Cruise Synopsis for the 2013 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 June 3, 2013 to August 9, 2013. 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 northward 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. Collecting and preserving voucher specimens of fish and invertebrates for taxonomic study.
3. Collecting stomach samples for trophic interaction research.
4. Collecting and preserving both fish and invertebrate specimens for approved Special Project requests.
5. Conducting an experiment to analyze the effect of trawl speed on the catchability of Pacific cod.
6. Deployment of the Cam-Trawl system, and assessing the feasibility of using bottom trawl gear for mid-water sampling.

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 (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 June 3, 2013. Both vessels made intermediate port calls to Dutch Harbor on June 26 and July 18 to exchange scientific personnel. The *Aldebaran* made an additional port call at St. Paul Island on July 6 to exchange vessel and scientific personnel. The survey was completed on August 9, 2013 and both vessels were offloaded 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 492,898 km^2. Sampling stations were based on a 37.04 km (20 nm) square grid pattern established during previous surveys. Stations were towed as close to the center point of the grid cell as logistically feasible. 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. 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 selected species and are summarized in Table 1. 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 389 bottom trawls in the execution of the standard survey. Of those trawls, 13 were determined to have unsatisfactory performance, resulting in redeployment the trawl at those stations to obtain a sample with acceptable performance. At the end of the survey, both vessels conducted side-by-side trawls to examine the effect of vessel speed on the catchability of Pacific cod, resulting in 66 tows, one of which was unsatisfactory.

The two vessels recorded 150,837 randomly selected length measurements from priority fish species by sex (Table 1). Additionally, 51,858 crabs were measured, and their shell conditions were assessed. Sagittal otoliths were extracted from 8,451 fish, representing 12 targeted species. Length and weight measurements were recorded for each fish sampled for otoliths. A total of 5,491 fish stomachs from 4 different species were extracted and preserved for food habits analysis, however *Atheresthes stomias* and *A. evermanni* were grouped together in the collection.

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, indicated by a total mean CPUE of 92.83 kg/ha. Pollock were present in every stratum (Figure 3), with the highest mean CPUE (222.75 kg/ha) observed in Stratum 9 at the northwest extent of sampling. Mean CPUE values were much lower within relatively shallower Strata 1 and 2 (6.74 and 7.12 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 46.24 kg/ha and 35.56 kg/ha respectively. The mean CPUE for both yellowfin sole and northern rock sole was highest in Stratum 1 (142.31 kg/ha and 116.46 kg/ha respectively). Yellowfin sole were not encountered within Strata 5 or 6 (Figure 4). The distribution of northern rock sole is generally concentrated in shallower water (Figure 5).

Pacific cod (*Gadus macrocephalus*) were encountered within every stratum (Figure 6). Mean CPUE was lowest in Stratum 8 (0.04 kg/ha). The highest mean CPUE value was observed in Stratum 1 (30.91 kg/ha), with a total mean CPUE of 16.47 kg/ha. Data from the trawl speed selectivity experiment were not used in these calculations.

The mean CPUE of Pacific halibut (*Hippoglossus stenolepis*) was highest in Stratum 1 (8.74 kg/ha) and lowest in Stratum 8, where no halibut were caught. The highest mean CPUE of Alaska plaice (*Pleuronectes quadrituberculatus*) occurred in Stratum 3 (27.21 kg/ha) and none were encountered in Stratum 5.

In the Bering Sea, two flatfish genera (*Hippoglossoides* spp. and *Atheresthes* spp.), each consisting of two species, are treated as a single taxonomic group for the purposes of reporting because, historically, these species were not always distinguished. The highest combined mean CPUE for flathead sole (*Hippoglossoides elassodon*) and Bering flounder (*H. robustus*) occurred in Stratum 6 (15.37 kg/ha). The combined mean CPUE for arrowtooth flounder (*A. stomias*) and Kamchatka flounder (*A. evermanni*) peaked in Stratum 5 (39.60 kg/ha), and neither species was encountered in Strata 2 or 8.

