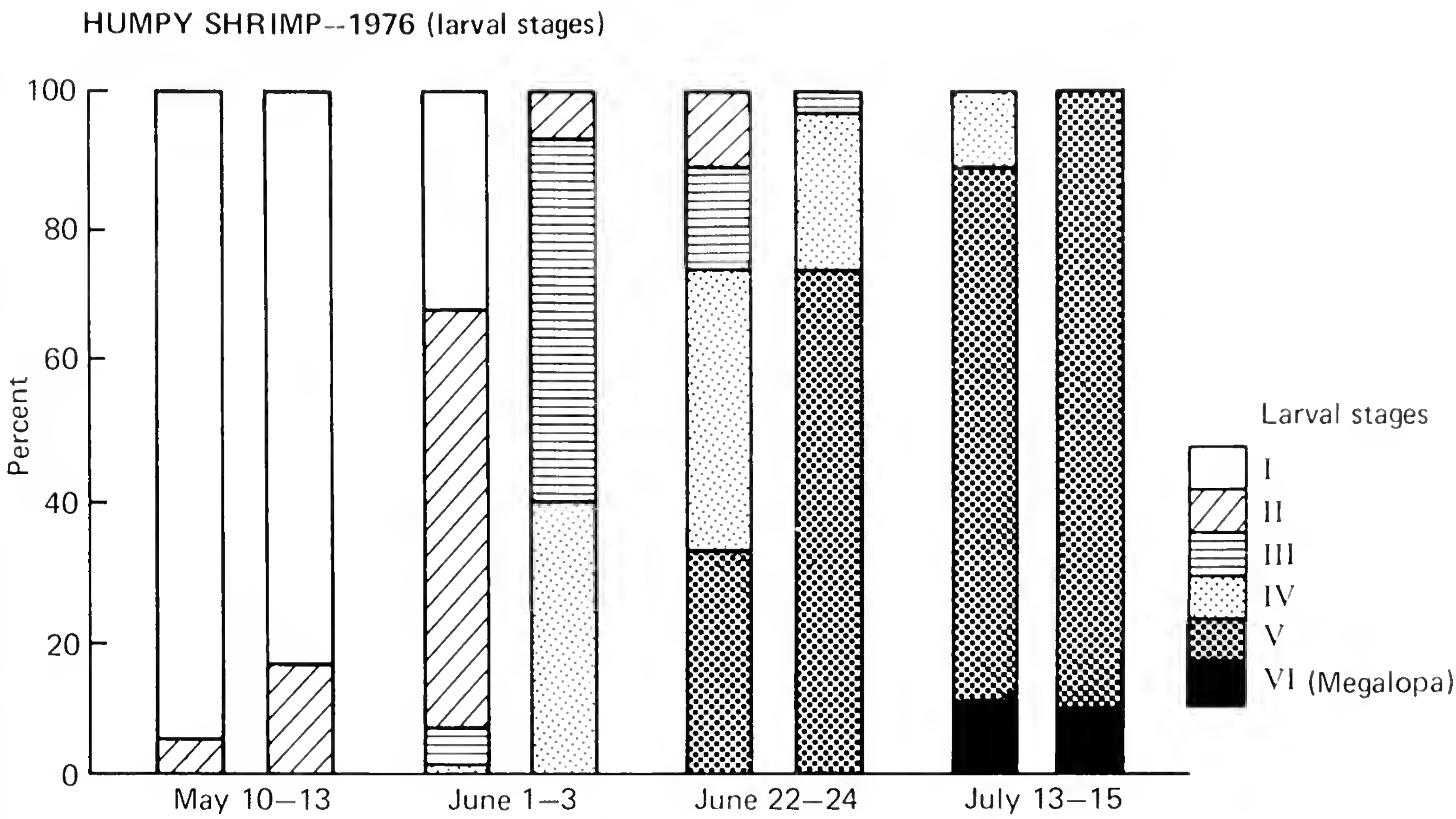


Figure 23.—Percentages of each of the larval stages of humpy shrimp sampled in lower Cook Inlet (left bar) and in Kachemak Bay (right bar).

