SOUTHEAST CHUKCHI SEA AND KOTZEBUE SOUND TRAWL SURVEY, 1998

By

Lowell F. Fair

And

Art Nelson

Regional Information Report[1] No. 3A99-34

Alaska Department of Fish and Game
Commercial Fisheries Division, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518-1599

September 1999

AUTHORS

Lowell Fair is a Fishery Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Division, AYK Region, 333 Raspberry Road, Anchorage, Alaska 99518-1599.

Art Nelson is a Fishery Biologist for the Bering Sea Fishermen's Association, 725 Christiansen Drive, Suite #3, Anchorage, Alaska 99501.

ACKNOWLEDGEMENTS

As described later in this report, the trawl survey was only part of a larger, two-year examination of the marine fishery resources in the Southeast Chukchi Sea and Kotzebue Sound region of northwest Alaska. The Bering Sea Fishermen's Association (BSFA) wishes to thank The National Oceanic and Atmospheric Administration and the National Marine Fisheries Service for their administration of the funding and technical support. Most importantly, Terry Sample and Robert Wolotira provided background information from the 1976 NOAA/NMFS trawl survey.

BSFA also wishes to thank the Alaska Department of Fish and Game (ADF&G) for their assistance in planning and in the execution of this trawl survey, namely, Pete Probasco and Al Spalinger (ADF&G-Kodiak) for the use of the trawl nets. Earl Krygier, Tom Kron, Charles Lean, and Betsey Brennan contributed significantly in the planning efforts and also in securing the on-board expertise of two ADF&G Biologists for the survey. Lowell Fair and Larry Neff were the two on-board ADF&G Biologists and we greatly appreciate their help with the survey and with the preparation of this report.

Without the wonderful crew of the F/V Morning Star and it's owner, David Stanchfield this survey may not have been nearly as successful and enjoyable. The Morning Star's crew: Tim Carrier, Scott Clark, Kyle Rice and the Captain, Jon Edson all performed above expectations and if BSFA was to do another survey like this one, the Morning Star would be our first choice as the platform.

And, most importantly, BSFA wishes to thank the three Kotzebue technicians who were on-board for the survey: Lance Kramer, John Schaeffer III and Kenny Tikik, who also performed well above expectations and had the unique opportunity to view the process and the catches, first-hand.

OEO/ADA STATEMENT

TABLE OF CONTENTS

LIST OF TABLES

Table	Page

LIST OF FIGURES

Figure Page

Figure | Page

LIST OF APPENDICES

ABSTRACT

The first of a two part study began with a trawl survey in the Alaskan waters of the southeast Chukchi Sea and Kotzebue Sound during August of 1998. The purpose was to document the distribution and abundance of the marine fishery resources present in the survey area to determine if they exist in sufficient numbers to create economically feasible fisheries alternatives for area residents. A total of 65 stations were successfully trawled using similar methodology as the 1976 National Marine Fisheries Service study. Total catches from this survey were about two times greater than those found in 1976 and tended to increase from the shallower waters of Kotzebue Sound to the deeper waters of the Chukchi Sea. Invertebrates accounted for 87% of the catch and were dominated by starfish. Fish abundance was low, accounting for only 13% of the catch with saffron cod the most prevalent. The second portion of this study will occur in the winter and summer of 1999 by test fishing promising sites determined from this study.

INTRODUCTION

The Bering Sea Fishermen's Association is conducting a two-year test fishing project in the southeast Chukchi Sea and Kotzebue Sound region of Alaska. The goals of this project are to determine what marine fishery resources are present in the study area, and to determine if they exist in sufficient numbers to create economically feasible fisheries alternatives for area residents. Part 1 of the study involved sampling the study area using bottom trawl gear. Part 2 will involve test fishing operations for commercial species conducted in promising locations provided from the analysis of Part 1.

The purpose of this report is to present the findings from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey. The findings presented here focus on relative abundance and biomass indices to better understand the population characteristics important for the development of new or expanded commercial fisheries in the region. This report does not cover biological aspects such as species associations or preferred habitat distribution related to depth, temperature, salinity, etc.

Prominent communities in the study area include: Point Hope, Kivalina, Noatak, Kotzebue, Kiana, Noorvik, Ambler, Shungnak, Kobuk, Selawik, Buckland, Deering, and Shishmaref (Figure 1). Most of these villages, with the exceptions of Point Hope and Shishmaref, are within the Northwest Arctic Borough. The population of the Northwest Arctic Borough (NWAB) is approximately 6,800 (ADL 1998), and nearly 8,200 including Point Hope and Shishmaref. Within the NWAB, median household income is approximately $33,300, with 18.4% living below the poverty line. Unemployment is slightly over 20%. Much of the economy of this region is based upon transportation, retail services, and mineral development.

Subsistence hunting, fishing, and gathering are primary activities in the smaller communities. Commercial fisheries in this region include salmon (almost exclusively chum salmon), sheefish, and smelt, with the most valuable being the salmon fishery. Average gross income from the salmon fishery has dropped in recent years to about $2,000-$3,000 (CFEC data), and participation in the fishery has also dropped. The value of the limited entry salmon permits for the Kotzebue region have declined sharply in recent years, from a range of roughly $7,000 to $11,000 in the years 1983 through 1995, to $4,400 in 1997. Sac roe herring fisheries aren't possible because of the late break-up of the sea ice, causing most herring to spawn under the ice. Fisheries may be possible in occasional years when the sea ice breaks up early, but because this is unpredictable, attracting buyers into the region is difficult.

Local residents are interested in examining other marine fishery resources for possible fishery development, but there are very little recent data regarding what species exist, and their location. There has been some subsistence harvest of crab, both through the ice, using handlines, and also with makeshift pots during the summer. Also, there have been several anecdotal reports of halibut washing up on the beach after storms and sightings of halibut near the surface. Local pilots have reported seeing halibut near the mouths of area streams in the fall, apparently feeding on washed out salmon. Capital investment and operating costs (mainly fuel) are hard to come by in this cash-poor region, and fisherman are reluctant about spending the necessary money to explore potential new opportunities.

The Community Development Quota (CDQ) Program, which was implemented in 1992, has been able to accomplish objectives, such as fisheries development, for fishermen of many Bering Sea communities that are included in the CDQ groups. However, the CDQ program community eligibility stops at the Bering Straits, and the coastal communities from Shishmaref northwards have no CDQ organization to examine and pursue fisheries alternatives.

A trawl survey of this area (Figure 2) by the National Marine Fisheries Service (NMFS) in 1976 indicated only small populations of commercially exploitable fisheries resources. However, if results from the present survey indicate sufficient resources are now present to justify creating small fishery opportunities, these opportunities would help to diversify the fishery economy in the region. This could lessen the area fishermen's dependence upon the volatile salmon markets.

The fish fauna of the Chukchi Sea and adjacent waters are characterized by three distinct groups: (1) those coldwater groups indigenous to Arctic marine waters including such taxa as Arctic cod, longhead dab, Arctic flounder, and a number of cottid and blennioid species; (2) a subarctic boreal group whose distribution is centered south of the study area in the Bering Sea or regions of the eastern and western Pacific which includes saffron cod, yellowfin sole, Alaska plaice, starry flounder, Pacific herring, and others; and (3) an anadromous fresh water group with several forms such as char, whitefish, and smelt, whose marine distribution occurs only in the estuarine and other near-shore environments (Wolotira 1977).

Invertebrates form the most diverse and abundant group in the benthic community of the study area (Wolotira et al. 1977). According to Abbott (1966) and Sparks and Pereyra (1966), 14 invertebrate phyla are present in the study area, representing 91 families, 145 genera, and over 220 species. Most organisms encountered in the study area are Pacific boreal, and the absence of many higher arctic forms is likely a result of the northward currents which slows the southerly migration by all but highly mobile forms (Wolotira et al. 1977).

Chukchi Sea and Kotzebue Sound Oceanography

Geological features of the coastline and sediments in the survey area are typical of other regions of the Pacific Ocean (Fleming and Heggarty 1966). The nearshore bottom composition consists of small rocks and gravel that changes to mud and sand, and eventually to gray mud and sand in deeper offshore areas (Alverson and Wilimovsky 1966). Extensive amounts of silt occur near the mouths of large rivers such as the Noatak and Kobuk rivers in Kotzebue Sound.

The study area, located on the northern portion of the Alaska continental shelf, is unique in its uniform shallowness with very slight bottom slopes except on approach to land masses such as Point Hope and Cape Prince of Wales. Maximum depth within Kotzebue Sound is less than 25 m and less than 50 meters in the southeast Chukchi Sea (Figure 3).

The most important circulation feature of the Chukchi Sea is the northward flow through Bering Strait. The northern transport of deep Bering Sea, Gulf of Anadyr, and northeast Bering shelf waters is driven by the 0.5 m drop in sea level between the Pacific Ocean and the Arctic Ocean (Overland and Roach 1987). Northward transport is minimum in winter when north winds prevail and is maximum in summer when south winds occur more frequently (Weingartner 1994). Tides in the region are small, averaging less than one-third of a meter.

The Chukchi Sea is generally ice-covered from November through June. North of the Bering Strait, the seasonal retreat of sea-ice begins in June and normally attains its farthest north position around 72.5°N in mid-September (Naval Oceanography Command Detachment 1986). The interannual differences in the seasonal retreat, advance, and position of the ice-edge are related to the winds, in which north winds advect the ice-edge southward and vice-versa (Muench et al. 1991).

METHODS

Trawl Survey

We examined the fishery resources in the U.S. waters of the Chukchi Sea section, located in the Kotzebue Sound District (Figure 1), between the latitudes of Point Hope (68.3° N) and Cape Prince of Wales (65.8° N), and the longitudes of 168.8° W and 162.0° W. East of longitude 165.3° in the southeast Chukchi Sea, the sampling density was one demersal station per 750 square km. West of longitude 165.3° in Kotzebue Sound, the sampling density was one demersal station per 375 square km. The centers of each survey station were standardized using latitude and longitude coordinates that denote where each trawl began within a station (Appendix A).

The nonrandom, systematic station location design used by NMFS in their 1976 trawl surveys of the Chukchi Sea was adopted for this survey to provide a comparable survey pattern and documentation of marine life for this area. We towed a 400 eastern otter trawl (Figure 4), spread by two 1.5 x 2.1 m Astoria "V" doors (Figure 5) for about 30 minutes at a speed near two knots, resulting in an average distance of 1.85 km (1.0 nmi). The gear was set and retrieved by a pair of steel cables from hydraulic deck winches. Tows were placed on trawlable substrate near each station's midpoint in the direction of the prevailing wind and swell while trying to maintain the same depth throughout the tow.

Distance towed was calculated using the vessel's global position system (GPS) and the data was recorded by the skipper on the trawl survey haul record form (Appendix B). A computerized temperature probe was attached to the trawl to measure the bottom temperature of each haul, which was then recorded and downloaded to a computer.

Figure 6 shows the planned stations, which are numbered in the order we intended to proceed. Top priority was to sample the stations in Kotzebue Sound and those within 50 miles of the coast because of the shorter distance from local communities. The goal was to trawl the 81 planned stations, averaging between five and six tows per day. In 1976, 13 of the 81 planned stations were not completed successfully. Stations *01 through *11 were of lower priority, and were to be sampled once the 81 planned stations were complete.

Catch Processing

During the net retrieval process, fish, crabs, and sea stars were shaken from the intermediate portion of the net to the codend by the vessel crew. With the codend of the trawl aboard, a lifting strap was placed around the net and attached to a crane scale for a weight estimate, which was recorded on the station catch record form (Appendix C), along with the haul and station number, and date. The contents of the trawl was emptied on deck, the tare weight of the net section originally weighed was reweighed and recorded on the station catch record form.

Whenever possible, the entire catch was sampled, however, most hauls required subsampling with two or three baskets. When subsampling occurred, the catch was first examined for large fish or invertebrates, which were removed and weighed/counted. With the removal of the large fish or invertebrates, the catch was more uniform in size, allowing for a more representative sample to be processed. Additionally, prior to subsampling the catch, all red king crabs, Pacific halibut, Pacific cod, and walleye pollock were removed from the haul regardless of their size. Their numbers and weights were recorded on the station catch record form as total catch. Halibut were handled gently by holding them by the body, not the tail, and released immediately after measurement. Halibut were not weighed, but their length was converted to a whole weight using a conversion table (IPHC 1991).

Two or three baskets were filled with subsamples using a shovel once all of the fish and invertebrates noted above were removed from the tow. The filled baskets were weighed prior to sorting the contents. The sampling fraction for estimating the total of a species in the haul was the basket(s) weight divided by the weight of the total haul (minus the weight of the fish or invertebrates removed as noted above).

The fish and invertebrates of each basket were separated to the lowest desirable taxon and from debris (sticks, algae, garbage, tundra). Each taxon was weighed, counted, assigned a NMFS species code (NMFS 1996), and recorded on the station catch record form. Length frequencies of potentially exploitable fish species were taken on an opportunistic basis and recorded on the fish length frequency form (Appendix D).

All red and blue king crabs were sampled from each trawl haul. The number and weight of each species was recorded on the station catch record form. Each crab was thoroughly examined and the data was recorded on the crab research data form (Appendix E). Carapace length was measured to the nearest millimeter from the posterior margin of the right eye socket to the midpoint of the rear margin of the carapace (Wallace et al. 1949).

Red and blue king crabs were aged by shell condition, which defines shell-age classes in the following way using the ventral side of the coxa of the walking legs (pereopods).

- *Soft-shell:* Crab has molted within weeks. Exoskeleton is still soft and pliable from recent molt.
- *New-shell-pliable:* Coxa and ventral surface of exoskeleton white. Legs easily compressed when pinched (legs contain little meat at this time). Exoskeleton fragile and subject to breakage or puncture when dumped from the trawl. If carapace is removed, the gills are translucent-cream in color. Crabs estimated to have had new exoskeletons for approximately one to three months.
- *New-shell-hard:* Coxa and ventral surface of exoskeleton white. Legs mostly full of meat, meri not easily compressed by pinching. If carapace is removed, the gills are a light cream color. Crabs estimated to have had exoskeletons for 4-12 months.
- *Old-shell*: Distal portion of the ventral coxa is partially or totally rimed with brown scratches or dots. Legs are full of meat, meri not easily compressed when pinched. If carapace is removed, gills are tan in color from fouling microorganisms. Crabs estimated to have had their exoskeletons for 13-24 months.
- *Very old-shell:* Distal portion of ventral coxa continuously rimed with black scratches or dots. Legs full of meat, meri not easily compressed when pinched. Tips of dactyls worn round and black. If carapace is removed, gills are dark gray or dark gray-brown in color from fouling microorganisms. Crabs estimated to have had their exoskeletons for more than 24 months.

Various samples were collected for paralytic shellfish poisoning tests. Samples included blue king crab (3), snow crab (3), scallops (2), fat whelk (4), northern whelk (4), and *Beringius beringii* snails (2). Also, approximately three hundred pounds of saffron cod were retained as bait for the ADF&G Norton Sound winter red king crab project.

To help document the survey (i.e., trawling process and captured marine life), a video (8mm film) and a 35 mm camera were used. Copies of the tape(s) and slides are available from ADF&G offices in Kotzebue, Nome, and Anchorage.

Population Estimates

For direct comparison to previous analyses, population estimates were generated using the area-swept method (Alverson and Pereyra 1969). Variances were estimated assuming catch was binomially distributed (Seber 1982; page 22). Using the area-swept method, the total catch in numbers, n, and the total area trawled, a, was computed for each area. Abundance for the jth area was then estimated as:

$$\hat{N}_j = n_j * \frac{A_j}{a_j} , \tag{1}$$

where A was the total area (Alverson and Pereyra 1969). The total abundance was estimated as:

$$\hat{N} = \sum_j \hat{N}_j \qquad (2)$$

The variance of $\hat{N}$ was estimated as:

$$\hat{V}(\hat{N}) = \sum_j \hat{N}_j \left(1 - \frac{a_j}{A_j}\right) \frac{A_j}{a_j} \qquad (3)$$

(Seber 1982; page 22).

The area-swept method assumes that catch is proportional to the area physically trawled and density (Ricker 1940, Gulland 1964). This assumption is likely satisfied. The method also assumes that density in the area physically trawled is representative of the grid section in which a trawl is located. The variance estimator assumes that the probability an animal is located within the trawl area is equal to the relative size of the trawl area; a uniformity assumption. The validity of these assumptions is difficult to assess. However, the distribution of animals within an area is likely dependent on a variety of factors, such as bottom topography and patterns of seasonal migration. Given the relatively large size of the sampling grid, these assumptions may be violated. The degree to which potential violations of these assumptions may bias the estimator is unknown.

RESULTS AND DISCUSSION

From August 8 to 21, 1998, we surveyed the marine fishery resources of the southeast Chukchi Sea and Kotzebue Sound for spatial distribution, biomass, abundance, and other population characteristics. From a total of 92 potential trawl site locations, 65 stations were successfully trawled, three stations were trawled unsuccessfully, and 24 stations were left untrawled (Figure 7). A total of 69 hauls were conducted during the survey with three that were unusable because of mud and one that failed because the trawl doors became crossed (Table 1). Stormy weather, questionable bottom topography, and a desire to sample stations *01 through *04 in the southwest corner of the study area caused us to skip approximately ten stations in the mid-portion of the westernmost study area. Additionally, stations 64 and 65 were skipped due to the combination of rough seas and shallow water. Because of a time shortage, stations *05 to *11, having a low priority, were skipped. Stations 44, 49, and 51, located within Kotzebue Sound were not trawled because of the questionable bottom topography related to the high incidence of mud encountered in that area.

The target tow distance was 1.85 km (1.0 nm); the average distance was 1.82 km. We shortened a few of the trawls when questionable bottom terrain suddenly appeared on the hydroacoustic equipment. The average trawl depth was 16 fathoms, ranging from 6 fathoms at station 43 in Kotzebue Sound to 33 fathoms at station 69 off Point Hope in the Chukchi Sea. The average tow speed was 2.1 nautical miles per hour, ranging from 1.8 to 4.0, with 95% of all trawls falling between 1.6 and 2.7.

We recorded bottom temperatures at each trawled station (Figure 8). Temperatures at stations 48, 50, 52, and 53 within Kotzebue Sound were the coldest, reaching a low of 0.1° C. The only other stations with bottom temperatures less than 2° C occurred in the distant offshore waters of the Chukchi Sea. The warmest bottom temperature occurred at station 41 in Kotzebue Sound with a 10.0° C reading. Other environmental data collected sporadically during the survey included dissolved oxygen, conductivity, salinity, and sea surface temperature (Table 2). Dissolved oxygen (Mg/L) ranged from 8.4 to 11.8, conductivity (Ms/cm) ranged from 21.9 to 36.3, salinity (ppt) ranged from 18.9 to 32.4, and sea surface temperature (°C) ranged from 4.7 to 10.2.

Total net catches for the survey ranged from 18 kg to 632 kg. The overall survey average was 150 kg, with Kotzebue Sound averaging 80 kg and the Chukchi Sea averaging 166 kg. In general, total net catches increased moving from the shallower Kotzebue Sound to the deeper waters of the Chukchi Sea. Total net catches in CPUE ranged from 9 to 342 with the highest catches found in the deeper waters (Figure 9).

Catch per unit effort (CPUE) throughout this report refers to kg caught per km trawled, unless otherwise noted. Additionally, total fish catch, total invertebrate catch, and total net catch is referenced in CPUE.

Fishes

Fifty-four types of fish taxons were identified from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey catches, representing twelve fish families (Table 3). However, only 52 types of fish taxons were sub-sampled from the catch. Not all fish were identified to the species taxon; many were lumped into genus classifications. Cottidae had the greatest species diversity with 21 species, followed by Pleuronectidae (7), Stichaedae (6), Agonidae (5), Gadidae (4), Zoarcidae (3), Osmeridae and Cyclopteridae (2), and Ammodytidae, Anarhichadidae, Clupeidae, and Hexagrammidae (1).

Fish accounted for 13% of the total net (fish and invertebrate) catch, ranging in CPUE from 1 kg/km to 63 kg/km for all trawl stations. Fish CPUE was lowest in Kotzebue Sound with the higher catches occurring in the strait of Kotzebue Sound and near Cape Prince of Wales (Figure 10). Three fish families, Gadidae, Pleuronectidae, and Cottidae provided over 88% of the total estimated fish biomass (Table 4).

Cod fishes, known as gadids, were represented by five species, with an average CPUE (kg/km) of 3.4 that accounted for 33% of the total fish catch and 4% of the total net catch. Gadidae CPUE was greatest (30.2) in the strait of Kotzebue Sound and near Cape Prince of Wales (Figure 11). Gadidae biomass was estimated to be 9,607 mt, representing 30% of the total fish catch and 4% of the total net catch.

Flatfishes, called pleuronectids, were represented by seven species, with an average CPUE of 3.2, accounting for 31% of the total fish catch and 4% of the total net catch. Pleuronectidae CPUE was highest (31.9) near Cape Prince of Wales and in the strait of Kotzebue Sound (Figure 12). Pleuronectidae biomass was estimated to be 8,749 mt, representing 28% of the total fish catch and 3% of the total net catch.

Sculpins, or Cottidae family, were represented by twenty-one species, with an average CPUE of 2.5 which accounted for 25% of the total fish catch and 3% of the total net catch. Cottidae CPUE was greatest (18.5) in the deep waters of the Chukchi Sea between Cape Prince of Wales and Point Hope (Figure 13). Sculpin biomass was estimated to be 9,587 mt, representing 30% of the total fish catch and 3% of the total net catch.

Osmeridae, Zoarcidae, Clupeidae, Cyclopteridae, Agonidae, Stichaeidae, Ammodytidae and Hexagrammidae made up the remaining 12% of the total fish biomass. Osmeridae CPUE was relatively high (2.3) in the strait of Kotzebue Sound and near Cape Prince of Wales (Figure 14). Large Zoarcidae CPUE (4.2) occurred in the offshore waters of Cape of Wales and Point Hope (Figure 15). Relatively high Clupeidae CPUE (5.4) occurred in the outside waters near the strait of Kotzebue Sound (Figure 16). We found the larger Cyclopteridae CPUE's (7.1) in the Point Hope offshore waters and Cape Prince of Wales nearshore waters (Figure 17). Agonidae CPUE was generally highest (2.7) in the central survey area (Figure 18). In general, the larger Stichaeidae CPUE's (0.3) were found in the deep waters of the central survey area (Figure 19). Both Ammodytidae and Hexagrammidae had only one station with any catch (Figure 20).

We captured saffron cod at 75% of the sampled stations, more stations than any other fish (Table 5). Other fish species captured at more than one-half of all the sampled stations included yellowfin sole (72%), sturgeon poacher (69%), warty sculpin (68%), Bering flounder (63%), rainbow smelt (63%), arctic staghorn sculpin (59%), snake prickleback (52%), and arctic cod (52%).

We captured 6,706 saffron cod during the trawl survey (Table 6), making them the most abundant fish species followed by the arctic staghorn sculpin (2,904), yellowfin sole (2,704), warty sculpin (2,479), and arctic cod (2,155). Similarly, saffron cod had the highest CPUE for the survey at 2.6 kg/km (Table 7), and were followed by the warty sculpin (1.4), starry flounder (1.0), yellowfin sole (0.7), and Pacific halibut (0.6).

Eight different fish species were randomly sampled for total length measurements (Table 8). All Pacific halibut were measured, having a median of 127 cm. We measured 61 yellowfin sole for a median length of 14 cm. Saffron cod median length was 15 cm from 56 measurements, and 25 Pacific herring had a median length of 18 cm. Sample sizes for the remaining fish species were likely too low to draw any meaningful estimations.

Commercial Species

In general, catches for potentially important commercial fish species were low throughout the survey. In the Bering Sea, Pacific halibut, walleye pollock, Pacific cod, and yellowfin sole are some of the most important commercial fish species. In the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey, only three halibut were captured from two stations in the southwest corner of the survey area near Cape Prince of Wales. Halibut CPUE for station 1 was 15.4 with station 9 having a CPUE of 23.3 (Figure 21). Walleye pollock were only found in the Chukchi Sea portion of the survey area. The highest pollock CPUE (7.4) occurred north and northwest of Cape Prince of Wales, and near Point Hope (Figure 22). Pacific cod were scarce throughout much of the survey area; the largest CPUE (8.8) occurred near Cape Prince of Wales (Figure 23). We captured yellowfin sole throughout Kotzebue Sound and in the shallower waters of the southeast Chukchi Sea, but rarely in the deeper waters. The highest yellowfin sole CPUE (3.7) was found between Cape Prince of Wales and Shishmaref (Figure 24).

Other commercial species found in the Chukchi Sea included saffron cod, starry flounder, Alaska plaice, and longhead dab. Saffron cod were the most abundant fish species captured, representing 25% of the fish biomass and 3% of the overall catch biomass. Saffron cod had a similar distribution to yellowfin sole with the most common occurrences in the shallower waters of the survey area. The highest saffron cod CPUE (55.8) occurred in the strait of Kotzebue Sound (Figure 25). We caught starry flounder in most of the southern stations, but nothing north of Kivalina (Figure 26). The southcentral survey area had the highest starry flounder CPUE (11.1). Similar to starry flounder, we captured all Alaska plaice in the southcentral survey area, and nothing north of Kivalina. The largest Alaska plaice CPUE (6.5) occurred in the deeper waters of the Chukchi Sea north of Cape Prince of Wales (Figure 27). Longhead dab were found at only a few stations in the southcentral survey area with the highest CPUE (3.0) in the strait of Kotzebue Sound (Figure 28).

We estimated the biomass for commercial fish species over the entire survey area (Figure 29), including their standard errors (Table 9). Again, saffron cod ranked number one, having a biomass estimate of 5,754 mt. Following saffron cod in rank order of biomass were starry flounder (3,050 mt), Pacific halibut (2,121 mt), yellowfin sole (1,676 mt), walleye pollock (1,301 mt), Alaska plaice (1,262 mt), Pacific cod (784 mt), and longhead dab (164 mt).

Other Species

Other species commonly found in the survey area, but lacking a commercial use, included the rainbow smelt, Bering flounder, arctic flounder, arctic cod, and warty sculpin. Rainbow smelt were most abundant (CPUE of 2.3) near the strait of Kotzebue Sound and Cape Prince of Wales (Figure 30). We found Bering flounder at most stations outside of Kotzebue Sound with the highest CPUE (3.5) located in the northcentral survey area (Figure 31). All arctic flounder were captured in the southcentral zone (Figure 32), with the northern portion of the strait of Kotzebue Sound having the highest CPUE (0.9). Arctic cod were located throughout most of the survey area with the largest CPUE (5.6) occurring in the central sampling zone (Figure 33). We captured the warty, or shorthorned sculpin, over much of the survey area with small CPUE's in Kotzebue Sound and large CPUE's (11.2) in the deeper waters of the Chukchi Sea, especially near Cape Prince of Wales (Figure 34).

Invertebrates

Seventy-one invertebrate taxons were identified from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey catches, representing nine phylums (Table 10). Not all invertebrates were identified down to the species taxon; many were lumped into the more broad genus, family, or order classifications. The phylum Mollusca had the greatest diversity with 29 taxons, followed by Arthropoda (21), Echinodermata (12), Cnidaria (3), Annelida (2), and Bryozoa, Chordata, Phoronida, and Porifera with one each.

Invertebrates accounted for 87% of the total net catch, ranging in CPUE from 9 kg/km to 325 kg/km for all trawl stations. Invertebrate CPUE was lowest in the southcentral study area near the strait of Kotzebue Sound, with the highest catches in deeper waters (Figure 35).

We captured starfish and hermit crabs at all successfully trawled stations (Table 11). Other invertebrates with wide distributions included northern argid shrimp (present in 98% of all trawled stations), tunicates (95%), snow crabs (91%), jellyfish (80%), circumboreal toad crabs (75%), and humpy shrimp (60%).

We caught 74,330 snow crab during the trawl survey, more than any other invertebrate or fish species (Table 12). Other invertebrate species found in high numbers included unidentified starfish (37,084), brittle starfish (33,821), green sea urchin (9,180), and the northern argid shrimp (8,682). Ranked by CPUE (Table 13), the highest invertebrate was starfish at 28.9 kg/km, followed by snow crab (17.2), tunicates (6.7), green sea urchin (3.2), and sponges (2.2).

Commercial Species

Of the potentially important commercial invertebrates, snow crab had the greatest CPUE (17.2), followed by green sea urchin (3.2), gastropod mollusks (1.3), shrimp (0.8), helmet crab (0.7), bivalve mollusks (0.4), and king crab (0.2). Snow crab CPUE was highest (236.4) in the deeper waters of the Chukchi Sea, especially at the offshore station of Point Hope (Figure 36). Unfortunately, the snow crab we caught during the survey, with few exceptions, were immature females and sublegal males. The mean weight for all snow crab captured during the survey was only 0.03 kg. Stations having the largest snow crabs were located about 30 nmi west and southwest from Point Hope (Figure 37). The highest (67.8) green sea urchin CPUE occurred off Cape Prince of Wales and also off Cape Thompson between Point Hope and Kivalina (Figure 38).

The higher gastropod CPUE's (20.3) were generally found in the deeper waters of the Chukchi Sea (Figure 39). The northern whelk and fat whelk accounted for most of the gastropod biomass, with smaller contributions from warped whelk and *Beringius beringii*. Northern whelk catches were sporadic throughout the survey area, with the largest CPUE (15.1) at the offshore station near Point Hope (Figure 40). We found the greatest concentration (CPUE of 11.7) of fat whelk near Point Hope and Cape Prince of Wales, and only seldom appearances in the shallower waters (Figure 41). Warped whelk were found at only four stations, including two in Kotzebue Sound (Figure 42). We captured *Beringius beringii* at eight different stations throughout the survey area, including three in Kotzebue Sound (Figure 43).

We caught shrimp at every trawl station except for one in Kotzebue Sound (Figure 44). The higher shrimp CPUE's (5.3) were generally found in the nearshore waters between Cape Krusenstern and Point Hope. The helmet crab range appears to be limited to the shallower waters of the Chukchi Sea and Kotzebue Sound (Figure 45). The higher helmet crab CPUE's (16.3) occurred along the coast between Shishmaref and Goodhope Bay in Kotzebue Sound. The highest bivalve catches (6.8) were found in the southwest corner of Kotzebue Sound, and in the offshore waters from Point Hope to Cape Prince of Wales (Figure 46). We found blue king crab at nine stations, exclusively in the deep waters of the survey (Figure 47), especially from the Diomede Islands northward, where CPUE was the greatest (3.7).

We estimated biomass for potentially important commercial invertebrate species over the entire survey area (Figure 48), including their standard errors (Table 9). Again, snow crab ranked number one, having a biomass estimate of 66,014 mt. Following snow crab in rank order of biomass were green sea urchin (6,513 mt), helmet crab (1,728 mt), northern whelk (1,584 mt), *Argis lar* shrimp (1,555 mt), fat whelk (1,496 mt), blue king crab (858 mt), and tank shrimp (733 mt).

Other Species

As previously mentioned, starfish, tunicates, and sponges had relatively high CPUE's for the trawl survey. Although these invertebrates presently have little commercial use in Alaska, results are presented here because of their high frequency in the survey area. Starfish accounted for 42% of the invertebrate biomass catch and 37% of the total catch biomass. We found starfish located throughout the survey area with the higher CPUE's (110.0) generally located in the central survey area (Figure 49). Small tunicate catches occurred within Kotzebue Sound, with a general increasing trend to the north, and maximum CPUE's (66.4) around Point Hope (Figure 50). We captured sponges at only 15 stations, some of which were relatively large (Figure 51). One large sponge catch was found inside Kotzebue Sound, and two large catches (79.2 kg/km) occurred near Cape Prince of Wales. The large sponge catch within Kotzebue Sound was particularly interesting because nearly every sponge had one clam attached to its surface. It appeared that the clams were utilizing the sponge in the unstable, muddy environment.

HISTORICAL COMPARISONS

Although trawl gear from the 1998 Chukchi Sea/Kotzebue Sound study differed from previous surveys, it is unlikely that catch selectivity differences exist between the 83-112 trawl used in the past and the 400 eastern used in 1998 (Robert Otto, NMFS, personal communication. The 83-112 trawl has a similar footrope configuration to the 400 eastern and tows similarly over rough bottom.

Prior to the 1998 survey, only four investigations provided information on the distribution and abundance of fish and/or invertebrates in the southeast Chukchi Sea and Kotzebue Sound. The first was an exploratory fishing survey by the Soviet Union in waters west of the dateline of the Bering and Chukchi Seas in 1933-34 (Andriyashev 1937). Unfortunately, the study was too general to be of use as baseline material. Next, the United States Atomic Energy Commission (AEC) launched Project Chariot in the Cape Thomson area in 1959 (Wilimovsky 1966). The AEC investigations provided a considerable amount of information on the marine fish and invertebrates for Alaskan waters north of the Bering Strait. Alverson and Wilimovsky (1966) described the fish fauna from the AEC survey, and studies of the marine invertebrate community were documented by Sparks and Pereyra (1966) and Abbott (1966). In 1976, the NMFS conducted an extensive trawl survey in the waters of the northern Bering Sea, Norton Sound, Kotzebue Sound and the southeastern Chukchi Sea between 63° and 68°40'N latitude and the US-Russia Convention line of 1867 eastward to the Alaska mainland (Wolotira et al. 1977). This study provided excellent quantitative data analysis of many fishes and invertebrates, thereby providing an outstanding baseline. Lastly, from 1989 to 1992, the U.S. Department of Interior's Mineral Management Service (MMS) conducted an extensive survey of the northeast Chukchi Sea, north of Point Hope (Barber et al. 1994). In 1989, five stations were sampled in the southeast Chukchi Sea within the 1998 study area.

Norton Sound Comparison

To gain a better understanding of the fish and invertebrate catches of the 1998 southeast Chukchi Sea and Kotzebue Sound, and how they relate to other areas, we compared the catches to those from the latest trawl survey conducted in Norton Sound, which was in 1996. Although these two surveys are only instantaneous assessments for the fishes and invertebrates in the respective areas, the comparison is useful for understanding relative population characteristics. For fishes, the Norton Sound total CPUE was 3.0 times higher than it was for Chukchi Sea/Kotzebue Sound, and for invertebrates, it was about 1.4 times higher.

For all commercial species except Pacific cod and longhead dab, the Norton Sound catches are three to seven times greater than those from the 1998 Chukchi Sea trawl survey. Pacific cod and longhead dab had relatively low catch rates in both surveys, with those from the Chukchi Sea slightly larger.

For invertebrates, the comparison tells a different story, especially with snow crab (Figure 53). About one-half of the potentially important commercial invertebrate species were more common in the Chukchi Sea/Kotzebue Sound survey. Snow crab were the anomaly, with CPUE from the Chukchi Sea/Kotzebue Sound area about 100 times larger than those from Norton Sound. Helmet crab estimates were similar for both surveys, red king crab were only caught in the Norton Sound survey, and blue king crab were only found in the Chukchi Sea/Kotzebue Sound survey. The northern and fat whelks had CPUE's more than two times greater in Norton Sound, and shrimp numbers were similar in both areas.

AEC 1959 Chukchi Sea Study

The 1959 AEC trawl survey was carried out in the southeastern Chukchi Sea from Bering Strait to just north of Cape Lisburne and west to 169° W from August 5 to August 31 (Figure 54). Catches from the 1959 AEC work were recorded in numbers caught per trawl. For comparability, Wolotira et al. (1977) adapted the 1959 invertebrate data (Sparks and Pererya 1966) into a relative index (Table 14), and some of the fish data (Alverson and Wilimovsky 1966) into kg/km trawled by multiplying the overall average number caught by a mean weight per individual (Table 15), assuming a standard trawling distance of 2.5 nm (4.6 km/hr).

Decapod crustaceans were the most abundant and frequently encountered invertebrate taxa in the region. Dominant forms included crangoinid and hippolytid shrimp, and hermit and snow crabs. Other invertebrates encountered at over half the stations sampled included starfish, gastropod and pelecypod molluscs, amphipod crustaceans, ophiuroideans, annelid worms, anthozoan coelenterates, and ascidians. Sparks and Pererya (1966) note that although large concentrations of invertebrates were encountered, no economically important species were found in commercial quantities. A few good catches of scallops and crangonid shrimp were taken with the trawl off Point Hope and in the southern sector, but the extent of the population is unknown.

Arctic cod, arctic staghorn sculpin, and Bering flounder were the only fish species present in over half of the demersal trawl catches. Less common fish species included the ribbed sculpin, unidentified eelpouts, and two cottid species from the genera *Artidellus* and *Myoxocephalus*.

NMFS 1976 Chukchi Sea/Kotzebue Sound Study

In a similar analysis, we compared the catches from this study to those from the 1976 southeast Chukchi Sea and Kotzebue Sound trawl survey (Wolotira et al. 1977), the only other complete trawl survey of the area. Because the trawl nets used by the two surveys differed by width, we first standardized the 1998 CPUE estimates to those from 1976 for a valid comparison. Total CPUE for the 1998 trawl survey was about 2.7 times greater than the 1976 survey.

For the fishes captured in the 1976 and 1998 surveys, we examined the CPUE for the most common (by weight) species. For all species except Pacific herring, the higher CPUE's came from the 1998 survey (Figure 55). Large differences, ranging from a factor of four to fourteen were found for saffron cod, warty sculpin, starry flounder, yellowfin sole, Pacific halibut, and the arctic staghorn sculpin. Pacific herring catches were about three times higher in 1976. Besides herring, capelin were also found in greater biomass (by a factor of five) during the 1976 survey, but at much lower numbers.

In the invertebrate category, again most of the more common (by weight) species had higher CPUE's from the 1998 survey (Figure 56). Starfish showed similar numbers for both surveys, but the 1998 snow crab and green sea urchin CPUE estimates were much larger than the 1976 estimates. The highlight for the 1976 survey was the northern whelk, whose 1976 CPUE estimate was more than four times greater than that from 1998.

Further crab comparisons for marketable species appear in Table 16. Although no blue king crab were captured in the 1976 Chukchi Sea trawl survey, NMFS did catch some in the Norton Sound portion of the survey area near St. Lawrence Island. It's likely that the blue king crab from both surveys are from the same St. Lawrence Island stock. However, the estimated blue king crab CPUE, biomass, and abundance from the 1976 and 1998 surveys are not comparable because the crab come from different areas, but are shown here to portray the relatively high biomass estimates found north of St. Lawrence Island in 1998. Both survey catches include females with similar egg characteristics (Table 17). Red king crab were found in low numbers in 1976 and were absent from the 1998 survey. Although snow crab were much more plentiful in 1998, the mean weight per individual was nearly identical in both studies.