The mean near-bottom temperature (measured as the temperature at the depth of the headrope while the trawl was on-bottom) for all survey stations was 1.6 °C in 2013, which is colder than the lower 95% decision limit (1.9 °C) around the long-term mean since 2001 (Figure 7).

SCIENTIFIC PERSONNEL[1]

FV *Aldebaran*

Leg 1	Leg 2	Leg 3
D. Nichol [2]	D. Nichol [2] / J. Conner [2]	S. Kotwicki [2]
D. Stevenson [3]	C.Yeung [3]	C.Yeung [3]
J. Murawski [4]	D. Benjamin	C. Long [4]
M. Dawson [7]	M. Inokuma [5]	R. Caruso
P. Jensen	J. Murawski [4]	A. Vijgen
	K. Holsman [7]	T. Buckley

FV *Alaska Knight*

Leg 1	Leg 2	Leg 3
B. Lauth [2]	L.Britt [2]	K. Weinberg [2]
S. Kotwicki [3]	J. Hoff [3]	J. Conner [3]
P. Cummiskey[4]	C. Long [4]	P. Cummiskey[4]
J. Webb [5]	N. Gabriel [7]	B. Daly [4]
K. Johnson [6]	S. Parker [6]	S. Parker [6]
K. Sawyer [7]	C. Robinson [7]	D. Drumm [7]

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[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 Alaska Department of Fish and Game

[6] Personnel from International Pacific Halibut Commission

[7] Contractor

Table 1 - Biological data collected during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Length measurements	Age structures	Stomachs collected	Pathobiology samples
Walleye pollock	35,908	1,856	2,506	–
Pacific cod	18,699	1,424	1,759	–
Yellowfin sole	23,261	821	–	–
Northern rock sole	21,189	358	–	–
Flathead sole/Bering flounder	16,894	693	–	–
Pacific halibut	2,232	1,133	372	–
Alaska plaice	9,705	544	–	–
Arrowtooth/Kamchatka flounder	11,236	519	854	–
Greenland turbot	1,160	382	–	–
Rex sole	528	–	–	–
Longhead dab	715	–	–	–
Plain sculpin	1,914	357	–	–
Great sculpin	438	266	–	–
Warty sculpin	143	98	–	–
Yellow Irish lord	340	–	–	–
Starry flounder	483	–	–	–
Pacific Ocean perch	302	–	–	–
Alaska skate	3,797	–	–	–
Bering skate	235	–	–	–
Misc. skates	40	–	–	–
Red king crab	1,352	–	–	323
Blue king crab	139	–	–	18
Opilio Tanner crab	31,269	–	–	24
Bairdi Tanner crab	16,146	–	–	84
Misc. species	4,570	–	–	4
Total	202,695	8,451	5,491	453

Table 2 – Summary of predominant species by weight at each survey station during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Number of stations	Percent of stations
Walleye Pollock	146	39
Yellowfin Sole	73	19
Northern Rock Sole	53	14
Arrowtooth Flounder	26	7
Alaska Plaice	23	6
Snow Crab	22	6
Pacific Herring	11	3
Flathead Sole	9	2
Pacific Cod	9	2
Alaska Skate	3	< 1
Pacific Ocean Perch	1	< 1

Table 3 - Mean CPUE (kg/ha) of commercially important species by stratum during the 2013 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	6.74	7.12	61.32	133.09	92.40	189.22	11.01	222.75	92.83
Yellowfin sole	142.31	93.37	65.00	10.78	NC	NC	0.01	0.01	46.24
Northern rock sole	116.46	46.83	39.55	21.59	0.24	1.20	0.08	0.21	35.56
Pacific cod	30.91	27.05	9.40	12.35	8.93	18.55	0.04	16.98	16.47
Alaska plaice	7.56	19.77	21.47	13.11	NC	0.19	0.11	0.37	10.26
Flathead sole/ Bering flounder	0.59	0.17	13.52	13.86	13.27	15.37	1.67	3.77	10.11
Arrowtooth flounder/ Kamchatka flounder	0.14	NC	7.54	1.97	39.60	20.47	NC	3.83	9.17
Pacific halibut	8.74	6.77	3.29	1.41	2.78	2.97	NC	0.06	3.73

* NC = None caught within the Stratum.

