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Effects of the Catcher Vessel Operational Area on Walleye Pollock Fisheries and Marine Mammals in the Eastern Bering Sea, 1990-94

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Effects of the Catcher Vessel Operational Area on Walleye Pollock Fisheries and Marine Mammals in the Eastern Bering Sea, 1990-94

by

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Abstract

This report contains data and discussion of the distribution (size and spatial) of walleye pollock in the eastern Bering Sea, the distribution (temporal and spatial) of the pollock fishery, and the impact that the Catcher Vessel Operation Area (CVOA) has had and may continue to have on the fishery and other members of the eastern Bering Sea ecosystem (marine mammals).

From 1990-94, the exploitable (30+ cm in length) pollock population in the eastern Bering Sea changed from one composed of several strong year-classes (spawned in 1978, 1982 and 1984) to one dominated by a single year-class (1989). Furthermore, there has been a shift in exploitable pollock biomass (and the fishery) to the southeast (toward the CVOA), due to the distribution of the 1989 year-class. While surveys in the last 5 years continue to show that commercial-sized pollock are widely distributed throughout the southeastern Bering Sea, both inside and outside of the CVOA, the distribution of exploitable pollock during the summer can change from year to year, which may cause the distribution of the fishery and areal CPUEs to change. The fishery harvests pollock disproportionately to its areal biomass distribution. During the 1990-94 B-seasons, harvest rates of exploitable pollock in the CVOA ranged from 22-50%, rates which were much higher than in Areas 51 and 52 outside of the CVOA (combined ranges of 1-14%). Furthermore, A-season pollock removals have also been concentrated in the CVOA.

Survey and fishery data have shown that bycatch rates of:

- herring and salmon have been higher inside the CVOA than outside, particularly from July-September;
- herring have been higher outside the CVOA from October-December;
- halibut by bottom trawls have been higher inside the CVOA than outside;
- red king crab have been higher outside the CVOA; and
- bairdi Tanner crab have been either higher or lower inside the CVOA than outside, depending on the fishery data set being analyzed.

Recent information on distribution of the crab species suggests that red king crab bycatch rates should be lower, and Tanner crab bycatch rates should be higher inside the CVOA than outside in areas frequented by the pollock fishery.

Pollock are an important prey for marine mammals and birds in the eastern Bering Sea. While most pollock are eaten as juveniles, there is considerable overlap in the size distributions of pollock taken by the fishery and those eaten by Steller sea lions. The spatial and temporal concentration of the pollock fishery is contrary to the management philosophy utilized for the pollock fishery in the Gulf of Alaska to minimize the likelihood of creation of localized depletions of marine mammal (particularly Steller sea lion) prey. Due to the distribution of the dominant 1989 year-class and the apparent desire of the fleet to avoid smaller members of that cohort, effort shifted from areas west of 170° W to the southeast (including a foraging area designated as Steller sea lion critical habitat under the ESA) in 1993-94. However, if the CVOA had not excluded the offshore fleet during these B-seasons, it is likely that harvest rates and removals from the CVOA and critical habitat would have been greater than they were.

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I. Eastern Bering Sea Pollock Natural History and Recent Stock Assessments

Walleye pollock (*Theragra chalcogramma*) is one of the most abundant fish species in the Bering Sea and supports one of the largest fisheries in the world (total Bering Sea pollock landings have ranged from 1.7-4.1 million t from 1988-94; Wespestad, pers. comm.). In addition, it is a very important forage fish for marine mammals, birds, as well as many fish, some of which are themselves commercially exploited. Pollock primarily inhabit waters over the outer continental shelf and slope (down to 500 m), but also live pelagically over deep waters in the central Bering Sea and the Aleutian Basin. As pollock age, they tend to become increasingly demersal. Juvenile pollock (ages 0–2) are more often found in pelagic schools, while older, mature pollock live closer to the bottom. Pollock have high fecundity (millions of eggs per female), have relatively short life spans (most live less than 15 years), and grow and become sexually mature quickly (>50% of L_∞ and sexually mature by ages 3–4) (Wespestad 1994). These life history characteristics can contribute to instability in the population size from year–to–year (which is typical of gadids) and to uncertainties in the ability to predict the size of incoming year–classes and future population sizes.

A. Reproduction and Stocks

Pollock undergo seasonal and diurnal migrations associated with spawning and feeding. While spawning can occur intermittently throughout the year, most spawning in the Bering Sea occurs from late winter through spring (February–June), and varies depending on location. There are at least two major spawning stocks of pollock in the Bering Sea, one on the relatively narrow western shelf off Russia, and a much larger one on and near the wider eastern shelf off Alaska (Figure 1). Spawning usually begins in late February on the southeastern continental slope (the Bogoslof district, NPFMC statistical area 518), and progresses onto the shelf north of Unimak Island. The amount of spawning usually declines and occurs later to the northwest (near the Pribilof Islands and as far north as St. Matthew Island). Pollock on the western shelf usually spawn in April through June. During spawning, pollock aggregate in large assemblages which are particularly susceptible to fisheries which target roe–bearing females (eastern Bering Sea "A" season).

Pollock spawn planktonic eggs (fertilization and development are external) that require approximately 2–3 weeks to hatch. Larvae from the eastern Bering Sea (EBS) shelf spawning aggregation generally drift to the northwest due to the prevailing currents where development progresses. Typically, bottom trawl and hydroacoustic surveys of pollock on the eastern shelf and slope find many more 1–2 year old pollock northwest of the Pribilof Islands than on the southeastern shelf. Furthermore, recent catches of pollock by Russian fisheries on the northern shelf near Cape Navarin and in the Gulf of Anadyr were predominately 2–3 year–old fish from strong EBS year-classes, and not members of strong western Bering Sea cohorts (V. Wespestad, pers. comm.). As pollock become mature in the EBS, they generally return to the southeastern Bering Sea to spawn. Some members of large EBS year-classes apparently remain in the Aleutian Basin.

It is unclear how much the spawning over deep slope waters in the Bogoslof district contributes to recruitment to the eastern Bering Sea shelf population (Wespestad, 1994). Spawning fish in the Bogoslof district are composed of pollock from the Aleutian Basin "stock", which may be primarily density–dependent "overflow" from the eastern shelf population. Since little spawning occurs and very few small pollock are found in the central Aleutian Basin, it is not clear that the Basin stock is self–sustaining. Furthermore, the relationship between the large spawning aggregations in the Bogoslof district and recruitment to the shelf population is not known. It is difficult to imagine, however, that such a large population of pollock existing pelagically in Basin waters and spawning in great numbers near the EBS shelf contributes little if any larval recruits to both itself and the EBS shelf population.

B. Diet

As pollock age and grow, the percentage of their diet composed of planktonic organisms decreases, while proportions of shrimp and fish increase. Larval pollock feed primarily on copepod eggs and nauplii after their yolk reserves have been exhausted, while juveniles prey on larger copepods, euphausiids, and amphipods. Pollock year–class strength may depend to some degree on the availability of planktonic prey during critical periods in the larval phase, particularly shortly after the yolk is depleted. Adult pollock feed on shrimp, euphausiids and various fish, including sand lance, juvenile pollock, capelin and herring. Adults also undergo diurnal movements, probably related to feeding, tending to aggregate near the bottom during the day and rising at night with their prey. Cannibalism by adult pollock may be a significant source of mortality of age–0 pollock in the EBS, and may affect cohort strength (Livingston 1993). Consequently, in the EBS, both density–independent (largely oceanographic and environmental) and density–dependent (size of adult pollock population) factors affect pollock cohort size.

C. Recent Population Dynamics, Fishery Catches and Predictions

Since the late 1970s, the pollock population in the EBS has been dominated by four year– classes spawned in 1978, 1982, 1984 and 1989 (Figure 2). The 1978 year-class was the largest known pollock year-class in the EBS (since the mid 1960s), and was chiefly responsible for the increase in age 3+ (exploitable) EBS pollock biomass from about 6 million t in 1979 to over 14 million t in 1985 (Figure 2). Since 1985, and the passage of the 1978, 1982 and 1984 year-classes through the population, age 3+ EBS pollock biomass declined to between 7–8 million t through 1994. Current (1995) exploitable biomass is projected to be 8.082 million t. The period from 1990-93 was a period of transition for the pollock population, from an older one composed primarily of the 1978, 1982 and 1984 year-classes, to a younger one dominated by the year-class spawned in 1989.

Since 1979, the total catch of pollock from the EBS increased from about 0.9 million t to about 1.3 million t in 1994. During this period, harvest rates (catch divided by exploitable biomass) of EBS pollock were slightly greater than 10% in 1979-80, 10% or less from 1981–1989, and 17% in the early 1990s (Figure 2; Wespestad 1994).

Wespestad (1994) projected age 3+ EBS pollock biomass and catches into the near future (1996–1998). These estimates utilized the age distribution and biomass as assessed for 1995 and age 3 recruitment from both (1) the relationship between age 1 abundance in the annual EBS bottom trawl survey and age 3 cohort size from the population model and (2) the spawner–recruit relationship. Based on his projections, which include a prediction of a relatively large 1992 year-class (observed in the hydroacoustic survey of the shelf in summer 1994), exploitable biomass will either increase or decrease slightly through 1998 depending on the fishing exploitation strategy employed. Fishing at an $F_{0.1}$ rate, age 3+ biomass should increase slightly from 8.082 million t in 1995 to 8.236 million t in 1998, with yields of 1.267, 1.298, and 1.313 million t in 1996–98 respectively. An $F_{0.1}$ strategy was chosen for the 1995 EBS pollock fishery, and the TAC was set at 1.250 million t. If fishing mortality is set using an $F_{35\%}$ rate in 1996–98, exploitable biomass could decrease slightly from 8.082 million t in 1995 to about 7.8 million t in 1998, with annual catches of between 1.4 and 1.5 million t.

Aleutian Basin pollock were harvested in international waters of the central Bering Sea (known as the Donut Hole) from 1984–1992. Pollock that spawn in the Bogoslof district in the southeastern Bering Sea are thought to part of the Aleutian Basin, or central Bering Sea "stock". Catches of Aleutian Basin pollock (Donut Hole plus Bogoslof) increased from 0.2 million t in 1984 to between 1.5–1.7 million t in 1987–89. Between 1989–1991, basin pollock catches declined from over 1 million t to less than 0.6 million t. This declining trend was also evidenced in the annual (since 1988), winter hydroacoustic surveys of the Bogoslof spawning population (the only survey of the basin stock conducted), which declined from 2.4 million t in 1988 to just over 0.5 million t in 1994. Beginning in 1991, the first in a series of international conferences between coastal (U.S. and Russia) and fishing states (China, Japan, Korea and Poland) was held to consider arrangements for the conservation of pollock resources in the central Bering Sea. While some agreements on limiting new effort were reached, no progress was made on reaching an agreement that would severely curtail catches of basin pollock as a stock conservation measure. It was not until mid-1992, after it became clear that the stock had been reduced to "economic extinction" (large reductions in catch–per–unit–effort by vessels from the fishing states) that all parties agreed to a suspension of fishing in the Donut Hole beginning in 1993. The U.S. (NPFMC) had already closed the Bogoslof district to directed pollock fishing beginning in 1992.

II. Pollock Populations and Fisheries (1990-94)

A. Size and Biomass Distribution from Surveys and Fisheries

For the purposes of analyzing survey information in this report, the eastern Bering Sea is divided into three main areas: the CVOA, located south of 56°N latitude, between 163-168°W longitude in the Bering Sea; and two areas outside the CVOA. The area outside of the CVOA was divided east and west of 170°W longitude, or the boundary of management areas 51 and 52. AREA 51 contains all the area outside of the CVOA and the Bogoslof district (518) in management area 51; AREA 52 is the entire area 52. These areas are shown in Figure 3.

1. Survey Information

NMFS conducts two types of surveys in the eastern Bering Sea during the summer months. First, bottom-trawl surveys of the southeastern shelf (to 200 m depth) south of about 61°N latitude (Figure 3) are conducted annually. Second, echo integration-midwater trawl (EIMWT) surveys of the same area are conducted every three years. Information on pollock size distribution from bottom trawl surveys conducted in 1990-94 and EIMWT surveys conducted in 1991 and 1994 were summarized for the southeastern Bering Sea shelf region.

a. Biomass Distribution - Table 1 shows the exploitable (30+ cm) and total pollock biomass from the bottom and EIMWT surveys conducted in 1990-94. The bottom trawl survey data and the 1994 EIMWT data were separated into the three areas shown in Figure 3; the 1991 EIMWT data were separable only into areas east and west of 170°W longitude (west of 170°W is equivalent to AREA 52; east is equivalent to AREA 51 and the CVOA combined). Bottom trawl exploitable pollock biomass ranged from 4.4 million to 7.0 million t in 1990-94, while the range in total biomass was similar (4.5 million to 7.0 million t). EIMWT exploitable biomass increased three-fold from 1991 to 1994 (0.6 to 2.1 million t), while total biomass almost doubled in that time period (1.4 to 2.4 million t).

Figures 4-8 show the distribution of exploitable (30+ cm in length) pollock biomass based on the haul-by-haul catch-per-unit-effort from the bottom trawl surveys of 1990-94. Figure 9 shows the relative fish density along the survey track line of the 1994 EIMWT survey. Exploitable pollock biomass was concentrated in AREA 52 in the 1990 bottom trawl survey. Beginning in 1991, however, both the bottom trawl and EIMWT surveys suggest that exploitable pollock biomass shifted proportionally from AREA 52 to the east and south. The CVOA and AREA 51 combined accounted for only 24% of the exploitable bottom trawl biomass in 1990 (total of 1.7 million t), but their combined fraction increased to between 41-63% in 1991-94 (totals ranging from 1.8-3.2 million t). Similarly, the midwater fraction of the exploitable population also shifted to the south and east, increasing from 15% in 1991 (total of only 0.09 million t) to 24% in 1994 (0.5 million t) in the combined CVOA/AREA 51.

Total and exploitable pollock biomasses were estimated for each year (1990-94) and each area (CVOA, and AREAs 51 and 52 outside of the CVOA) based on the ratios of combined/bottom biomass by area in 1991 and 1994 (Table 2). The 1991 combined/bottom ratios were used to compute midwater fractions in 1990 and 1992, while the 1994 combined/bottom ratios were used to compute midwater fractions in 1993. Separate estimates of the midwater fractions of both pollock biomasses in the CVOA in 1991 were obtained by using the CVOA/AREA 51 ratios for the appropriate pollock fraction from the 1994 EIMWT survey. Using the 1994 areal midwater ratios was thought to be appropriate since the areal bottom ratios in 1991 and 1994 were similar. The percentages of estimated combined survey exploitable biomass in each area were applied to the age 3+ EBS pollock biomass from age-structured modelling (Wespestad 1994), yielding areal estimates of exploitable biomass from 1990-94 (Table 2). These will be compared (in the next section) to estimates of B-season (and annual) pollock catch in each area in 1990-93 to obtain estimates of areal pollock harvest rates.

b. Size Distribution - The bottom trawl survey pollock population by length and area conducted in 1990, 1992 and 1993 are shown in Figure 10, while the combined midwater and bottom survey results for 1991 and 1994 are shown in Figures 11 and 12. Based on the bottom trawl data (Figure 10), the CVOA has had virtually no pollock < 30 cm in the summer, and between 6-17% of the total EBS exploitable pollock (by number). The bottom trawl surveys show a shift in distribution of 30+ cm pollock to the southeast between 1990-1993. The 1991 combined EIMWT-bottom trawl data (Figure 11) show that the juvenile and exploitable pollock populations were distributed similarly in 1991, with about 64% of both in AREA 52, and about 36% of both in combined area 51 and the CVOA. In the 1994 combined results, the shift of the exploitable population to the southeast is evident in the drop to 58% in the fraction located in area 52, while the CVOA and AREA 51 increased to 17% and 25% by number, respectively. Almost all of the juvenile pollock (91%) < 30 cm in length were located in area 52 in 1994.

2. Catch and Size Distribution of Fisheries, 1990-93

a. Catch Distribution and Areal Exploitation Rates- Areas defined in this analysis are shown in Figure 13. These were defined for two reasons. First, statistical reporting area 518, the Bogoslof district, was closed beginning in 1992 to protect the declining stock of Aleutian Basin pollock. This also closed the southwestern portion of the CVOA which had been fished for pollock primarily during the A season (CVOA-518). Consequently, since only the shelf portion of the CVOA (CVOA-SHELF) was open to directed pollock fishing, this area was defined separately. Secondly, pollock northwest of the Pribilof Islands are generally smaller at age and the population composed of younger fish than those on the southeast shelf between the Pribilofs and Unimak Island (including inside the CVOA). Because of this, it would not be appropriate to lump all areas outside of the CVOA for comparison of pollock CPUE and other data with the CVOA. The area outside of the CVOA was divided east and west of 170°W longitude, or the boundary of management areas 51 and 52. AREA 51 contains all the area outside of the CVOA and the Bogoslof district (518) in management area 51; AREA 52 is the entire management area 52.

Table 3 contains estimates of areal pollock catch distribution in the eastern Bering Sea in 1990-94 by sectors and season (A and B-seasons, the latter of which includes CDQ catches). Catch estimates were calculated using both observed catch distribution by sector and area (1990-93) and blend catch estimates by sector and area (1990-94). Because of the CVOA itself could not be identified within the blend data, the observed data were used to apportion the blend data within each season and sector. In 1994, 1993 distributions were used, since the blend proportions within management areas 51 and 52 were similar in both years. In 1990, seasonal pollock catches were assumed to be 40% in A-season and 60% in B-season; inshore:offshore ratios by season were those of 1991. Plots of midwater pollock trawl locations for both processor types during each season are shown in Appendix 1. Only the B-season data and plots will discussed in detail here since the CVOA will only be enforced during the B-season. Areal differences in pollock CPUE will be discussed in a subsequent section.

In 1990, catcher-processors caught 95% of their B-season pollock in area 52. By contrast, catcher boats for inshore processors caught almost 100% of their B-season pollock within the CVOA-SHELF. Catcher boats fished primarily in the center of the CVOA, in the area north of Akutan and Akun islands north and west of Unimak Pass, and along the 200 m isobath. The pattern of B-season pollock fishing in 1991 was similar to 1990, where catcher processors fished primarily in AREA 52 (83% of their catch), while catcher boats fished primarily in the CVOA-SHELF (84% of their catch).

In 1992, the CVOA first became enforced during the B-Season (which began 1 June). Catcher processors continued the pattern they exhibited during the previous two years and caught the vast majority of the B-season pollock in AREA 52 (95%), and the remainder in AREA 51 east of the Pribilof Islands. Similarly, catcher boats continued their pattern of B-season harvest, catching 93% of their pollock within the CVOA-SHELF. Catcher boats fished the same area on the CVOA-SHELF that they had used in 1990 and 1991, basically a Y-shaped area extending northeast on the shelf from Akutan island to north of Unimak island, and northwest along the 200 m isobath. The north-central area and the eastern quarter of the CVOA were not utilized by the inshore catcher boats for midwater pollock fishing. The CVOA did not significantly alter fishing patterns for either sector in 1992 compared to both 1990 and 1991.

In both the 1993 and 1994 B-seasons (which began 15 August each year), catcher-processors fished in much different areas than they had the previous three years. AREA 51 provided about 65% and 46% of the catcher processor's B-season catch in 1993 and 1994, respectively, while AREA 52 (chiefly in the area south of the Pribilof Islands) provided most of the remainder. The areas fished by the offshore sector during the B-seasons may have reflected their desires to avoid the smaller members of the 1989 year-class, which dominated the fishery landings at this time throughout the eastern Bering Sea; smaller individuals of a pollock cohort are generally found north and west of the Pribilof Islands. Consequently, the offshore sector was apparently "squeezed" during the B-season between their expectations of smaller pollock in AREA 52 and the northern and western boundaries of the CVOA. Most of the offshore sector's B-season landings in 1993 came from an area only lightly exploited in previous years, located on the central shelf north of the CVOA (56°N) between 164-166°W (mostly west of the red king crab savings area). Catcher boats fished in the 1993 and 1994 B-seasons in basically the same manner as during the 1990-92 B-seasons, with 98% of their pollock landings coming from the CVOA-SHELF in both years.

The areal catch and exploitable biomass distributions in Table 2C and Table 3 were combined to compute areal B-season harvest rates over the last five years (Table 3). The surveys and B-season fishery have not occurred simultaneously in each of the last five years, which allows for some redistribution of the population and decreases the accuracy of areal harvest rate estimates. However, both the surveys and the B-season fishery occur in summer, permitting some general conclusions to be made. B-season harvest rates vary greatly by area within the southeastern Bering Sea. B-season harvest rates within the CVOA-SHELF have been consistently higher (ranging from 22 to 50% in 1990-94) than in either of the areas outside of the CVOA in AREAs 51 and 52 (ranging from 1 to 14%).

B-season harvest rates of pollock in AREA 52 were lower in 1993-94 than in 1990-92 because the offshore fleet apparently tried to avoid smaller members of the 1989 cohort. B-season removals from AREA 52 declined from a range of 446,000 to 534,000 t in 1990-92, to 115,000 and 157,000 t in 1993 and 1994. Because of this shift, B-season harvest rates and total pollock removals from AREA 51 and the CVOA-SHELF increased. B-season removals from AREA 51 increased from a range of 15,000 to 107,000 t in 1990-92, to 184,000 and 222,000 t in 1993 and 1994. Similarly, B-season removals from the CVOA-SHELF increased from a range of 244,000 to 255,000 t in 1990-92 to 291,000 and 300,000 t in 1993 and 1994.

Because of spawning aggregations in the area, A-season pollock catches have also concentrated within the CVOA-SHELF. This seasonal trend added on to the B-season catch distribution noted above resulted in much greater removals of pollock from east of 170°W (CVOA-SHELF and AREA 51) than from AREA 52 in 1993-94 compared with 1990-92.

b. Size Distribution - Pollock lengths obtained by observers aboard fishing vessels in the eastern Bering Sea were accumulated by year (1990-93), time period (January-April, May-July, and August-December), area (Figure 13), gear (bottom trawl and pelagic trawl), and processor type (catcher/processors and catcher boats for inshore processors). The years were chosen to contrast fishery length-frequencies from two years prior to the establishment of the CVOA (1990-91) with two years with the CVOA in place (1992-93). The time periods were chosen to represent the A-season (January-April) and the various B-seasons, which started at different times in each of the years. In 1990 and 1991, the B-season began on June 1; in 1992, the offshore sector's B-season began on June 1, while the inshore sector voluntary delayed their's until July; in 1993, the B-season for both sectors began on August 15. The 1993 August-December data includes some data collected prior to the B-season, which is why there are length-frequency data collected aboard catcher processors from within the CVOA. Only length data from pollock caught by pelagic trawls were used since this would best represent the directed pollock fishery. Data are summarized in tabular form in Table 4, and are displayed for the January-April period in Figures

14 and 15 for catcher-processors and catcher boats, and for May-July and August-December in Figures 16-19. Only B-season data will be discussed in detail.

In both May-July and August-December 1990 (Figure 16), mean pollock lengths caught by catcher-processors and catcher boats were largest in the CVOA-SHELF (ranging from 48.09 to 51.42 cm), intermediate in AREA 51 (ranging from 44.45 to 46.09 cm), and smallest in AREA 52 (ranging from 39.01 to 41.84 cm). Conversely, the percentage of the measured fish that were less than 30 cm in length was highest in AREA 52, intermediate in AREA 51, and smallest in the CVOA-SHELF. This pattern generally represents the distribution of the pollock population during the 1980s when the domestic fishery developed, and what would be expected with several large old year classes in the population. In 1990, two large year-classes, one spawned in 1982 and the other in 1984, accounted for almost 50% of the catch by numbers of the entire year's fishery (A and B seasons); furthermore, over 70% of the catch by numbers were of pollock aged 6 years and older. This is reflected in the broad peaks in the length-frequency distributions from approximately 40 to 60 cm and the large variances in size.

In May-July 1991 (Figure 17), the size and importance of the 1989 year-class first became apparent in the fishery (modes in the mid-20 cms). However, for the entire year of 1991 (A and B-seasons), almost 80% of the catch in numbers was composed of pollock aged 6 years and older. The fishery targeted on the same sizes that were fished in 1990, but it could not avoid the 1989 year-class in some areas, which lowered the mean length of pollock caught (only in May-July) and increased the percentage < 30 cm. In May-July, both catcher-processors and catcher vessels had larger percentages of pollock < 30 cm in the CVOA-SHELF than in AREA 51 suggesting that the 1989 year-class was in greater abundance on the outer than on the inner shelf at that time. The mean pollock length was similar in the two areas for catcher-processors (47.64 and 47.75 cm in the CVOA-SHELF and AREA 51, respectively), but was larger outside of the CVOA in AREA 51 (48.20 cm) than in the CVOA-SHELF (47.00 cm) for catcher boats. Mean pollock length was smallest and the percentage < 30 cm was greatest in AREA 52 than in either of the other two areas in May-July.

In August-December 1991, both catcher-processors and catcher vessels successfully avoided the 1989 year-class, catching principally aged 6+ individuals. Mean lengths in August-December were greater, and percentages < 30 cm were smaller in each area than in May-July. Catcher-processors had similar mean pollock lengths in the CVOA-SHELF (49.78 cm) and AREA 51 (49.42 cm), but a smaller mean length in AREA 52 (43.91 cm); percentages < 30 cm were greatest in AREA 52 and smallest in the CVOA-SHELF. Catcher-boats did not fish much in AREA 51 during August-December. The mean sizes of pollock they caught in AREA 52 (48.02 cm) was only slightly smaller than in the CVOA-SHELF (49.19 cm), and the percentage < 30 cm was also smaller in AREA 52 (0.87%) than in the CVOA-SHELF (3.69%).

The 1989 year-class became of major importance in 1992 (Figure 18), comprising the principal modal length caught by the fishery in the B-season. The 1989 year-class comprised a third of all pollock caught (by number) during both the A- and B-seasons in 1992. Its importance in the catches was also reflected in a decline in the percentage (to 55%) of the catch composed of pollock age 6+ years.

The Inshore/Offshore Bering Sea/Aleutian Island Fishery Management Plan Amendment 18 became effective in 1992 at the same time that the 1989 year-class began to recruit to the fishery. By coincidence, this provides a "test" of the impact that the CVOA could have on the ability of catcher-processors to locate and catch pollock of marketable size (> 30 cm). In the early B-season, catcher-processors fished only outside of the CVOA for pollock. Mean pollock length was greater in AREA 51 (47.41 cm) than in AREA 52 (40.98 cm), and the percentage < 30 cm was also smaller (2.6% in 51 compared to 10.4% in 52). The average length and percentage < 30 cm in AREA 51 were similar for the same period in 1991, while for AREA 52, the average length was about 1 cm smaller in May-July 1992 than 1991 for catcher-processors.

Because the inshore sector had its own B-season allocation, its members voluntarily chose to postpone the start of their 1992 B-season fishery until later than June 1 because of the large numbers of 1989 year-class pollock located within the CVOA at that time. Some boats fished in July and their pollock catches throughout the three areas had much smaller mean lengths than in May-July 1991. In both the CVOA-SHELF and AREA 51, mean lengths were between 41.5 and 42 cm, and the percentages < 30 cm were higher in AREA 51 (2.5%) than in the CVOA-SHELF (0.6%), both much lower than the same time period in 1991. The mean length was lower (37.64 cm) and the percentage < 30 cm (8.2%) was higher in AREA 52 than either of the two areas to the southeast at this time. In May-July, mean pollock lengths caught by catcher-processors were greater than those caught by catcher boats in both AREAS 51 and 52; percentages < 30 cm were about the same in AREA 51 for both sectors, but catcher-processors had a higher percentage of pollock < 30 cm in AREA 52 than did catcher boats.

The offshore B-season closed on July 28, 1992, while the inshore B-season remained open until September 22. For catcher-processors, pollock measured during August-December were all caught during the Community Development Quota (CDQ) fishery in December. At this time, the 1989 year-class was encountered more frequently in the CVOA-SHELF, resulting in a smaller mean length there (40.61 cm) than in either of the areas outside the CVOA (AREA 51: 47.79 cm; AREA 52: 49.60 cm). Percentages < 30 cm were very small in all areas in December for catcher-processors. Catcher boats fished almost exclusively within the CVOA-SHELF during their late B-season, and had only a slightly larger mean pollock length (41.3 cm) than did catcher-processors, but a similarly low percentage < 30 cm.

In 1993 (Figure 19), the 1989 Year-class dominated pollock catches of all sectors as a single mode centered in the low 40 cms. Catch-at-age analysis revealed that for the year (combined A- and B-seasons), the 1989 year-class comprised almost 60% of the catch (in numbers), while the percentage of age 6+ year-old fish declined to about 20%. The dominance of the 1989 year-class in the catches from May-December is evidenced by the single modes and the low variances compared with all other years.

The 1993 B-season started on August 15 for both sectors, however some catcher-processors participated in the CDQ fishery before this, which is why there is data from the CVOA-SHELF for the offshore sector in both the May-July and August-December periods. In May-July, mean pollock lengths were similar in the CVOA-SHELF and AREAS 51 and 52 (41-42 cm); percentages < 30 cm were 0 in both the CVOA-SHELF and outside the CVOA in AREA 51.

From August-December, catcher-processors and catcher boats had very similar size distributions of pollock in each of the three areas fished. Mean pollock lengths only ranged between 41.92-44.13 cm, and the highest areal percentage < 30 cm was only 0.82%.

3. Conclusions

While the distribution of pollock > 30 cm may change from year to year during the summer, surveys conducted in the last 5 years have shown that commercial-sized pollock are widely distributed throughout the southeastern Bering Sea, both inside and outside of the CVOA. From May-December 1990-93 (Table 4), only in 4 of 58 sector/time/area cells did any sector of the pollock fishing industry have a mean pollock length less than 40 cm. Furthermore, the year when percentages < 30 cm were highest was 1991, when the 1989 year-class was unavoidable by both sectors and prior to the establishment of the CVOA.

Pollock are harvested disproportionately to their areal biomass distribution. Harvest rates in the CVOA during the B-season are much higher than in AREAs 51 and 52. Furthermore, A-season pollock removals are also concentrated in the CVOA. Due to the distribution of the dominant 1989 year-class and the desire of the fleet to avoid smaller members of that cohort, effort shifted from areas west of 170° W to the southeast in 1993-94. If the CVOA had not excluded the offshore fleet during these B-seasons, it is likely that harvest rates and removals from the CVOA would have been greater than they were.

B. Bycatch of Prohibited Species (Surveys and Fishery) and Fishery Pollock CPUE

1. Distribution of Halibut, Red King Crab, and Bairdi Tanner Crab from Surveys

Bottom trawl surveys in 1990-94 have shown that halibut are distributed primarily along the inner and outer shelf regions, with centers of abundance occurring south and east of Nunivak Island, around the Pribilof Islands, and within the CVOA (Figures 20-24). Mean survey catch-per-unit-effort (CPUE) within the CVOA has also been higher than AREAs 51 or 52 in 4 of the last 5 years (all but 1991; Table 5).

Red king crab have declined in abundance recently, necessitating the creation of a red king crab savings area (trawl exclusion zone) in Bristol Bay (see Appendix 1). In the last 5 years, red king crab have been caught in bottom trawl surveys only in Bristol Bay northeast of the CVOA (where the savings area is located) and around the Pribilof Islands (Figures 25-29); there has been little or no catch of red king crab in the CVOA in the bottom trawl surveys of 1990-94

(Table 5). Furthermore, in areas outside of the CVOA, there are large areas in area 52 and 51 where 30+ cm pollock abundance is high and red king crab abudance is low.

Tanner (bairdi) crab are widely distributed in the middle and outer shelf regions of the Bering Sea, with centers of abundance in Bristol Bay to Unimak Island (including the CVOA) and around the Pribilof Islands (Figures 30-34). Survey mean Tanner crab CPUE's have been highest inside the CVOA in each of the last 5 years, second highest in area 51 outside the CVOA, and lowest in area 52 (Table 5). This ranking is due primarily to inclusion of many stations along the inner shelf in both areas 51 and 52 where no Tanner crab were caught, while Tanner crab were caught at almost every station on the outer shelf each year inside the CVOA.

2. Pollock Fishery CPUE and Prohibited Species Bycatch

a. Extension of Nelson/Berger Analysis from Supplementary Analysis of CVOA - In the original environmental assessment of BSAI FMP Amendment 18 (Supplementary Analysis section 4.3.3.2), pollock catch per unit effort and prohibited species bycatch rates of individual vessels fishing in different areas in the same quarter were compared (Nelson/Berger analysis). In this re-analysis of the effects of the CVOA, the Nelson/Berger analysis was extended (with slight modifications) through 1993. Their analysis looked at catch rates of pollock and prohibited species by individual vessels fishing in the same quarter (quarters 1-3) and year (1990 and 1991) both inside and outside the CVOA. In general, average CPUE of pollock was greater outside the CVOA than inside (except for the second quarter in 1990), and bycatch rates of herring and salmon were higher in the CVOA than outside the area. During the first quarter (A-season) of both 1990 and 1991, pollock catch rates were higher outside the CVOA in the Bogoslof district. The Bogoslof district was closed to directed pollock fishing beginning in 1992 (also when the Inshore/Offshore allocations began). There was no trend in the halibut bycatch rates with respect to the area. The Nelson/Berger analysis used data from prior to the establishment of the CVOA and enactment of BSAI FMP Amendment 18.

For 1992 and 1993, data on pollock and prohibited species bycatch of catcher/processors (C/P), motherships (MS) and inshore catcher boats (CB) that fished both inside and outside of the CVOA in the same quarter were compared. Four changes in methodology from the Nelson/Berger analysis were made: (1) individual vessels had at least 10 sampled hauls in each area to be utilized (as compared with 30 in Nelson/Berger), (2) only pelagic trawl data were utilized, (3) additional areas were defined, and (4) data from quarter 1 (A-season) were excluded.

Gear was defined as a classification variable because of the differences in catch rates of pollock and prohibited species between pelagic and bottom trawls (Norris et al. 1991a,b). Once gear was defined, it was found that very few vessels had as many as 30 sampled hauls inside and outside of the CVOA in a given quarter; consequently, the minimum number of sampled hauls was reduced to 10 to increase the number of vessels for the comparison. Areas defined in this analysis are shown in Figure 13.

Only data from July-December (quarters 3 and 4) 1992 and 1993 were included in this analysis. Since offshore processors can use the CVOA during the A season, there was no reason to include this time of year in the analysis. Furthermore, under the alternative considered in this analysis, the inshore processing sector has exclusive use of the CVOA only during the pollock B-season. There were no data available for comparison in quarters 2 of both 1992 and 1993. In 1992, the B-season began June 1, but there were no vessels that fished both inside and outside the CVOA during the second quarter due to the exclusion of the offshore sector from the CVOA and the voluntary delay by the inshore sector of the start of their B-season (until July) due to large numbers of small pollock in the CVOA. In 1992, the offshore sector's B-season closed on July 28, while the inshore sector's B-season remained open until September 22. The 1992 CDQ fishery occurred in December. In 1993, the B-season did not begin until August 15, and lasted until September 22 for the offshore sector and October 3 for the inshore sector. The 1993 CDQ fishery occurred both before and after the B-season.

In 1992, 8 vessels had at least 10 sampled hauls per quarter in areas both inside and outside the CVOA (Table 6). In quarter 3, five inshore catcher boats fished in both the CVOA and in area 51 outside the CVOA. Three of these had equivalent or slightly lower pollock CPUEs in the CVOA than outside, while the remaining two had CPUEs 2-3 times greater inside the CVOA than outside. Salmon bycatch rates were higher inside the CVOA for 3 of the 5 vessels, averaging almost 0.8 salmon per t pollock for one vessel. There was no trend in halibut, crab or herring bycatch rates with respect to location fished. In quarter 4, only 3 catcher/processors fished both inside and outside the CVOA. Since the offshore pollock's B-season closed on July 28, these data are all from the CDQ fishery which took place in December. CPUE was greater inside the CVOA than outside since pollock were probably concentrating on the southeastern shelf in preparation for spawning. There were no clear areal trends with respect to bycatch of prohibited species at this time.

In 1993, 14 vessels had at least 10 sampled hauls per quarter in areas both inside and outside the CVOA (Table 6). From July-September (quarter 3), 8 catcher/processors, 2 motherships and 1 catcher boat fished in both the CVOA and areas outside. The catcher/processors fished in the CVOA prior to the start of the B-season (on August 15) as part of the CDQ fishery. Six of these had higher CPUEs inside the CVOA than outside the CVOA (either or both AREAs 51 and 52), while only two had higher CPUEs outside the CVOA. Similarly, 2 out of the 3 motherships and catcher boats had higher CPUEs inside the CVOA than outside. Generally, pollock CPUE was highest inside the CVOA, second highest in AREA 51 outside the CVOA, and lowest in AREA 52 in quarter 3, 1993. Salmon bycatch rates were higher in the CVOA than outside for 9 of the 11 vessels in quarter 3; in one case, salmon bycatch rates were almost 2 salmon/mt of pollock caught in the CVOA compared with 0.03 salmon/mt of pollock caught in AREA 52. There were no observed trends for herring, halibut or crab bycatch rates with respect to area fished in quarter 3, 1993. In quarter 4, 2 out of the 3 catcher/processors that fished in the CVOA and in Area 52 had greater pollock CPUE inside the CVOA, while all three had higher salmon bycatch rates inside the CVOA. Salmon bycatch rates in quarter 4 were generally lower than those in quarter 3, and there was little or no herring or crab bycatch in quarter 4.

In summary, pollock CPUE using pelagic trawls was generally higher inside the CVOA than outside the CVOA during the 1992 and 1993 B-seasons and CDQ fisheries. The areal trend was stronger in 1993 than in 1992, probably due to movement of the 1989 year-class to the area. Salmon bycatch rates were also higher inside the CVOA than outside, while there were no clear trends in other prohibited species bycatch rates.

b. Norris (1992) Analysis of CPUE and Bycatch Data from 1981-90 Pollock Fisheries - Norris (1992) summarized all pollock fishery observer data collected aboard foreign, joint-venture, and domestic vessels (excluding motherships) from 1981-90 with respect to pollock CPUE and bycatch rates of prohibited species inside and outside of the CVOA. The area inside the CVOA did not include that shared with the Bogoslof district (CVOA-518 in Figure 3), while the area outside the CVOA included the Aleutian Islands district (Area 540) but not statistical areas 512, 514, and 516 where little directed pollock fishing occurs. These data are fleet averages and do not account for differences in vessel capacity, but are separated by gear type (bottom and midwater) based on catch composition. Averages across all years (1981-90) and fisheries (foreign, joint-venture, and domestic) for quarters 2-4 are listed in Table 7. In general, bottom trawl fisheries had higher pollock CPUEs and higher bycatch rates of prohibited species inside the CVOA than outside. Instances where bottom trawl bycatch rates were considerably greater inside than outside the CVOA were: quarter 3, other salmon bycatch rates; quarter 3, herring bycatch rate; quarters 2-4, red king crab and halibut bycatch rates. In quarter 4, herring bycatch rates were higher outside the CVOA than inside, reflecting the offshore migration of herring during the winter.

Midwater pollock fisheries had greater pollock CPUE inside the CVOA only during the second quarter, but were similar to bottom trawl fisheries in that other salmon and herring bycatch rates in quarter 3 were much greater inside than outside the CVOA. Also similar to the bottom trawl pollock fishery, herring bycatch rates were higher outside the CVOA than inside in quarter 4. Average bycatch rates of crabs and halibut by midwater pollock fisheries were too low and variable to note any trend with respect to area.

c. Summaries of Pollock CPUE by Gear, Zone, Processor Type, Season - Table 8 contains summaries of pollock CPUE data collected by observers in 1990-93. Two types of mean CPUE were computed for each gear (pelagic and bottom trawls), zone (see Figure 13), processor type (catcher-processors and catcher boats only), and season (A, B and CDQ): Grand Mean = total pollock caught divided by total hours in each gear, zone, processor type, season cell; and the mean of the individual haul CPUEs in each cell.

In 1990, catcher-processors caught 95% of their B-season pollock in AREA 52, and their pollock CPUE was also higher there than either AREA 51 or the CVOA-SHELF. By contrast, catcher boats for inshore processors caught almost 100% of their B-season pollock within the CVOA-SHELF, where their grand mean midwater trawl CPUE (8.1 t/hr) was about the same as the catcher processors in the same zone (8.7 t/hr). Catcher boats fished primarily in the center of the

CVOA, in the area north of Akutan and Akun islands north and west of Unimak Pass, and along the 200 m isobath.

The pattern of B-season pollock fishing in 1991 was similar to 1990, where catcher processors fished primarily in area 52 (83% of their catch), while catcher boats fished primarily in the CVOA-SHELF (84% of their catch). In the same areas, catcher processors and catcher boats had similar grand mean midwater pollock CPUEs: in area 52, catcher processors had a mean of 14.1 t/hr, while catcher boats had 15.5 t/hr; in CVOA-SHELF, catcher processors had a mean of 4.8 t/hr, while catcher boats had 4.9 t/hr, considerably lower than in 1990.

In 1992, the CVOA first became enforced during the B-Season (which began 1 June). Catcher processors continued the pattern they exhibited during the previous two years and caught the vast majority of the B-season pollock in AREA 52 (95%), and the remainder in AREA 51 east of the Pribilof Islands. Similarly, catcher boats continued their pattern of B-season harvest, catching 93% of their pollock within the CVOA-SHELF. Catcher boats fished the same area on the CVOA-SHELF that they had used in 1990 and 1991, which was basically a Y-shaped area extending northeast on the shelf from Akutan island to north of Unimak Island, and northwest along the 200 m isobath. The north-central area and the eastern quarter of the CVOA were not utilized by inshore catcher boats for midwater pollock fishing. The CVOA did not significantly alter fishing patterns for either sector in 1992 compared to both 1990 and 1991.

Catcher boats fished for pollock in a large number of places in AREA 51, and did not fish to any great degree east of the Pribilof Islands where the catcher processors were. Taken in aggregate, however, catcher boats had a lower grand mean midwater pollock CPUE in AREA 51 (5.4 t/hr) than did catcher processors (8 t/hr), but much better bottom pollock grand mean CPUE (12.1 t/hr compared with 2.3 t/hr). Catcher boat CPUE in the CVOA-SHELF was much higher in 1992 (13.0 t/hr) than in either 1990 (8.1) or 1991 (4.9).

The CVOA was not enforced during the 1992 CDQ-season in December. However, catcher processors had much higher grand mean midwater pollock CPUEs on the CVOA-SHELF (23.3 t/hr) than catcher boats (13.0 t/hr), fishing in identical locations.

In the 1993 B-season (which began 15 August), catcher-processors fished in different areas than in the previous 3 years. AREA 51 provided about 65% of the catcher processor's B-season catch in 1993, while AREA 52 (chiefly in the area south of the Pribilof Islands) provided the remainder (35%). The areas fished by the offshore sector during the B-season reflected their desires to avoid the smaller members of the 1989 year-class, which dominated the fishery landings at this time throughout the eastern Bering Sea; smaller individuals of a pollock cohort are generally found north and west of the Pribilof Islands. Consequently, the offshore sector was "squeezed" during the B-season between the smaller pollock in AREA 52 and the northern and western boundaries of the CVOA. Most of the offshore sector's B-season landings came from an area only lightly exploited in previous years, located on the central shelf north of the CVOA (56°N) between 164-166°W (mostly west of the red king crab savings area). Grand mean midwater pollock CPUE for the offshore sector was slightly higher in AREA 51 (24.3 t/hr) than 52 (20.5 t/hr).

Catcher boats fished in 1993's B-season in basically the same manner as during the 1990-92 B-seasons, with 98% of their pollock landings coming from the CVOA-Shelf, where their mean CPUE was 18.4 t/hr (the highest of the four 1990-1993 B-seasons). Catcher boat mean CPUE's in the two other areas had the same pattern as catcher processors (at a slightly lower level), with area 51 having a slightly higher grand mean midwater CPUE (21.3 t/hr) than area 52 (17.0 t/hr).

3. Summary of CPUE and Bycatch Rates

Both the lack of standardized sampling (as noted by Norris (1992)) and small sample sizes in some time/area/sector cells requires that caution be used in drawing conclusions from the aggregate fishery data presented. However, even with these precautions, some general conclusions can be made regarding pollock CPUE and bycatch rates of prohibited species by the fishery inside and outside of the CVOA from April-December:

a) based on the extension of the Nelson/Berger and Norris (1992) analyses, CPUE for pollock has generally been higher inside the CVOA than outside during quarters 2-4, but there is also considerable temporal/spatial variability in pollock CPUE. Analysis of fleet-wide 1990-93 B-season (mostly quarter 3) averages (catcher-processor and catcher boat), however, suggests that in most years (1990-92), CPUE is greater in AREA 52 than to the southeast during the B-season, but can vary depending on the distribution of a dominant year-class (the 1989 year-class in 1993).

b) bycatch rates of herring and salmon have been higher inside the CVOA than outside, particularly from July-September;

c) bycatch rates of herring have been higher outside the CVOA from October-December;

d) bycatch rates of halibut by bottom trawls have been higher inside the CVOA than outside; and

e) bycatch rates of Tanner and red king crab were either higher or lower inside the CVOA than outside, depending on the fishery data set being analyzed. Recent information on distribution of these two species suggests that red king crab bycatch rates should be lower, and Tanner crab bycatch rates should be higher inside the CVOA than outside in areas frequented by pollock fisheries.

III. Effects of CVOA on Marine Mammals

Natural histories of marine mammals inhabiting the Bering Sea and neighboring North Pacific Ocean waters were summarized in the original analysis for BSAI Amendment 18, and is incorporated in its entirety here by reference. Since that summary was completed, new information has been obtained on some North Pacific pinnipeds (Steller sea lions, harbor seals and northern fur seals) and cetaceans (killer and gray whales) that frequent the CVOA. The population of Steller sea lions, currently listed as threatened under the Endangered Species Act, has continued to decline to the point where they are being considered for reclassification as endangered, while gray whale populations have increased to where they were recently removed from the list of endangered species.

Possible effects of continuation of the CVOA on marine mammals relate primarily to the availability of pollock as a prey item for species which forage in the southeastern Bering Sea, particularly since mortality associated with incidental catches of marine mammals in the groundfish trawl fleet is low. Consequently, could the continuation of the CVOA reduce or increase the availability of pollock to marine mammal foragers through its effect on distribution of fishing effort in the B-season? This question will be addressed after brief summaries of recent information on various pinnipeds and cetaceans that frequent the CVOA.

A. Steller Sea Lions

Steller sea lions were listed as threatened under the Endangered Species Act by emergency rule in April 1990 after a significant (-64%) decline in their population size in Alaska through 1989. Since 1989, their population has continued to decline (another 24%), with most of this decline coming from southwest Alaska (western and central Gulf of Alaska, Bering Sea, and Aleutian Islands). NMFS recently published a status review of the US Steller sea lion population (NMFS 1995) as part of the process of considering a reclassification of their listing to endangered. While a decision on the reclassification has not yet been made, the Steller Sea Lion Recovery Team (appointed by NMFS in 1990 to write a Recovery Plan for the species), after reviewing and discussing (in November 1994) recent data on population trends, stock separation, energetics and diet summarized in the draft status review, recommended that the sea lion stock west of Cape Suckling (about 145°W longitude) be listed as endangered while the stock to the east remain as threatened.

An important proximate cause of the decline appears to be reductions in juvenile (post-weaning) sea lion survival. Causes of this increase in juvenile mortality are not known with certainty. However, the following factors have probably contributed most significantly to the decline (or have not been eliminated as possible contributors): incidental take, shooting, disease, and changes in the prey base. The first two factors contributed to the decline mostly during the 1970s and early 1980s, but little since then. Disease could still be a factor, but would have to be very widespread and chronic. Changes in the prey base have occurred in the last several decades, but sorting out "natural" change from "human-induced" change has been elusive.

Information on Steller sea lions obtained since the preparation of the environmental assessment for Amendments 18/23 was reviewed in the status review, and is summarized here.