The more common and marketable whelk species appear in Table 16, in which northern whelk and *Beringius beringii* population estimates from the 1976 survey far surpass those from this study, but the larger mean weights come from 1998. Fat and warped whelk population estimates are similar for both surveys, but again indicate a larger mean weight for the 1998 study.

MMS 1989 to 1992 Chukchi Sea Study

From 1989 through 1992, a study was conducted by the MMS of the U.S. Department of Interior to oversee oil exploration in the northeast Chukchi Sea in a manner consistent with protection of marine and coastal environments (Barber et al. 1994). The study occurred during five summer and autumn cruises conducted between Cape Lisburne in the south to the ice-edge in the north. In 1989, however, five stations were sampled south of Point Hope and north of Shishmaref within the 1998 study area. In 1990, four stations were sampled due west of Point Hope similar to stations 66, 67, and 68 from the 1998 survey.

Barber et al. (1994) found considerable interannual variability in the transport of waters through the Bering Strait. They believe that the interannual variation in the physical oceanographic conditions impact the abundance and distribution of fishes in the northeast Chukchi Sea to a large degree. The Arctic staghorn sculpin and Bering flounder biomass, abundance, and age structure varied tremendously between 1990 and 1991. Additionally, there was support for Pruter and Alverson's (1962) hypothesis that some species of fishes and invertebrates inhabiting the northeastern Chukchi Sea are maintained via continual recruitment of eggs and larvae transported northward from the southeastern Chukchi Sea or northeastern Bering Sea.

The highest abundance and biomass of snow crab, epifaunal mollusks, and fishes tended to be in the south. Investigators suggest that the northeastern Chukchi Sea appears to be a transition zone between the northern Bering Sea and Arctic Ocean. The observed differences in distributions, abundance, biomass, and the resulting fish and invertebrate associations involve sediment type, the area's hydrography, import of particulate organic carbon, and flux of plankton from the water column to the benthos. Therefore, processes operating in the Bering Sea have considerable influence on the physical and biological characteristics of the northeastern Chukchi Sea. A similar case could probably be made for the southeast Chukchi Sea.

Fish biomass was dominated by Arctic cod in 1990 and 1991, followed by saffron cod in 1990 and warty sculpin in 1991 (Table 18). Some of the high biomass fish species (top 10) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey, such as starry flounder, Pacific halibut, Alaska plaice, and rainbow smelt were absent from the top ten rankings from the MMS study. However, saffron cod and warty sculpin ranked high in both studies.

The main invertebrate species discussed in Barber et al. (1994) are snow crab, and infaunal and epifaunal mollusks. Snow crab were plentiful throughout much of the survey area, with high concentrations near Point Hope and a slight decreasing trend to the north. The average sizes of snow crab were similar in both studies, with a general increase in size occurring with increasing depth. Gastropods made up the greatest portion of the molluscan epifauna in abundance and biomass. The northern whelk was typically the most abundant mollusk present. Two other species of *Neptunea*, fat whelk and *Neptunea borealis* were nearly as common. Protobranch bivalves dominated the infaunal abundance and biomass, and were widely distributed.

CONCLUSIONS

In the summer of 1999, Part 2 of this study will begin by test fishing the "hot spots" identified from Part 1, the trawl survey. The overall goal of this study is the determination of any additional marketable commercial fisheries in the Chukchi Sea/Kotzebue Sound area. Because of the lack of large boats in the survey region, it is unlikely local residents will be willing or capable of safely fishing areas far from the coast, so initially, we identified only those potentially successful fishing areas near coastal communities. Next, based on CPUE maps, prospective fishers can identify likely locations to test fish for the potential commercial species previously mentioned. The marketability of species with fishery potential will be thoroughly examined in the report following the completion of Part 2.

Because CPUE's for the study area are generally smaller than more southern locations, we will not initially scrutinize absolute catch rates, but instead will focus on relative estimates. Next, based on test fishing results, absolute numbers and marketability will be incorporated into an overall commercial feasibility outlook.

A number of communities had relatively high catches of commercial fishes and invertebrates nearby, including Wales, Shishmaref, Deering, Buckland, Kotzebue, Kivalina, and Point Hope. We defined potential test fishing sites to be within 20 nautical miles of these communities for one or more of the commercial species previously discussed (Table 19).

The community of Wales is located near the richer waters of the Bering Strait, having relatively high numbers of ten commercial species nearby. The next most promising community is Point Hope with seven commercial species, six of which are invertebrate, in relatively high numbers close by. Kivalina also shows promise, having five commercial species, followed by Shishmaref and Deering at three, Kotzebue with two, and Buckland with one. Table 19 should be used as a baseline for the test fishing operations.

We hope that our findings provide another measure of the average conditions of demersal resource abundance, distribution, and composition with a general view of the types of pelagic species which occur in this northern region of the Alaska continental shelf. The catches of fishes and invertebrates in the Chukchi Sea and Kotzebue Sound are small compared to more southern areas, but may support some small fisheries for local communities depending on future economic markets and catch rates from test fishing operations.

LITERATURE CITED

Abbott, D.P. 1966. The ascidians. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 839-841. U.S. Atomic Energy Comm., Wash., D.C.

ADL. 1998. Population estimates. Alaska Department of Labor, Research and Analysis Section, Demographics Unit, Juneau, AK.

Alverson, D.L., and W.T. Pereyra. 1969. Demersal fish explorations in the northeastern Pacific Ocean. J. Fish. Res. Board Can. 26:1985-2001.

Alverson, D.L., and N.J. Wilimovsky. 1966. Fishery investigations of the Chukchi Sea. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 843-860. U.S. Atomic Energy Comm., Wash., D.C.

Andriyashev, A.P. 1937. A contribution to the knowledge of the fishes from the Bering and Chukchi Seas. In Russian. Explor. Des mers de l' urss. Fasc. 25, Inst. Hydro. Leningrad, p. 292-355.

Barber, W.E., R.L. Smith, and T.J. Weingartner. 1994. Fisheries Oceanography of the northeast Chukchi Sea. Mineral Management Service, U.S. Department of the Interior, Anchorage, AK. OCS Study MMS-93-0051.

Flemming, R.H., and D. Heggarty. 1966. Oceanography of the southeastern Chukchi Sea. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 697-754. U.S. Atomic Energy Comm., Wash., D.C.

Gulland, J.A. 1964. Catch per unit effort as a measure of abundance. Rappt. Proces.-Verbaux Reunions Conseil Perm. Intern. Exploration Mer. 155:8-14.

International Pacific Halibut Commission (IPHC). 1991. Halibut length-weight table. International Pacific Halibut Commission Information Bulletin No. 40, Seattle.

Muench, R.D., C.H. Pease, and S.A. Salo. 1991. Oceanographic and meteorological effects on autumn sea-ice distribution in the western Arctic. Journal of Glaciology 15: 171-177.

National Marine Fisheries Service (NMFS). 1996. Species code book, March 1996. National Marine Fisheries Service, U.S. Department of Commerce.

Naval Oceanography Command Detachment. 1986. Sea ice atlas: Volume 3. Arctic west. Naval Oceanography Command Detachment, Asheville, North Carolina.

Overland, J.E., and A.T. Roach. 1987. Northward flow in the Bering and Chukchi Seas. Journal of Geophysical Research 92: 7097-7105.

Pruter, A.T., and D.L. Alverson. 1962. Abundance, distribution, and growth of flounders in the southeastern Chukchi Sea. J. Conseil 27: 81-99.

Ricker, W.E. 1940. Relation of "catch per unit effort" to abundance and rate of exploitation. J. Fish. Res. Bd. Canada 5:43-70.

Seber, G.A.F. 1982. The Estimation of Animal Abundance and related parameters. Charles Griffin & Company Limited, England.

Sparks, A.K., and W.T. Pereyra. 1966. Benthic invertebrates of the southeastern Chukchi Sea. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 817-838. U.S. Atomic Energy Comm., Wash., D.C.

Wallace, M.M., C.J. Pertuit, and A.R. Hvatum. 1949. Contribution to the biology of the king crab (*Paralithodes camtschatica* (Tilesius)). U.S. Department of the Interior, Fish and Wildlife Service, Technical Report 340: 1-50.

Weingartner, T.J. 1994. A physical oceanographic review of the northeast Chukchi Sea. In Barber et. al. 1994, Fisheries Oceanography of the Northeast Chukchi Sea. Symposium on Fish Ecology in Arctic North America, American Fisheries Society.

Wilimovsky, N.J. 1966. Synopsis of previous scientific explorations. In N.J. Wilimovsky and J.N. Wolf (editors), Environment of the Cape Thompson region, Alaska, p. 1-5. U.S. Atomic Energy Comm., Wash., D.C.

Wolotira, R.J., Jr., T.M. Sample, and M. Morin, Jr. 1977. Demersal fish and shellfish resources of Norton Sound, the southeastern Chukchi Sea, and adjacent waters in the baseline year 1976. National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Processed Report. October 1977. 292 pages.

Table 1. Haul data for each station trawled during the southeast Chukchi Sea and Kotzebue Sound survey, 1998.

Station	Haul	Date	Total Fish and Invert. Catch (kg)	1998 Tow Distance (km)	Longitude	Latitude	Compass Heading	Average Depth (FM)	Comments
1	69	20-Aug	191	1.9	-166.27	65.75	110	26	Initially skipped - trawled later.
2	1	9-Aug	170	1.9	-168.00	66.00	0	18	
3	2	9-Aug	337	1.9	-168.13	66.24	350	24	
4	3	9-Aug	238	1.9	-168.05	66.50	0	14	
5	4	9-Aug	151	1.9	-168.09	66.74	0	16	
6	5	9-Aug	161	1.9	-167.43	66.76	180	17	
7		9-Aug			-167.40	66.50			Rocky bottom - did not trawl.
8	6	10-Aug	80	1.9	-167.45	66.26	120	12	
9	7	10-Aug	99	1.9	-167.40	65.99	15	9	
10	8	10-Aug	39	1.9	-166.79	66.24	10	9	
11	9	10-Aug			-166.77	66.50	0	15	Unusable - net full of mud.
12	10	10-Aug	161	1.9	-167.00	66.74	0	19	
13	11	10-Aug	88	1.9	-166.82	67.00	0	21	
14	12	11-Aug	464	1.7	-166.85	67.24	15	24	
15	13	11-Aug	255	1.9	-166.18	67.26	190	21	
16	14	11-Aug	47	1.9	-166.15	67.01	180	15	
17	15	11-Aug	52	1.9	-166.15	66.76	180	11	
18	16	11-Aug			-166.12	66.51	180	10	Unusable - net full of mud.
19	17	11-Aug	44	1.9	-165.49	66.49	10	8	
20	18	12-Aug	52	1.9	-165.51	66.74	0	12	
21	19	12-Aug							Unsuccessful first attempt - crossed doors.
21	20	12-Aug	100	1.9	-165.50	67.01	180	14	
22	21	12-Aug	79	1.9	-165.50	67.24	0	17	
23	22	12-Aug	108	1.9	-165.14	67.17	180	16	
24	23	12-Aug	123	1.9	-165.12	67.01	180	14	
25	24	12-Aug	165	1.9	-165.12	66.84	180	14	
26	25	12-Aug	156	1.9	-165.19	66.69	0	12	
27	26	13-Aug	77	1.9	-1643.64	66.66	290	9	
28	27	13-Aug	95	1.9	-164.70	66.84	300	13	
29	28	13-Aug	111	1.9	-164.64	67.00	290	15	
30	29	13-Aug	122	1.9	-164.68	67.16	320	16	
31	30	13-Aug	71	1.9	-163.23	67.16	295	14	
32	31	13-Aug	147	1.9	-164.25	67.00	310	14	
33	32	13-Aug	114	1.9	-164.24	66.83	160	12	

continued

Table 1 (page 2 of 3).

Station	Haul	Date	Total Fish and Invert. Catch (kg)	1998 Tow Distance (km)	Longitude	Latitude	Compass Heading	Average Depth (FM)	Comments
34	33	14-Aug	71	1.9	-164.27	66.67	55	9	
35	34	14-Aug	64	1.9	-163.82	66.66	0	11	
36	35	14-Aug	122	1.9	-163.84	66.83	0	13	
37	36	14-Aug	45	1.9	-163.85	66.99	10	9	
38	49	16-Aug	163	1.9	-163.40	67.00	255	7	Initially skipped - rough seas.
39	37	14-Aug	33	1.9	-163.41	66.83	330	7	
40	38	14-Aug	156	1.9	-163.38	66.66	45	12	
41	39	14-Aug	97	1.9	-163.39	66.50	170	7	
42	40	15-Aug	142	1.9	-163.43	66.33	30	7	
43	41	15-Aug	88	1.9	-163.41	66.17	50	6	
44		15-Aug			-162.98	66.17			Muddy bottom - did not trawl.
45	42	15-Aug			-162.99	66.33	45	7	Unusable - net full of mud.
46	43	15-Aug	48	1.9	-162.99	66.49	60	8	
47	44	15-Aug	112	1.9	-163.00	66.68	0	8	
48	45	15-Aug	47	0.9	-162.59	66.62	180	7	
49		15-Aug			-162.53	66.50			Muddy bottom - did not trawl.
50	46	15-Aug	24	0.7	-162.53	66.34	210	7	
51		15-Aug			-162.52	66.17			Muddy bottom - did not trawl.
52	47	16-Aug	18	1.9	-162.19	66.32	240	7	
53	48	16-Aug	28	1.9	-162.10	66.50	255	7	
54	50	16-Aug	118	1.9	-164.26	67.34	195	13	
55	52	17-Aug	119	1.9	-164.68	67.34	200	16	
56	53	17-Aug	318	1.9	-164.86	67.50	160	18	
57	51	17-Aug	65	1.9	-164.26	67.50	165	10	
58	54	17-Aug	158	1.9	-164.85	67.75	270	10	
59	55	17-Aug	125	1.9	-165.55	67.75	65	21	
60	56	17-Aug	251	1.9	-165.53	67.50	65	20	
61	57	18-Aug	468	1.9	-166.19	67.50	15	23	
62	58	18-Aug	70	1.9	-166.23	67.75	15	26	
63	59	18-Aug	196	1.9	-166.25	68.00	20	18	
64					-165.53	68.00			Rough seas - did not trawl.
65					-166.27	68.25			Rough seas - did not trawl.
66	60	18-Aug	210	1.9	-166.96	68.24	15	21	
67	61	18-Aug	212	1.9	-167.63	68.25	10	27	

continued

Table 1 (page 3 of 3).

Station	Haul	Date	Total Fish and Invert. Catch (kg)	1998 Tow Distance (km)	Longitude	Latitude	Compass Heading	Average Depth (FM)	Comments
68	62	19-Aug	632	1.9	-168.30	68.25	0	31	
69	63	19-Aug	293	1.9	-168.25	68.00	320	33	
70	64	19-Aug	75	1.9	-167.62	68.02	320	29	
*01	68	20-Aug	342	1.9	-168.66	65.76	90	29	
*02	67	20-Aug	291	1.9	-168.63	66.00	140	29	
*03	66	20-Aug	295	1.9	-168.68	66.26	130	30	
*04	65	20-Aug	132	1.9	-168.70	66.50	160	30	

Table 2. Environmental sea surface data collected during the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

Haul	Date	Dissolved Oxygen (Mg/L)	Conductivity (Ms/cm)	Salinity (ppt)	Temperature (C)
1	9-Aug	9.8	29.1	27.5	8.3
2	9-Aug	9.9	30.3	29.0	7.5
3	9-Aug	----	----	----	----
4	9-Aug	11.8	27.1	28.9	7.3
5	9-Aug	9.4	30.7	28.9	8.3
6	10-Aug	9.4	30.0	29.1	9.0
7	10-Aug	9.0	31.5	29.3	8.9
8	10-Aug	----	----	----	----
9	10-Aug	9.4	31.7	29.9	8.3
10	10-Aug	10.0	31.4	31.0	6.8
11	10-Aug	----	----	----	----
12	11-Aug	----	----	----	----
13	11-Aug	----	----	----	----
14	11-Aug	----	----	----	----
15	11-Aug	----	----	----	----
16	11-Aug	----	----	----	----
17	11-Aug	----	----	----	----
18	12-Aug	9.2	32.3	30.0	9.0
19	12-Aug	----	----	----	----
20	12-Aug	9.4	31.8	31.1	7.1
21	12-Aug	----	----	----	----
22	12-Aug	8.9	32.6	30.4	8.9
23	12-Aug	8.7	32.8	30.3	9.2
24	12-Aug	----	----	----	----
25	12-Aug	8.7	32.5	30.2	9.0
26	13-Aug	8.5	32.7	30.0	9.6
27	13-Aug	----	----	----	----
28	13-Aug	----	----	----	----
29	13-Aug	----	----	----	----
30	13-Aug	----	----	----	----
31	13-Aug	----	----	----	----
32	13-Aug	----	----	----	----
33	14-Aug	8.4	32.8	30.0	9.6
34	14-Aug	----	----	----	----
35	14-Aug	----	----	----	----
36	14-Aug	8.7	32.2	29.3	9.5
37	14-Aug	----	----	----	----
38	14-Aug	----	----	----	----
39	14-Aug	----	----	----	----

continued

Table 2 (page 2 of 2).

Haul	Date	Dissolved Oxygen (Mg/L)	Conductivity (Ms/cm)	Salinity (ppt)	Temperature (C)
40	15-Aug	8.8	27.4	24.3	10.0
41	15-Aug	----	----	----	----
42	15-Aug	8.4	30.3	27.3	10.0
43	15-Aug	8.7	32.3	30.2	9.1
44	15-Aug	9.4	36.3	22.8	9.6
45	15-Aug	----	----	----	----
46	15-Aug	----	----	----	----
47	16-Aug	9.4	28.0	25.7	8.7
48	16-Aug	9.1	25.1	22.2	9.8
49	16-Aug	9.1	21.9	18.9	10.2
50	16-Aug	----	----	----	----
51	17-Aug	8.7	31.7	29.5	8.7
52	17-Aug	8.9	30.2	28.3	8.3
53	17-Aug	----	----	----	----
54	17-Aug	8.5	30.7	28.0	9.5
55	17-Aug	9.3	28.4	26.2	8.7
56	17-Aug	9.7	30.1	32.0	6.0
57	18-Aug	9.8	30.4	32.4	5.5
58	18-Aug	----	----	----	----
59	18-Aug	----	----	----	----
60	18-Aug	9.1	31.8	30.1	8.2
61	19-Aug	10.6	29.8	31.2	4.7
62	19-Aug	10.5	29.7	30.9	4.9
63	19-Aug	----	----	----	----
64	19-Aug	----	----	----	----
65	20-Aug	----	----	----	----
66	20-Aug	----	----	----	----
67	20-Aug	9.6	31.7	32.2	5.7
68	20-Aug	----	----	----	----
69	20-Aug	----	----	----	----

Table 3. List of fish species captured in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Family	Scientific Name	Common Name
AGONIDAE	*Agonidae sp.*	Unidentified poachers
	Aspidophoides bartoni	Aleutian alligatorfish
	Occella dodecaedron	Bering poacher
	Pallasina barbata	Tubenose poacher
	Podothecus acipenserinus	Sturgeon poacher
AMODYTIDAE	*Ammodytes hexapterus*	Pacific sand lance
ANARHICHADIDAE	*Anarhichas orientalis*	Bering wolffish
CLUPEIDAE	*Clupea pallisi*	Pacific herring
COTTIDAE	*Artedellius sp.*	Unidentified Artedellius sculpins
	Artedellius miacanthus	Bride sculpin
	Blepsias bilobus	Crested sculpin
	Cottidae sp.	Unidentified sculpins
	Enophrys lucasi	Antlered sculpin
	Eurymen gyrinus	Smoothcheek sculpin
	Gymnocanthus pistilliger	Threaded sculpin
	Gymnocanthus sp.	Unidentified Gymnocanthus sculpins
	Gymnocanthus tricuspis	Arctic staghorn sculpin
	Hemilepidotus papilio	Butterfly sculpin
	Icelus sp.	Unidentified Icelus sculpins
	Leptocottus armatus	Pacific staghorn sculpin
	Megalocottus playcephalus	Belligerent sculpin
	Microcottus sellaris	Brightbelly sculpin
	Myoxocephalus jaok	Plain sculpin
	Myoxocephalus polyacanthocephalus	Great sculpin
	Myoxocephalus quadricornis	Fourhorn sculpin
	Myoxocephalus sp.	Unidentified Myoxocephalus sculpins
	Myoxocephalus verrucosus	Warty or shorthorned sculpin
	Nautichthys pribilovius	Eyeshade sculpin
	Triglops sp.	Unidentified Triglops sculpins
CYCLOPTERIDAE	*Careproctus sp.*	Unidentified snailfish
	Cyclopteridae sp.	Unidentified snailfish
GADIDAE	*Boreogadus saida*	Arctic cod
	Eleginus gracilis	Saffron cod
	Gadus macrocephalus	Pacific cod
	Theragra chalcogramma	Walleye pollock
HEXAGRAMMIDAE	*Hexagrammos stelleri*	Whitespotted greenling
OSMERIDAE	*Mallotus villosus*	Capelin
	Osmerus mordax	Rainbow smelt

continued

Table 3 (page 2 of 2).

Family	Scientific Name	Common Name
PLEURONECTIDAE	*Hippoglossus robustus*	Bering flounder
	Hippoglossus stenolepis	Pacific halibut
	Limanda proboscidea	Longhead dab
	Liopsetta glacialis	Arctic flounder
	Platichthys stellatus	Starry flounder
	Pleuronectes asper	Yellowfin sole
	Pleuronectes quadrituberculatus	Alaska plaice
STICHAEIDAE	*Acantholumpenus mackayi*	Pighead prickleback
	Lumpenus fabricii	Slender eelblenny
	Lumpenus sagitta	Snake prickleback
	Lumpenus sp.	Unidentified Lumpenus pricklebacks
	Stichaeus punctatus	Arctic shanny
	Stichaeidae sp.	Unidentified Stichaeidae pricklebacks
ZOARCIDAE	*Zoarcidae sp.*	Unidentified Zoarcidae eelpouts
	Lycodes palearis	Wattled eelpout
	Lycodes brevipes	Shortfin eelpout

Table 4. Average catch per unit effort and biomass of major taxonomic groups by subarea estimated from the1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

Taxa	CPUE (kg/km)	Proportion of total CPUE	Biomass (mt)	Proportion of Total Biomass
Gadidae	3.41	0.043	9,607	0.036
Pleuronectidae	3.15	0.040	8,749	0.033
Cottidae	2.53	0.032	9,587	0.036
Osmeridae	0.36	0.004	895	0.003
Zoarcidae	0.27	0.003	1,027	0.004
Clupeidae	0.23	0.003	485	0.002
Cyclopteridae	0.18	0.002	695	0.003
Agonidae	0.14	0.002	545	0.002
Other fish	0.03	0.000	113	0.000
Total Fish	10.30	0.130	31,703	0.120
Chionecetes sp.	17.19	0.217	66,014	0.249
Green Sea Urchin	3.19	0.040	12,055	0.045
Gastropod Molluscs	1.25	0.016	4,850	0.018
Shrimp	0.79	0.010	2,555	0.010
Telemessus sp.	0.73	0.009	1,728	0.007
Bivalve Molluscs	0.37	0.005	1,282	0.005
Paralithodes sp.	0.21	0.003	858	0.003
Total Commercially Important Invertebrates	23.73	0.299	89,342	0.337
Starfish	28.9	0.365	85,804	0.323
Other Echinoderms	2.69	0.034	9,377	0.035
Other Invertebrates	13.6	0.171	47,823	0.180
Total Invertebrates	68.9	0.870	233,205	0.879
Total Catch	79.2		265,240	

Table 5. Rank order by frequency of occurrence (number of trawls) of the 20 most common fish taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	Frequency	Percent
1	Saffron Cod	49	75.4%
2	Yellowfin Sole	47	72.3%
3	Sturgeon Poacher	45	69.2%
4	Warty Sculpin	44	67.7%
5	Bering Flounder	41	63.1%
6	Rainbow Smelt	41	63.1%
7	Arctic Staghorn Sculpin	38	58.5%
8	Snake Prickleback	34	52.3%
9	Arctic Cod	34	52.3%
10	Alaska Plaice	30	46.2%
11	Starry Flounder	29	44.6%
12	Pacific Herring	26	40.0%
13	Wattled Eelpout	23	35.4%
14	Unidentified Triglops	20	30.8%
15	Walleye Pollock	20	30.8%
16	Antlered Sculpin	16	24.6%
17	Unidentified Sculpin	15	23.1%
18	Pacific Cod	15	23.1%
19	Polar Eelpout	12	18.5%
20	Longhead Dab	11	16.9%
Total number of fish classifications		54	
Total number of successful hauls		65	

Table 6. Rank order by catch abundance (number of fish) of the 20 most common fish taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	Number	Percent
1	Saffron Cod	6,706	23.3%
2	Arctic Staghorn Sculpin	2,904	10.1%
3	Yellowfin Sole	2,704	9.4%
4	Warty Sculpin	2,479	8.6%
5	Arctic Cod	2,155	7.5%
6	Unidentified Sculpin	1,497	5.2%
7	Walleye Pollock	1,282	4.5%
8	Sturgeon Poacher	1,038	3.6%
9	Bering Flounder	991	3.4%
10	Rainbow Smelt	975	3.4%
11	Pacific Cod	891	3.1%
12	Pacific Herring	787	2.7%
13	Alaska Plaice	731	2.5%
14	Unidentified Artedelius Sculpin	552	1.9%
15	Unidentified Triglops Sculpin	424	1.5%
16	Longhead Dab	379	1.3%
17	Unidentified Snailfish	378	1.3%
18	Snake Prickleback	301	1.0%
19	Threaded Sculpin	277	1.0%
20	Wattled Eelpout	175	0.6%

Total number of fish classifications	54
Total number of successful hauls	65

Table 7. Rank order by biomass (weight) of the 20 most common fish taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	CPUE (kg/km)	Percent
1	Saffron Cod	2.56	23.2%
2	Warty Sculpin	1.35	12.3%
3	Starry Flounder	1.04	9.5%
4	Yellowfin Sole	0.66	6.0%
5	Pacific Halibut	0.61	5.9%
6	Arctic Staghorn Sculpin	0.51	4.6%
7	Alaska Plaice	0.39	3.5%
8	Rainbow Smelt	0.35	3.2%
9	Walleye Pollock	0.34	3.1%
10	Unidentified Sculpin	0.34	3.1%
11	Bering Flounder	0.31	2.8%
12	Pacific Cod	0.27	2.4%
13	Arctic Cod	0.25	2.2%
14	Pacific Herring	0.23	2.0%
15	Polar Eelpout	0.19	1.7%
16	Unidentified Snailfish	0.18	1.7%
17	Sturgeon Poacher	0.13	1.1%
18	Wattled Eelpout	0.08	0.8%
19	Longhead Dab	0.08	0.8%
20	Unidentified Myoxocephalus Sculpin	0.07	0.7%

Total number of fish classifications	54
Total number of successful hauls	65

Table 8. Number of length measurements taken by species in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Species	Number of Fish Measured	Number of Observation Sets	Minimum Size (cm)	Maximum Size (cm)	Median (cm)
Pacific Halibut	3	2	110	130	127
Arctic Flounder	2	1	17	17	17
Yellowfin Sole	61	5	8	23	14
Starry Flounder	17	5	27	50	38
Alaska Plaice	9	1	10	22	12
Pacific Herring	25	2	15	22	18
Saffron Cod	56	3	7	30	15
Walleye Pollock	4	2	73	83	77
Total	177				

Table 9. Abundance (millions) and biomass (mt) estimates for various fish and invertebrates, with accompanying standard errors and confidence intervals from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

Invertebrate Species	Abundance (millions)	Standard Error	95% Lower Confidence Interval	95% Upper Confidence Interval	Biomass (mt)	Standard Error	95% Lower Confidence Interval	95% Upper Confidence Interval
Snow Crab	2,433.9	9.1	2,416.1	2,451.7	66,014	1,490	63,093	68,935
Urchin	298.5	3.1	292.3	304.6	6,513	462	5,608	7,418
Helmet Crab	10.9	0.5	9.9	11.8	1,728	198	1,340	2,115
Northern Whelk	12.0	0.6	10.7	13.2	1,584	230	1,133	2,035
Argis lar shrimp	238.7	2.7	233.4	244.0	1,555	219	1,125	1,984
Fat Whelk	14.4	0.7	13.0	15.9	1,496	232	1,042	1,950
Blue King Crab	3.2	0.3	2.6	3.9	858	171	523	1,194
Tank Shrimp	47.6	1.1	45.4	49.9	733	144	450	1,016
Warped Whelk	1.3	0.2	0.9	1.7	163	74	18	308
Beringius beringii	1.1	0.2	0.8	1.5	141	68	8	273
Fish Species								
Saffron Cod	142.6	1.8	139.0	146.2	5,754	350	5,068	6,440
Warty Sculpin	75.2	1.5	72.2	78.3	5,022	404	4,231	5,814
Starry Flounder	23.8	0.3	23.2	24.4	3,050	293	2,476	3,624
Halibut	0.1	0.1	0.0	0.2	2,121	255	1,621	2,622
Yellowfin Sole	57.3	1.2	54.9	59.6	1,676	204	1,275	2,076
Walleye Pollock	42.5	1.2	40.2	44.9	1,301	208	894	1,708
Alaska Plaice	18.4	0.7	17.0	19.8	1,262	195	880	1,644
Bering Flounder	32.5	1.1	30.5	34.6	1,221	204	821	1,621
Arctic Cod	65.2	1.4	62.4	68.1	910	172	572	1,247
Pacific Cod	23.8	0.8	22.2	25.4	784	143	504	1,065
Longhead Dab	6.2	0.3	5.5	6.8	164	55	57	272
Arctic Flounder	2.2	0.2	1.8	2.7	113	51	13	213

Table 10. List of invertebrate species collected in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Scientific Nomenclature	Common Name
Phylum CNIDARIA (COELENTERATA)	
Class Scyphozoa	Unidentified jellyfish
Class Anthozoa	
Family Alcyonacea Nephtheidae	
Eunephthya rubiformis	Sea raspberry
Order Gorgonacea	Unidentified horny corals
Phylum ANNELIDA	
Class Polychaeta	
Family Polynoidae	Unidentified scale worms
Eunoe sp.	Unidentified Eunoe scale worms
Phylum ARTHROPODA	
Class Cirripedia	
Order Thoracica	Unidentified barnacles
Class Malacostraca	
Subclass Eucarida	Unidentified shrimp
Family Pandalidae	
Pandalis goniurus	Humpy shrimp
Pandalis hypsinotus	Coonstripe shrimp
Family Hippolytidae	
Lebbeus sp.	Unidentified Lebbeus shrimp
Lebbeus groenlandicus	Spiny Lebbeid
Lebbeus polaris	Polar Lebbeid
Family Crangonidae	
Crangon communis	Common two-spinned crangon
Crangon dalli	Ridged crangon
Crangon septemspinosa	Sand shrimp
Argis lar	Northern argid
Sclerocrangon boreas	Tank shrimp
Order Amphipoda	Unidentified amphipods
Order Isopoda	Unidentified isopods
Family Majidae	
Oregonia gracilis	Graceful decorator crab
Hyas coarctatus	Circumboreal toad crab
Chionoecetes opilio	Tanner crab
Family Atelecyclidae	
Telemessus cheiragonus	Helmet crab
Family Paguridae	Unidentified hermit crabs
Family Lithodidae	
Hapalogaster grebnitzkii	Soft crab
Paralithodes playpus	Blue king crab
Phylum MOLLUSCA	
Class Gastopoda	Unidentified snails
Order Nudibranchia	Unidentified nudibranchs
Family Naticidae	
Natica russa	Rusty moonsnail
Polinices pallidus	Pale moonsnail

continued

Table 10 (page 2 of 3).

Scientific Nomenclature	Common Name
Family Neptuneidae	
Colus hypolispus	Oblique whelk
Velutopsius sp.	Unidentified Velutopsius snails
Velutopsius stefanssoni	Shouldered whelk
Pyrulofusus deformis	Warped whelk
Beringius beringii	Northern beringius
Beringius stimpsoni	Simpson's beringius
Neptunea sp.	Unidentified Neptunea snails
Neptunea lyrata	Ribbed neptune
Neptunea ventricosa	Fat whelk
Neptunea heros	Northern neptune
Plicifusus kroeyeri	Kroeyer's Plicifus
Family Buccinidae	
Buccinum sp.	Unidentified buccinum snails
Buccinum angulosum	Angled buccinum
Buccinum polare	Polar whelk
Class Bivalvia	Unidentified bivalves
Family Pectinidae	
Chlamys sp.	Unidentified Chlamys scallops
Family Hiatellidae	
Hiatella arctica	Arctic hiatella
Family Nuculanidae	
Yoldia sp.	Unidentified Yoldia clams
Nuculana sp.	Unidentified Nuculana nut clams
Family Astartidae	
Tridonta borealis	Boreal tridonta
Family Cardiidae	Unidentified cockles
Clinocardium sp.	Unidentified Clinocardium cockles
Family Veneridae	
Saxidomus giganteus	Butter clam
Family Mactridae	
Spisula polynyma	Arctic surf clam
Family Myidae	
Mya sp.	Unidentified Mya clams
Phylum ECHINODERMATA	
Class Asteroidea	
Family Pterasteridae	
Pteraster tesselatus	Cushion sea star
Pteraster obsurus	Obscure sea star
Family Solasteridae	
Crossaster papposus	Rose sea star
Crossaster borealis	Grooved sea star
Family Asteridae	
Asterias amurensis	Flatbottom sea star
Lethasterias nanimensis	Blackspined sea star
Leptasterias sp.	Unidentified Leptasterias starfish
Class Echinodea	
Family Strongylocentrotidae	
Strongylocentrotus droebachiensis	Green sea urchin

continued

Table 10 (page 3 of 3).

Scientific Nomenclature	Common Name
Family Echinarachniidae	
Echinarachnius parma	Greenspined sand dollar
Family Gorgonocephalidae	
Gorgonocephalus caryi	Basket starfish
Family Ophiactidae	
Ophiura sarsi	Notched brittle star
Class Holothurodea	Unidentified sea cucumbers
Phylum PORIFERA	Unidentified sponges
Phylum PHORONIDA	Unidentified tube worms
Phylum BRYOZOA	Unidentified bryozoans
Phylum CHORDATA	
Subphylum Urochordata	Unidentified tunicates

Table 11. Rank order by frequency of occurrence (number of trawls) of the 20 most common invertebrate taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	Frequency	Percent
1	Unidentified Starfish	65	100%
2	Unidentified Hermit Crabs	65	100%
3	Northern Argid Shrimp	65	98%
4	Unidentified Tunicates	62	95%
5	Snow Crab	59	91%
6	Unidentified Jellyfish	52	80%
7	Circumboreal Toad Crab	49	75%
8	Humpy Shrimp	39	60%
9	Unidentified Snail Eggs	33	51%
10	Basket Starfish	33	51%
11	Sea Raspberry	32	49%
12	Northern Whelk	26	40%
13	Helmet Crab	24	37%
14	Brittle Starfish	22	34%
15	Fat Whelk	22	34%
16	Ridged Crangon Shrimp	20	31%
17	Green Sea Urchin	19	29%
18	Tank Shrimp	18	28%
19	Unidentified Tube Worms	16	25%
20	Unidentified Sponge	15	23%
Total number of invertebrate classifications		71	
Total number of successful hauls		65	

Table 12. Rank order by catch abundance (number of fish) of the 20 most common invertebrate taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	Number	Percent
1	Snow Crab	74,330	38.8%
2	Unidentified Starfish	37,084	19.3%
3	Brittle Starfish	33,821	17.6%
4	Green Sea Urchin	9,180	4.8%
5	Northern Argid Shrimp	8,682	4.5%
6	Unidentified Hermit Crab	5,049	2.6%
7	Unidentified Tunicate	4,427	2.3%
8	Humpy Shrimp	3,861	2.0%
9	Tank Shrimp	1,918	1.0%
10	Circumboreal Toad Crab	1,908	1.0%
11	Unidentified Nut Shell Clams	1,759	0.9%
12	Unidentified Sea Cucumber	1,590	0.8%
13	Basket Starfish	1,328	0.7%
14	Unidentified Jellyfish	1,210	0.6%
15	Unidentified Sponge	804	0.4%
16	Boreal Tridonta Clam	606	0.3%
17	Helmet Crab	529	0.3%
18	Ridged Crangon Shrimp	427	0.2%
19	Fat Whelk	404	0.2%
20	Northern Whelk	368	0.2%

Total number of invertebrate classifications	71
Total number of successful hauls	65

Table 13. Rank order by biomass (weight) of the 20 most common invertebrate taxa in the southeast Chukchi Sea and Kotzebue Sound trawl survey, 1998.

Rank	Classification	CPUE (kg/km)	Percent
1	Unidentified Starfish	28.94	42.0%
2	Snow Crab	17.19	24.9%
3	Unidentified Tunicates	6.68	9.7%
4	Green Sea Urchin	3.19	4.6%
5	Unidentified Sponge	2.22	3.2%
6	Unidentified Jellyfish	1.87	2.7%
7	Brittle Starfish	1.44	2.1%
8	Basket Starfish	1.07	1.5%
9	Unidentified Hermit Crab	1.05	1.5%
10	Sea Raspberry	0.99	1.4%
11	Circumboreal Toad Crab	0.73	1.1%
12	Helmet Crab	0.73	1.1%
13	Northern Argid Shrimp	0.47	0.7%
14	Northern Whelk	0.42	0.6%
15	Fat Whelk	0.36	0.5%
16	Unidentified Snail Eggs	0.27	0.4%
17	Tank Shrimp	0.24	0.3%
18	Blue King Crab	0.21	0.3%
19	Unidentified Sea Cucumbers	0.18	0.3%
20	Unidentified Scallops	0.15	0.2%
Total number of invertebrate classifications		71	
Total number of successful hauls		65	

Table 14. Rank order by frequency of occurrence and relative abundance of the 20 most common invertebrate taxa in the 1959 AEC southeastern Chukchi Sea survey.

