Cruise Synopsis for the 2014 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, 2014 to August 6, 2014. 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 ground truth acoustic data by towing the bottom trawl in mid-water.

VESSELS AND GEAR

Sampling at survey stations was coordinated between two commercial fishing vessels, the FV *Alaska Knight* and FV *Vesteraalen*, 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 *Vesteraalen* has an LOA of 38 m (125 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 *Vesteraalen* began in Dutch Harbor, Alaska on June 3, 2014. Both vessels made intermediate port calls to Dutch Harbor on June 24 and July 16 to exchange scientific personnel. The *Vesteraalen* made an additional port call at St. Paul Island on July 7 to exchange vessel and scientific personnel. The survey was completed on August 6, 2014 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. The geometric wire counter readouts for each vessel 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 *Vesteraalen* conducted 383 bottom trawls in the execution of the standard survey. Of those trawls, 7 were determined to have unsatisfactory performance, resulting in redeployment the trawl at those stations to obtain a sample with acceptable performance. A project investigating the feasibility of using bottom trawl gear to sample mid-water pollock involved conducting 45 additional trawls in areas where sufficient echosounder backscatter was observed.

The two vessels recorded 144,847 randomly selected length measurements from priority fish species by sex (Table 1). Additionally 55,865 crabs were measured and assessed for shell condition. Sagittal otoliths were extracted from 8,160 fish, representing the following targeted species: *Gadus chalcogrammus, G. macrocephalus, Limanda aspera, Lepidopsetta polyxystra, Hippoglossoides elassodon, Hippoglossus stenolepis, Pleuronectes quadrituberculatus, Atheresthes stomias, A. evermanni,* and *Reinhardtius hippoglossoides*. Length and weight measurements were recorded for each fish sampled for otoliths. A total of 5,817 fish stomachs from 5 different species were extracted and preserved for food habits analysis, however *A. 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 (*G. chalcogrammus*) was the most abundant fish species overall, with a total mean CPUE of 150.74 kg/ha. Pollock were present in every stratum (Figure 3), with the highest mean CPUE (313.90 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 (16.47 and 17.35 kg/ha respectively).

Yellowfin sole (*L. aspera*) and northern rock sole (*L. polyxystra*) were the most abundant flatfish species with total mean CPUE values of 50.97 kg/ha and 37.68 kg/ha respectively. The mean CPUE for both yellowfin sole and northern rock sole was highest in Stratum 1 (179.49 kg/ha and 124.1 kg/ha respectively). Yellowfin sole were not encountered within Strata 5, 6, or 9 (Figure 4). The distribution of northern rock sole is generally concentrated in shallower water (Figure 5).

Pacific cod (*G. macrocephalus*) were encountered within every stratum (Figure 6). Mean CPUE was lowest in Stratum 8 (4.51 kg/ha). The highest mean CPUE value was observed in Stratum 2 (71.03 kg/ha), with a total mean CPUE of 22.22 kg/ha.

The mean CPUE of Pacific halibut (*H. stenolepis*) was highest in Stratum 1 (7.42 kg/ha) and lowest in Stratum 8, where no halibut were caught. The highest mean CPUE of Alaska plaice (*P. quadrituberculatus*) occurred in Stratum 3 (17.49 kg/ha) and none were encountered in Stratum 5.

The highest combined mean CPUE for flathead sole (*H. elassodon*) and Bering flounder (*H. robustus*) occurred in Stratum 3 (23.8 kg/ha). The combined mean CPUE for arrowtooth flounder (*A. stomias*) and Kamchatka flounder (*A. evermanni*) peaked in Strata 5 and 6 (28.17 and 27.54 kg/ha respectively), 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 3.02 °C in 2014, which is warmer than the lower 95% decision limit (2.4 °C) around the long-term mean since 2001 (Figure 7).