1. Diet and Foraging

As a prey item for Steller sea lions, walleye pollock ranked first in importance in 11 of 13 series of studies summarized by NMFS (1995), and second in importance in the remaining two. Other prey consumed off Alaska were Pacific cod, Atka mackerel, salmon, octopus, squid, Pacific herring, capelin, sand lance, flatfishes, and sculpins. Most of the prey are schooling fish, many of which are commercially exploited. Juvenile sea lions tend to eat smaller fish than adults. Consequently, the overlap in the size distribution of their food with commercial fisheries may be less than that of adults.

Sea lion pups (less than 1 year old) are more restricted in their foraging range, both vertically and horizontally than adults. In summer, adult females with pups foraged close to shore (usually < 20 km) and to shallow depths (most < 30 m), while in winter, they ranged much farther (some > 500 km offshore) and dove to greater depths (often > 250 m). Pups by their sixth month (January) were able to range more than 300 km in a trip, but most of their trips offshore were brief (< 1day), and their dives were shallow (<10 m) and short (< 1min) (Merrick and Loughlin 1993).

2. Movements and Distribution

Steller sea lions are found predominately from shore to the edge of the continental shelf, but are not uncommon in waters several thousand meters deep (see Appendix 2 for platform of opportunity sighting data). During the breeding season (summer), adult Steller sea lions (ages 4+) are generally located near shore and near rookeries. Juveniles (1-3 year olds) are less tied to the rookeries during summer, but are often found at nearby haulouts. After the breeding season, sea lions disperse widely, such that rookeries that were populated in the summer may be vacated in winter. In the Bering Sea, sea lions have been most often sighted over shelf waters from Unimak Pass northward and near the Aleutian Islands. On the shelf, there is a clustering of sightings in the southeastern Bering Sea (including the CVOA). It is thought, based on telemetry data and how the population was distributed prior to the decline, that the shelf in the southeastern Bering Sea is an important foraging area for sea lions (which led to the designation of the EBS critical habitat foraging area, discussed below under Management Actions and see Figure 35). The sighting data, however, because it has not been standardized by sighting effort, cannot by itself be used to determine relative importance of certain areas to Steller sea lions.

3. Stock Identification and Population Trends

Recent genetic and other data suggest that there are at least two stocks of Steller sea lions: one located east and south of Cape Suckling, Alaska (located near 60°N, 145°W) and one located to the west. The smaller eastern stock has been either stable or increasing in recent years, while the (formerly) much larger western stock has declined, and continues to decline, significantly. Declines in the western stock were first observed in the late 1970s in the eastern Aleutian Islands (which includes the CVOA) by Braham et al (1980), where the reduction in numbers has been near 80% between 1976-94. Groups of sea lions associated with two areas in the Bering Sea, one located in the Pribilof Islands and the other on Amak/Sea Lion Rock near the Alaskan Peninsula have declined 95% since 1960 and 75% since 1975, respectively.

Population viability analyses (Merrick and York 1994; York and Merrick 1993) using either aggregate counts on rookeries from the Kenai Peninsula to Kiska Island, or individual trends for each of the 26 rookeries in the area, predicted that the western stock will be reduced to very low levels (< 10 animals) within 100 years from the present if the 1985-94 trends persist. Times to extinction were 63 and 95 years, respectively for the aggregate and individual rookery models. If only the less severe 1989-94 trend persists into the future, then neither model type predicted the extinction of the western stock within 100 years. However, the decline is predicted to continue and reach an adult female population of around 3,000 animals in the next 20 years, at which time individual rookeries would disappear. It was principally discussion of these recent modelling results, and recent continued declines in pup counts in the western stock area, that prompted the Recovery Team to recommend a change of listing status for the western stock to endangered.

4. Management Actions Taken by NMFS and NPFMC

The record of specific Steller sea lion conservation management actions taken by NMFS and the NPFMC since the listing includes:

- creation of 3 nautical mile (nm) radius no-entry buffer zones around all sea lion rookeries west of 150° W longitude (April 1990; NMFS);
- prohibition of shooting at or near sea lions and reductions in the number of sea lions that could be killed incidental to commercial fishing (April 1990; NMFS);
- spatial allocations, and conditions on temporal allocations of pollock TAC in the Gulf of Alaska (June 1991; NMFS and NPFMC);
- creation of year-round 10 nm radius trawl fishery exclusion zones around all rookeries west of 150°W longitude, and 20 nm radius trawl fishery exclusion zones around 6 rookeries in the eastern Aleutian Islands during the BSAI pollock A-season (June 1991, January 1992, and January 1993; NMFS and NPFMC);
- publication of a final recovery plan for the species written by the recovery team for NMFS (December 1992; NMFS);
- designation of critical habitat under the ESA in April 1993 (58 FR 17181; NMFS). Specific areas designated as critical habitat were (1) all rookeries and major haulout sites (where greater than 200 sea lions had been counted, but where few pups are present and little breeding takes place), including a) a zone 3,000 feet (914 m) landward and seaward from each site east of 144°W longitude (including those in Alaska, Washington, Oregon and California); and b) a zone 3,000 feet (914 m) landward and 20 nmi (36.5 km) seaward of each site (36 rookeries and 79 haul outs) west of 144°W longitude where the population had declined more precipitously and

where the former center of abundance of the species was located; and 2) three aquatic foraging regions within the core of the species' range (Figure 35). Note the high degree of overlap between the eastern Bering Sea critical habitat foraging area and the CVOA in Figure 35.

The rationale behind each management action was outlined in each Federal Register notice announcing the action and will be summarized here. The shooting prohibition, reduction in incidental take mortality and creation of no-entry zones around rookeries were enacted to limit potential for direct human-related mortality, and had only minor impact on groundfish fisheries in the BSAI and GOA. Spatial (and temporal, to some extent) allocations of pollock TAC in the Gulf of Alaska, and creation of trawl-exclusion zones around rookeries were promulgated after the ESA Section 7 consultation for the 1991 GOA pollock TAC specifications was written. In that document, NMFS reviewed and presented data which showed that 1) pollock is a major component of the sea lion diet; 2) sea lions collected near Kodiak Island in the 1980s weighed less, had smaller girths, and had thinner blubber layers than sea lions from the same area collected in the 1970s; and 3) the pollock fishery had become increasingly concentrated in time and in areas thought to be important to sea lions. NMFS concluded that the spatial and temporal compression of the pollock fishery that occurred during the 1980s in both the GOA and BSAI could have created localized depletions of Steller sea lion prey, which in turn could have contributed to or exacerbated the decline of the sea lion population (5 June 1991). Much of the area in which the pollock (and other groundfish trawl fisheries, principally Atka mackerel and Pacific cod) fisheries had become spatially compressed was designated as critical habitat for Steller sea lions (Fritz 1993a;b;c). Estimated removals of pollock from Steller sea lion critical habitat in the BSAI region have increased from between 250,000 and 300,000 t in 1981-1986 (between 20-30% of total BSAI pollock landings) to between 410,000 and 680,000 t in 1987-93 (between 35-53% of total BSAI pollock landings; Figure 36). Much of this increase in pollock landings from critical habitat came from the EBS foraging area, which overlaps considerably with the CVOA.

B. Pacific Harbor Seals

Harbor seals are found in all coastal areas of the Gulf of Alaska and are widely distributed in nearshore habitats of the Bering Sea (Pitcher 1980a; Calkins 1986; Frost and Lowry 1986; see Appendix 2 for platform of opportunity sightings). Individuals are occasionally observed as far as 100 km offshore (Pitcher 1980a). Only limited information is available on the diet of harbor seals in Alaska. Pitcher (1980a; b) reported that the harbor seal diet in the GOA was composed of at least 27 species of fish, as well as cephalopods (both octopi and squids) and shrimp in 269 stomachs analyzed. The seven principal prey were (in order of frequency of occurrence): pollock (21 %), octopus (17 %), capelin (9 %), herring (6 %), Pacific cod (6 %), flatfishes (5 %), and eulachon (5 %). There were some significant regional differences in the harbor seal diet in the Gulf of Alaska. Octopus, capelin, and cod were more important components of the diet in the Kodiak area, while pollock was the principal prey in Prince William Sound. Harbor seal food habits data from the Bering Sea (16 stomachs analyzed by Lowry et al. (1986) from animals collected in Bristol Bay) are much less extensive than for the Gulf of Alaska. Herring and capelin were the principal components of the diet of harbor seals in Bristol Bay.

Little information is available on the size composition of fish in the diet of harbor seals compared with Steller sea lions and northern fur seals. What information is available suggests that harbor seals consume smaller fish than Steller sea lions. Pitcher (1981) found that harbor seals collected from the same area and during the same period as Steller sea lions consumed smaller pollock (mean length of pollock ingested by harbor seals = 19.2 cm; for Steller sea lions, 29.8 cm). This suggests a low overlap in body size between pollock harvested by the fishery and those ingested by harbor seals.

The status of Pacific harbor seals in Alaska is currently in review. Based on the results of a four-year project to obtain a minimum population estimate for harbor seals in Alaska and other data (e.g. Pitcher 1990), it was clear that harbor seal populations in various areas in Alaska and the North Pacific had vastly different recent trends in abundance. The central and western Gulf of Alaska stock may have decreased recently by as much as 90% (Pitcher 1990), while populations in other portions of the range may be more stable (Bering Sea, southeast Alaska) or increasing (British Columbia; Olesiak et al. 1990). Reasons for the decline in harbor seals in the central and western Gulf of Alaska are not known.

The Bering Sea stock of harbor seals was surveyed in 1991 (Bristol Bay and the northern side of the Alaskan Peninsula) and 1994 (the Aleutian Islands). The total mean count for 1991 survey was 9,324 seals, with 797 from Bristol Bay and 8,527 from the north side of the Alaskan peninsula (Loughlin 1992). The sum of the mean counts from the 1994 Aleutian survey was 2,056 (NMFS unpublished), yielding a total mean count for all three areas of 11,380. If a correction factor (=1.7, to account for seals not hauled out during the survey) is applied to the count, then the estimated abundance of harbor seals in the Bering sea/Aleutian Islands is 19,346. The population in the Bering Sea is thought to be stable since the late 1960s (Loughlin 1992). Locations within the CVOA that harbor seals were sighted during the 1994 Aleutian survey are shown in Figure 37.

C. Northern Fur Seals

The northern fur seal is a migratory species, returning to the Bering Sea (both of the Pribilof Islands and Bogoslof Island) in summer to breed. Throughout the remainder of the year, fur seals are distributed pelagically throughout the north Pacific Ocean (see Appendix 2 for platform of opportunity sighting data). The CVOA encompasses important foraging and transit zones of fur seals of all ages from May-December, but particularly for pregnant and lactating females, juveniles, and departing adult males during August and September.

The most recent estimate for the number of northern fur seals in the North Pacific Ocean is approximately 1,000,000, down approximately 20% from the 1.25 million estimated in 1974. It is thought that much of this decline occurred in the late 1970s, and that the population has been stable at about 1 million since 1980. Northern fur seals are listed as depleted under the MMPA because the population has declined to less than 50% of the estimated size in the 1950s. The current population of northern fur seals on St. George Island (closest to the the CVOA) is decreasing, while the larger St. Paul Island population has been stable since 1984. Entanglement in marine debris associated with commercial fishing may be a significant factor in mortality for northern fur seals (Fowler 1985; Fowler et al 1994). Entanglement monitoring programs conducted on the Pribilof Islands throughout the 1980s and 1990s have found that trawl netting is a significant component of entanglement debris found on northern fur seals (Fowler et al. 1994). While harvests of females and entanglement in fishing gear may have contributed to the decline in the size of the population since the 1950s, there is also evidence that the carrying capacity (K) of the North Pacific ocean and Bering Sea for fur seals has also changed substantially in that period (NMFS 1993).

The diet of the northern fur seal in the Gulf of Alaska and the Bering Sea has been studied at least since the mid-1950s and has been summarized by Kajimura (1984) and Perez and Bigg (1986). In the Gulf of Alaska, data exist for the months of February-July, and indicate a varied diet composed primarily of herring, Pacific sand lance, capelin, squid, and pollock. In the Bering Sea, data exist for the months of June-October, and also reveal a varied diet of small schooling fish and squid. Pollock composed a larger percentage of the diet in the Bering Sea (35 % of diet volume) than in the Gulf of Alaska (5 %) and Atka mackerel comprised between 10-20 % of the diet in the Bering Sea during June. Foraging occurs to depths up to 200 m over both shelf and pelagic waters (Kajimura 1984; Gentry et al. 1986; Loughlin et al 1987; Goebel et al. 1991).

The data for northern fur seals, although obtained primarily from females ≥ 3 years of age, suggest that they eat smaller fish than Steller sea lions. Perez and Bigg (1986) reported that fur seals collected in the north Pacific Ocean ate primarily 1-2 year-old pollock (total range of 4-40 cm; n = 1,721 pollock from 71 stomachs). The largest fish consumed by northern fur seals reported by Perez and Bigg (1986) (n > 3,000 fish) was a 41 cm salmon. Pollock and Atka mackerel fisheries primarily target fish larger than 30 cm and 35 cm, respectively (Hollowed et al., 1991; Lowe 1991; Wespested and Dawson 1991). Consequently, the overlap between fisheries takes and the preferred fish sizes of northern fur seals is low, a conclusion also reached by Swartzman and Haar (1983).

D. Killer Whales

One of the most obvious direct marine mammal/fishery interactions in the Bering Sea is between longline fishing vessels (particularly those targeting on sablefish or Greenland turbot) and killer whales. While the proposal to continue the CVOA and BSAI FMP Amendment 18 does not deal with longline vessels, it should be noted that the area where interactions are most frequent is a triangular-shaped area from Unimak Pass to the Pribilof Islands to Seguam Pass, much of which also overlaps with the CVOA (Yano and Dahlheim, in prep.) The shelf edge from Unimak Pass to the Pribilof Islands also has a preponderance of the killer whale sightings in the platform of opportunity sighting data, particularly in May-December (Appendix 2). Interactions between killer whales and trawlers have not been as frequent as with longliners in the area. Killer whale populations off Alaska are thought to be stable, and they probably number in the many hundreds of animals, not in the many thousands. This estimate is based on sighting information and surveys conducted in the 1980s, and replicate surveys conducted in 1992 and 1993 by NMFS.

E. Gray Whales

Gray whales migrate through Unimak Pass during both their spring and fall migrations into and out of the Bering Sea, passing through, but not remaining within the CVOA. During the pollock B-season, much of the gray whale population is in the northern part of the Bering Sea. Gray whales have recovered to the point where they were removed from the endangered species list, and may be as numerous now as they have ever been (around 23,000 animals). There is no known recent fishery-induced mortality due to incidental take or entanglement.

F. Pollock as Prey, Fishery Exploitation Rates in the Bering Sea (1990-94) and Impacts of the CVOA

Juvenile pollock are an important prey for a wide variety of marine piscivores, including many groundfish species, marine mammals, and seabirds. Some of this information was summarized in the analysis of BSAI and GOA FMP Amendments 18 and 23, and will not be reviewed in detail here. However, recent summaries of groundfish and pinniped food habits were written by Livingston (1993) and Perez and McAlister (1993). Based on data collected in 1985, Livingston (1993) estimated that marine fish (principally pollock) were the primary source of pollock removals, eating 3.9 million t of principally age–0 pollock, or about 39% of total pollock biomass. In her analysis, the fishery was the second largest pollock predator (1.2 million t, principally age 3+; about 12%), followed by marine birds (0.3 million t, principally age–0, about 3%) and marine mammals (0.3 million t, ages 1+, about 3%). As noted, each "predator" tended to remove a particular size group of pollock, with removals of 0-1 year old pollock dominating (both in terms of numbers and biomass). Fishery removals of pollock were four times higher than removals by either marine mammals or marine birds. There was considerable annual variability in rates of cannibalism by pollock, which reflected, to some degree, the relative sizes of pollock cohorts at age–0.

Perez and McAlister (1993) estimated the average percent of biomass of fish consumed annually by marine mammals and fisheries in the eastern Bering Sea using data collected throughout the late 1970s and 1980s. Their estimate of annual marine mammal consumption of commercial fish species was 0.4 million t, which represented about 2% of the biomass of all commercial groundfish species; pollock is the principal component of both values. These estimates are similar to those calculated by Livingston (1993). Perez and McAlister (1993) estimated annual removals of commercial groundfish at approximately 1.8 million t, which represented about 4% of the biomass of all fish species and 7% of all commercial groundfish species. Their estimate of fishery groundfish removals was also about 4 times higher than marine mammal groundfish removals.

The pollock and fish "budgets" estimated by Livingston (1993) and Perez and McAlister for the eastern Bering Sea as a whole put in perspective removals by various components of the ecosystem. However, what is not discussed in either is the spatial and temporal distribution of those removals by each component. For instance, the fishery is probably more concentrated (in both space and time) than other pollock predators, particularly groundfish. Competitors which are more limited in their foraging ranges (marine mammals and birds) than either the fishery or groundfish could be disadvantaged by the timing, location and magnitude of the fishery removals despite the fact that on a system-wide, annual basis, fishery removals may constitute about 10% of the available pollock biomass. Furthermore, pollock removals by the fishery are just that, removals of carbon from the marine ecosystem of the Bering Sea. By contrast, pollock "removals" by groundfish are not carbon losses to the Bering Sea, but transfers to other species some of which are themselves prey for other upper trophic level predators, such as marine mammals and commercially exploited groundfish species (e.g., Pacific cod, various flatfish).

While exploitation rates of pollock ≥ 30 cm in length have been between 8-17% for the last 5 years for the eastern Bering Sea as a whole, Table 3 shows that areas to the east of 170°W have had greater harvest rates than areas to the west, and that removals have increasingly come from the east in 1993-94. Much of this area was designated as critical habitat for the Steller sea lion (Figure 35). While the relationship between fishery removals of pollock and sea lion population size or trend is unclear (Loughlin and Merrick 1989; Ferrero and Fritz 1994), spatial concentration of pollock removals in the Bering Sea is contrary to the objectives of the management philosophy utilized for the pollock fishery in the Gulf of Alaska and outlined in the ESA Section 7 consultation on the 1991 GOA fishery. In that document, NMFS concluded that spatial-temporal concentration of pollock removals by the fishery could have contributed to the sea lion decline by creating localized depletions of prey. It is not known whether either the GOA or Bering Sea pollock fisheries actually created localized depletions of sea lion prey, nor how long they lasted. However, it can be assumed that localized depletions of commercially-sized pollock are created by the fishery, since one of the principal objectives of the CVOA was to prevent the offshore fleet from removing pollock from the waters adjacent to Dutch Harbor and Akutan early in the B-season and then moving to areas north and west of the Pribilof Islands. In this manner, pollock populations in the only areas accessible to the inshore fleet could be reduced to low levels, which could preclude the inshore sector from achieving its assigned quota share. Since the fishery acknowledged that it localized depletions of commercial-sized pollock could be created, the fact that they occur is not necessarily at issue. What is still uncertain, however, is the duration and extent of localized depletions of prey and what effects they have on the ability of sea lions (and other marine mammals) to find food. As was shown above in discussing pollock catch and biomass distributions, the establishment of the CVOA in 1992 probably prevented the B-season pollock fisheries in 1993-94 from being more spatially concentrated than they were. In this sense only, the CVOA (and the Inshore/Offshore allocation scheme) may not be disadvantageous to sea lions.

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Table 1. Total and exploitable (30+ cm) pollock biomass (t) by area from the 1990-94 bottom and echo-integration midwater trawl (EIMWT) surveys, bottom trawl survey standard area only. 1991 EIMWT biomasses for AREA 51 (in bold and underlined) include the CVOA (Catcher Vessel Operational Area). In all other surveys, biomasses for the three areas in Figure 3 are separate.

		Exploitable (30+ cm)				Total			
Year	AREA	Bottom	EIMWT	Combined	Percent	Bottom	EIMWT	Combined	Percent
1990	CVOA	719,319			10%	719,535			10%
	51	1,000,364			14%	1,006,996			14%
	52	5,301,877			76%	5,349,852			76%
	TOTAL	7,021,560				7,076,383			
1991	CVOA	863,725		863,725	16%	864,222		864,222	13%
	51	1,580,837	**<u>94,516</u>**	1,675,353	31%	1,594,838	**<u>473,474</u>**	2,068,312	32%
	52	2,419,405	532,062	2,951,467	54%	2,537,932	980,179	3,518,110	55%
	TOTAL	4,863,967	626,578	5,490,545		4,996,992	1,453,653	6,450,645	
1992	CVOA	304,372			7%	304,588			7%
	51	1,497,105			34%	1,505,715			34%
	52	2,621,765			59%	2,674,717			60%
	TOTAL	4,423,242				4,485,020			
1993	CVOA	866,955			15%	866,959			15%
	51	2,330,343			41%	2,365,175			41%
	52	2,443,531			43%	2,471,040			43%
	TOTAL	5,640,829				5,703,174			
1994	CVOA	1,064,040	246,307	1,310,347	19%	1,064,062	246,603	1,310,665	18%
	51	2,031,291	257,708	2,288,999	33%	2,047,588	263,215	2,310,803	31%
	52	1,847,596	1,572,044	3,419,640	49%	1,900,316	1,915,080	3,815,396	51%
	EBS	4,942,927	2,076,059	7,018,986		5,011,965	2,424,898	7,436,863	

Table 2. Estimated total and exploitable (30+ cm) pollock biomass (t) by area based on the 1990-94 bottom and echo-integration midwater trawl (EIMWT) surveys (bottom trawl standard survey area only. See Figure 3 for areas (CVOA=Catcher Vessel Operational Area). In years when combined surveys were not conducted, the ratio of combined/bottom total or exploitable biomass from an adjacent year was used (1991 ratio used in 1990 and 1992; 1994 ratio used in 1993). To estimate separate CVOA and AREA 51 area biomasses in 1991 in EIMWT survey, the ratio of CVOA/AREA 51 from the 1994 EIMWT survey was used.

A. Estimated Total Pollock Population by Area

	Tons				Percent		
Year	AREA 51	AREA 52	CVOA	TOTAL	AREA 51	AREA 52	CVOA
1990	1,161,344	7,416,027	910,216	9,487,587	12%	78%	10%
1991	1,839,289	3,518,110	1,093,245	6,450,645	29%	55%	17%
1992	1,736,505	3,707,724	385,305	5,829,535	30%	64%	7%
1993	2,669,215	4,961,279	1,067,882	8,698,376	31%	57%	12%
1994	2,310,803	3,815,396	1,310,665	7,436,863	31%	51%	18%

B. Estimated Exploitable Pollock Population by Area

	Tons				Percent		
Year	AREA 51	AREA 52	CVOA	TOTAL	AREA 51	AREA 52	CVOA
1990	1,030,946	6,467,835	757,786	8,256,567	12%	78%	9%
1991	1,629,164	2,951,467	909,914	5,490,545	30%	54%	17%
1992	1,542,872	3,198,328	320,649	5,061,849	30%	63%	6%
1993	2,625,991	4,522,632	1,067,640	8,216,263	32%	55%	13%
1994	2,288,999	3,419,640	1,310,347	7,018,986	33%	49%	19%

C. Application of Areal Exploitable Percentages to Model Estimates of EBS 3+ Biomass

	Tons			
Year	AREA 51	AREA 52	CVOA	TOTAL*
1990	1,145,250	7,184,946	841,804	9,172,000
1991	2,028,983	3,675,797	1,133,220	6,838,000
1992	2,459,159	5,097,764	511,077	8,068,000
1993	2,445,328	4,211,483	994,189	7,651,000
1994	2,227,694	3,328,053	1,275,253	6,831,000

* from Wespestad (1994)

Table 3. Distribution of pollock catch (A-season and B-season; latter includes Community Development Quota (CDQ) fishery in 1992-94) and summer pollock biomass by area (Table 2C). Harvest rate is Catch/Biomass multiplied by 100. Catch and biomass are both in tons. See Figure 13 for area definitions. CVOA=Catcher Vessel Operational Area.

			A-Season			B-Season		Annual	Summer Exploitable	Harvest Rate
Year	Zone	Offshore	Onshore	Total	Offshore	Onshore	Total	Catch	Biomass	B-Season
1990	CVOA-518	2,846	4,359	7,205				7,205		
	CVOA-SHELF	71,389	89,510	160,899	21,517	222,931	244,448	405,347	841,804	29.0%
	AREA 518	141,533	12,554	154,087				154,087		
	AREA 51	154,791	22,675	177,467	26,851	3,147	29,998	207,465	1,145,250	2.6%
	AREA 52	38,928	214	39,142	533,536	218	533,753	572,896	7,184,946	7.4%
1991	CVOA-518	7,072	12	7,084				7,084		
	CVOA-SHELF	112,978	136,202	249,180	22,605	221,214	243,819	492,999	1,133,220	21.5%
	AREA 518	322,325	4,976	327,302				327,302		
	AREA 51	9,175	1,232	10,407	83,526	23,549	107,075	117,482	2,028,983	5.3%
	AREA 52	1,358	0	1,358	523,596	5,045	528,641	529,999	3,675,797	14.4%
1992	CVOA-SHELF	117,949	123,971	241,920	10,923	243,859	254,783	496,703	511,077	49.9%
	AREA 51	169,237	2,366	171,603	5,076	9,635	14,710	186,313	2,459,159	0.6%
	AREA 52	99,287	79	99,366	437,494	8,164	445,658	545,024	5,097,764	8.7%
1993	CVOA-SHELF	77,937	170,296	248,233	67,645	231,873	299,518	547,750	994,189	30.1%
	AREA 51	169,005	6,838	175,843	218,802	3,067	221,869	397,713	2,445,328	9.1%
	AREA 52	86,267	221	86,488	114,404	1,040	115,444	201,932	4,211,483	2.7%
1994	CVOA-SHELF	109,808	172,512	282,320	55,878	234,747	290,624	572,945	1,275,253	22.8%
	AREA 51	238,119	6,927	245,046	180,739	3,105	183,845	428,890	2,227,694	8.3%
	AREA 52	3,376	57	3,433	157,165	25	157,190	160,623	3,328,053	4.7%

Table 4. The size distribution of pollock caught by three fishery sectors using pelagic trawls in three time periods in 1990-93. CVOA=Catcher Vessel Operational Area. Mean length in cm. C/P=catcher/processors; MS=motherships; CB=catcher boats. See Figure 13 for area definitions. N=Number of pollock measured.

			A. January-April				B. May-July				C. August-December			
Sector	Year	Area	Mean Length	N	Variance	% < 30 cm	Mean Lengt	N	Variance	% < 30 cm	Mean Length	N	Variance	% < 30 cm
C/P	90	CVOA-518	49.39	2,820	7.02	0.00								
		CVOA-SHELF	45.42	21,696	22.30	0.09	49.29	1,232	26.85	0.00	49.58	16,735	34.35	1.90
		AREA 518	49.42	89,612	8.47	0.00								
		AREA 51	44.63	52,885	30.84	0.15	46.08	13,744	34.26	0.75	46.09	3,980	41.33	3.84
		AREA 52	43.57	11,951	32.73	0.37	41.81	141,679	53.97	6.74	40.89	173,906	47.60	6.84
	91	CVOA-518	49.89	1,875	11.43	0.16								
		CVOA-SHELF	46.61	41,481	32.06	1.52	47.64	15,545	101.01	11.51	49.78	16,856	41.70	1.75
		Area 518	49.90	130,629	12.92	0.01								
		AREA 51	44.20	1,393	84.54	11.41	47.75	44,823	38.92	3.19	49.42	6,572	39.86	2.86
		AREA 52	37.22	787	80.55	19.44	42.94	165,093	88.05	14.57	43.91	96,992	62.49	8.08
	92	CVOA-SHELF	46.83	40,545	71.22	3.67	36.21	131	5.90		40.61	30,391	15.52	0.00
		AREA 51	48.81	47,747	66.12	1.28	47.41	12,876	72.73	2.58	47.79	1,502	70.68	0.20
		AREA 52	47.92	36,799	56.05	0.50	40.98	152,647	87.12	10.35	49.60	8,247	79.14	0.35
	93	CVOA-SHELF	42.14	22,395	33.73	0.11	41.93	3,816	13.43	0.00	43.34	28,408	13.64	0.07
		AREA 51	47.54	51,309	43.23	0.06	41.06	3,335	9.30	0.00	43.60	80,099	11.92	0.08
		AREA 52	43.22	22,125	60.18	0.61	42.12	924	31.38	3.25	42.68	50,405	16.58	0.82
MS	90	CVOA-518	48.97	332	7.53	0.00								
		CVOA-SHELF	45.74	341	23.76	0.00	48.86	332	21.59	0.00	51.42	5,363	16.16	0.21
		AREA 518	50.04	22,497	9.34	0.00								
		AREA 51	46.32	4,744	33.73	0.04	44.84	684	16.50	0.29				
		AREA 52					41.84	14,667	40.39	5.08	39.01	20,145	43.41	6.90
	91	CVOA-SHELF	47.32	18,219	33.58	2.27								
		AREA 518	49.81	5,439	9.58	0.00								
		AREA 51	46.53	165	15.91	0.00	47.47	2,724	29.47	2.75				
		AREA 52	51.64	193	25.19	0.00	44.30	6,604	49.60	4.42	43.24	3,506	56.91	6.96
	92	CVOA-SHELF	41.35	16,465	93.64	8.24					45.07	3,252	54.71	0.00
		AREA 51	49.67	4,501	49.02	1.47								
		AREA 52	45.53	768	44.42	0.78	37.64	28,721	69.80	14.16				
	93	CVOA-SHELF	41.41	10,269	33.74	0.03					42.97	18,064	7.39	0.00
		AREA 51	46.42	2,162	33.56	0.09					43.55	3,722	9.75	0.11
		AREA 52	45.77	450	65.55	0.00					42.09	2,803	20.00	2.18
CB	90	CVOA-518	49.71	765	6.30	0.00								
		CVOA-SHELF	44.52	21,004	23.07	0.21	48.09	51,319	26.66	0.40	50.00	50,452	29.50	1.23
		AREA 518	49.11	2,509	6.38	0.00								
		AREA 51	45.63	4,915	39.33	0.43	44.45	1,837	36.63	3.27	51.60	47	7.68	0.00
	91	CVOA-518					51.58	152	28.23					
		CVOA-SHELF	45.81	48,637	20.61	0.50	47.00	78,018	77.94	10.36	49.19	60,919	63.26	3.69
		AREA 518	48.92	1,976	11.04	0.00	50.46	114	18.50					
		AREA 51					48.20	15,472	49.16	4.56	41.77	240	72.06	10.00
		AREA 52					41.52	2,186	121.13	27.72	48.02	3,350	29.51	0.87
	92	CVOA-SHELF	48.97	99,855	35.84	0.64	41.58	39,121	56.15	0.59	41.30	115,343	40.56	0.29
		AREA 51	46.94	1,670	63.08	0.54	42.03	12,322	63.82	2.50	40.05	157	21.81	0.00
		AREA 52					37.64	4,485	37.81	8.21				
	93	CVOA-SHELF	43.59	87,698	40.06	0.09	44.20	46	12.96		44.13	95,632	15.06	0.00
		AREA 51	47.66	3,681	26.42	0.00					43.47	1,881	8.15	0.00
		AREA 52									41.92	1,408	9.53	0.00

Table 5. Average catch per unit effort (CPUE=kg per km-squared) of Pacific halibut, red king crab, and bairdi Tanner crab in the CVOA and outside the CVOA in AREAs 51 and 52 (see Figure 3) from the 1990-94 summer bottom trawl surveys. See Figures 20 to 34 for station locations and haul-by-haul CPUEs. CVOA = Catcher Vessel Operational Area.

Year	Area	Halibut	Red King Crab	Bairdi Tanner Crab
1990	AREA 51	1.88	2.22	4.44
	AREA 52	1.60	0.93	3.45
	CVOA	3.91	0.13	10.29
1991	AREA 51	2.80	3.10	3.33
	AREA 52	1.29	0.79	2.62
	CVOA	2.11	0.00	17.24
1992	AREA 51	2.22	1.55	2.82
	AREA 52	1.47	0.46	1.91
	CVOA	5.34	0.01	13.73
1993	AREA 51	3.96	1.99	2.06
	AREA 52	2.36	1.34	0.72
	CVOA	4.58	0.00	4.89
1994	AREA 51	3.65	1.34	1.57
	AREA 52	3.04	0.95	0.75
	CVOA	5.53	0.00	2.55

Table 6. Comparisons of pollock catch per unit effort (CPUE=t/hour trawled) and prohibited species bycatch rates of individual vessels that fished for pollock both within and outside of the Catcher Vessel Operational Area (CVOA) in the same quarter (QTR=3 and 4, 1992-93). Only data from vessels with at least 10 sampled hauls in each area and quarter were utilized. Only pelagic trawl data are shown. See Figure 13 for area definitions. CB = Catcher Boats; C/P=Catcher/Processors; MS=Motherships. Bycatch rates are based on tons of pollock caught.

1992

QTR=3	VESSEL	AREA	POLLOCK TONS	HOURS	CPUE	HALIBUT KG/TON	HERRING KG/TON	SALMON #/TON	KING CRAB #/TON	TANNER CRAB #/TON
CB	1	CVOA-SHELF	325.2	125.0	2.60	0.0277	0.0000	0.0246	0.0000	0.0000
		AREA 51	351.8	98.5	3.57	0.0227	0.0000	0.0284	0.0000	0.0000
	2	CVOA-SHELF	3,643.4	233.7	15.59	0.0000	1.5557	0.7828	0.0000	0.0011
		AREA 51	265.6	36.7	7.24	0.0000	0.1242	0.1130	0.0000	0.0000
	3	CVOA-SHELF	3,646.3	548.6	6.65	0.0247	2.1586	0.0233	0.0000	0.0000
		AREA 51	337.5	157.5	2.14	0.2104	0.0000	0.0800	0.0000	0.0000
	4	CVOA-SHELF	167.9	110.0	1.53	0.0000	0.0000	0.1072	0.0000	0.0000
		AREA 51	238.3	114.9	2.07	0.0000	18.3385	0.0294	0.0000	0.0000
	5	CVOA-SHELF	547.0	150.9	3.63	0.1481	0.3821	0.1609	0.0000	0.0000
		AREA 51	377.6	101.2	3.73	0.0132	18.2356	0.0318	0.0000	0.0000
QTR=4										
C/P	1	CVOA-SHELF	2,965.7	180.3	16.45	0.0199	0.0000	0.0020	0.0000	0.0000
		AREA 52	558.1	55.8	10.00	0.0000	0.0000	0.0000	0.0000	0.6630
	2	CVOA-SHELF	1,106.7	102.1	10.84	0.0000	0.0000	0.0000	0.0000	0.0000
		AREA 52	271.2	35.1	7.73	0.0000	0.0000	0.0000	0.0000	0.0000
	3	CVOA-SHELF	441.4	19.5	22.64	1.3253	0.0000	0.0000	0.0000	1.7331
		AREA 51	289.8	26.3	11.04	1.7011	0.0000	0.0000	0.0000	0.0000
		AREA 52	1,570.8	103.8	15.14	1.2453	0.0000	0.0000	0.0000	0.0000

Table 6 (continued).

1993

QTR=3	VESSEL	AREA	POLLOCK TONS	HOURS	CPUE	HALIBUT KG/TON	HERRING KG/TON	SALMON #/TON	KING CRAB #/TON	TANNER CRAB #/TON
C/P	1	CVOA-SHELF	2,834.3	184.3	15.38	0.0000	5.0182	0.7737	0.0000	0.0000
		AREA 51	2,609.1	178.3	14.64	0.0119	0.1506	0.5220	0.0000	0.0000
		AREA 52	1,122.9	89.6	12.53	0.0080	0.0053	0.1808	0.0000	0.0000
	2	CVOA-SHELF	3,999.3	127.9	31.26	0.0650	0.0940	0.6851	0.0000	0.0000
		AREA 51	6,664.3	230.6	28.90	0.0368	0.2185	0.1510	0.0000	0.0000
		AREA 52	3,550.3	119.8	29.63	0.0724	0.0006	0.0245	0.0000	0.0003
	3	CVOA-SHELF	1,494.7	37.2	40.22	0.0000	0.1238	0.5192	0.0000	0.0000
		AREA 51	5,071.0	184.1	27.55	0.0148	0.0302	0.2662	0.0000	0.0000
		AREA 52	3,104.5	107.7	28.81	0.0158	0.0055	0.0177	0.0000	0.0000
	4	CVOA-SHELF	1,290.9	113.8	11.34	0.0302	0.1046	0.4199	0.0000	0.0000
		AREA 51	3,542.6	278.1	12.74	0.0000	0.2896	0.1609	0.0000	0.0000
		AREA 52	883.8	100.7	8.77	0.0362	0.0091	0.3711	0.0000	0.0011
	5	CVOA-SHELF	1,974.1	92.5	21.35	0.0000	1.2907	0.0431	0.0000	0.0000
		AREA 51	7,728.2	239.9	32.21	0.0128	0.0163	0.3428	0.0000	0.0000
		AREA 52	2,379.3	80.6	29.53	0.0668	0.0181	0.0660	0.0000	0.0000
	6	CVOA-SHELF	2,448.2	87.4	28.00	0.0020	0.1091	0.7565	0.0000	0.0000
		AREA 51	1,096.5	45.2	24.29	0.2189	0.0246	0.2161	0.0000	0.0000
		AREA 52	514.0	19.2	26.82	0.6342	0.0525	0.0156	0.0000	0.0097
	7	CVOA-SHELF	3,616.2	63.3	57.10	0.0581	0.1911	0.3835	0.0000	0.0000
		AREA 51	7,182.1	159.1	45.15	0.0253	0.1601	0.0913	0.0000	0.0008
		AREA 52	3,934.6	119.4	32.95	0.1360	0.0330	0.0241	0.0000	0.0000
	8	CVOA-SHELF	3,222.8	108.1	29.82	0.0000	0.0515	0.2578	0.0000	0.0000
		AREA 51	5,269.0	178.7	29.49	0.0106	0.0676	0.1740	0.0000	0.0000
		AREA 52	2,088.3	80.7	25.88	0.0000	0.0450	0.0532	0.0000	0.0091
MS	9	CVOA-SHELF	12,567.8	1,164.5	10.79	0.0146	0.7726	1.8657	0.0000	0.0000
		AREA 52	2,624.5	304.9	8.61	0.0141	0.0297	0.0339	0.0000	0.0000
	10	CVOA-SHELF	365.1	29.3	12.46	0.1917	0.0110	0.0685	0.0000	0.0000
		AREA 51	1,944.8	75.7	25.70	0.0000	0.4042	0.0000	0.0000	0.0000
		AREA 52	1,007.5	32.4	31.06	0.0000	0.0000	0.0000	0.0000	0.0000
CB	11	CVOA-SHELF	2,598.7	113.1	22.98	0.0000	0.8466	0.5014	0.0000	0.0000
		AREA 51	1,757.1	84.8	20.73	0.0000	2.3117	1.0329	0.0000	0.0000
		AREA 52	1,290.2	75.8	17.03	0.0000	0.0000	0.5557	0.0000	0.0000
QTR=4										
C/P	1	CVOA-SHELF	967.0	43.7	22.15	0.0000	0.0000	0.0341	0.0000	0.0000
		AREA 52	1,954.1	104.8	18.64	0.6903	0.0000	0.0261	0.0000	0.0000
	2	CVOA-SHELF	1,733.9	165.8	10.46	0.4314	0.0000	0.3149	0.0000	0.0000
		AREA 52	1,541.0	111.3	13.84	0.2219	0.0013	0.0376	0.0000	0.0013
	3	CVOA-SHELF	4,575.6	165.9	27.58	0.0771	0.0000	0.0662	0.0000	0.0000
		AREA 52	2,514.6	141.1	17.82	0.0191	0.0000	0.0060	0.0000	0.0000

Table 7. Average pollock catch-per-unit-effort (CPUE) and bycatch rates (number (#) per ton of total catch, or percent weight of total catch) of prohibited species inside and outside the Catcher Vessel Operational Area (CVOA) by all observed foreign, joint-venture and domestic fishing vessels (excluding motherships) in quarters 2-4, 1981-90. All data from the Bogoslof district (area 518) are excluded. Data from outside the CVOA includes the Aleutian Islands (area 540), but inshore portions of area 51 where little pollock fishing has occurred (areas 512, 514 and 516) are excluded. Data from Norris (1992).

	Bottom Pollock Fishery		**Midwater Pollock Fishery**	
	Inside CVOA	Outside CVOA	Inside CVOA	Outside CVOA
Pollock CPUE (t/hr)				
Apr-Jun	8.2	5.2	22.6	10.5
Jul-Sep	6.5	5.4	13.2	14.7
Oct-Dec	6.0	4.5	9.5	10.8
Chinook Salmon Bycatch Rate (#/t total catch)				
Apr-Jun	0.013	0.003	0.010	0.004
Jul-Sep	0.004	0.000	0.004	0.000
Oct-Dec	0.019	0.015	0.023	0.015
Other Salmon Bycatch Rate (#/t total catch)				
Apr-Jun	0.000	0.000	0.004	0.001
Jul-Sep	0.078	0.003	0.203	0.007
Oct-Dec	0.008	0.009	0.009	0.006
Halibut Bycatch Rate (%)				
Apr-Jun	0.32	0.16	0.01	0.01
Jul-Sep	0.10	0.06	0.01	0.01
Oct-Dec	0.29	0.18	0.03	0.01
Herring Bycatch Rate (%)				
Apr-Jun	0.02	0.02	0.18	0.00
Jul-Sep	0.34	0.08	0.83	0.20
Oct-Dec	0.02	0.16	0.02	0.34
Red King Crab Bycatch Rate (#/t total catch)				
Apr-Jun	0.25	0.04	0.01	0.00
Jul-Sep	0.20	0.08	0.00	0.00
Oct-Dec	0.40	0.09	0.01	0.00
Bairdi Tanner Crab Bycatch Rate (#/t total catch)				
Apr-Jun	0.94	0.50	0.04	0.03
Jul-Sep	0.35	0.34	0.03	0.04
Oct-Dec	0.70	0.55	0.05	0.04

Table 8. Eastern bering sea pollock fishery catch-per-unit-effort (CPUE=tons pollock/hour trawled) by year, season, processor type (C/P=catcher processor; CB=catcher boat for inshore processor), gear and area. CVOA=Catcher Vessel Operational Area; see Figure 13 for area definitions.

		Pelagic Trawls						**Bottom Trawls**					
		Area						Area					
Process		CVOA-518	CVOA-SHELF	AREA 518	AREA 51	AREA 52	Grand Total	CVOA-518	CVOA-SHELF	AREA 518	AREA 51	AREA 52	Grand Total
1990 A-season													
C/P	Mean of ind. CPUE	99.1	55.9	97.6	63.3	32.2	76.9		26.7		64.2	52.9	43.7
	Sum of hours	48.8	851.3	2,412.3	1,932.1	635.8	5,880.3		1,819.2		1,162.6	284.5	3,267.8
	Sum of pollock	1,710.8	18,566.6	85,300.0	59,954.5	14,483.2	180,015.1		21,638.9		31,178.6	8,600.8	61,421.1
	Grand Mean CPUE	35.0	21.8	35.4	31.0	22.8	30.6						
CB	Mean of ind. CPUE	217.1	70.1	116.4	45.8		76.0		6.4				5.9
	Sum of hours	19.8	1,229.2	104.8	332.9		1,686.7		110.0				127.7
	Sum of pollock	1,763.8	34,880.1	5,080.2	9,126.3		50,850.4		529.4				574.7
	Grand Mean CPUE	89.0	28.4	48.5	27.4		30.1						
1990 B-Season													
C/P	Mean of ind. CPUE		11.3		19.5	29.1	27.6	1.4	3.4	0.9	1.6	24.6	20.6
	Sum of hours		1,463.6		389.8	14,566.2	16,419.6	31.5	74.1	32.0	177.2	1,400.0	1,714.8
	Sum of pollock		12,676.4		5,256.0	307,088.1	325,020.5	41.6	209.1	24.8	244.9	24,214.5	24,734.9
	Grand Mean CPUE		8.7		13.5	21.1	19.8	1.3	2.8	0.8	1.4	17.3	14.4
CB													
	Mean of ind. CPUE		11.8		8.9		11.7						
	Sum of hours		13,546.3		58.3		13,611.8						
	Sum of pollock		109,670.2		258.6		109,992.1						
	Grand Mean CPUE		8.1		4.4		8.1						
1991 A-season													
C/P	Mean of ind. CPUE	171.5	32.1	58.9	36.4	10.1	53.4		10.2		8.1	5.4	8.4
	Sum of hours	35.8	1,873.1	5,316.8	52.2	33.3	7,311.2		1,434.3		384.4	907.2	2,738.2
	Sum of pollock	3,119.5	36,225.9	142,706.0	627.9	314.9	182,994.1		9,210.9		2,057.9	3,815.1	15,116.1
	Grand Mean CPUE	87.3	19.3	26.8	12.0	9.4	25.0		6.4		5.4	4.2	5.5
CB													
	Mean of ind. CPUE		23.9	40.3	13.8		24.4		6.5		11.5		7.4
	Sum of hours		4,574.6	159.8	7.0		4,741.4		280.9		38.7		319.6
	Sum of pollock		63,480.2	2,500.0	94.5		66,074.7		1,406.2		271.2		1,677.4
	Grand Mean CPUE		13.9	15.6	13.5		13.9		5.0		7.0		5.2
1991 B-Season													
C/P	Mean of ind. CPUE		5.7		13.6	16.9	15.4		4.9		4.8	12.2	9.6
	Sum of hours		2,261.2		3,259.3	16,973.6	22,494.2		223.7		702.8	1,467.7	2,404.2
	Sum of pollock		10,958.2		36,910.0	239,231.7	287,099.9		962.9		2,466.0	16,431.1	19,888.4
	Grand Mean CPUE		4.8		11.3	14.1	12.8		4.3		3.5	11.2	8.3
CB													
	Mean of ind. CPUE	3.3	7.1		6.3	19.1	7.6		3.1		5.1		4.1
	Sum of hours	36.0	15,209.5		1,580.3	356.4	17,188.4		141.8		76.2		218.0
	Sum of pollock	115.5	73,997.0		7,743.4	5,527.3	87,454.9		367.8		401.5		769.3
	Grand Mean CPUE	3.2	4.9		4.9	15.5	5.1		2.6		5.3		3.5

Grand Mean=total tons pollock/total hours trawled for year, season, gear, processor, area cell; Mean of Ind CPUE=mean of individual haul CPUEs for cell; Source: NMFS Observer Data.

Table 8. (continued).

		Pelagic Trawls: CVOA-518	CVOA-SHELF	518	AREA 51	AREA 52	Grand Total	Bottom Trawls: CVOA-518	CVOA-SHELF	A 518	AREA 51	AREA 52	Grand Total
1992 A-season													
Process													
C/P	Mean of ind. CPUE		21.4		31.8	29.3	28.2		17.4		20.1	4.4	16.0
	Sum of hours		2,599.4		2,993.9	2,591.2	8,184.5		1,384.2		1,028.6	610.1	3,041.1
	Sum of pollock		38,499.2		65,066.7	52,103.1	155,669.1		16,977.8		15,288.9	2,045.0	34,336.3
	Grand Mean CPUE		14.8		21.7	20.1	19.0		12.3		14.9	3.4	11.3
CB	Mean of ind. CPUE		9.2		67.2		9.8		3.3		3.9	5.7	3.4
	Sum of hours		11,393.9		50.1		11,444.0		498.0		36.5		540.6
	Sum of pollock		80,747.8		1,316.4		82,064.2		1,418.3		100.0		1,542.1
	Grand Mean CPUE		7.1		26.3		7.2		2.8		2.7		2.9
1992 B-Season													
C/P	Mean of ind. CPUE				8.9	21.6	20.5				2.9	10.4	8.4
	Sum of hours				974.1	10,365.5	11,348.4				258.0	700.9	958.9
	Sum of pollock				7,764.5	########	172,938.5				596.3	6,484.6	7,080.9
	Grand Mean CPUE				8.0	15.9	15.2				2.3	9.3	7.4
CB													
	Mean of ind. CPUE		19.5		12.9	35.2	19.5		21.3		21.4	4.5	21.2
	Sum of hours		11,360.8		1,126.7	300.7	12,788.2		1,297.7		83.5	3.3	1,384.5
	Sum of pollock		147,383.1		6,092.5	6,171.9	159,647.6		19,030.2		1,009.2	15.0	20,054.4
	Grand Mean CPUE		13.0		5.4	20.5	12.5		14.7		12.1	4.5	14.5
1992 CDQ-Season (December)													
C/P	Mean of ind. CPUE		49.0		14.8	19.3	38.0		10.7				10.3
	Sum of hours		1,533.6		105.4	531.3	2,170.3		297.0				306.0
	Sum of pollock		35,714.1		1,071.0	7,478.9	44,263.9		2,563.3				2,573.3
	Grand Mean CPUE		23.3		10.2	14.1	20.4						
CB													
	Mean of ind. CPUE		20.9				20.9						
	Sum of hours		1,223.3				1,223.3						
	Sum of pollock		15,920.8				15,920.8						
	Grand Mean CPUE		13.0				13.0						

Grand Mean=total tons pollock/total hours trawled for year, season, gear processor, area cell; Mean of Ind CPUE=mean of individual haul CPUEs for cell: Source: NMFS Observer Data.

