Cruise Synopsis for the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources

by
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INTRODUCTION

The Resource Assessment and Conservation Engineering (RACE) Division of the National Oceanic and Atmospheric Administration's (NOAA) Alaska Fisheries Science Center (AFSC) conducted the Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources from May to August, 2012. This cruise continued the annual series of eastern Bering Sea crab and groundfish stock assessment surveys, which began in 1971. The survey covered the Bering Sea shelf between the depths of 20 and 200 m from Bristol Bay north to latitude 62° N.

OBJECTIVES

The primary objectives of this survey were to provide the following:

1. Data on the distribution, abundance, and biological condition of commercially important groundfish and crab species for the North Pacific Fishery Management Council (NPFMC).
2. Catch per unit effort (CPUE) and size composition data for the commercial fisheries of the U.S.
3. Support for ongoing studies on the biology, behavior, and dynamics of key ecosystem components.

Secondary objectives included:

1. Conducting additional sampling in areas of blue king crab habitat (Pribilof Islands and St. Matthew Island) to reduce variance in population estimates.
2. Evaluating the calibration of the trawl warps and the performance and geometry of the trawl using net mensuration sensors.
3. Collecting and preserving voucher specimens of fish and invertebrates for taxonomic study.
4. Collecting stomach samples for trophic interaction research.
5. Collecting and preserving both fish and invertebrate specimens for approved Special Project requests.
6. Recording auxiliary data for oceanographic studies.
7. Resampling stations in Bristol Bay toward the end of the survey to assess the reproductive status and availability to the survey of red king crab after bottom temperatures had increased.
8. Sampling additional stations for red king crab in near-shore areas outside of the standard survey grid to investigate their availability to the survey.

VESSELS AND GEAR

Sampling at survey stations was coordinated between two commercial fishing vessels, the FV *Alaska Knight* and FV *Aldebaran*, which were chartered for the bottom trawl survey. Both vessels are house-forward trawlers with stern ramps. The *Alaska Knight* has an LOA of 43.5 m (143 ft), while the *Aldebaran* has an LOA of 39.6 m (130 ft).

The bottom trawl used for sampling was an 83-112 eastern trawl. These nets have a 25.3 m (83 ft) headrope and a 34.1 m (112 ft) footrope (Figure 1). They were towed behind 816 kg, 1.8 X 2.7 m, steel V-doors and paired 54.9 m (180.1 ft) dandylines. Each lower dandyline had a 61 cm chain extension connected to the lower wing edge to improve bottom tending characteristics.

A digital bathythermograph was attached to the headrope and deployed with each trawl, resulting in observations of depth/temperature through the water column and at the targeted trawl depth. A bottom contact sensor (inclinometer/accelerometer) provided data used to assess the bottom tending performance of the net and to determine when the footrope was in contact with the seafloor. Net mensuration sensors were used to assess trawl performance and to provide net geometry data used to calculate the area swept by the trawl.

ITINERARY

The charters of the *Alaska Knight* and *Aldebaran* began in Dutch Harbor, Alaska on May 29, 2012. Both vessels made intermediate port calls to Dutch Harbor on June 22 and July 16 to exchange scientific personnel. The *Aldebaran* made an additional port call at St. Paul Island on July 1 to exchange vessel personnel. The charter of the *Aldebaran* ended on July 30, 2012 in Dutch Harbor. The *Alaska Knight* completed the survey and returned to Bristol Bay to resurvey 20 stations to investigate red king crab. The charter of the *Alaska Knight* ended on August 6, 2012 in Dutch Harbor.

Prior to the beginning of the survey, both vessels marked the trawl warps with paint at 45.73 m (25 fm) intervals. Each vessels' geometric counter readouts were verified and calibrated to the marks on the trawl warps to ensure that consistent lengths of wire were deployed at all sampling stations for a given depth.

SURVEY DESIGN AND METHODS

The total standard survey area encompassed 492,897.5 km^2. Sampling stations were based on a 37.04 km (20 nm) square grid pattern established during previous surveys. However, higher density sampling was conducted in the Pribilof Islands and St. Matthew Island regions to better assess local blue king crab populations. For reporting purposes, the survey area is divided into strata (Figure 2) that correspond to the inner (0 – 50 m), middle (50 – 100 m), and outer (> 100 m) Bering Sea shelf domains, which are further divided into northwest and southeast geographical strata. Since 1982, 20 stations, representing two strata, have extended the standard survey sampling to the north.

Sampling began in Bristol Bay and proceeded westward to the Bering Sea shelf edge, demarcated by the 200 m isobath. After the standard survey was completed, the *Alaska Knight* returned to Bristol Bay to resurvey 20 stations in an effort to assess the availability of mature red king crab to the survey after bottom temperatures had increased from the original sampling of those stations at the beginning of the survey.