SCIENTIFIC PERSONNEL[1]

FV *Vesteraalen*

Leg 1	Leg 2	Leg 3
B. Lauth [2]	S. Kotwicki [2]	L.Britt [2]
C.Yeung [3]	J. Conner [3]	C.Yeung [3]
P. Cummiskey [4]	E. Munk [4]	D. Urban [4]
M. Knutson [5]	N. Sisson [4]	A. Hopkins [7]
J. Monahan [6]	J. Napp/B. Daly [4]	B. Daly [4]
	D. Chamberlin [7]	D. Chamberlin [7]

FV *Alaska Knight*

Leg 1	Leg 2	Leg 3
L.Britt [2]	C. Long [2,4]	K. Weinberg [2]
J. Conner [3]	D. Nichol [3]	D. Stevenson [3]
C. Armistead [4]	D. Benjamin [4]	D. Benjamin [4]
C. Long [4]	S. Johnson-Mestre [5]	V. White
H. Kenney	C. Lindsay [6]	C. Lindsay [6]
J. Brogan	A. Whitehouse [7]	T. Buckley

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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 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Length measurements	Age structures	Stomachs collected	Pathobiology samples
Walleye pollock	43,042	2,106	2,950	–
Pacific cod	17,946	1,441	1,707	–
Yellowfin sole	20,229	799	–	–
Northern rock sole	17,636	283	–	–
Flathead sole/Bering flounder	15,808	703	–	–
Pacific halibut	2,018	1,186	463	–
Alaska plaice	7,296	502	–	–
Arrowtooth/Kamchatka flounder	10,621	706	697	–
Greenland turbot	973	359	–	–
Rex sole	580	–	–	–
Longhead dab	247	–	–	–
Plain sculpin	1,933	–	–	–
Great sculpin	453	–	–	–
Warty sculpin	161	–	–	–
Yellow Irish lord	196	75	–	–
Starry flounder	619	–	–	–
Pacific Ocean perch	84	–	–	–
Alaska skate	3,576	–	–	–
Bering skate	215	–	–	–
Misc. skates	43	–	–	–
Red king crab	2,922	–	–	–
Blue king crab	241	–	–	–
Opilio Tanner crab	34,959	–	–	649
Bairdi Tanner crab	15,799	–	–	581
Misc. species	3,115	–	–	–
Total	200,712	8,160	5,817	1,230

Table 2 – Summary of predominant species by weight at each survey station during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

Species	Number of stations	Percent of stations
Walleye Pollock	214	57
Yellowfin Sole	59	16
Northern Rock Sole	58	15
Pacific Cod	11	3
Alaska Plaice	9	2
Snow Crab	9	2
Arrowtooth Flounder	8	2
Flathead Sole	6	2
Alaska Skate	1	< 1
Pacific Ocean Perch	1	< 1

Table 3 - Mean CPUE (kg/ha) of commercially important species by stratum during the 2014 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	16.47	17.35	183.35	240.42	114.05	150.67	286.28	313.90	150.74
Yellowfin sole	179.49	65.69	67.11	14.07	NC	NC	0.01	NC	50.97
Northern rock sole	124.10	58.30	35.99	25.22	0.09	0.82	0.03	0.06	37.68
Pacific cod	32.92	71.03	14.28	19.87	9.03	14.30	4.51	6.45	22.22
Alaska plaice	7.14	14.47	17.49	13.70	NC	0.67	0.73	0.62	9.16
Flathead sole/ Bering flounder	0.68	0.08	23.80	6.85	16.03	13.95	3.29	7.53	10.84
Arrowtooth flounder/ Kamchatka flounder	0.13	NC	9.61	4.61	28.17	27.54	NC	3.44	10.62
Pacific halibut	7.42	6.94	3.04	1.55	3.29	2.55	NC	0.09	3.48

* NC = None caught within the Stratum.