Table 8. (continued).

1993 A-season Process		Pelagic Trawls Area CVOA-518	CVOA-SHELF	518	AREA 51	AREA 52	Grand Total	Bottom Trawls Area CVOA-518	CVOA-SHELF	A 518	AREA 51	AREA 52	Grand Total
C/P	Mean of ind. CPUE		63.8		27.8	34.0	36.7		14.0		20.2	18.2	17.1
	Sum of hours		1,003.1		4,021.0	1,551.4	6,592.4		1,180.7		788.3	1,566.1	3,541.3
	Sum of pollock		28,225.7		78,737.5	34,583.9	141,580.1		10,970.5		11,567.9	18,473.5	41,016.0
	Grand Mean CPUE		28.1		19.6	22.3	21.5		9.3		14.7	11.8	11.6
CB	Mean of ind. CPUE		61.3		27.7		60.0		11.6				11.4
	Sum of hours		4,014.6		258.4		4,272.9		987.5				998.0
	Sum of pollock		115,281.9		5,089.7		120,371.5		8,219.7				8,245.0
	Grand Mean CPUE		28.7		19.7		28.2		8.3				8.3
1993 CDQ (June-August 14)													
C/P	Mean of ind. CPUE		47.2		26.3	38.3	40.8		2.5		2.3	1.6	2.3
	Sum of hours		393.6		216.2	30.5	640.3		15.8		998.4	56.4	1,070.5
	Sum of pollock		9,078.6		3,891.1	987.3	13,957.0		28.8		2,263.0	102.7	2,394.5
	Grand Mean CPUE		23.1		18.0	32.4	21.8		1.8		2.3	1.8	2.2
1993 B-Season													
C/P	Mean of ind. CPUE				37.3	31.3	35.0				6.9	15.9	8.9
	Sum of hours				4,785.7	2,915.4	7,852.4				557.9	157.7	718.9
	Sum of pollock				116,178.9	59,653.3	177,457.4				2,844.2	1,834.5	4,680.8
	Grand Mean CPUE				24.3	20.5	22.6				5.1	11.6	6.5
CB	Mean of ind. CPUE		26.3		32.7	33.7	26.6						
	Sum of hours		8,241.6		94.5	75.8	8,411.9						
	Sum of pollock		151,428.0		2,009.0	1,290.2	154,727.1						
	Grand Mean CPUE		18.4		21.3	17.0	18.4						
1993 CDQ-Season (Sept. 23-December)													
C/P	Mean of ind. CPUE		28.5		14.4	23.4	26.1		3.3		3.1	2.8	3.1
	Sum of hours		1,759.2		214.6	707.0	2,680.7		76.8		301.3	73.7	451.8
	Sum of pollock		31,228.9		2,997.5	13,343.6	47,569.9		241.2		858.3	199.2	1,298.7
	Grand Mean CPUE		17.8		14.0	18.9	17.7		3.1		2.8	2.7	2.9

Grand Mean=total tons pollock/total hours trawled for year, season, gear, processor, area cell; Mean of Ind CPUE=mean of individual haul CPUEs for cell; Source: NMFS Observer Data.

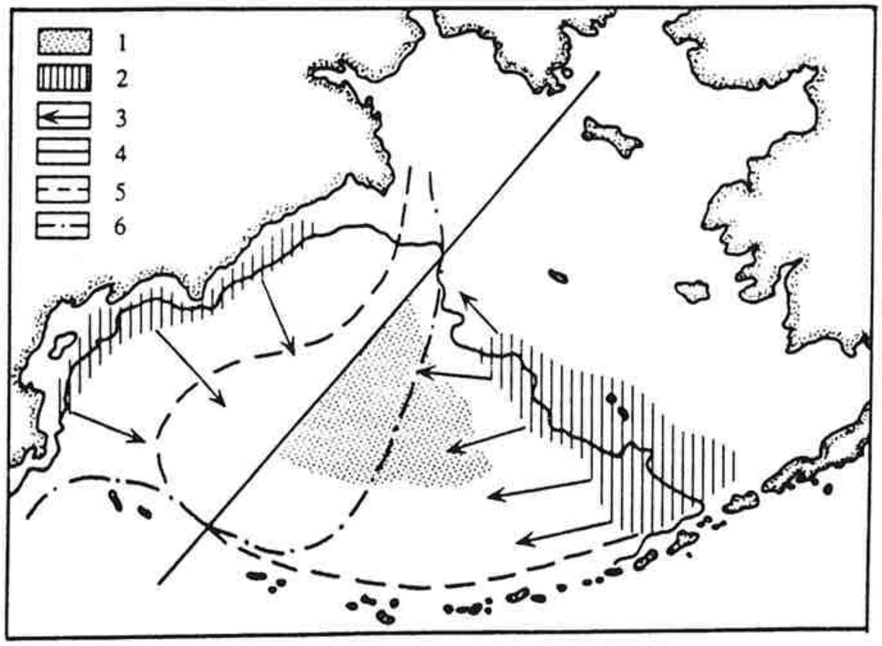
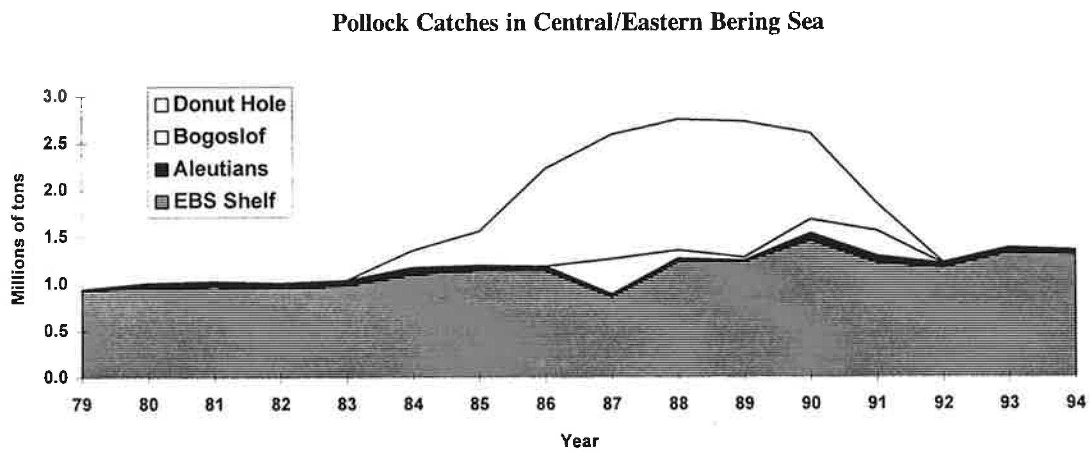
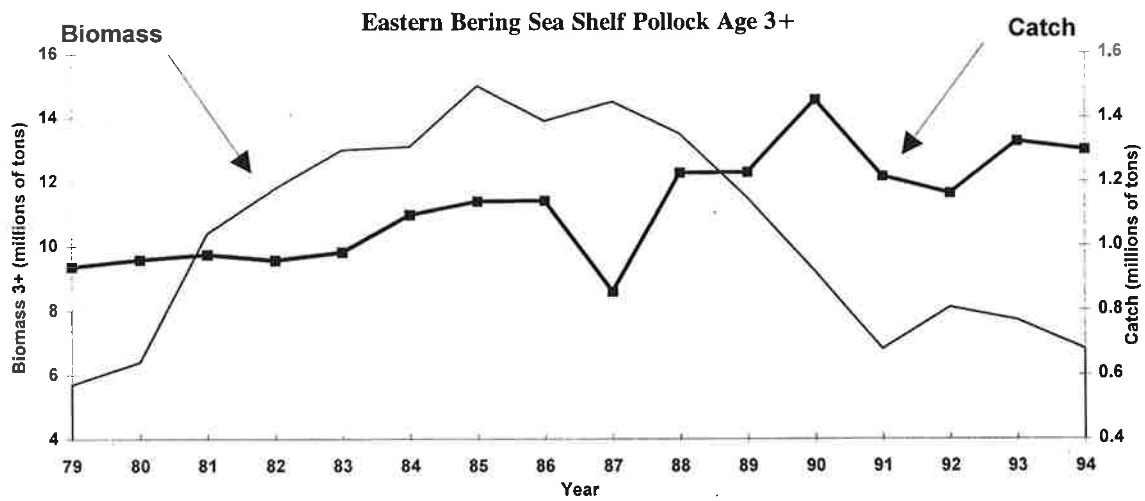
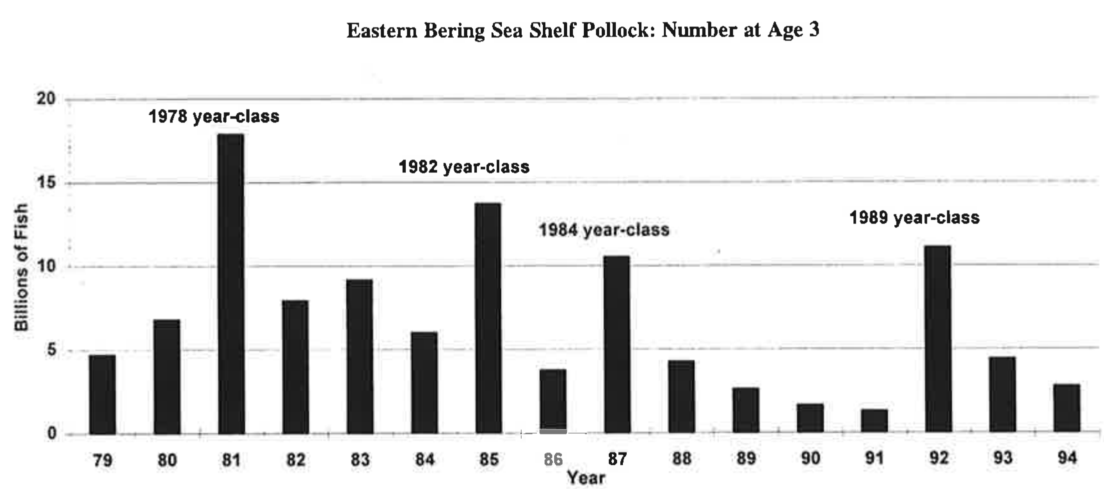


Figure 1. Principal spawning areas and post-spawning movements of pollock in the Bering Sea. 1=Donut Hole; 2=spawning areas; 3=directions of post-spawning movements; 4=continental shelf edge (200 m); 5=approximate western extent of pollock from eastern stock; and 6=approximate eastern extent of pollock from western stock. From Springer (1992) redrawn from Stepanenko (1989).

Figure 2. Catches, biomass and year-class strength of eastern Bering Sea (EBS) shelf pollock. Catches of pollock in the Donut Hole and Bogoslof areas of the Central Bering Sea are also shown.







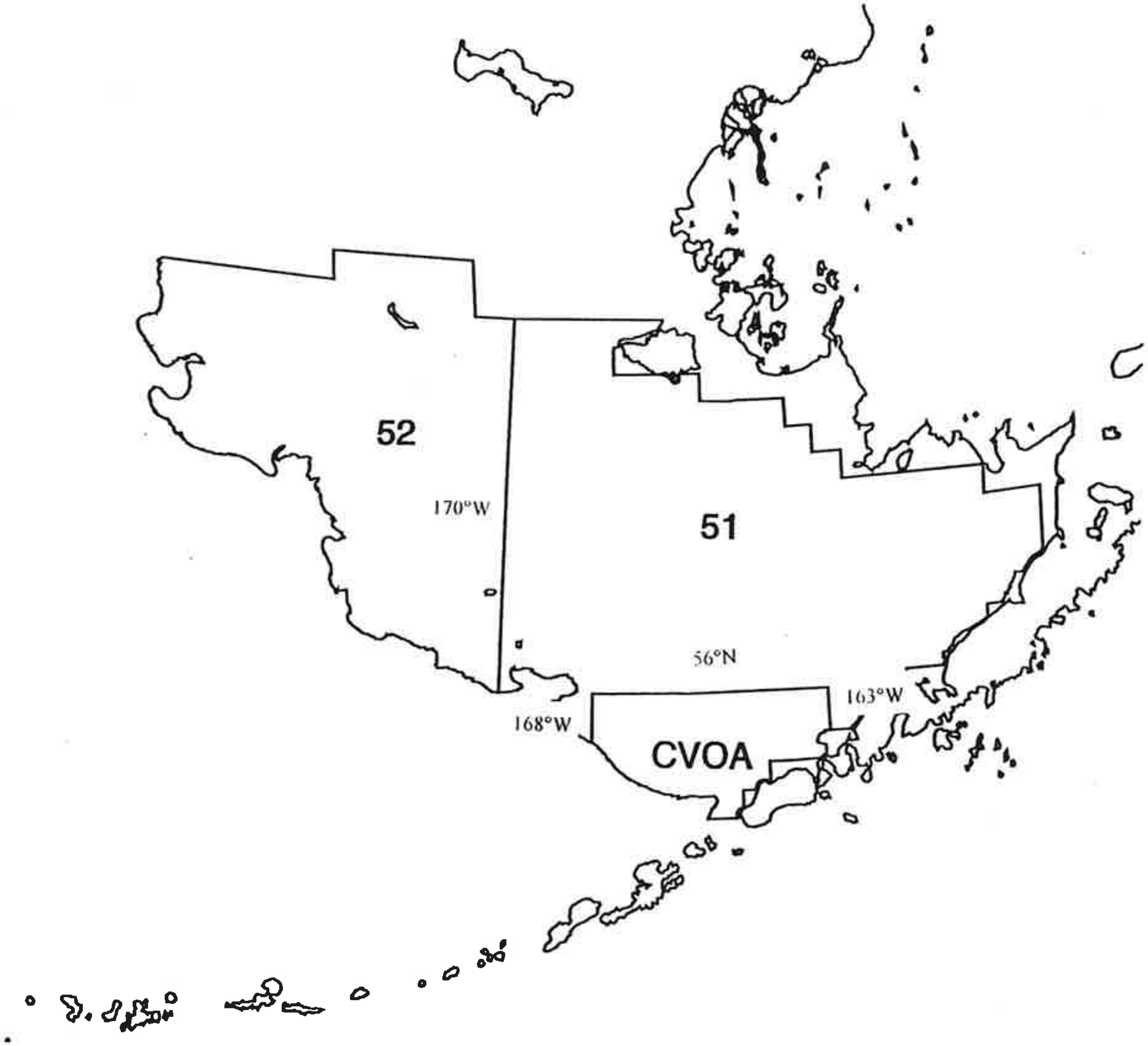


Figure 3. Eastern Bering sea groundfish bottom trawl survey areas. CVOA=Catcher Vessel Operational Area.

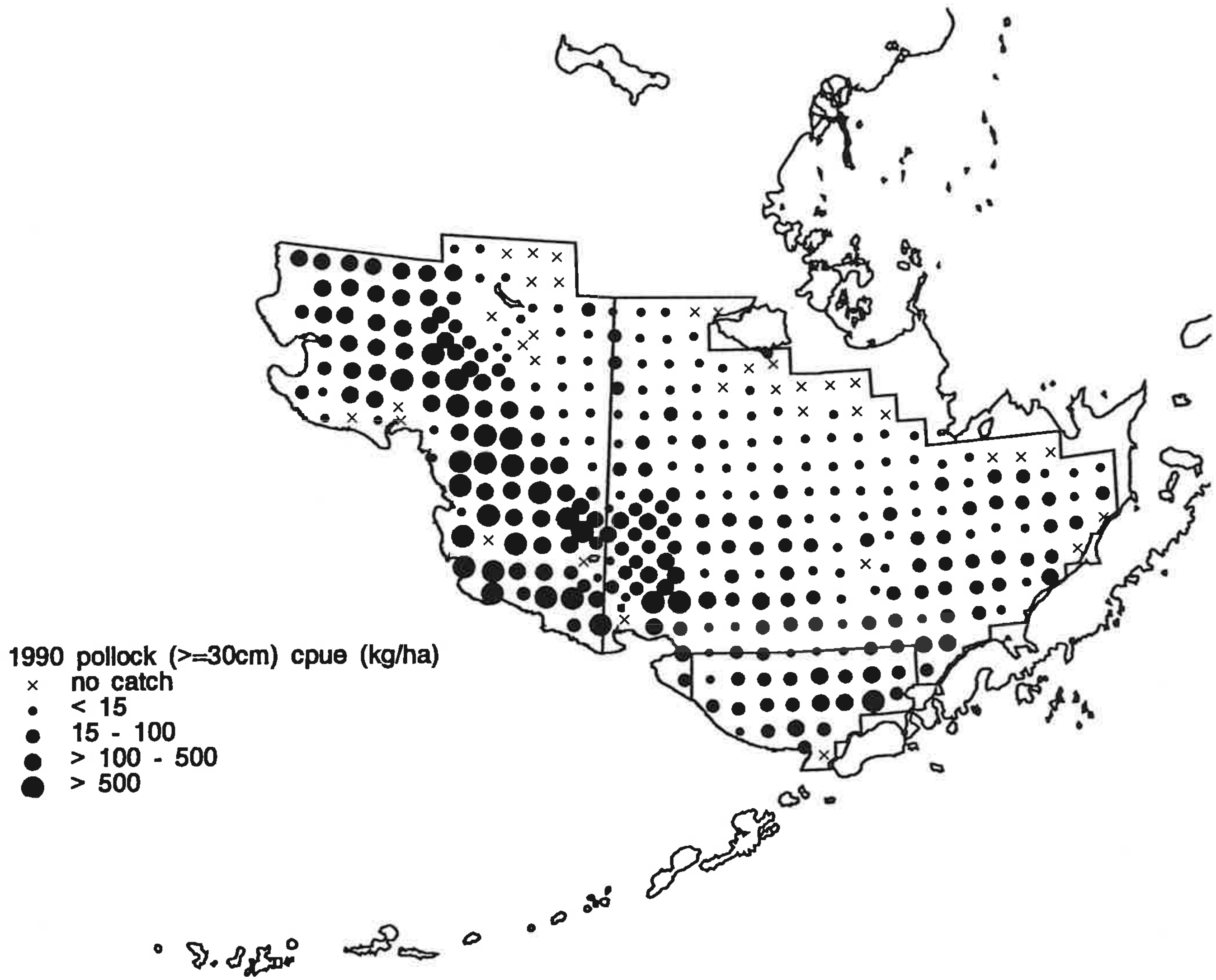


Figure 4. Haul-by-haul exploitable (30+ cm in length) pollock catch-per-unit-effort (CPUE=kg/hectare) from the 1990 Eastern Bering sea groundfish bottom trawl survey.

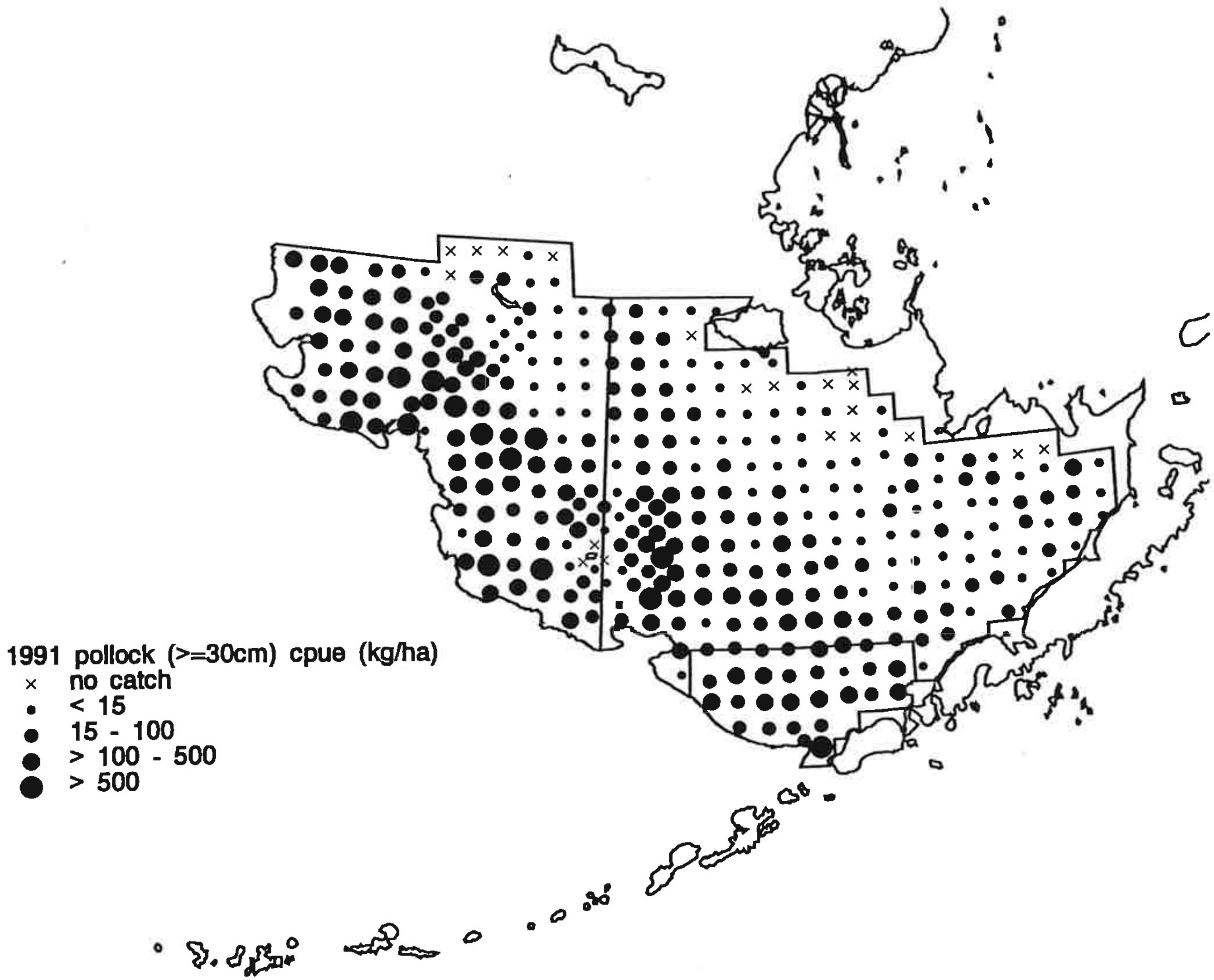


Figure 5. Haul-by-haul exploitable (30+ cm in length) pollock catch-per-unit-effort (CPUE=kg/hectare) from the 1991 Eastern Bering sea groundfish bottom trawl survey.

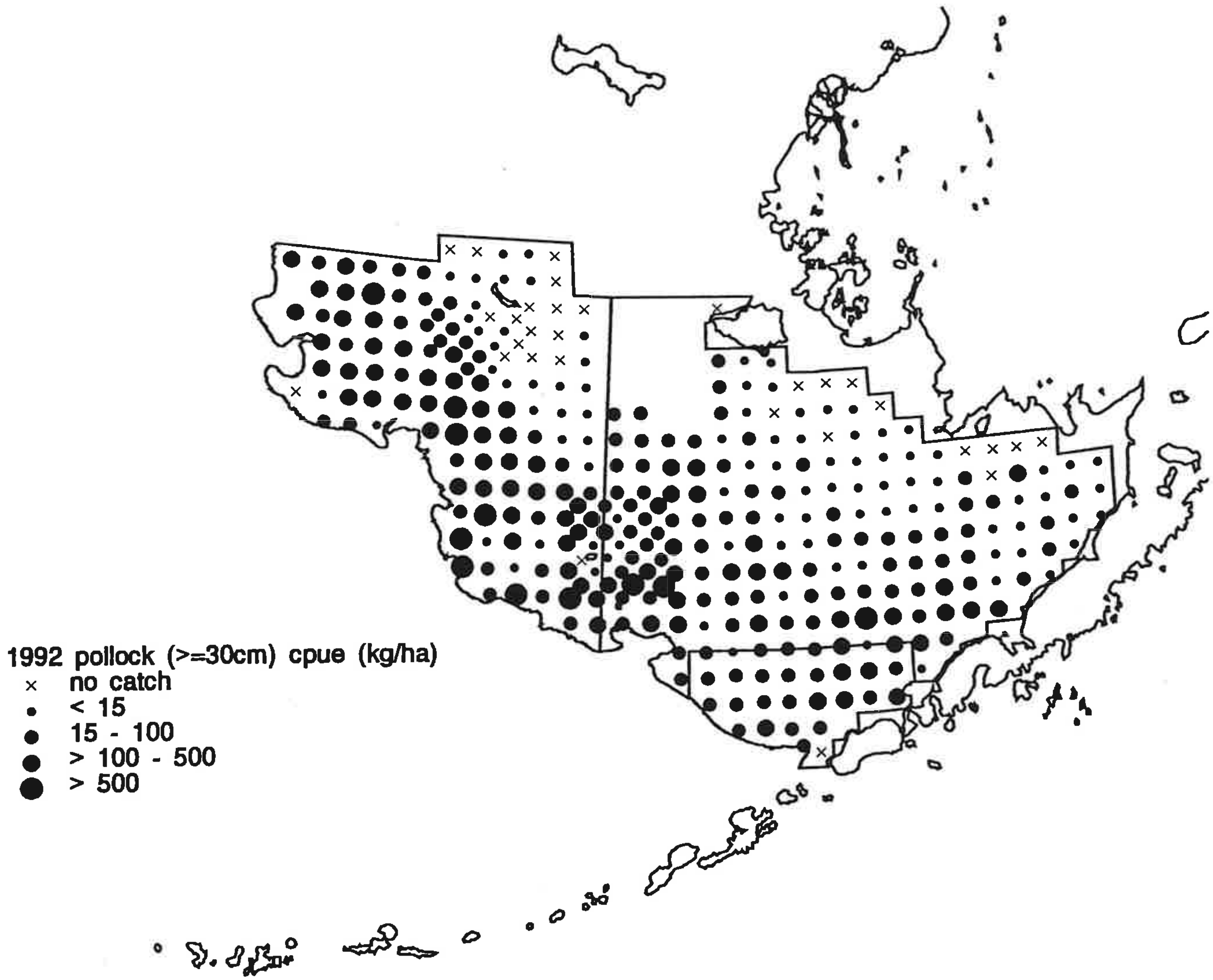


Figure 6. Haul-by-haul exploitable (30+ cm in length) pollock catch-per-unit-effort (CPUE=kg/hectare) from the 1992 Eastern Bering sea groundfish bottom trawl survey.

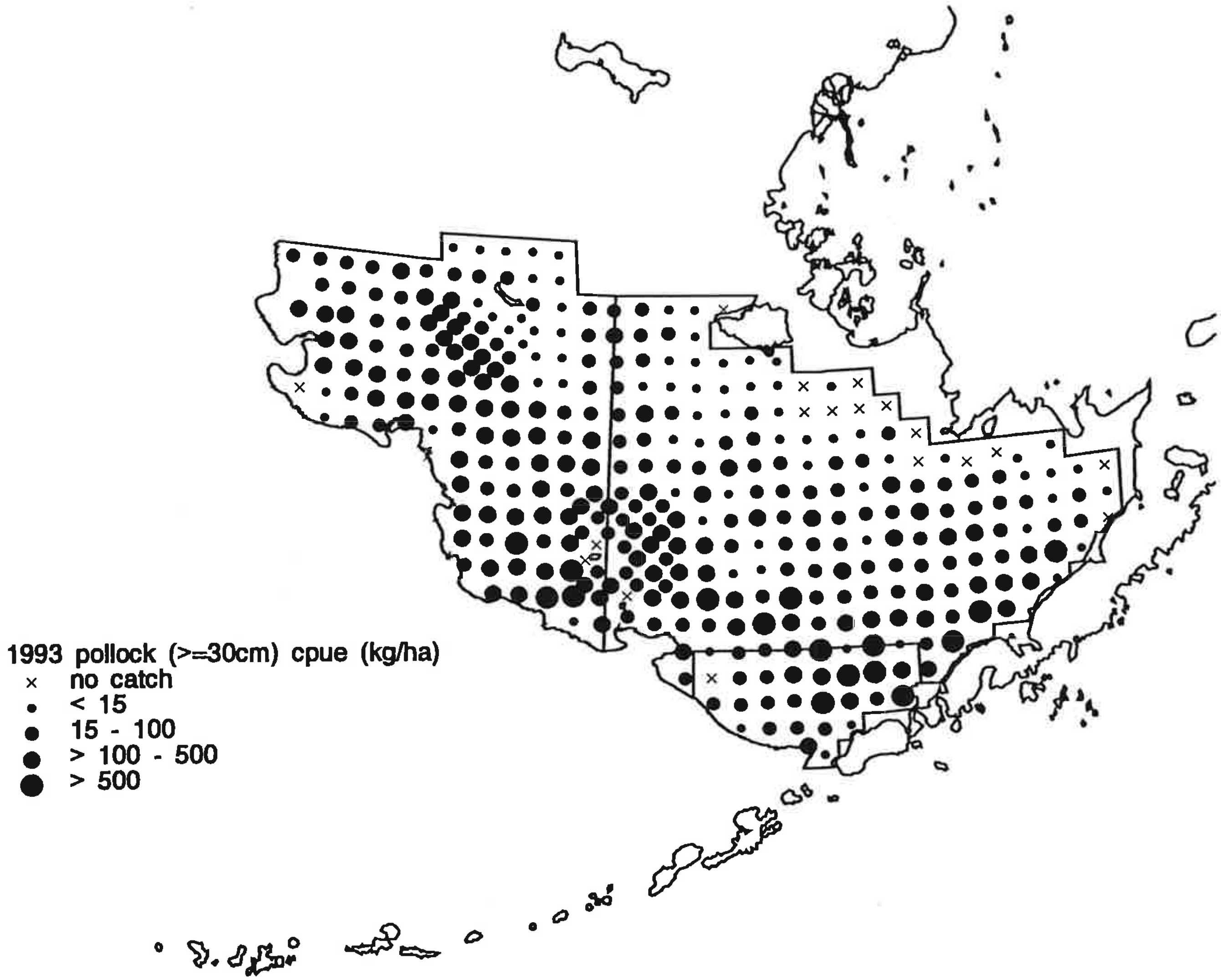


Figure 7. Haul-by-haul exploitable (30+ cm in length) pollock catch-per-unit-effort (CPUE=kg/hectare) from the 1993 Eastern Bering sea groundfish bottom trawl survey.

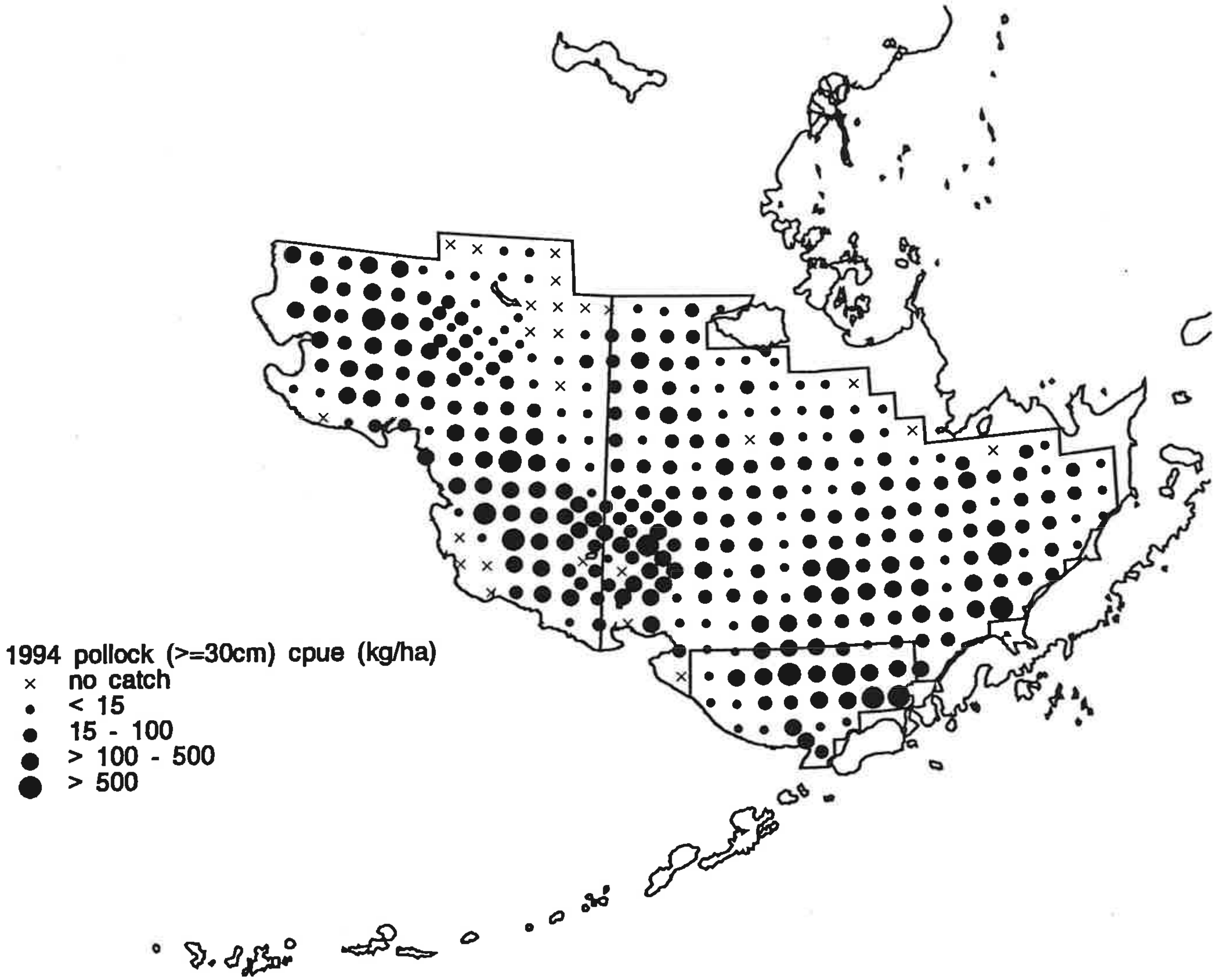


Figure 8. Haul-by-haul exploitable (30+ cm in length) pollock catch-per-unit-effort (CPUE=kg/hectare) from the 1994 Eastern Bering sea groundfish bottom trawl survey.

Figure 9. Transects during the 1994 echo integration-midwater trawl survey of the Bering Sea shelf, MF94-07. Deflections off transect lines indicate relative fish density.

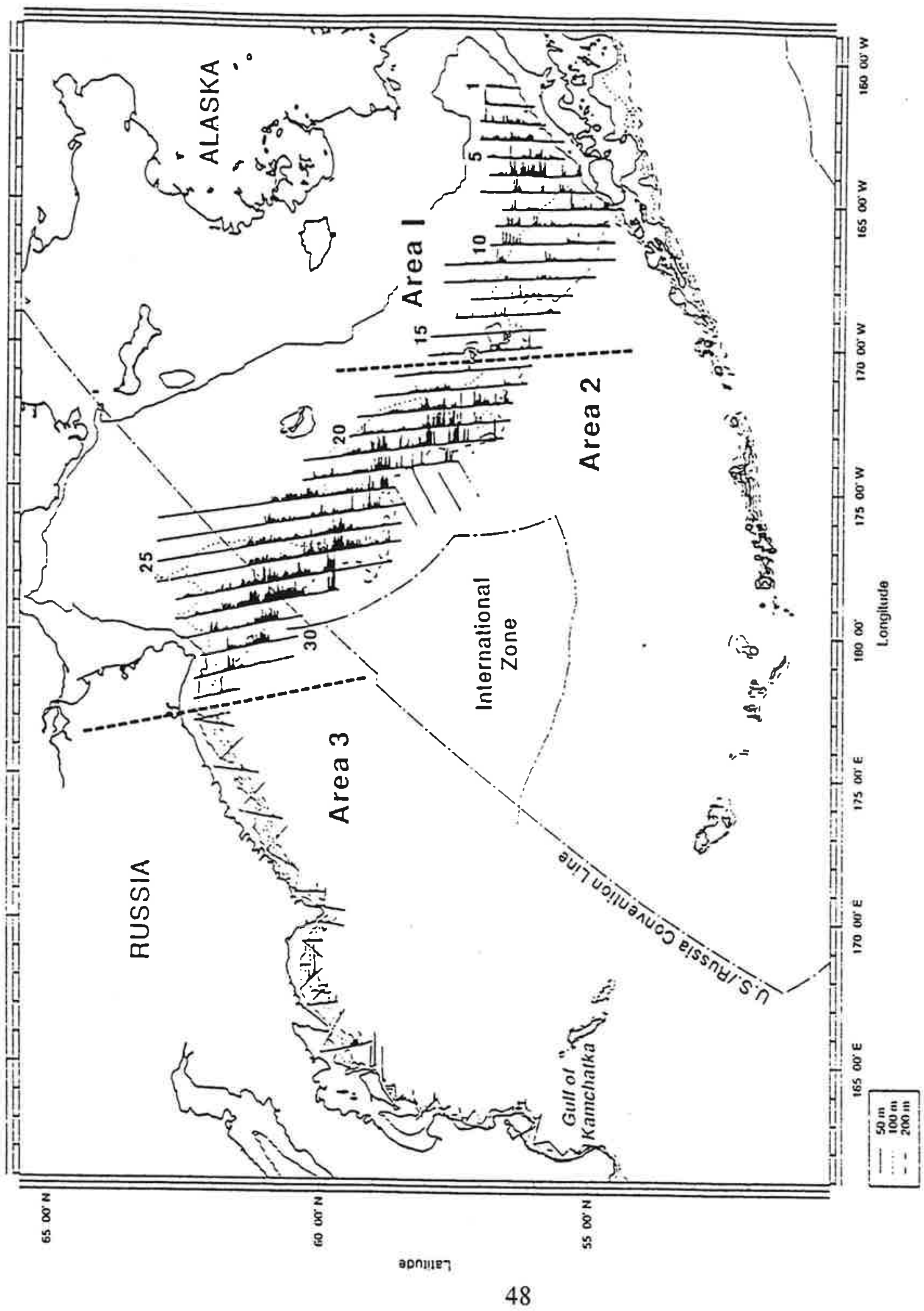


Figure 10. Pollock population estimates by length and area based on bottom trawl surveys conducted in 1990 (A), 1992 (B), and 1993 (C). CVOA=Catcher Vessel Operational Area. See Figure 3 for area definitions. Bottom trawls do not accurately sample pollock 20-30 cm in length. EBS=eastern Bering Sea.

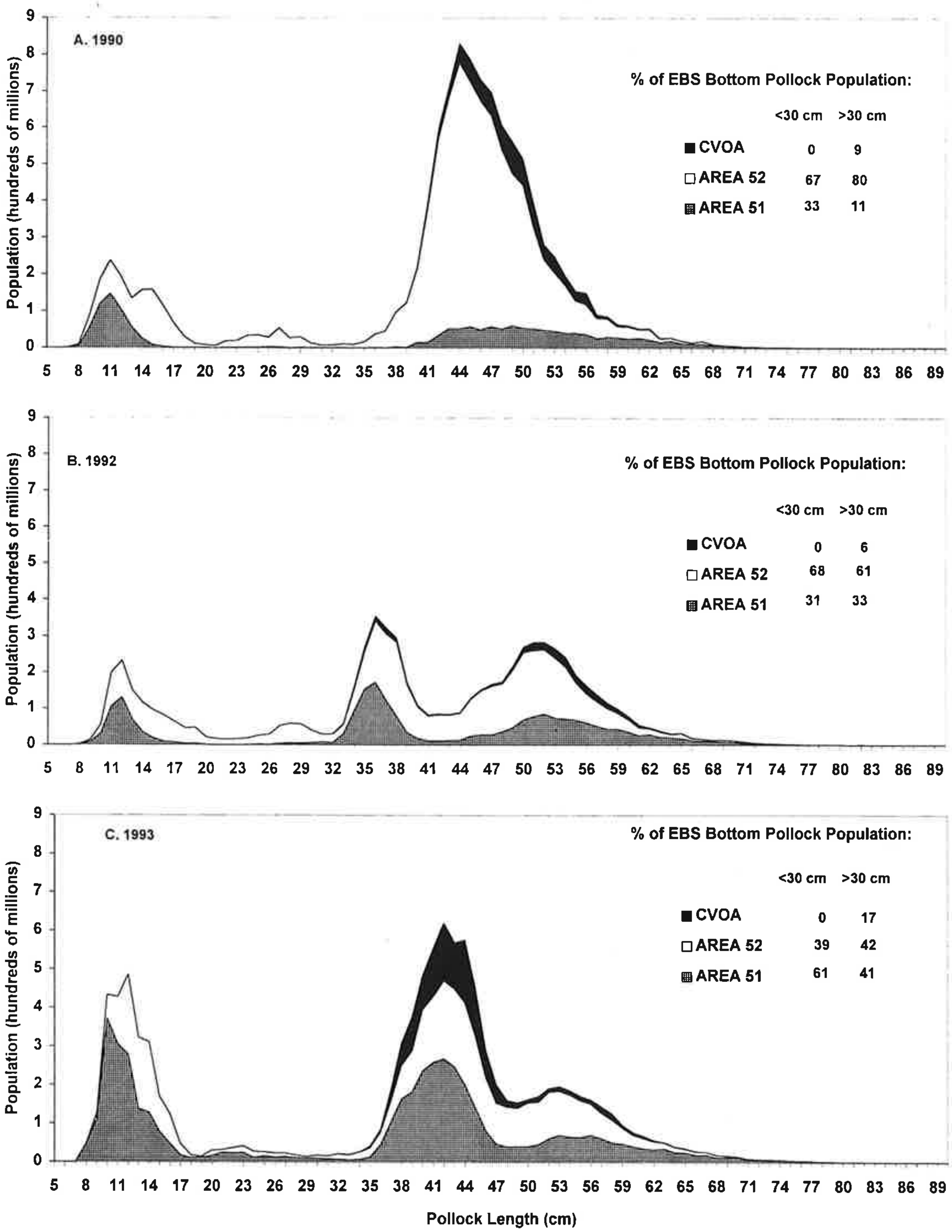


Figure 11. 1991 Eastern Bering Sea (EBS) pollock population (numbers) by length in AREAs 51 and 52 based on bottom and midwater (Mid) surveys. CVOA = Catcher Vessel Operational Area. Midwater = surface to 3 m off bottom (unavailable for CVOA separately). See Figure 3 for area definitions.

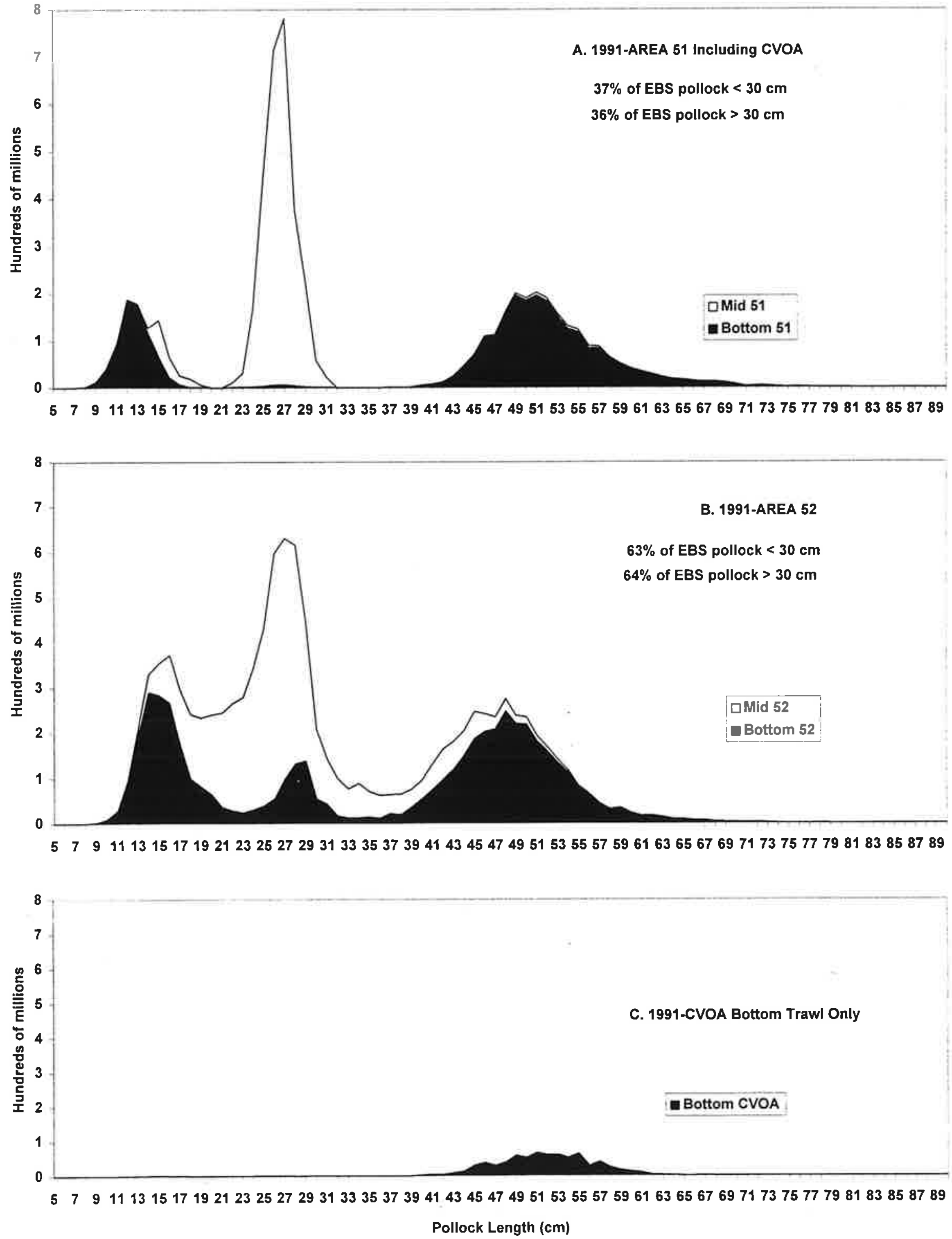
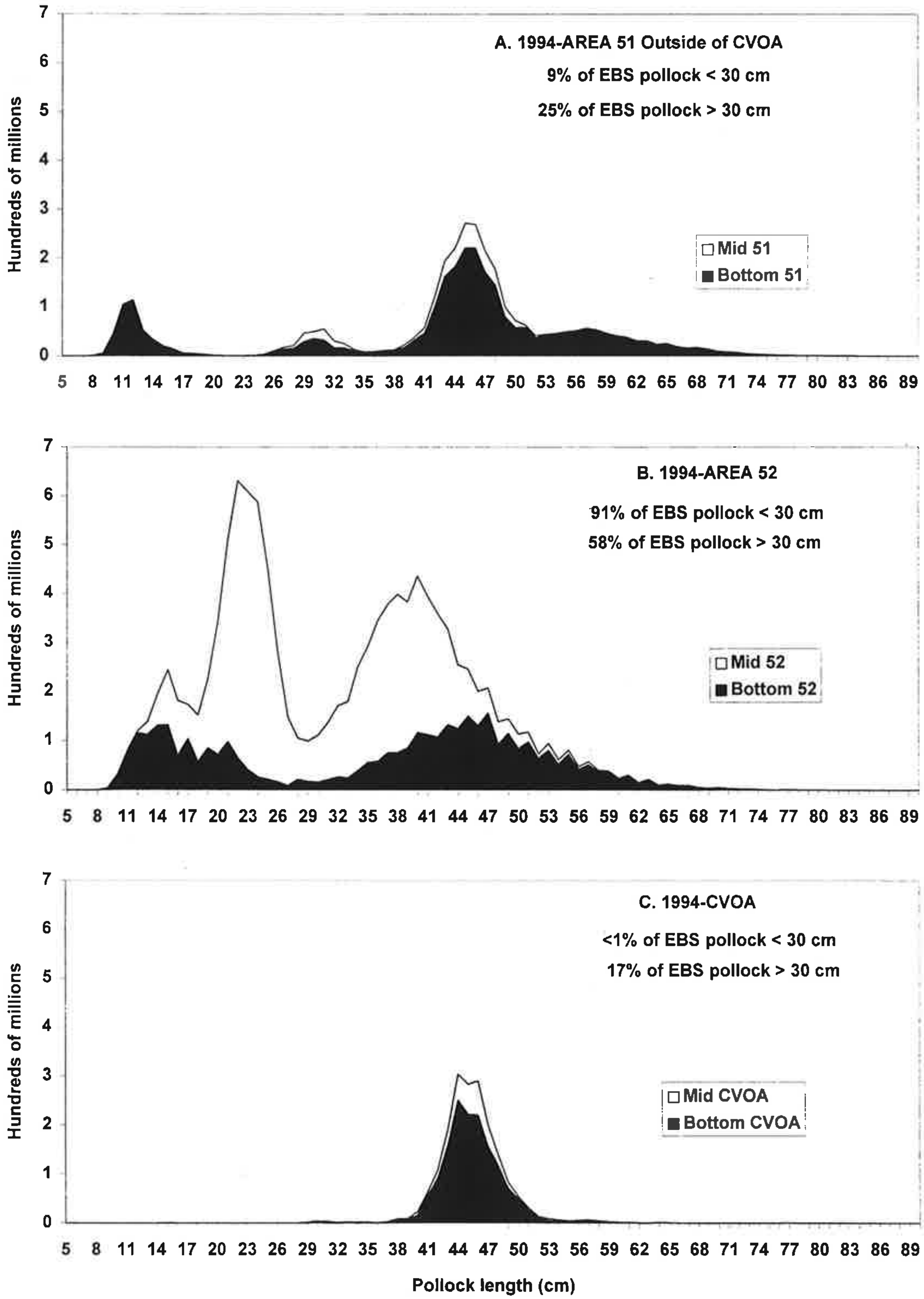


Figure 12. 1994 Eastern Bering Sea (EBS) pollock population (numbers) by length and area (see Figure 3) based on bottom and midwater (Mid) surveys. CVOA = Catcher Vessel Operational Area. Midwater = surface to 3 m off bottom.