Figure 2 details the distribution of standard sampling stations for the survey by vessel. Trawls were 30 minutes in duration, as estimated from the time the footrope made contact with the seafloor until the time the footrope was completely off-bottom as the net was hauled back. At each station, observations of time, position, trawl performance and distance fished were recorded. All catches were sorted to the lowest possible taxon, weighed, and enumerated. Age structures, length measurements, and other biological data were collected for the major fish species encountered. Collection of age structures was stratified by length, sex, and region for most species, but a stratified-random method was used for walleye pollock. Catch and station data were entered into shipboard computer systems. Carapace length and width, shell condition and clutch size were observed and recorded from the major crab species, and various tissues and organs were collected for further analysis. Collections for approved Special Projects were stored in appropriate fixatives or were frozen.

RESULTS

The *Alaska Knight* and *Aldebaran* conducted 385 bottom trawls in the execution of the standard survey. Of those trawls, 9 were determined to have unsatisfactory performance, resulting in redeploying the trawl at those stations to obtain a sample with acceptable performance. At the end of the survey, sampling was repeated at 20 stations in Bristol Bay; these data were not included in the present analysis. In continuance of a project to examine the near-shore areas of Bristol Bay for red king crab, 9 additional trawls were conducted outside of the standard survey stations.

Biological data collected from fish species are summarized in Table 1. The two vessels recorded 148,039 randomly selected length measurements from priority fish species by sex. Additionally, 55,418 crabs were measured, and their shell conditions were assessed. Sagittal otoliths were extracted from 7,776 fish, representing 9 targeted species. Length and weight measurements were recorded for each fish sampled for otoliths. A total of 5,258 fish stomachs from 13 different species were extracted and preserved for food habits analysis, however *Atheresthes stomias* and *A. evermanni* were grouped together, and *Hippoglossoides elassodon* and *H. robustus* were grouped together as well.

Whole specimens of selected fish and invertebrate species were preserved for use in identification training programs and other research. Various tissue samples were removed and preserved for approved research projects.

Table 2 displays the percentage of all stations sampled where fish or commercial crab species, excluding non-commercial invertebrates, accounted for the majority of the catch by weight. Mean catch rates of commercial fish and crab species are listed by Stratum and total survey area in Table 3. Mean catch per unit effort (CPUE) is calculated as the total weight of a species in a given tow, divided by the product of the distance fished and the average net width from the time the footrope contacted the seafloor until the footrope was no longer in contact with the seafloor.

Walleye pollock (*Theragra chalcogramma*) was the most abundant fish species overall, resulting in a total mean CPUE of 70.75 kg/ha. Pollock were present in every stratum (Figure 3), with the largest mean CPUE (123.88 kg/ha) observed in Stratum 4. The mean CPUE values were much lower within relatively shallower Strata 1 and 2 (7.18 and 8.46 kg/ha respectively).

Yellowfin sole (*Limanda aspera*) and northern rock sole (*Lepidopsetta polyxystra*) were the most abundant flatfish species with total mean CPUE values of 39.59 kg/ha and 38.96 kg/ha respectively. The mean CPUE for both yellowfin sole and northern rock sole was highest in Stratum 1 (134.06 kg/ha and 91.99 kg/ha respectively). Yellowfin sole were not encountered within Strata 5, 6, or 9 (Figure 4).

Pacific cod (*Gadus macrocephalus*) were encountered within every stratum (Figure 6). Mean CPUE was lowest in Stratum 8 (0.94 kg/ha). The highest mean CPUE value was observed in Stratum 1 (43.49 kg/ha) with a total mean CPUE of 18.19 kg/ha over all strata.

The mean CPUE of Pacific halibut (*Hippoglossus stenolepis*) was highest in Stratum 2 (7.09 kg/ha) and lowest in Stratum 8 (0.12 kg/ha). The highest mean CPUE of Alaska plaice (*Pleuronectes quadrituberculatus*) occurred in Stratum 2 (27.21 kg/ha) and none were encountered in Stratum 5.

In the Bering Sea, two flatfish genera (*Hippoglossoides* spp. and *Atheresthes* spp.), consisting of two species each, are treated as a single taxonomic group for the purposes of reporting because, historically, these species were not always identified as separate. The highest combined mean CPUE for flathead sole (*Hippoglossoides elassodon*) and Bering flounder (*H. robustus*) occurred in Stratum 3 (14.8 kg/ha). The combined mean CPUE for arrowtooth flounder (*Atheresthes stomias*) and Kamchatka flounder (*A. evermanni*) peaked in Stratum 5 (31.10 kg/ha), and neither species was encountered in Strata 2 or 8.

The near-bottom temperature (measured as the mean temperature at the depth of the headrope while the trawl was on-bottom) averaged over all survey stations was 0.8 °C in 2012, which represents the coldest mean temperature in over a decade (Figure 7).