83/112 EASTERN

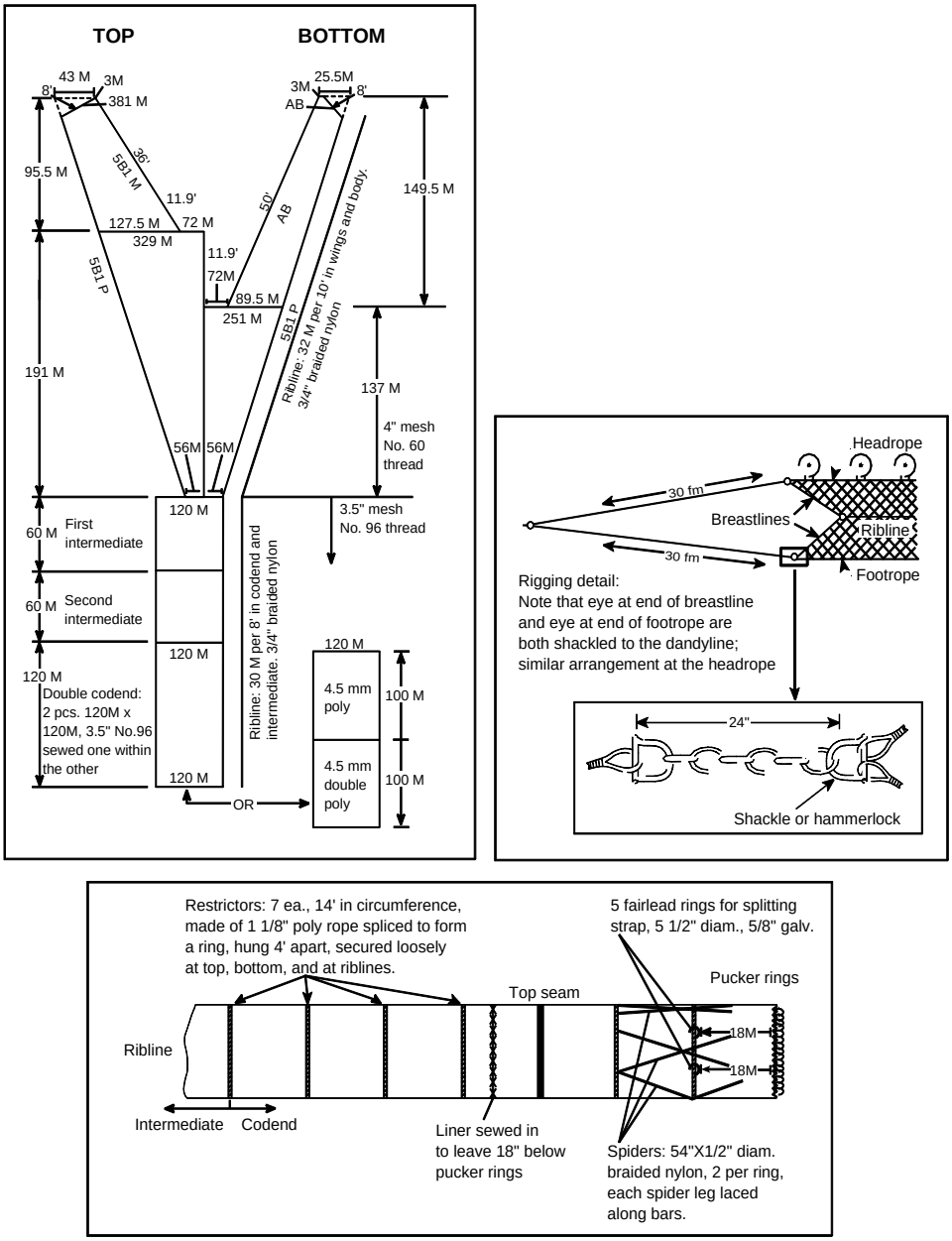

Figure 1 - Diagram of the 83-112 eastern bottom trawl used in the annual Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