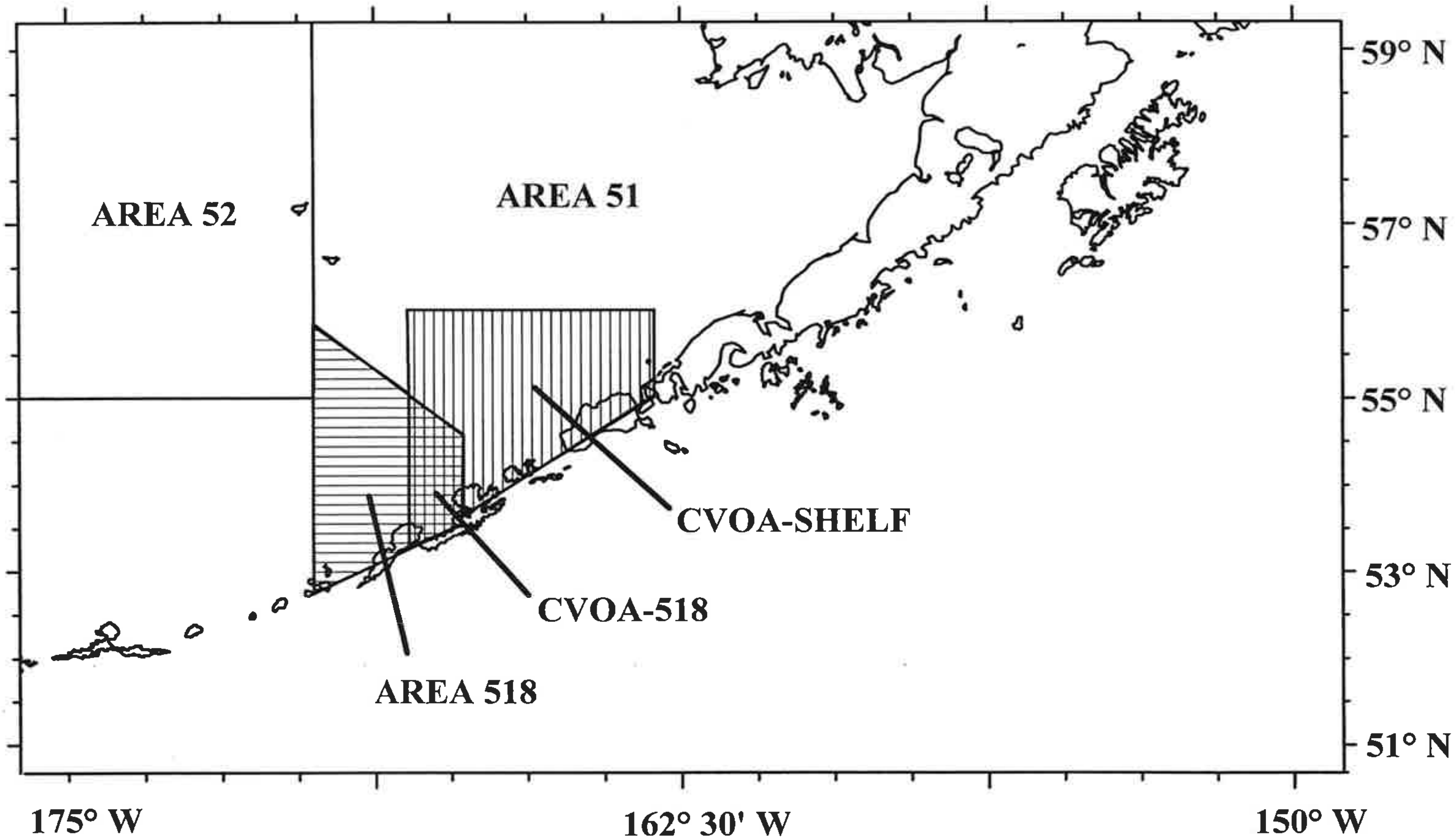


Figure 13. Areas in the eastern Bering Sea defined for analysis of pollock fishery bycatch, catch per unit effort, and length frequency. The Catcher Vessel Operational Area (CVOA) extends from 163°-168°W longitude, south of 56°N latitude, and overlaps the Bogoslof district (AREA 518) in the area labelled CVOA-518. Areas outside the CVOA and 518 are divided at 170°W longitude (AREAs 51 and 52).

Figure 14. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher-processors in the eastern Bering Sea in January-April 1990-93 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.

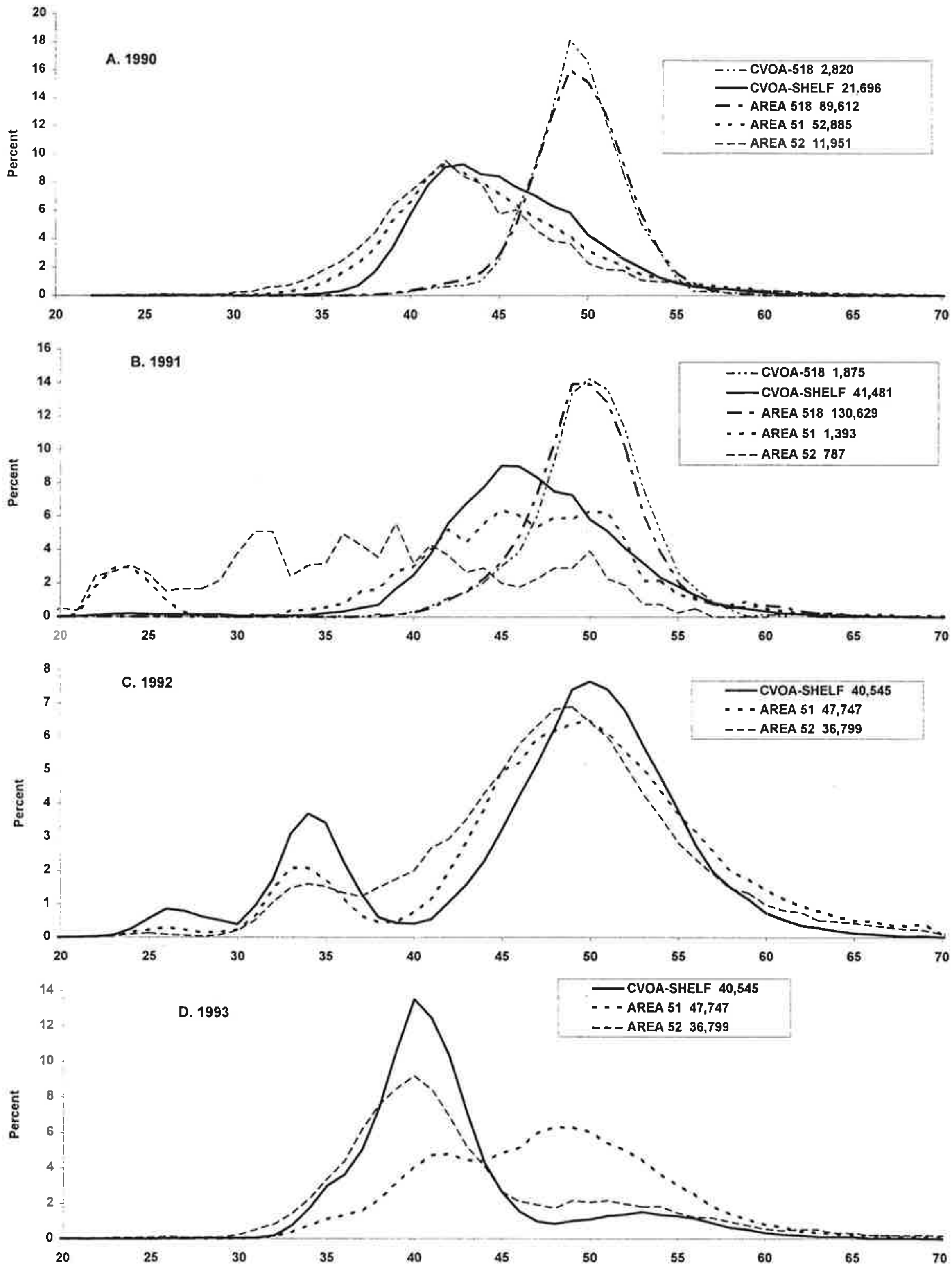


Figure 15. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher boats in the eastern Bering Sea in January-April 1990-93 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.

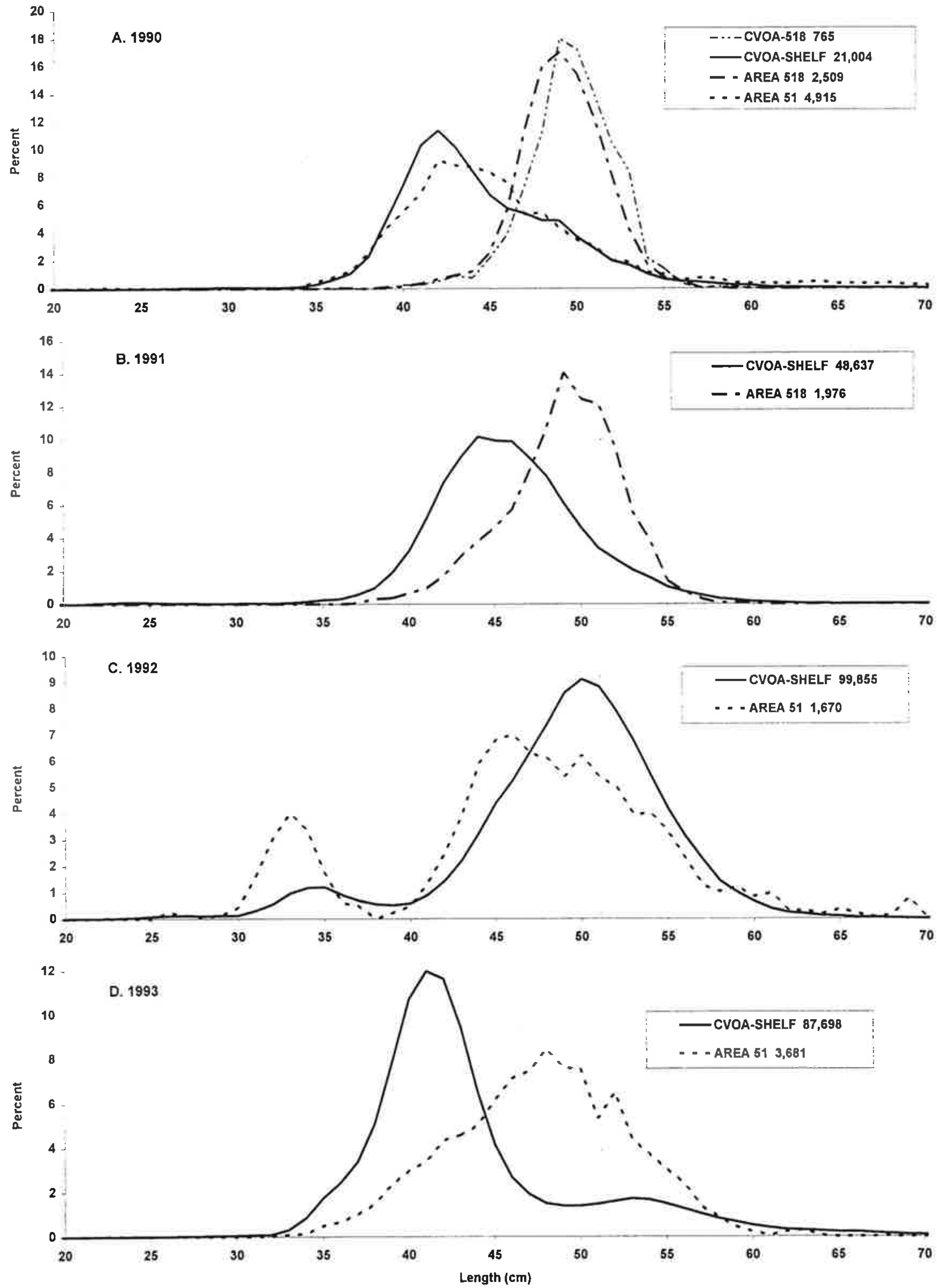


Figure 16. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher processors and catcher boats in the eastern Bering Sea in May-July and August-December 1990 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.

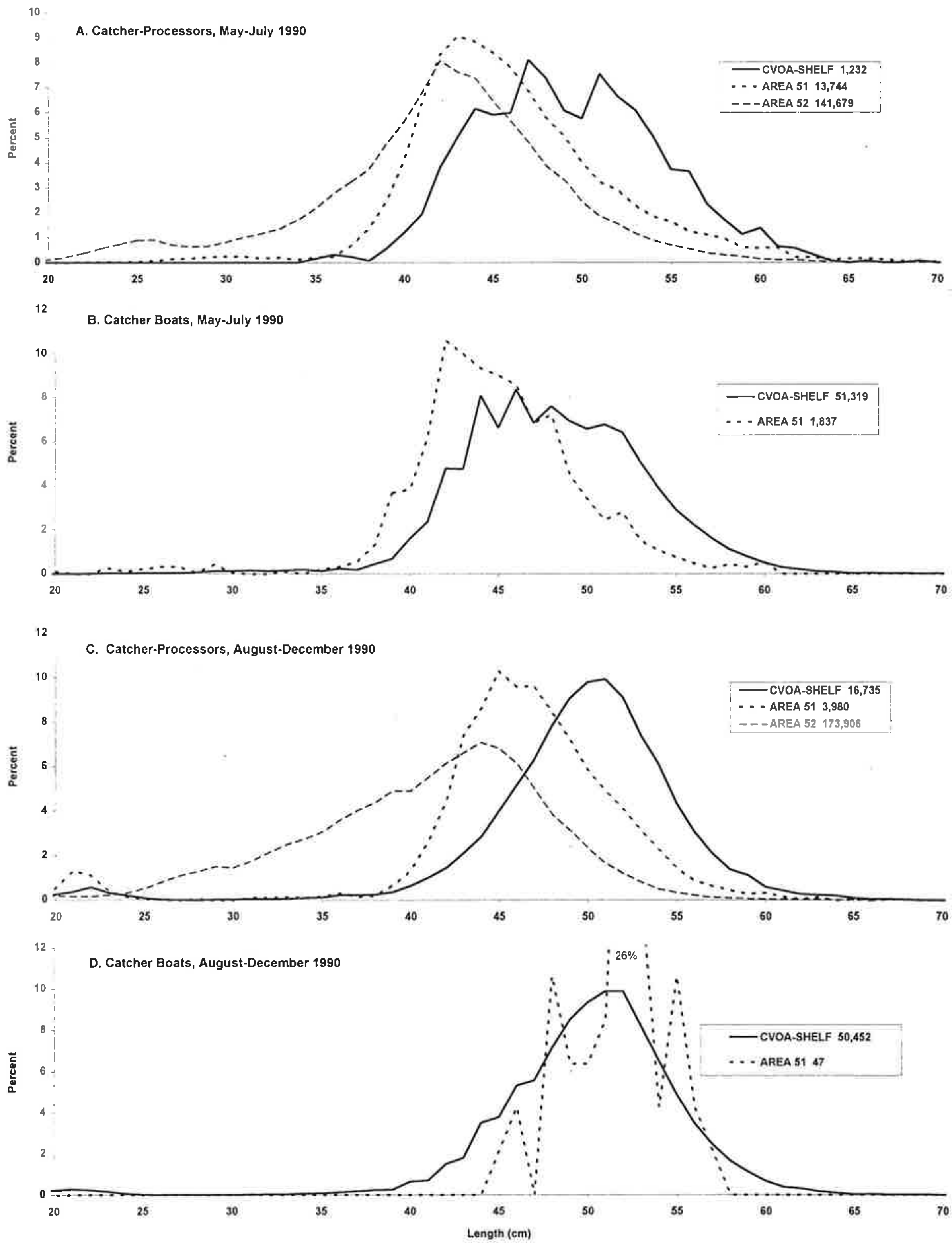


Figure 17. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher processors and catcher boats in the eastern Bering Sea in May-July and August-December 1991 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.

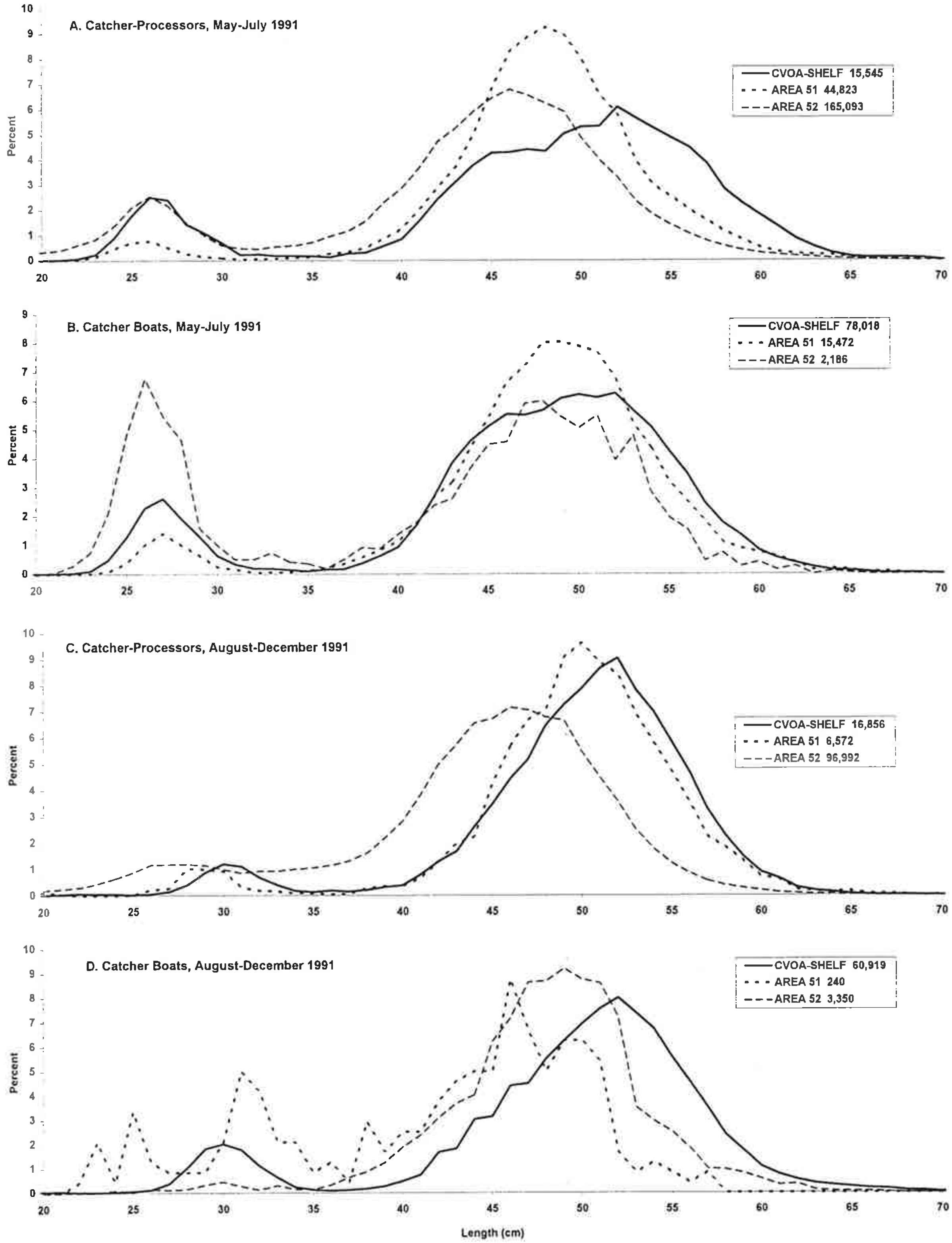


Figure 18. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher processors and catcher boats in the eastern Bering Sea in May-July and August-December 1992 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.

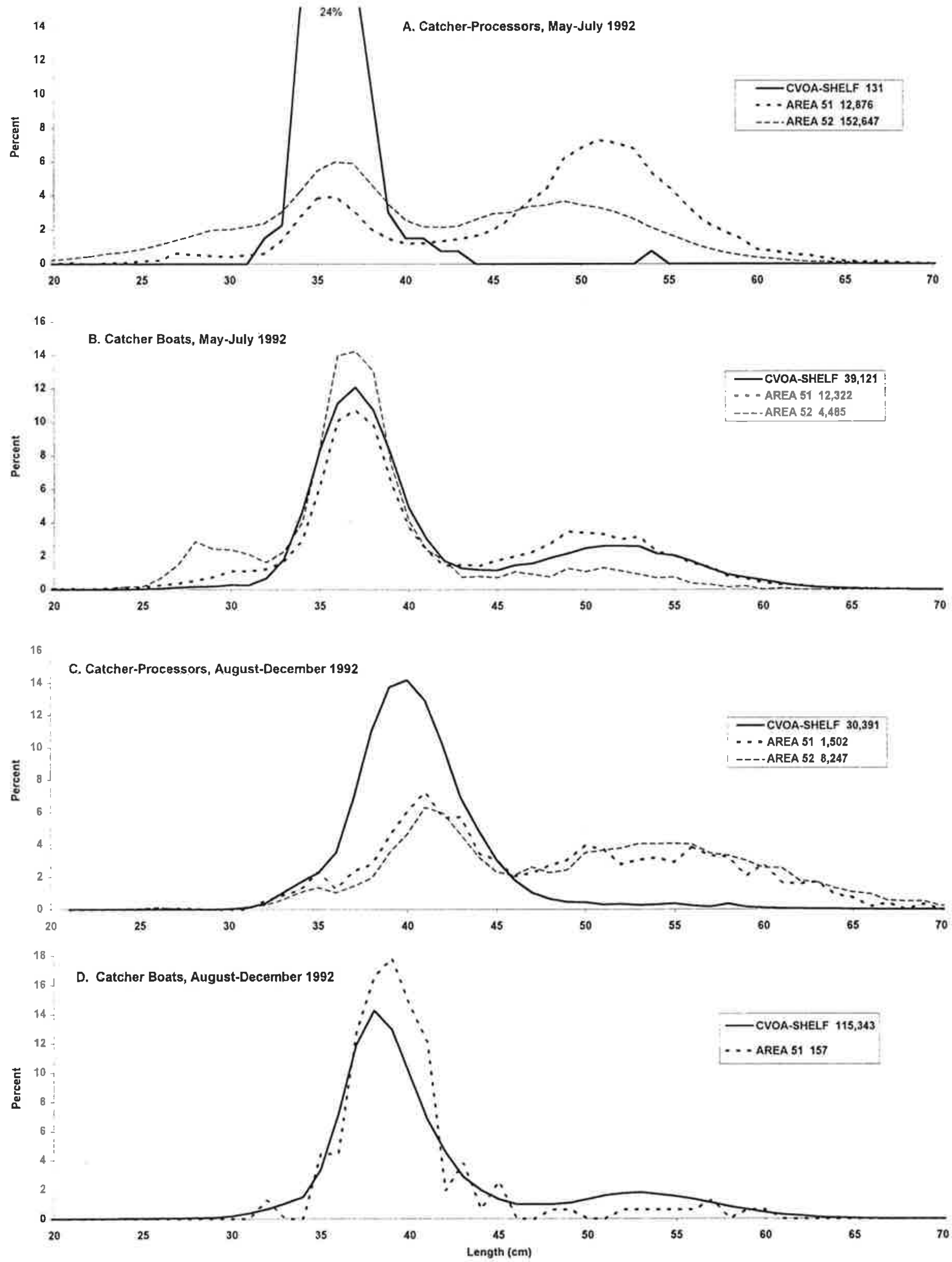
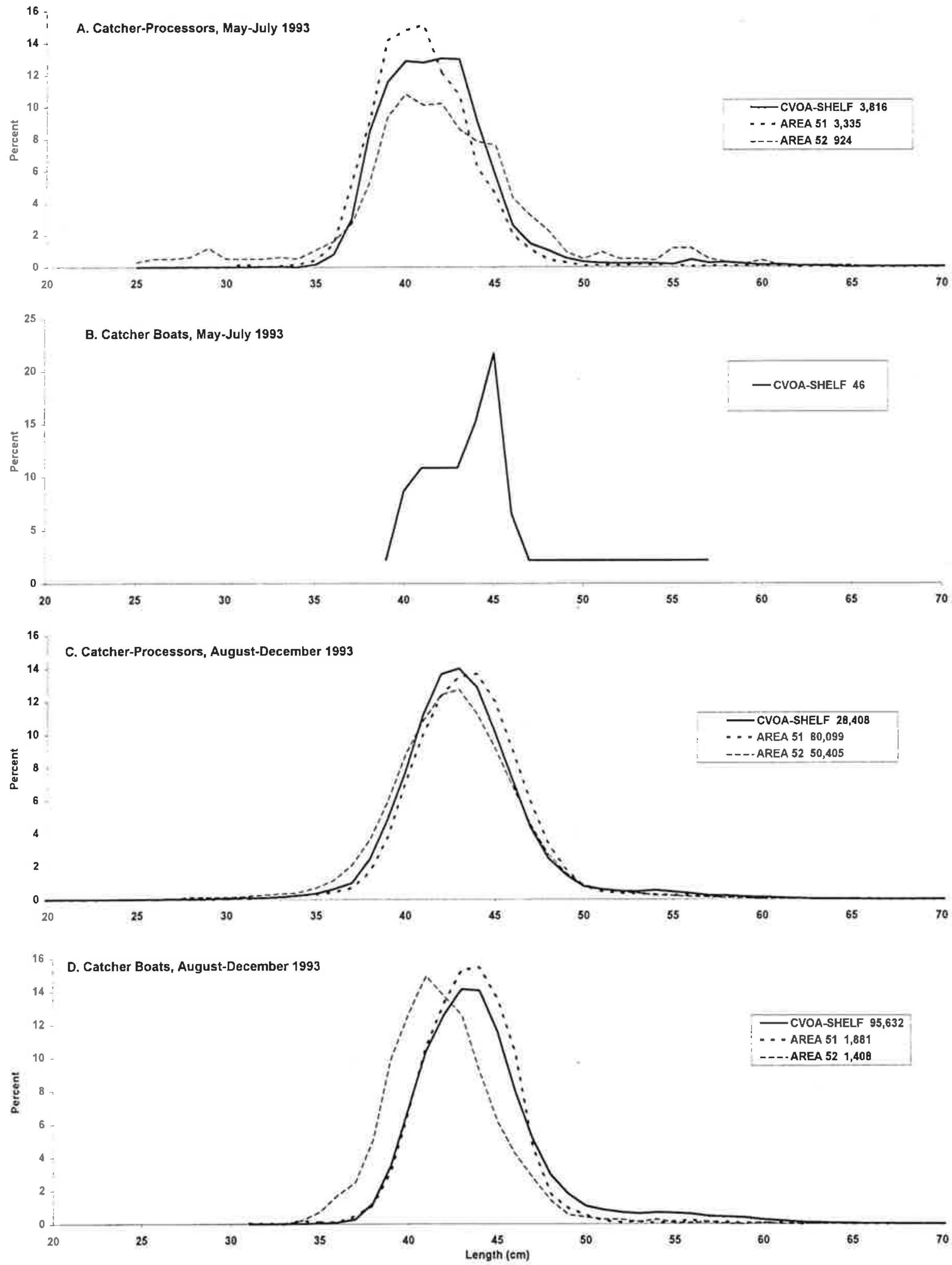


Figure 19. Pollock length-frequencies by area (see Figure 13) from observer samples taken aboard catcher processors and catcher boats in the eastern Bering Sea in May-July and August-December 1993 (pelagic trawls only). Sample sizes are shown in legend. CVOA=Catcher Vessel Operational Area.



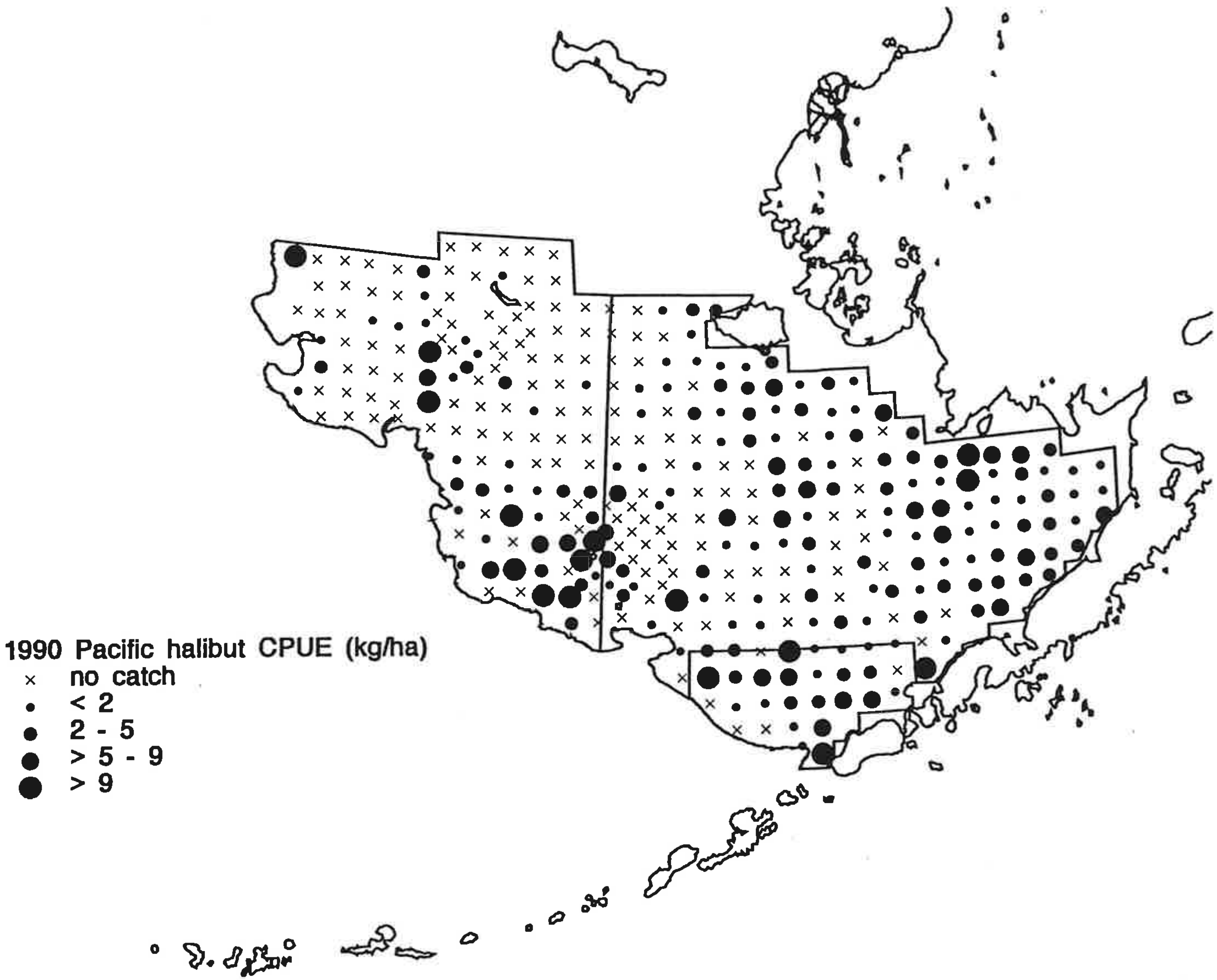


Figure 20. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Pacific halibut from 1990 eastern Bering Sea groundfish bottom trawl survey.

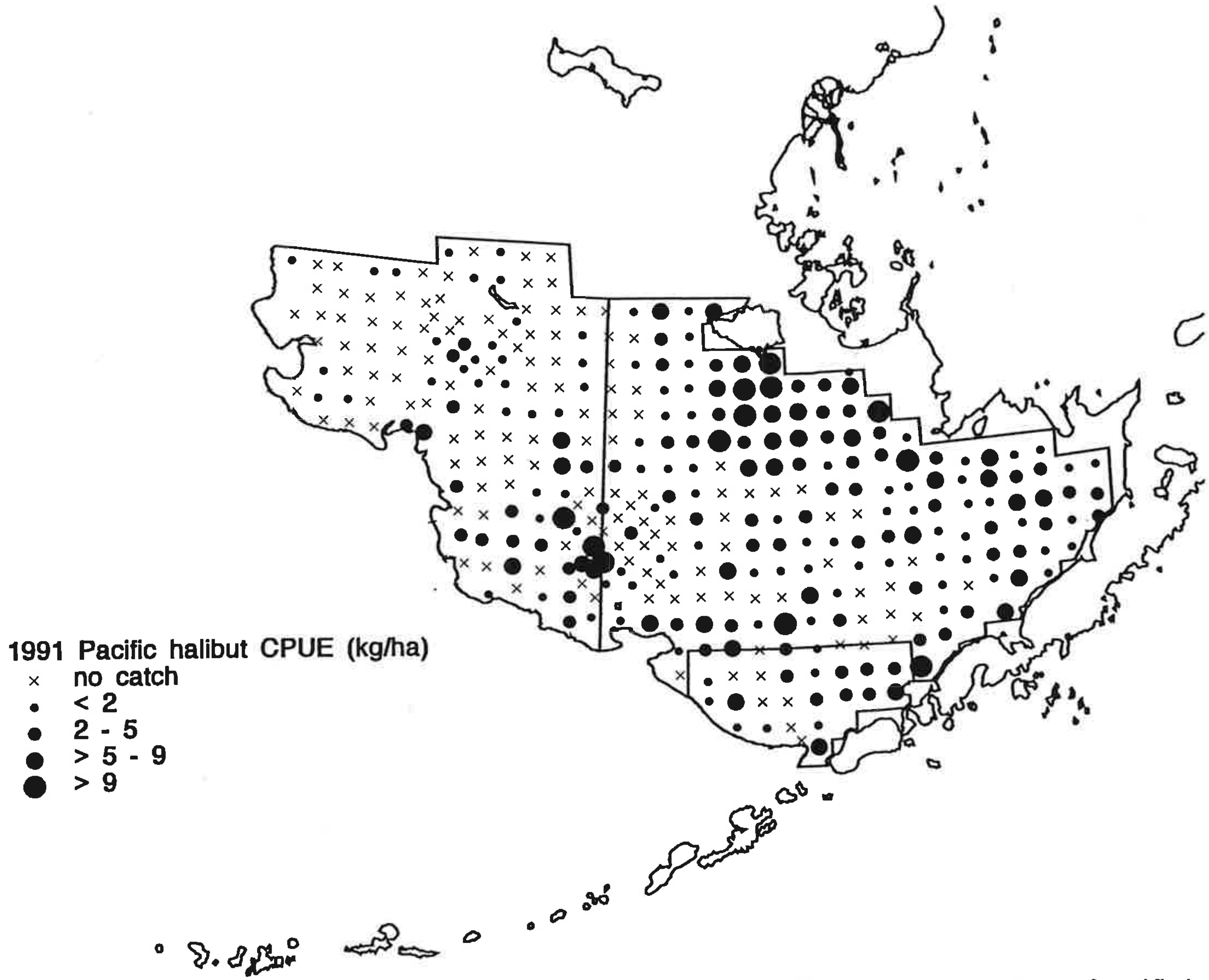


Figure 21. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Pacific halibut from 1991 eastern Bering Sea groundfish bottom trawl survey.

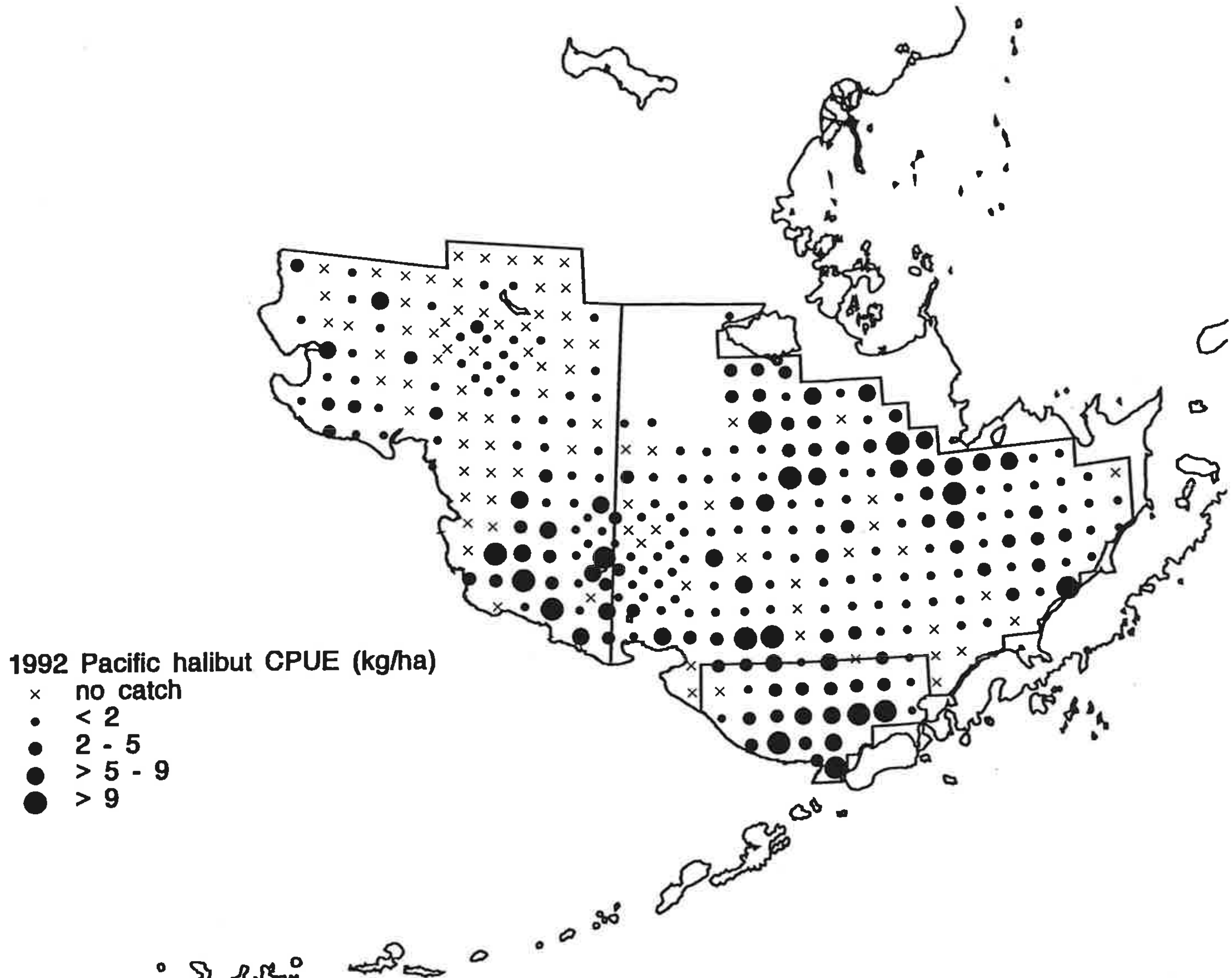


Figure 22. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Pacific halibut from 1992 eastern Bering Sea groundfish bottom trawl survey.

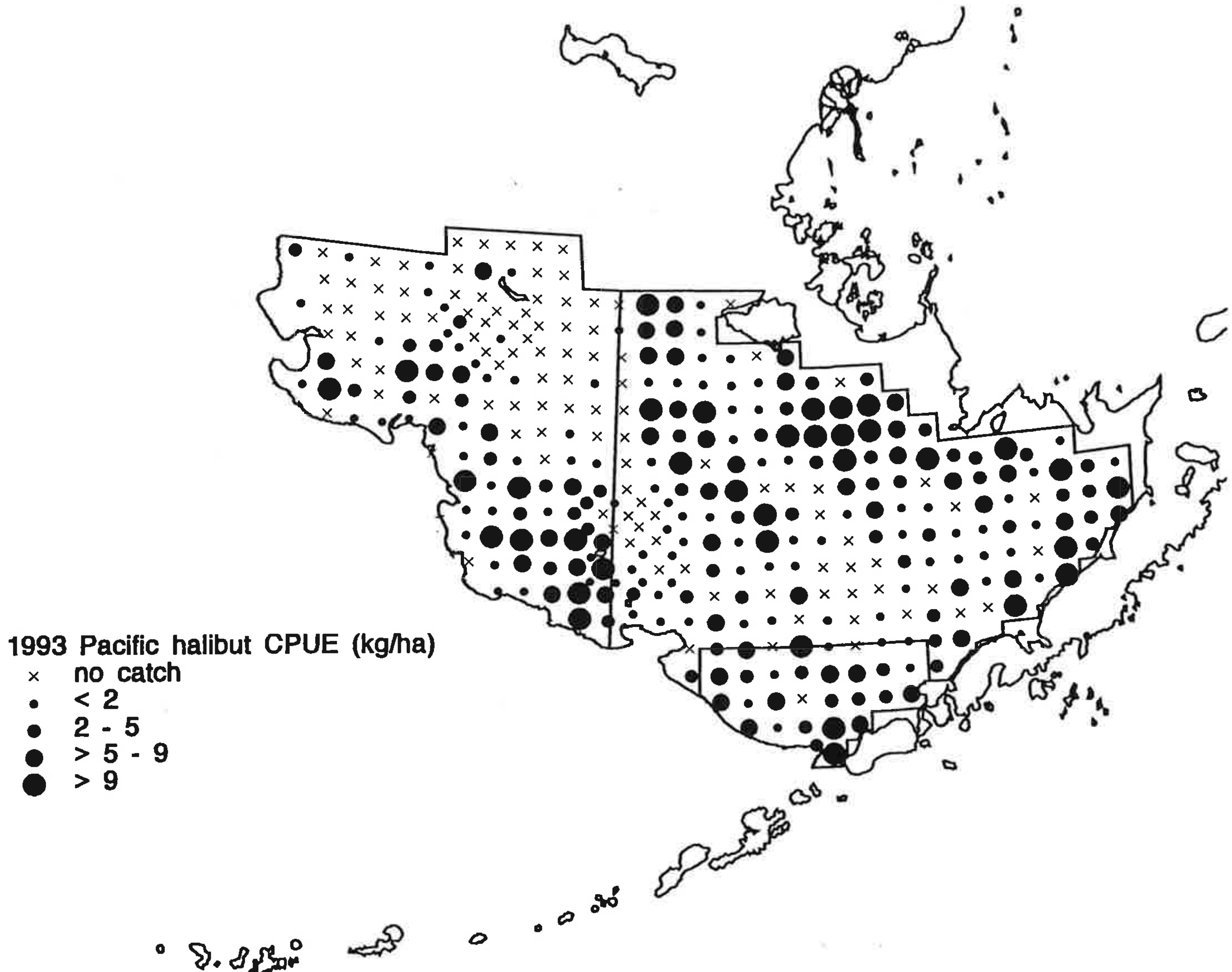


Figure 23. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Pacific halibut from 1993 eastern Bering Sea groundfish bottom trawl survey.

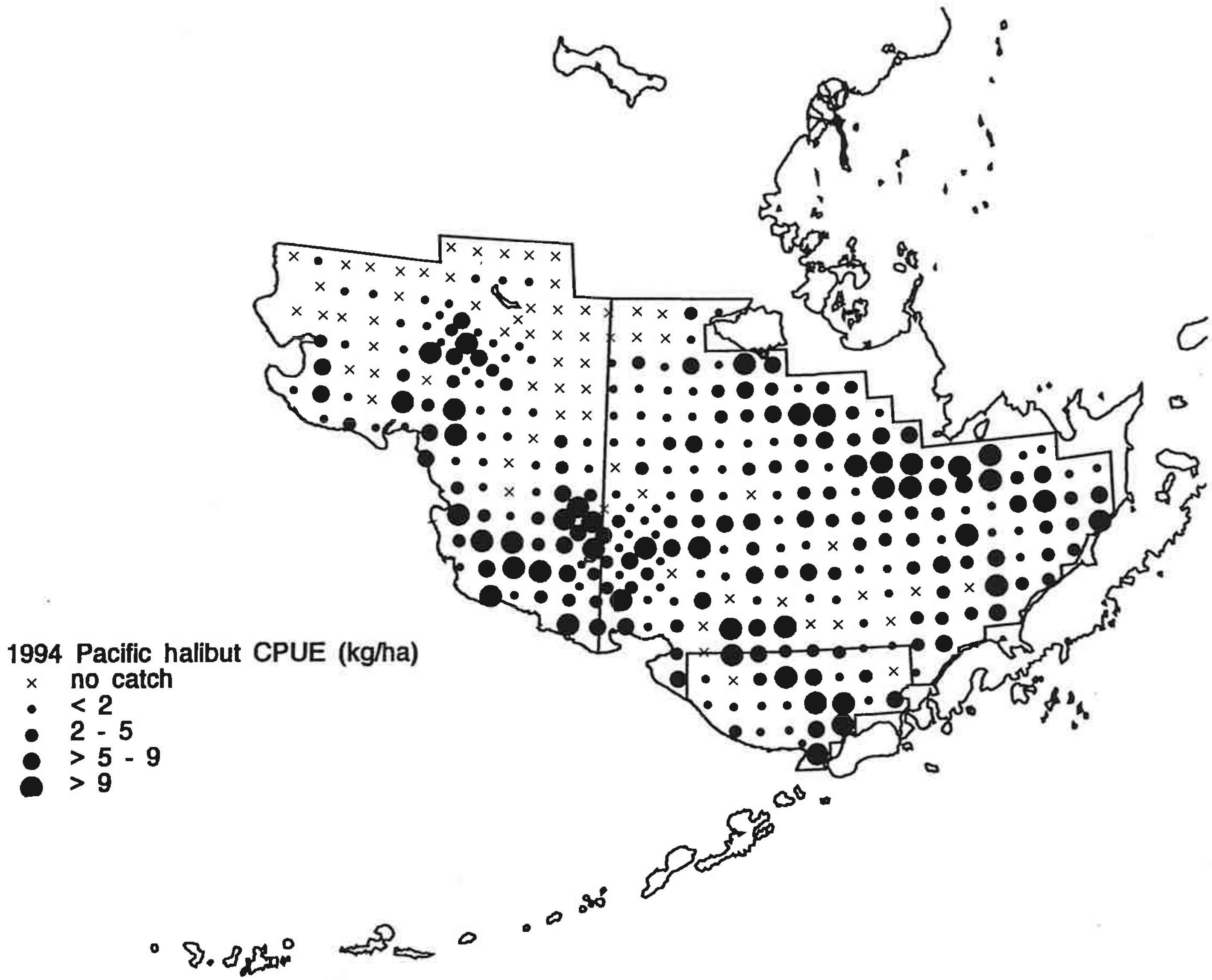


Figure 24. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Pacific halibut from 1994 eastern Bering Sea groundfish bottom trawl survey.