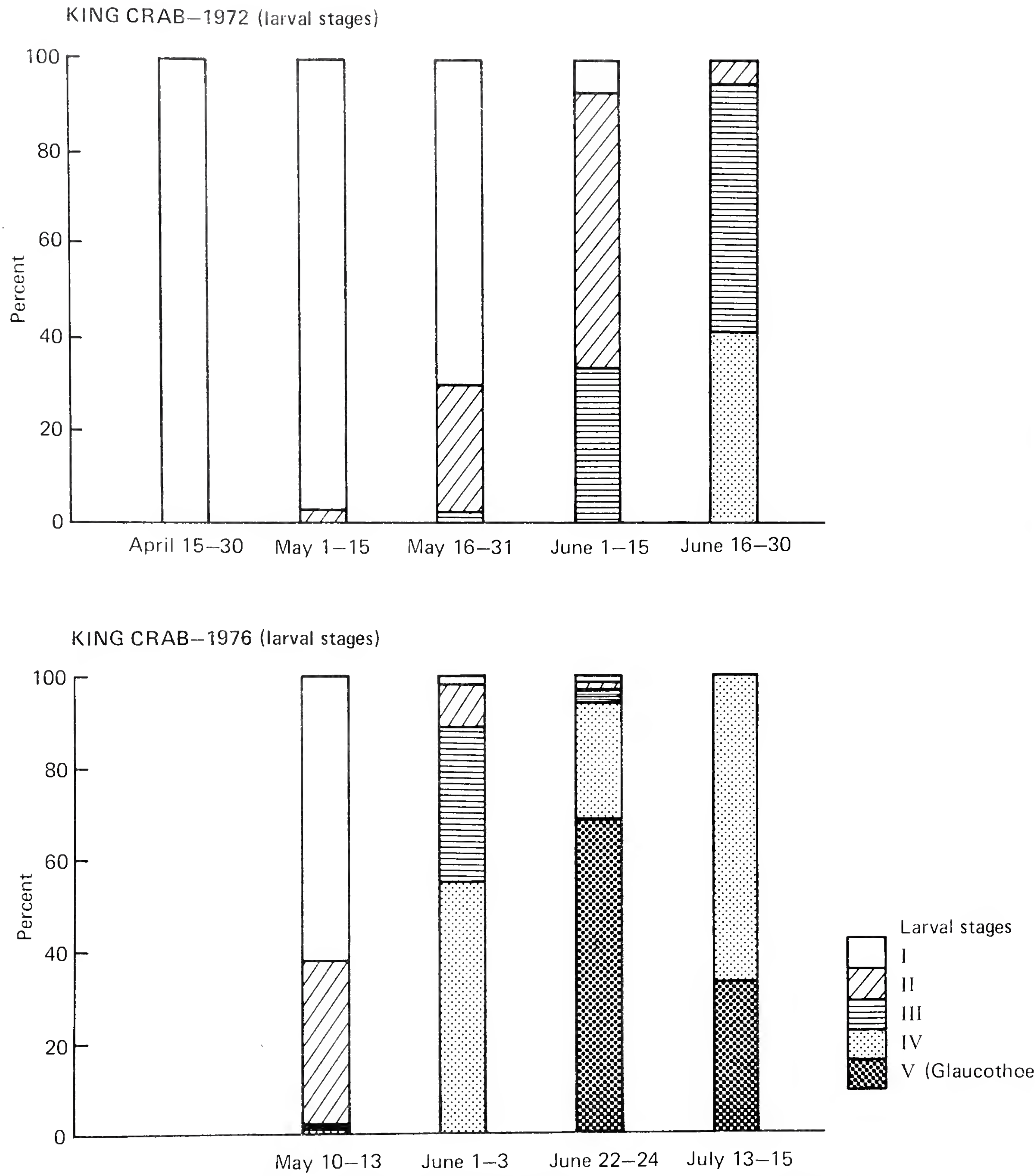


Figure 24.—Percentages of each of the larval stages of king crab larvae sampled inKachemak Bay, 1972, and outer Kachemak Bay-lower Cook Inlet, 1976, for each sampling period.

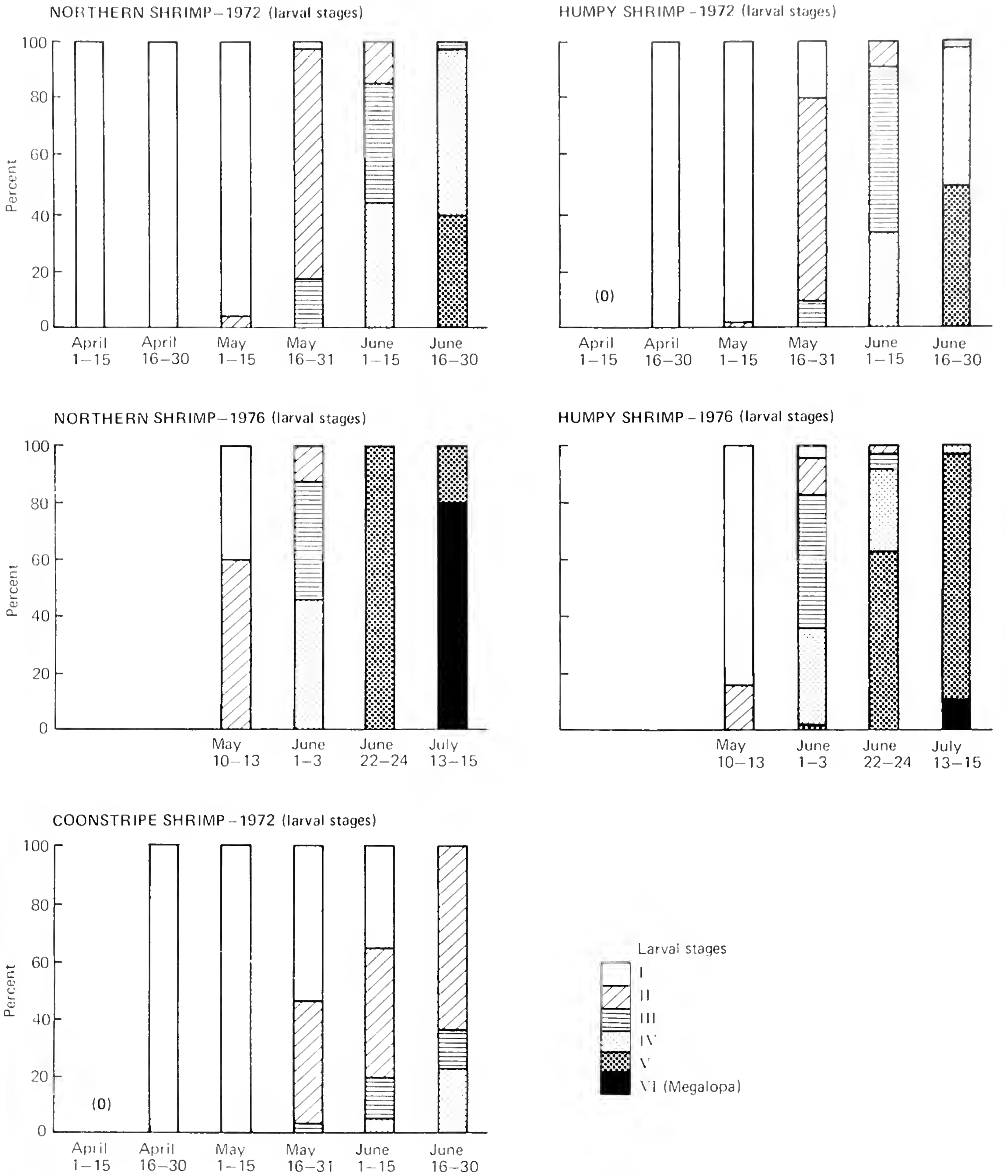


Figure 25.—Percentages of each of the larval stages of northern shrimp, humpy shrimp, and coonstripe shrimp collected in Kachemak Bay, 1972; and northern shrimp and humpy shrimp collected in Kachemak Bay-lower Cook Inlet, 1976.