Rank	Taxon	Percent Frequency of Occurrence [1]	Relative Abundance Index [2]
1	Decapod Crustaceans	99	5,883
2	Starfish	77	2,253
3	Gastropod Molluscs	70	1,065
4	Amphipod Molluscs	68	1,039
5	Pelecypod Molluscs	64	1,423
6	Omphiuroidean Echinoderms	62	2,798
7	Annelid Worms	57	2,048
8	Anthozoan collenterates	57	1,267
9	Ascidians	55	2,715
10	Holothuroidean Echinoderms	42	1,354
11	Echinoidean Echinoderms	32	922
12	Cirripedia Crustaceans	32	625
13	Scyphozoa Coelenterates	30	485
14	Bryozoans	27	378
15	Sponges	23	664
16	Hydrazoan Coelenterates	22	286
17	Sipunculoidea	20	59
18	Nemertian Worms	19	48
19	Isopod Crustaceans	14	25
20	Amphineura Molluscs	11	51

[1] Number of sampling stations (trawls or trawls and dredge): 74.

[2] Total number of animals present in all samples adapted from rank key presented by Sparks and Pereyra (1966).

Table 15. Rank order by catch rate (numbers/trawl) and frequency of occurrence (percent) of the 20 most common fish taxa in the 1959 AEC southeastern Chukchi Sea survey.

Rank	Taxon	CPUE 1 (Number Trawled)	Proportion of Total CPUE 2	Percent Frequency of Occurrence
1	Arctic Cod	59.0	0.586	71.9
2	Arctic Staghorn Sculpin	10.6	0.105	68.4
3	Bering Flounder	4.3	0.043	61.4
4	Capelin	4.0	0.040	22.8
5	*Artedellus sp.*	3.7	0.037	43.9
6	Ribbed Sculpin	2.1	0.021	45.6
7	Toothed Smelt	2.0	0.019	22.8
8	*Myoxocephalus sp.*	1.4	0.013	33.3
9	Saffron Cod	1.3	0.013	24.6
10	Unidentified eelpouts	1.2	0.012	43.9
11	Unidentified Snailfish	1.1	0.010	31.6
12	Sturgeon Poacher	0.9	0.009	24.6
13	Leister Sculpin	0.6	0.006	22.8
14	Slender Eelblenny	0.6	0.006	24.6
15	Stout Eelblenny	0.6	0.006	22.8
16	Yellowfin Sole	0.5	0.005	14.0
17	*Triglops sp.*	0.5	0.005	14.0
18	Pacific Herring	0.5	0.005	14.0
19	Unidentified Sea Poachers	0.5	0.005	28.1
20	Eyeshade Sculpin	0.2	0.002	14.0

[1] Overall catch per unit effort, no./trawl. Total effort = 57 trawls.

[2] Proportion of total catch per unit effort, fish only. Total CPUE = 100.63/hour trawl haul.

Table 16. Southeast Chukchi Sea and Kotzebue Sound trawl survey comparisons, 1976 and 1998.

Survey Year	Species	Mean CPUE (kg/km)[1]	Estimated Biomass (mt)	Estimated Population (X10)	Mean Weight per Individual (kg)
1976*	Blue King Crab	0.020	62	163	0.375
1998	Blue King Crab	0.297	858	3,242	0.264
1976	Red King Crab	0.008	20	41	0.450
1998	Red King Crab	0.000	0	0	0.000
1976	Snow Crab	2.436	7,108	251,721	0.029
1998	Snow Crab	23.974	66,014	2,433,915	0.027
1976	Northern Whelk	2.127	7,738	80,378	0.096
1998	Northern Whelk	0.582	1,584	11,960	0.133
1976	Fat Whelk	0.387	1,364	18,971	0.073
1998	Fat Whelk	0.500	1,496	14,426	0.104
1976	Warped Whelk	0.054	129	1,577	0.085
1998	Warped Whelk	0.059	163	1,263	0.124
1976	Beringius beringii	0.119	319	3,695	0.084
1998	Beringius beringii	0.054	141	1,147	0.123
1976	Total	39.273	135,534	-------	-------
1998	Total	79.248	265,240	-------	-------

* Includes the Norton Sound survey area.

Table 17. Male and female blue king crab standardized estimated abundance by size, and female egg characteristics from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

Males

Survey Year	<100 mm	100-125 mm	>125	Legal	All Sizes
	Estimated Abundance ($X10^3$)				
1976	81	-----	-----	-----	81
1998	1,318	129	64	103	1,510

Females

Survey Year	<70 mm	>70 mm	All Sizes
	Estimated Abundance ($X10^3$)		
1976	39	81	120
1998	1,145	385	1,530

Females

Survey Year	Carapace Length (mm)	No Eggs	Trace - 1/8 Full	1/4 Full	1/2 Full	3/4 Full	Full	Proportion With Eggs
1976*	0-84	57	--	--	--	--	--	0.00
1976*	85-89	7	--	--	--	1	1	0.22
1976*	90-94	1	--	--	--	--	--	0.00
1976*	95-99	1	--	--	--	--	--	0.00
1976*	100-104	1	--	--	--	--	--	0.00
1976*	105-109	--	--	--	--	--	--	--
1976*	110-114	1	--	--	--	--	--	0.00
1998	0-84	43	--	--	--	--	--	0.00
1998	85-89	1	--	--	--	--	--	0.00
1998	90-94	1	--	--	--	--	--	0.00
1998	95-99	--	--	--	--	--	--	--
1998	100-104	2	--	--	1	--	1	0.50
1998	105-109	1	--	--	--	--	--	0.00
1998	110-114	--	--	--	--	--	--	--

* Includes the Norton Sound survey area.

Table 18. Top 10 ranks by biomass for fishes captured during the 1990 and 1991 MMS northeast Chukchi Sea study.

1990

Rank	Species Name	% of Biomass
1	Arctic Cod	61.34
2	Saffron Cod	7.88
3	*Myoxocephalus* sp.	9.99
4	Pacific Herring	3.55
5	Bering Flounder	3.54
6	Warty Sculpin	2.56
7	Arctic Staghorn Sculpin	1.84
8	*Lycodes raridens* Eelpout	1.64
9	*Lycodes polaris* Eelpout	1.58
10	Wattled Eelpout	0.98

1991

Rank	Species Name	% of Biomass
1	Arctic Cod	61.34
2	Warty Sculpin	7.88
3	Saffron Cod	9.99
4	*Lycodes raridens* Eelpout	3.55
5	Arctic Staghorn Sculpin	3.54
6	*Myoxocephalus* sp. 1	2.56
7	*Liparis gibbus* Snailfish	1.84
8	*Pleuronectes quadrituberculatus*	1.64
9	Yellowfin Sole	1.58
10	Myoxocephalus sp.	0.98

Table 19. Communities within the Chukchi Sea and Kotzebue Sound survey area that may be suitable for test fishing operations in 1999 based on high relative catches of commercial species in nearby waters.

Species Name	Wales	Shishmaref	Deering	Buckland	Kotzebue	Kivalina	Point Hope	TOTAL
Pacific Halibut	X							1
Walleye Pollock	X						X	2
Pacific Cod	X					X		2
Yellowfin Sole	X	X			X			3
Starry Flounder	X	X	X					3
Saffron Cod	X				X	X		3
Snow Crab							X	1
Green Sea Urchin	X					X	X	3
Northern Whelk			X	X			X	3
Fat Whelk	X						X	2
Shrimp	X					X	X	3
Helmet Crab		X	X			X		3
Blue King Crab	X						X	2
Total	10	3	3	1	2	5	7	31

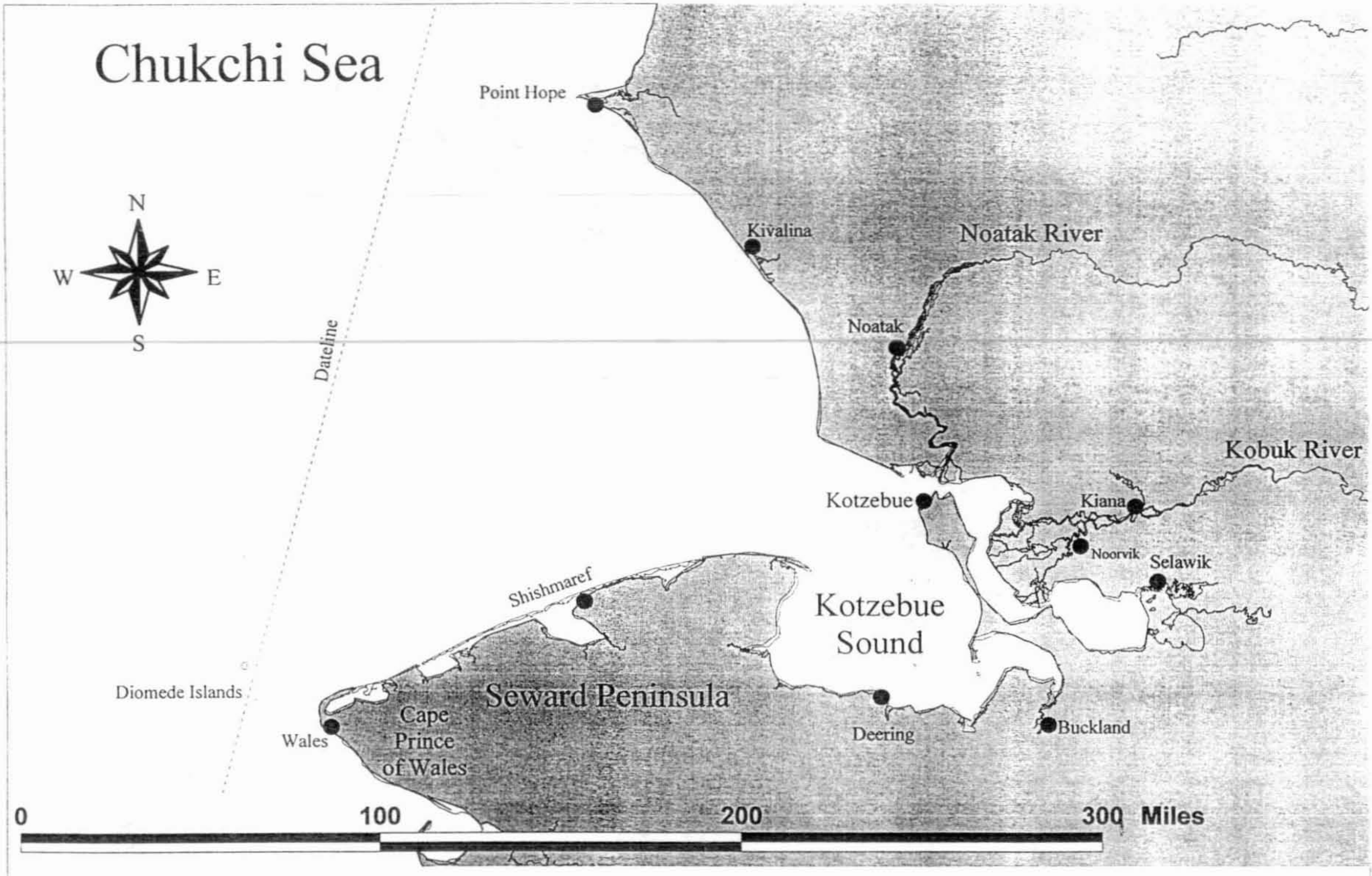

Figure 1. Map of the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey area and the surrounding communities.

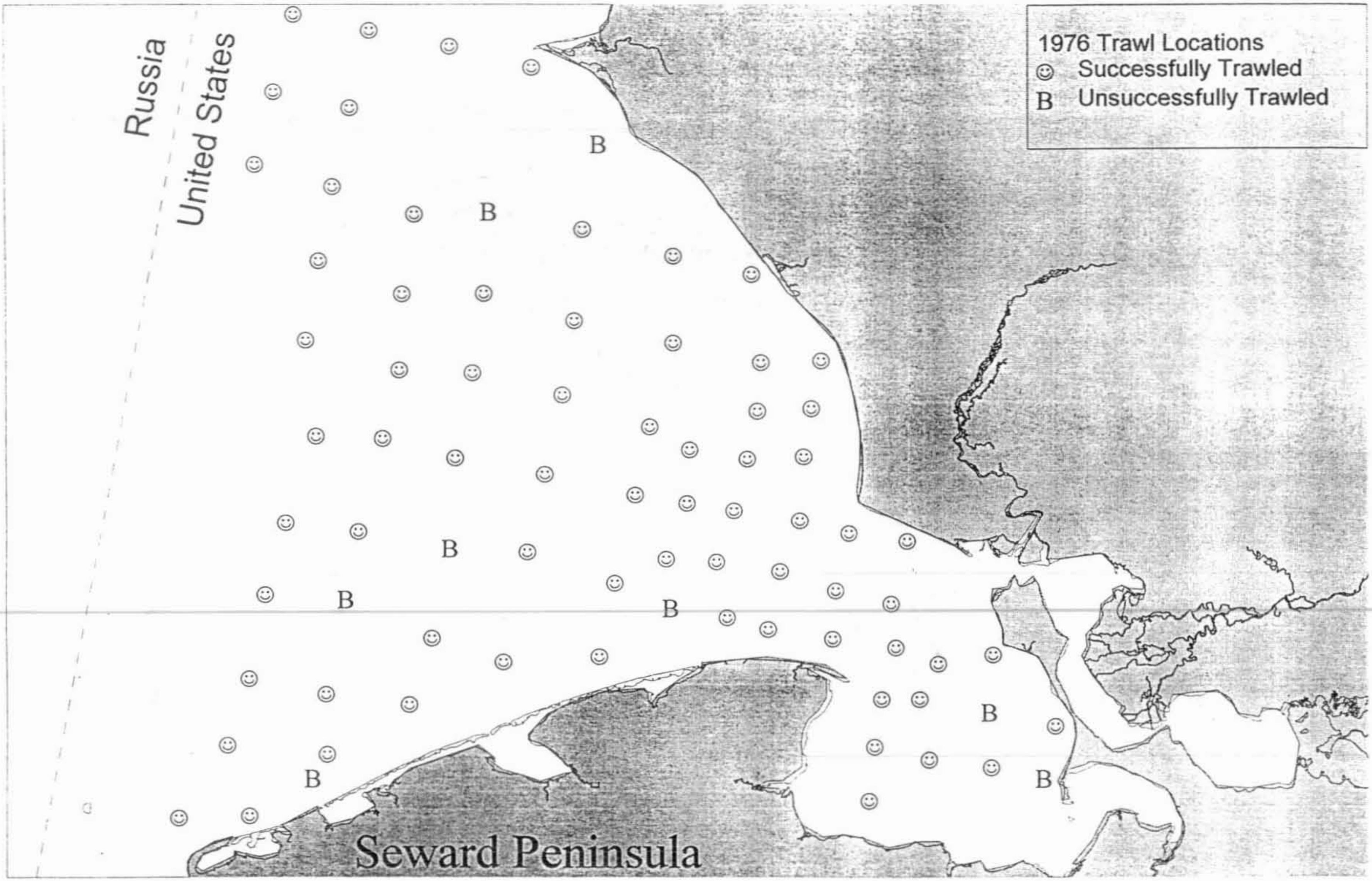

Figure 2. Map of the trawl station locations from the 1976 NMFS survey of the southeast Chukchi Sea and Kotzebue Sound.

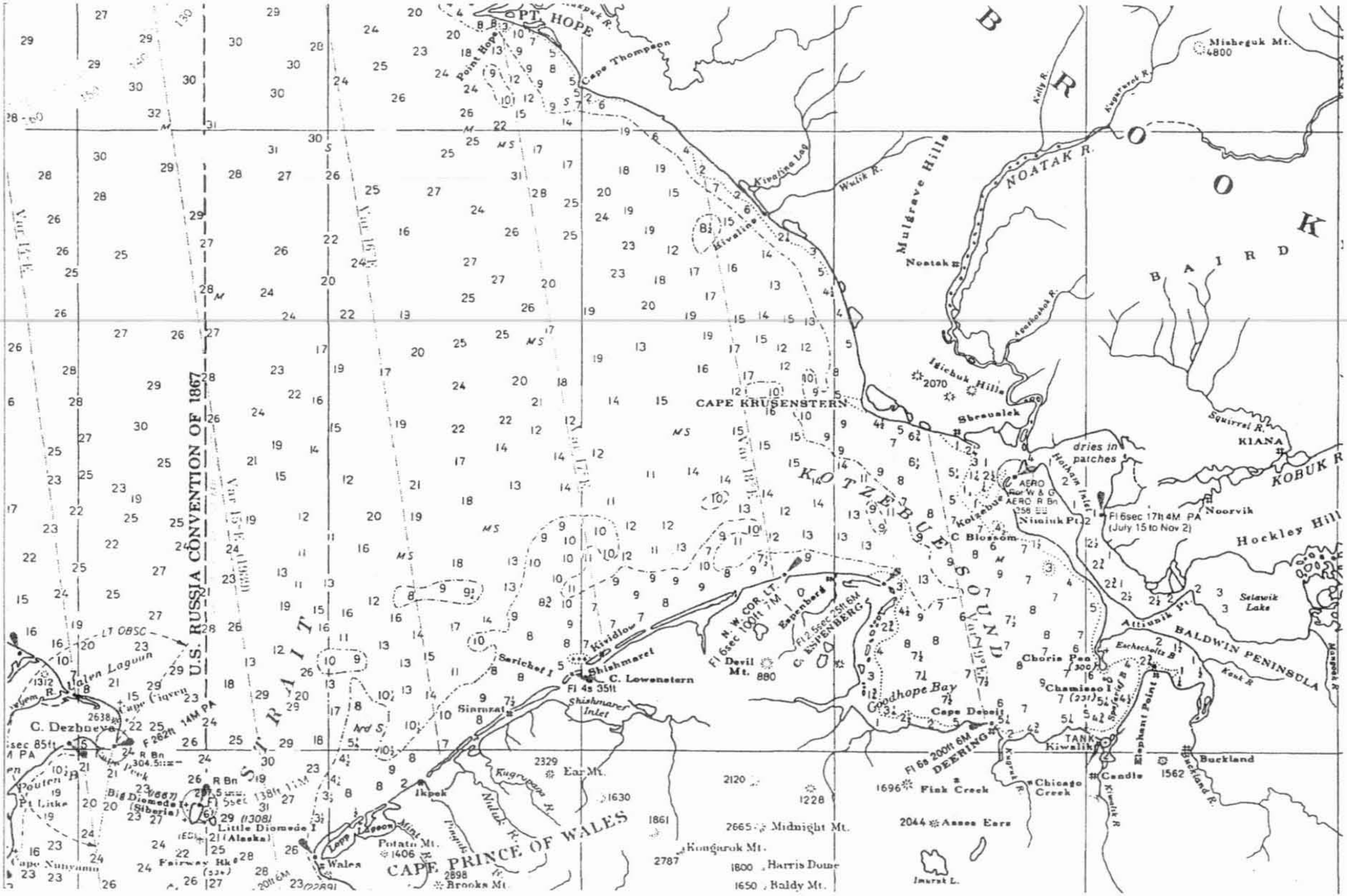

Figure 3. Map showing bottom depth contours for the Chukchi Sea and Kotzebue Sound.

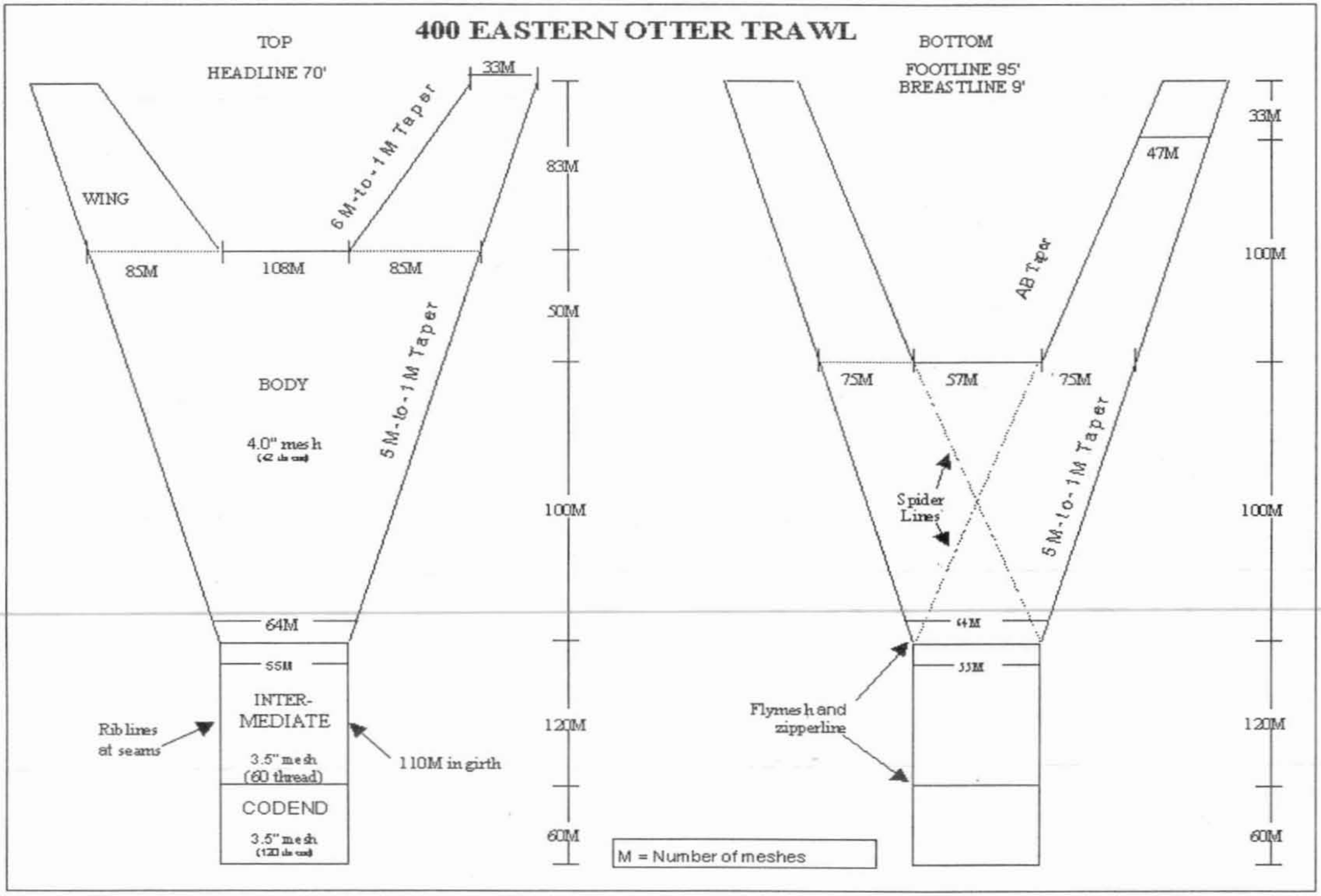

Figure 4. Diagram of the 400 eastern otter trawl used on the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

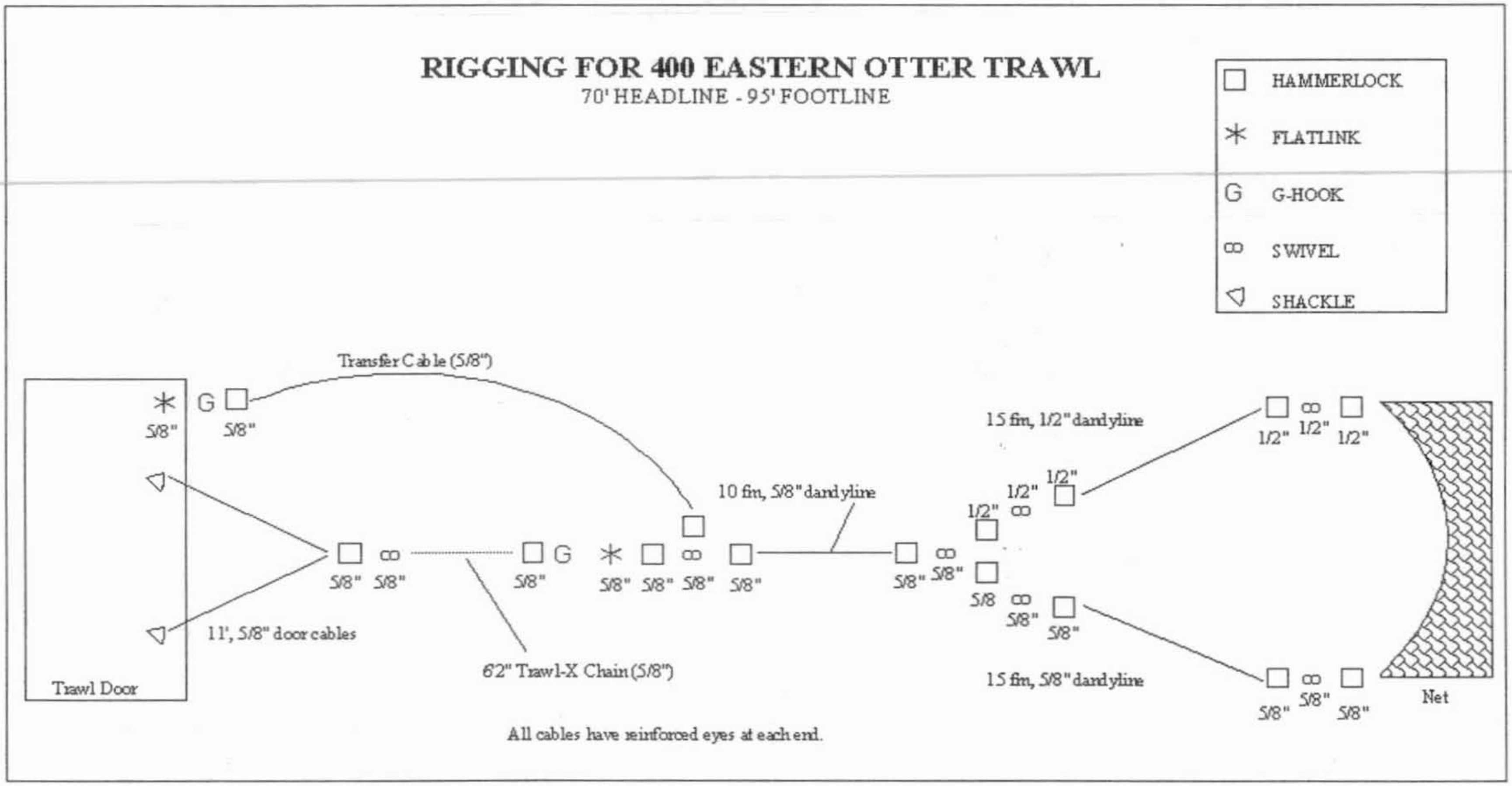

Figure 5. Trawl rigging for the 400 eastern otter trawl used on the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

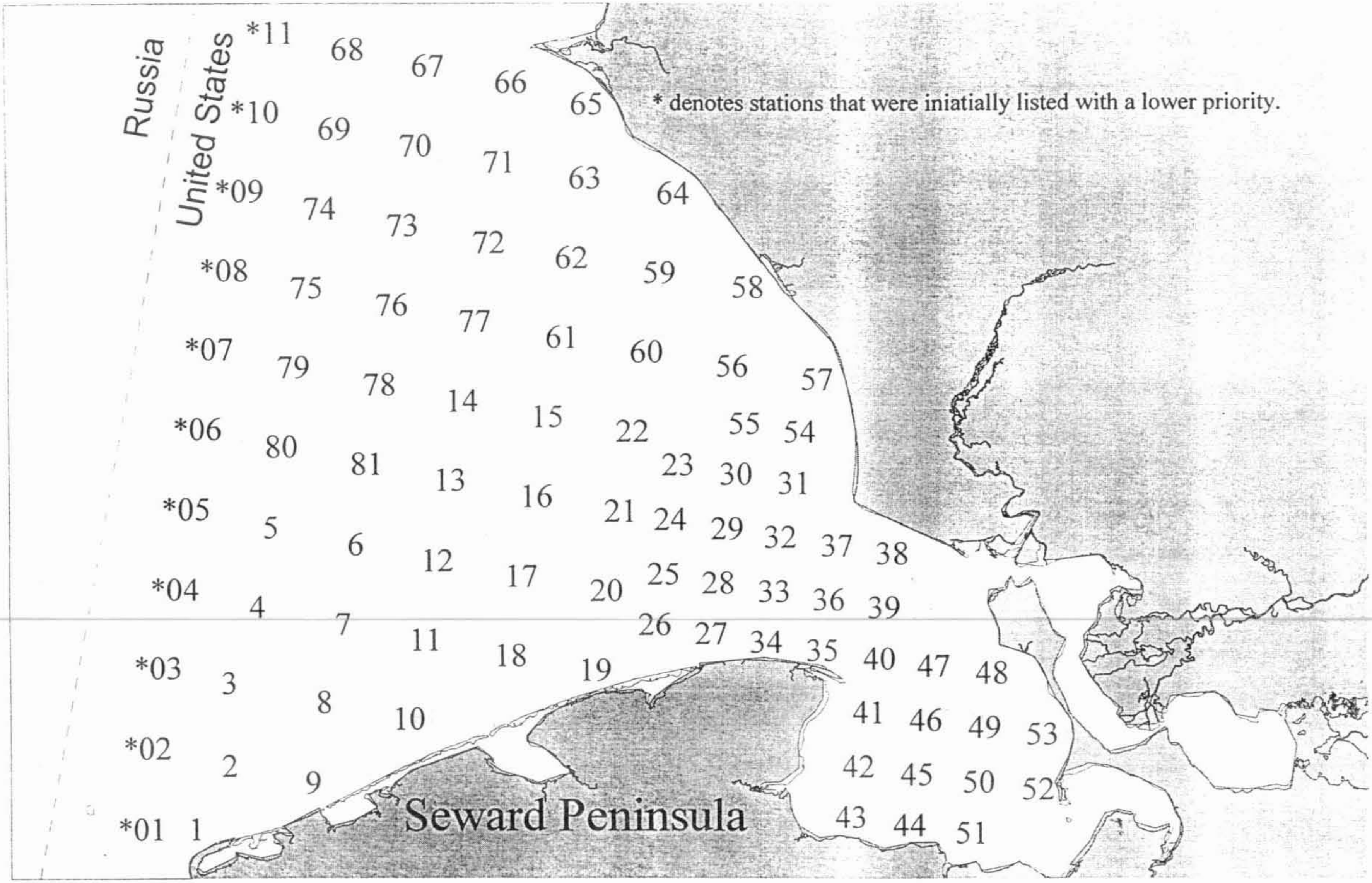

Figure 6. Map of the sampling stations and the projected sampling order for the 1998 southeast Chukchi Sea and Kotzebue Sound.

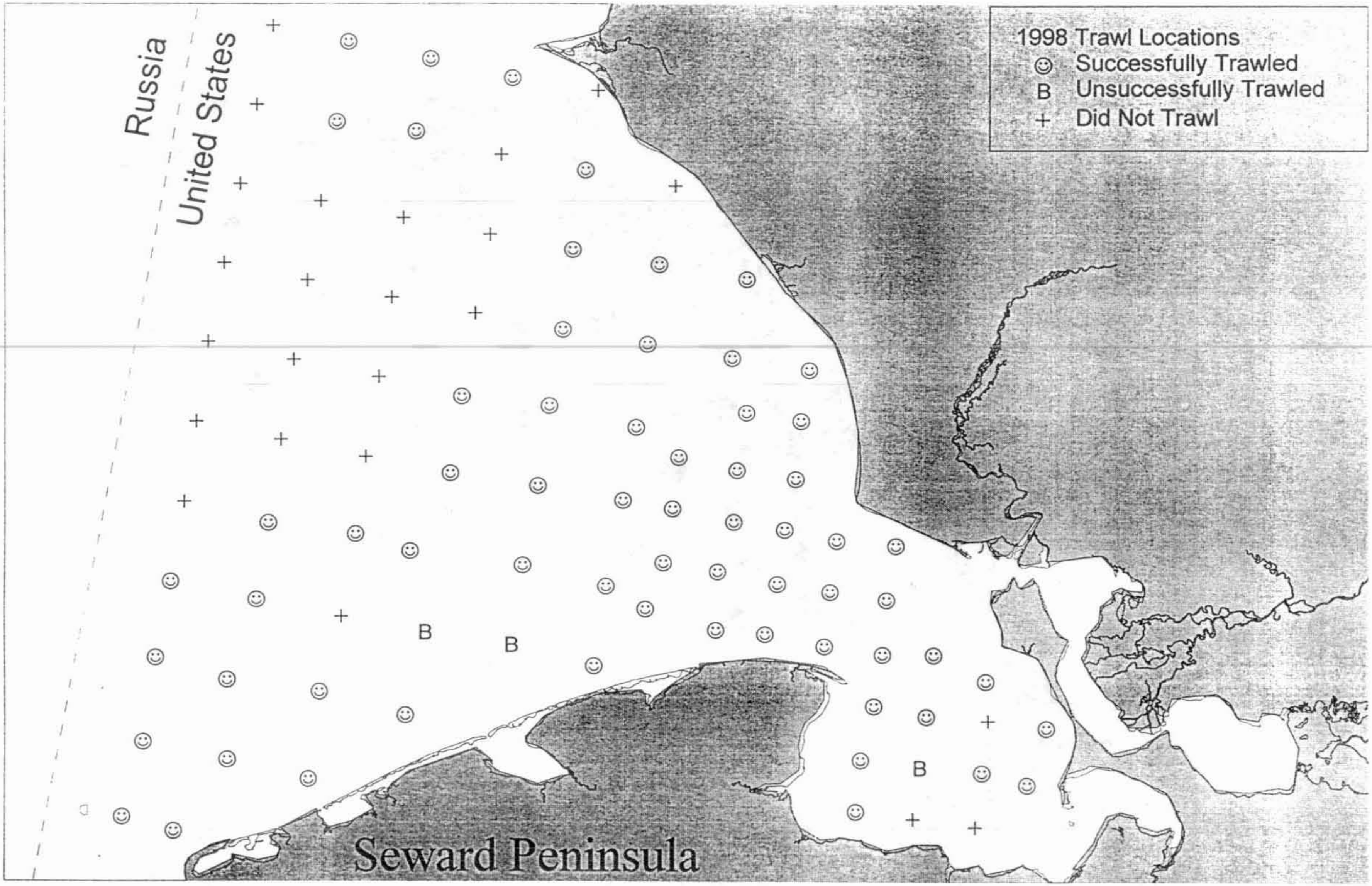

Figure 7. Map of station locations for the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

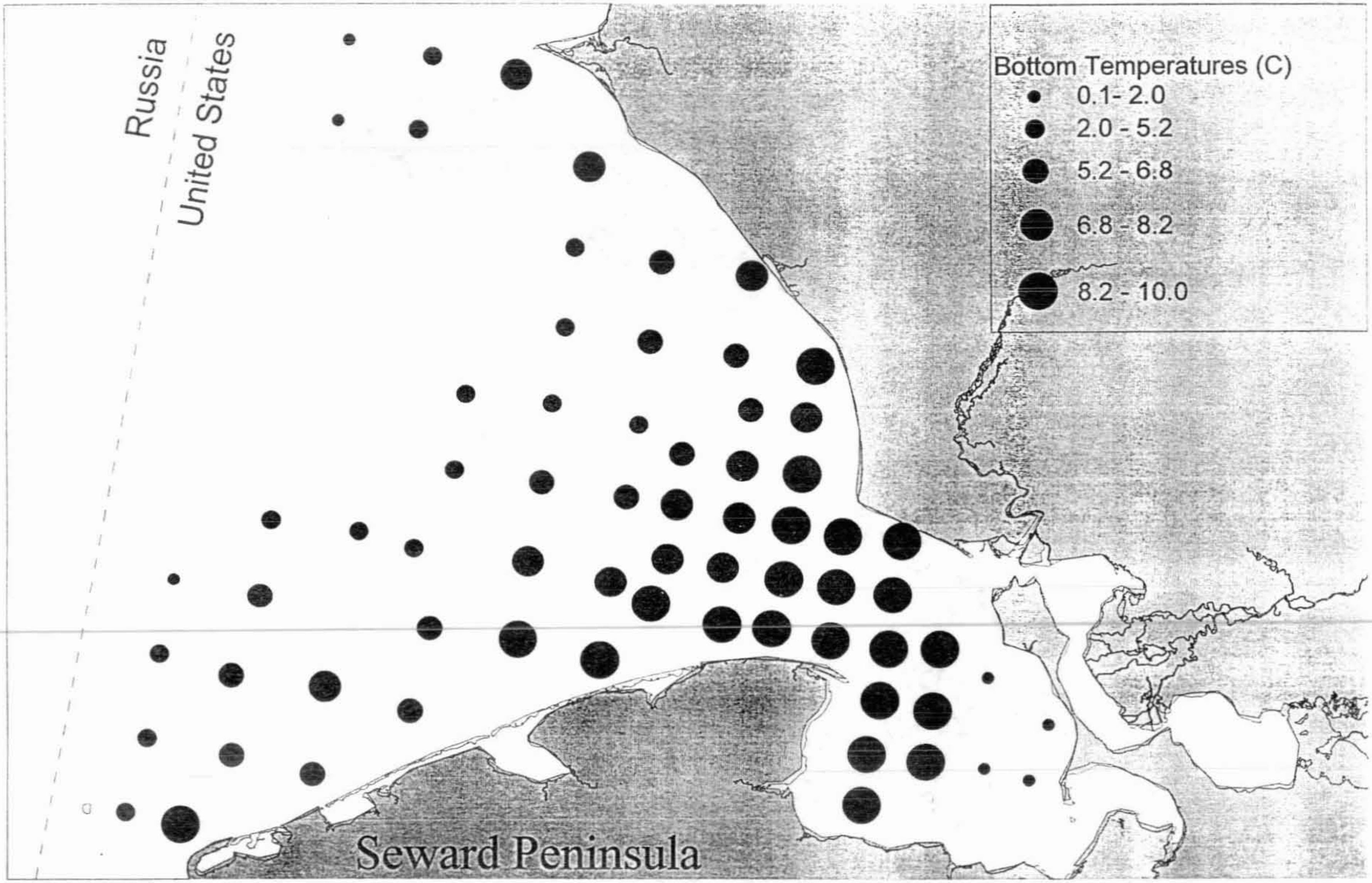

Figure 8. Map of bottom temperatures (° C) recorded from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