83/112 EASTERN

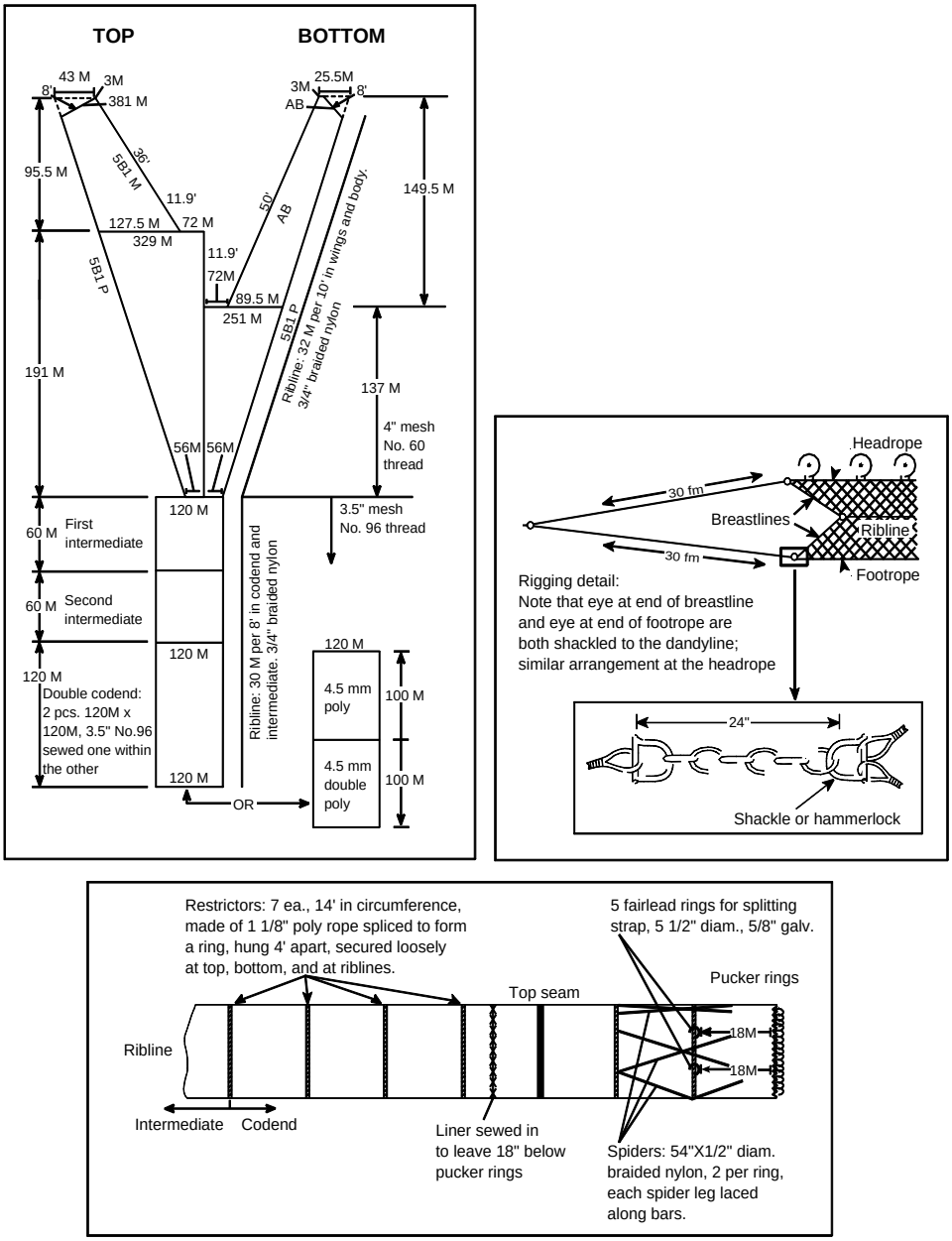

Figure 1 - Diagram of the 83-112 eastern bottom trawl used in the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