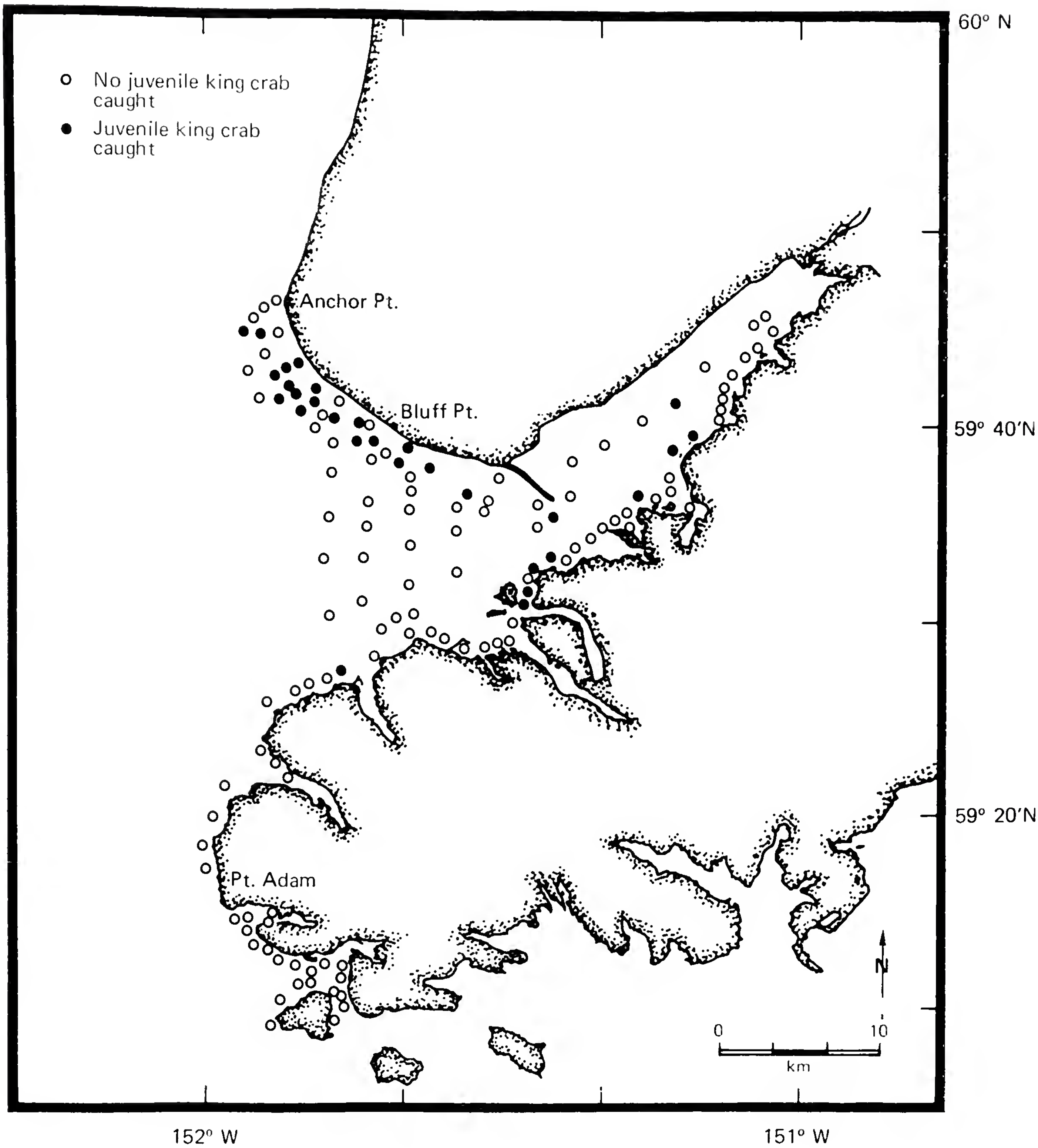


Figure 26.—Distribution of juvenile king crab, 21 July–8 October 1976 (Sundberg and Clausen 1977).

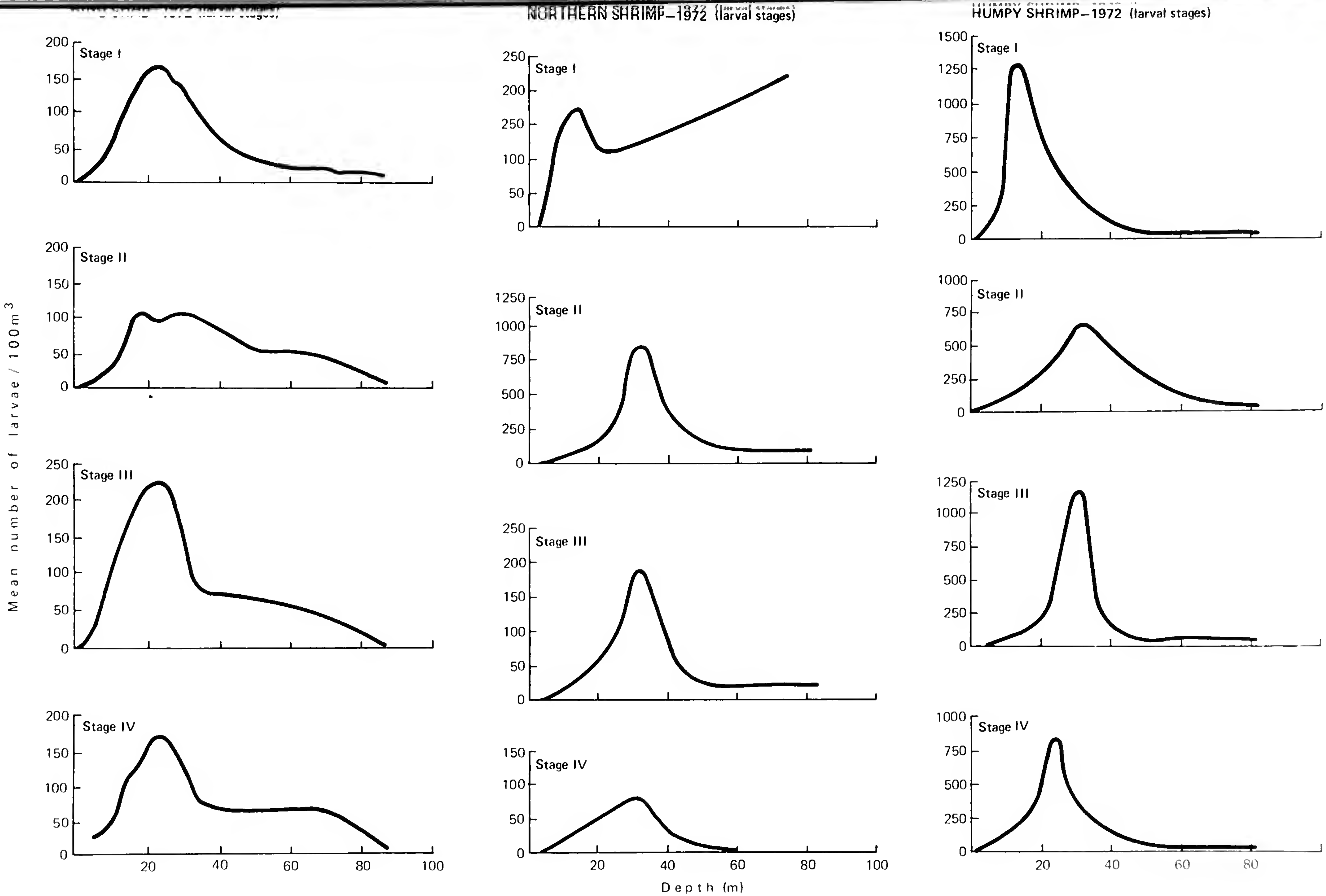


Figure 27.—Mean depth distribution of larval stages of king crab, northern shrimp, and humpy shrimp in Kachemak Bay, 1972.