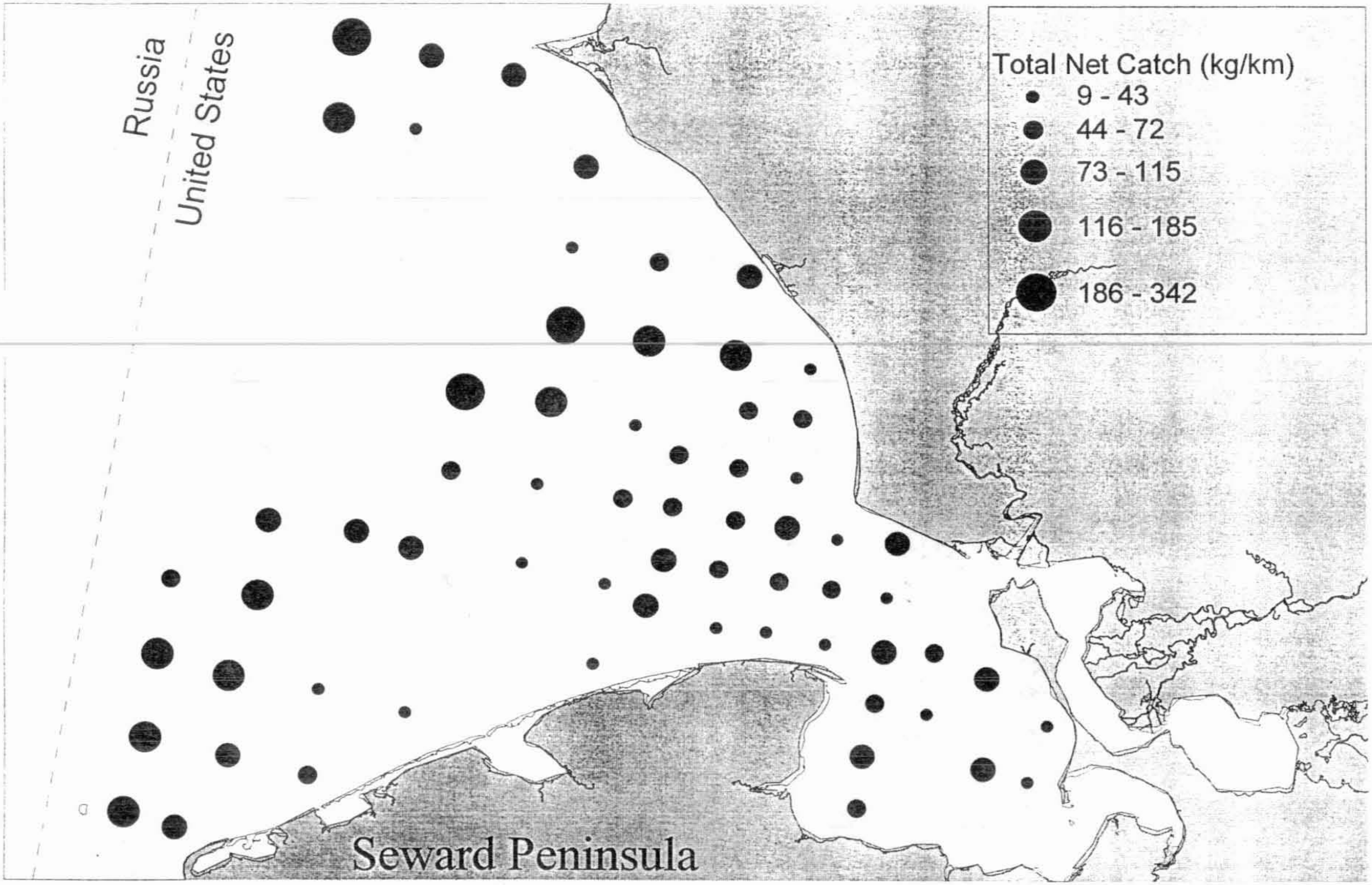

Figure 9. Map of total net catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

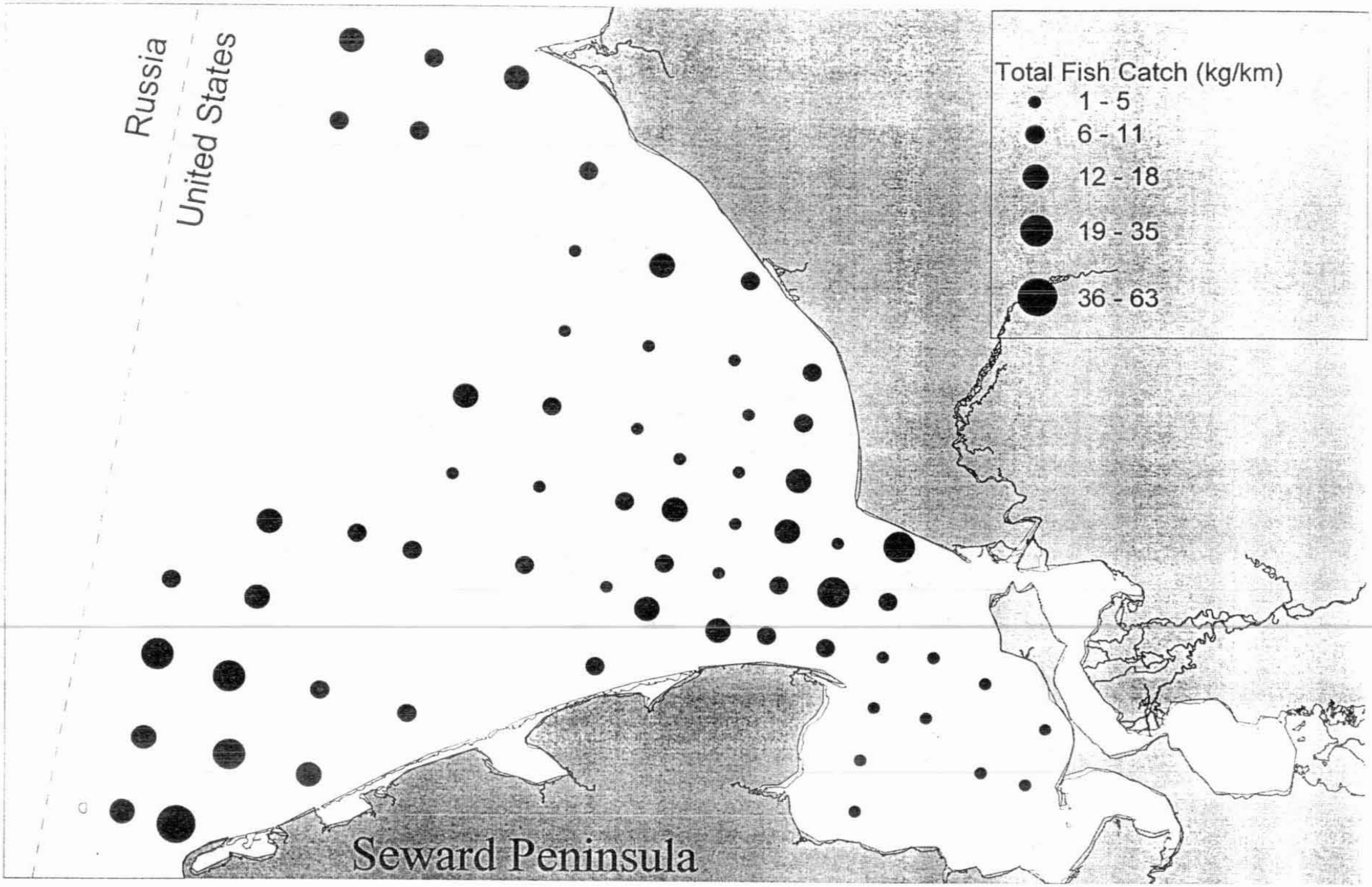

Figure 10. Map of total fish catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

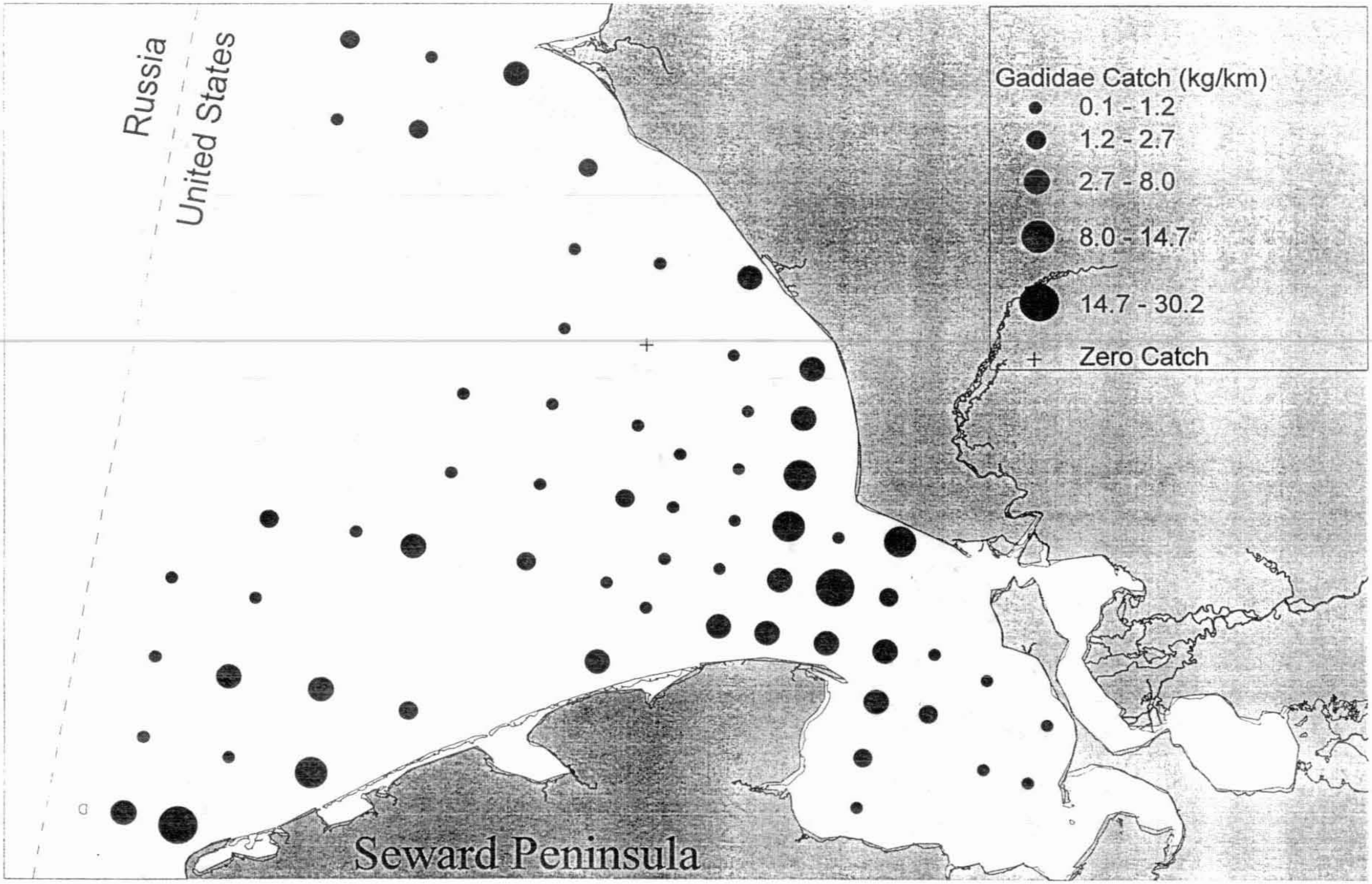

Figure 11. Map of Gadidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

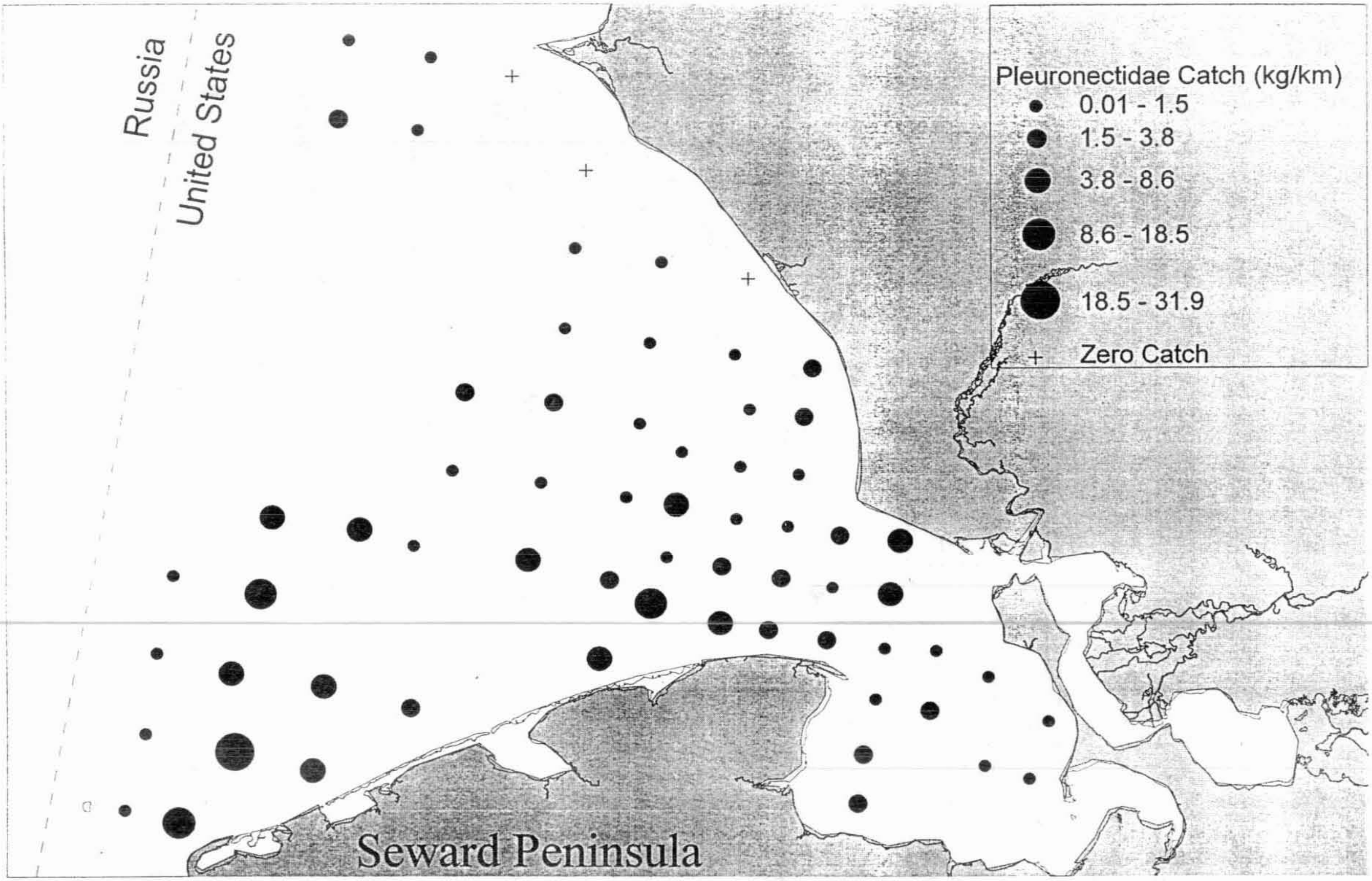

Figure 12. Map of Pleuronectidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

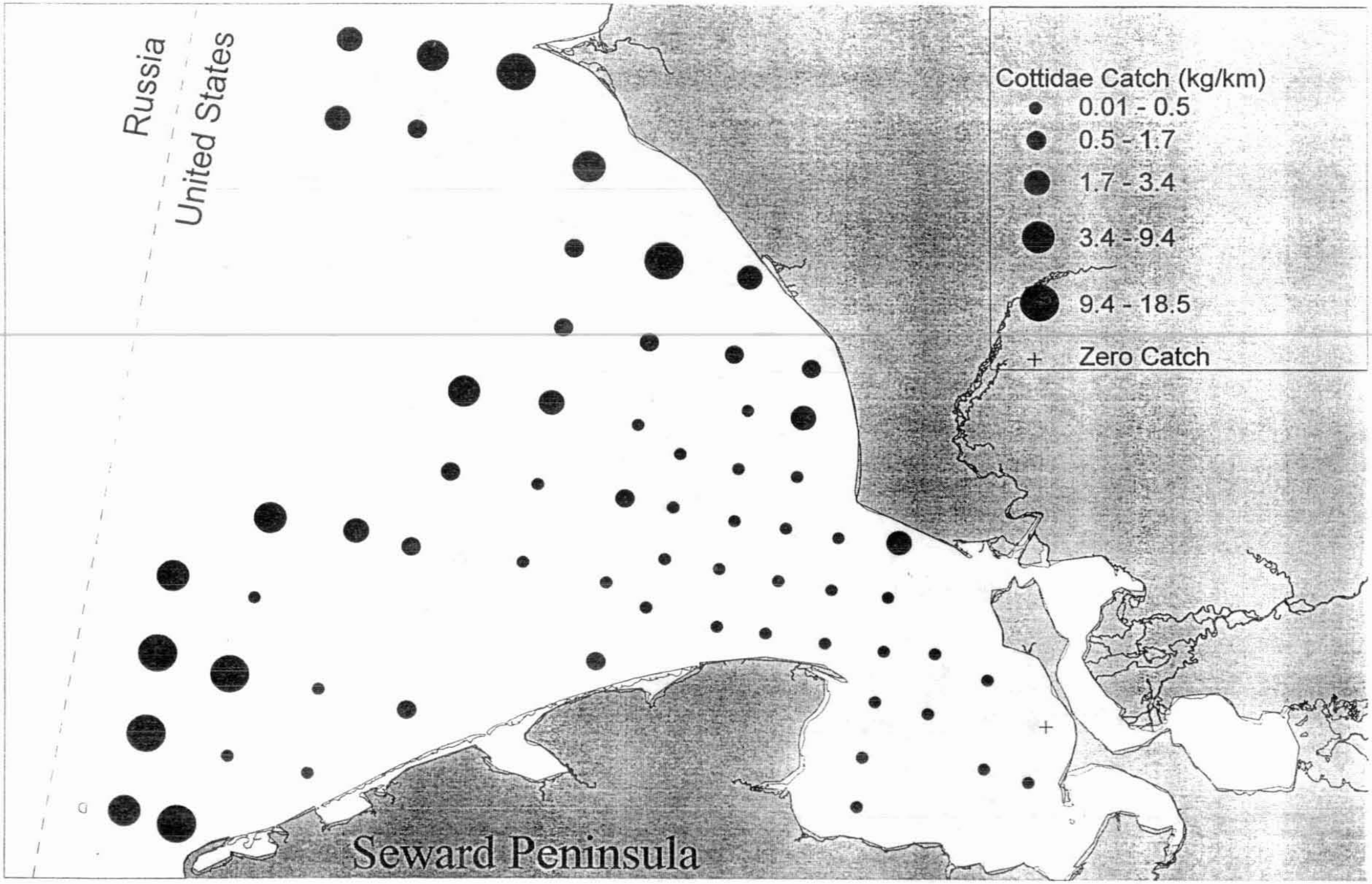

Figure 13. Map of Cottidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

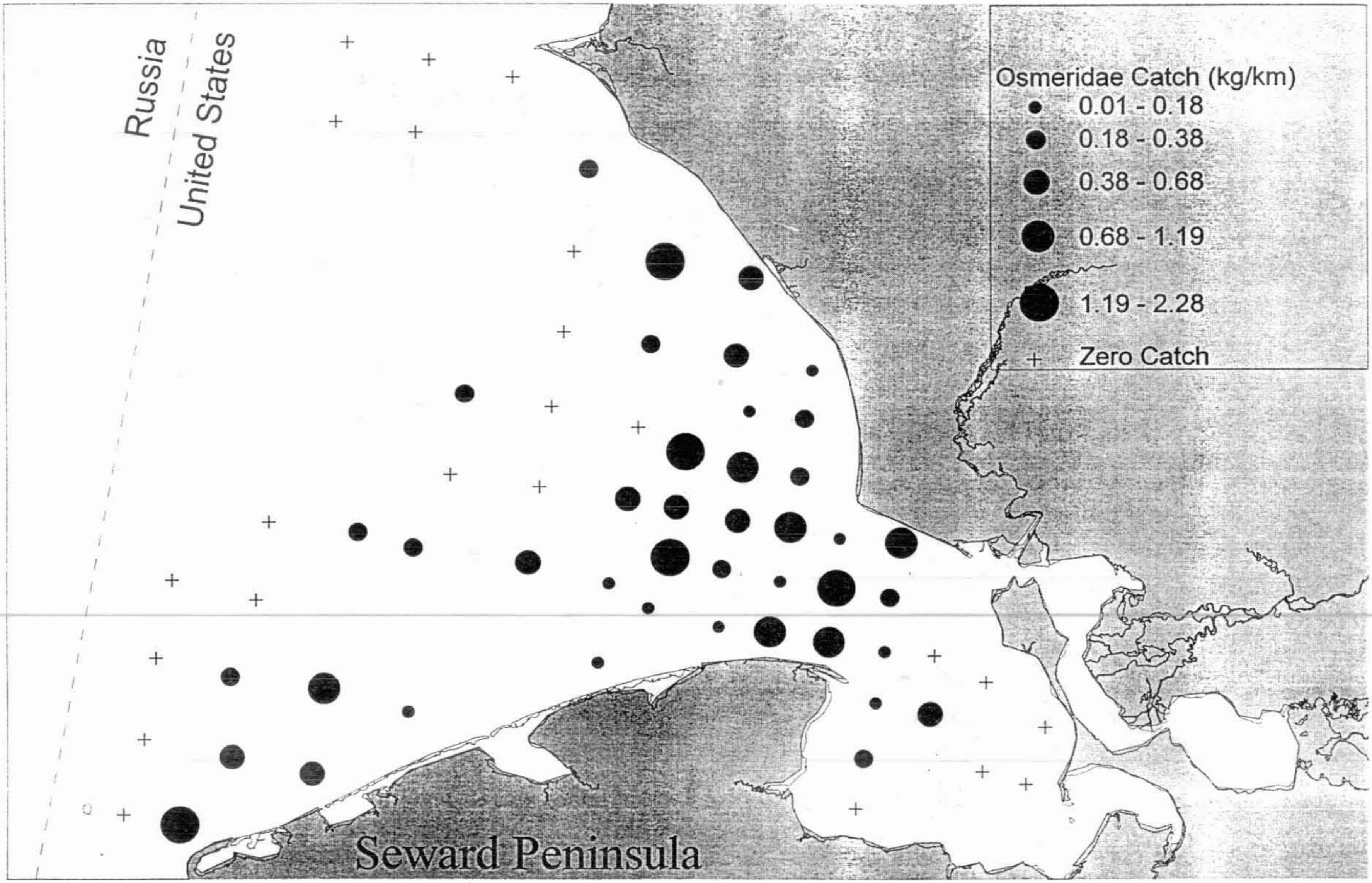

Figure 14. Map of Osmeridae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

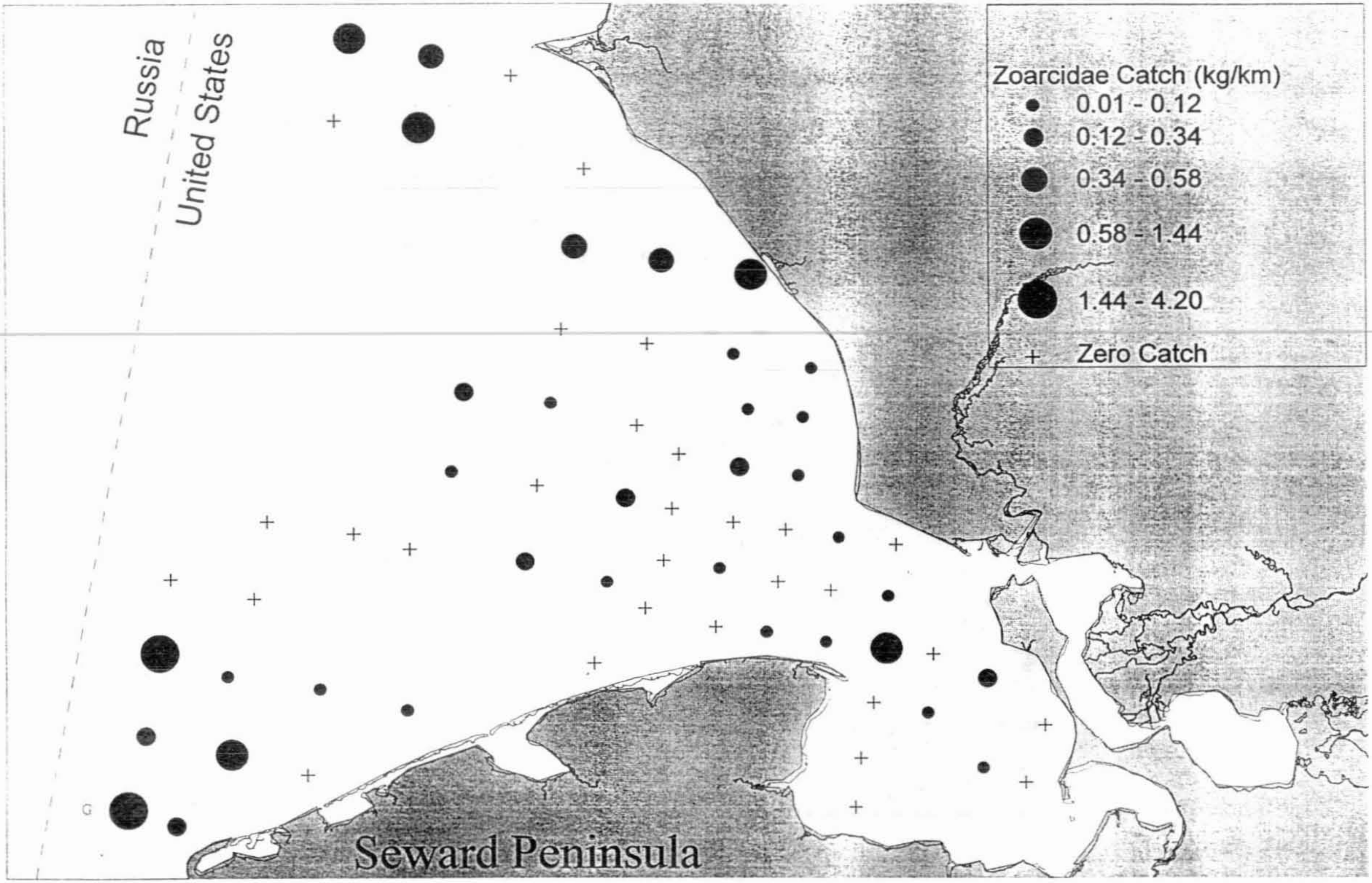

Figure 15. Map of Zoarcidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

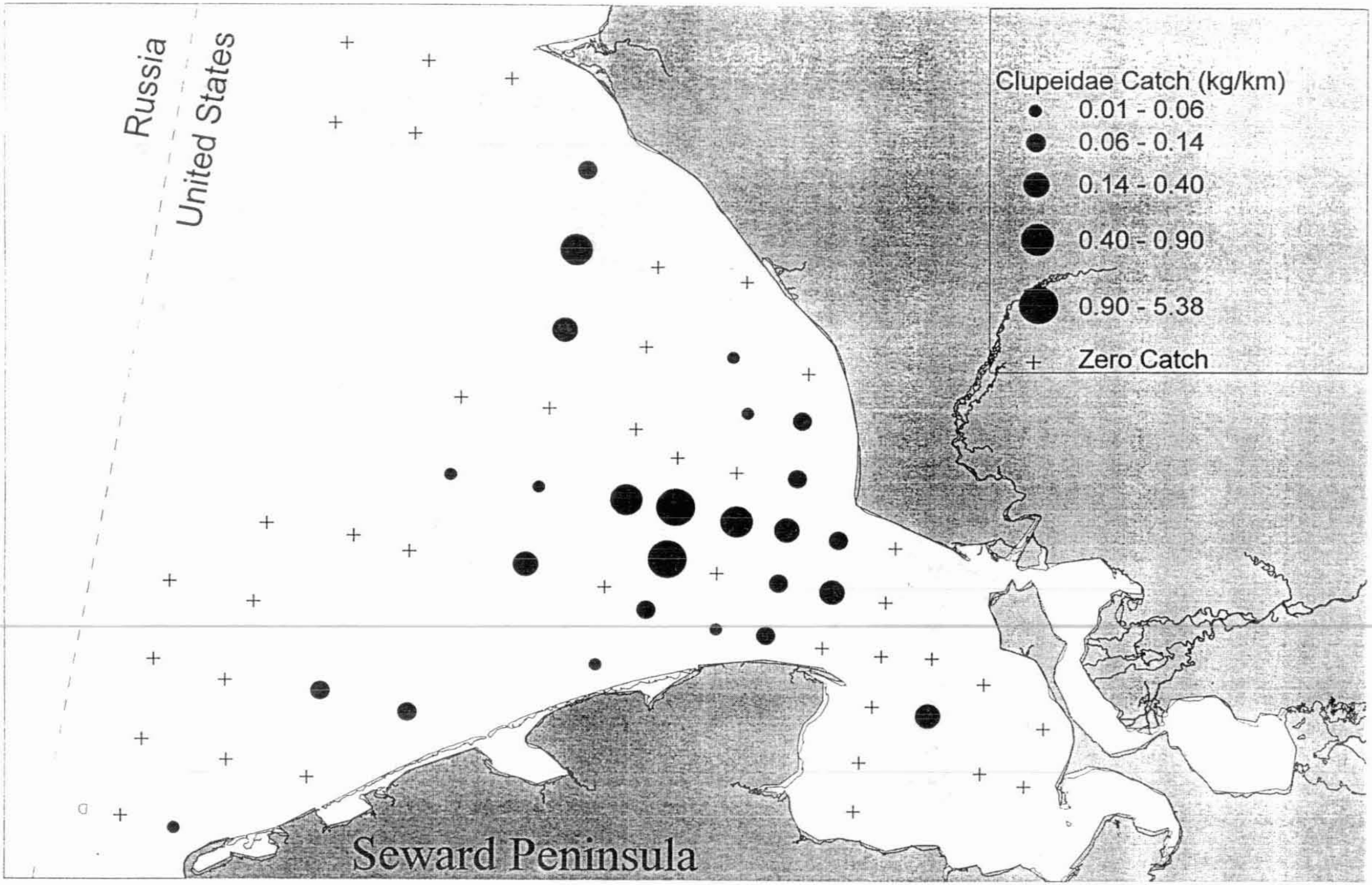

Figure 16. Map of Clupeidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

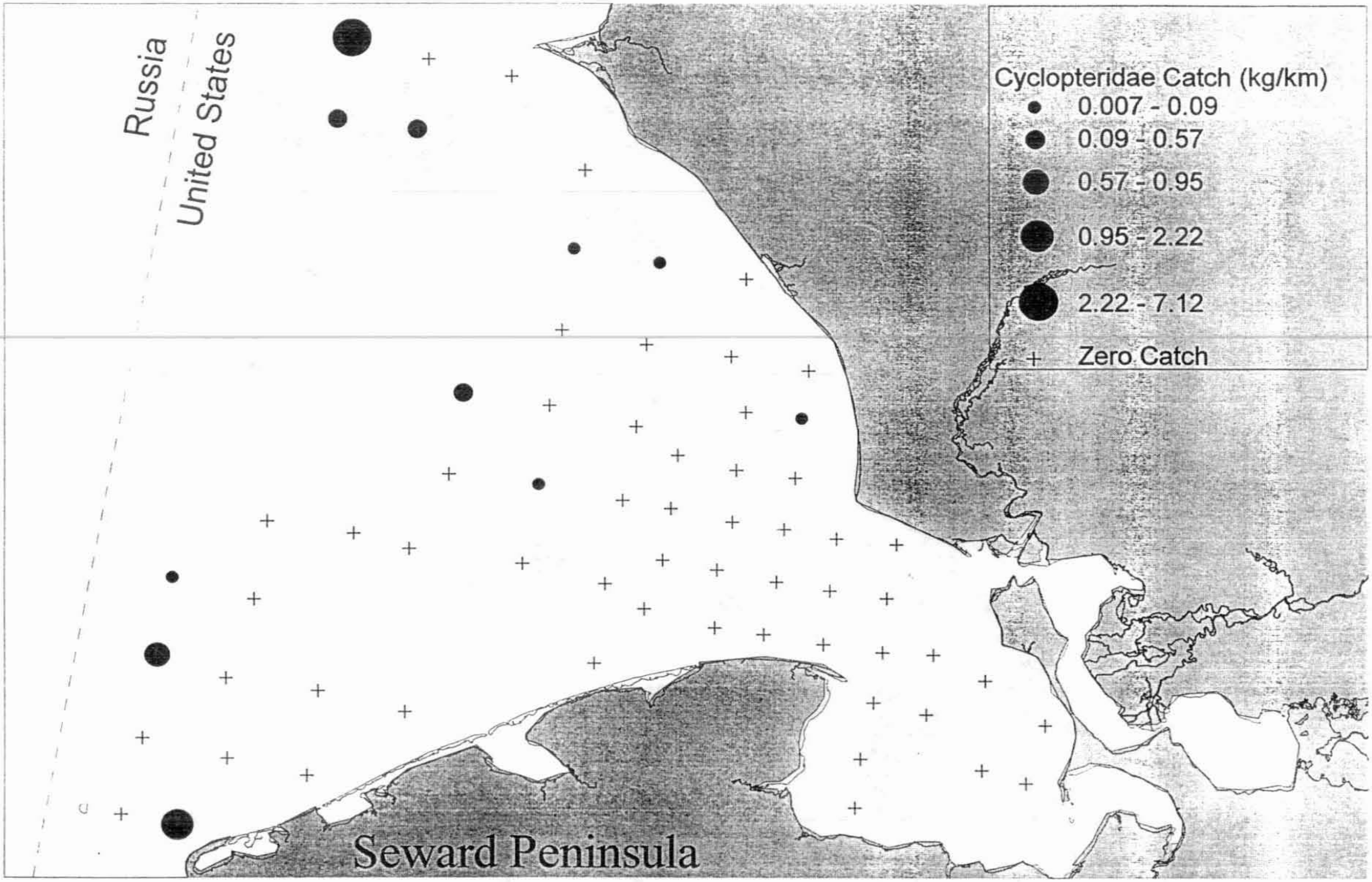

Figure 17. Map of Cyclopteridae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

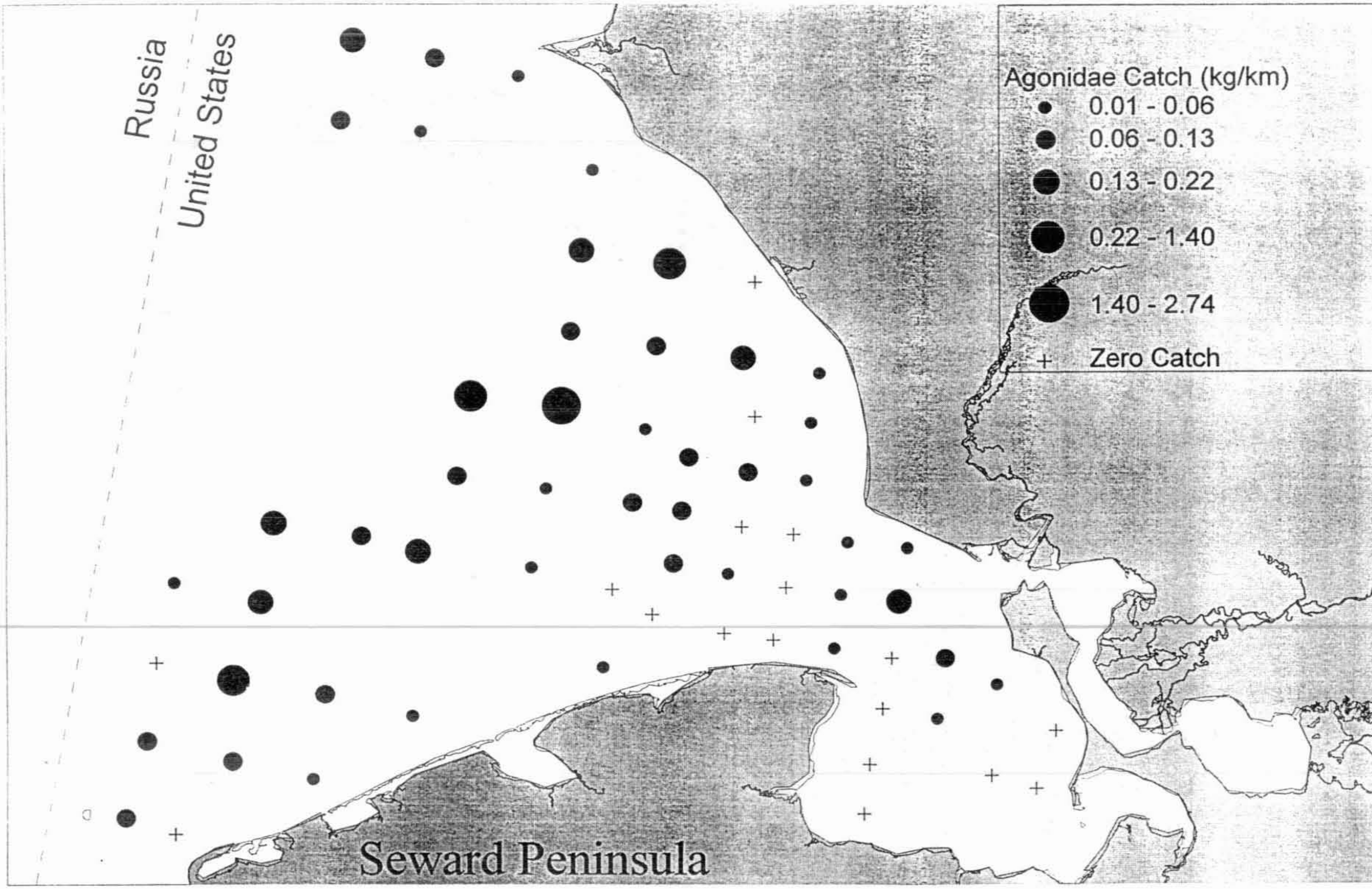

Figure 18. Map of Agonidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

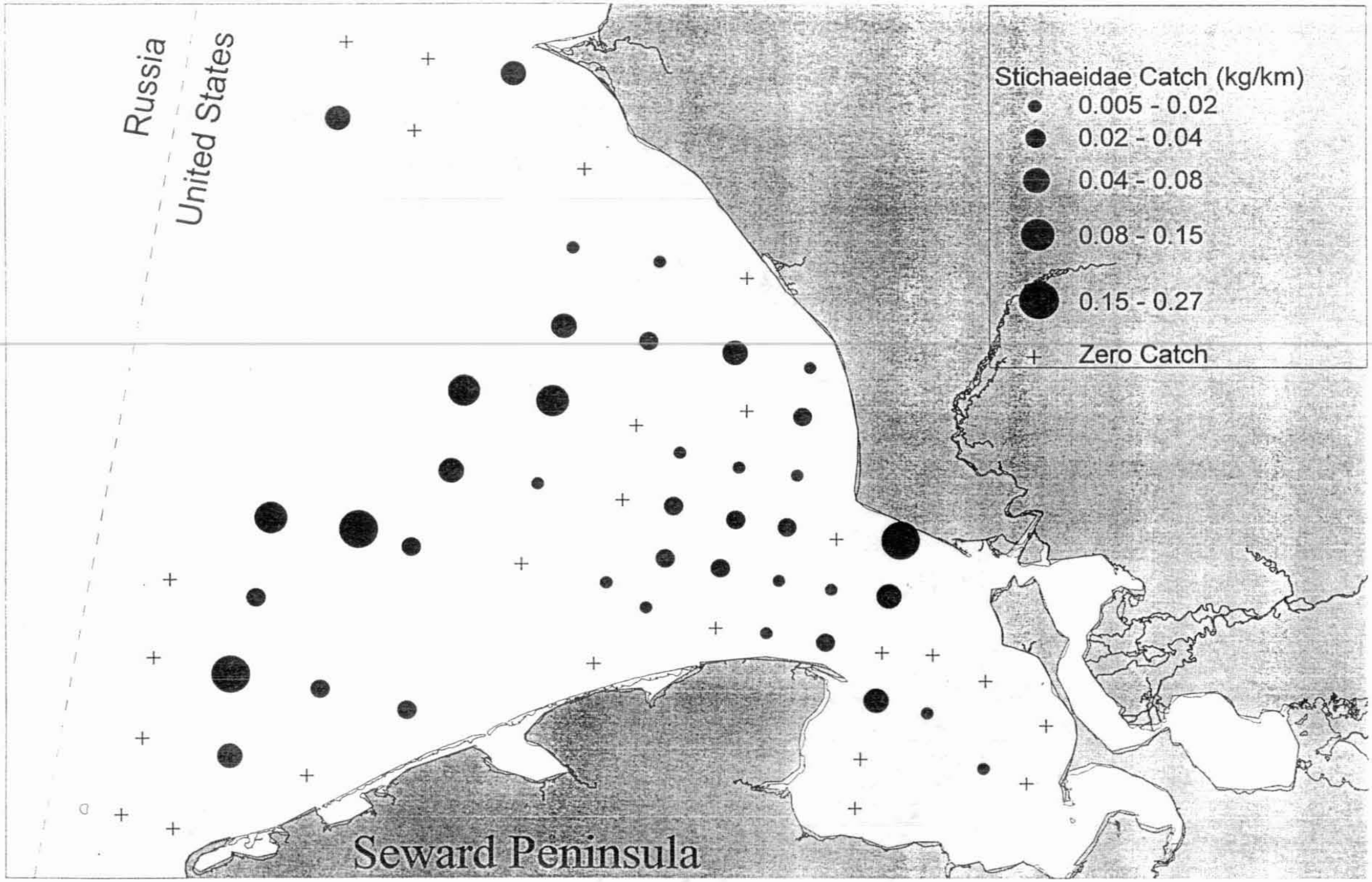

Figure 19. Map of Stichaeidae catches (kg/kmtrawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