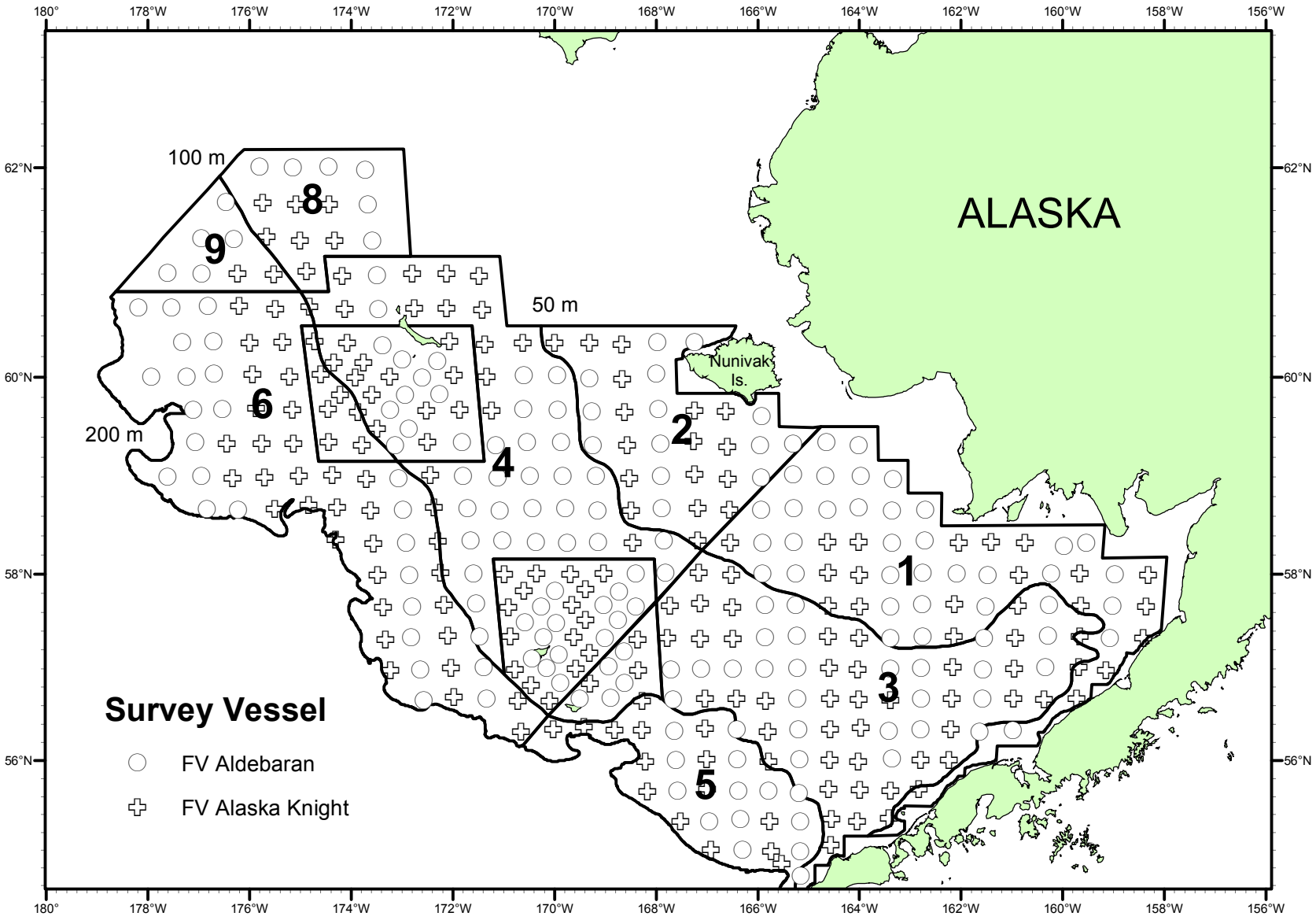

Figure 2 - Designation of the 9 primary strata and distribution of total sampling effort by the F/V *Alaska Knight* and F/V *Aldebaran* during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