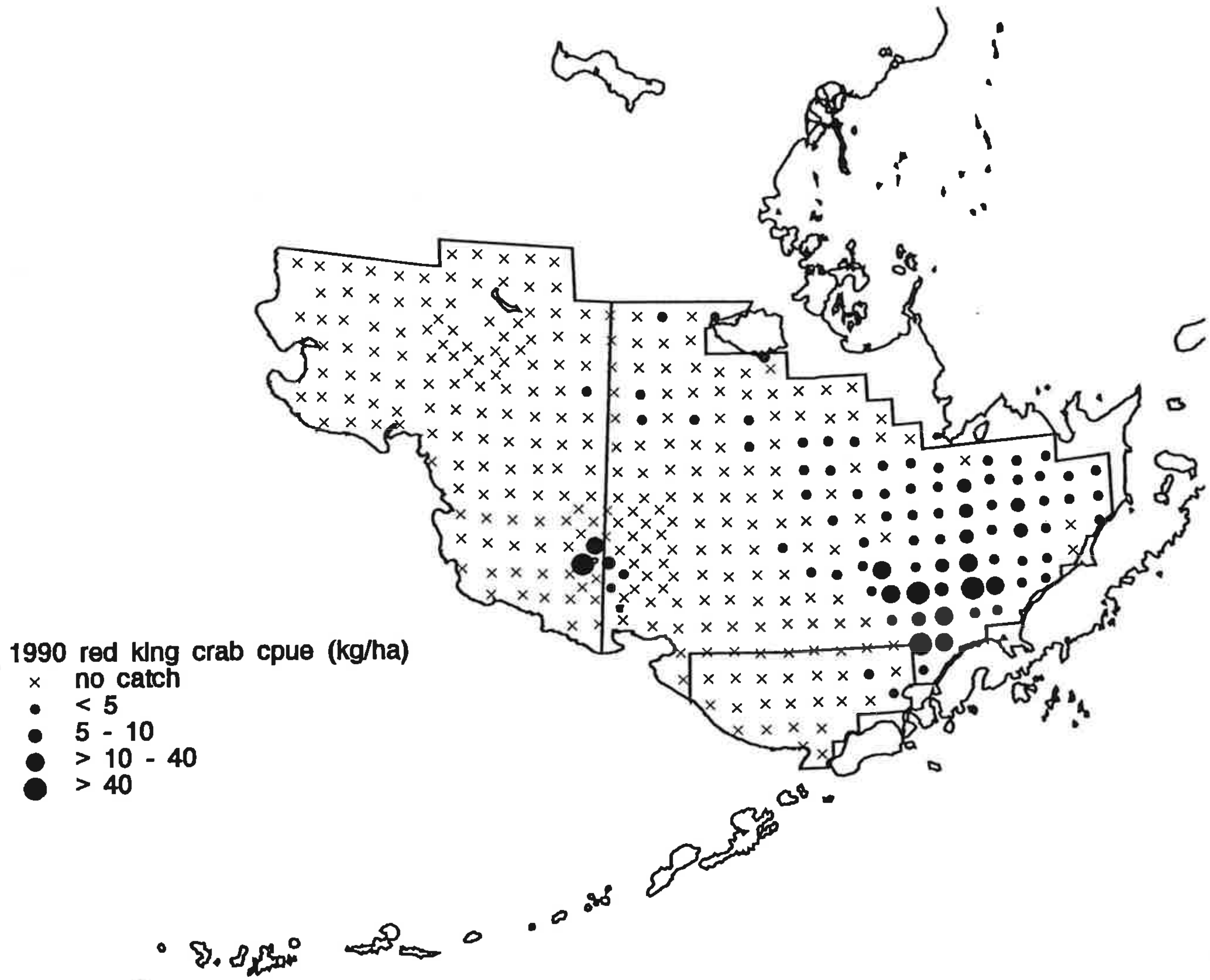


Figure 25. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of red king crab from 1990 eastern Bering Sea groundfish bottom trawl survey.

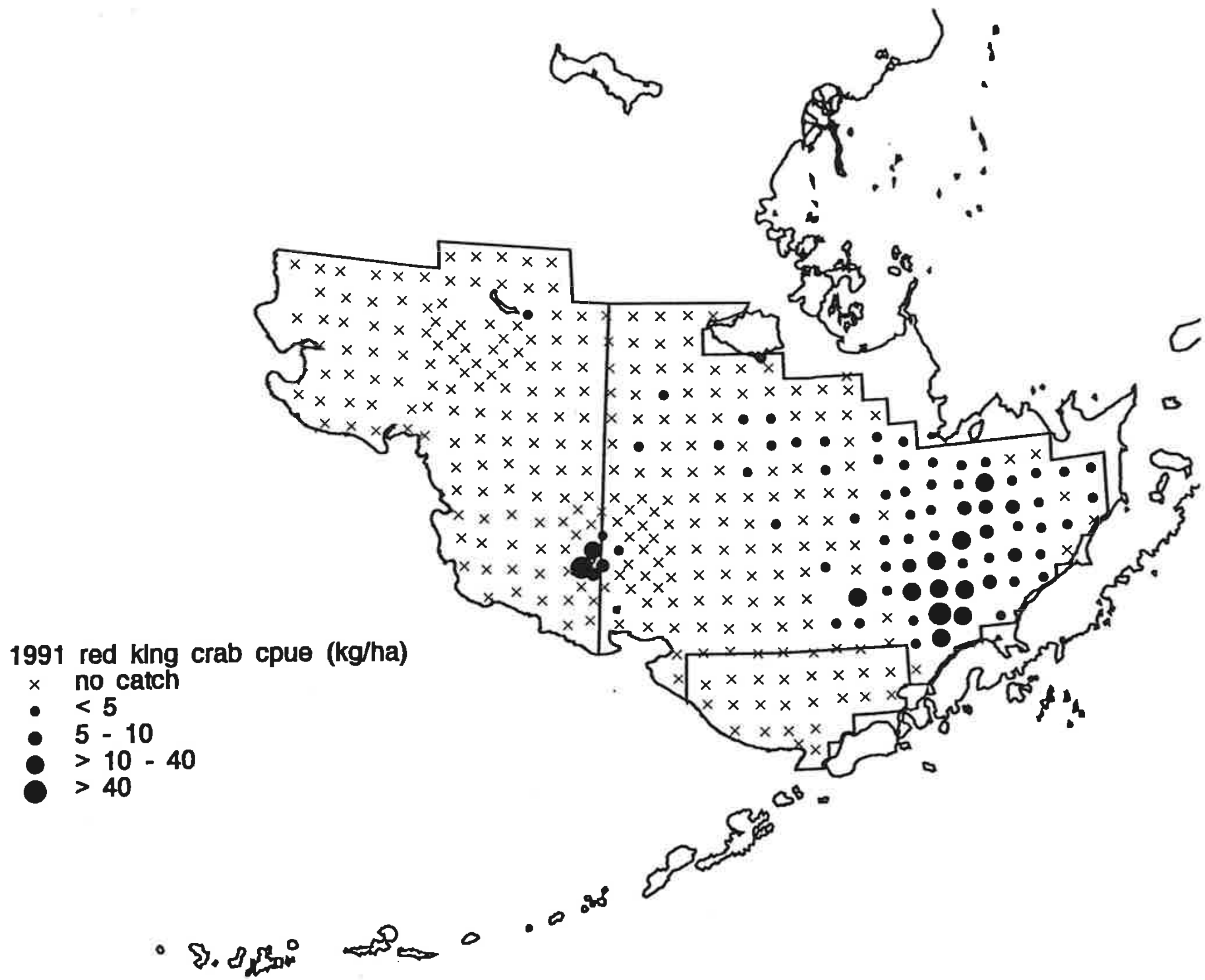


Figure 26. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of red king crab from 1991 eastern Bering Sea groundfish bottom trawl survey.

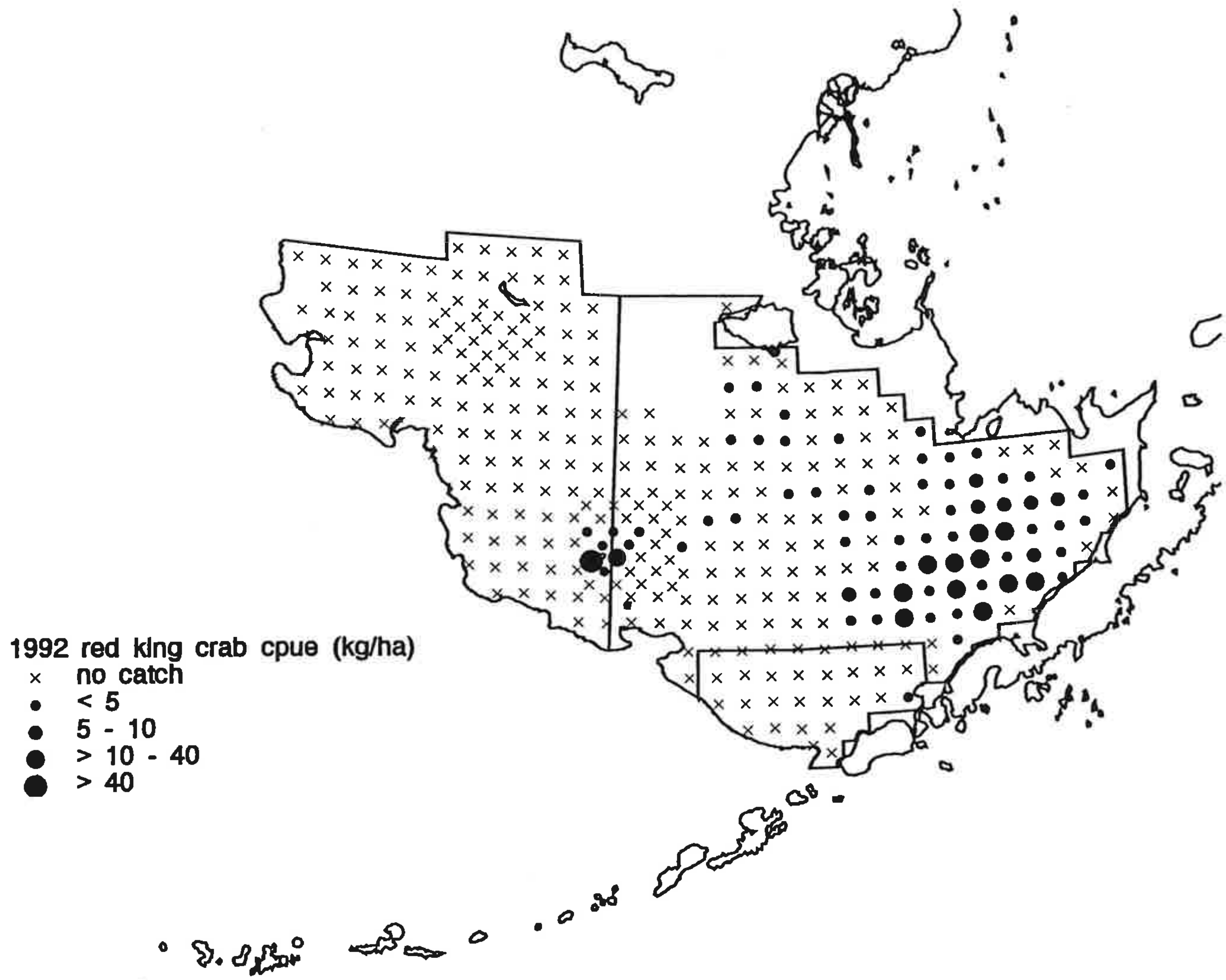


Figure 27. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of red king crab from 1992 eastern Bering Sea groundfish bottom trawl survey.

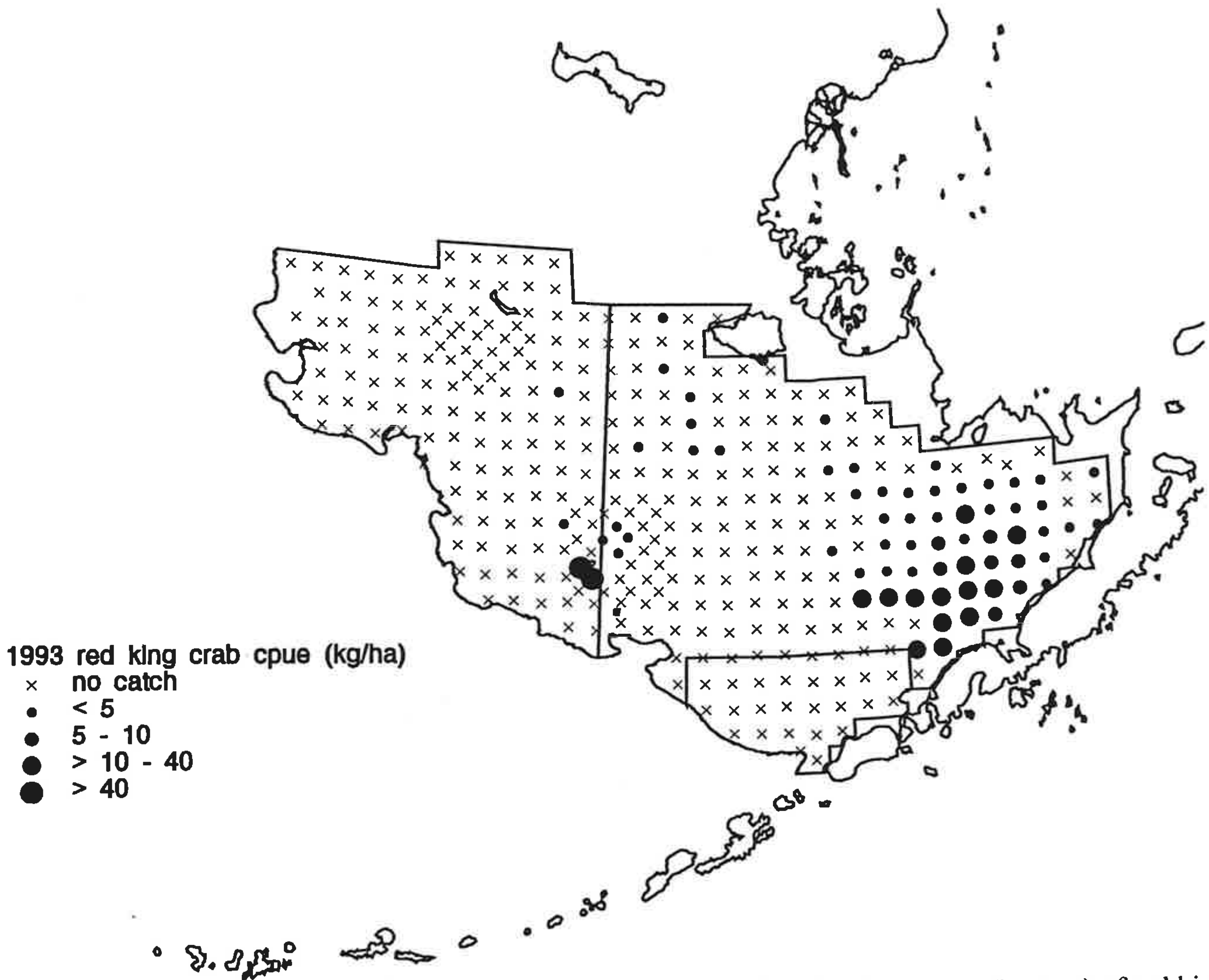


Figure 28. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of red king crab from 1993 eastern Bering Sea groundfish bottom trawl survey.

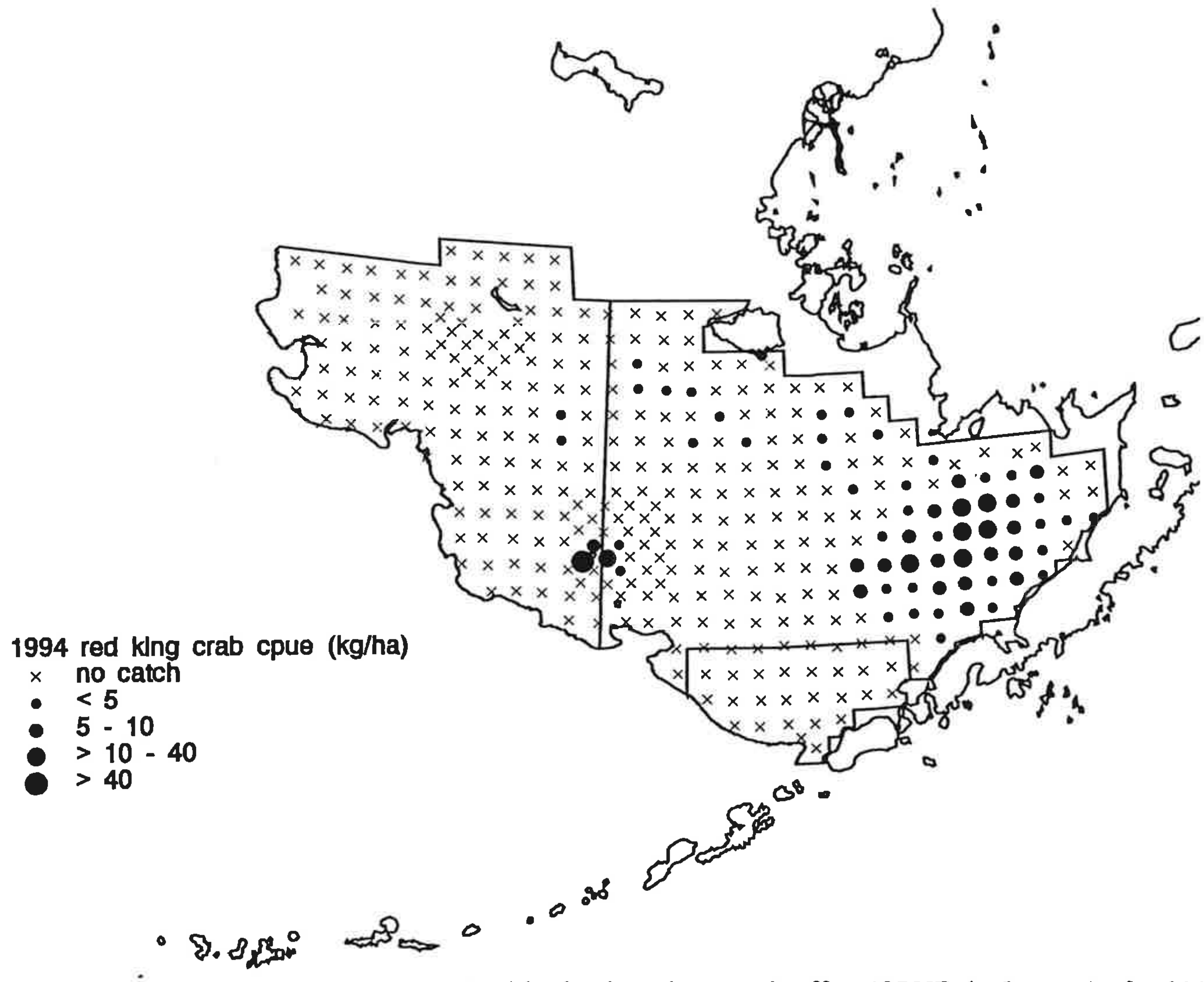


Figure 29. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of red king crab from 1994 eastern Bering Sea groundfish bottom trawl survey.

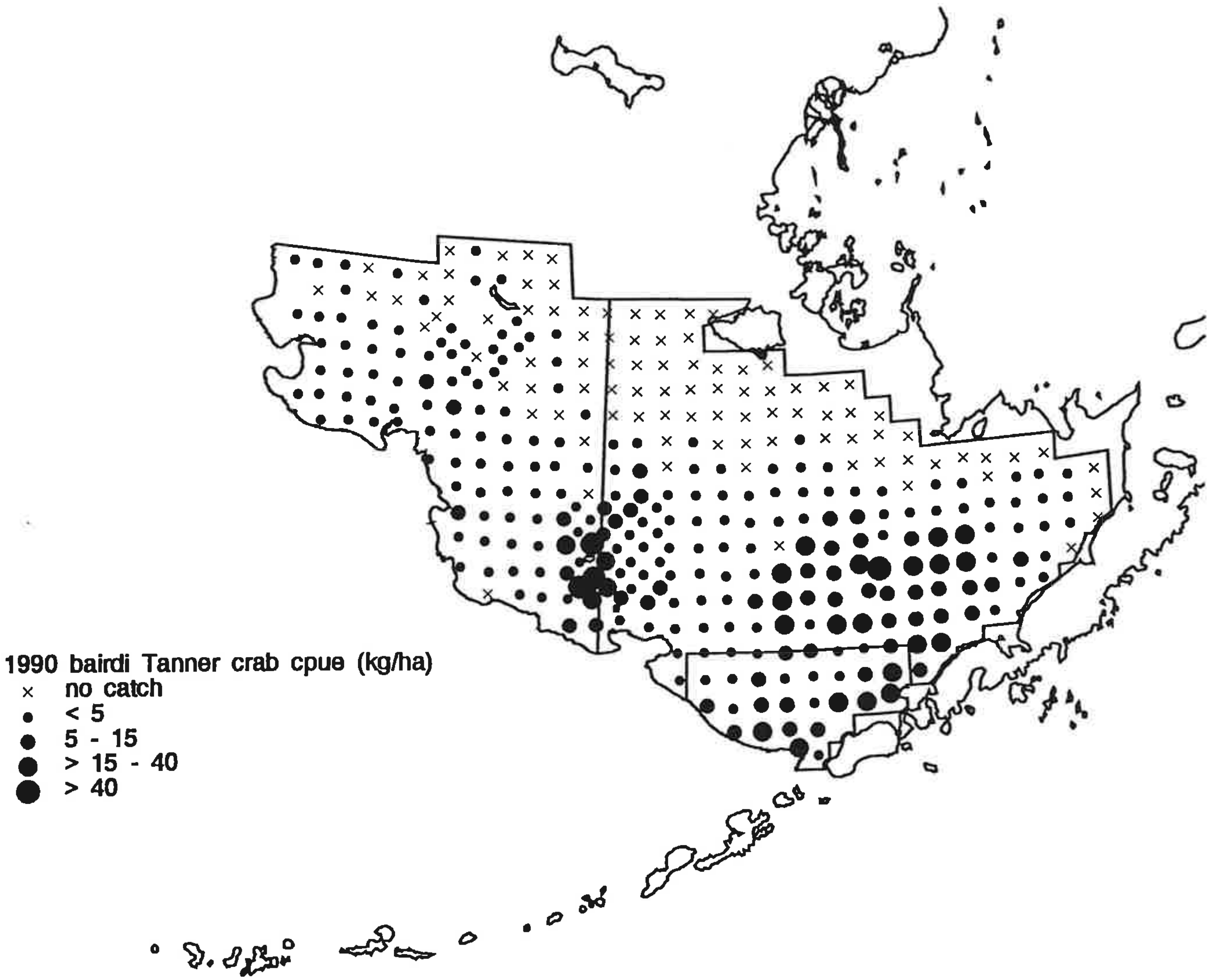


Figure 30. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Bairdi tanner crab from 1990 eastern Bering Sea groundfish bottom trawl survey.

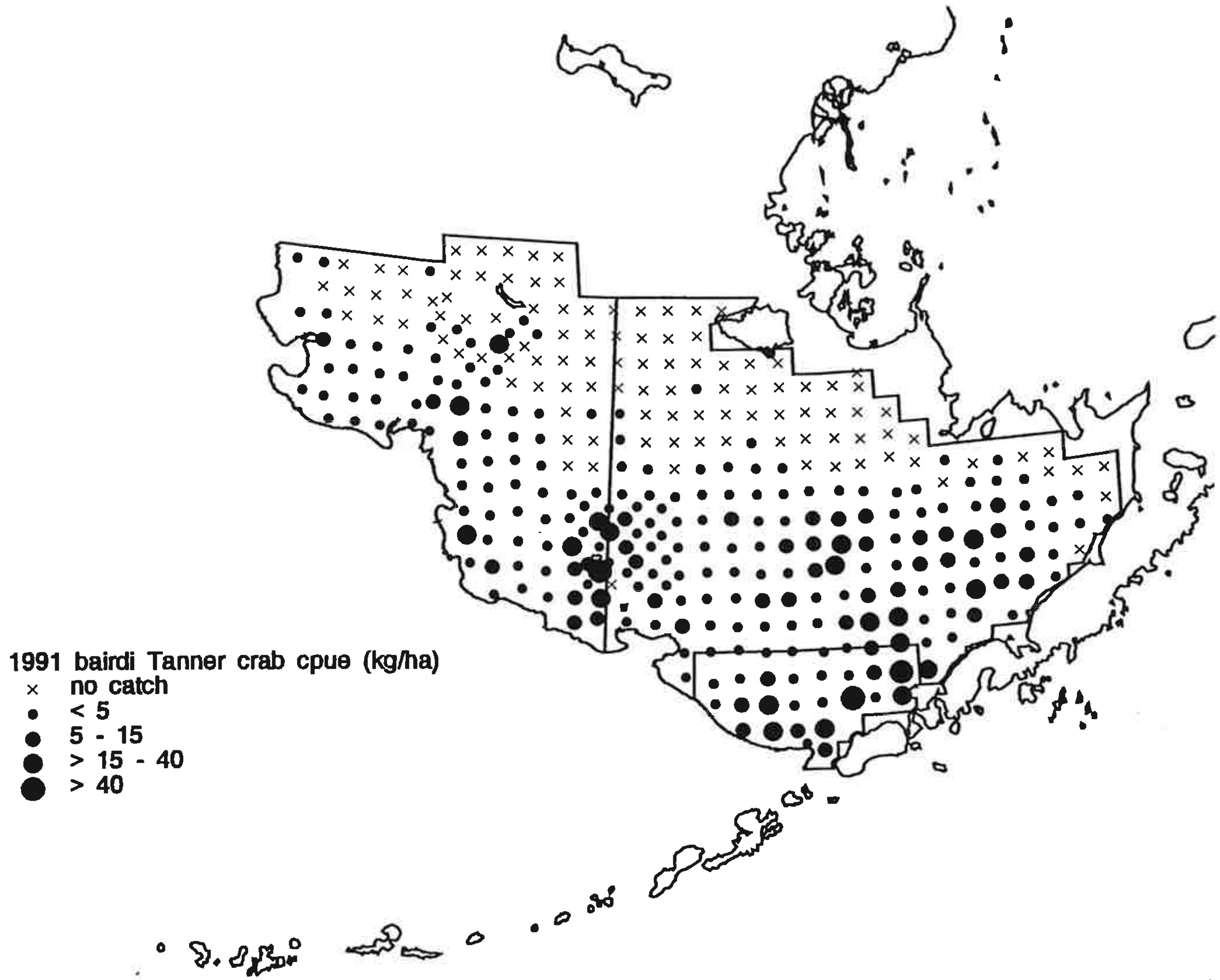


Figure 31. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Bairdi tanner crab from 1991 eastern Bering Sea groundfish bottom trawl survey.

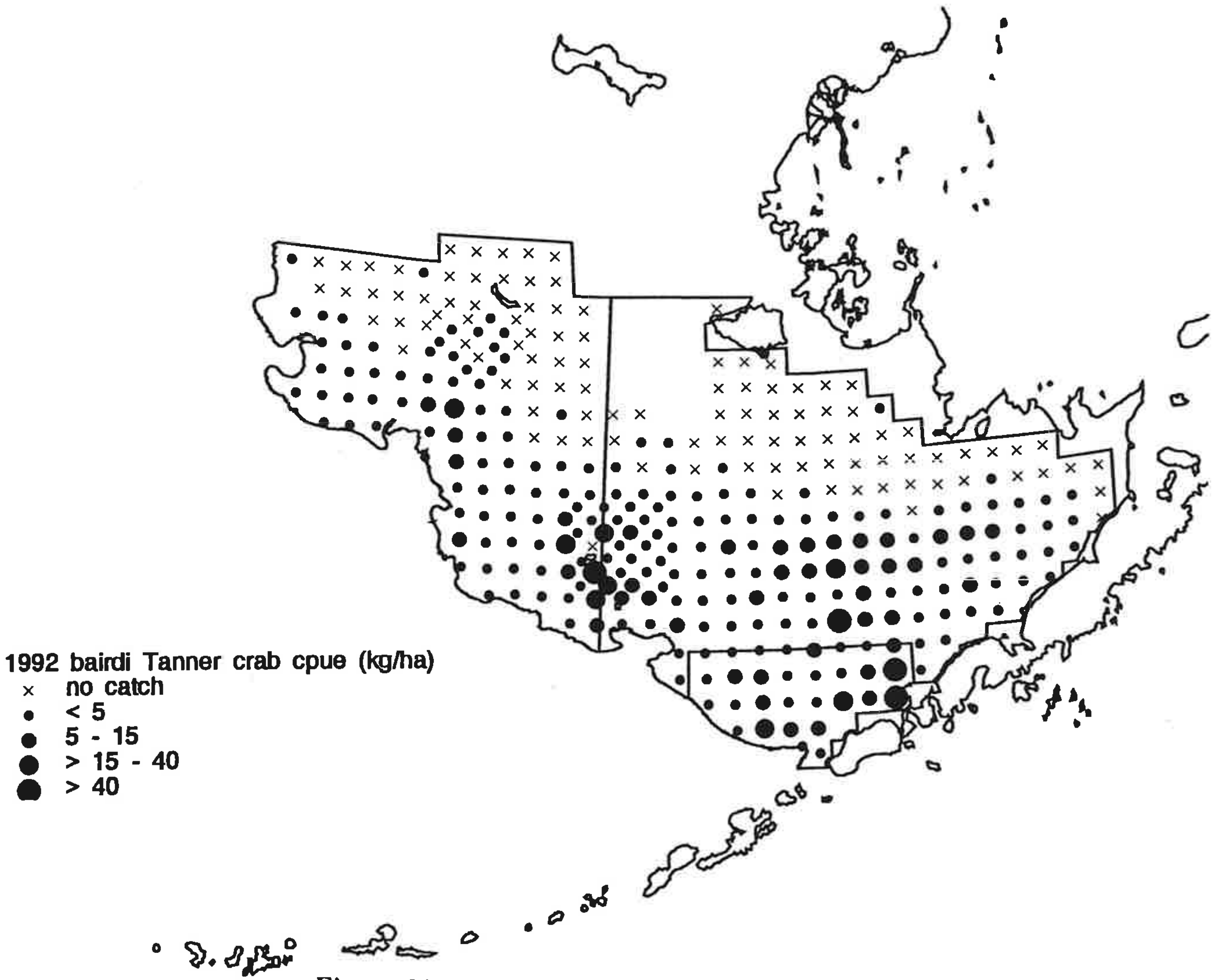


Figure 32. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Bairdi tanner crab from 1992 eastern Bering Sea groundfish bottom trawl survey.

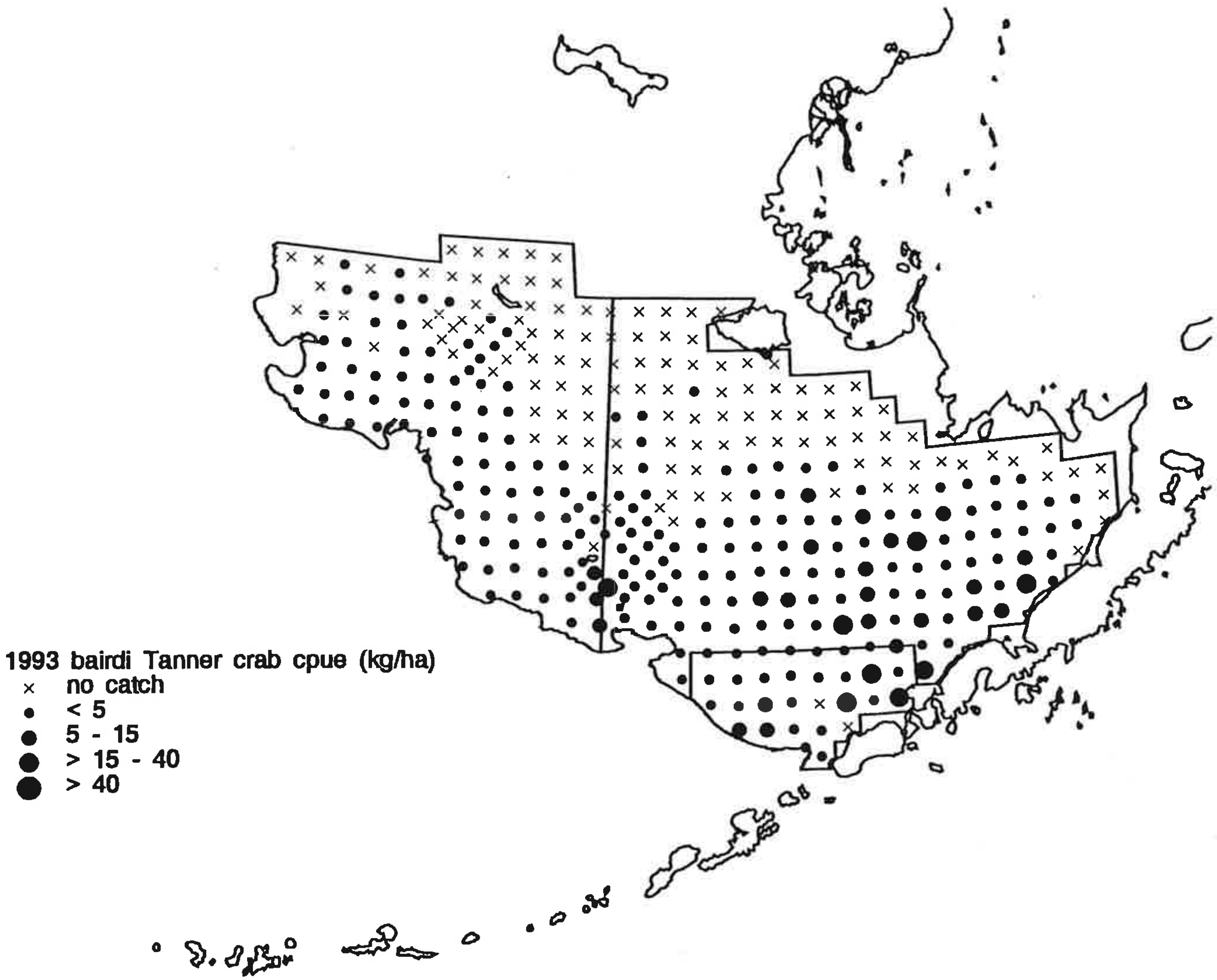


Figure 33. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Bairdi tanner crab from 1993 eastern Bering Sea groundfish bottom trawl survey.

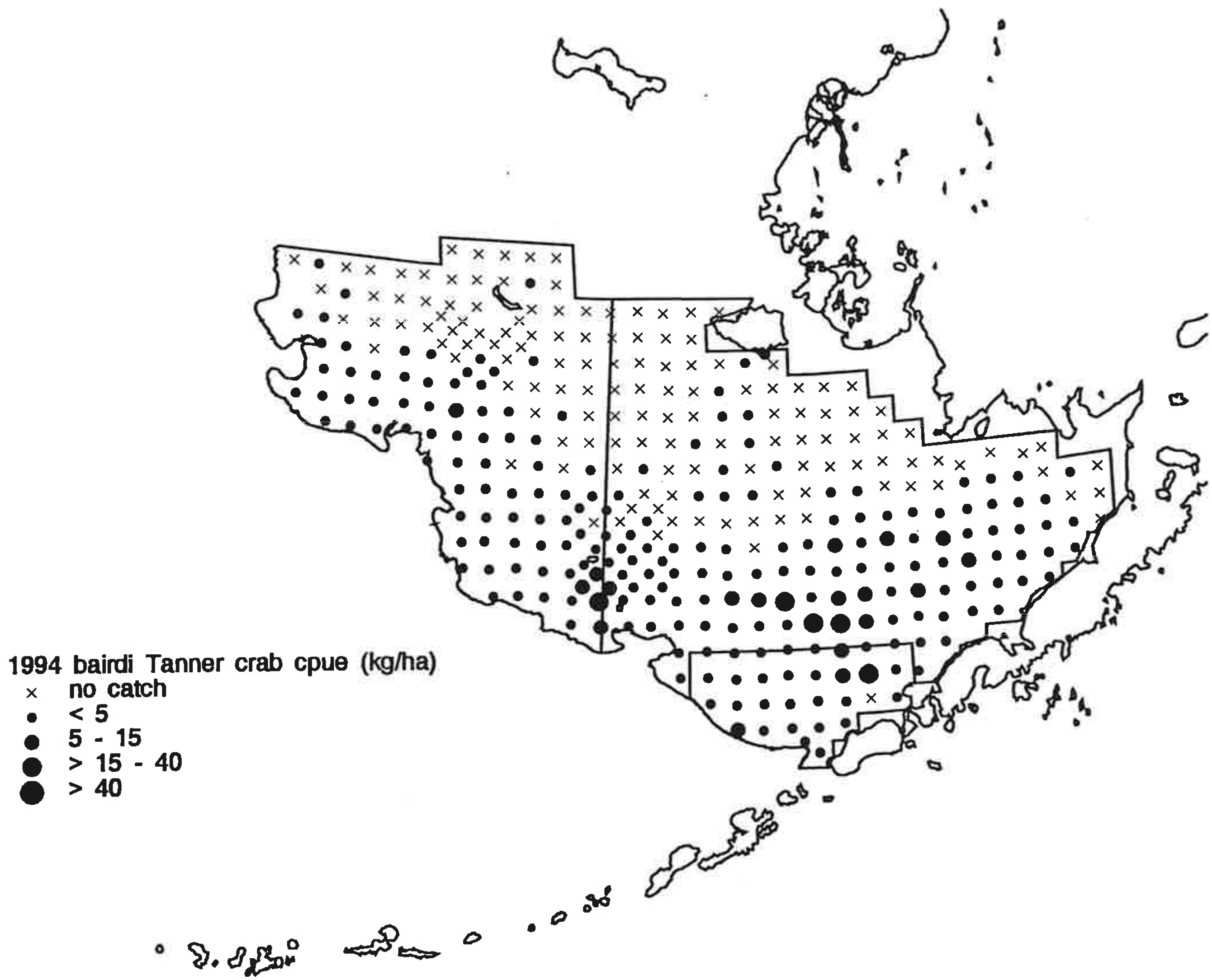


Figure 34. Haul-by-haul catch-per-unit-effort (CPUE=kg/hectare) of Bairdi tanner crab from 1994 eastern Bering Sea groundfish bottom trawl survey.

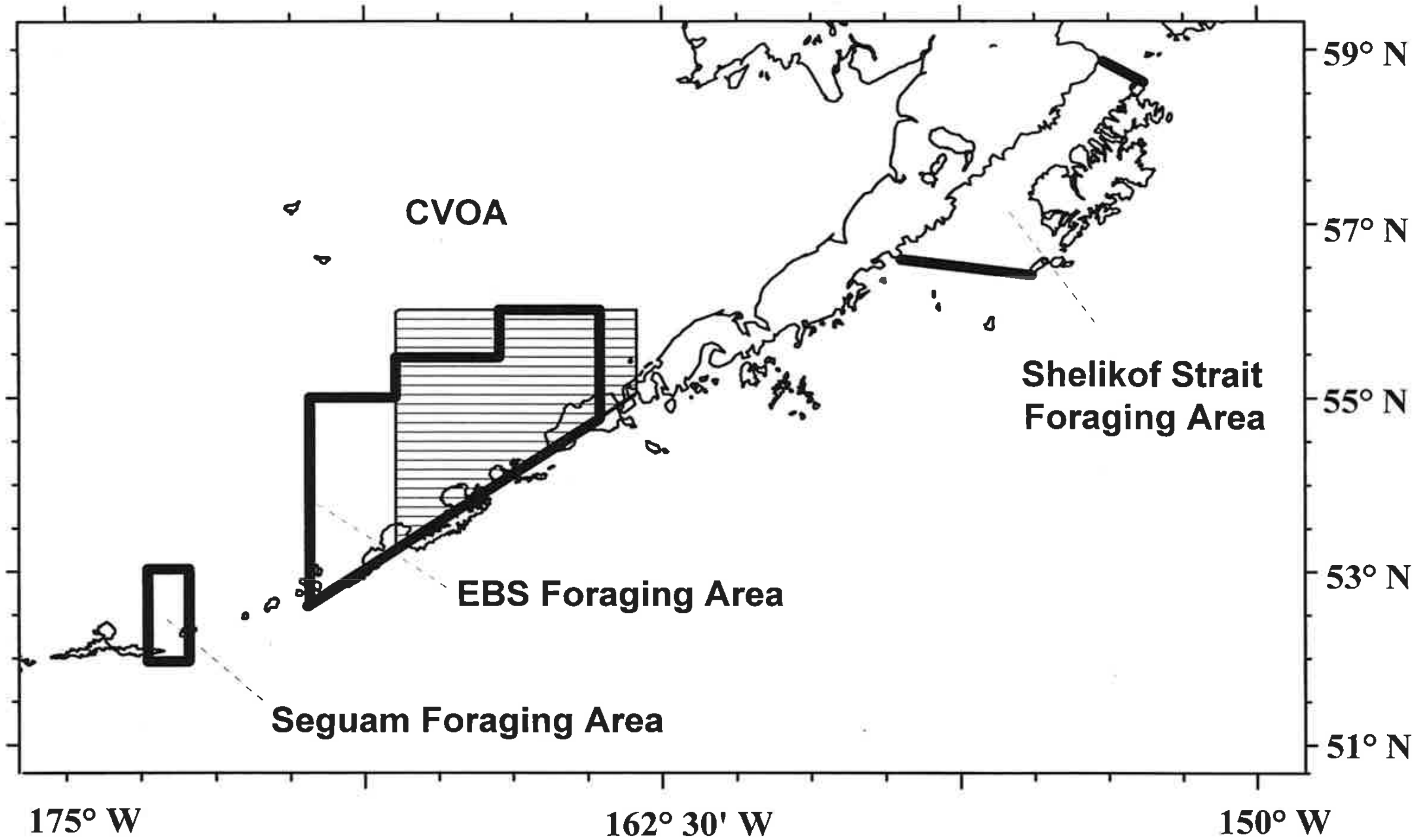
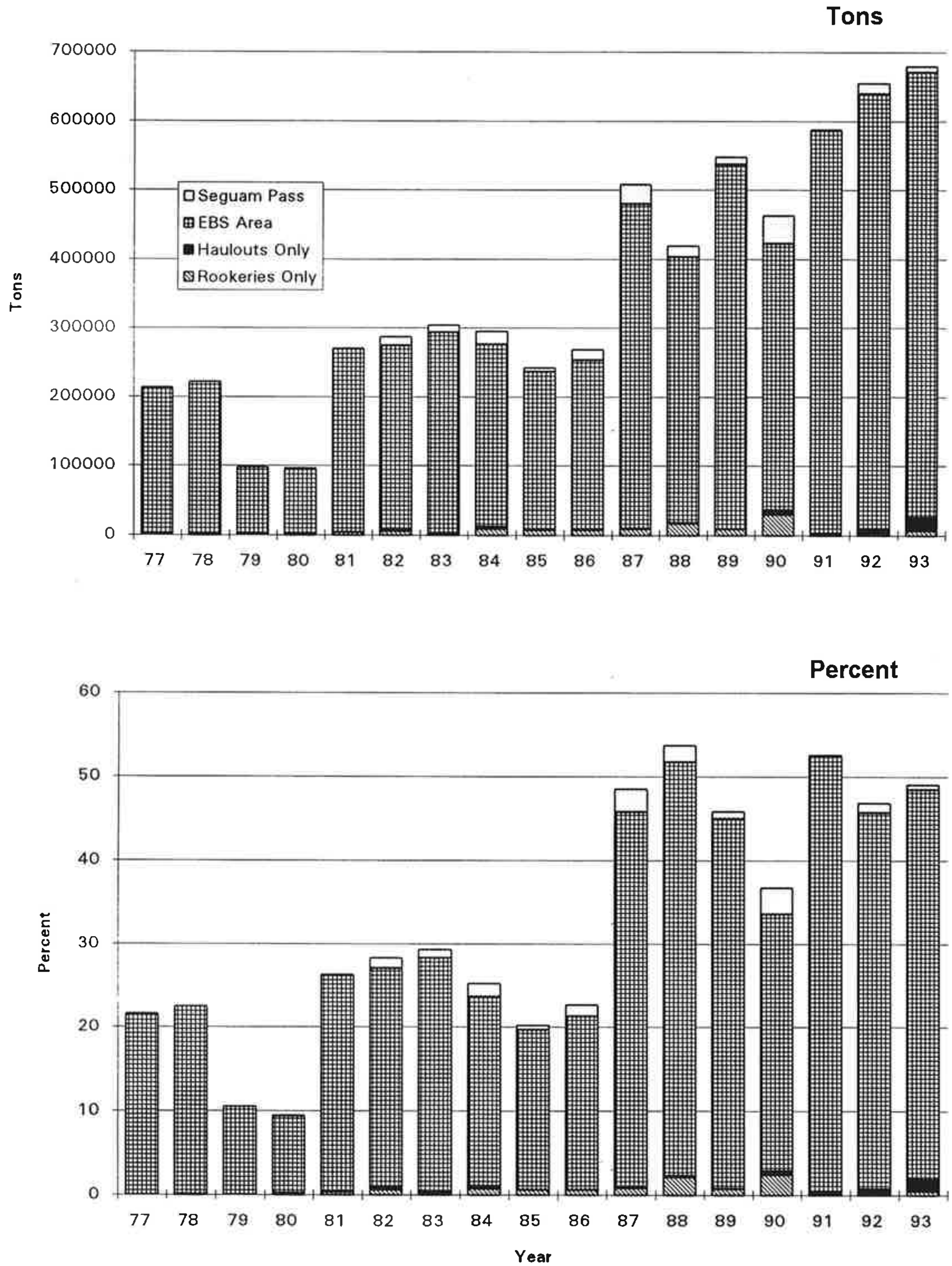


Figure 35. Critical habitat foraging areas designated for the Steller sea lion in Seguam Pass (Aleutian Islands fishery management area), eastern Bering Sea (EBS; Bering Sea fishery management area), and Shelikof Strait (Gulf of Alaska fishery management area). The Catcher Vessel Operational Area (CVOA) is also shown.

Figure 36. Pollock catches within critical habitat for the Steller sea lion in the Bering Sea and Aleutian Islands (BSAI; top) and percent of total BSAI pollock catch caught within critical habitat (bottom). See Figure 35 for areas; EBS=eastern Bering Sea.