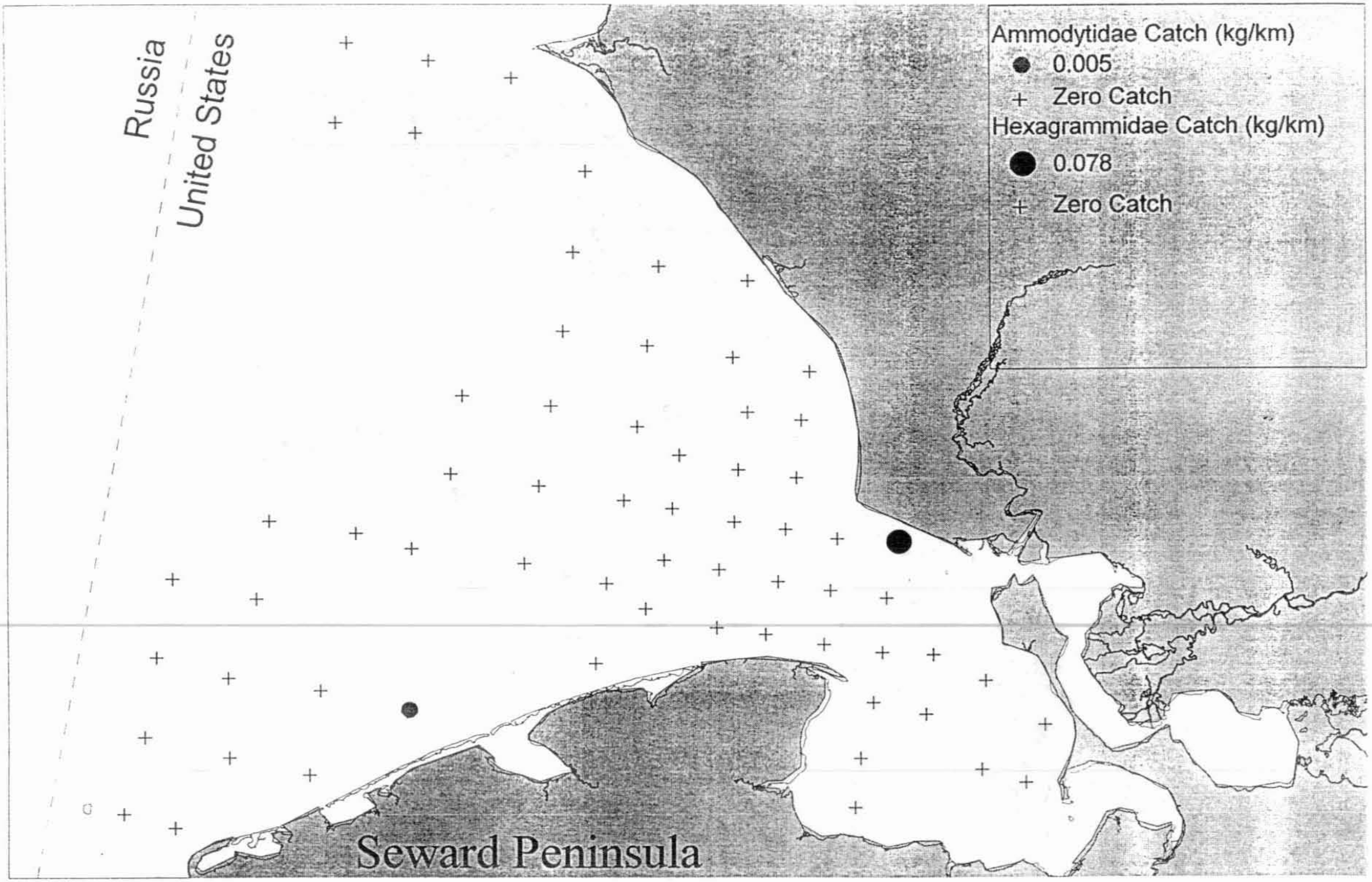

Figure 20. Map of Ammodytidae and Hexagrammidae catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

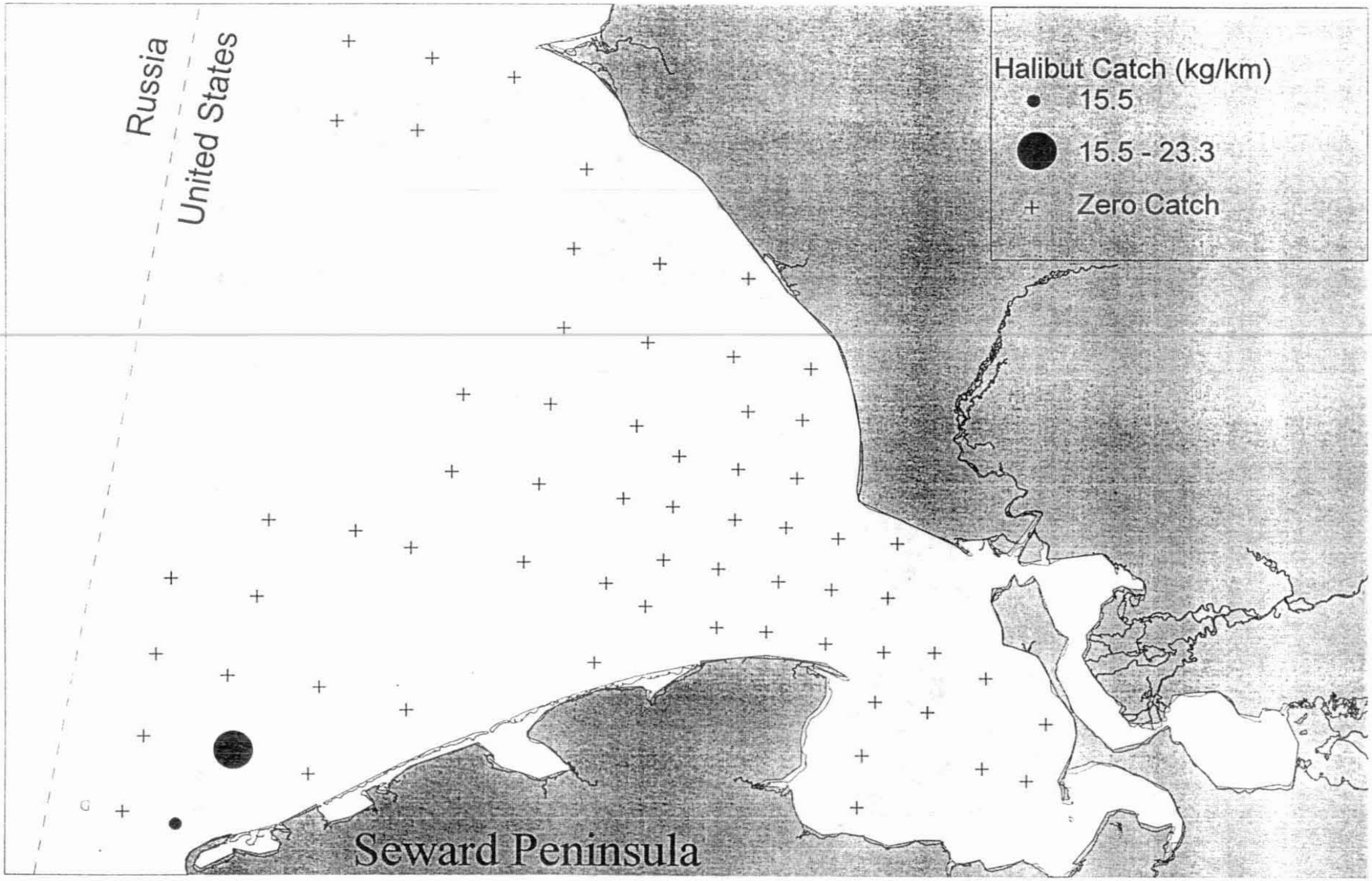

Figure 21. Map of halibut catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

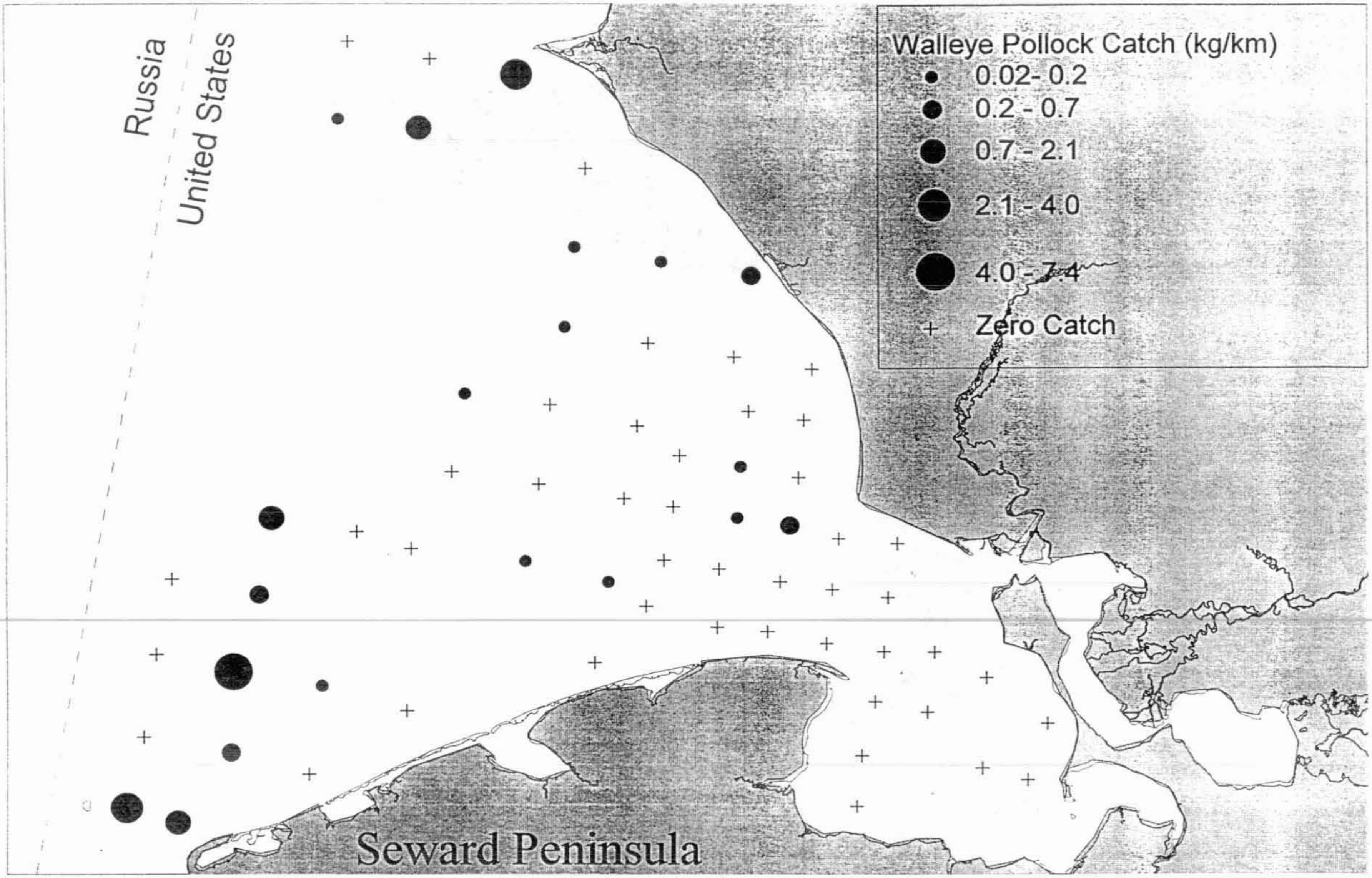

Figure 22. Map of walleye pollock catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

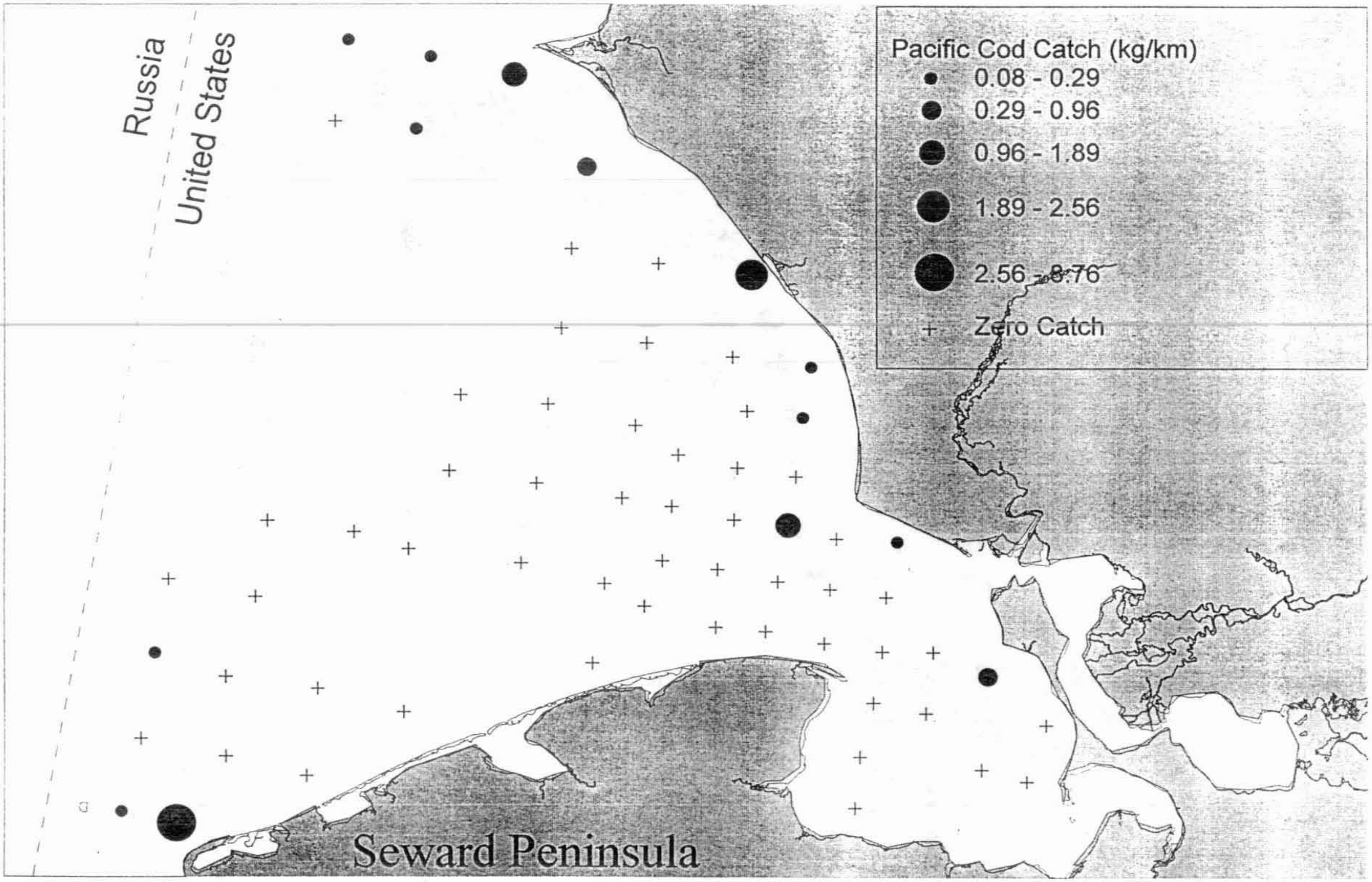

Figure 23. Map of Pacific cod catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

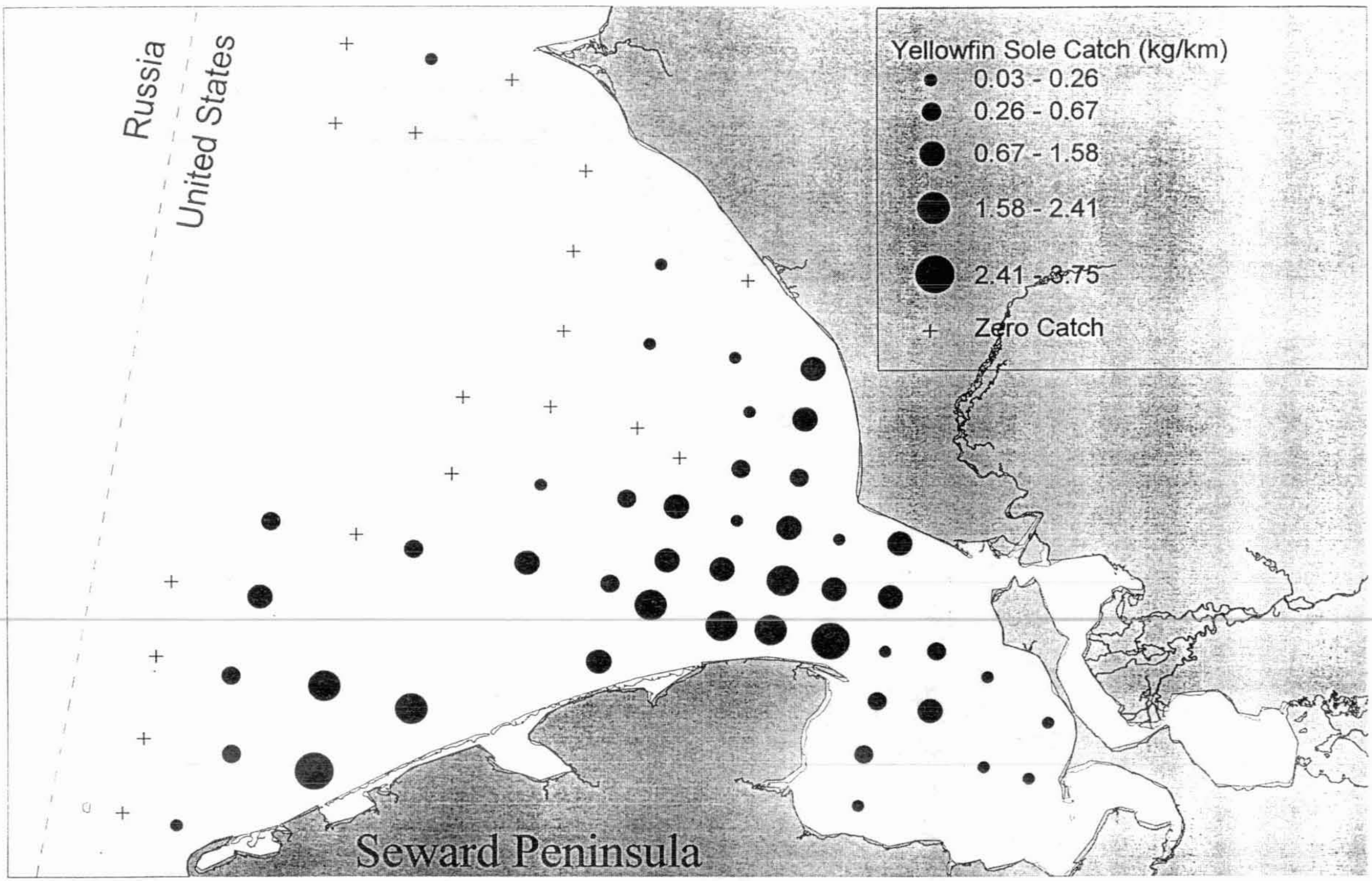

Figure 24. Map of yellowfin sole catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

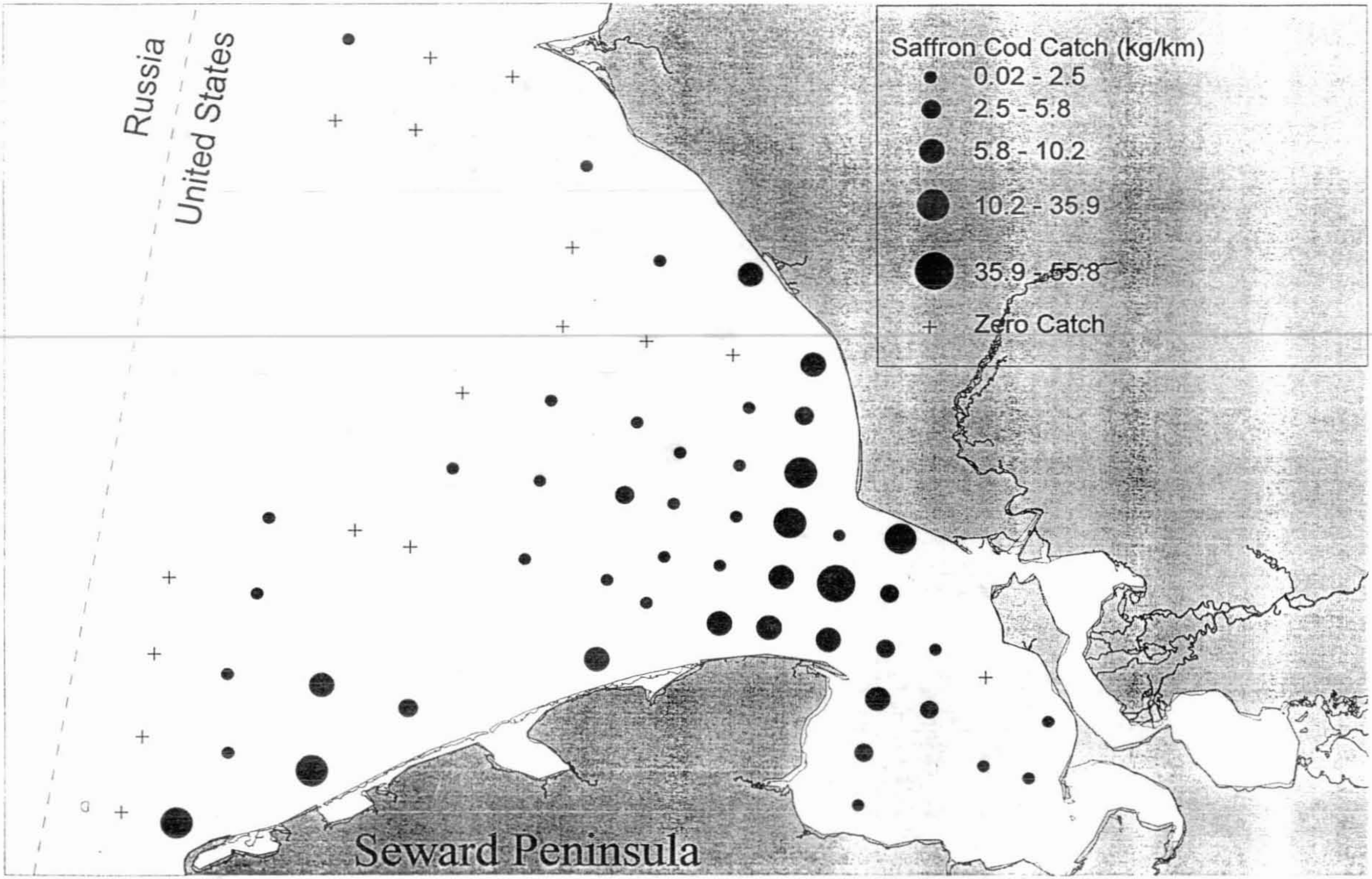

Figure 25. Map of saffron cod catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

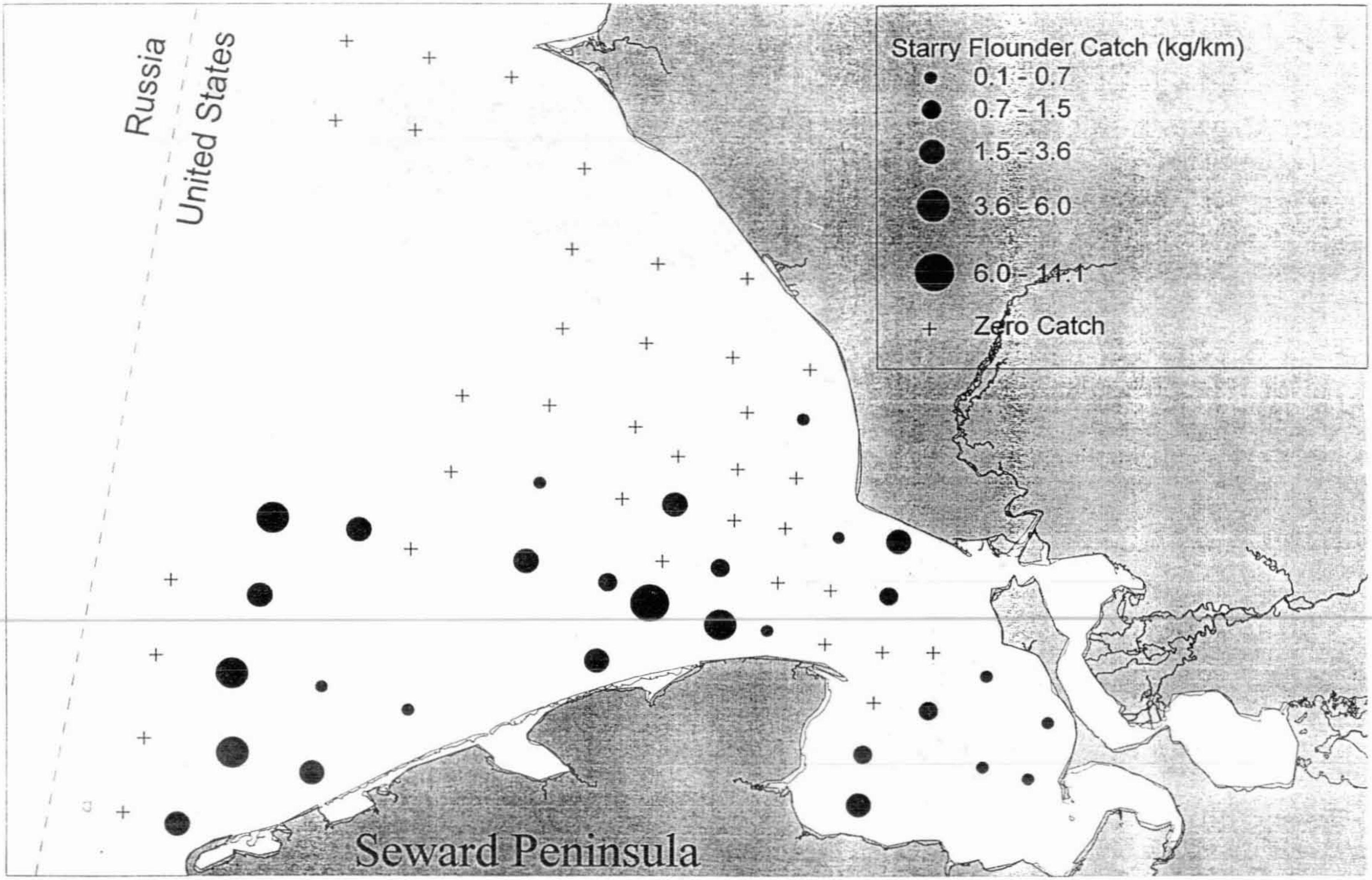

Figure 26. Map of starry flounder catches (kg/km trawed) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

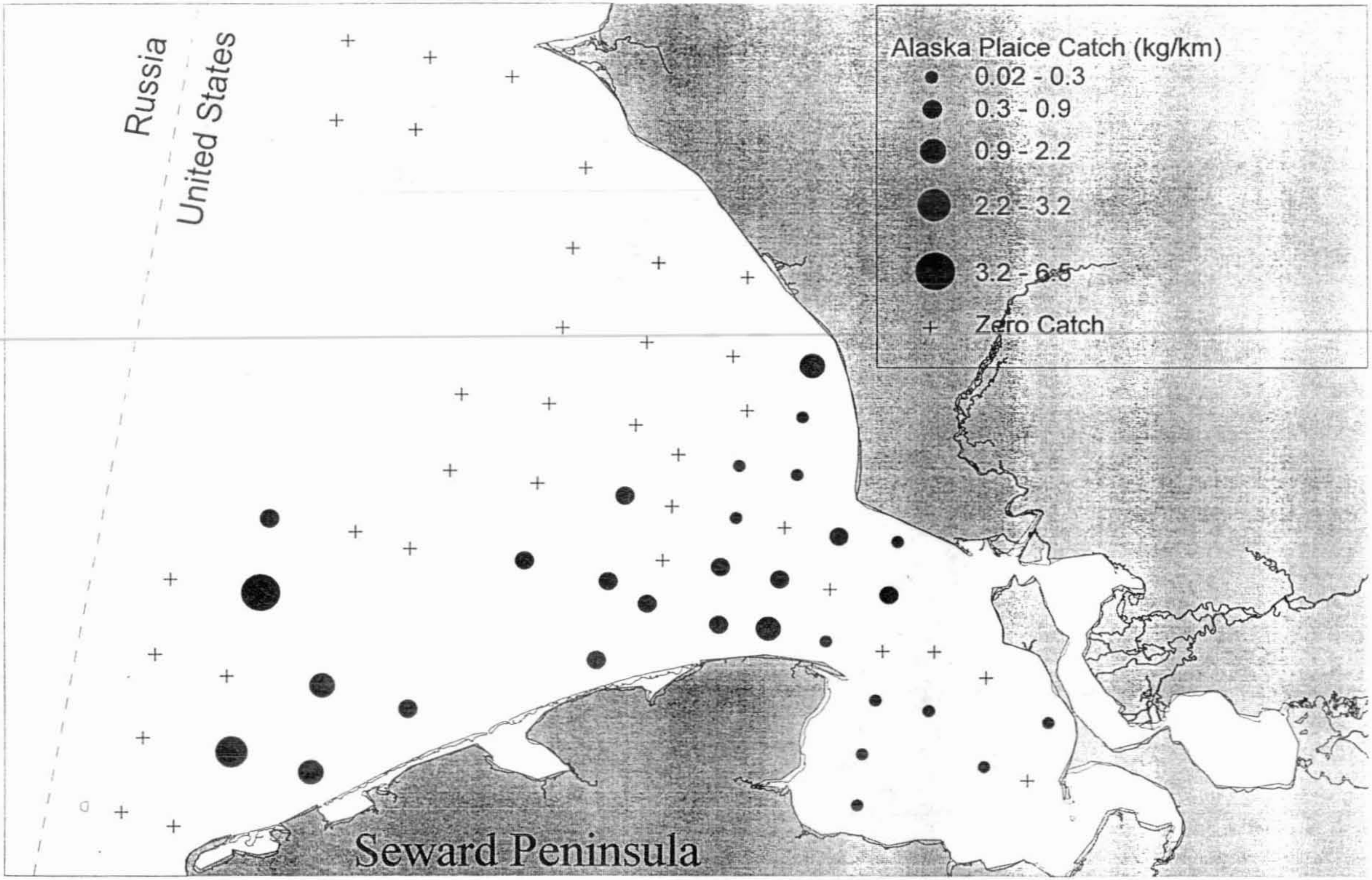

Figure 27. Map of Alaska plaice catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

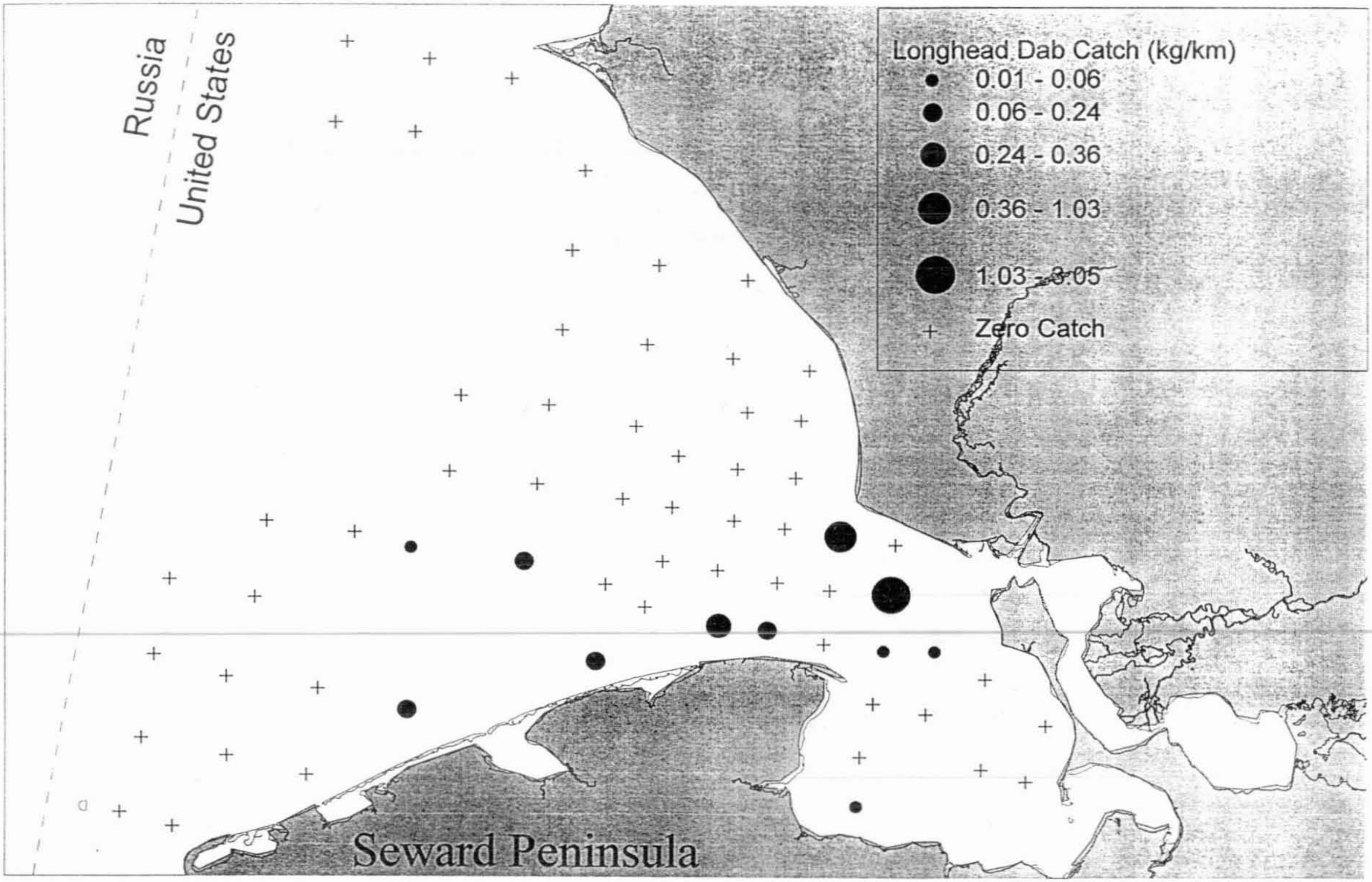

Figure 28. Map of longhead dab catches (kg/km trawled) from the 1998 southeast Chukchi S71ea and Kotzebue Sound trawl survey.