Cold bottom temperatures may have reduced the availability of red king crab to sampling in Bristol Bay, as well as delaying the onset of molting, and therefore reproduction, in females. This led to a resurvey of 20 stations toward the end of the charter. The mean temperature for these stations had increased from 1.9 °C to 4.6 °C between the original observations and the resurvey.

SCIENTIFIC PERSONNEL[1]

FV *Aldebaran*

Leg 1	Leg 2	Leg 3
B. Lauth[2]	D. Nichol[2]	C. Long[2,4]
J. Conner[3]	J. Conner[3]	D. Nichol[3]
C. Armistead[4]	C. Long[4]	P. Cummiskey[4]
E. Keller[7]	M. Inokuma[5]	A. Vijgen
C. Yeung	V. Lowe	P. Jensen
S. Rohan	S. Rohan	T. Buckley

FV *Alaska Knight*

Leg 1	Leg 2	Leg 3
K. Weinberg[2]	B. Lauth[2]	K. Weinberg[2]
S. Kotwicki[3]	E. Acuna[3]	D. Stevenson[3]
E. Munk[4]	D. Benjamin	D. Benjamin
J. Murawski[8]	M. Dawson[8]	L. Stichert[5]
S. Romaine[6]	S. Romaine[6]	S. Romaine[6]
J. Brogan	T. Tenbrink	R. Payne

[1] Personnel from the AFSC, Seattle, unless otherwise noted
[2] Field Party Chief
[3] Deck Lead
[4] Personnel from the AFSC, Kodiak Laboratory
[5] Personnel from the Alaska Department of Fish & Game
[6] Personnel from the International Pacific Halibut Commission
[7] Personnel from University of Alaska
[8] Contractor

Table 1 - Biological data collected during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Length measurements	Age structures	Stomachs collected	Pathobiology samples
Walleye pollock	35,782	1,797	712	4
Pacific cod	15,698	1,307	1,876	6
Yellowfin sole	23,519	993	–	1
Northern rock sole	18,192	355	–	2
Flathead sole/ Bering flounder	14,807	608	474	2
Pacific halibut	2,738	1,190	289	–
Alaska plaice	10,399	484	–	3
Arrowtooth flounder/ Kamchatka flounder	11,986	624	786	–
Greenland turbot	2,133	418	272	–
Rex sole	704	–	–	–
Longhead dab	720	–	–	–
Plain sculpin	1,946	–	–	–
Great sculpin	622	–	–	–
Warty sculpin	162	–	–	–
Yellow Irish lord	349	–	–	–
Starry flounder	611	–	–	–
Pacific Ocean perch	208	–	–	–
Alaska skate	3,704	–	770	–
Bering skate	189	–	75	–
Misc. skates	18	–	4	–
Red king crab	2,817	–	–	1
Blue king crab	288	–	–	132
Opilio Tanner crab	34,272	–	–	900
Bairdi Tanner crab	15,263	–	–	293
Misc. species	6,330	–	–	34
Total	203,457	7,776	5,258	1,378

Table 2 – Summary of predominant species by weight at each survey station during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Number of stations	Percent of stations
Walleye Pollock	148	39
Yellowfin Sole	74	20
Northern Rock Sole	50	13
Arrowtooth Flounder	29	8
Snow Crab	22	6
Alaska Plaice	18	5
Pacific Cod	11	3
Flathead Sole	9	2
Alaska Skate	8	2
Pacific Herring	5	1
Butterfly Sculpin	1	< 1
Pacific Ocean Perch	1	< 1

Table 3 - Mean CPUE (kg/ha) of commercially important species by stratum during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources

Species	Stratum								Total
	1	2	3	4	5	6	8	9	
Walleye pollock	7.18	8.46	105.74	123.88	51.72	59.43	47.42	104.48	70.75
Yellowfin sole	134.06	70.95	45.66	13.41	NC	NC	0.03	NC	39.59
Northern rock sole	91.99	46.66	63.90	31.83	0.29	0.84	0.04	0.18	38.96
Pacific cod	43.49	35.06	9.31	15.32	4.14	13.83	0.94	3.50	18.19
Alaska plaice	12.14	27.21	14.75	20.57	NC	0.09	0.31	0.15	11.81
Flathead sole/ Bering flounder	0.65	0.02	14.80	7.24	8.83	11.75	2.52	3.36	7.91
Arrowtooth flounder/ Kamchatka flounder	0.16	NC	8.35	1.61	31.10	23.06	NC	1.85	9.04
Pacific halibut	6.22	7.09	5.84	1.72	2.10	2.55	0.12	0.19	3.83

* NC = None caught within the Stratum.