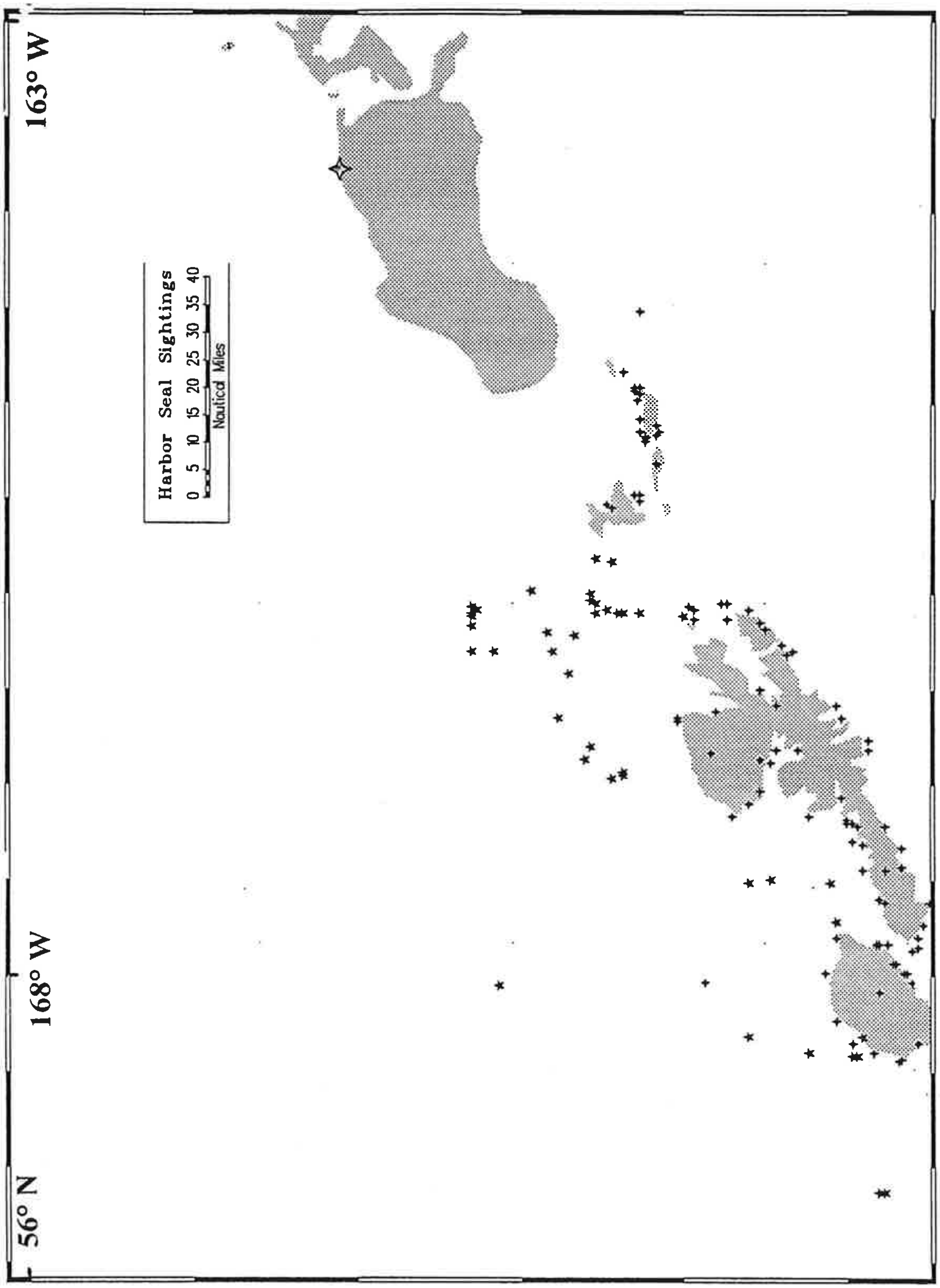
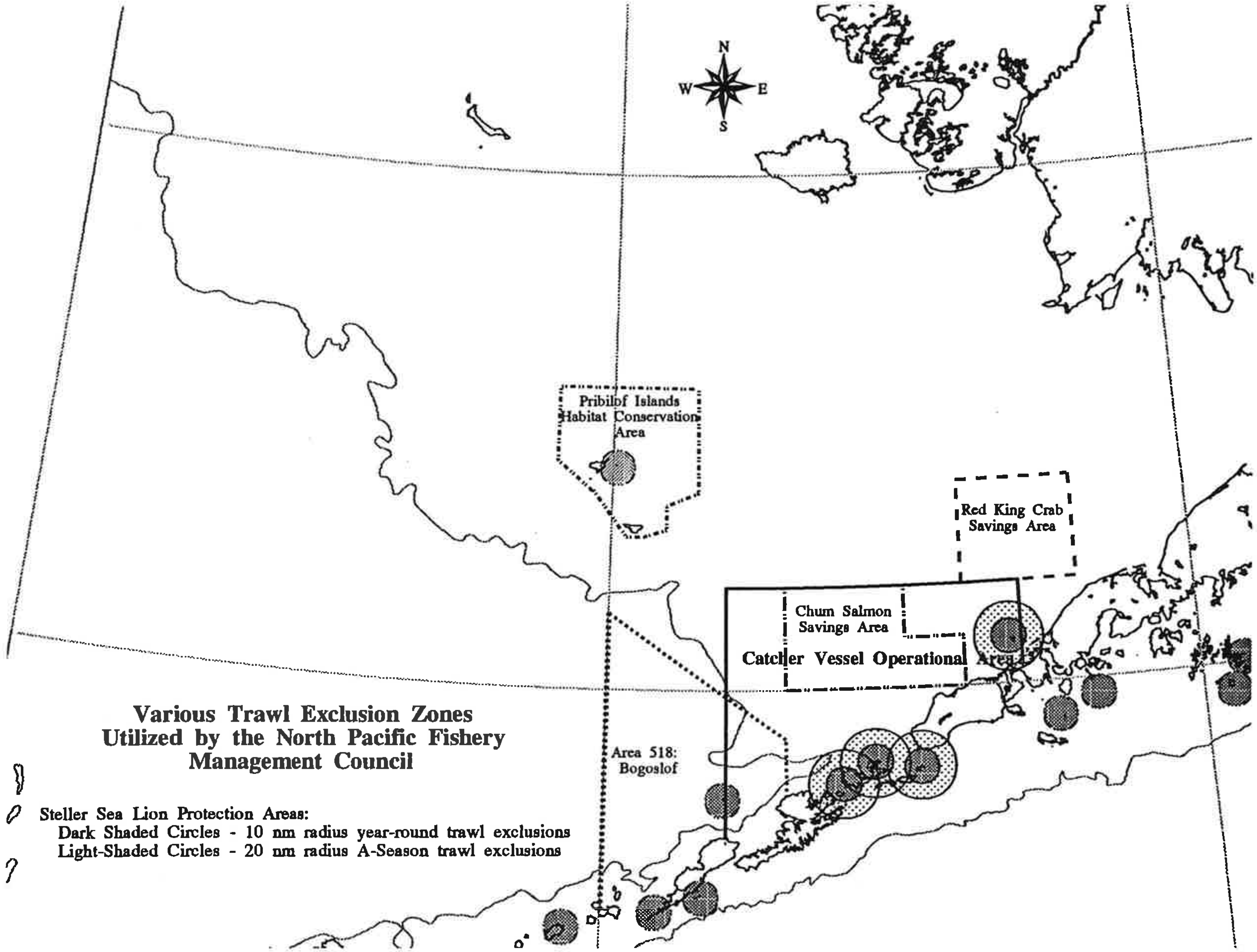


Figure 37. Locations in the eastern Aleutian Islands where Pacific harbor seals were sighted during the 1994 Aleutian Islands harbor seal survey (small four-pointed diamonds) and other sources (stars).

Appendix 1. Pollock fishery pelagic trawl locations and catch-per-unit-effort (CPUE=tons pollock/hours trawled) by season (A, B and CDQ) and year (1990-93). The first figure identifies the various trawl exclusion zones shown on the following charts. Trawl locations are shaded by CPUE. CPUE within a season and year and across all fishery processor types (catcher-processors, motherships, catcher boats) was sorted by quartiles. Trawl locations where CPUE was in the lowest 25% of all season-year data are labelled with open circles. Trawl locations where CPUE was in the upper 25% of all season-year data are labelled with dark-filled circles. Trawl locations were CPUE was in the middle 50% of all season-year data are labelled with two shades of gray circles. Numbers in parentheses indicate the upper value (in t/hour) of the range (mt/hour=metric tons/hour=t/hour).

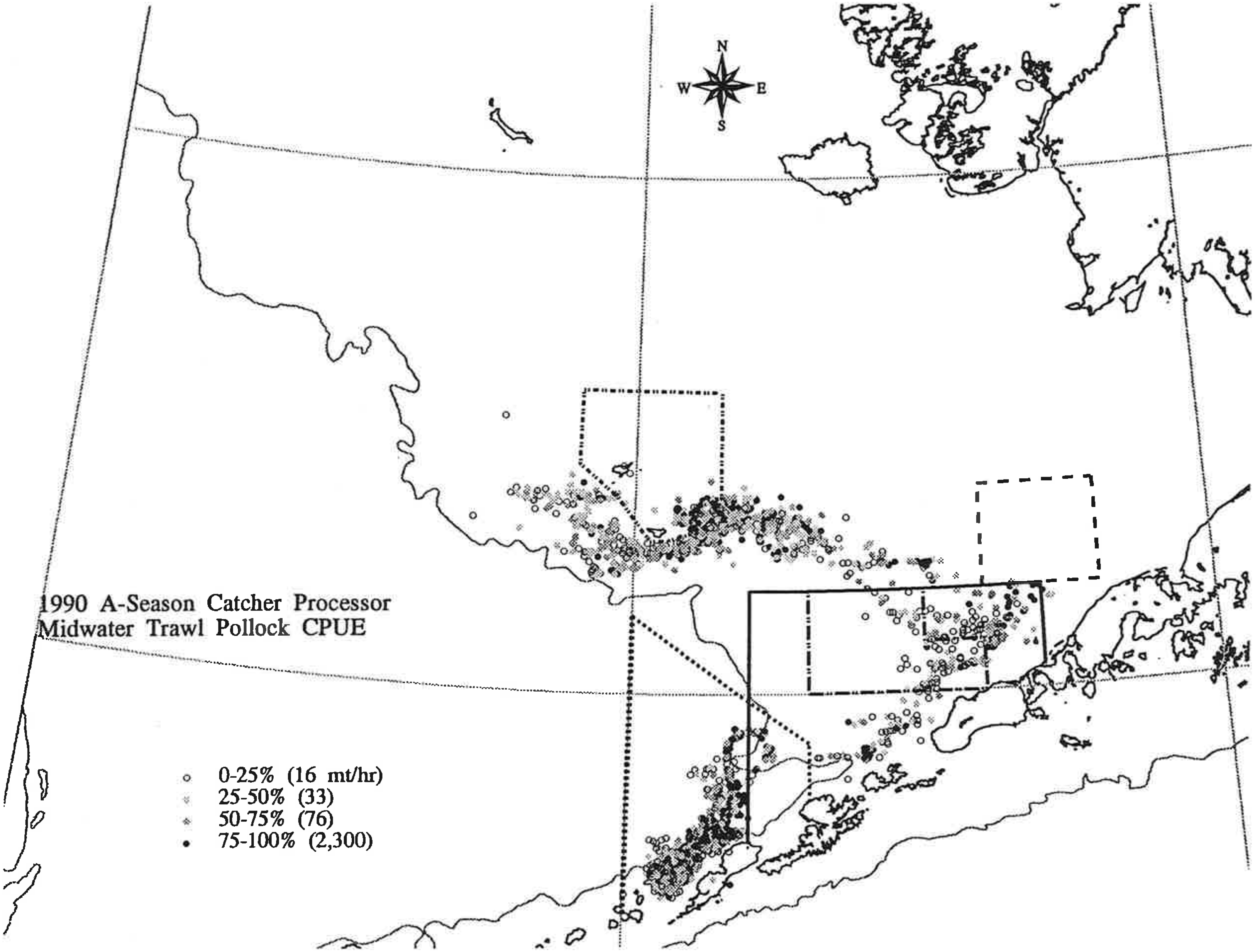
For instance, in the first plot:
0-25% (16 t/hr) = the lower 25% of the data, ranging from 0-16 t pollock/hour;
25-50% (33) = the second quartile of data, ranging from 16-33 t pollock/hour (33 t/hour is the median);
50-75% (76) = the third quartile of data, ranging from 33-76 t pollock/hour ;
75-100% (2,300) = the fourth quartile of data, ranging from 76-2,300 t pollock/hour (a CPUE value of 2,300 t/hr would be from a very short haul that caught large numbers of pollock).

A-Season each year = January-April.
B-Seasons:
1990: June 1-October 13;
1991: June 1-September 4;
1992: June 1-September 22 for onshore, June 1-July 28 for offshore;
1993: August 15-October 3 for onshore, August 15-September 22 for offshore.
CDQ-Seasons:
1992: December
1993: June 1-August 14 and September 23-December 31.

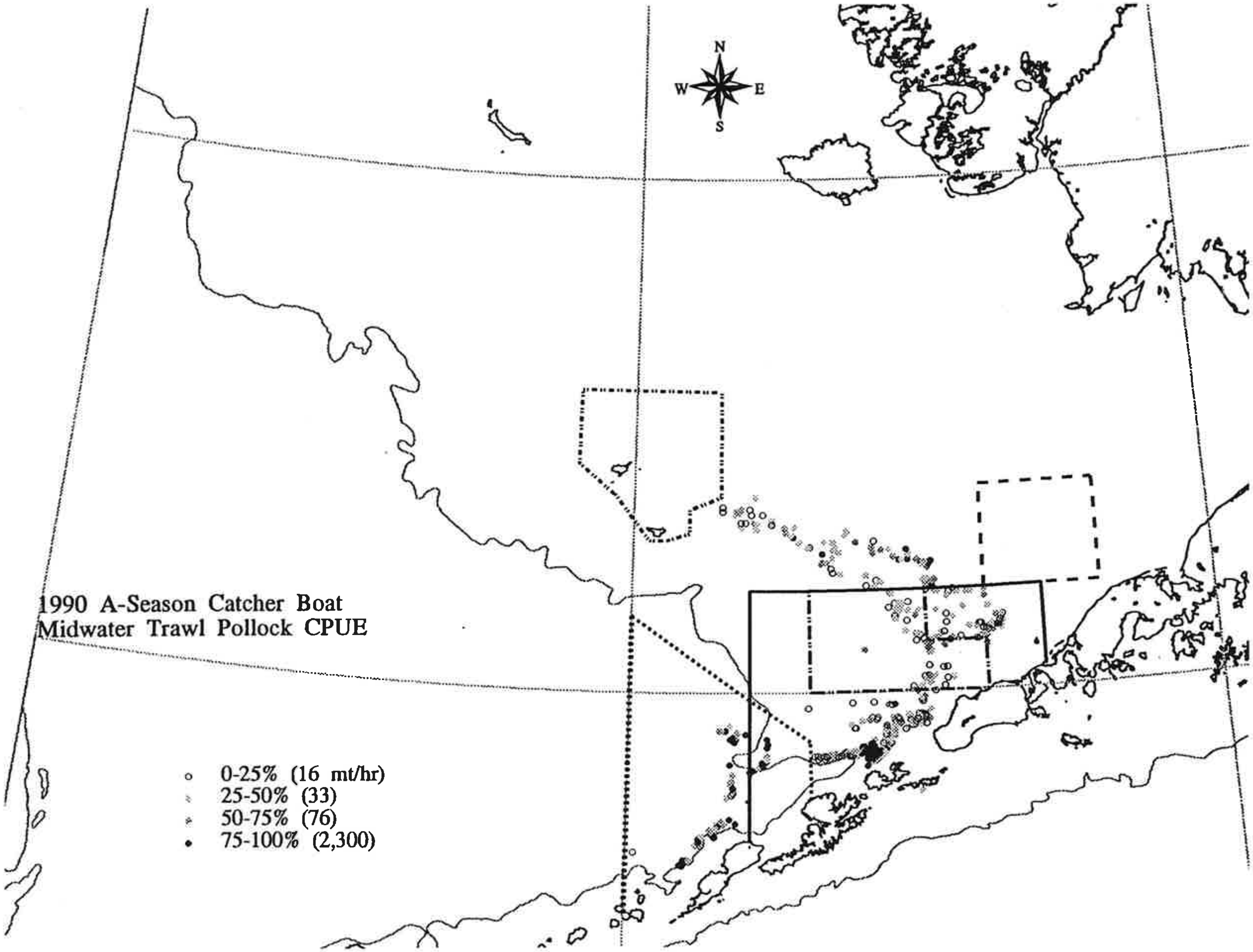


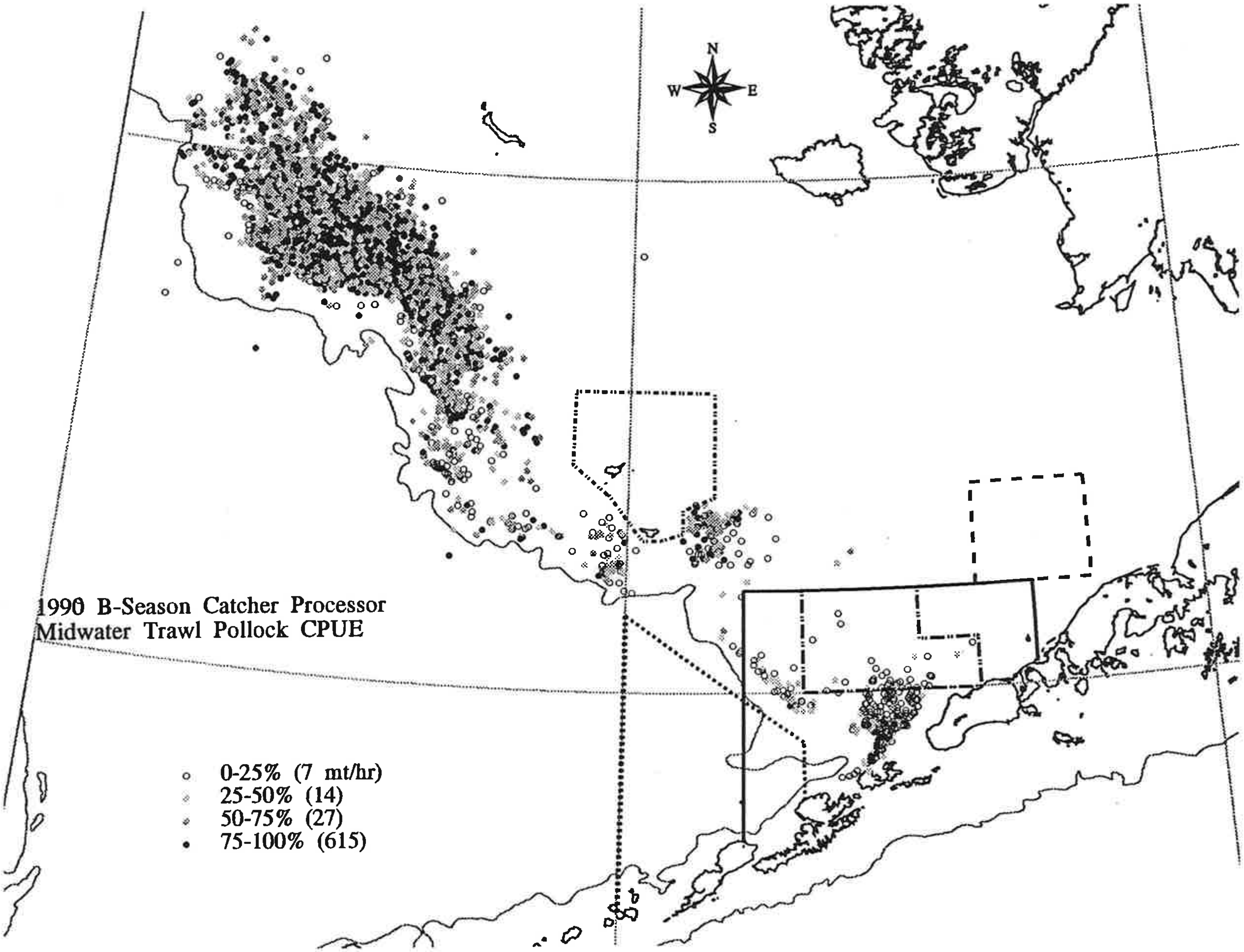
Various Trawl Exclusion Zones Utilized by the North Pacific Fishery Management Council

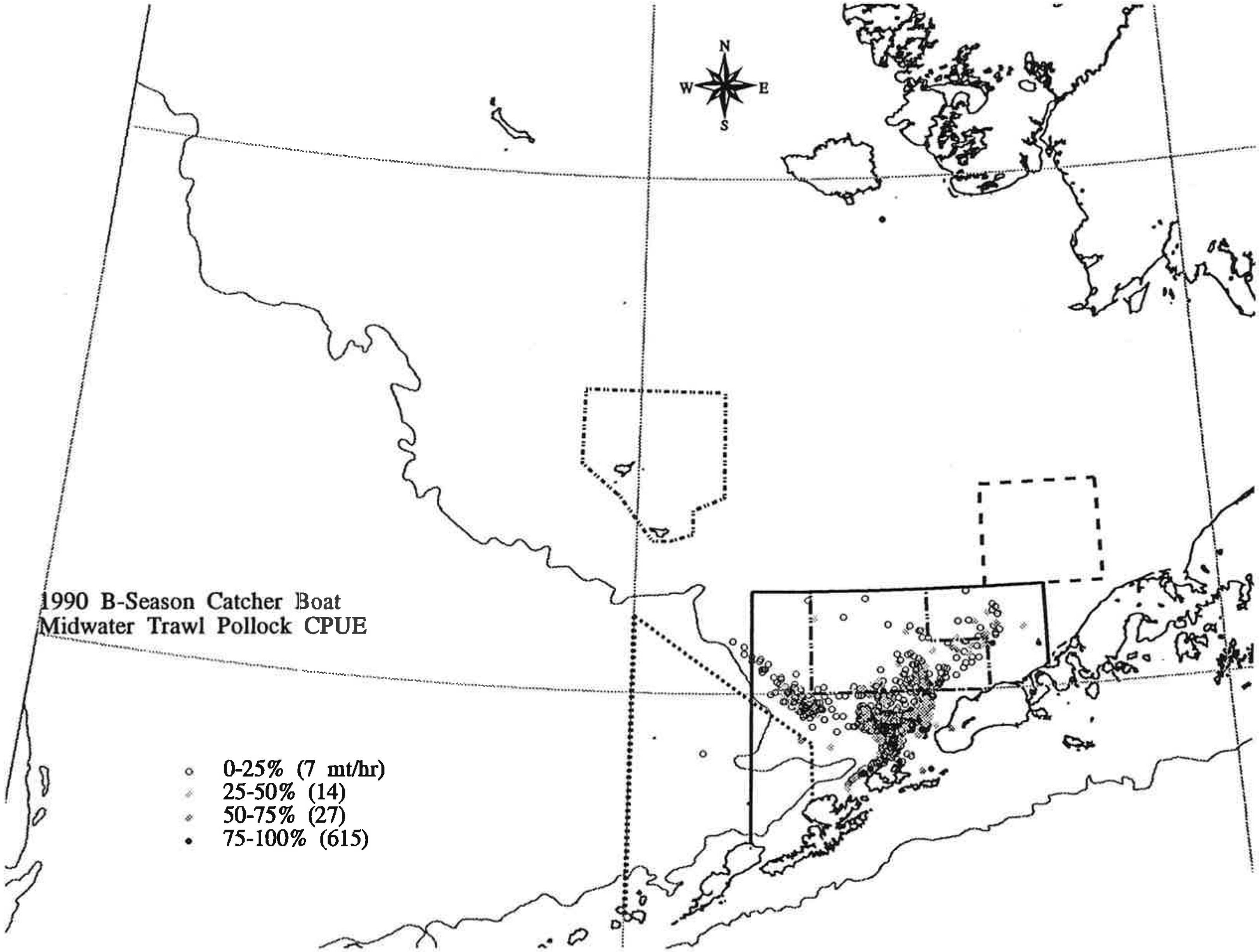
Steller Sea Lion Protection Areas:
Dark Shaded Circles - 10 nm radius year-round trawl exclusions
Light-Shaded Circles - 20 nm radius A-Season trawl exclusions

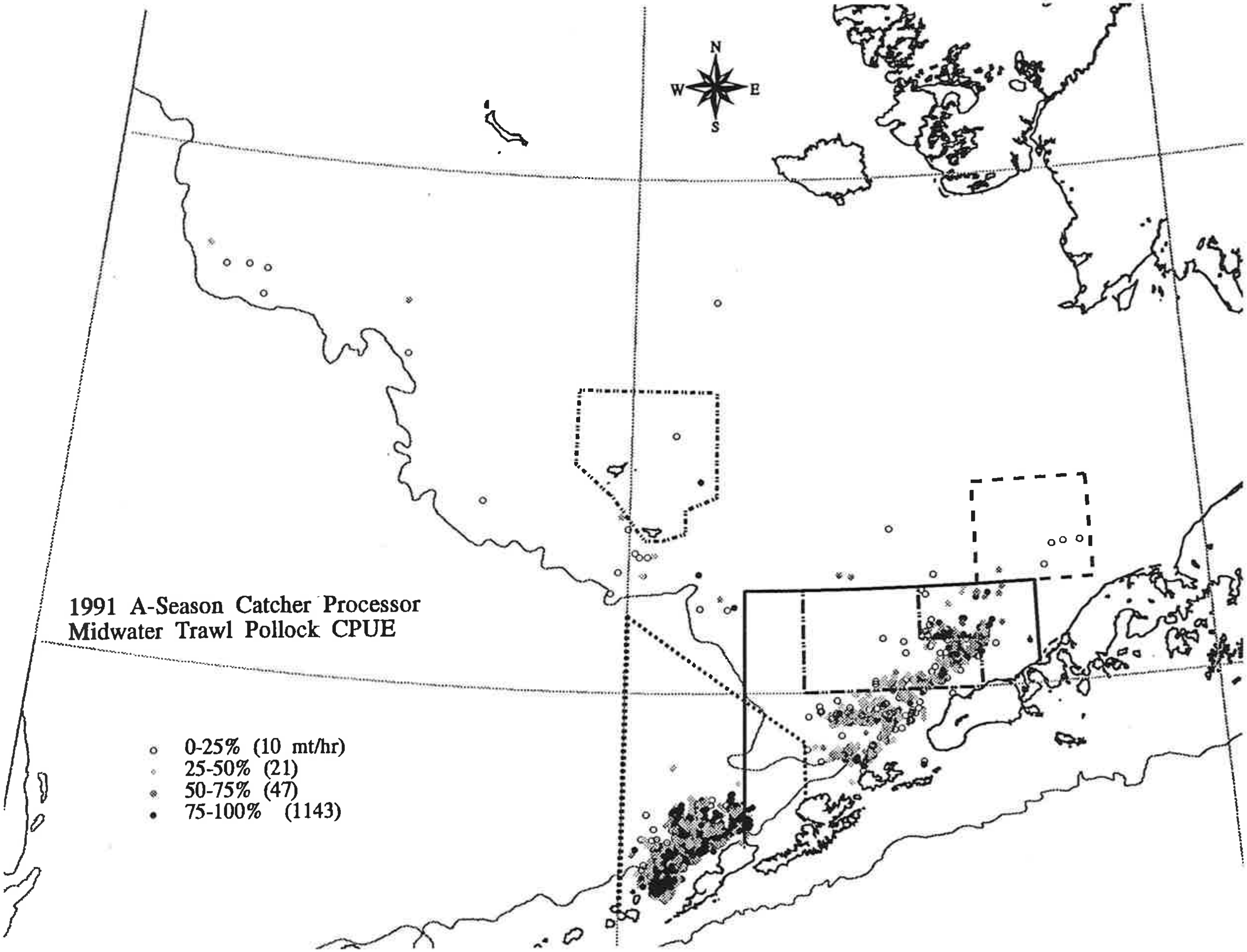


1990 A-Season Catcher Processor
Midwater Trawl Pollock CPUE

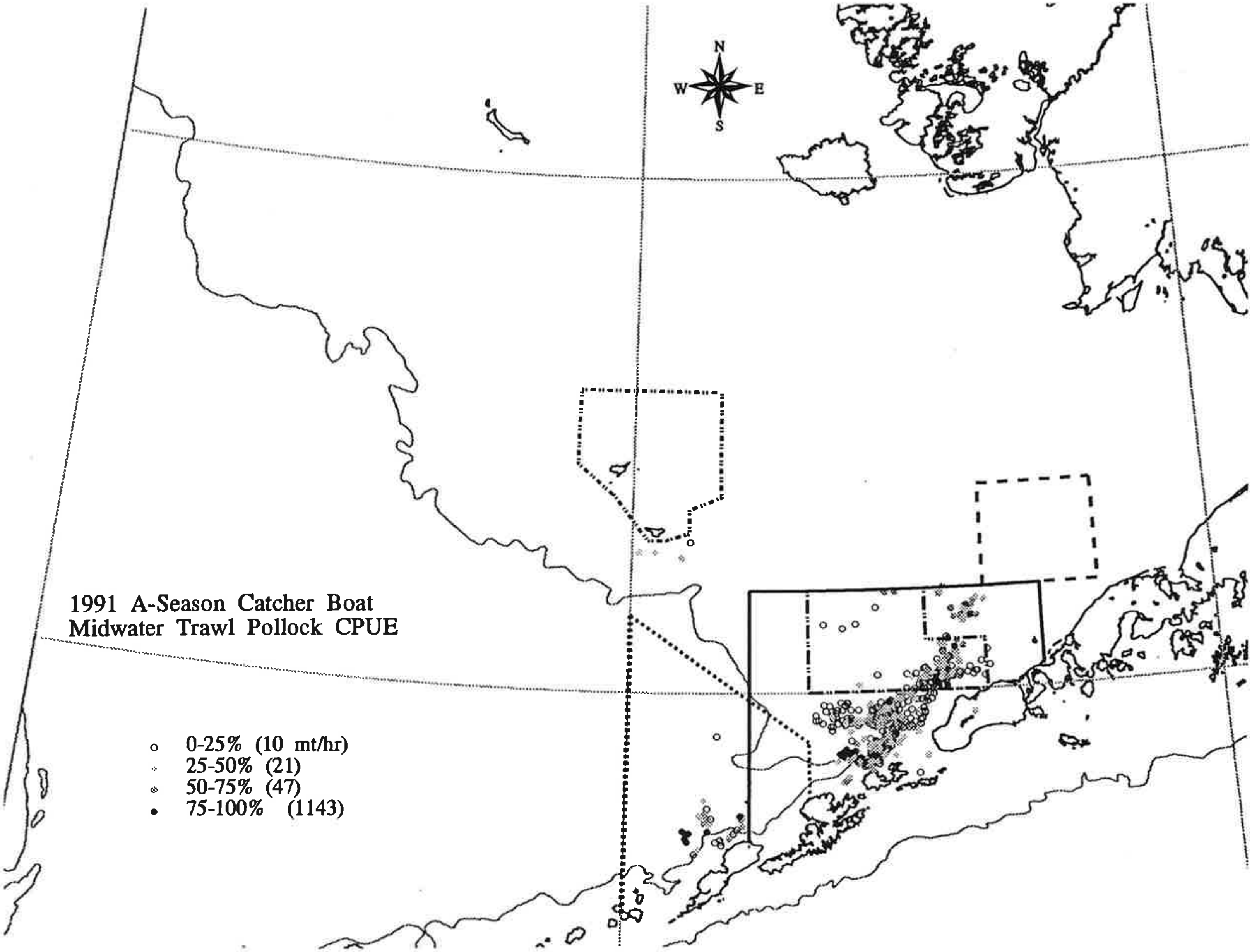

1990 A-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (16 mt/hr)
25-50% (33)
50-75% (76)
75-100% (2,300)
N
W
E
S

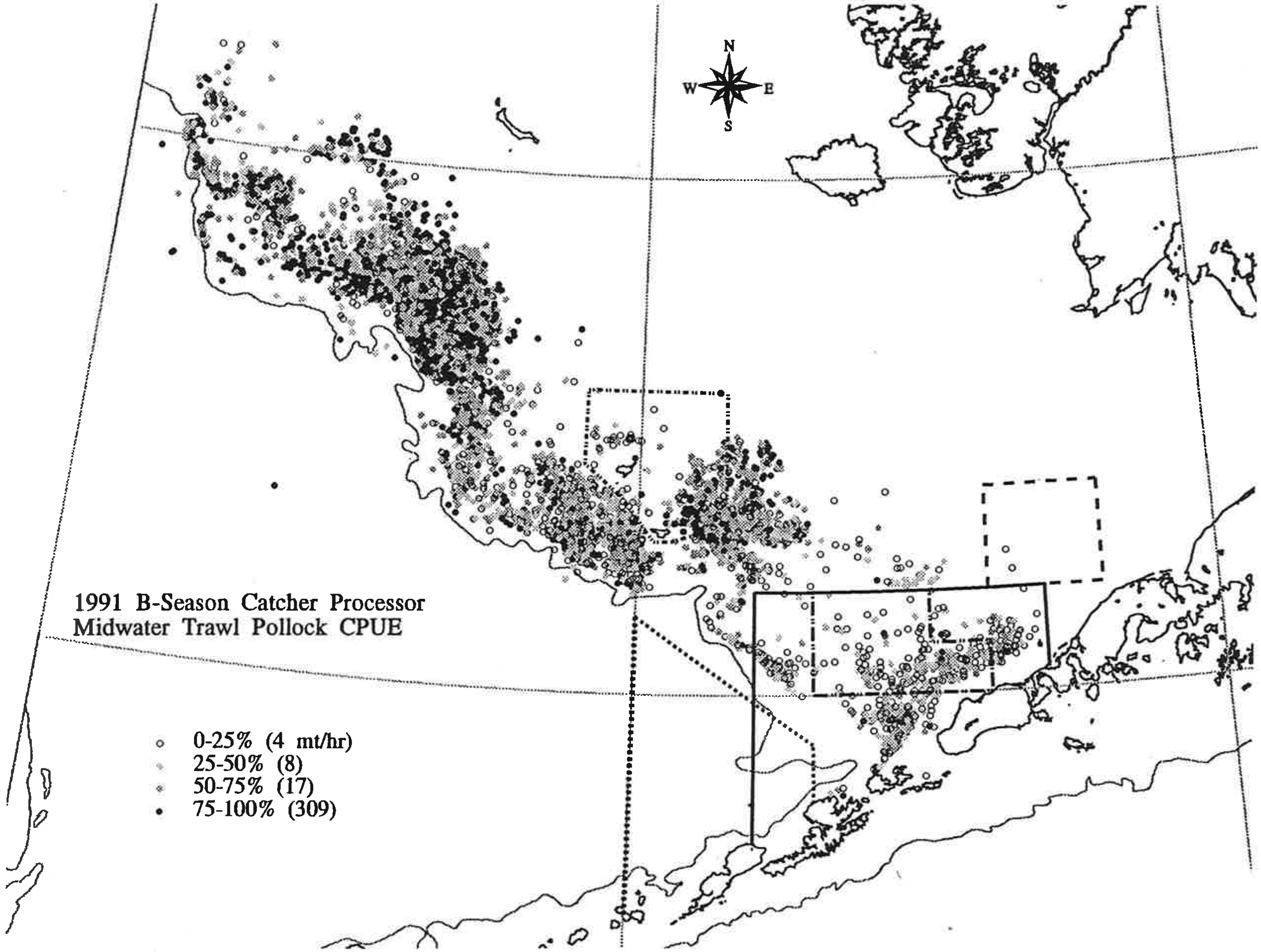

N
W
E
S
1990 B-Season Catcher Processor
Midwater Trawl Pollock CPUE
0-25% (7 mt/hr)
25-50% (14)
50-75% (27)
75-100% (615)

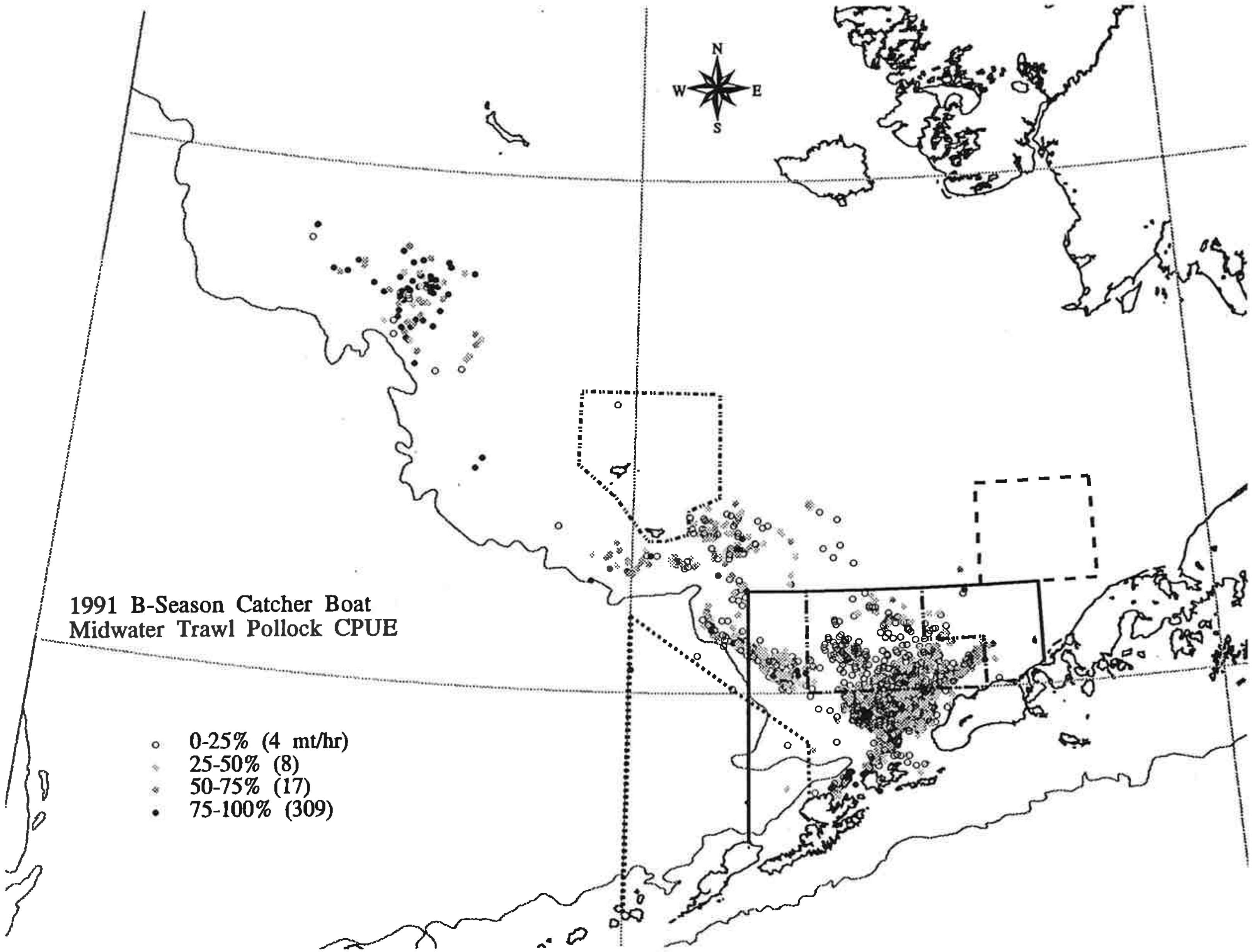

N
W
E
S
1990 B-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (7 mt/hr)
25-50% (14)
50-75% (27)
75-100% (615)

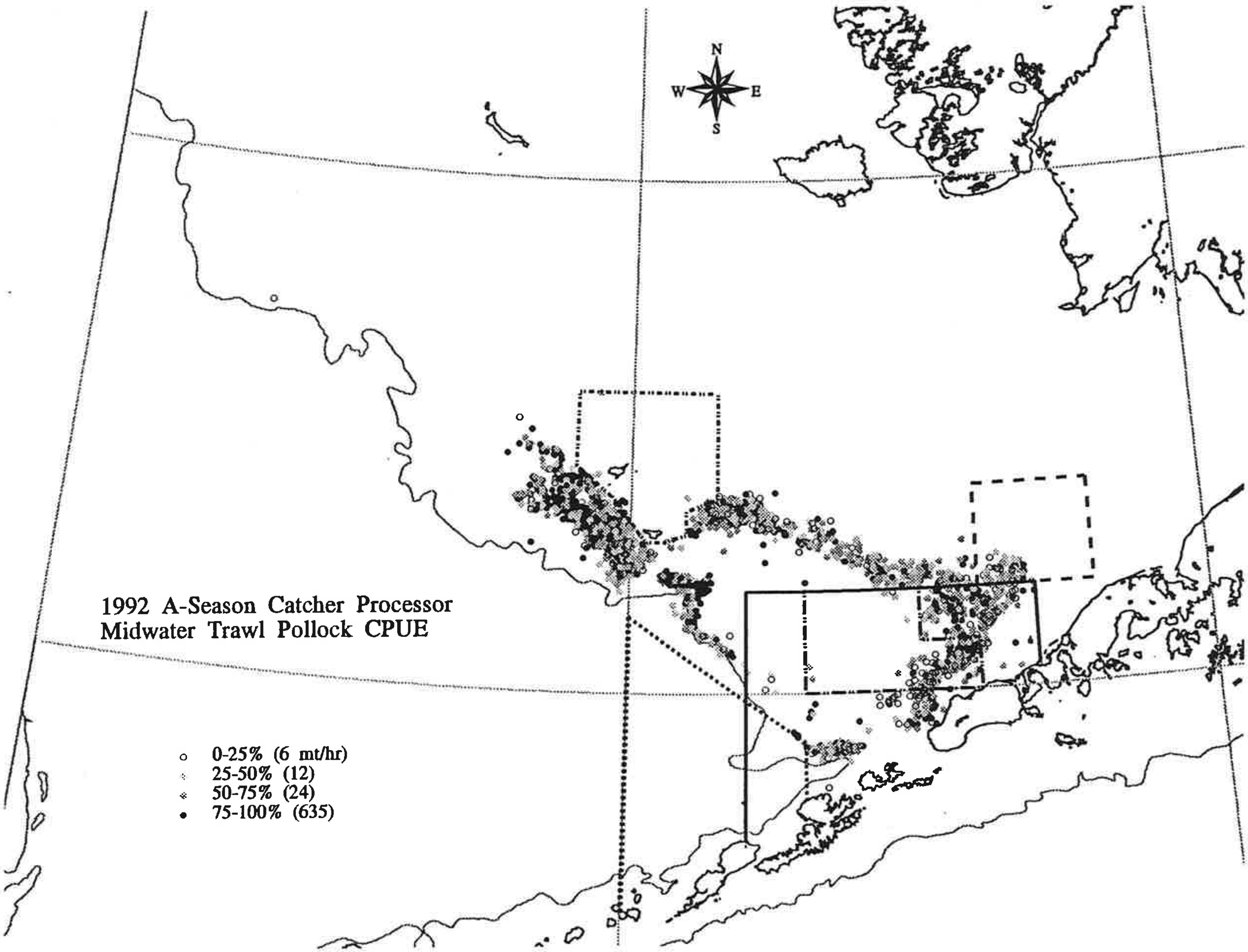


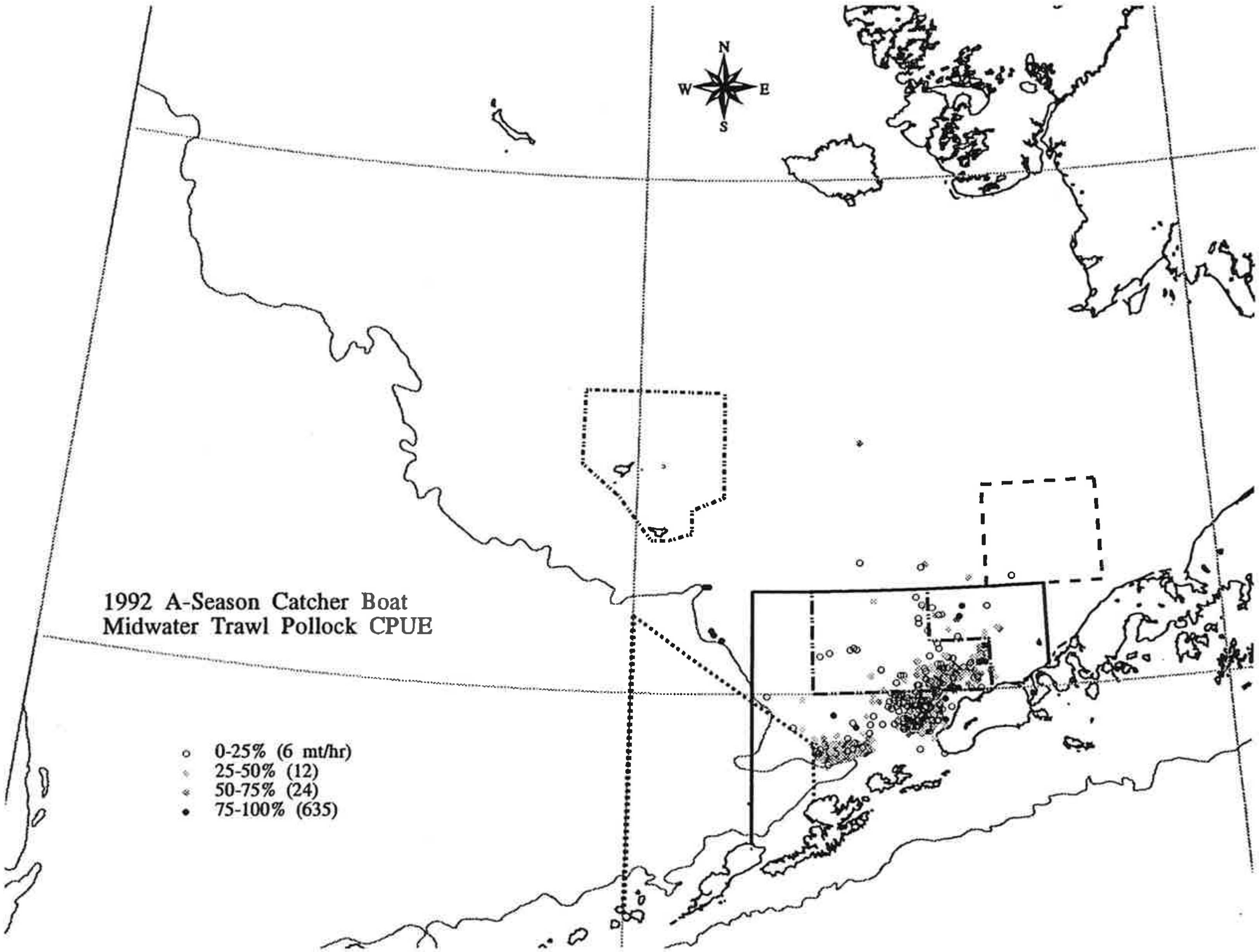
1991 A-Season Catcher Processor Midwater Trawl Pollock CPUE