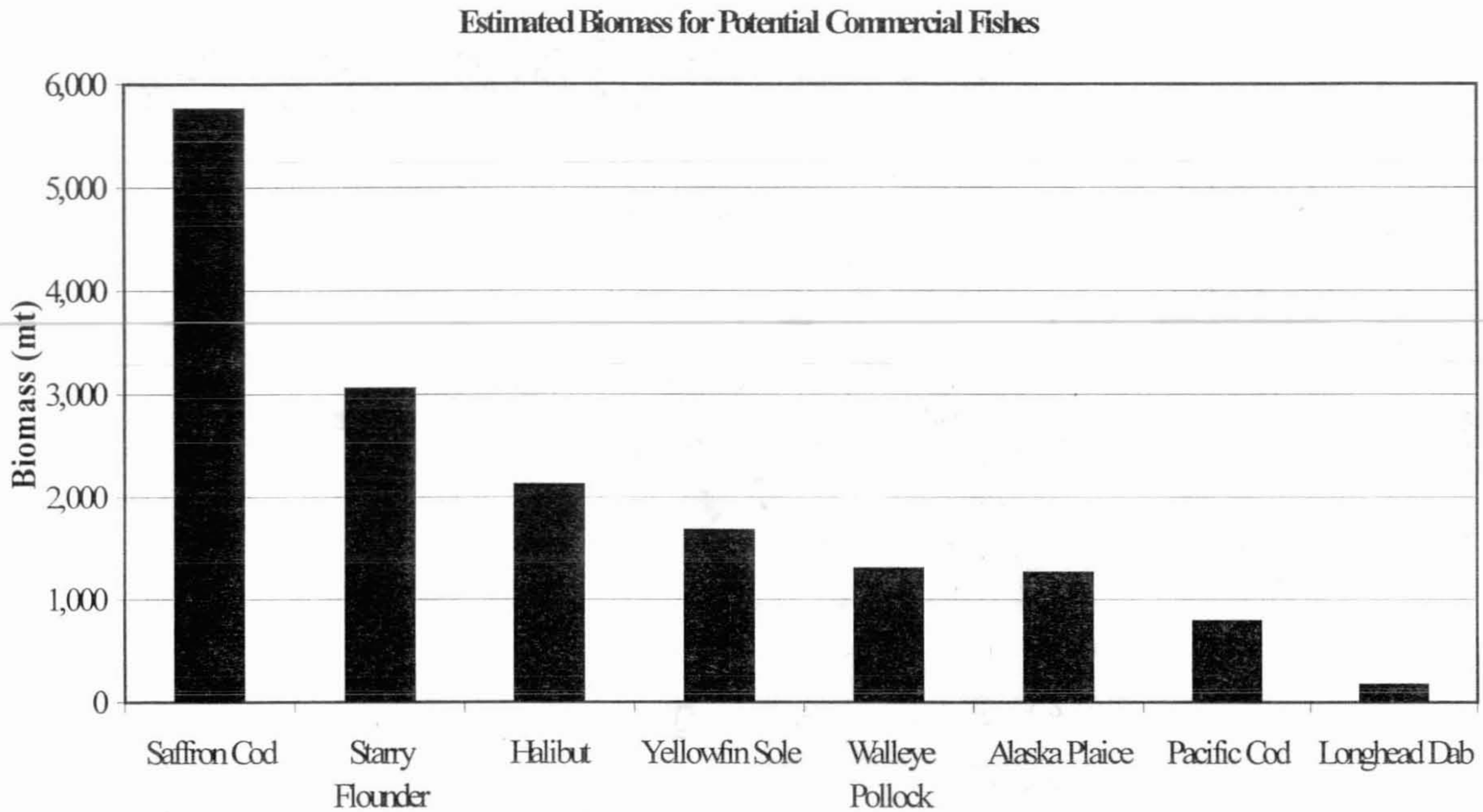

Figure 29. Biomass estimates for potentially important commercial fishes from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

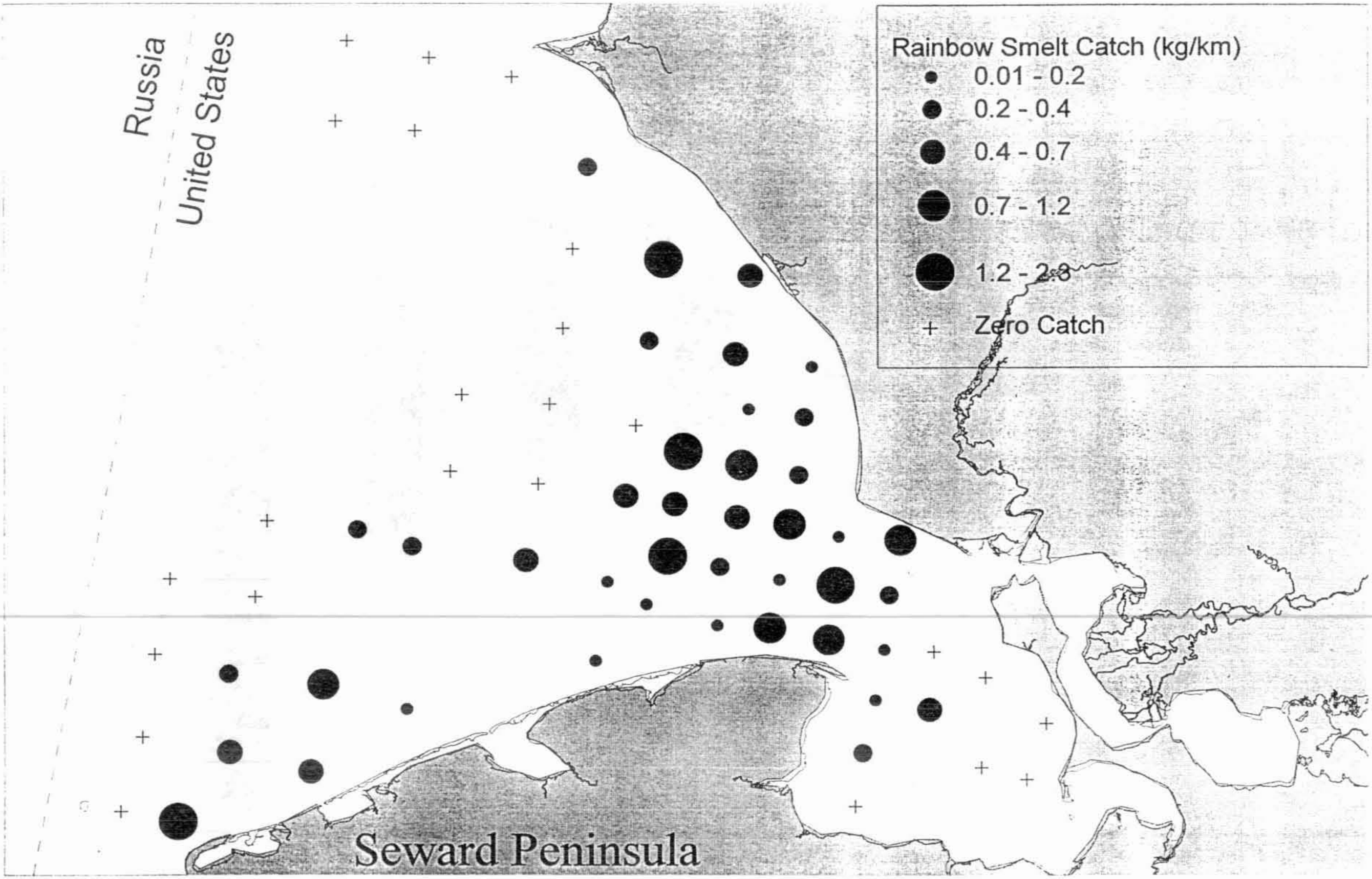

Figure 30. Map of rainbow smelt catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

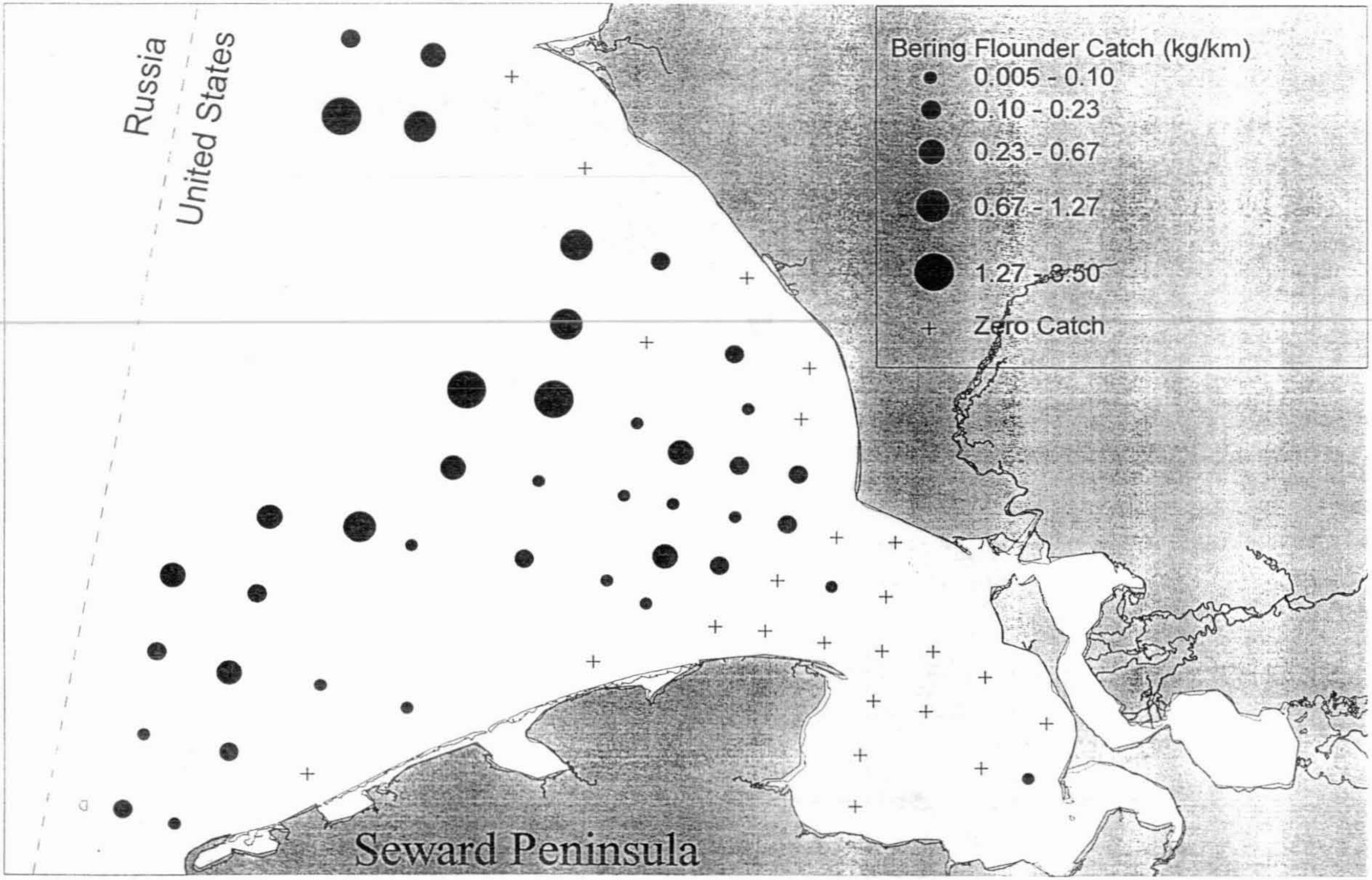

Figure 31. Map of Bering flounder catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

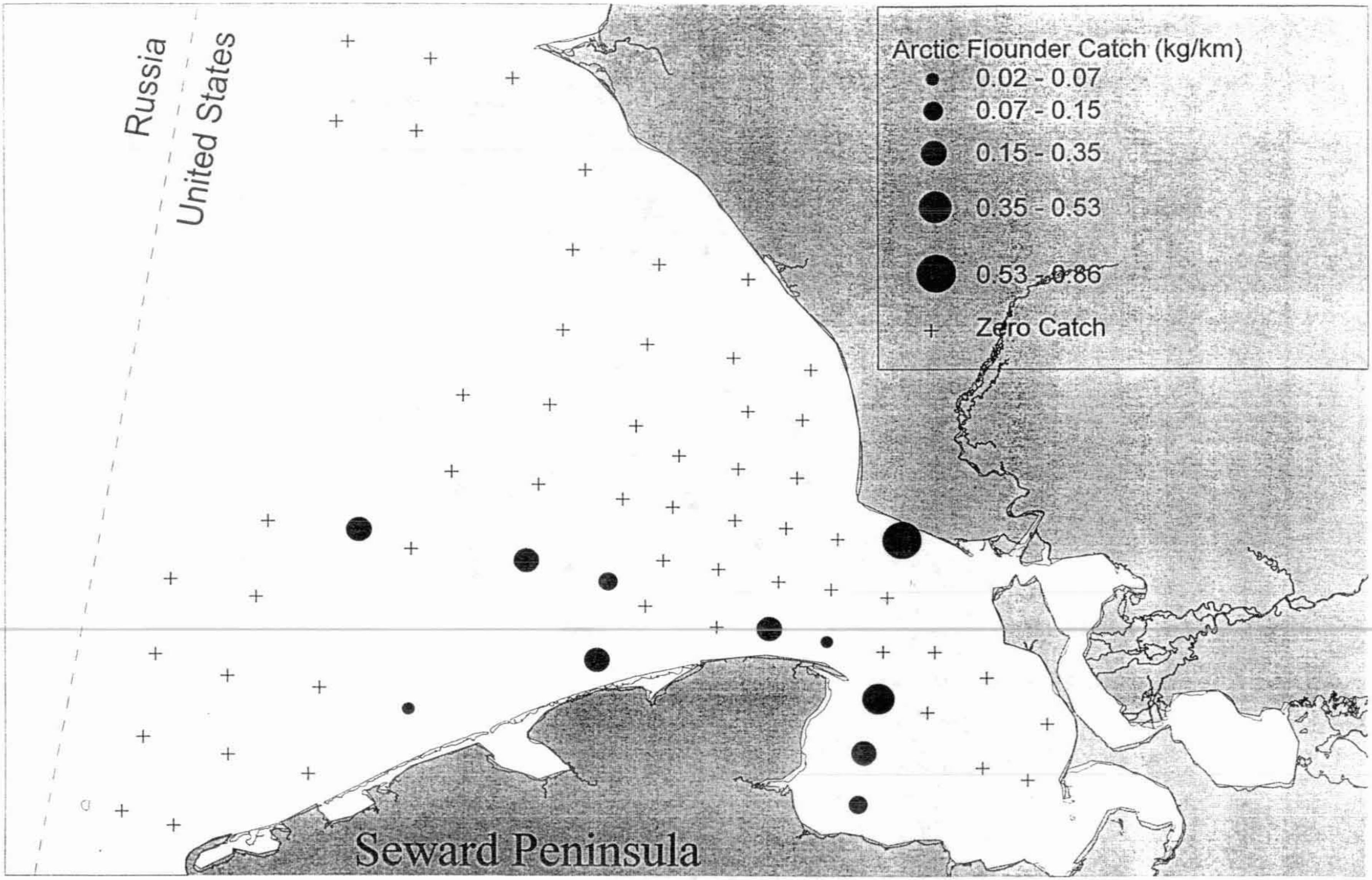

Figure 32. Map of Arctic flounder catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

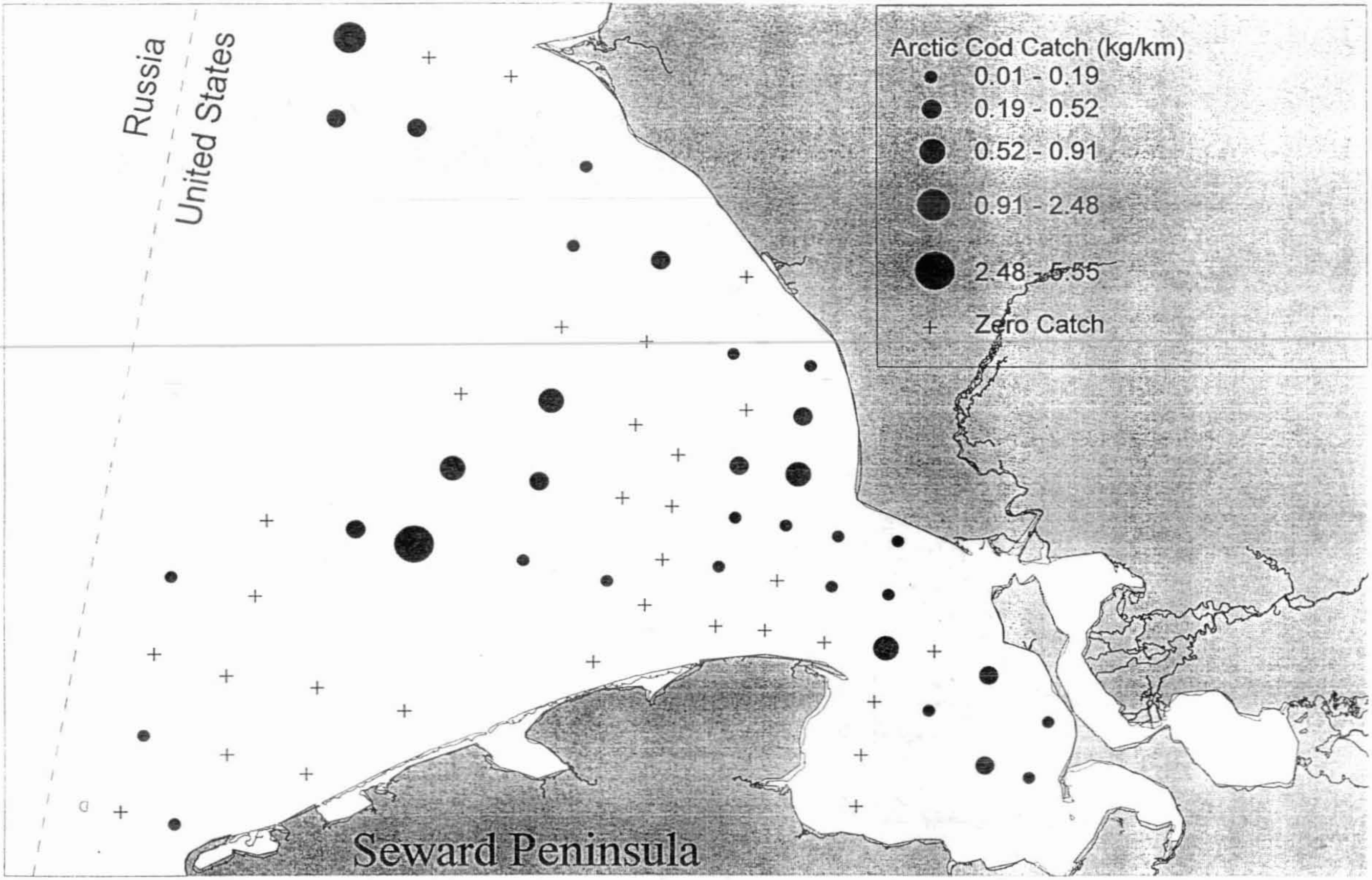

Figure 33. Map of Arctic cod catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

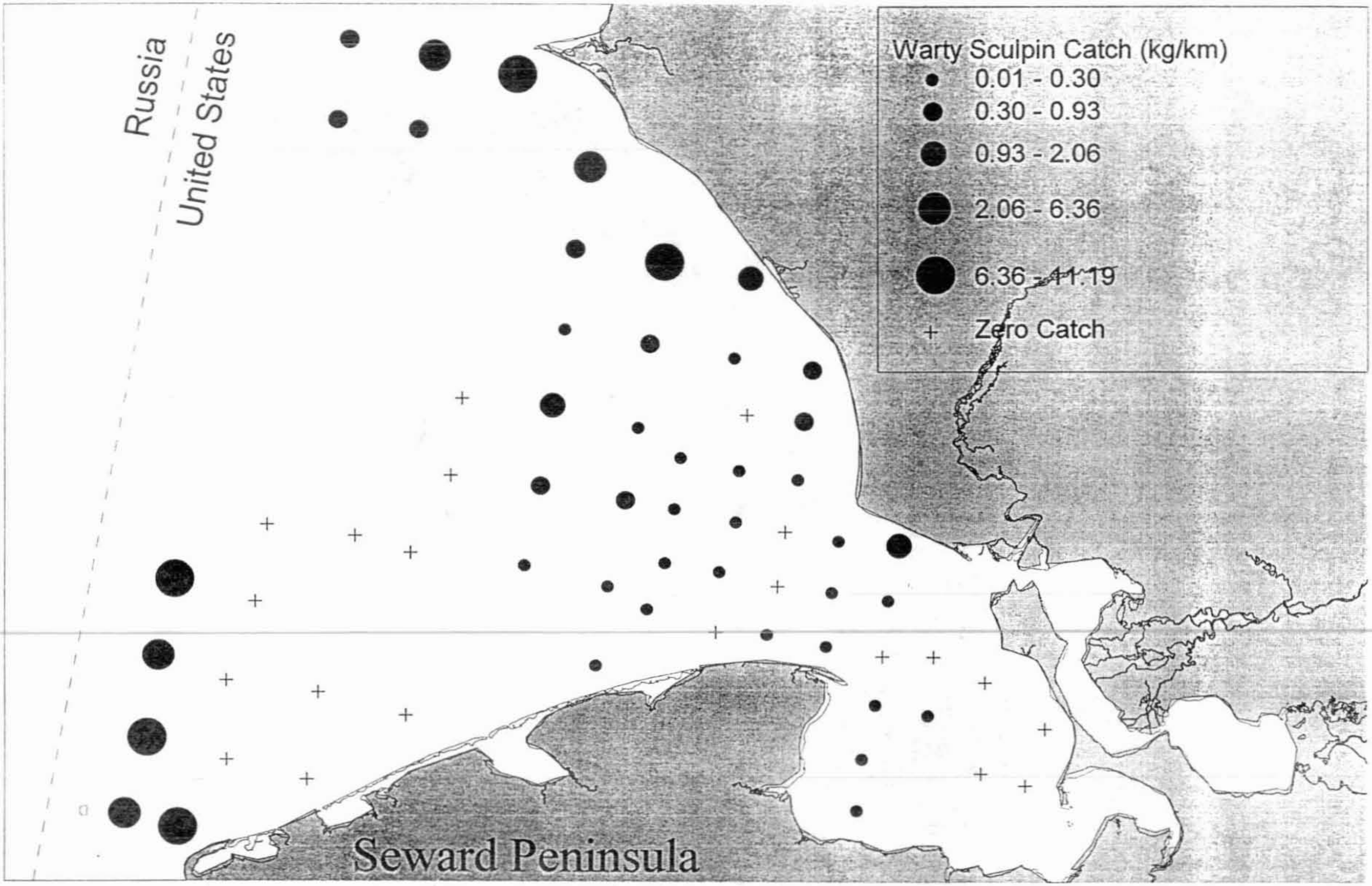

Figure 34. Map of warty sculpin catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

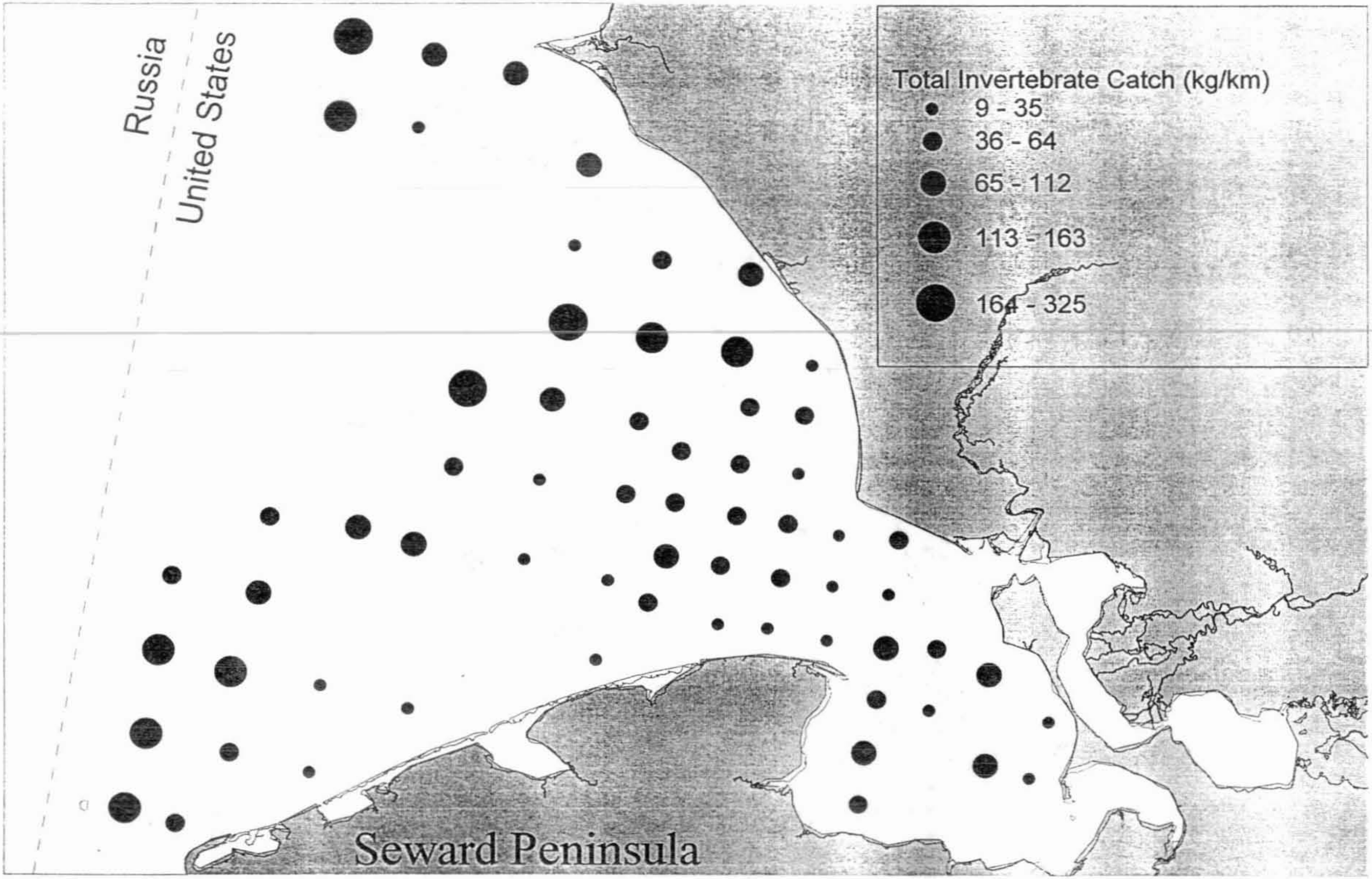

Figure 35. Map of total invertebrate catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

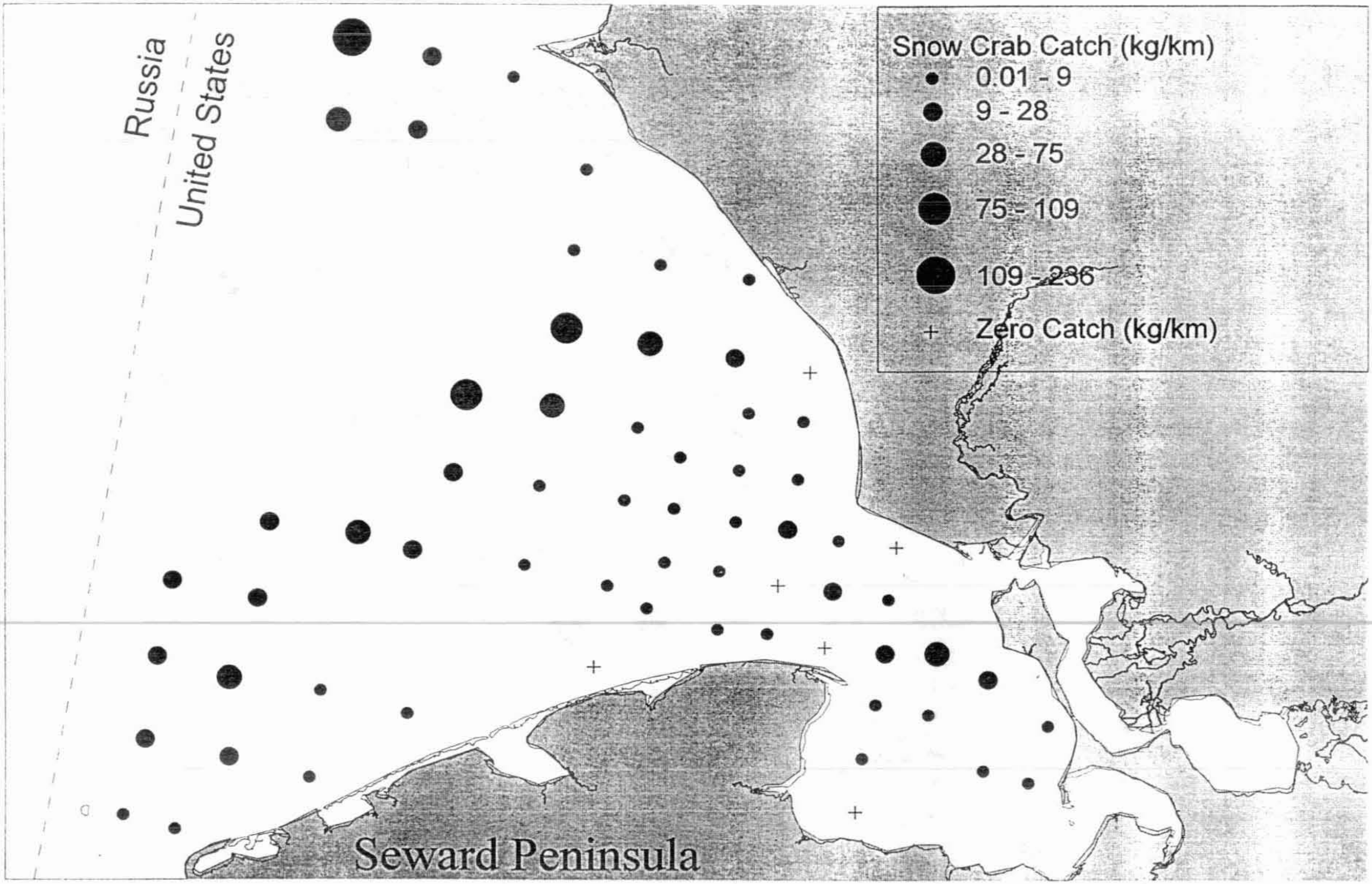

Figure 36. Map of snow crab catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

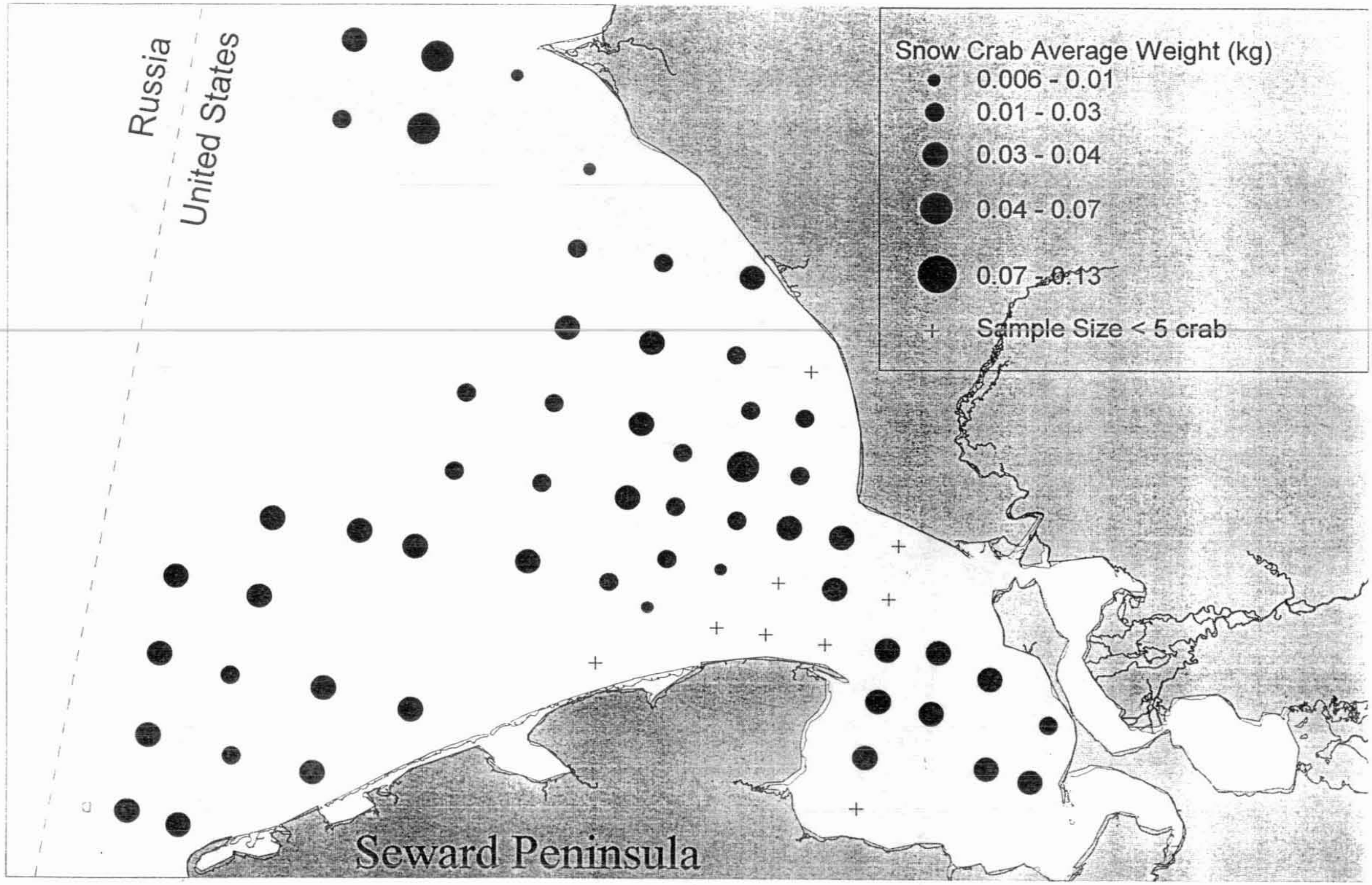

Figure 37. Map of snow crab average weights (kg) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

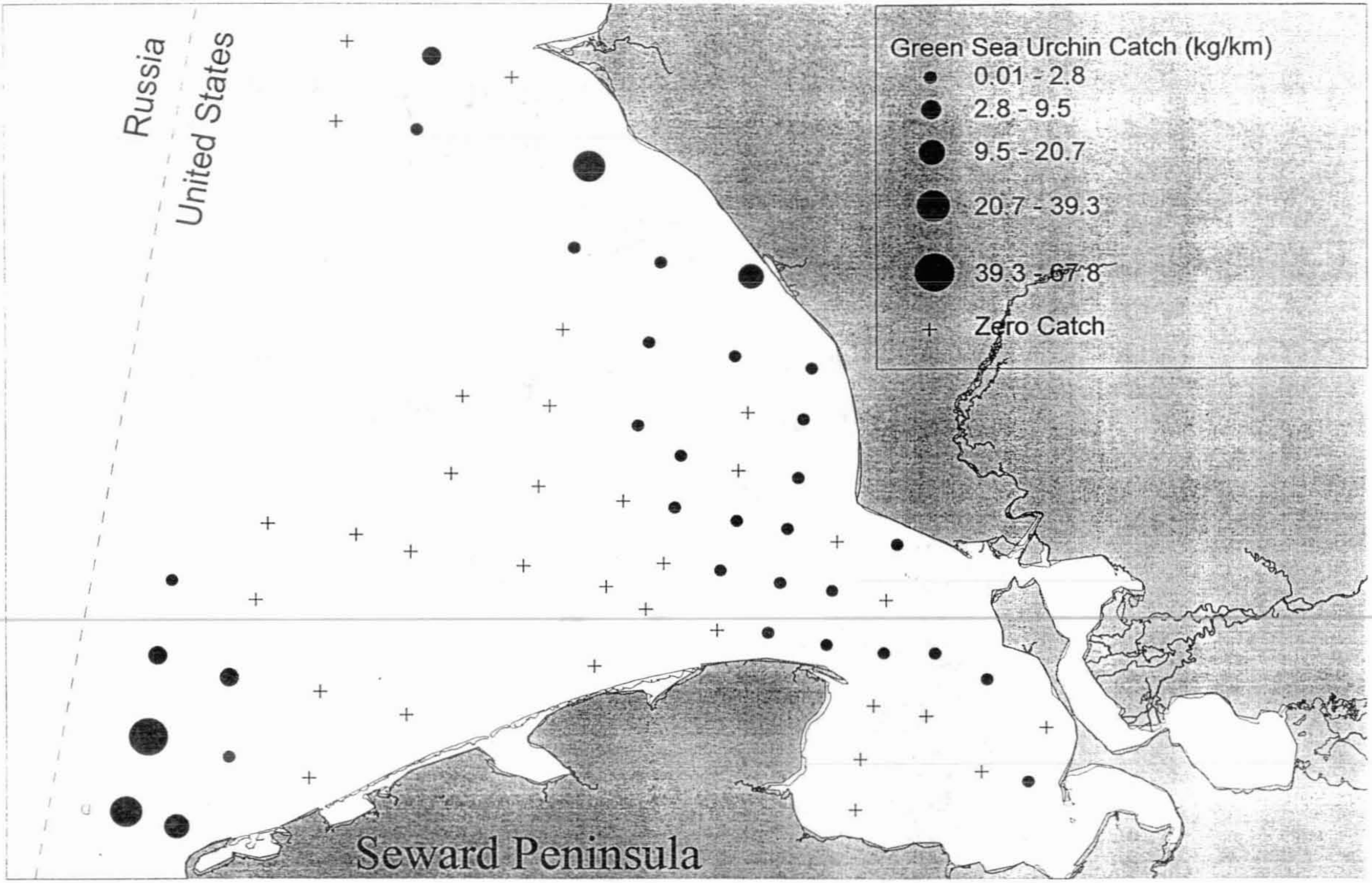

Figure 38. Map of green sea urchin catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