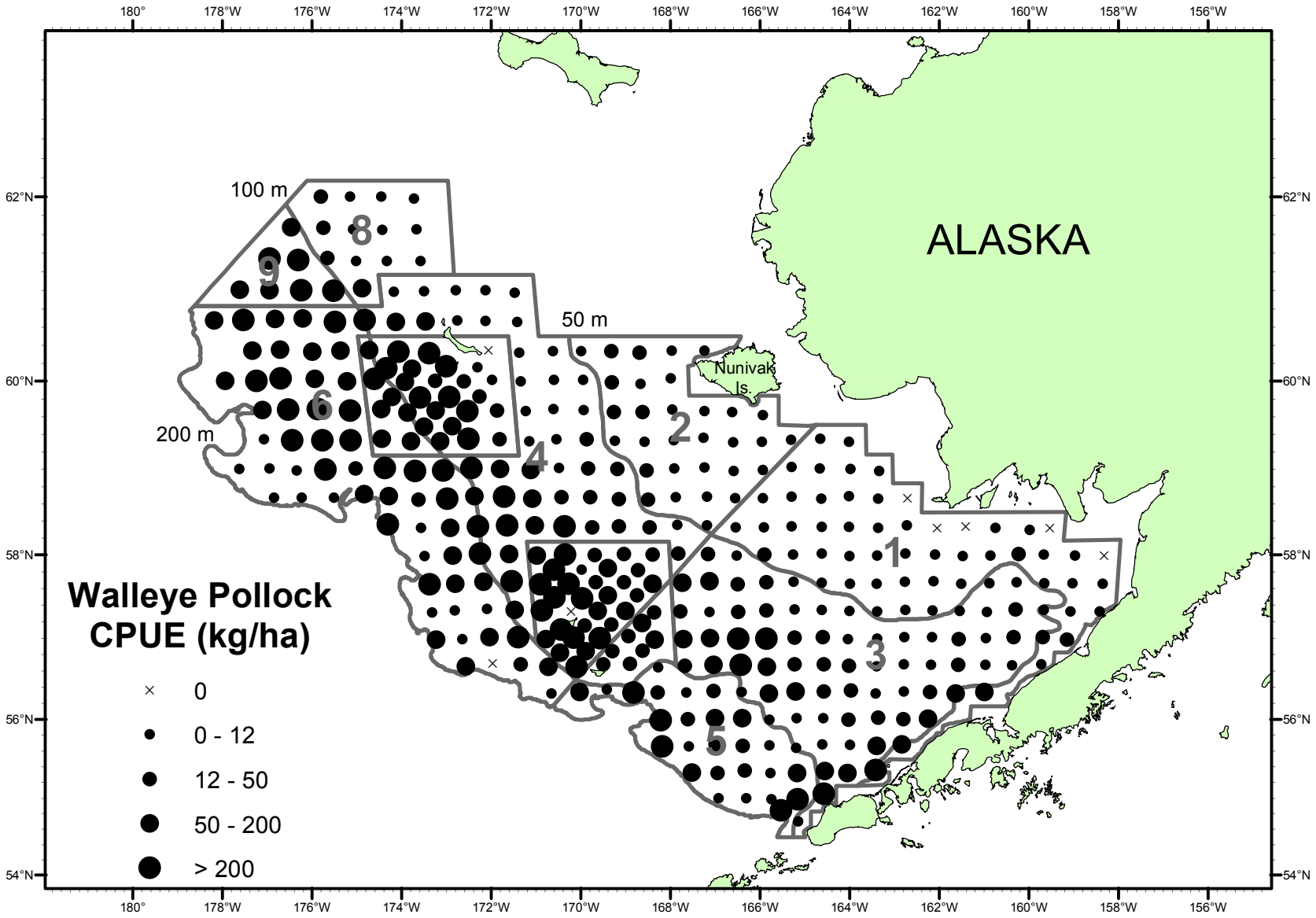

Figure 3 - Catch rates (kg/ha) of walleye pollock during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