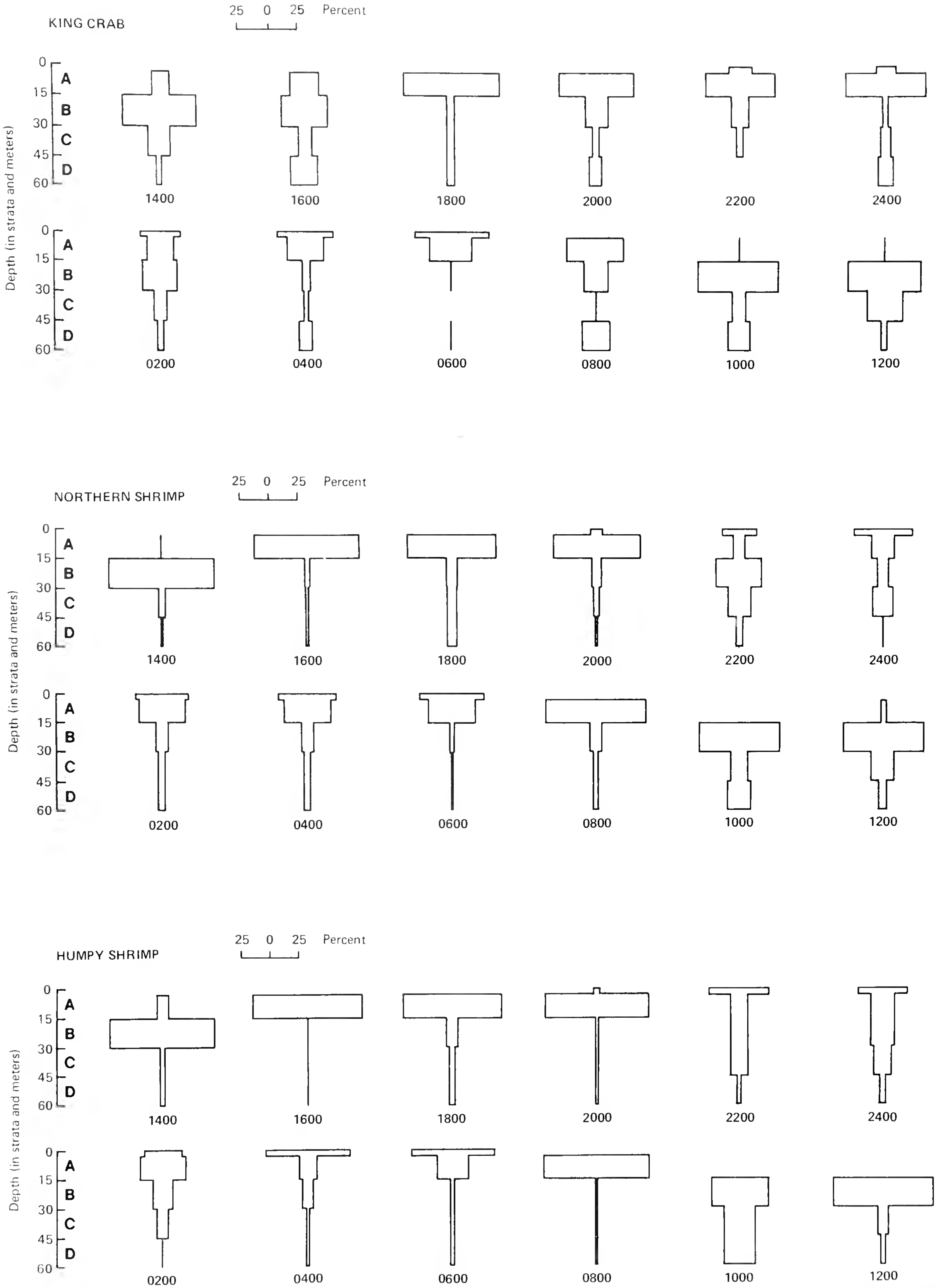


Figure 28.—Diel vertical migration of larvae of king crab, northern shrimp, and humpy shrimp in Kachemak Bay, 10–11 May 1972. Widths of blocks are proportional to the percentage of all larvae collected within the depth strata.

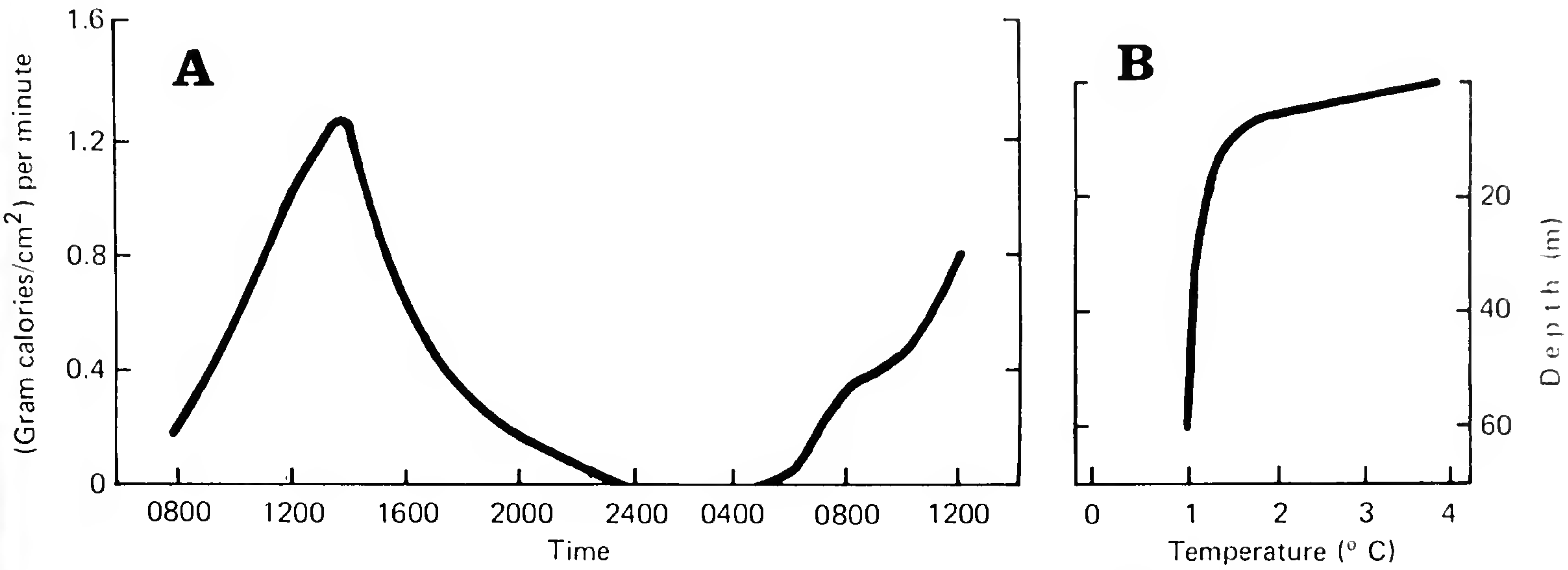


Figure 29.—Incident sunlight profile (A) and water temperature profile (B) in Kachemak Bay, 10–11 May 1972.

Appendix Table 1.--Depth and location of stations where larvae of king crab and pandalid shrimp were collected in Kachemak Bay and lower Cook Inlet, Alaska, 1972 and 1976.