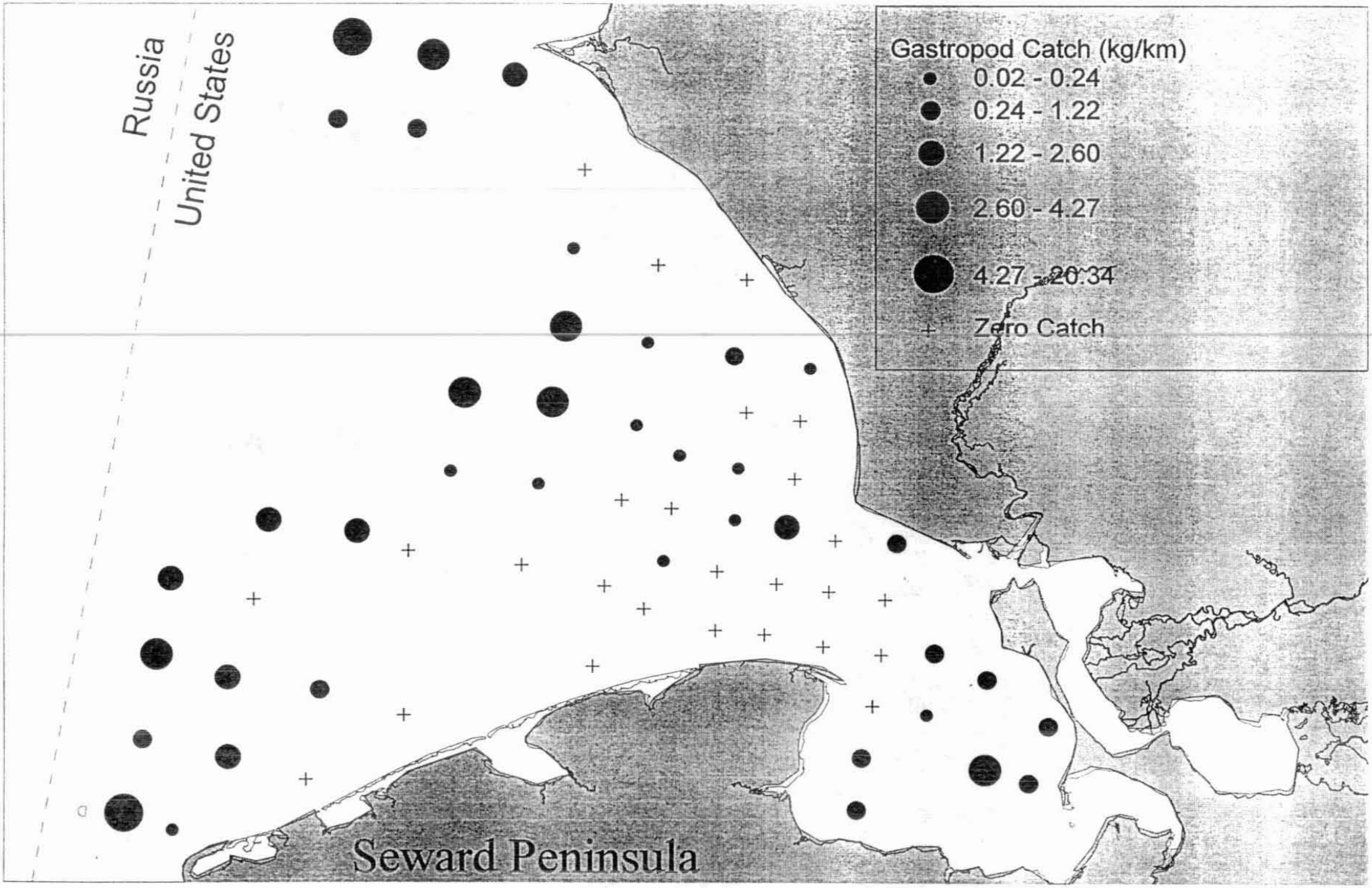

Figure 39. Map of gastropod catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

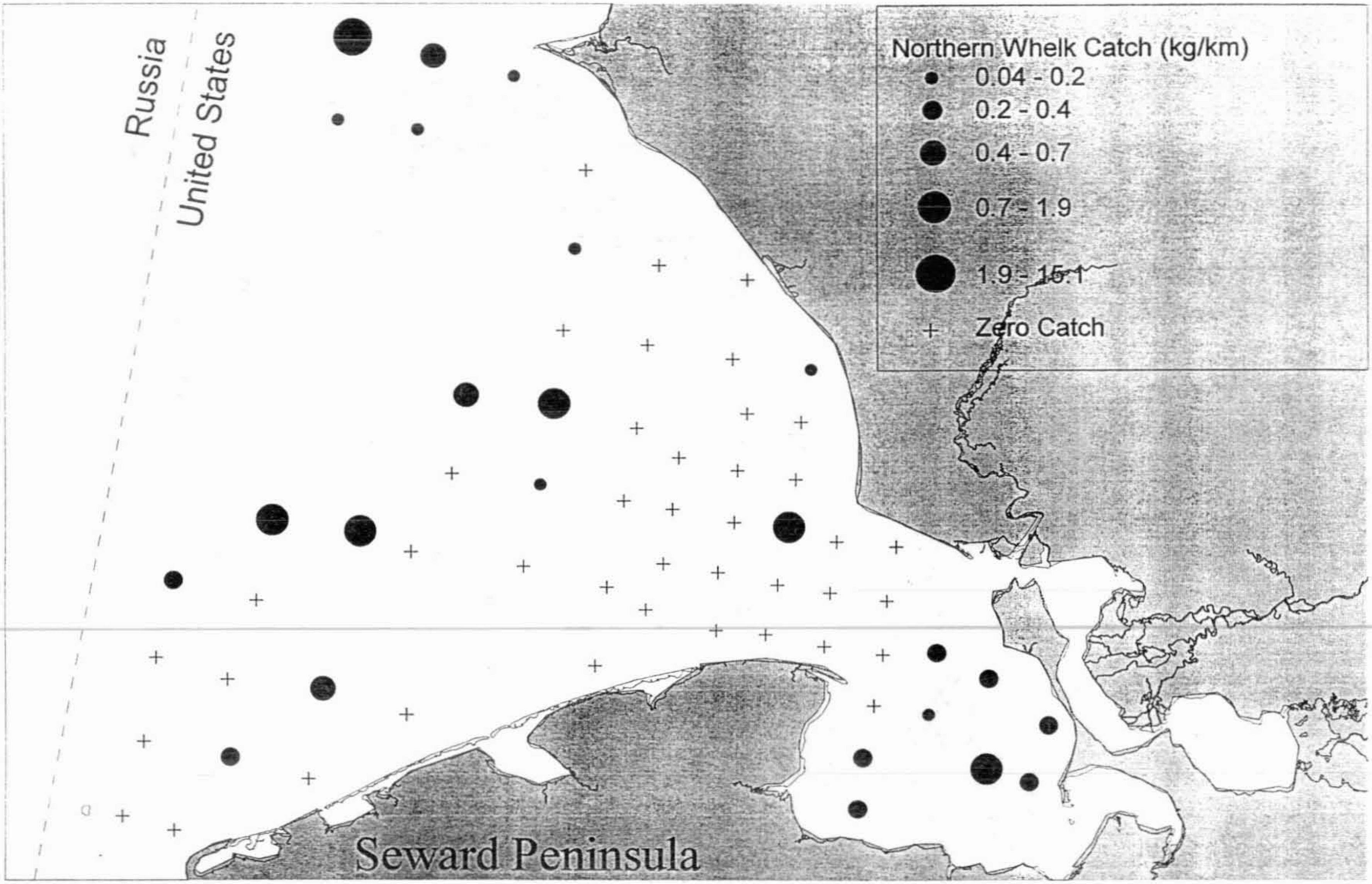

Figure 40. Map of northern whelk catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

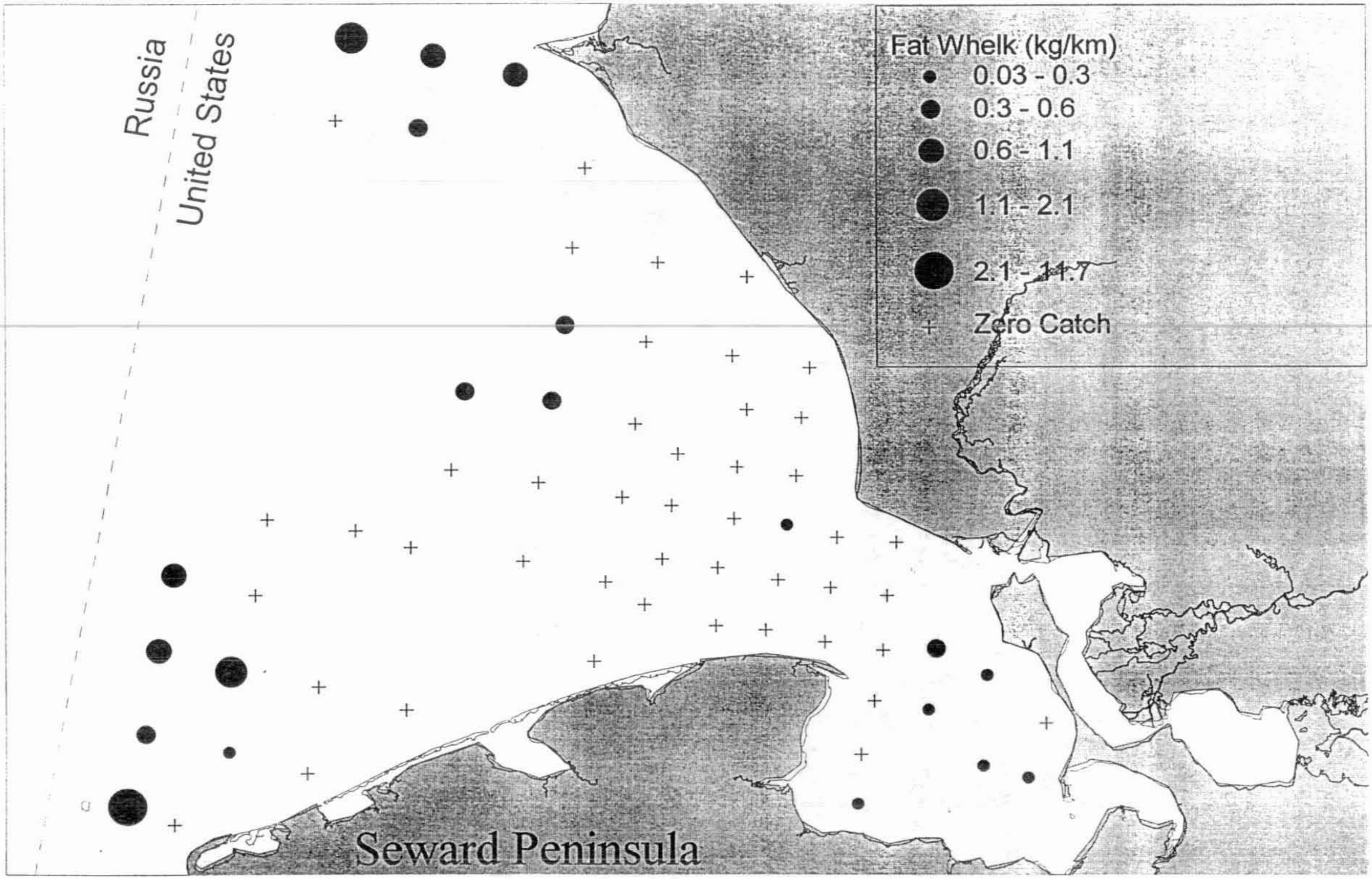

Figure 41. Map of fat whelk catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

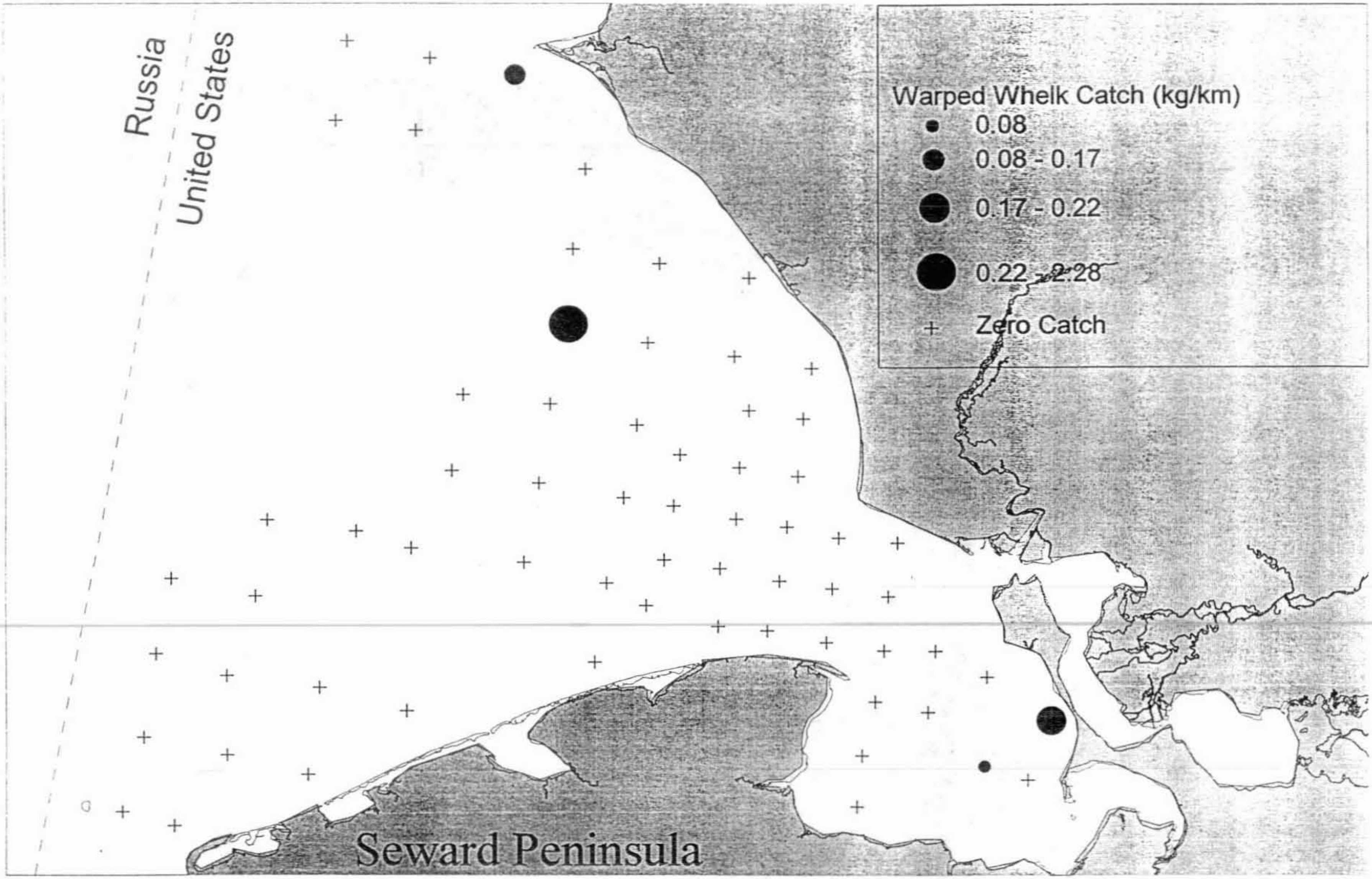

Figure 42. Map of warped whelk catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

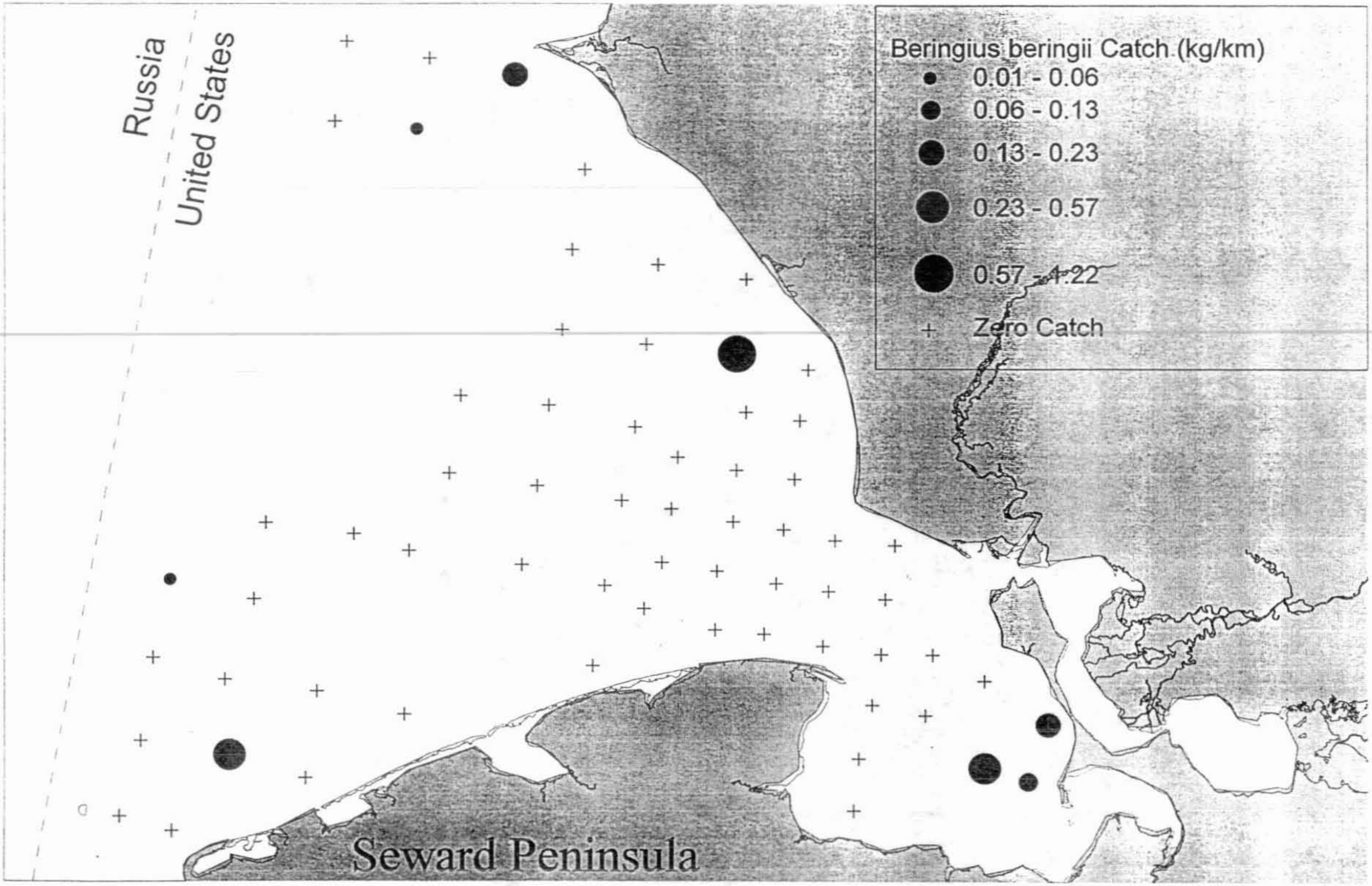

Figure 43. Map of *Beringius beringii* catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

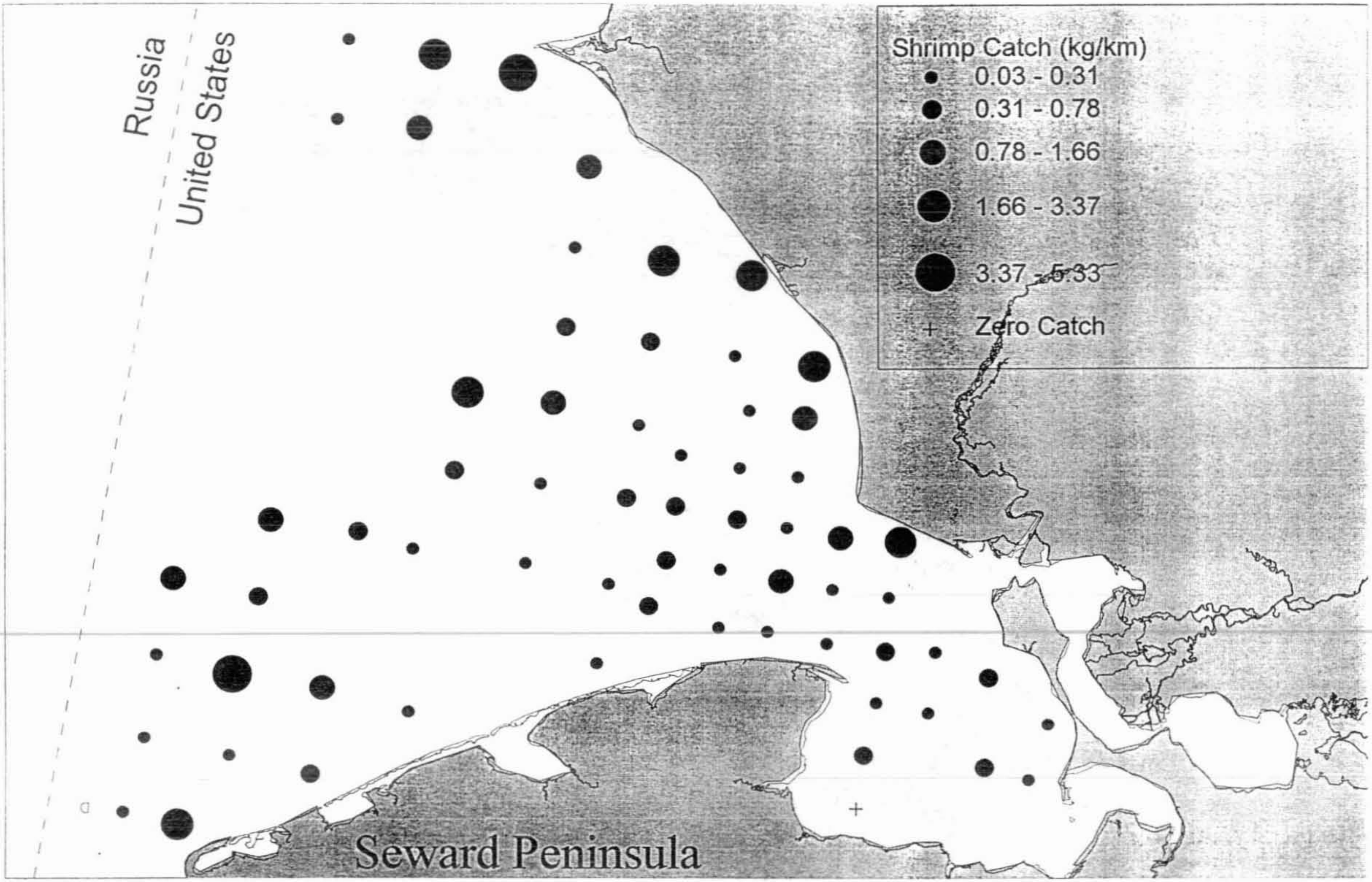

Figure 44. Map of shrimp catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

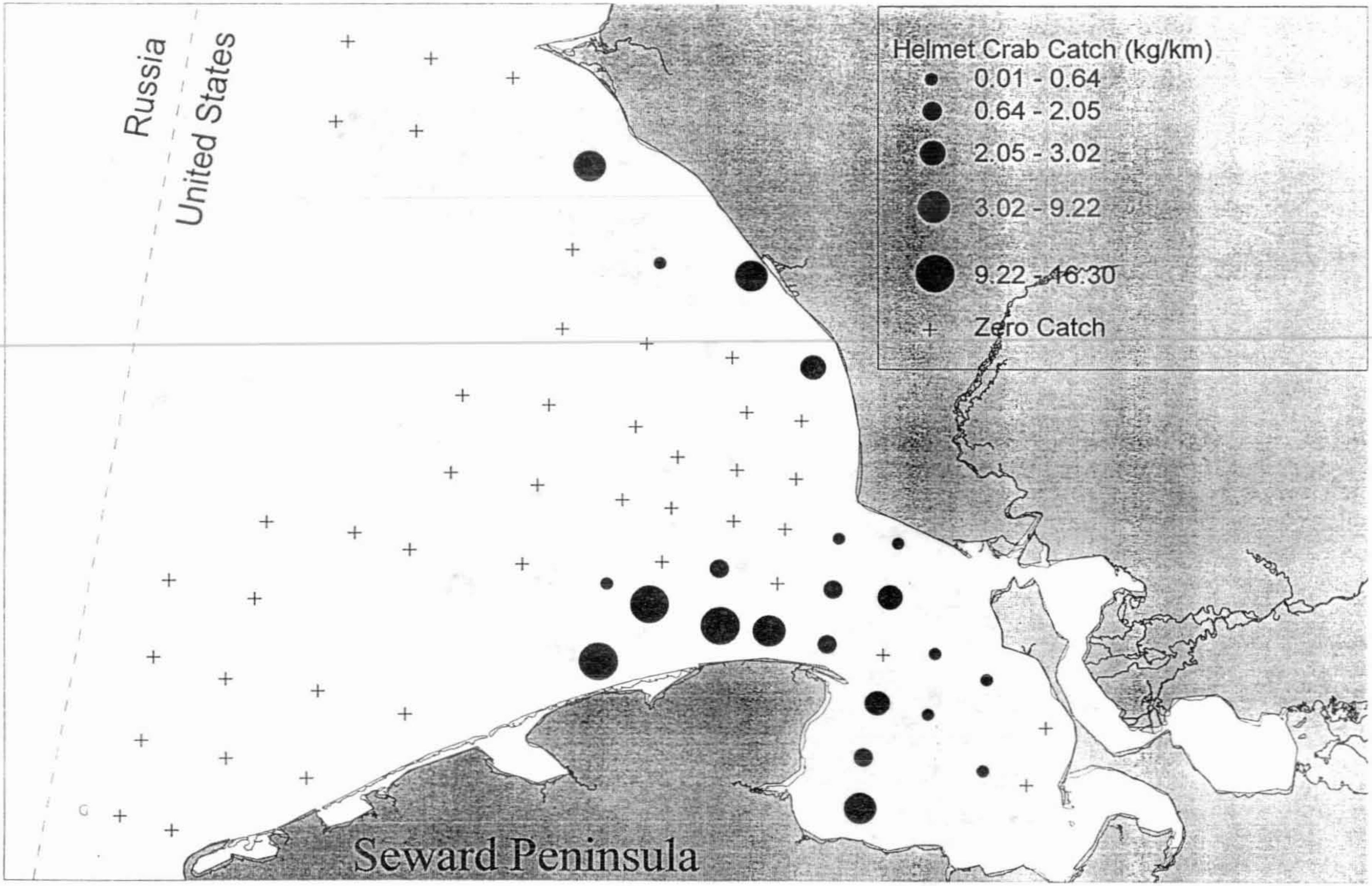

Figure 45. Map of helmet crab catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

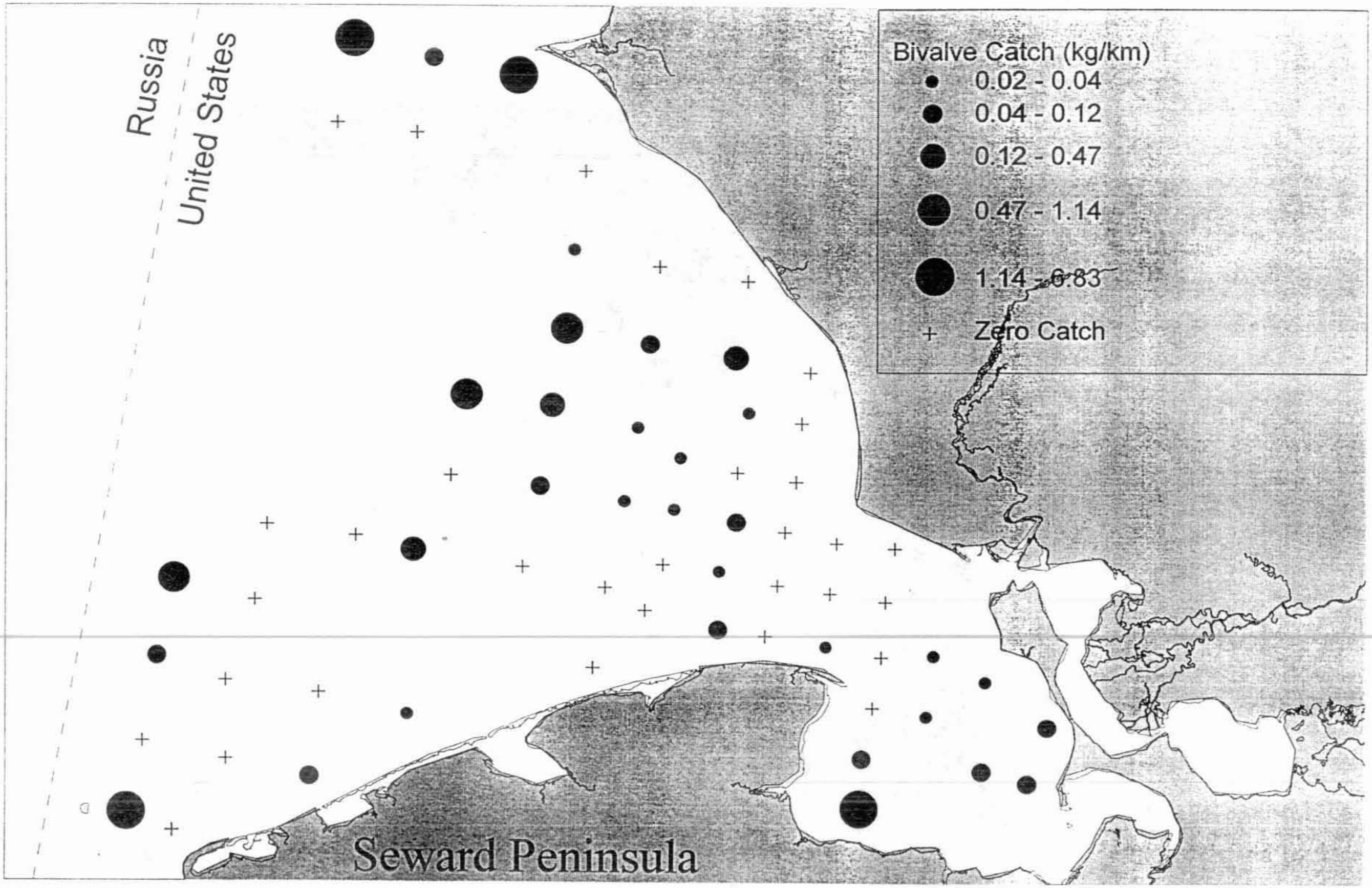

Figure 46. Map of bivalve catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

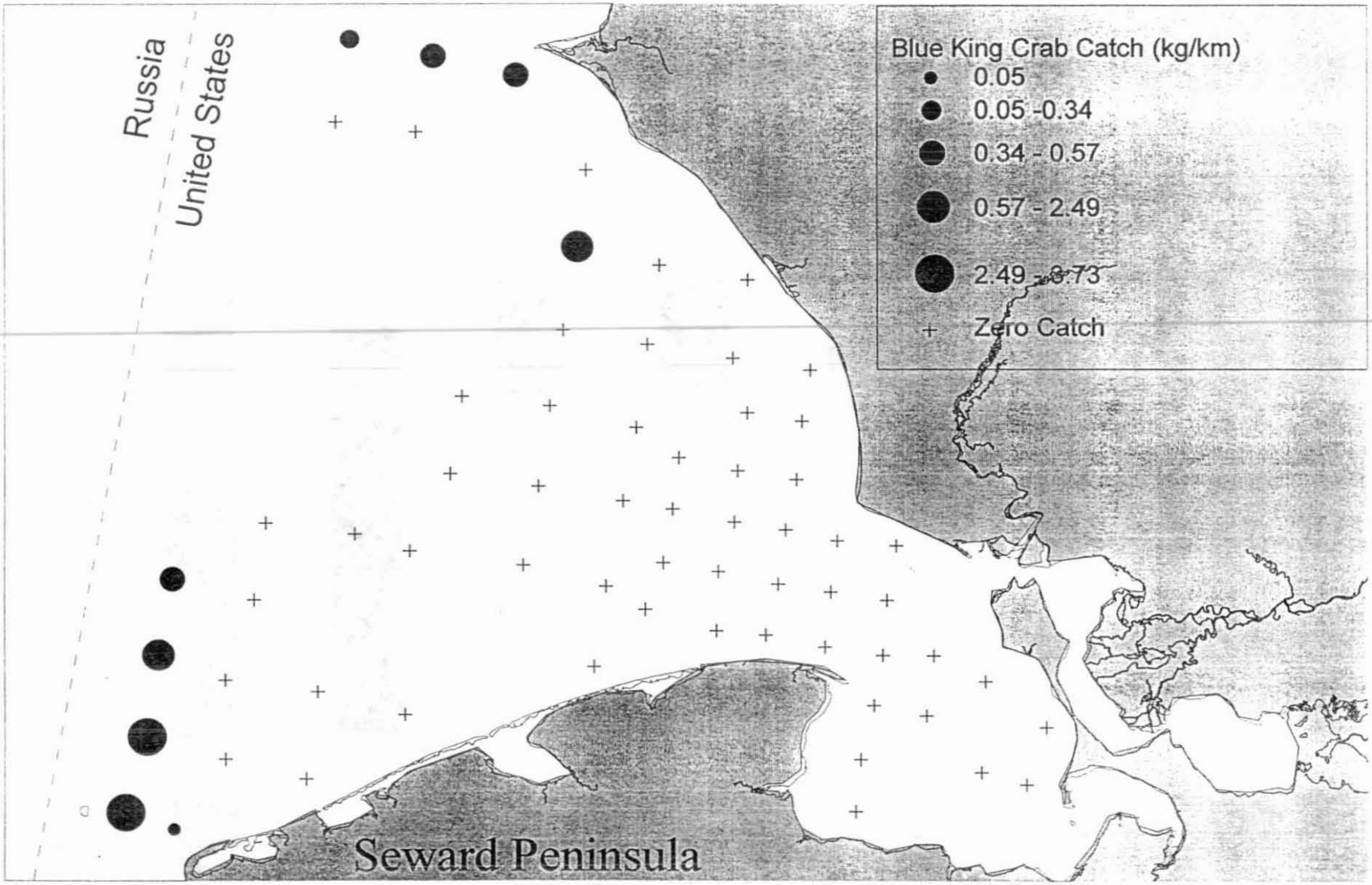

Figure 47. Map of blue king crab catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

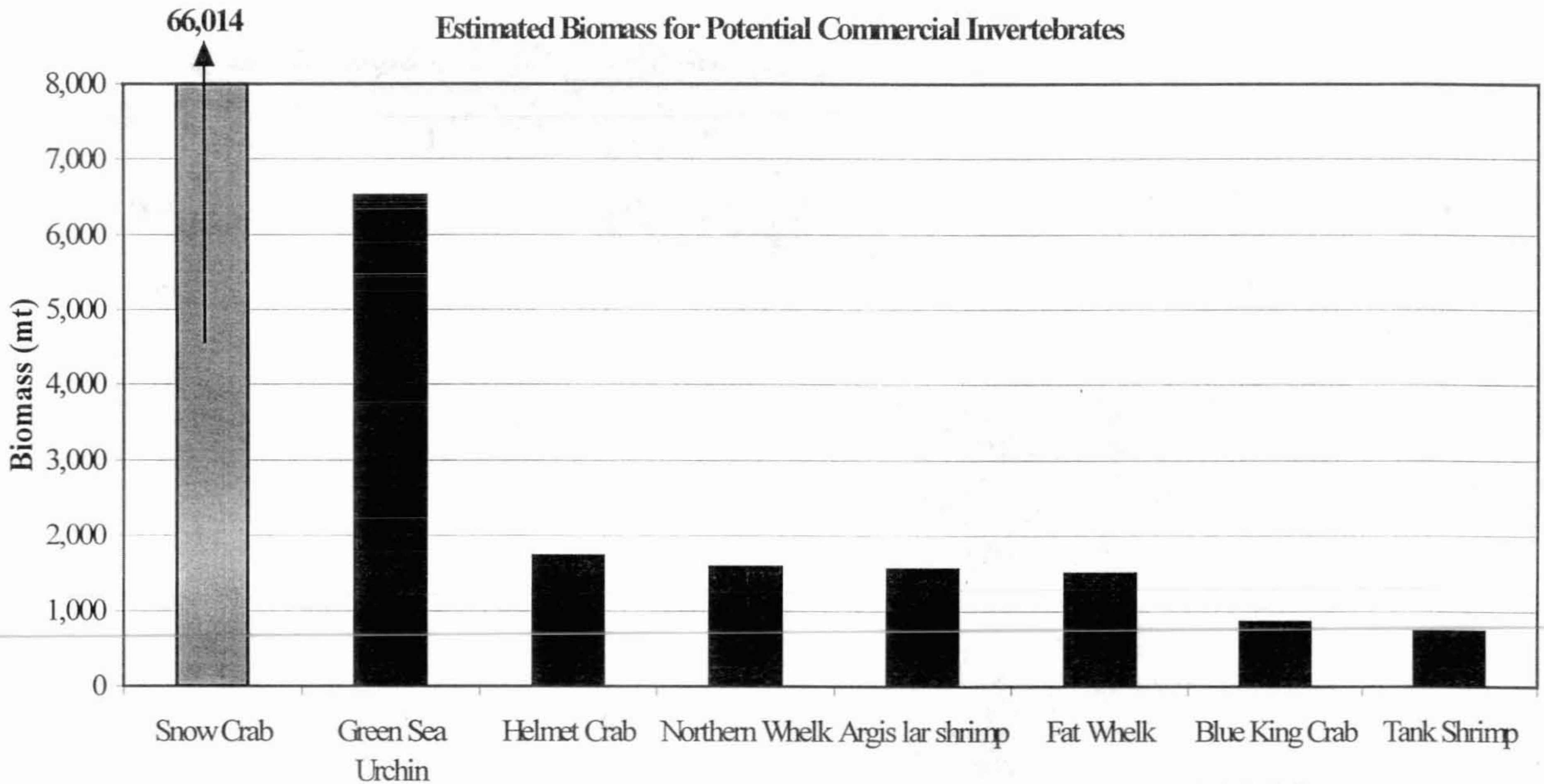

Figure 48. Biomass estimates for potentially important commercial invertebrates from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