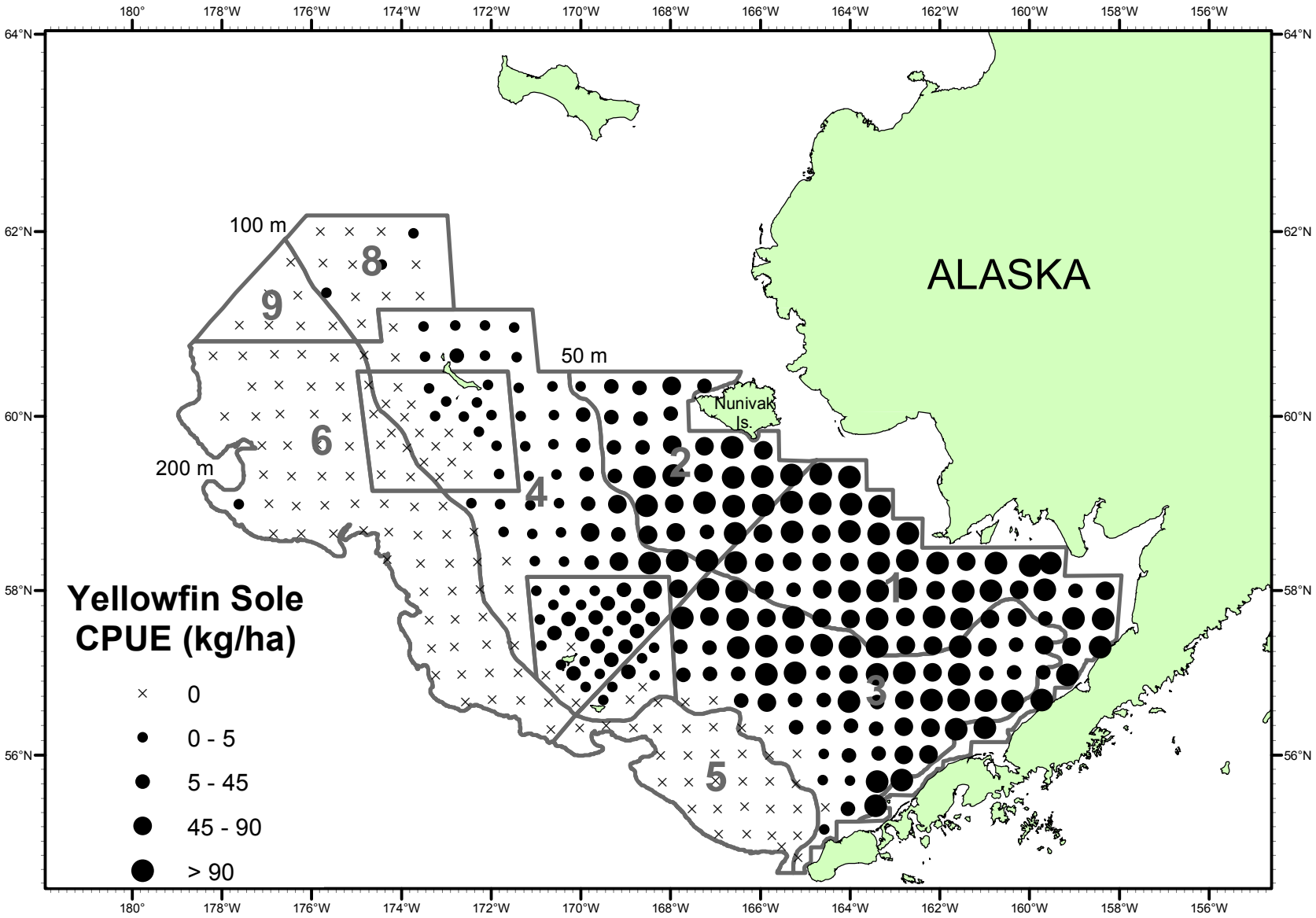

Figure 4 - Catch rates (kg/ha) of yellowfin sole during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