1972			
	Depth	Location	
Station	(m)	Lat. N.	Long. W.
1	40	59°44.3'	151°05.5'
2	58	59°42.0'	151°11.5'
3	20	59°38.2'	151°23.8'
4	77	59°37.5'	151°18.0'
5	33	59°36.8'	151°12.8'
6	119	59°35.0'	151°23.0'
7	73	59°29.8'	151°21.9'
8	165	59°27.5'	151°25.2'
9	128	59°30.0'	151°32.0'
10	110	59°33.2'	151°32.5'
11	13	59°36.2'	151°32.5'
12	33	59°38.0'	151°40.0'
13	86	59°34.0'	151°40.0'
14	20	59°30.0'	151°40.0'
15	53	59°27.4'	151°50.0'
16	68	59°32.5'	151°50.0'
17	37	59°36.5'	151°50.0'
18	20	59°40.4'	151°50.0'
19	37	59°42.7'	152°00.0'
20	40	59°38.6'	152°00.0'
21	46	59°34.7'	152°00.0'
22	49	59°30.0'	152°00.0'
23	95	59°25.4'	152°00.0'
24	49	59°21.5'	152°00.0'

Appendix Table 1.--continued.

1976			
	Depth	Location	
Station	(m)	Lat. N.	Long. W.
1	35	59°35'	151°40'
2	33	59°30'	151°40'
3	49	59°27'	151°52'
4	60	59°30'	151°50'
5	33	59°35'	151°50'
6	27	59°40'	151°50'
7	22	59°43'	151°54'
8	24	59°50'	151°54'
9	37	59°50'	152°00'
10	22	59°45'	152°00'
11	31	59°40'	152°00'
12	37	59°35'	152°00'
13	62	59°30'	152°00'
14	49	59°25'	152°00'
15	37	59°20'	152°00'
16	60	59°15'	152°00'
17	113	59°10'	152°00'
18	141	59°10'	152°10'
19	77	59°15'	152°10'
20	71	59°20'	152°10'
21	57	59°25'	152°10'
22	44	59°30'	152°10'
23	40	59°35'	152°10'
24	38	59°40'	152°10'

Appendix Table 1.--continued.

1976			
	Depth	Location	
Station	(m)	Lat. N.	Long. W.
25	33	59°45'	152°10'
26	48	59°50'	152°10'
27	82	59°50'	152°10'
28	82	59°45'	152°20'
29	64	59°40'	152°20'
30	60	59°35'	152°20'
31	71	59°30'	152°20'
32	82	59°25'	152°20'
33	84	59°20'	152°20'
34	95	59°15'	152°20'
35	100	59°10'	152°20'
36	84	59°10'	152°30'
37	60	59°20'	152°30'
38	55	59°30'	152°30'
39	82	59°40'	152°30'
40	60	59°50'	152°30'
41	70	59°45'	152°30'
42	82	59°35'	152°30'
43	60	59°25'	152°30'
44	90	59°15'	152°30'
45	18	59°38'	151°40'
46	15	59°36'	151°32'
47	86	59°31'	151°34'

Appendix Table 2.--Number (per 100 m^3 water strained) and stage of development of larvae of king crab, northern shrimp, humpy shrimp, coonstripe shrimp, and sidestripe shrimp captured in each tow in Kachemak Bay, 1972.

		King crab					
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
16-30 April	9	8	--	--	--	--	8
	11	8	--	--	--	--	8
	12	368	--	--	--	--	368
	16	15	--	--	--	--	15
	17	149	--	--	--	--	149
	18	16	--	--	--	--	16
1-15 May	1	7	--	--	--	--	7
	3	45	--	--	--	--	45
	5	69	7	--	--	--	76
	6	166	15	--	--	--	181
	9	7	7	--	--	--	14
	10	7	--	--	--	--	7
	11	121	--	--	--	--	121
	12	823	--	--	--	--	823
	13	14	--	--	--	--	14
	14	45	7	--	--	--	52
	15	29	--	--	--	--	29
	16	50	--	--	--	--	50
	17	4,731	65	--	--	--	4,796
	18	620	--	--	--	--	620

Appendix Table 2.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
16-31 May	1	34	263	17	--	--	314
	2	61	70	9	--	--	140
	3	116	78	--	--	--	194
	4	9	17	9	--	--	35
	5	79	134	--	--	--	213
	6	367	359	39	--	--	765
	7	79	147	52	--	--	278
	8	151	236	25	--	--	412
	9	207	572	--	--	--	779
	10	490	171	--	--	--	661
	11	675	210	--	--	--	885
	12	124	21	--	--	--	145
	13	1,468	1,240	--	--	--	2,708
	14	1,206	272	--	--	--	1,478
	15	44	22	--	--	--	66
	16	2,524	30	--	--	--	2,554
	17	3,355	499	23	--	--	3,877
	18	1,123	307	16	--	--	1,446
	22	8	17	--	--	--	25
	23	8	16	--	--	--	24
	24	7	7	--	--	--	14

Appendix Table 2.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
1-15 June	1	--	24	31	--	--	55
	2	--	26	165	26	--	217
	3	--	101	247	46	--	394
	4	--	56	103	8	--	167
	5	--	15	161	16	--	192
	6	18	451	88	--	--	557
	7	--	92	16	8	--	116
	8	--	33	16	8	--	57
	9	157	2,801	614	18	--	3,590
	10	124	1,311	305	--	--	1,740
	11	192	2,280	857	--	--	3,329
	12	16	16	8	--	--	40
	13	--	537	434	--	--	971
	14	--	8	--	--	--	8
	15	--	193	346	--	--	539
	16	254	1,529	1,786	284	--	3,853
	17	353	1,403	2,273	245	--	4,274
	18	--	87	138	8	--	233
	19	--	22	11	--	--	33
	21	--	8	81	16	--	105
	22	8	35	17	8	--	68
	23	125	440	626	95	--	1,286
	24	45	89	44	--	--	178

Appendix Table 2.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
16-30 June	1	--	--	15	8	--	23
	6	--	23	93	76	--	192
	7	--	--	23	16	--	39
	8	--	--	41	16	--	57
	9	--	25	82	49	--	156
	10	--	24	348	234	--	606
	11	--	--	97	73	--	170
	12	--	563	5,993	2,061	10	8,627
	13	--	15	619	537	--	1,171
	14	--	7	--	--	--	7
	15	--	22	87	33	--	142
	16	--	18	328	338	--	684
	17	--	169	1,667	1,492	8	3,336
	18	--	175	3,798	2,638	16	6,627
	19	--	--	7	58	8	73
	20	--	--	58	100	--	158
	21	--	--	17	86	--	103
	22	--	--	--	103	16	119
	23	--	--	84	761	50	895
	24	--	--	8	8	--	16

Appendix Table 2.--continued.