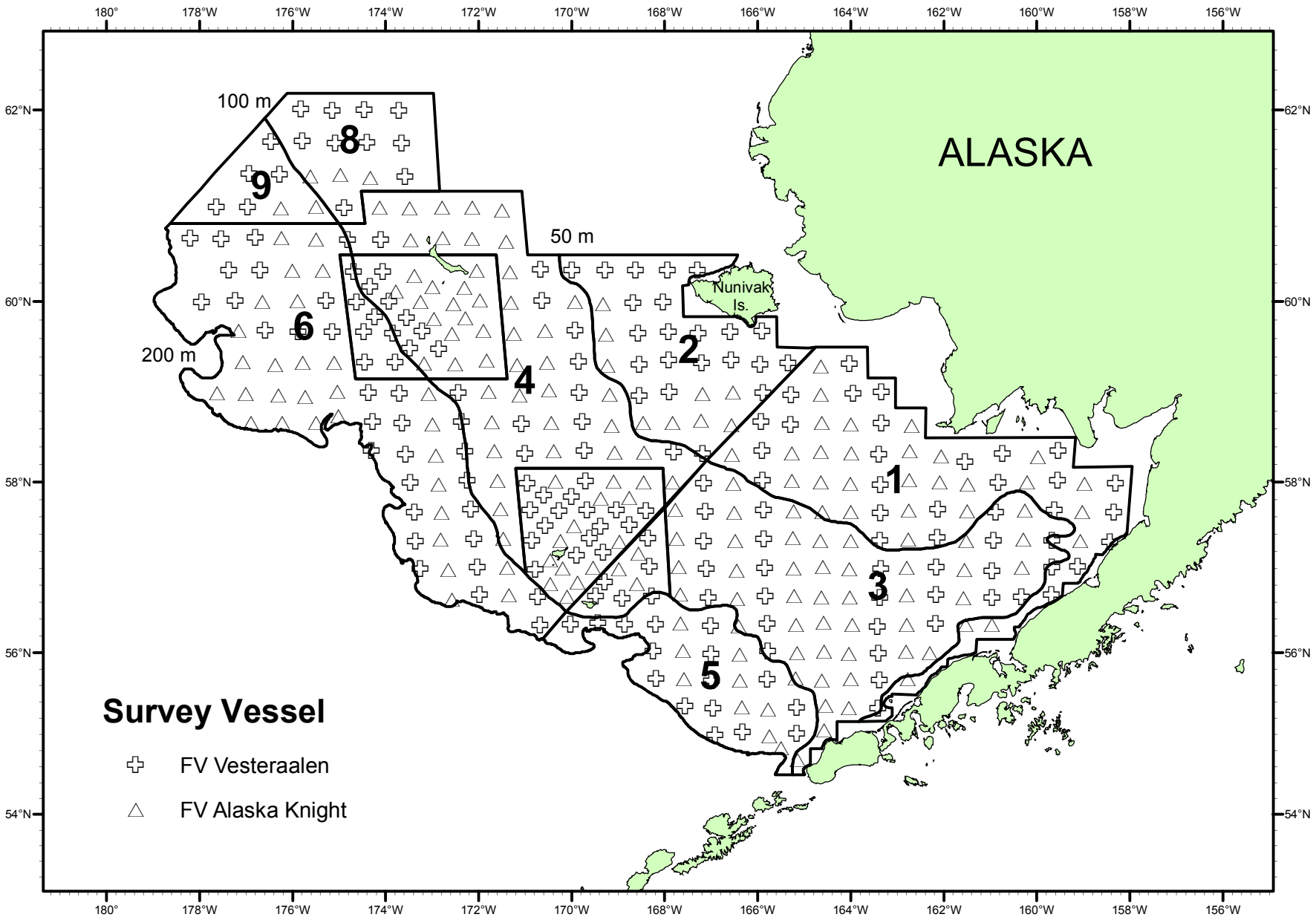

Figure 2 - Designation of the 9 survey strata and the distribution of total sampling effort by the F/V *Vesteraalen* and F/V *Alaska Knight* during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