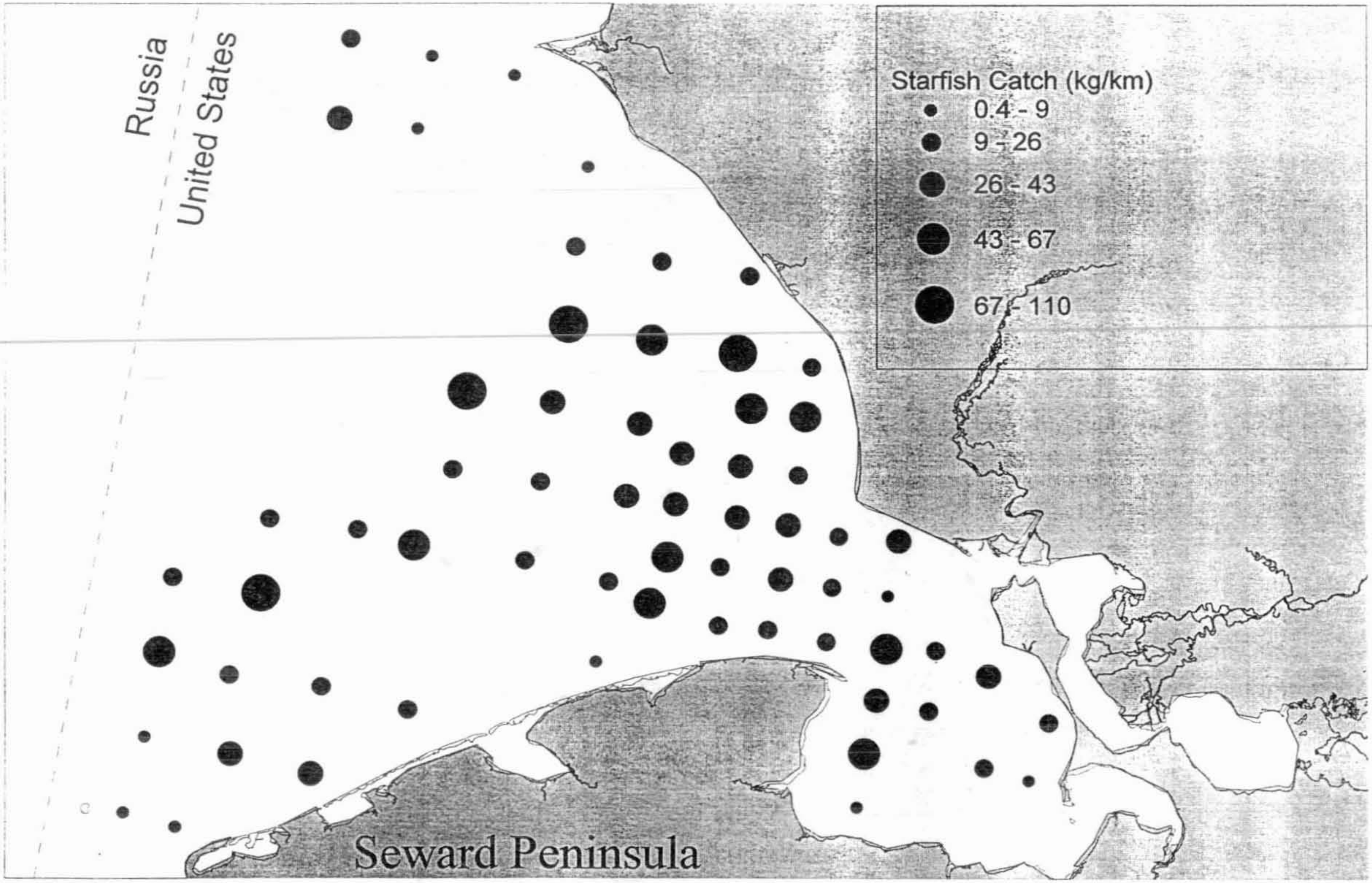

Figure 49. Map of starfish catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

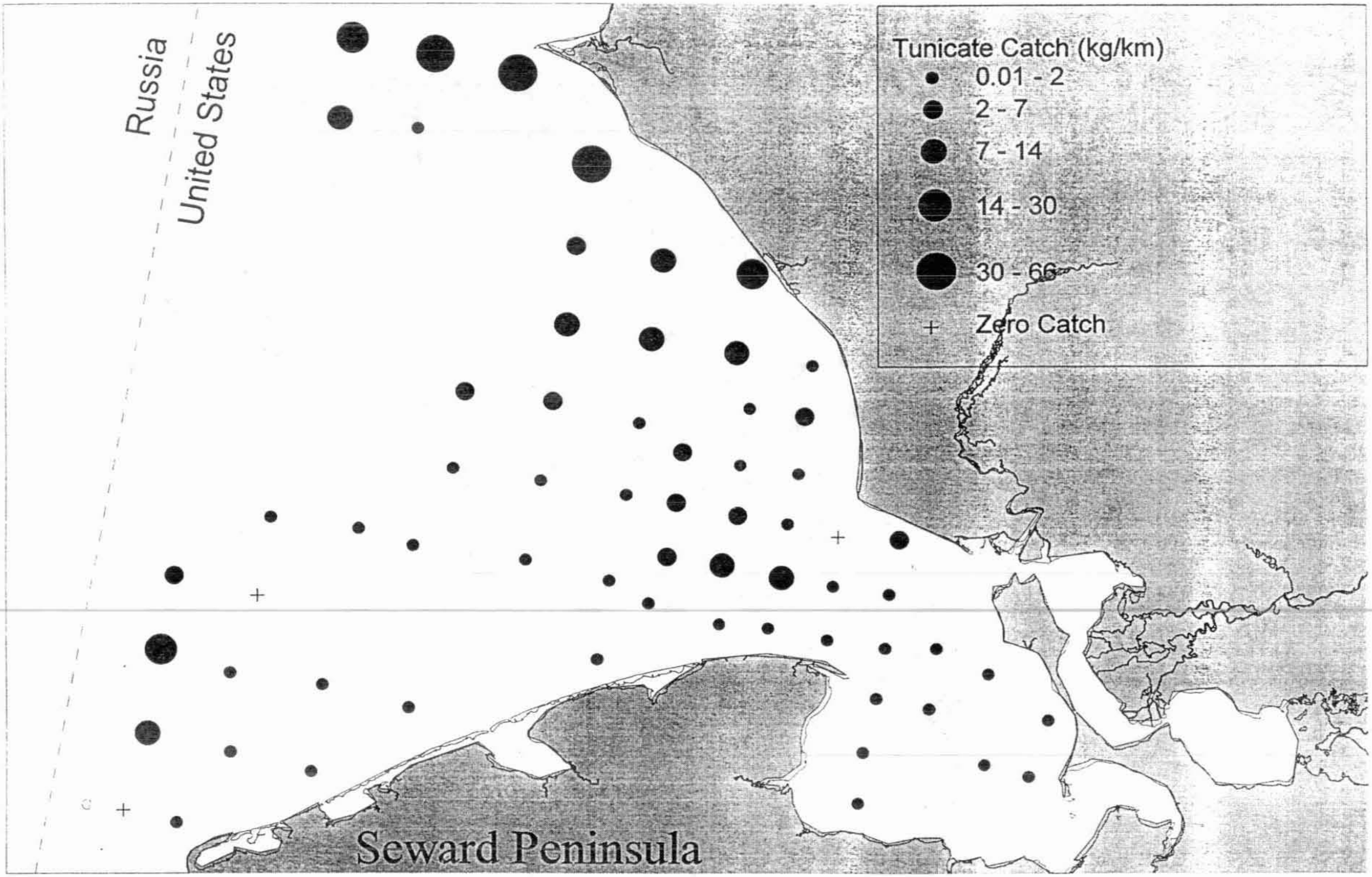

Figure 50. Map of tunicate catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

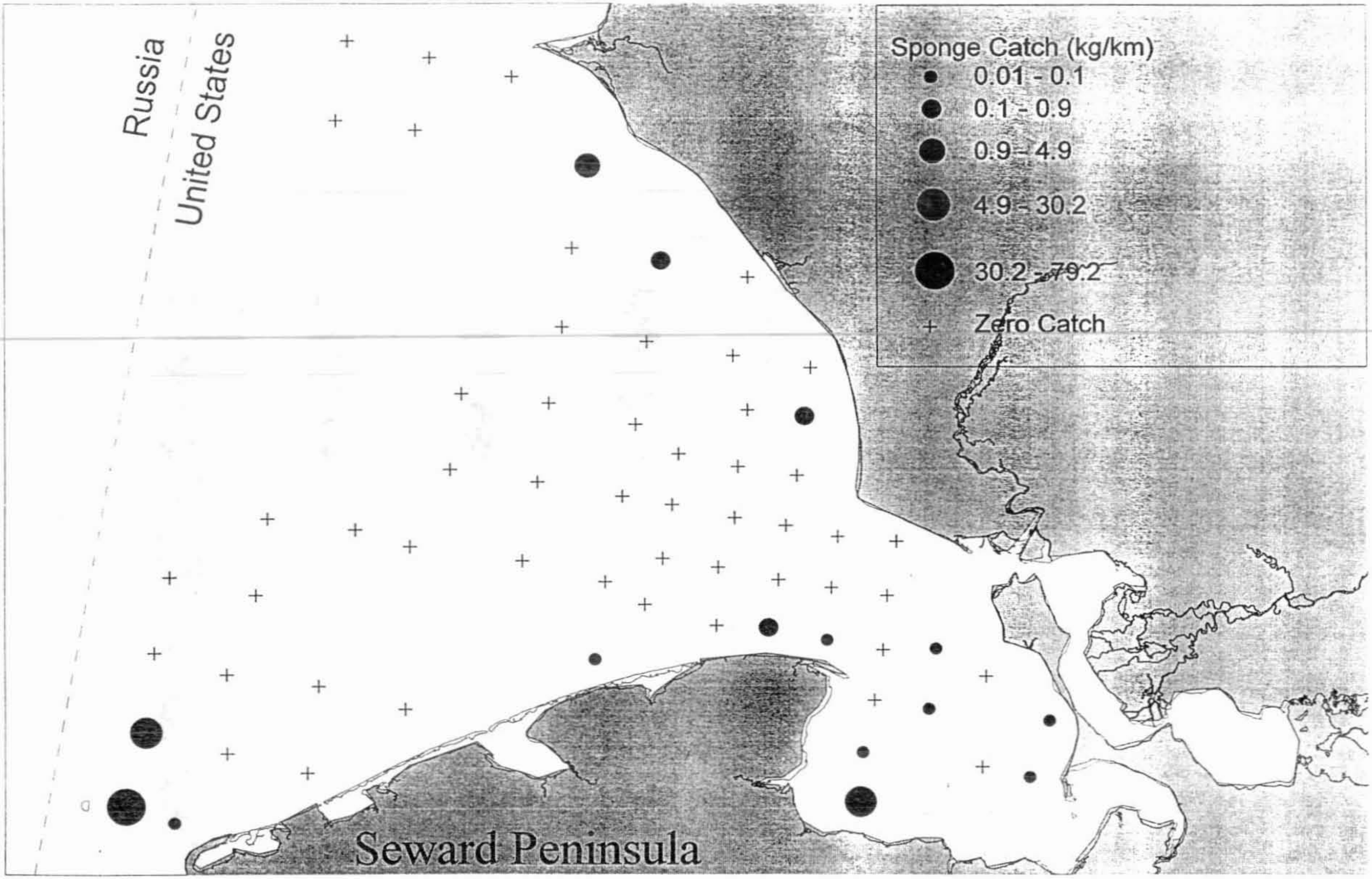

Figure 51. Map of sponge catches (kg/km trawled) from the 1998 southeast Chukchi Sea and Kotzebue Sound trawl survey.

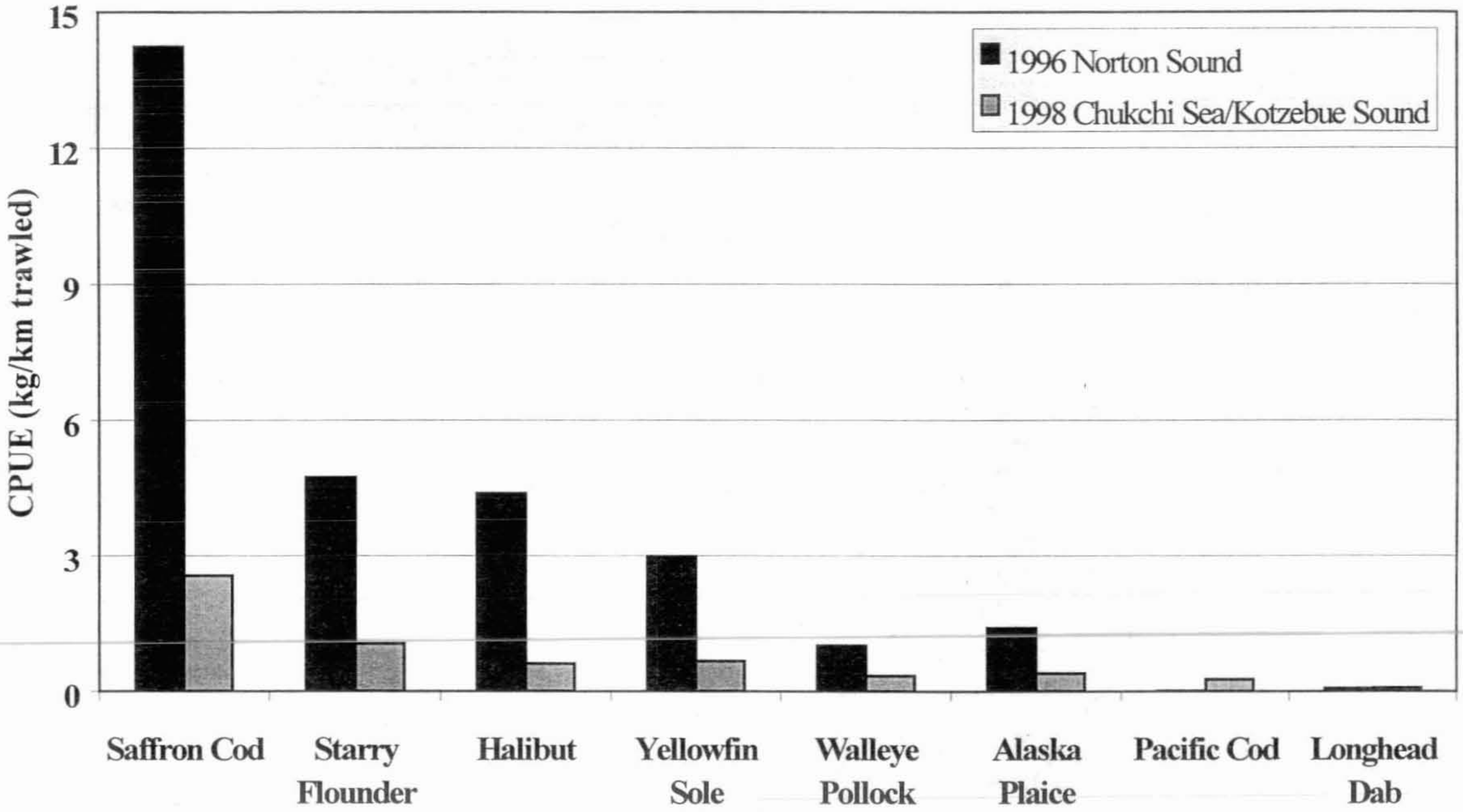

Figure 52. Biomass estimates for potentially important commercial fish species from the 1996 Norton Sound and 1998 southeast Chukchi Sea and Kotzebue Sound trawl surveys.

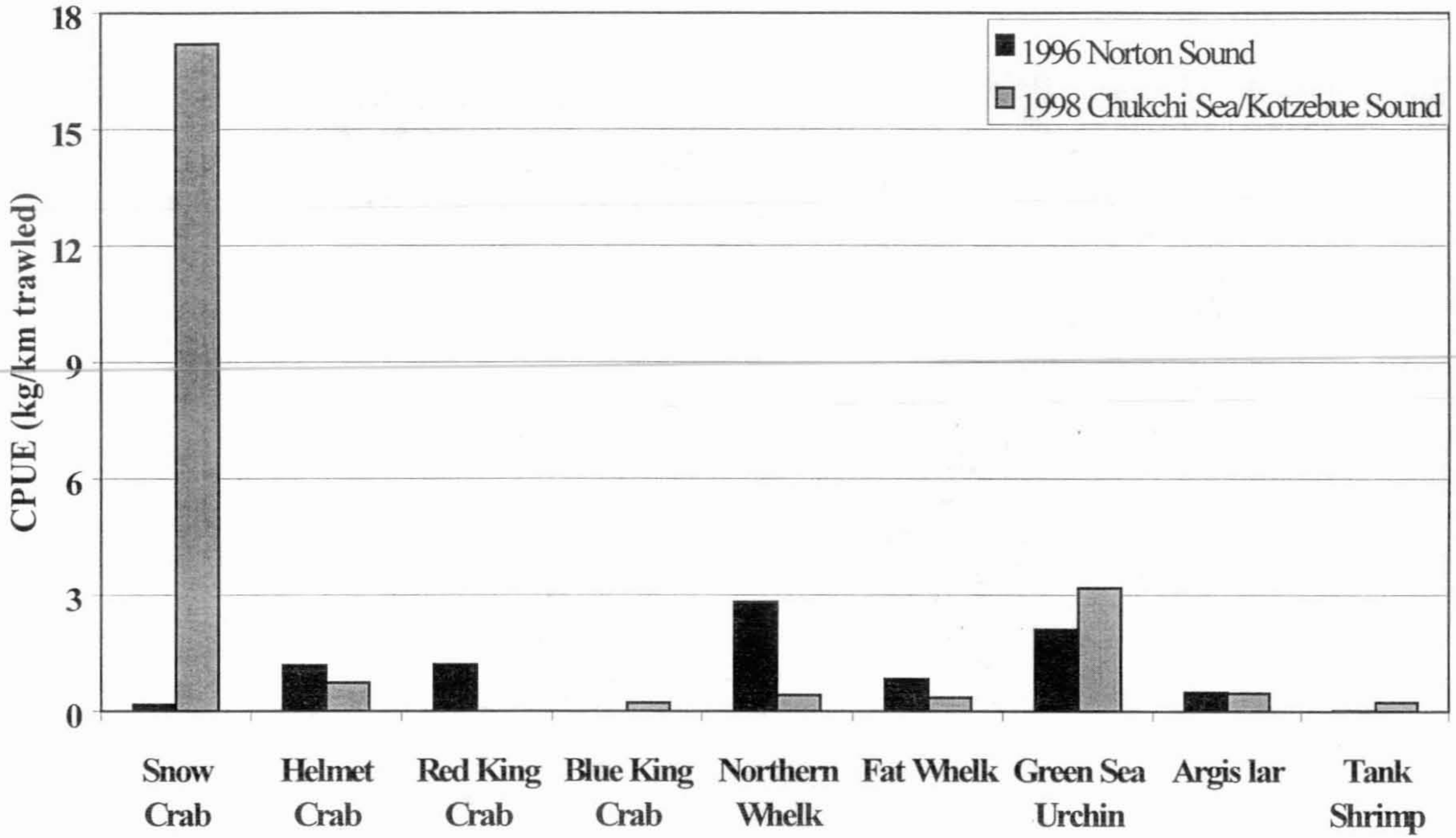

Figure 53. Biomass estimates for potentially important commercial invertebrate species from the 1996 Norton Sound and 1998 southeast Chukchi Sea and Kotzebue Sound trawl surveys.

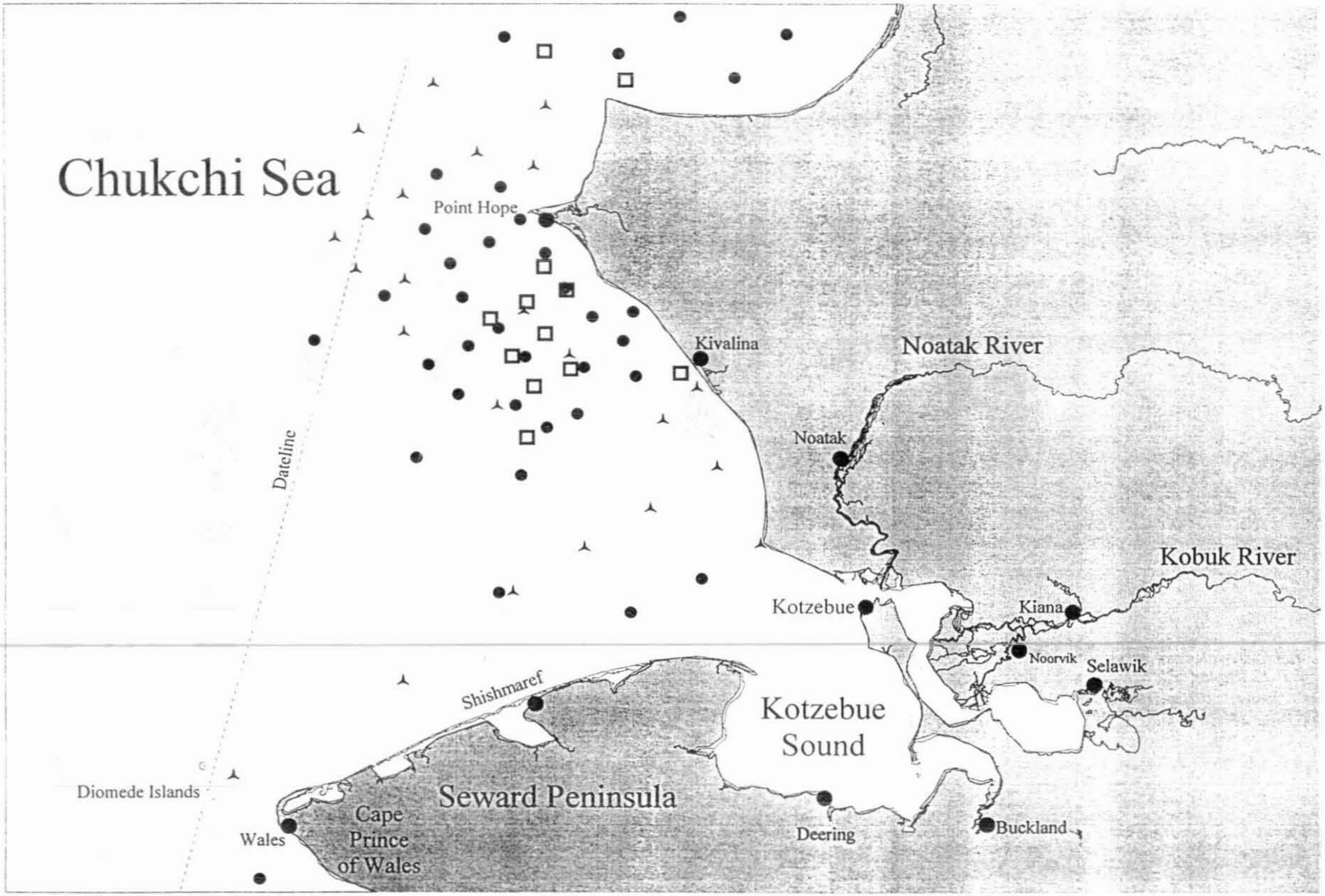

Figure 54. Map showing the fishing gear used and locations of stations from the AEC 1959 Chukchi Sea study.

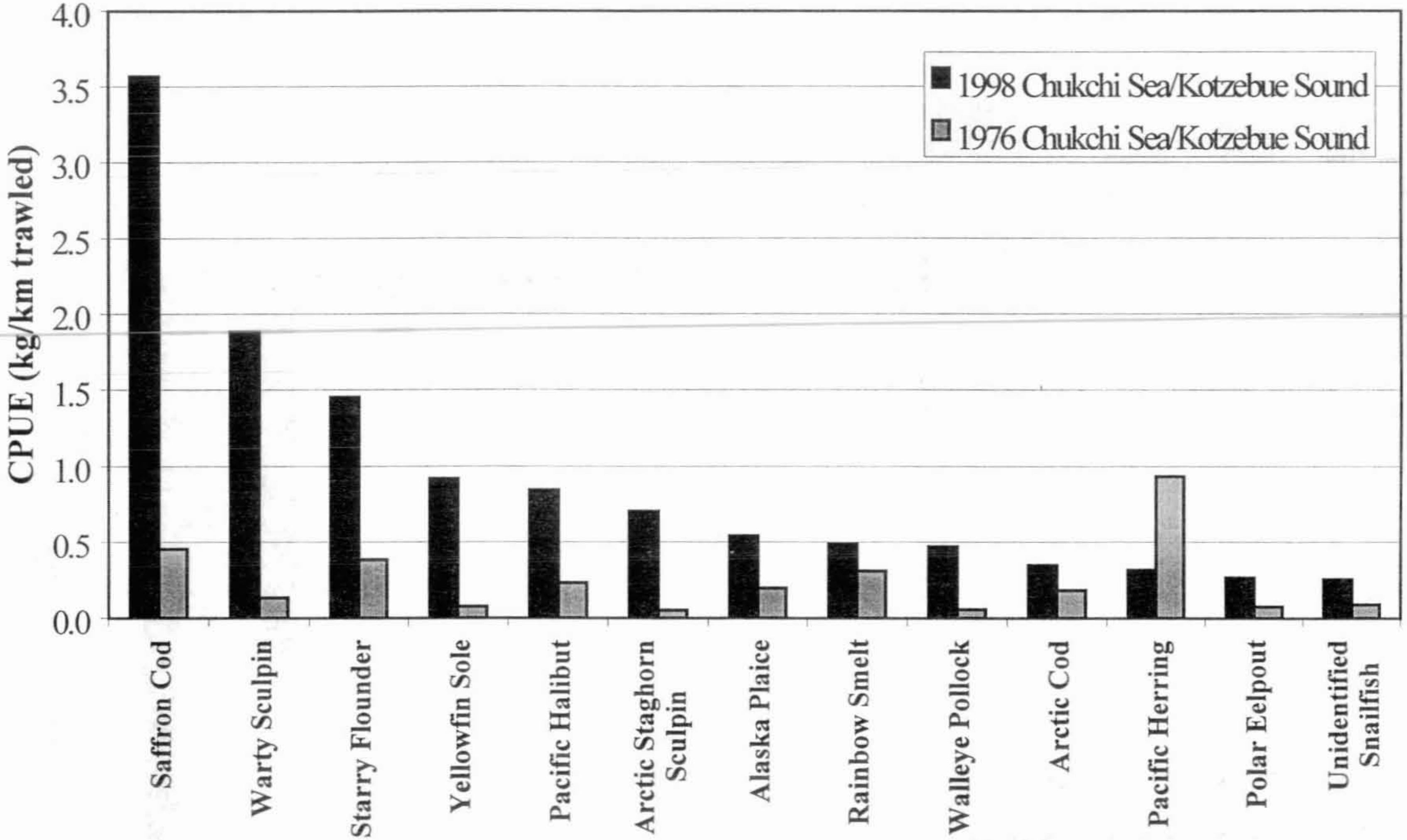

Figure 55. Standardized biomass estimates for the most common (in weight) fish species from the 1998 and 1976 southeast Chukchi Sea and Kotzebue Sound trawl surveys.

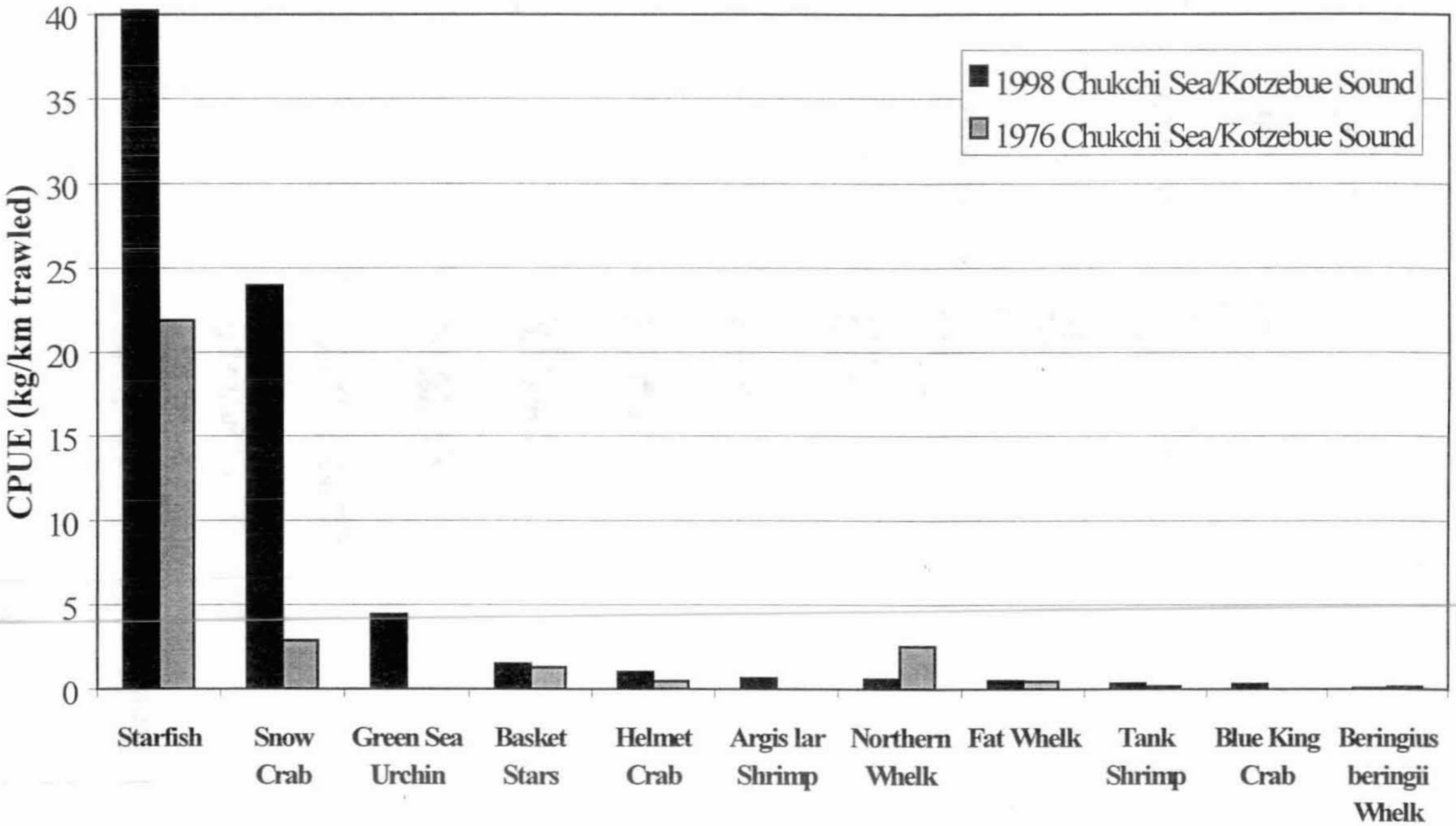

Figure 56. Biomass estimates for some of the most common (in weight) invertebrate species from the 1998 and 1976 southeast Chukchi Sea and Kotzebue Sound trawl surveys.

Appendix A. Planned station locations for the 1998 Chukchi Sea trawl survey.

STATION NUMBER	LATITUDE		LONGITUDE	
	deg	min	deg	min
1	65	45	167	58
2	66	0	168	0
3	66	15	168	8
4	66	30	168	3
5	66	45	168	5
6	66	45	167	26
7	66	30	167	24
8	66	15	167	25
9	66	0	167	23
10	66	15	166	47
11	66	30	166	46
12	66	45	166	48
13	67	0	166	49
14	67	15	166	51
15	67	15	166	11
16	67	0	166	9
17	66	45	166	9
18	66	30	166	7
19	66	30	165	29
20	66	45	165	30
21	67	0	165	30
22	67	15	165	31
23	67	10	165	8
24	67	0	165	7
25	66	50	165	6
26	66	40	165	6
27	66	40	164	40
28	66	50	164	41
29	67	0	164	41
30	67	10	164	41
31	67	10	164	14
32	67	0	164	16
33	66	50	164	15
34	66	40	164	15
35	66	40	163	49

continued

Appendix A (page 2 of 3).

STATION NUMBER	LATITUDE		LONGITUDE	
36	66	50	163	50
37	67	0	163	50
38	67	0	163	24
39	66	50	163	24
40	66	40	163	23
41	66	30	163	24
42	66	40	162	58
42	66	20	163	25
43	66	10	163	25
44	66	10	162	59
45	66	20	162	59
46	66	30	162	58
48	66	40	162	32
49	66	30	162	32
50	66	20	162	31
51	66	10	162	31
52	66	20	162	5
53	66	30	162	6
54	67	20	164	15
55	67	20	164	41
56	67	30	164	51
57	67	30	164	11
58	67	45	164	50
59	67	45	165	32
60	67	30	165	31
61	67	30	166	11
62	67	45	166	13
63	68	0	166	14
64	68	0	165	32
65	68	15	166	16
66	68	15	166	57
67	68	15	167	38
68	68	15	168	17
69	68	0	168	15
70	68	0	167	36
71	68	0	166	55
72	67	45	166	53

continued

Appendix A (page 3 of 3).

STATION NUMBER	LATITUDE		LONGITUDE	
73	67	45	167	34
74	67	45	168	14
75	67	30	168	12
76	67	30	167	32
77	67	30	166	52
78	67	15	167	30
79	67	15	168	10
81	67	0	168	8
81	67	0	167	28
*01	65	45	168	32
*02	66	0	168	37
*03	66	15	168	40
*04	66	30	168	41
*05	66	45	168	44
*06	67	0	168	47
*07	67	15	168	50
*08	67	30	168	51
*09	67	45	168	52
*10	68	0	168	53
*11	68	15	168	55

Note:
Chukchi Sea standard station location positions obtained from the National Marine Fisheries Service.

Appendix B. Trawl survey haul record form – Chukchi Sea trawl survey.

TRAWL SURVEY HAUL RECORD - CHUKCHI SEA TRAWL SURVEY PG OF

CAPTAIN: VESSEL:

SEQUENTIAL HAUL NUMBER	STATION NUMBER	VESSEL CODE	DATE			STARTING POSITION				COMPASS HEADING
						N. LATITUDE		W. LONGITUDE		
			MONTH	DAY	YEAR	DEG.	MINUTES	DEGREE	MINUTES	

TRAWL TIME		TOTAL (MIN)	DIST. TOWED (NMI)	DEPTH (FM)			WEATHER (SEE CODES BELOW)			SCOPE (FM)	GEAR PERF.	BOTTOM TEMP. (C)
START	END			MIN.	AVE.	MAX.	CLOUD	SEA	SWELL			

COMMENTS:

SEQUENTIAL HAUL NUMBER	STATION NUMBER	VESSEL CODE	DATE			STARTING POSITION				COMPASS HEADING
						N. LATITUDE		W. LONGITUDE		
			MONTH	DAY	YEAR	DEG.	MINUTES	DEGREE	MINUTES	

TRAWL TIME		TOTAL (MIN)	DIST. TOWED (NMI)	DEPTH (FM)			WEATHER (SEE CODES BELOW)			SCOPE (FM)	GEAR PERF.	BOTTOM TEMP. (C)
START	END			MIN.	AVE.	MAX.	CLOUD	SEA	SWELL			

COMMENTS:

WEATHER CODES					
CLOUD COVER		SEA STATE (FEET)		SWELL (FEET)	
Clear	1	0 to 2	1	0 to 2	1
1/8 obscured	2	2 to 4	2	2 to 4	2
1/4 obscured	3	4 to 6	3	4 to 6	3
3/8 obscured	4	6 to 8	4	6 to 8	4
1/2 obscured	5	8 to 10	5	8 to 10	5
5/8 obscured	6	10 to 12	6	10 to 12	6
3/4 obscured	7	12 to 14	7	12 to 14	7
7/8 obscured	8	14 to 16	8	14 to 16	8
Completely overcast	9	Over 16	9	Over 16	9

GEAR PERFORMANCE CODES	
Performance unsatisfactory	01
Performance satisfactory	20
Doors non-functional (collapsed, crossed)	21
Net non-functional (collapsed, torn, twisted)	22
Gear hung up on bottom	23
Trawl flipped or upside down	24
Mudded down	26
Telemetry malfunction (GPS, fathometer, etc.)	50

Appendix C. Station catch record form – Chukchi Sea trawl survey.

F&G STATION CATCH RECORD - CHUKCHI SEA TRAWL SURVEY PG ___ OF ___

SEQUENTIAL HAUL NUMBER [ ][ ][ ] VESSEL: ____________

STATION NUMBER [ ][ ][ ] DATE: ____________

(1) Gross catch weight (kg):	____________	(5) Adjusted net catch weight	____________
(2) Tare (kg):	____________	(3) or (3)- (4) (kg):	____________
(3) Net catch weight [(1) - (2)] (kg):	____________	(6) Subsample weight (kg):	____________
(4) Large fish and debris (kg): (100% sample)	____________	(7) Raising factor [(5)/(6)] (kg):	____________

SPECIES NAME	SPECIES CODE					SAMPLE 1		SAMPLE 2		TOTAL CATCH	
						KILOS	NUMBER	KILOS	NUMBER	KILOS	NUMBER
Purple-Orange Starfish	8	1	7	4	2						
Saffron Cod	2	1	7	3	5						
Plain Sculpin	2	1	3	7	1						
Yellowfin Sole	1	0	2	1	0						
Alaska Plaice	1	0	2	8	5						
Red King Crab	6	9	3	2	2						
Helmet Crab	6	8	7	8	1						

Appendix D. Crab research data form – Chukchi Sea trawl survey.

CRAB RESEARCH DATA FORM - CHUKCHI SEA TRAWL SURVEY PG ____ OF ____

DATE: | | | | | | | | MEASURER: ____________

VESSEL: RECORDER:

	SEQUENTIAL HAUL NUMBER	SPECIES	SEX	SIZE (CL-MM)	LEGAL	SHELL AGE	EMBRYOS COLOR	EMBRYOS DEVEL.	EMBRYOS COND.	% CLUTCH	OTHER	DURO-METER	COMMENTS
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													

CRAB SPECIES
2 - P. camtschaticus
3 - P. playpus

LEGAL
1 - Sublegal
2 - Legal

RKC
<120.7mm(4.75")
≥120.7mm(4.75")

BKC
<139.7mm(5.5")
≥139.7mm(5.5")

SEX
1 - Male
2 - Female

SHELL AGE
0 - Soft
1 - New, pliable
2 - New, hard
3 - Old
4 - Very old

OTHER
1 - Dead
2 - Alive
3 - Nemerteans in clutch
4 - Turbellarians in clutch
5 - Black mat
6 - Bitter crab disease
7 - "Cottage cheese" disease
8 - Shell rust (chitonclastic bacteria
9 - *Briarosaccus callosus*

LIVE EGG COLOR
1 - Tan
2 - Purple
3 - Brown
4 - Orange
5 - Purple-brn.
6 - Pink
7 - Reddish
0 - Other; describe

EGG DEVEL.
1 - Uneyed
2 - Eyed

CLUTCH COND.
1 - Dead eggs not apparent
2 - Dead eggs <20%
3 - Dead eggs ≥20%

PERCENT CLUTCH
1 - Barren, clean pleopods
2 - Barren, with empty embryo cases (matted setae)
3 - Clutch 1-29% full
4 - Clutch 30-59% full
5 - Clutch 60-89% full
6 - Clutch 90-100% full

Appendix E. Fish length frequency form – Chukchi Sea trawl survey.

)F&G FISH LENGTH FREQUENCY FORM - CHUKCHI SEA TRAWL SURVEY

DATE: | | | | | | | PG _____ OF _____

VESSEL: ______________

SPECIES NAME	SEQ. HAUL NUMBER	SPECIES CODE	SIZE GROUP	FREQ	SPECIES NAME	SEQ. HAUL NUMBER	SPECIES CODE	SIZE GROUP	FREQ