83/112 EASTERN

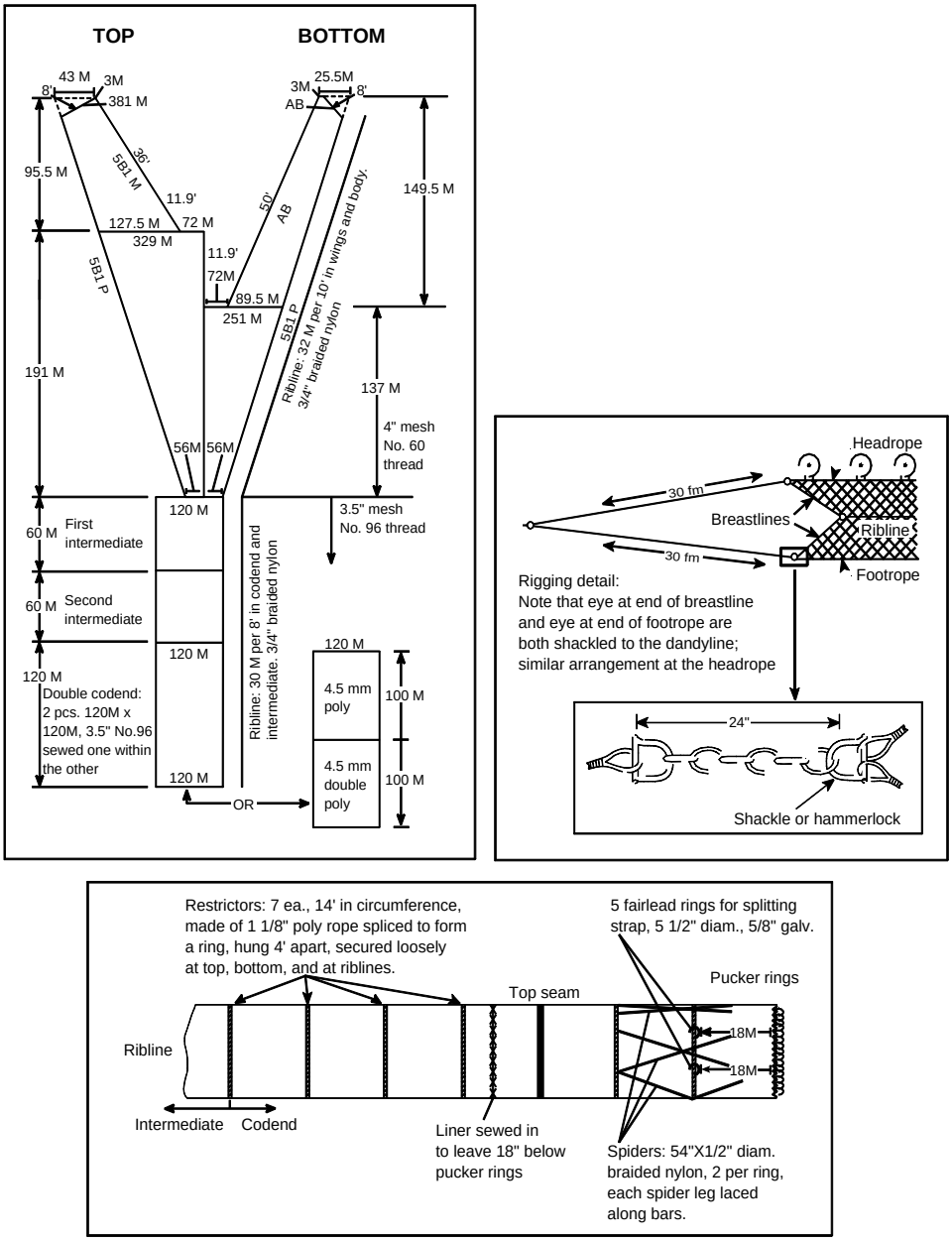

Figure 1 - Diagram of the 83-112 eastern bottom trawl used in the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