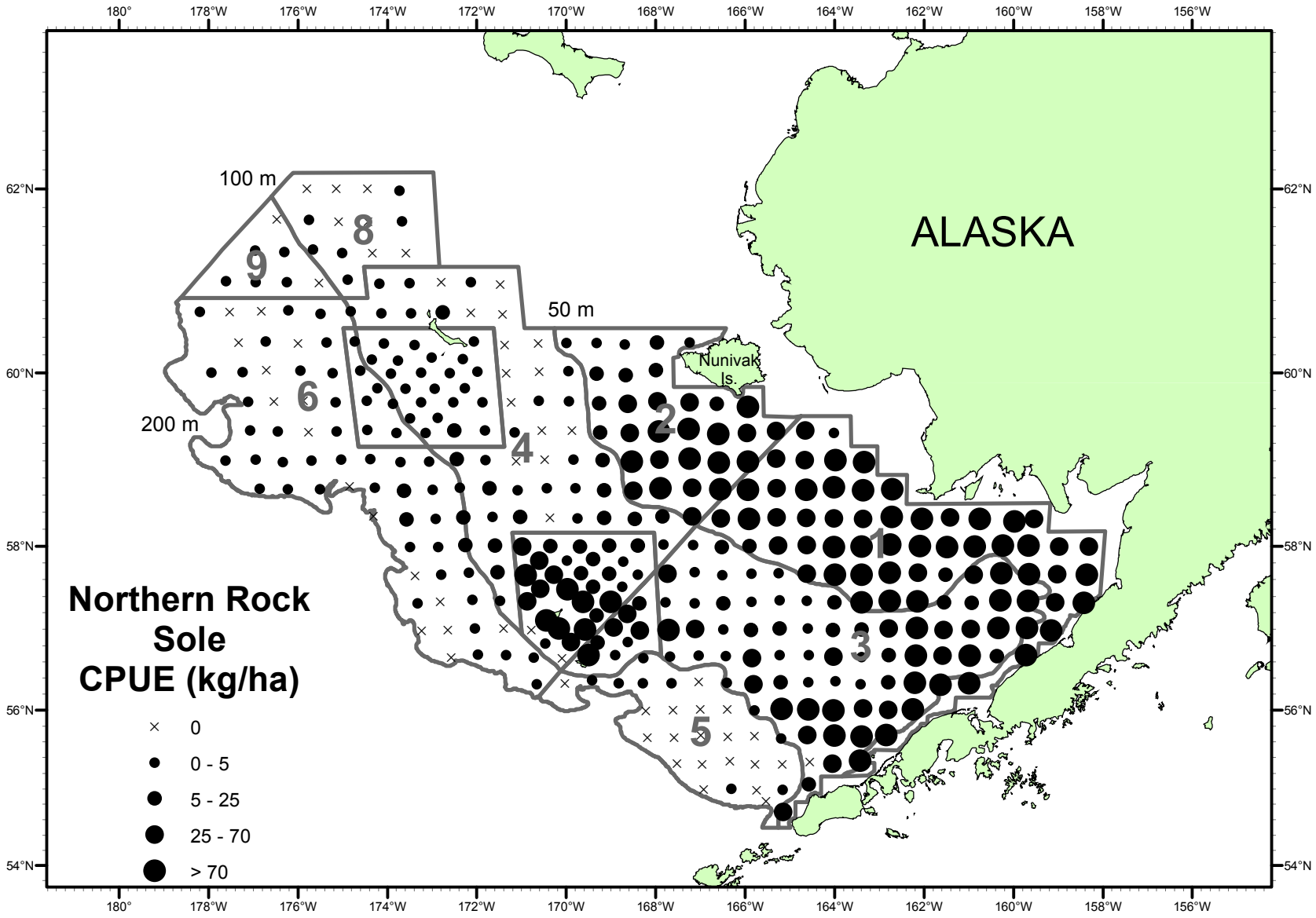

Figure 5 - Catch rates (kg/ha) of northern rock sole during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