		Northern shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-15 April	10	9	--	--	--	--	--	9
	13	32	--	--	--	--	--	32
	17	56	--	--	--	--	--	56
16-30 April	1	8	--	--	--	--	--	8
	3	8	--	--	--	--	--	8
	4	128	--	--	--	--	--	128
	5	56	--	--	--	--	--	56
	6	424	--	--	--	--	--	424
	7	374	--	--	--	--	--	374
	8	2,242	--	--	--	--	--	2,242
	9	722	--	--	--	--	--	722
	10	413	--	--	--	--	--	413
	11	338	--	--	--	--	--	338
	12	56	--	--	--	--	--	56
	13	1,186	--	--	--	--	--	1,186
	14	8	--	--	--	--	--	8
	15	216	--	--	--	--	--	216
	16	278	--	--	--	--	--	278
	17	320	--	--	--	--	--	320
	18	40	--	--	--	--	--	40

Appendix Table 2.--continued.

		Northern shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-15 May	1	49	7	--	--	--	--	56
	2	56	--	--	--	--	--	56
	3	158	8	--	--	--	--	166
	4	78	--	--	--	--	--	78
	5	407	--	--	--	--	--	407
	6	1169	84	--	--	--	--	1,253
	7	419	8	--	--	--	--	427
	8	1,356	21	--	--	--	--	1,377
	9	1,723	7	--	--	--	--	1,730
	10	1,475	65	--	--	--	--	1,540
	11	5,600	104	--	--	--	--	5,704
	12	166	37	--	--	--	--	203
	13	2,431	158	--	--	--	--	2,589
	14	54	--	--	--	--	--	54
	15	7	--	--	--	--	--	7
	16	2,748	51	--	--	--	--	2,799
	17	2,176	208	--	--	--	--	2,384
	18	78	26	--	--	--	--	104

Appendix Table 2.--continued.

		Northern shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-31 May	1	9	149	140	--	--	--	298
	2	--	79	44	18	--	--	141
	3	--	32	--	--	--	--	32
	4	--	34	52	--	--	--	86
	5	--	64	103	--	--	--	167
	6	62	405	250	--	--	--	717
	7	53	175	79	--	--	--	307
	8	--	194	16	--	--	--	210
	9	103	483	309	--	--	--	895
	10	15	315	353	--	--	--	683
	11	28	200	62	--	--	--	290
	12	--	42	14	--	--	--	56
	13	--	15,902	2,454	97	--	--	18,453
	15	24	--	--	--	--	--	24
	16	243	631	60	--	--	--	934
	17	39	--	--	--	--	--	39
	18	--	75	33	--	--	--	108
	22	--	36	9	--	--	--	45
	24	8	77	--	--	--	--	85

Appendix Table 2.--continued.

		Northern shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-15 June	1	--	8	40	95	--	--	143
	2	--	9	69	190	--	--	268
	3	--	--	32	32	--	--	64
	4	--	--	16	48	--	--	64
	5	--	--	8	54	--	--	62
	6	--	8	69	--	--	--	77
	8	--	--	24	80	--	--	104
	9	--	37	120	--	--	--	157
	10	--	8	169	8	--	--	185
	11	--	47	141	93	--	--	281
	12	--	--	8	--	--	--	8
	13	15	333	747	792	--	--	1,887
	15	--	14	294	432	--	--	740
	16	--	--	260	288	--	--	548
	17	--	249	276	--	--	--	525
	18	--	--	18	18	--	--	36
	19	--	--	31	--	--	--	31
	21	--	--	--	16	--	--	16
	22	--	--	--	8	--	--	8
	23	--	78	232	293	--	--	603
	24	11	--	--	22	--	--	33

Appendix Table 2.--continued.

		Northern shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-30 June	2	--	--	--	26	9	--	35
	4	--	--	--	36	27	--	63
	5	--	--	--	--	8	--	8
	6	--	--	--	122	106	--	228
	7	--	--	--	8	--	--	8
	8	--	--	--	16	--	--	16
	9	--	--	--	18	--	--	18
	10	--	--	--	32	64	--	96
	11	--	--	--	--	12	--	12
	12	--	--	--	21	--	--	21
	13	--	--	--	2,137	1,677	--	3,814
	16	--	--	--	242	165	--	407
	17	--	--	35	566	58	--	659

Appendix Table 2.--continued.

		Humpy shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-30 April	4	8	--	--	--	--	--	8
	6	8	--	--	--	--	--	8
	7	22	--	--	--	--	--	22
	8	77	--	--	--	--	--	77
	9	94	--	--	--	--	--	94
	10	35	--	--	--	--	--	35
	11	22	--	--	--	--	--	22
	12	7	--	--	--	--	--	7
	13	68	--	--	--	--	--	68
	16	217	--	--	--	--	--	217
	17	1,378	--	--	--	--	--	1,378
	18	243	--	--	--	--	--	243
1-15 May	1	7	--	--	--	--	--	7
	2	8	--	--	--	--	--	8
	3	76	--	--	--	--	--	76
	4	13	--	--	--	--	--	13
	5	224	--	--	--	--	--	224
	6	700	14	--	--	--	--	714
	7	190	--	--	--	--	--	190
	8	156	--	--	--	--	--	156
	9	483	--	--	--	--	--	483
	10	1,735	--	--	--	--	--	1,735
	11	3,912	--	--	--	--	--	3,912
	12	856	45	--	--	--	--	901
	13	755	21	--	--	--	--	776
	16	3,948	--	--	--	--	--	3,948
	17	34,512	16	--	--	--	--	34,528
	18	1,534	13	--	--	--	--	1,547

Appendix Table 2.--continued.

		Humpy shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-31 May	1	9	146	18	--	--	--	173
	2	--	105	35	--	--	--	140
	3	--	22	16	--	--	--	38
	4	--	8	26	--	--	--	34
	5	24	246	79	--	--	--	349
	6	289	1,225	273	--	--	--	1,787
	7	53	3,195	353	--	--	--	3,601
	8	93	370	25	--	--	--	488
	9	735	2,437	182	--	--	--	3,354
	10	470	3,564	346	--	--	--	4,380
	11	566	3,560	269	--	--	--	4,395
	12	140	868	126	--	--	--	1,134
	13	995	3,986	529	--	--	--	5,510
	14	623	64	--	--	--	--	687
	16	2,083	2,356	--	--	--	--	4,439
	17	8	187	--	--	--	--	195
	18	83	207	34	--	--	--	324
	21	--	--	9	--	--	--	9
	22	--	27	--	--	--	--	27
	24	54	--	--	--	--	--	54

Appendix Table 2.--continued.

Humpy shrimp								
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-15 June	1	--	--	16	24	--	--	40
	2	--	--	26	79	--	--	105
	3	--	8	--	31	--	--	39
	4	--	--	24	56	--	--	80
	5	--	--	23	16	--	--	39
	6	--	76	91	--	--	--	167
	7	--	91	381	--	--	--	472
	8	--	--	256	200	--	--	456
	9	9	551	662	46	--	--	1,268
	10	--	113	719	64	--	--	896
	11	--	468	896	328	--	--	1,692
	12	--	--	24	--	--	--	24
	13	--	665	10,737	510	--	--	11,912
	14	8	8	--	--	--	--	16
	15	--	70	686	2,226	--	--	2,982
	16	--	144	2,340	3,449	--	--	5,933
	17	--	129	2,882	1,574	--	--	4,585
	18	--	--	18	36	--	--	54
	19	--	--	20	62	--	--	82
	21	--	--	24	8	--	--	32
	22	--	--	--	16	--	--	16
	23	--	--	490	2,427	--	--	2,917
	24	--	--	22	22	--	--	44

Appendix Table 2.--continued.