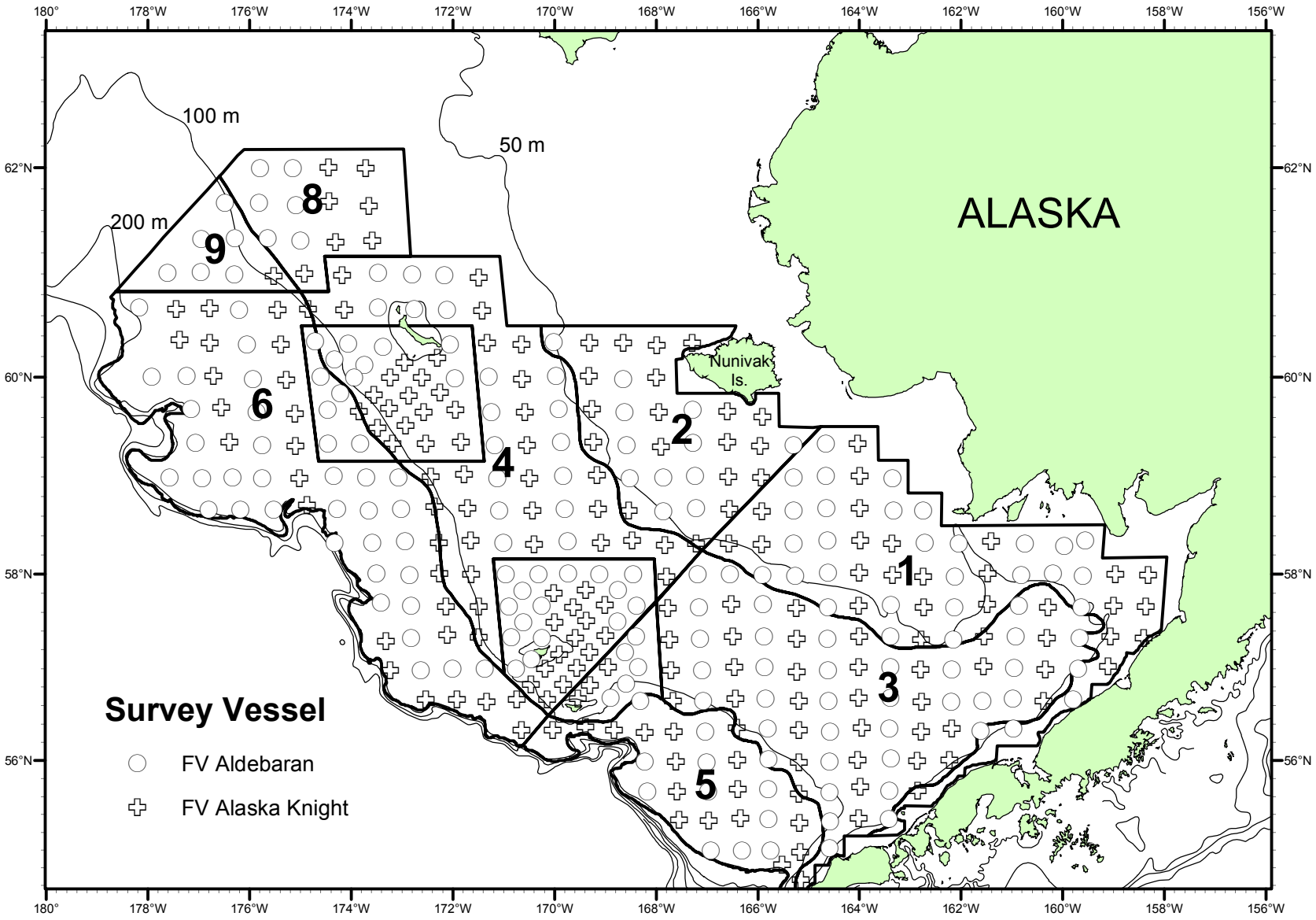

Figure 2 - Distribution of total sampling effort by the F/V *Alaska Knight* and F/V *Aldebaran* during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