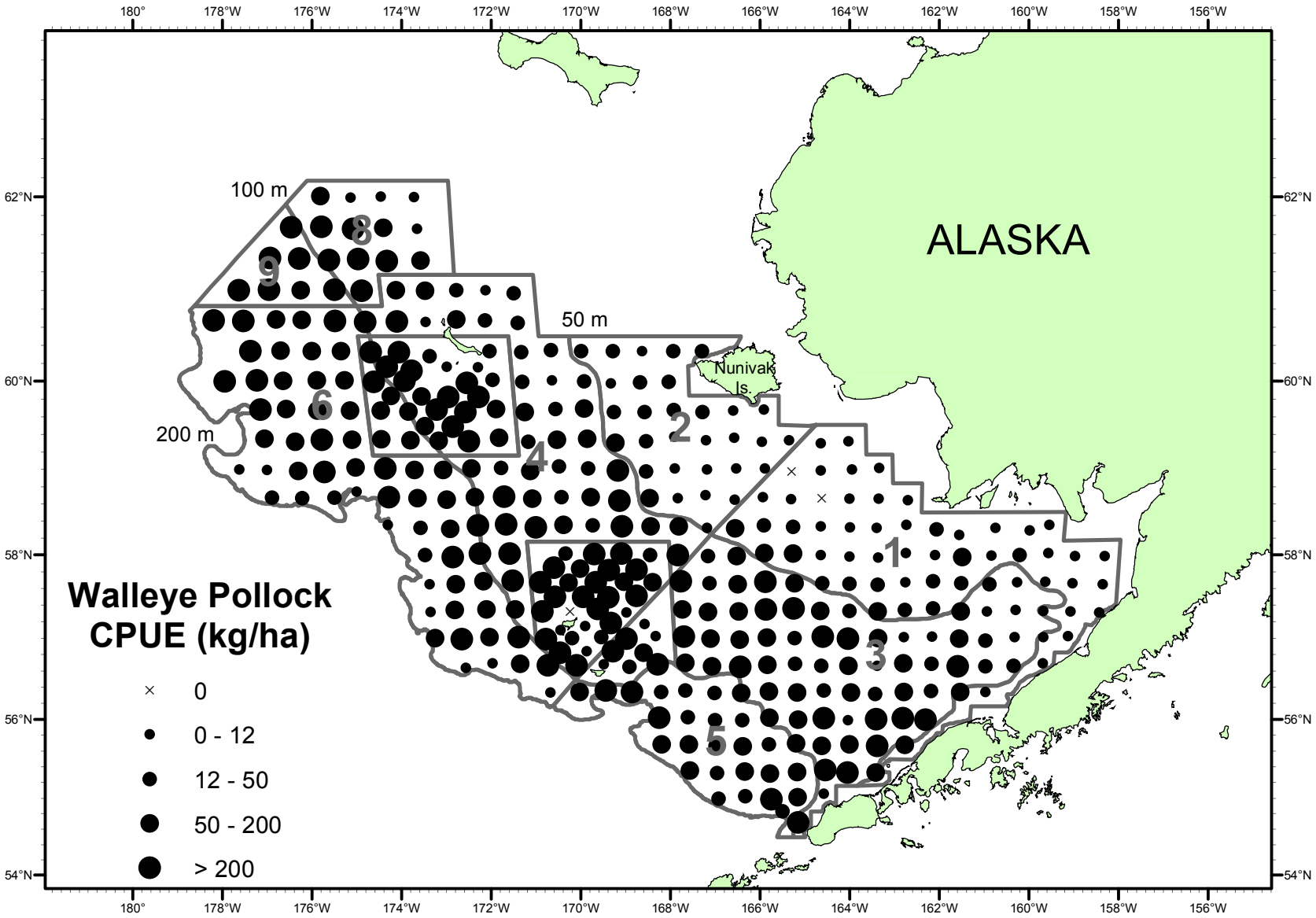

Figure 3 - Catch rates (kg/ha) of walleye pollock during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