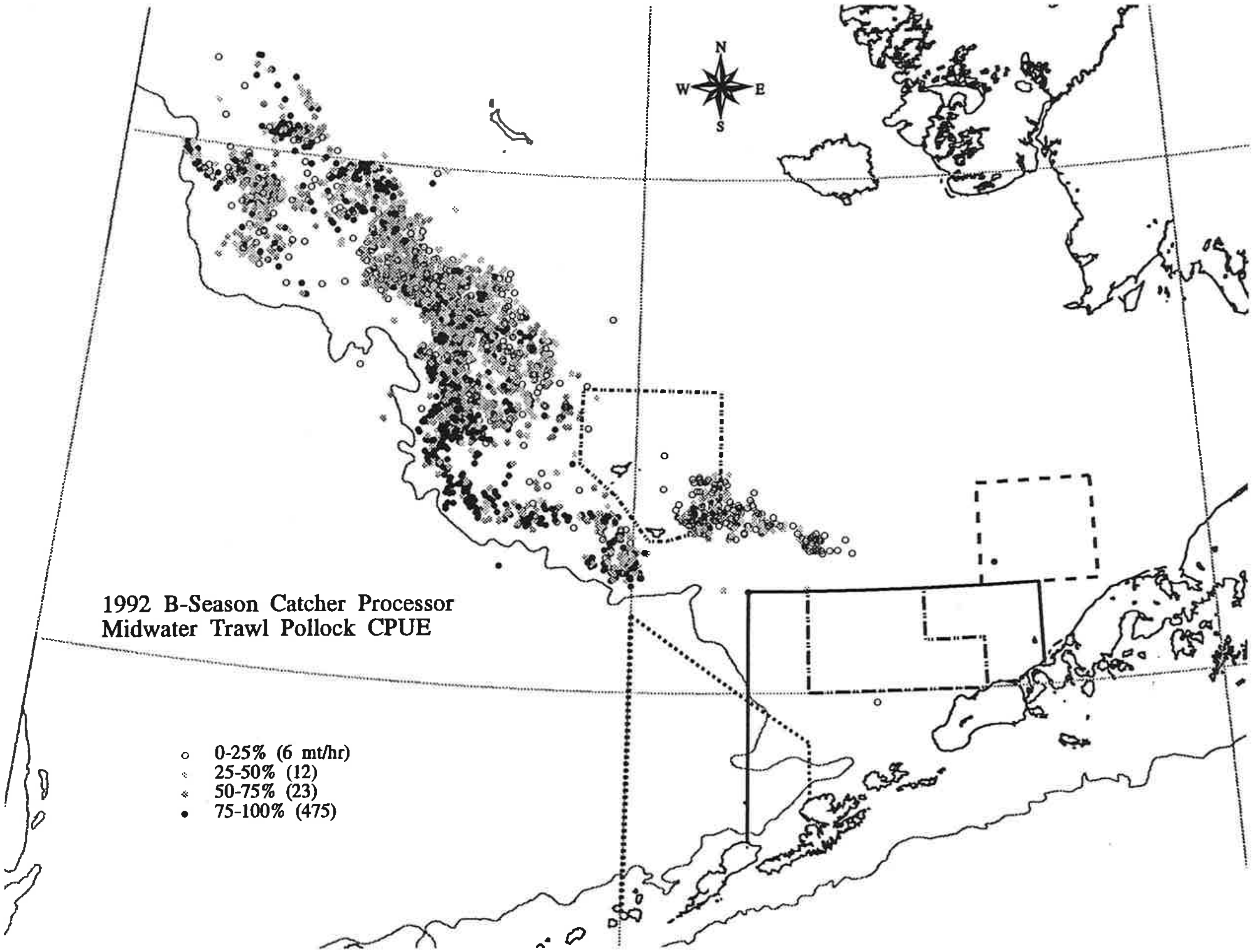

N
W
E
S
1991 A-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (10 mt/hr)
25-50% (21)
50-75% (47)
75-100% (1143)

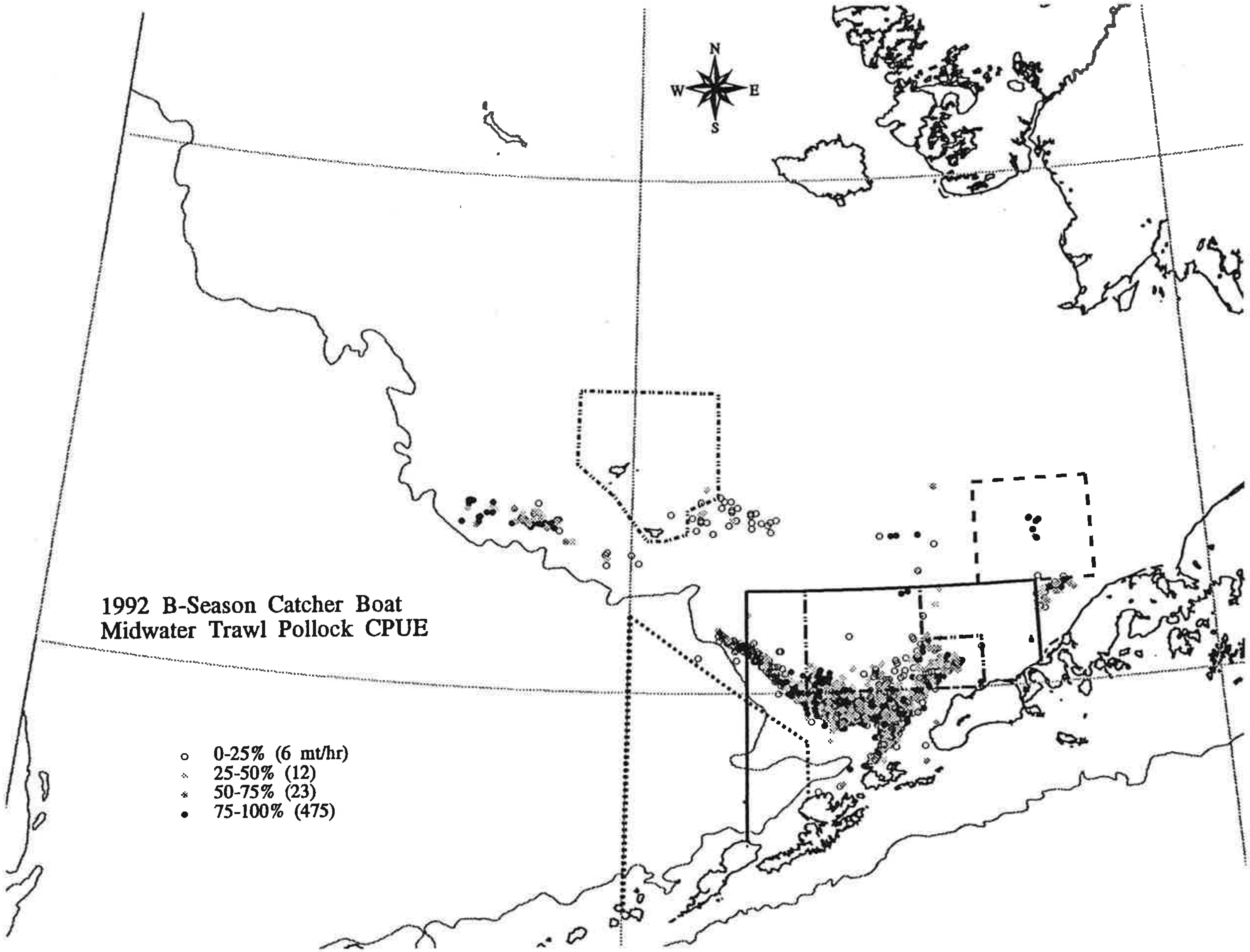

N
W
E
S
1991 B-Season Catcher Processor
Midwater Trawl Pollock CPUE
0-25% (4 mt/hr)
25-50% (8)
50-75% (17)
75-100% (309)

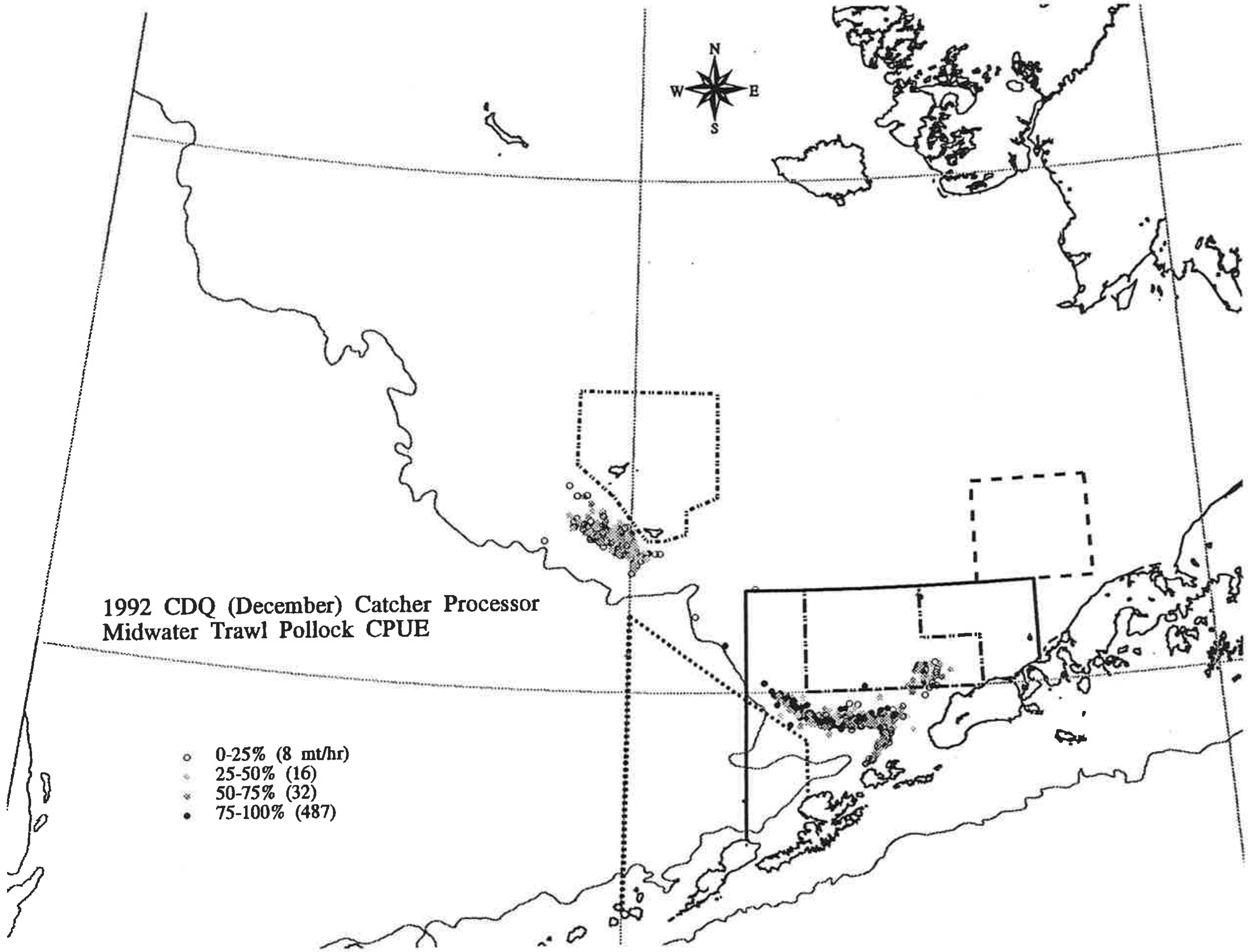

1991 B-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (4 mt/hr)
25-50% (8)
50-75% (17)
75-100% (309)
N
S
E
W

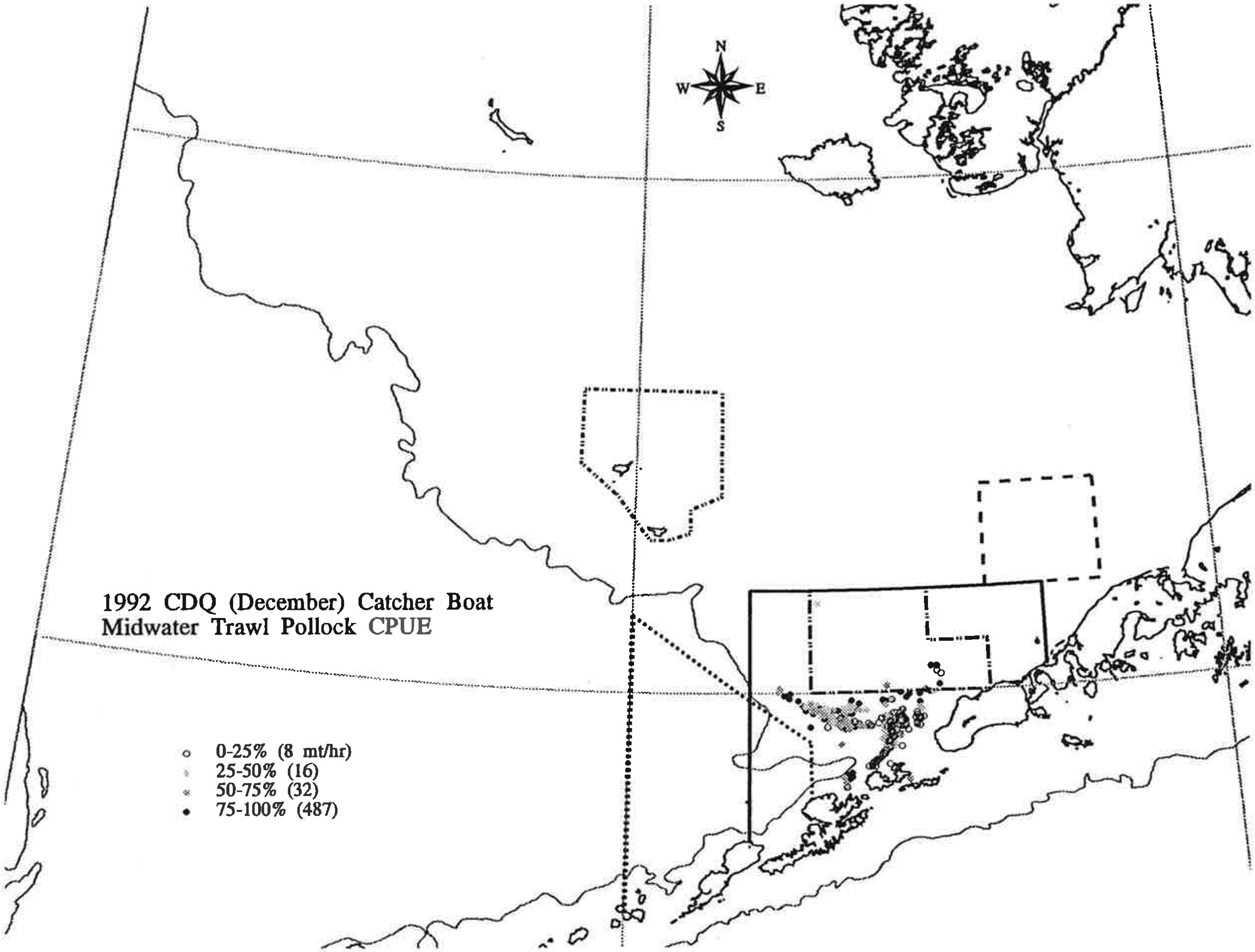

N
W
E
S
1992 A-Season Catcher Processor
Midwater Trawl Pollock CPUE
0-25% (6 mt/hr)
25-50% (12)
50-75% (24)
75-100% (635)


N
W
E
S
1992 A-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (6 mt/hr)
25-50% (12)
50-75% (24)
75-100% (635)

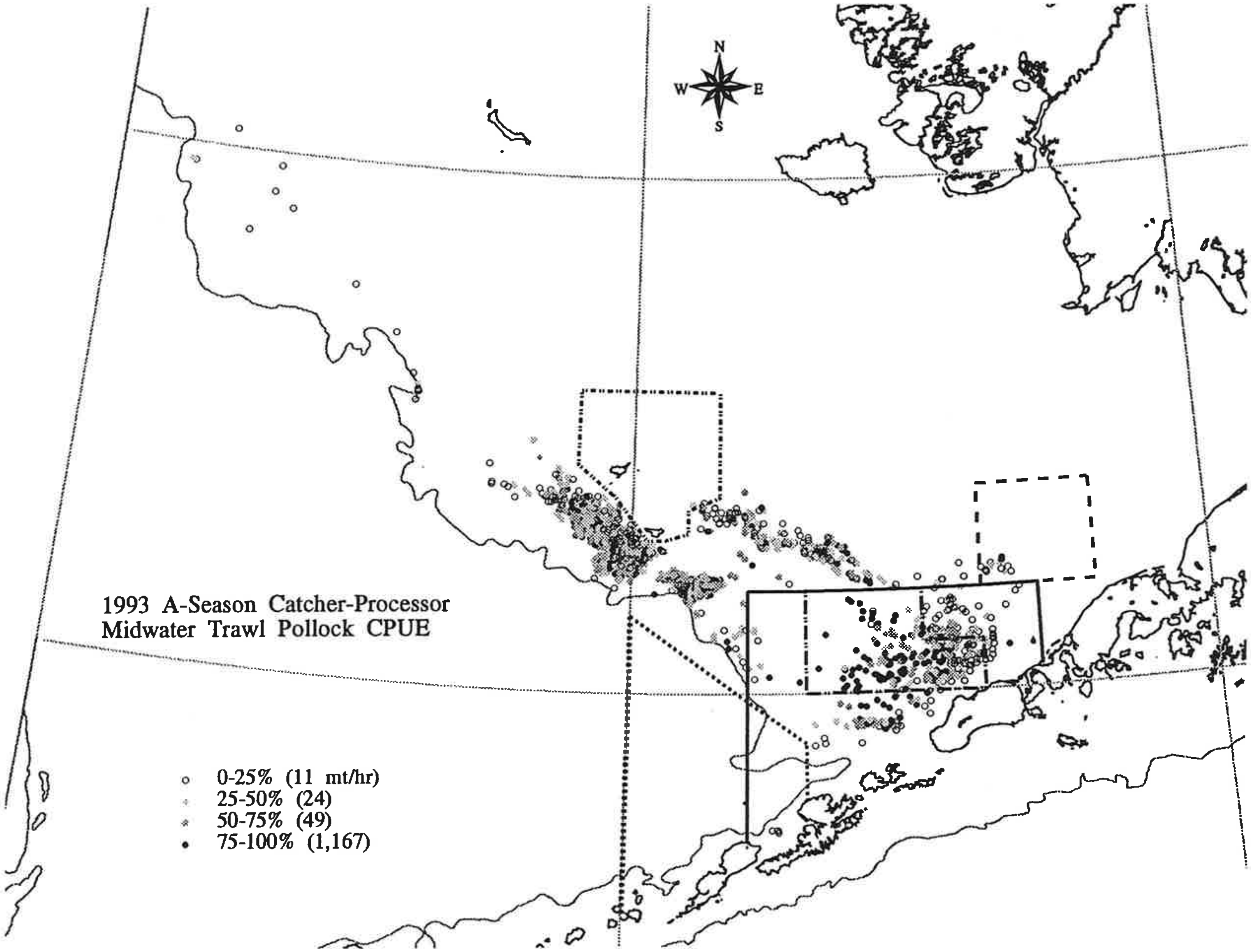

N
W
E
S
1992 B-Season Catcher Processor
Midwater Trawl Pollock CPUE
0-25% (6 mt/hr)
25-50% (12)
50-75% (23)
75-100% (475)

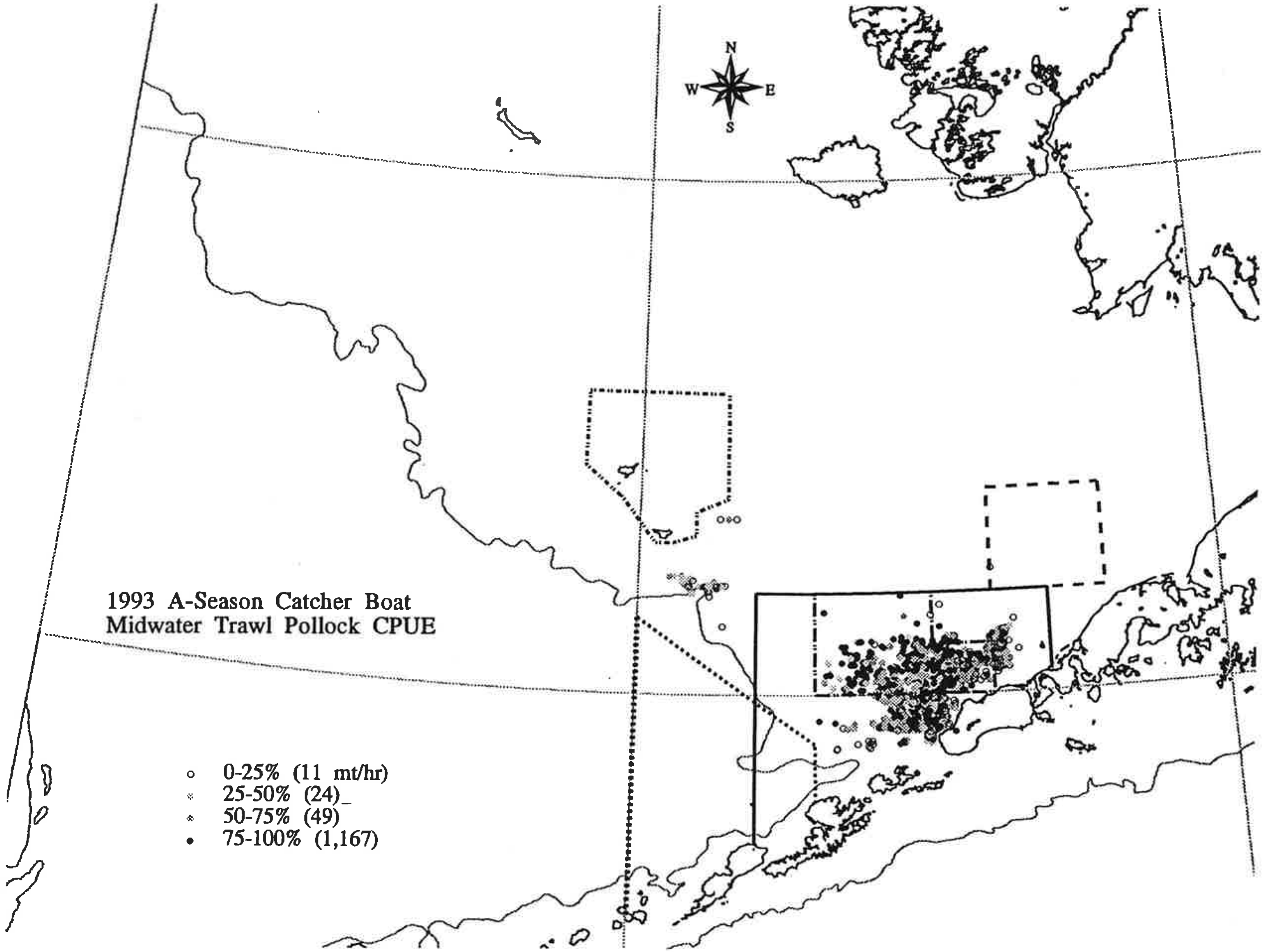

N
W
E
S
1992 B-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (6 mt/hr)
25-50% (12)
50-75% (23)
75-100% (475)

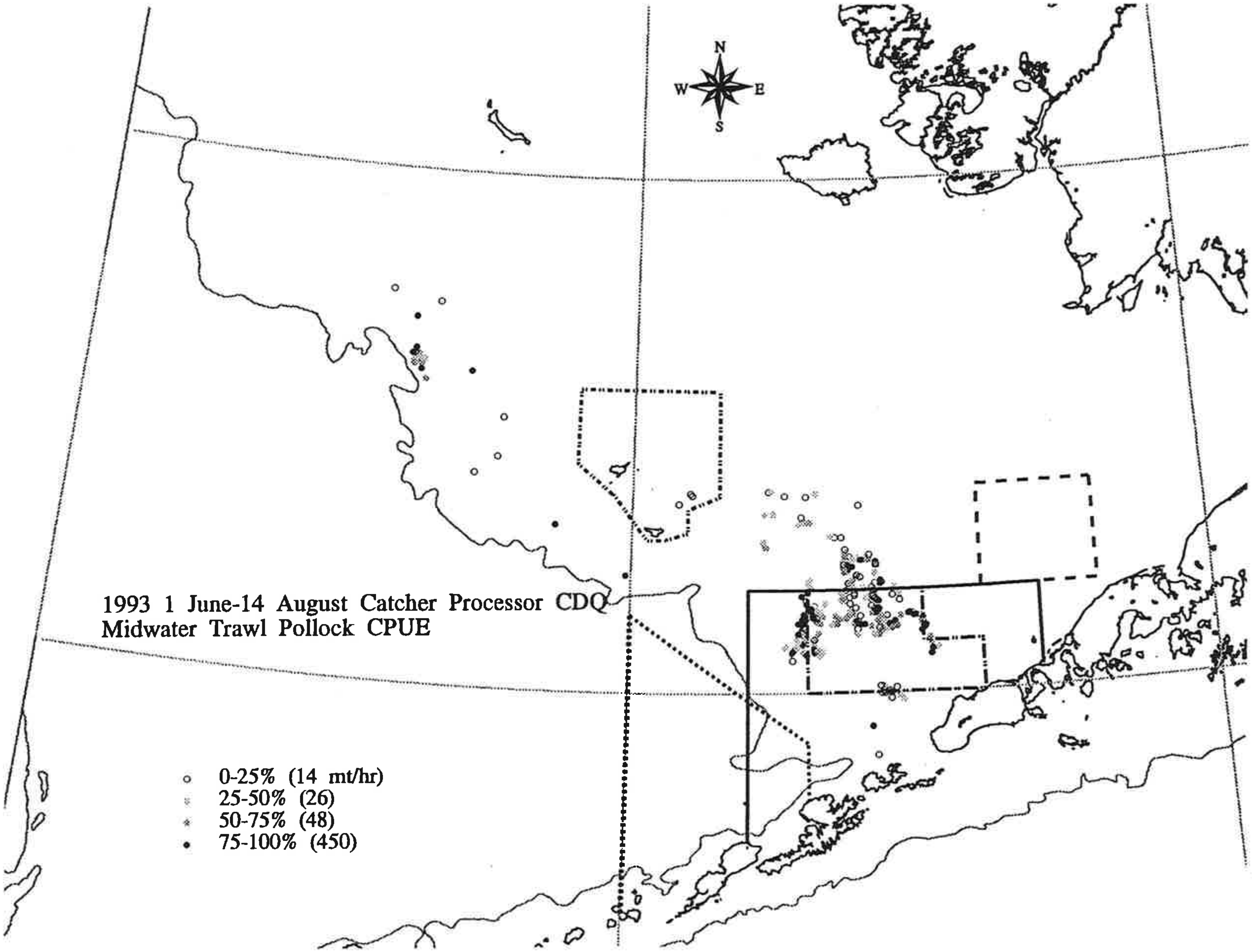

1992 CDQ (December) Catcher Processor
Midwater Trawl Pollock CPUE
N
W
E
S
0-25% (8 mt/hr)
25-50% (16)
50-75% (32)
75-100% (487)



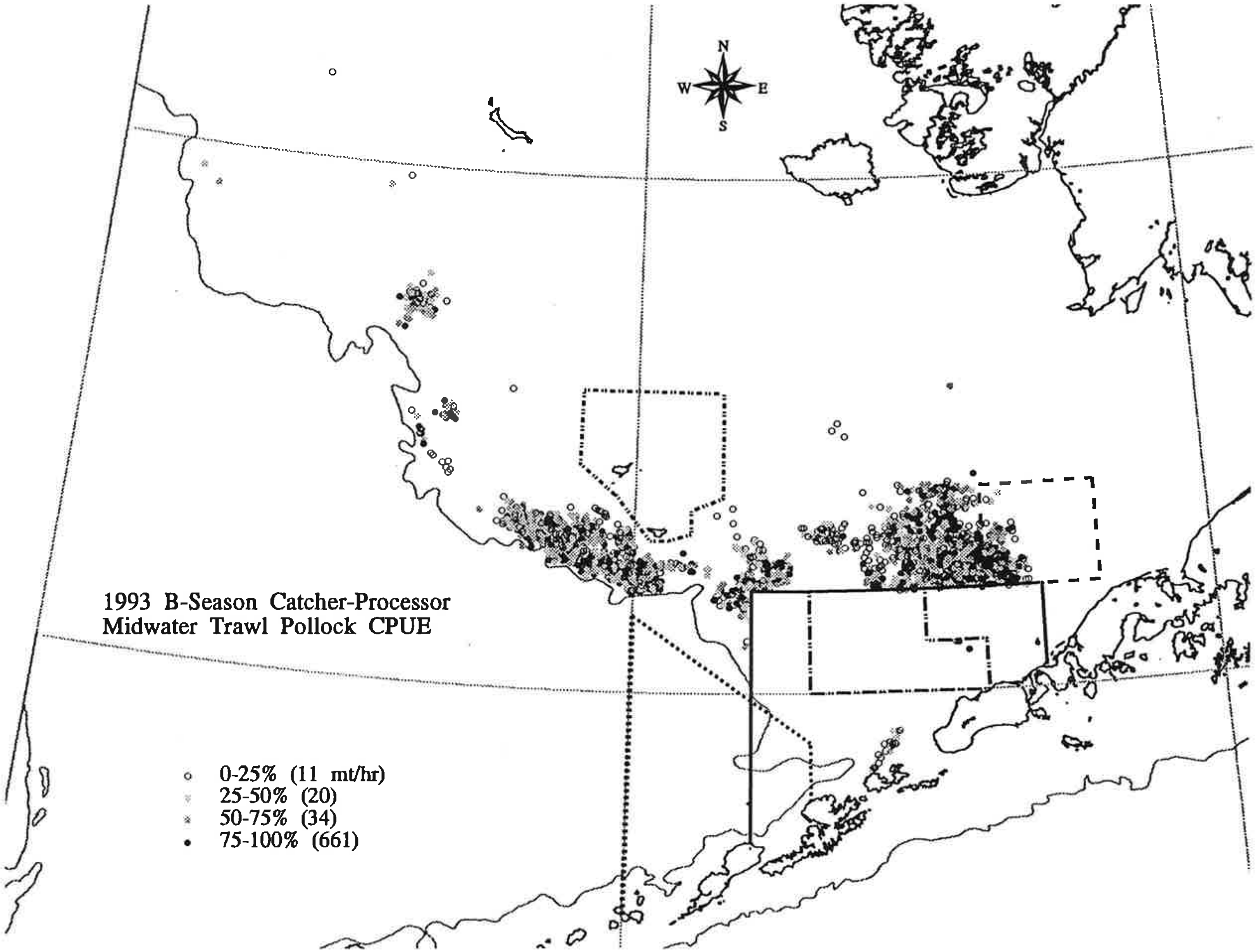
N
W
E
S
1992 CDQ (December) Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (8 mt/hr)
25-50% (16)
50-75% (32)
75-100% (487)


N
W
E
S
1993 A-Season Catcher-Processor
Midwater Trawl Pollock CPUE
0-25% (11 mt/hr)
25-50% (24)
50-75% (49)
75-100% (1,167)

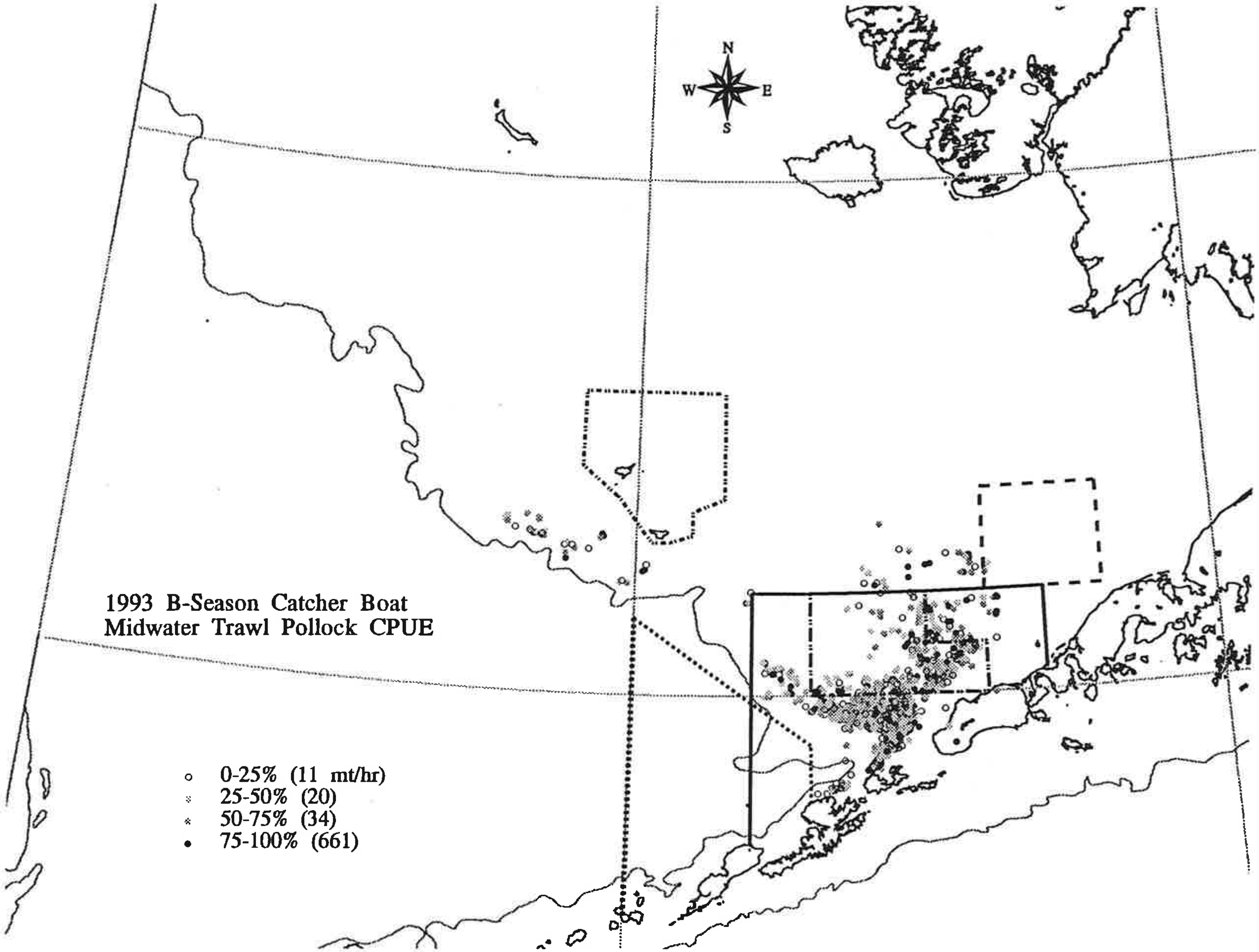

N
W
E
S
1993 A-Season Catcher Boat
Midwater Trawl Pollock CPUE
0-25% (11 mt/hr)
25-50% (24)_
50-75% (49)
75-100% (1,167)



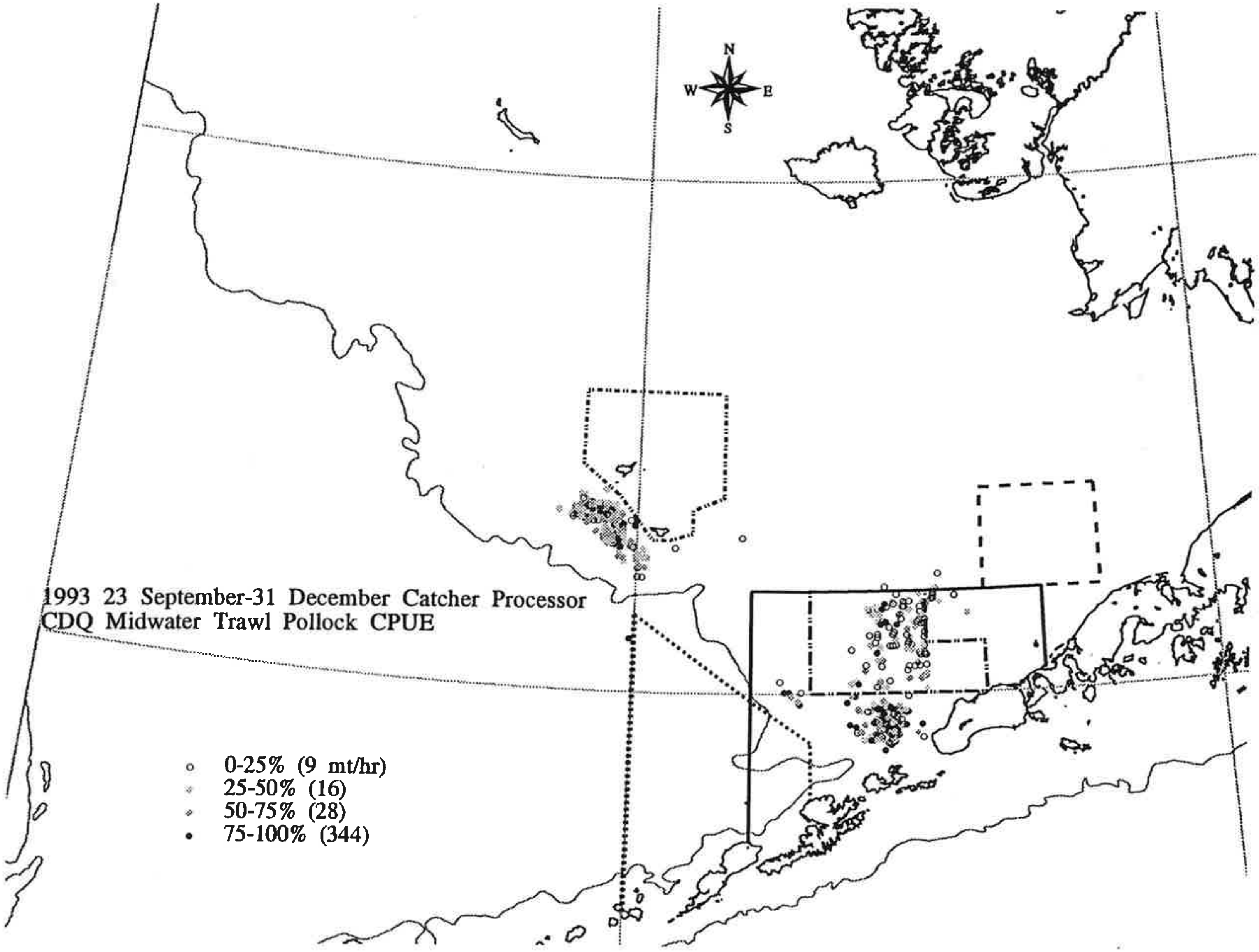
1993 1 June-14 August Catcher Processor CDQ Midwater Trawl Pollock CPUE



1993 B-Season Catcher-Processor
Midwater Trawl Pollock CPUE

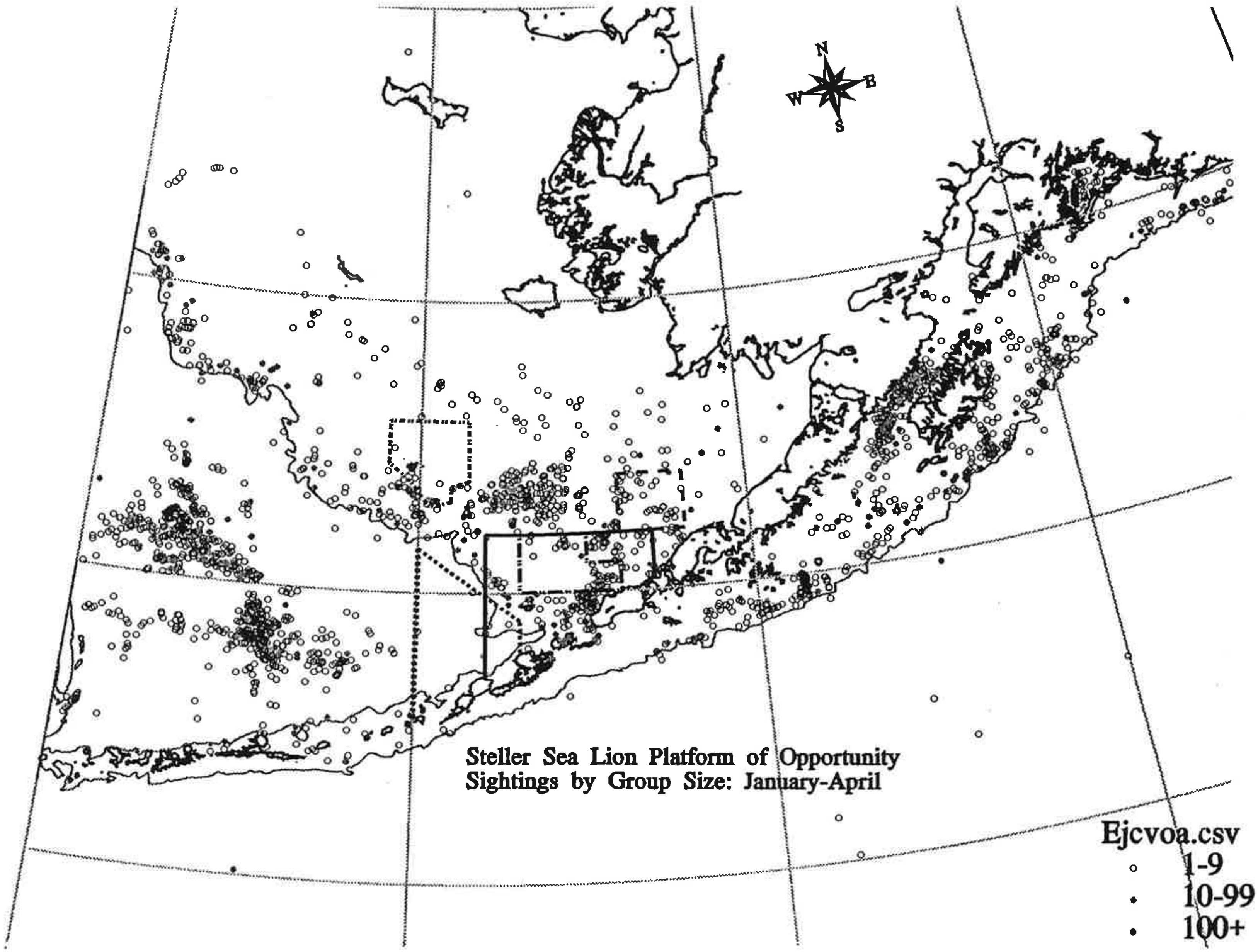


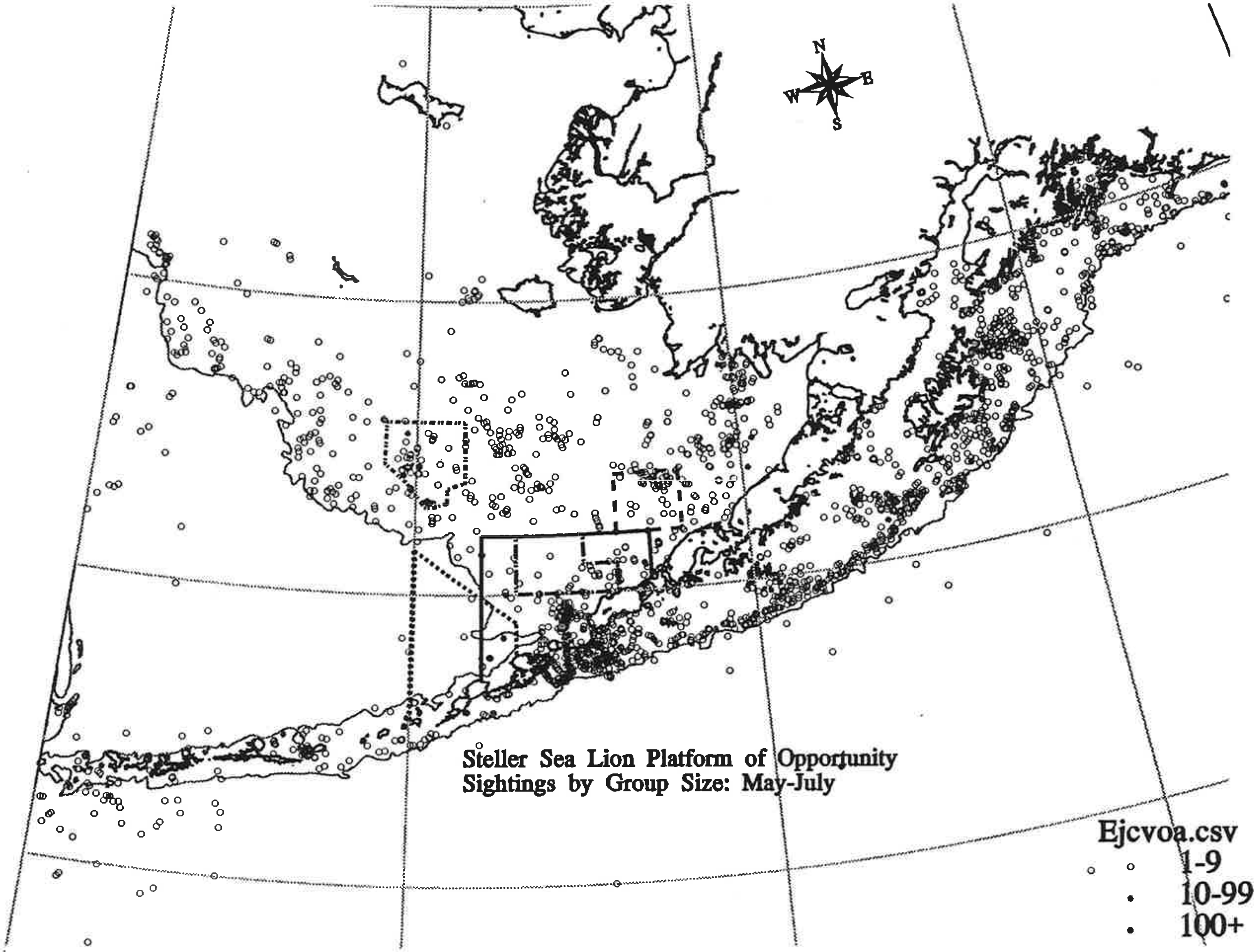
1993 B-Season Catcher Boat
Midwater Trawl Pollock CPUE

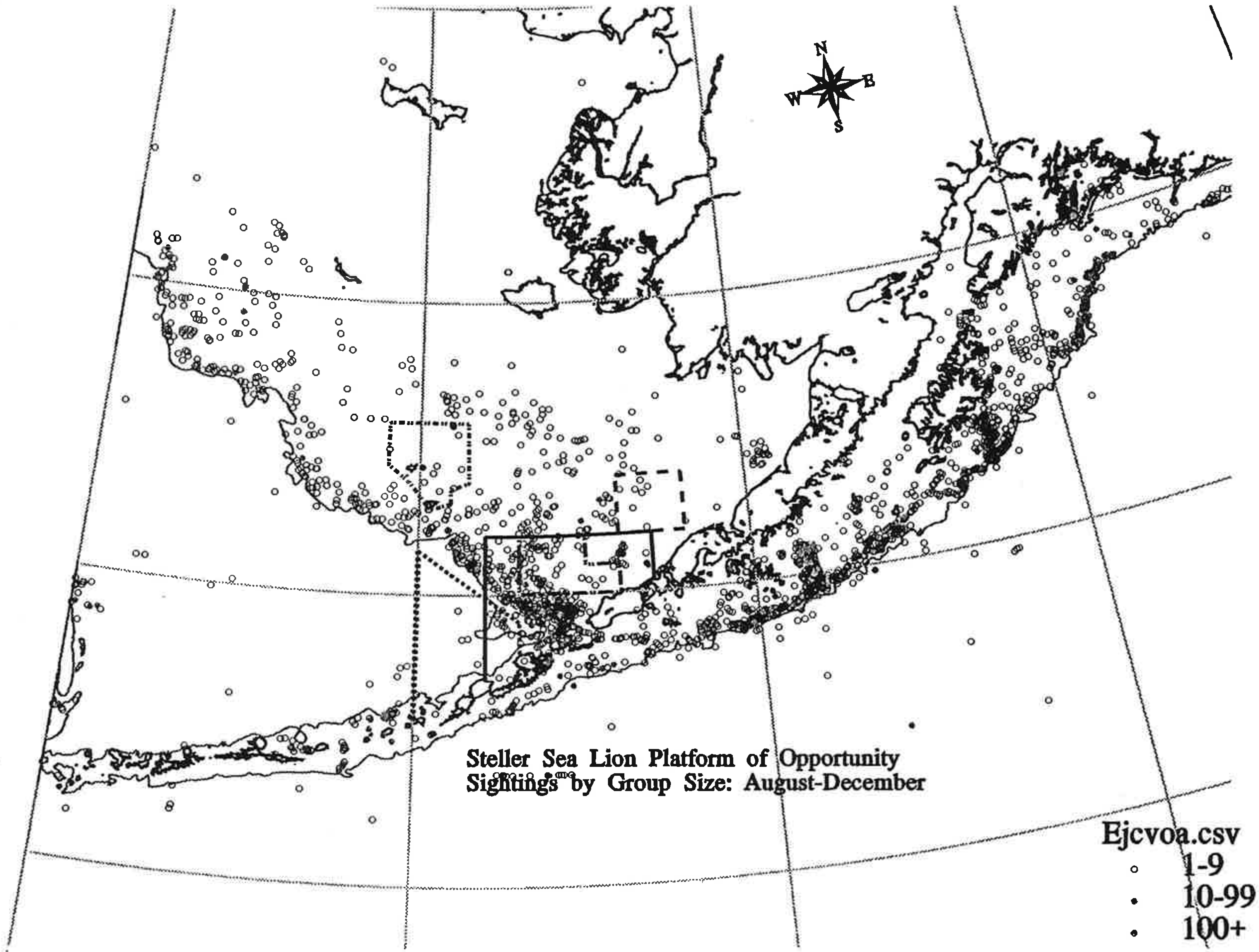


1993 23 September-31 December Catcher Processor
CDQ Midwater Trawl Pollock CPUE

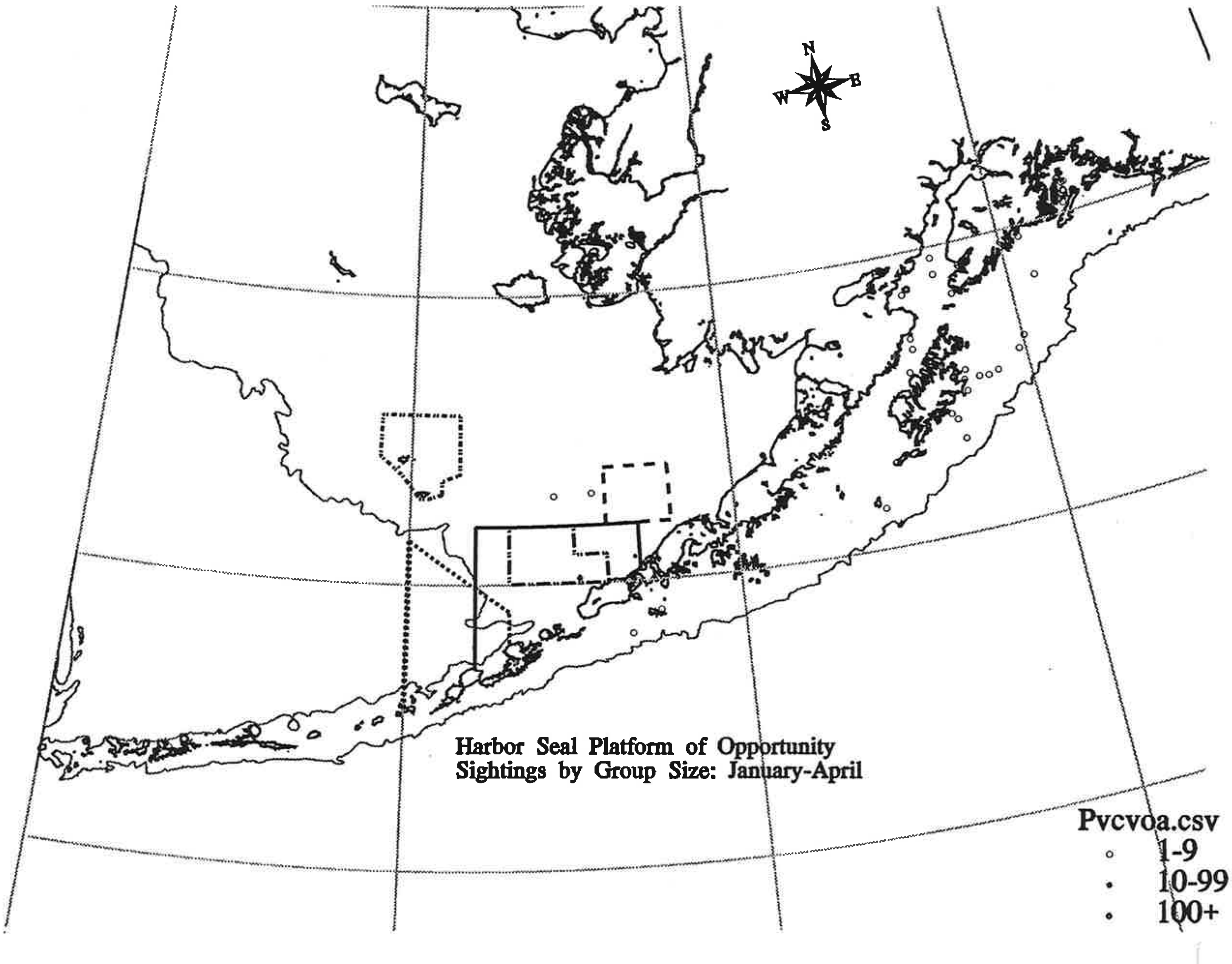
Appendix 2. Platform of opportunity sightings of Steller sea lions, harbor seals, northern fur seals, killer whales, and gray whales by season (January-April, May-July, and August-December). Data are from the late 1950s through 1991. Sighting locations are scaled by group size (open circles=1-9 animals; gray circles=10-99 animals, dark circles=100+ animals in group). Trawl exclusion zones described in Appendix 1 are shown.