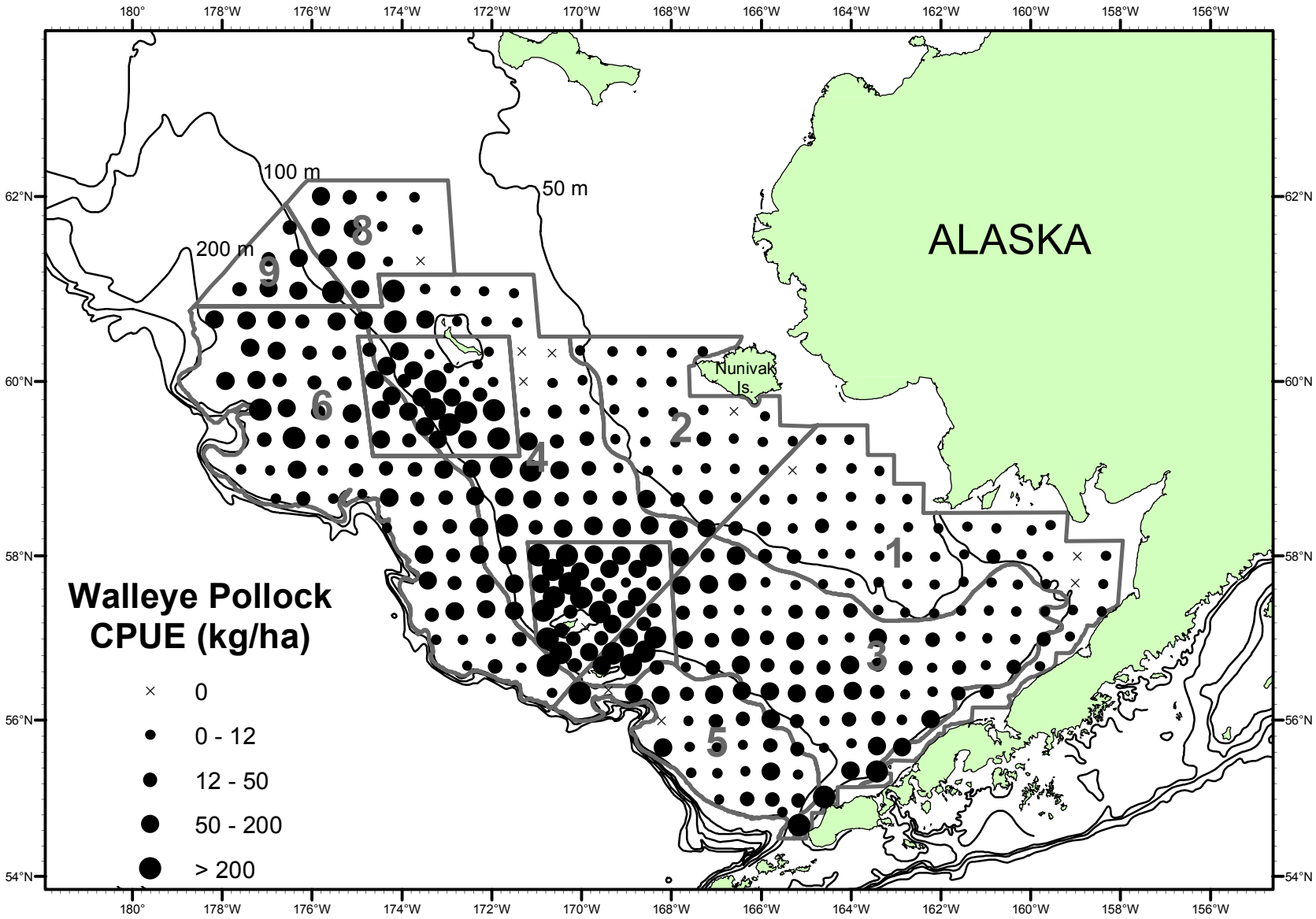

Figure 3 - Catch rates (kg/ha) of walleye pollock during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