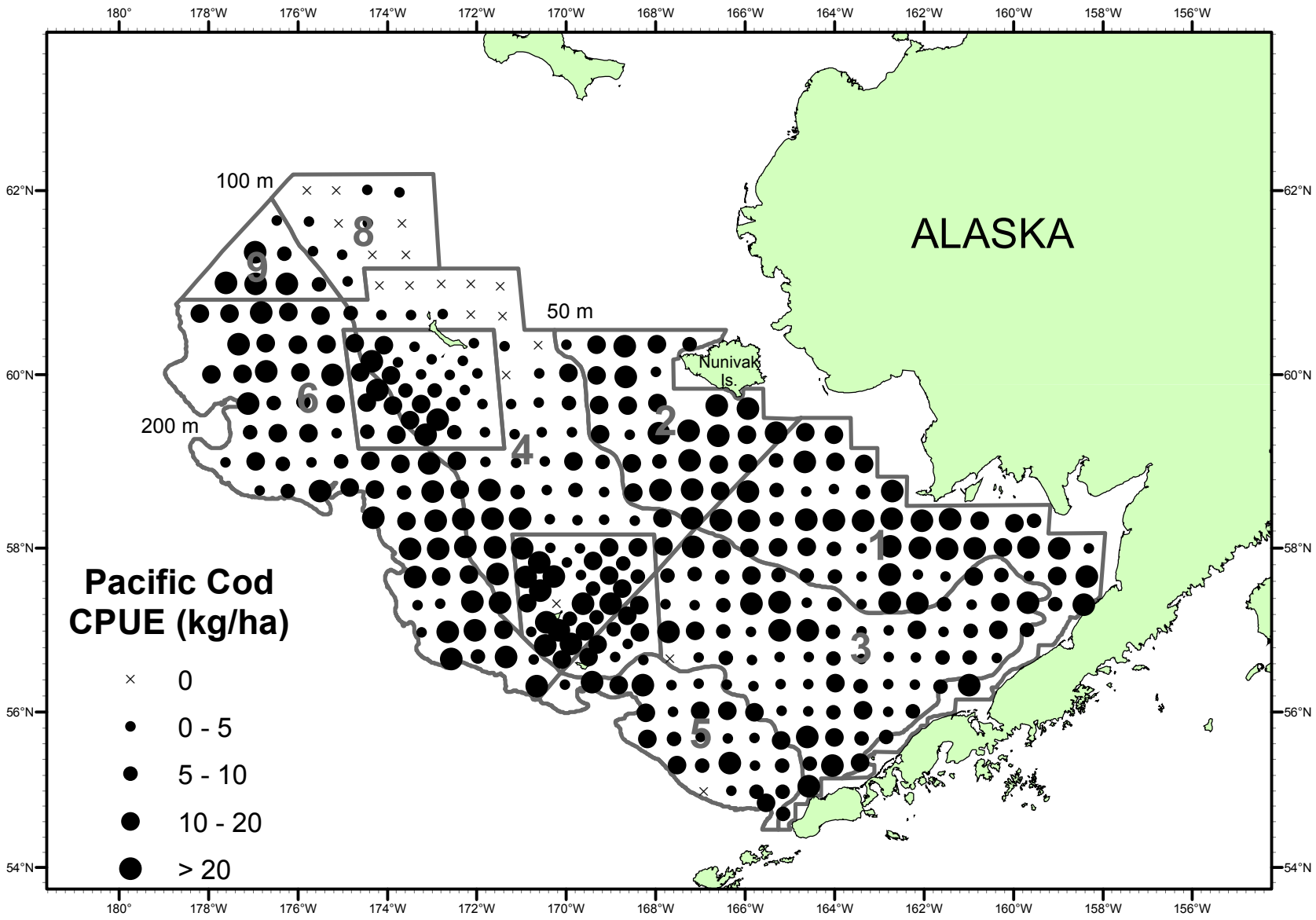

Figure 6 - Catch rates (kg/ha) of Pacific cod during the 2013 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

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 2013. The dashed lines represent the 95% decision limits around the grand mean.