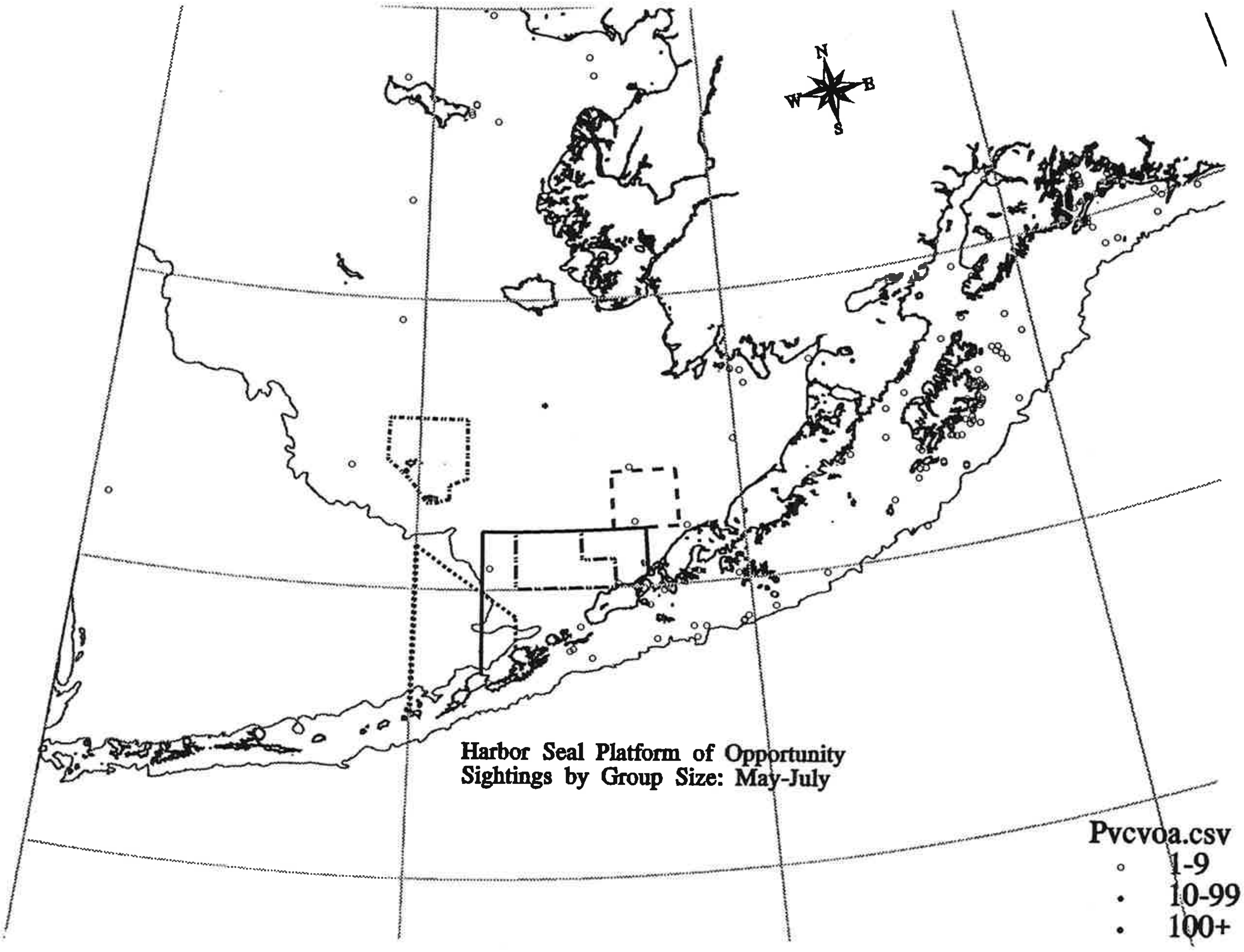

N
E
S
W
Steller Sea Lion Platform of Opportunity
Sightings by Group Size: January-April
Ejcvoa.csv
1-9
10-99
100+

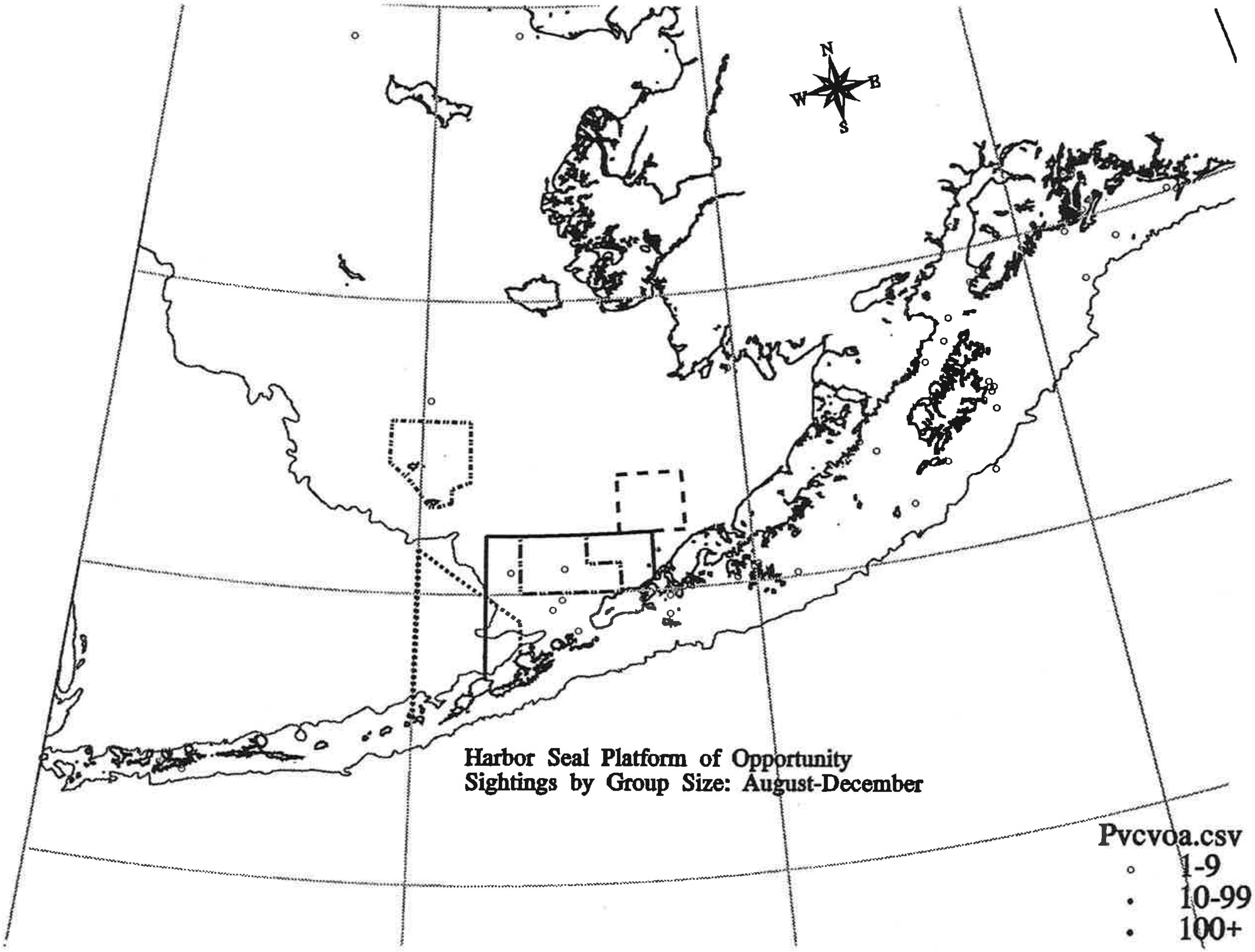

N
E
S
W
Steller Sea Lion Platform of Opportunity
Sightings by Group Size: May-July
Ejcvoa.csv
1-9
10-99
100+

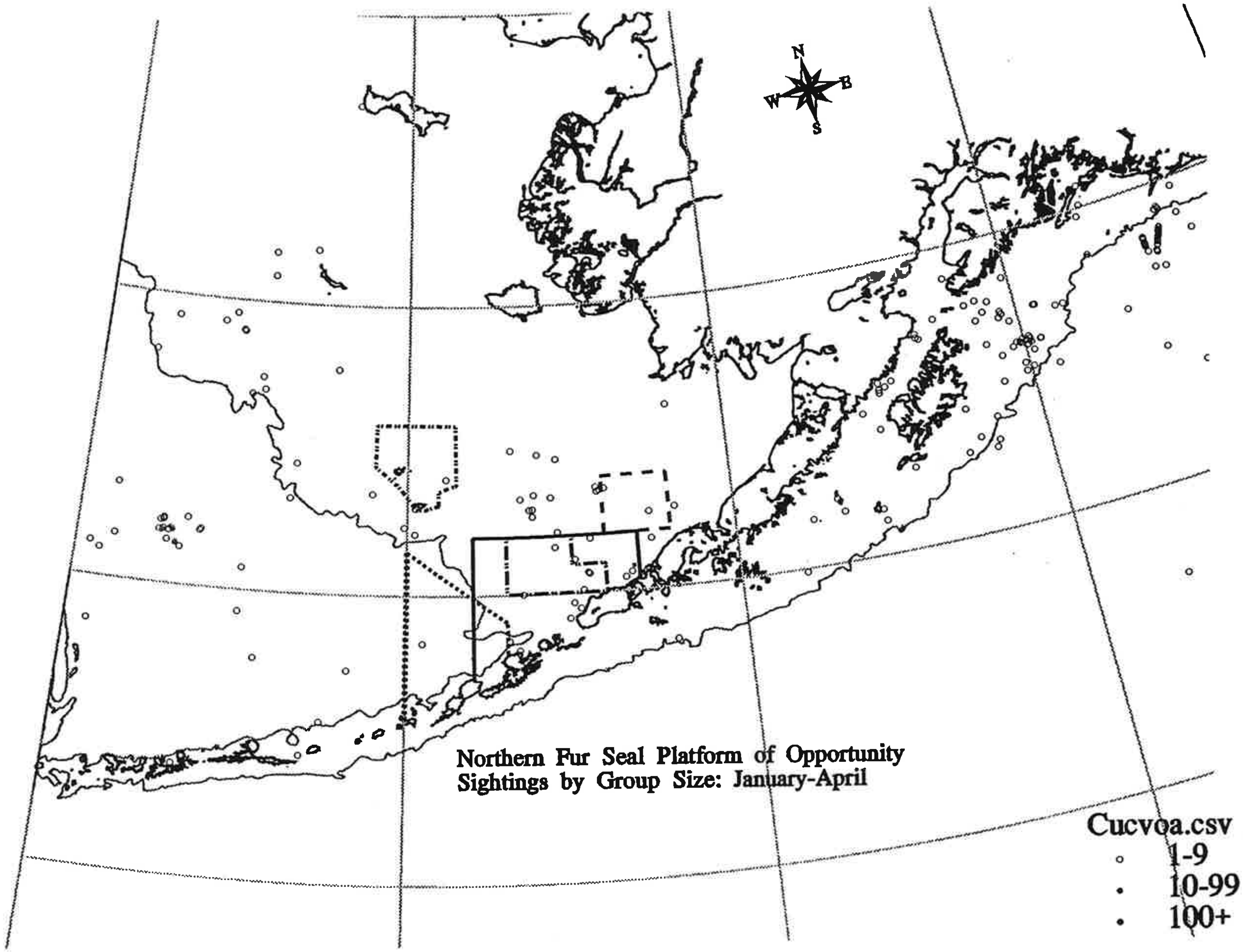


Steller Sea Lion Platform of Opportunity
Sightings by Group Size: August-December

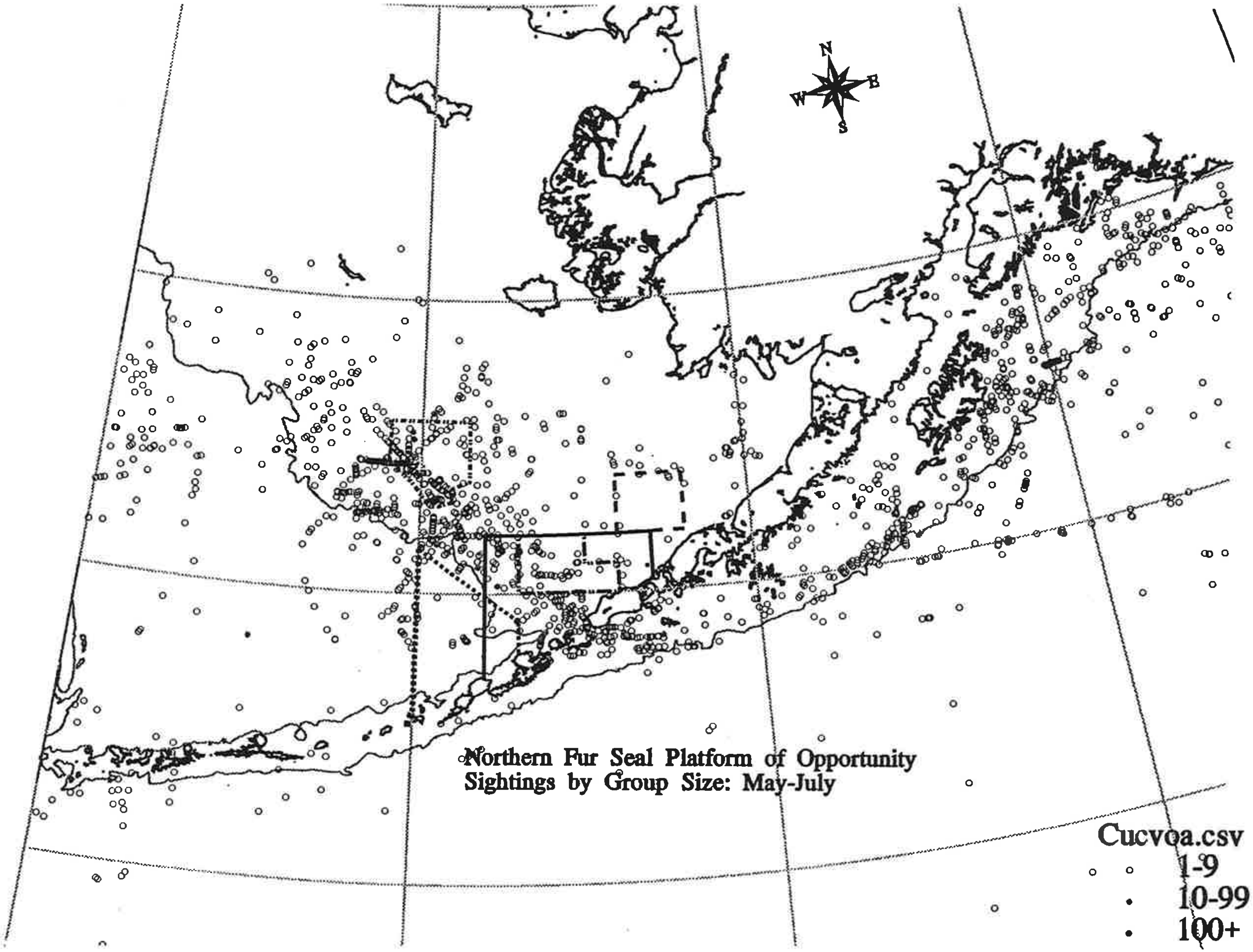

N
E
S
W
Harbor Seal Platform of Opportunity
Sightings by Group Size: January-April
Pvcvoa.csv
1-9
10-99
100+

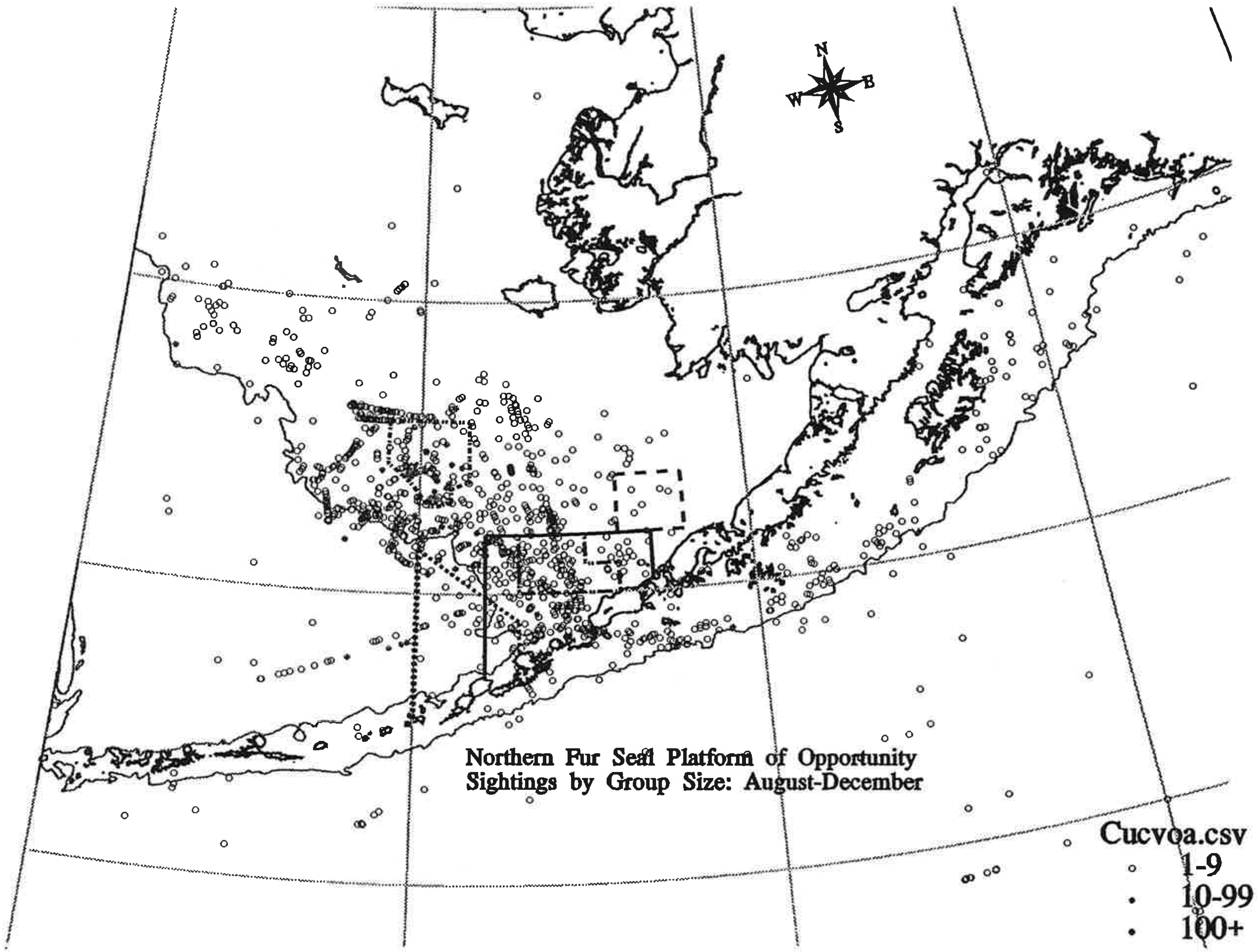

N
W
E
S
Harbor Seal Platform of Opportunity
Sightings by Group Size: May-July
Pvcvoa.csv
1-9
10-99
100+

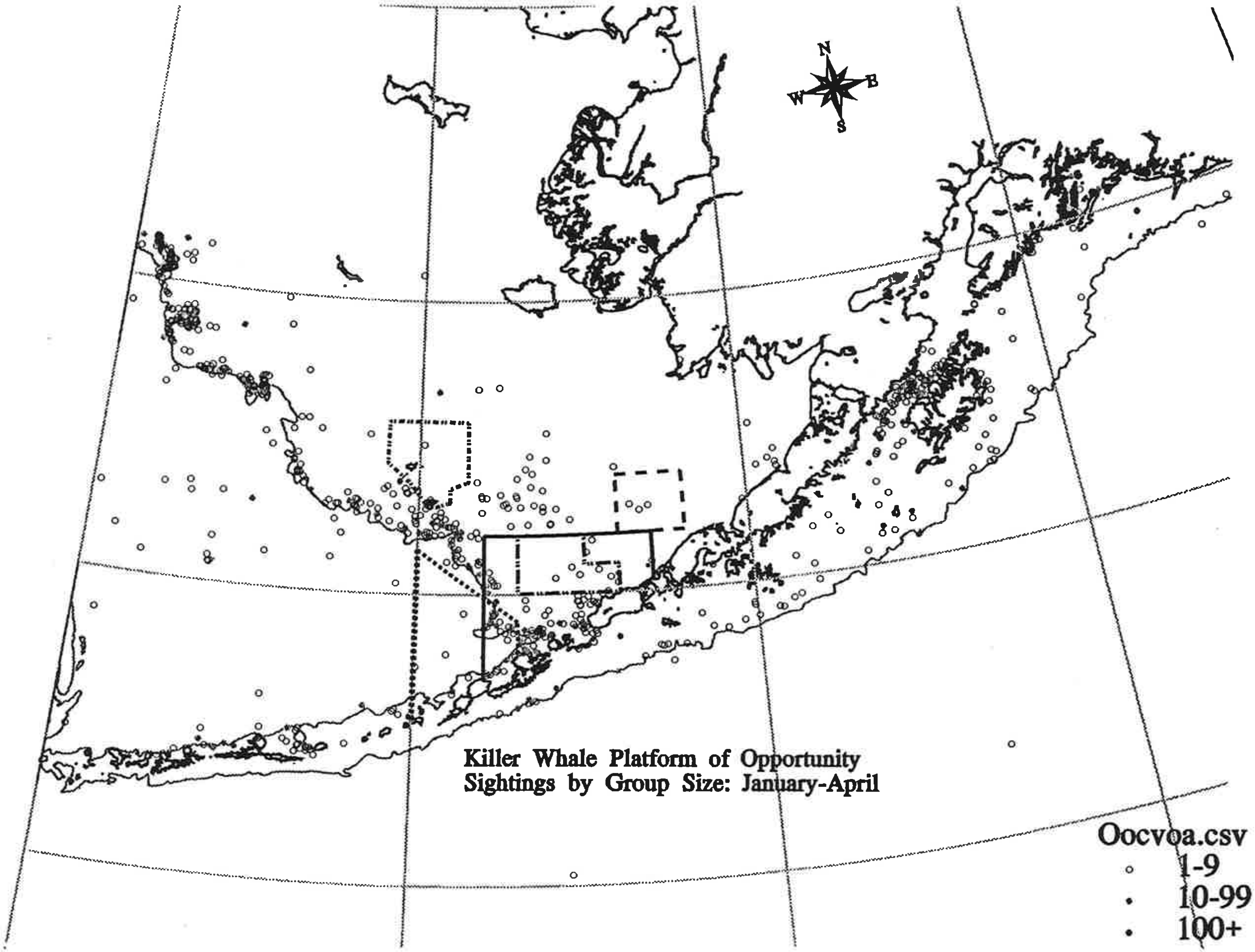

Harbor Seal Platform of Opportunity
Sightings by Group Size: August-December
Pvcvoa.csv
1-9
10-99
100+



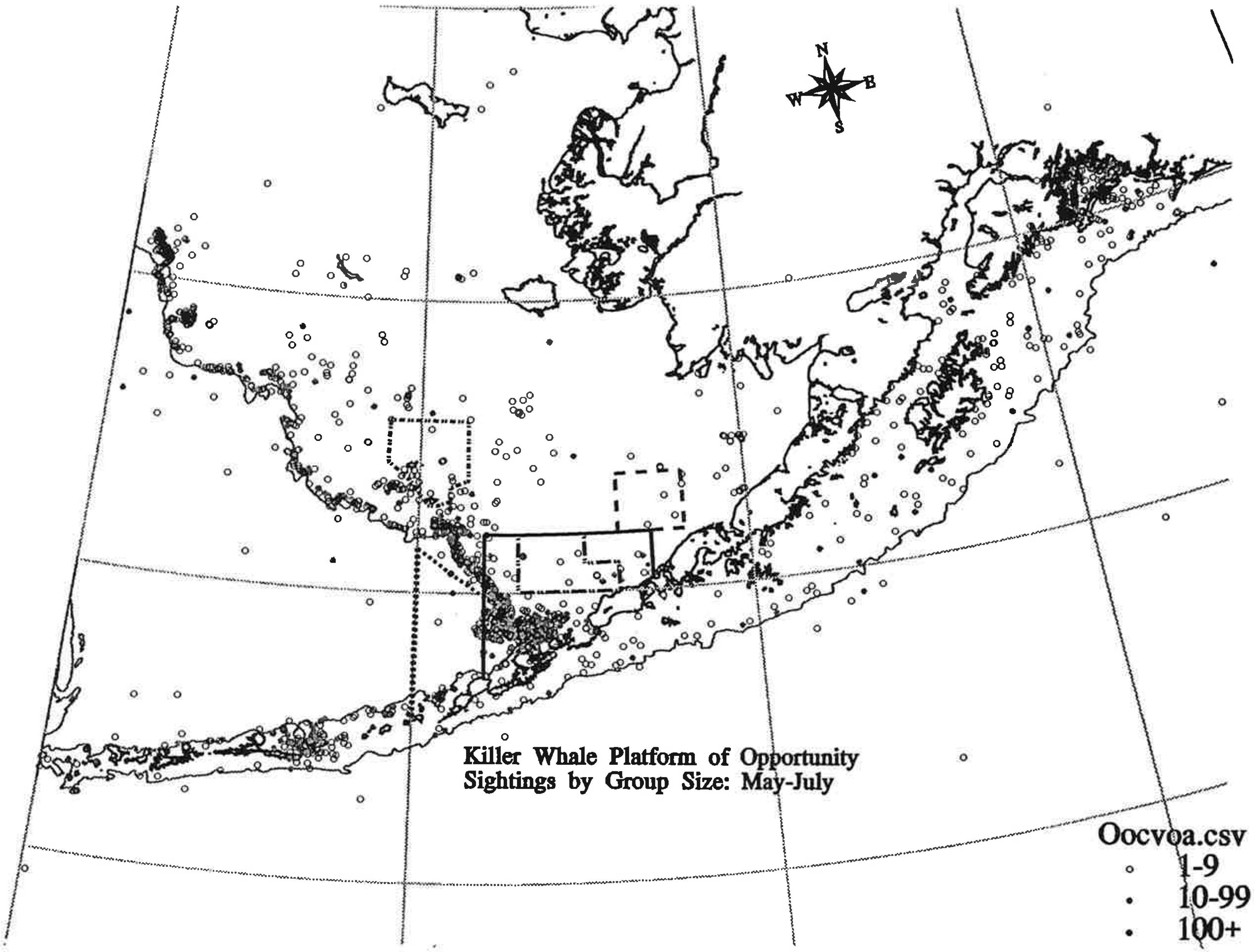
Northern Fur Seal Platform of Opportunity
Sightings by Group Size: January-April


N
E
W
S
Northern Fur Seal Platform of Opportunity
Sightings by Group Size: May-July
Cucvoa.csv
1-9
10-99
100+

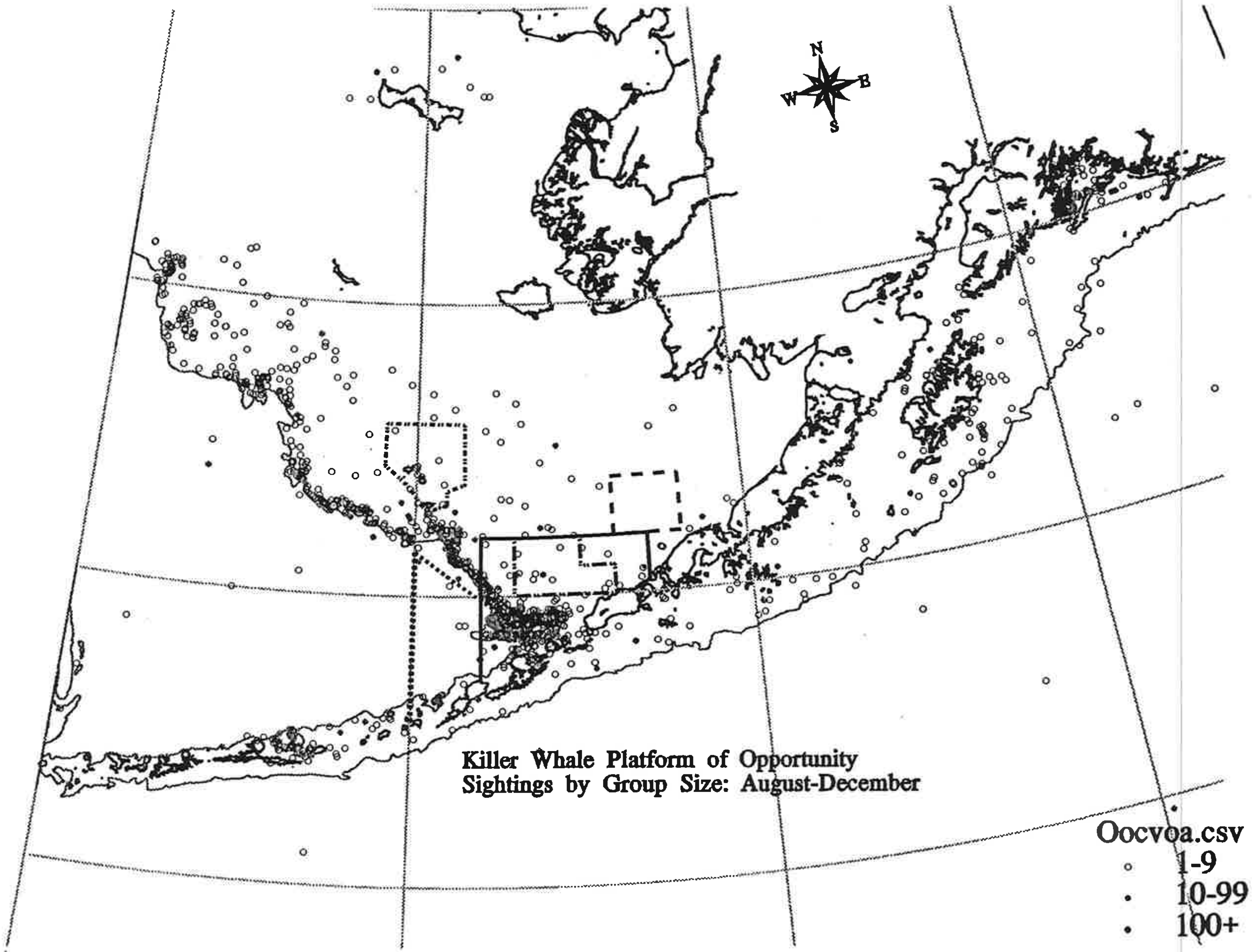

N
E
S
W
Northern Fur Seal Platform of Opportunity
Sightings by Group Size: August-December
Cucvoa.csv
1-9
10-99
100+

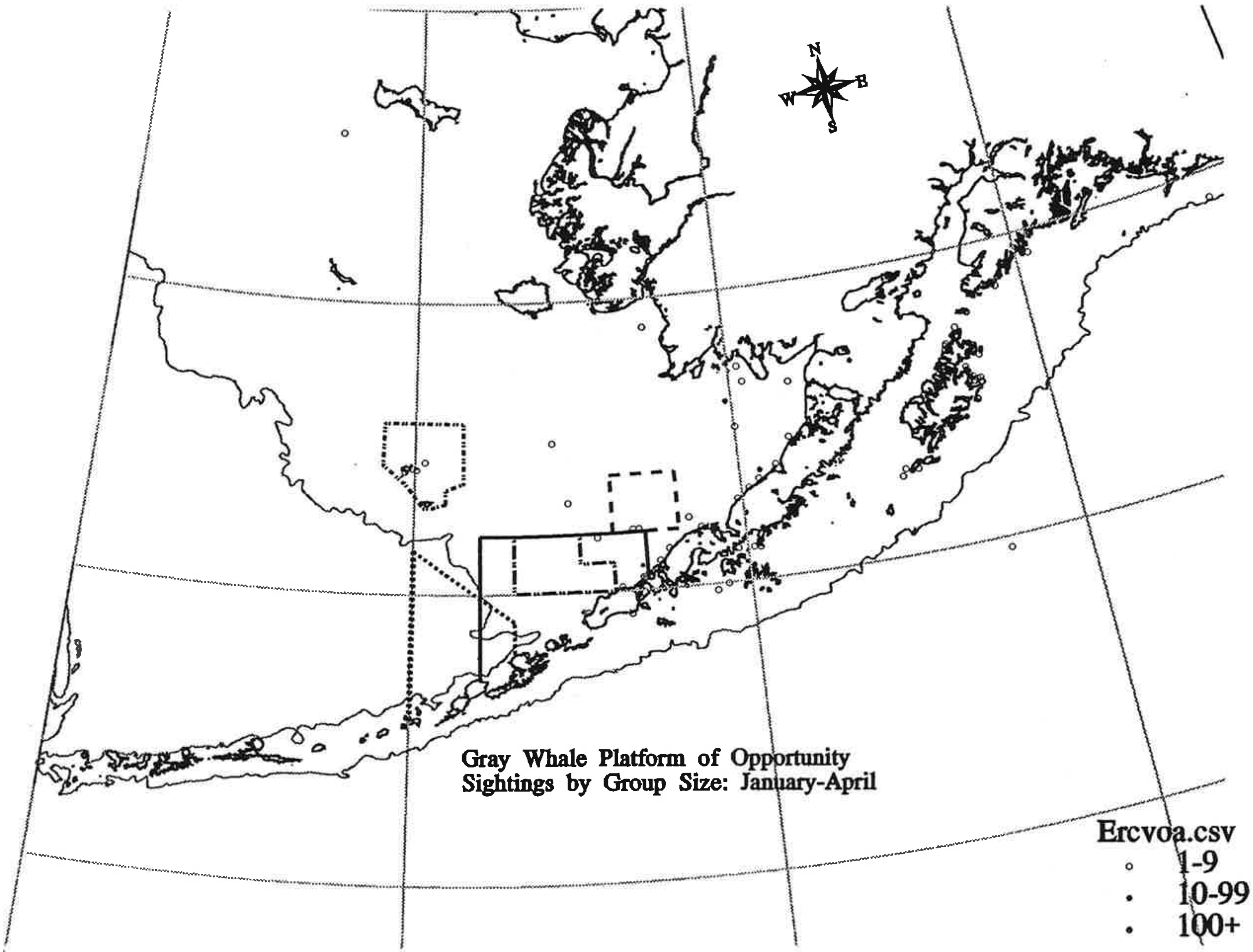


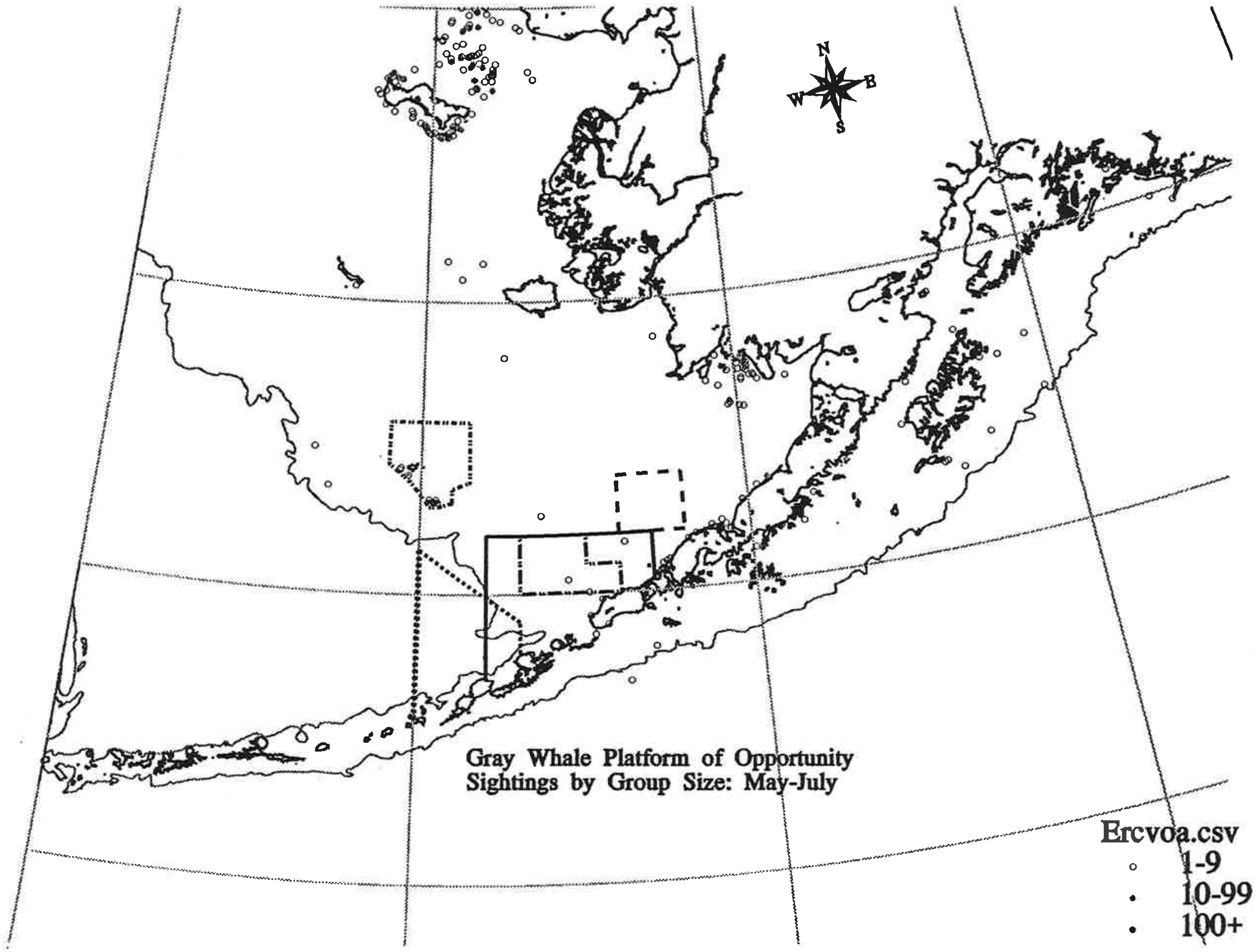
Killer Whale Platform of Opportunity Sightings by Group Size: January-April

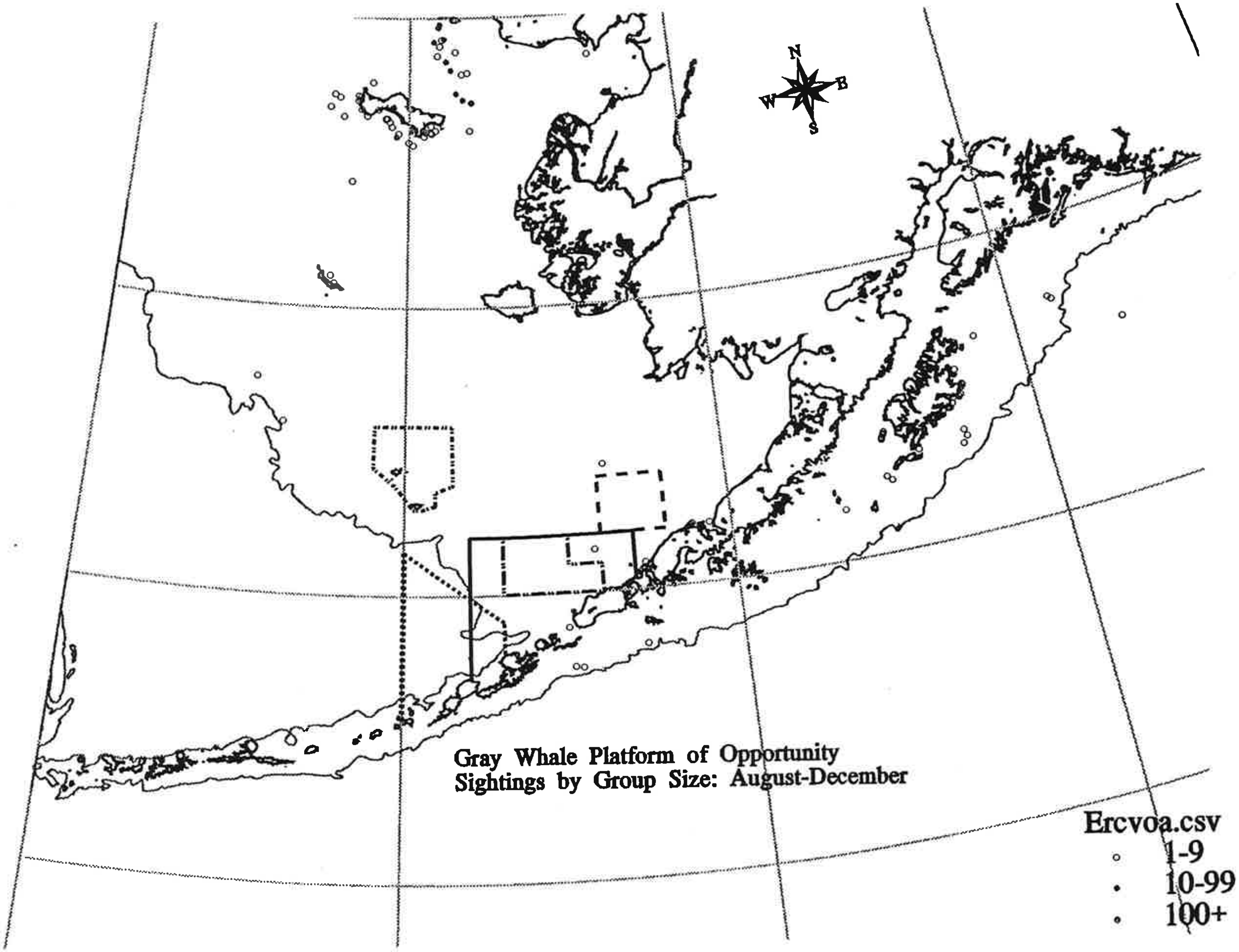


Killer Whale Platform of Opportunity Sightings by Group Size: May-July


N
W
E
S
Killer Whale Platform of Opportunity
Sightings by Group Size: August-December
Oocvoa.csv
1-9
10-99
100+


N
E
S
W
Gray Whale Platform of Opportunity
Sightings by Group Size: January-April
Ercvoa.csv
1-9
10-99
100+


N
E
W
S
Gray Whale Platform of Opportunity
Sightings by Group Size: May-July
Ercvoa.csv
1-9
10-99
100+



N
E
S
W
Gray Whale Platform of Opportunity
Sightings by Group Size: August-December
Ercvoa.csv
1-9
10-99
100+