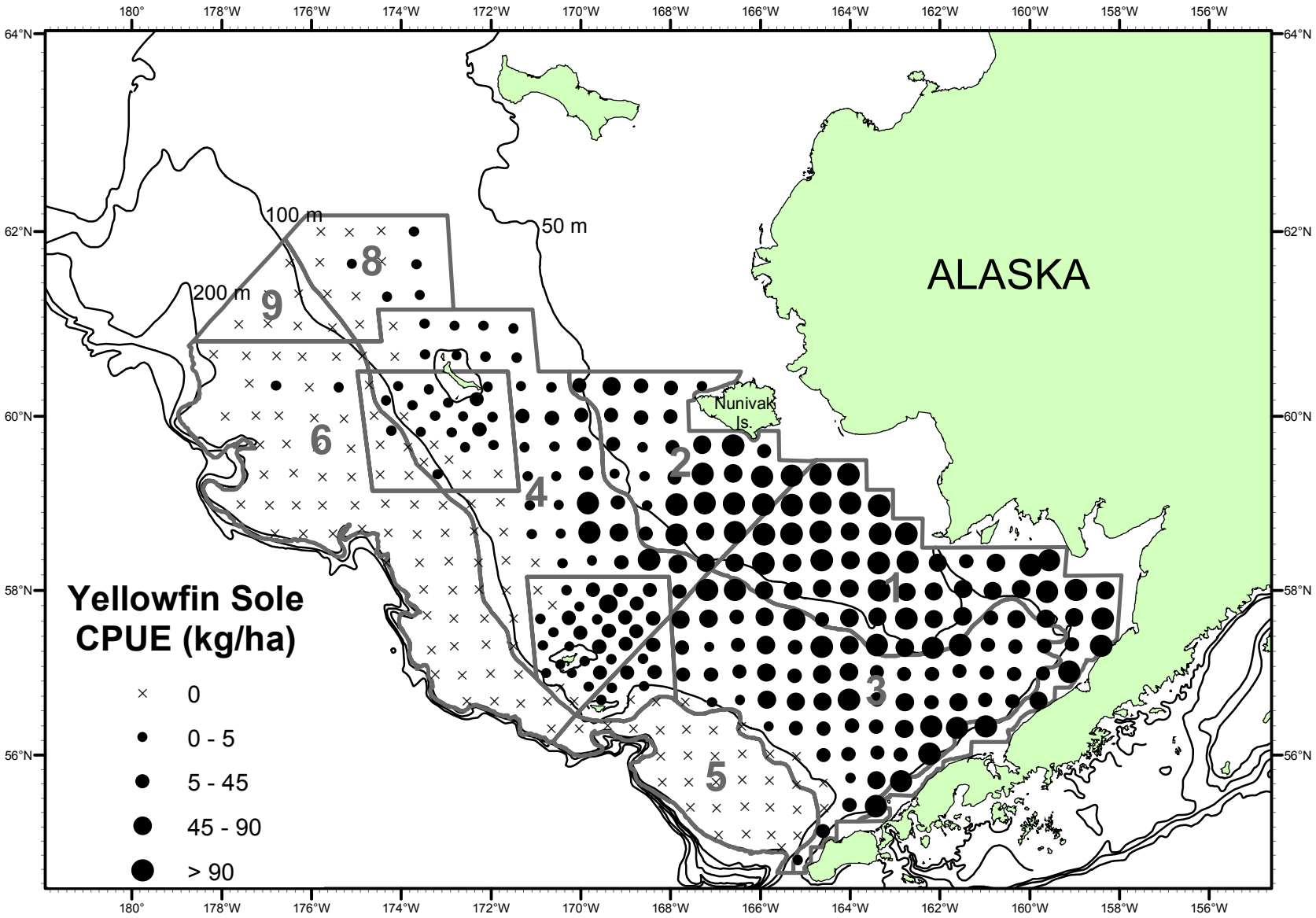

Figure 4 - Catch rates (kg/ha) of yellowfin sole during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

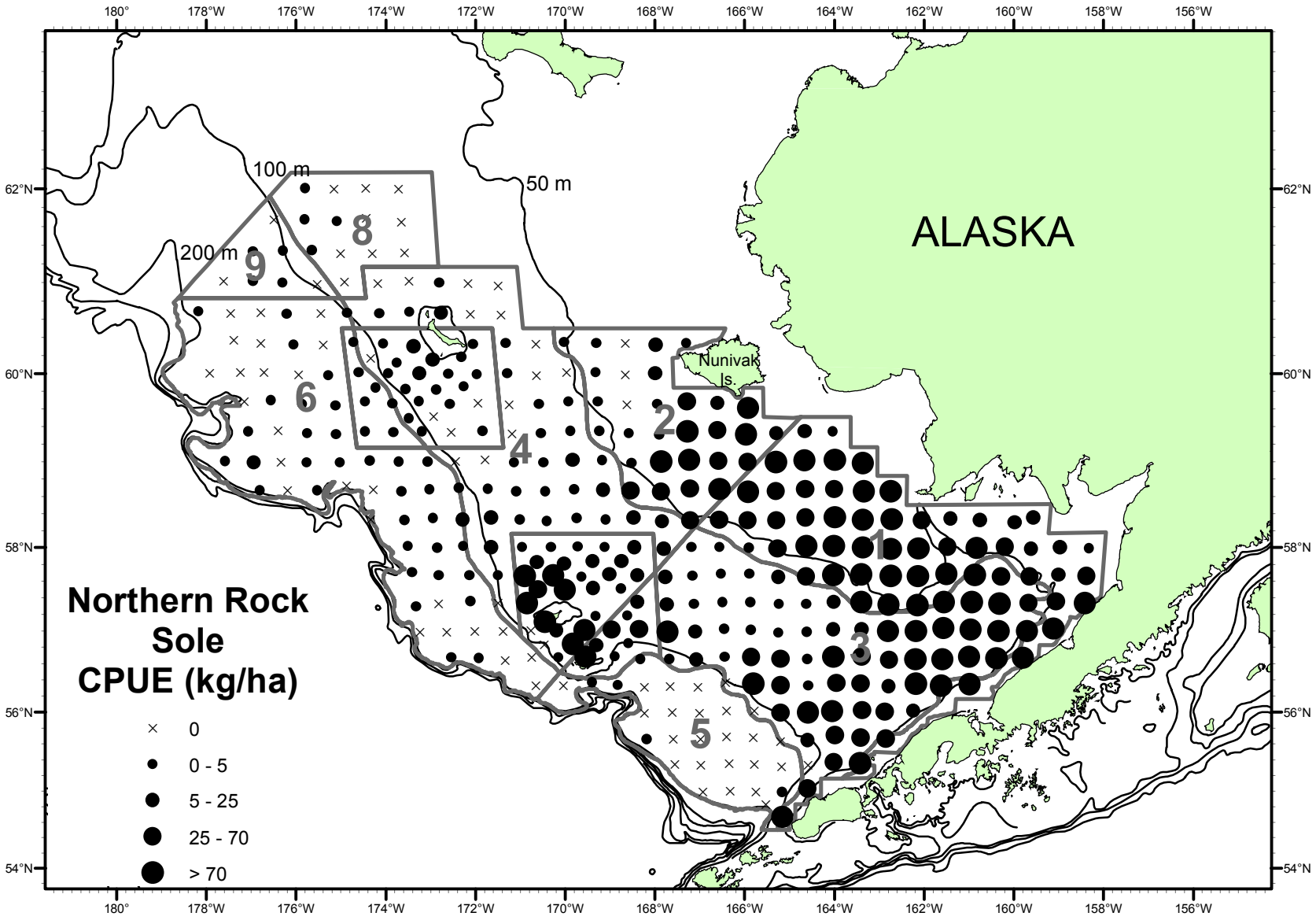

Figure 5 - Catch rates (kg/ha) of northern rock sole during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