		Humpy shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-30 June	1	--	--	--	--	8	--	8
	2	--	--	--	9	--	--	9
	4	--	--	--	9	--	--	9
	6	--	--	15	16	38	--	69
	7	--	--	16	77	--	--	93
	8	--	--	8	64	--	--	72
	9	--	--	--	45	--	--	45
	10	--	--	32	275	105	--	412
	11	--	--	--	48	24	--	72
	12	--	--	--	2,720	2,782	--	5,502
	13	--	--	94	1,388	1,436	--	2,918
	16	--	--	11	517	869	--	1,397
	17	--	--	82	3,858	3,292	--	7,232
	18	--	--	72	416	256	16	760
	20	--	--	--	--	19	--	19
	21	--	--	10	30	10	--	50
	22	--	--	--	18	115	--	133
	23	--	--	--	82	1,028	--	1,110
	24	--	--	--	26	95	--	121

Appendix Table 2.--continued.

		Coonstripe shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-30 April	12	7	--	--	--	--	--	7
1-15 May	1	7	--	--	--	--	--	7
	3	38	--	--	--	--	--	38
	4	13	--	--	--	--	--	13
	5	14	--	--	--	--	--	14
	6	42	--	--	--	--	--	42
	8	7	--	--	--	--	--	7
	9	7	--	--	--	--	--	7
	12	22	--	--	--	--	--	22
	17	8	--	--	--	--	--	8
	18	52	--	--	--	--	--	52
16-30 May	1	148	26	--	--	--	--	174
	2	44	18	--	--	--	--	62
	3	443	356	16	--	--	--	815
	4	51	51	--	--	--	--	102
	5	103	72	--	--	--	--	175
	6	55	47	--	--	--	--	102
	7	97	36	--	--	--	--	133
	8	42	8	--	--	--	--	50
	11	42	28	--	--	--	--	70
	12	56	238	56	--	--	--	350
	13	--	9	--	--	--	--	9
	16	15	--	--	--	--	--	15
	18	67	42	--	--	--	--	109

Appendix Table 2.--continued.

		Coonstripe shrimp						
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-15 June	2	17	18	--	--	--	--	35
	3	70	101	70	--	--	--	241
	4	--	32	8	--	--	--	40
	5	23	--	--	--	--	--	23
	6	15	54	--	--	--	--	69
	7	33	16	8	--	--	--	57
	8	16	--	--	--	--	--	16
	9	37	--	--	--	--	--	37
	10	--	16	--	--	--	--	16
	11	--	47	--	--	--	--	47
	12	--	--	--	8	--	--	8
	14	8	8	8	16	--	--	40
	18	9	--	--	--	--	--	9
16-30 June	1	--	8	--	--	--	--	8
	2	--	17	--	--	--	--	17
	4	--	9	--	--	--	--	9
	8	8	--	--	--	--	--	8
	11	--	36	--	48	--	--	84
	12	--	200	63	42	--	--	305
	14	--	--	--	8	--	--	8
	18	--	16	--	--	--	--	16

Appendix Table 2.--continued.

Sidestripe shrimp								
		Larval Stage						
Date	Station	I	II	III	IV	V	Megalopa	Total
16-30 April	13	15	--	--	--	--	--	15
1-15 May	8	21	--	--	--	--	--	21
	9	7	--	--	--	--	--	7
	10	14	--	--	--	--	--	14
	11	40	--	--	--	--	--	40
	13	65	--	--	--	--	--	65
	16	17	--	--	--	--	--	17
	18	13	--	--	--	--	--	13
16-31 May	12	14	--	--	--	--	--	14
	13	18	--	--	--	--	--	18
	17	8	--	--	--	--	--	8
	18	8	--	--	--	--	--	8
	22	9	--	--	--	--	--	9
1-15 June	11	16	--	--	--	--	--	16
	17	34	--	--	--	--	--	34
16-30 June	6	8	--	--	--	--	--	8
	9	--	9	--	--	--	--	9
	10	8	--	--	--	--	--	8
	15	--	8	--	--	--	--	8
	18	--	8	8	--	--	--	16
	24	9	--	--	--	--	--	9

Appendix Table 3.--Number (per 10 m^2 water strained) and stage of development of larvae of king crab, northern shrimp, and humpy shrimp captured in each positive tow in outer Kachemak Bay - lower Cook Inlet, 1976.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
10-13 May	1	582	274	51	--	--	907
	2	805	496	--	17	--	1,318
	3	1,832	582	17	--	--	2,431
	4	1,198	445	--	--	--	1,643
	5	2,808	1,387	--	--	--	4,195
	6	308	274	--	--	--	582
	9	17	--	--	--	--	17
	10	17	17	--	--	--	34
	12	17	--	--	--	--	17
	13	2,054	445	--	--	--	2,499
	14	428	394	--	--	--	822
	15	17	34	--	--	--	51
	16	51	17	--	--	--	68
	19	68	137	--	--	--	205
	20	68	274	--	--	--	342
	21	120	68	--	--	--	188
	22	17	--	--	--	--	17
	24	34	17	--	--	--	51
	25	17	--	--	--	--	17
	26	17	103	--	--	--	120

Appendix Table 3.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
10-13 May	28	86	137	17	--	--	240
	29	17	--	--	--	--	17
	39	17	17	--	--	--	34
	40	17	--	--	--	--	17
	42	68	34	--	--	--	102
	46	103	86	--	--	--	189
	47	1,644	2,242	120	--	--	4,006
1-3 June	1	17	17	574	1,524	--	2,132
	3	--	34	103	170	--	307
	4	--	86	531	976	17	1,610
	5	--	--	--	17	--	17
	6	--	--	34	137	--	171
	7	--	--	--	34	--	34
	9	--	--	--	17	--	17
	10	--	--	103	68	--	171
	12	--	--	34	34	--	68
	13	--	34	86	17	--	137
	14	17	68	360	137	--	582
	15	--	--	--	34	--	34
	16	--	34	17	34	--	85
	17	17	34	51	34	--	136
	19	17	17	--	--	--	34
	20	--	--	17	86	--	103
	21	--	34	--	--	--	34
	22	--	--	34	34	--	68

Appendix Table 3.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
1-3 June	24	--	--	--	17	--	17
	26	--	--	--	17	--	17
	27	--	34	34	34	--	102
	28	34	68	86	17	--	205
	29	--	--	17	--	--	17
	34	--	--	--	17	--	17
	35	--	--	34	51	--	85
	37	17	34	17	--	--	68
	38	17	--	--	--	--	17
	39	--	--	51	--	--	51
	41	--	--	17	--	--	17
	42	--	34	--	17	--	51
	43	--	34	--	--	--	34
	44	--	34	86	--	--	120
	46	--	17	51	103	--	171
	47	--	--	188	325	--	513
22-24 June	1	--	--	--	17	86	103
	3	--	--	--	--	17	17
	4	--	--	--	--	51	51
	5	--	--	--	17	120	137
	6	--	--	--	--	120	120
	7	--	--	--	--	171	171
	10	17	--	--	--	17	34
	11	--	--	--	17	--	17
	13	--	--	--	--	17	17
	14	--	--	--	--	17	17

Appendix Table 3.--continued.

King crab							
		Larval Stage					
		Zoea					
Date	Station	I	II	III	IV	Glaucothoe	Total
	15	--	--	--	--	17	17
	17	--	--	--	68	17	85
	19	--	--	--	17	--	17
	20	--	--	--	--	34	34
	21	--	--	--	--	17	17
	31	--	--	--	--	17	17
	33	--	--	--	34	17	51
	34	--	--	--	--	17	17
	35	--	--	17	17	--	34
	36	--	17	--	--	--	17
	39	--	--	--	17	--	17
	41	--	--	--	17	--	17
	43	--	--	--	17	--	17
	44	--	--	17	17	17	51
	47	--	--	--	34	34	68
13-15 July	18	--	--	--	17	--	17
	21	--	--	--	17	--	17
	26	--	--	--	--	17	17

Appendix Table 3.--continued.

Northern shrimp								
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
10-13 May	1	223	205	--	--	--	--	428
	4	223	205	--	--	--	--	428
	5	462	565	--	--	--	--	1,027
	6	51	205	--	--	--	--	256
	8	34	--	--	--	--	--	34
	12	--	17	--	--	--	--	17
	13	17	103	--	--	--	--	120
	14	--	17	--	--	--	--	17
	17	--	17	--	--	--	--	17
	18	34	--	--	--	--	--	34
	46	17	51	--	--	--	--	68
	47	548	959	51	--	--	--	1,558
1-3 June	1	--	--	68	274	--	--	342
	2	--	17	--	--	--	--	17
	4	--	--	103	120	--	--	223
	21	--	17	--	--	--	--	17
	28	--	51	17	--	--	--	68
	34	--	--	17	--	--	--	17
	37	--	34	--	--	--	--	34
	39	--	17	--	--	--	--	17
	43	--	--	17	--	--	--	17
	46	--	17	--	68	--	--	85
	47	--	--	51	360	--	--	411

Appendix Table 3.--continued.

Northern shrimp								
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
22-24 June	1	--	--	--	--	17	--	17
	4	--	--	--	--	17	--	17
	17	--	--	--	--	17	--	17
	19	--	--	--	--	17	--	17
	34	--	--	--	--	17	--	17
	35	--	--	--	--	17	--	17
13-15 July	4	--	--	--	--	17	--	17
	27	--	--	--	--	--	17	17
	30	--	--	--	--	--	17	17
	33	--	--	--	--	--	17	17
	40	--	--	--	--	--	17	17

Appendix Table 3.--continued.

		Humpy shrimp						
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
10-13 May	1	2,482	240	--	--	--	--	2,722
	2	51	17	--	--	--	--	68
	3	599	--	--	--	--	--	599
	4	9,621	154	--	--	--	--	9,775
	5	5,033	1,798	--	--	--	--	6,831
	6	1,079	445	--	--	--	--	1,524
	8	51	--	--	--	--	--	51
	10	17	--	--	--	--	--	17
	13	103	34	--	--	--	--	137
	14	51	--	--	--	--	--	51
	15	17	--	--	--	--	--	17
	16	17	--	--	--	--	--	17
	20	17	--	--	--	--	--	17
	26	34	34	--	--	--	--	68
	27	34	17	--	--	--	--	51
	28	17	--	--	--	--	--	17
	39	34	--	--	--	--	--	34
	42	308	17	--	--	--	--	325
	46	308	103	--	--	--	--	411
	47	4,006	1,678	--	--	--	--	5,684

Appendix Table 3.--continued.

Humpy shrimp								
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
1-3 June	1	--	188	2,191	2,397	68	--	4,844
	2	--	--	--	17	--	--	17
	3	--	103	428	171	--	--	702
	4	17	291	3,047	2,106	--	--	5,461
	5	--	--	17	17	--	--	34
	6	--	--	17	--	--	--	17
	9	--	17	86	--	--	--	103
	10	--	17	34	17	--	--	68
	11	--	--	34	--	--	--	34
	13	--	17	86	--	--	--	103
	16	--	--	17	--	--	--	17
	22	--	--	17	51	--	--	68
	26	--	17	--	--	--	--	17
	27	--	34	--	--	--	--	34
	28	17	17	17	--	--	--	51
	29	--	17	--	--	--	--	17
	38	51	171	--	--	--	--	222
	39	68	68	--	--	--	--	136
	42	411	496	68	17	--	--	992
	43	17	274	34	--	--	--	325
	45	--	--	17	17	--	--	34
	46	--	17	34	51	--	--	102
	47	34	51	753	308	17	--	1,163

Appendix Table 3.--continued.

		Humpy shrimp						
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
22-24 June	1	--	--	--	34	274	--	308
	2	--	--	--	17	--	--	17
	4	--	--	17	34	86	--	137
	5	--	--	--	--	86	--	86
	7	--	--	--	--	51	--	51
	11	--	--	--	17	--	--	17
	13	--	--	--	17	17	--	34
	17	--	--	--	--	17	--	17
	18	--	--	--	17	--	--	17
	24	--	--	--	--	17	--	17
	26	--	--	--	34	17	--	51
	27	--	17	--	17	--	--	34
	29	--	17	--	17	17	--	51
	30	--	--	--	17	--	--	17
	38	--	--	--	17	--	--	17
	39	--	17	--	17	34	--	68
	40	--	--	--	34	34	--	68
	41	--	--	17	34	34	--	85
	42	--	--	51	34	34	--	119
	45	--	--	--	--	17	--	17
	47	--	--	17	103	291	--	411

Appendix Table 3.--continued.

Humpy shrimp								
		Larval Stage						
		Zoea						
Date	Station	I	II	III	IV	V	Megalopa	Total
13-15 July	3	--	--	--	--	17	--	17
	4	--	--	--	--	171	51	222
	5	--	--	--	--	34	--	34
	39	--	--	--	--	34	--	34
	40	--	--	--	--	34	17	51
	42	--	--	--	--	34	--	34
	43	--	--	--	17	--	--	17
	44	--	--	--	--	17	--	17
	46	--	--	--	--	17	--	17
	47	--	--	--	--	223	--	223

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