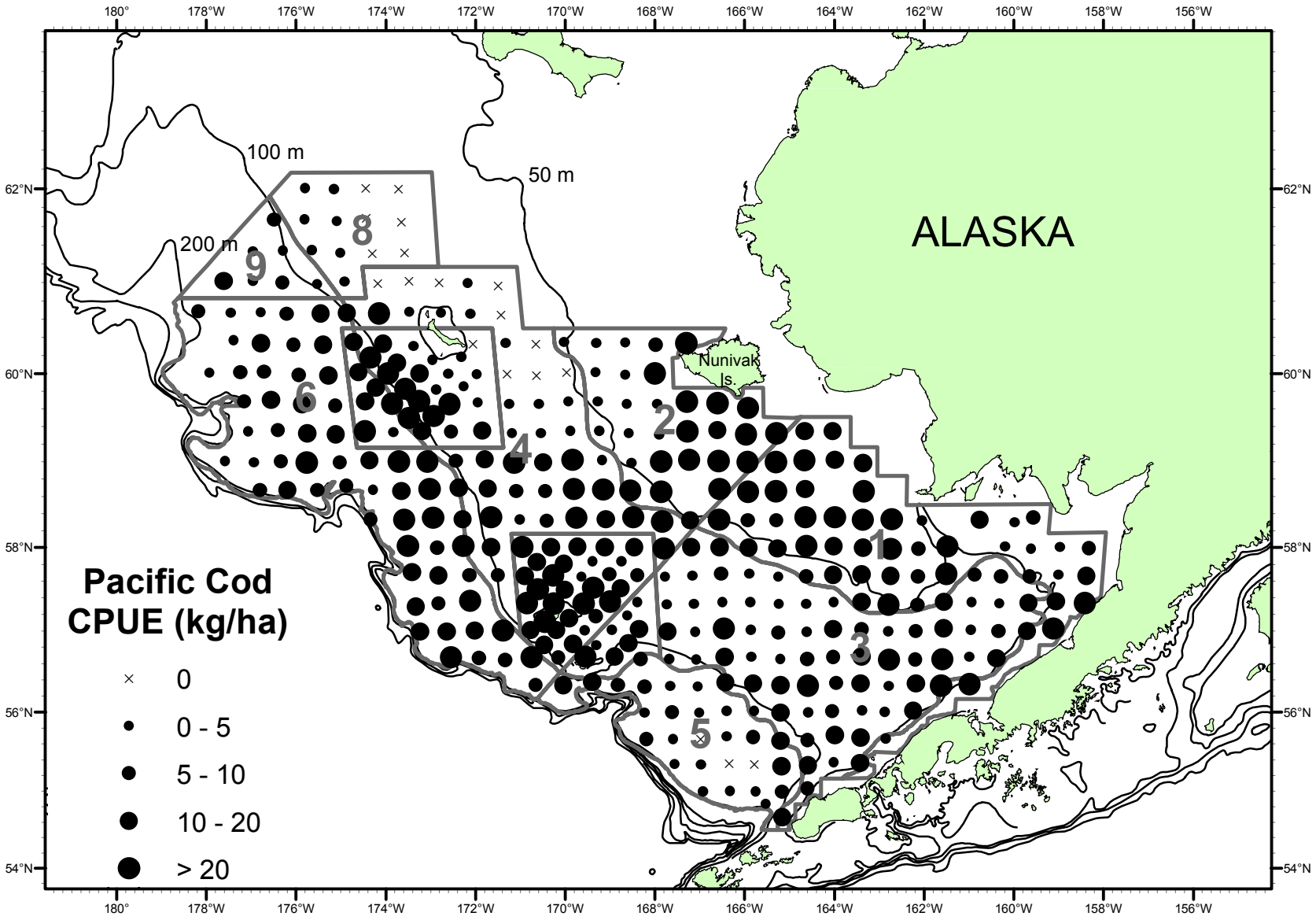

Figure 6 - Catch rates (kg/ha) of Pacific cod during the 2012 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Figure 7: Analysis of means of near-bottom temperatures (° C) recorded during the Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources for each of the years between 2001 and 2012. The dashed lines represent the 95% decision limits around the grand mean.