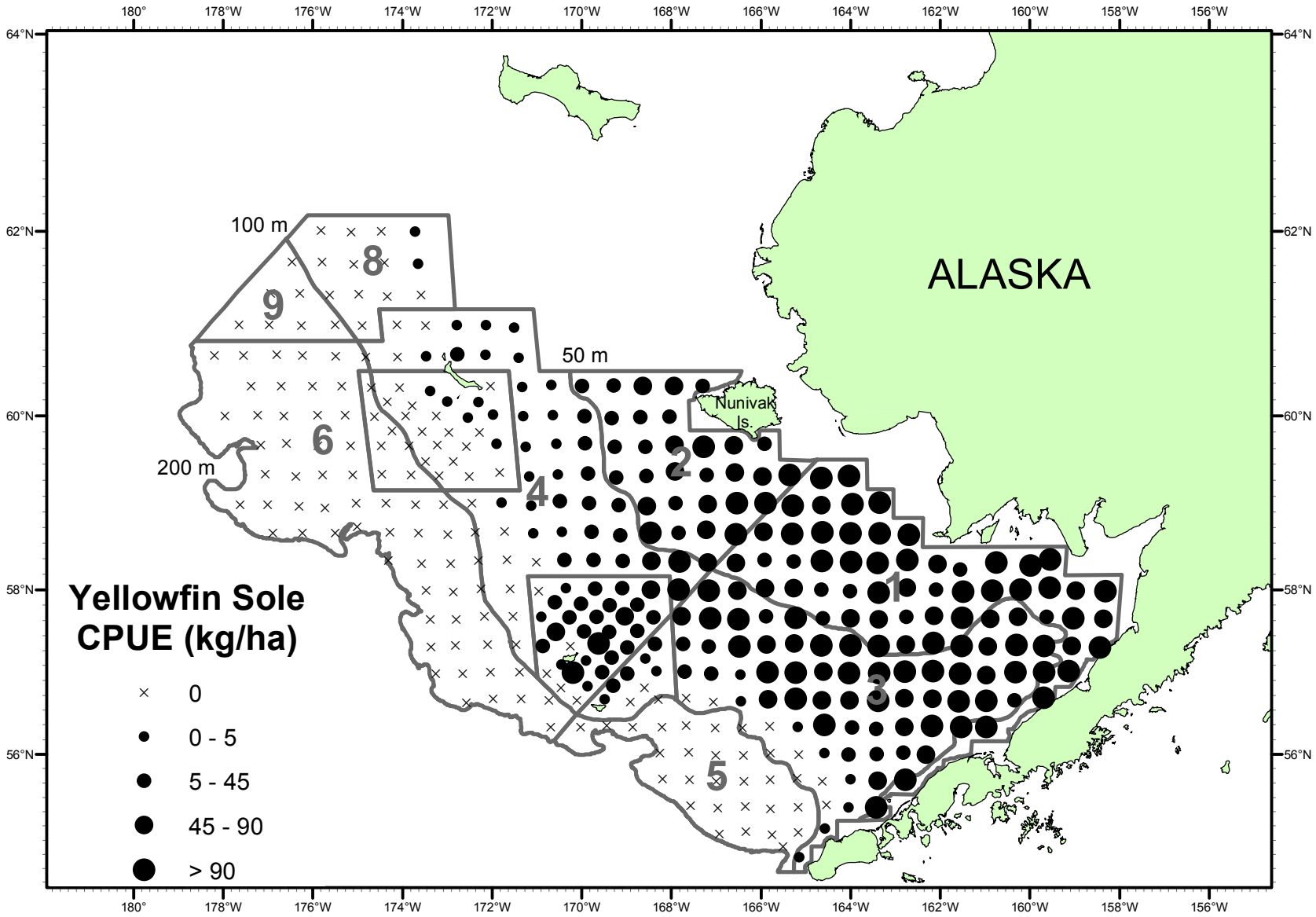

Figure 4 - Catch rates (kg/ha) of yellowfin sole during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

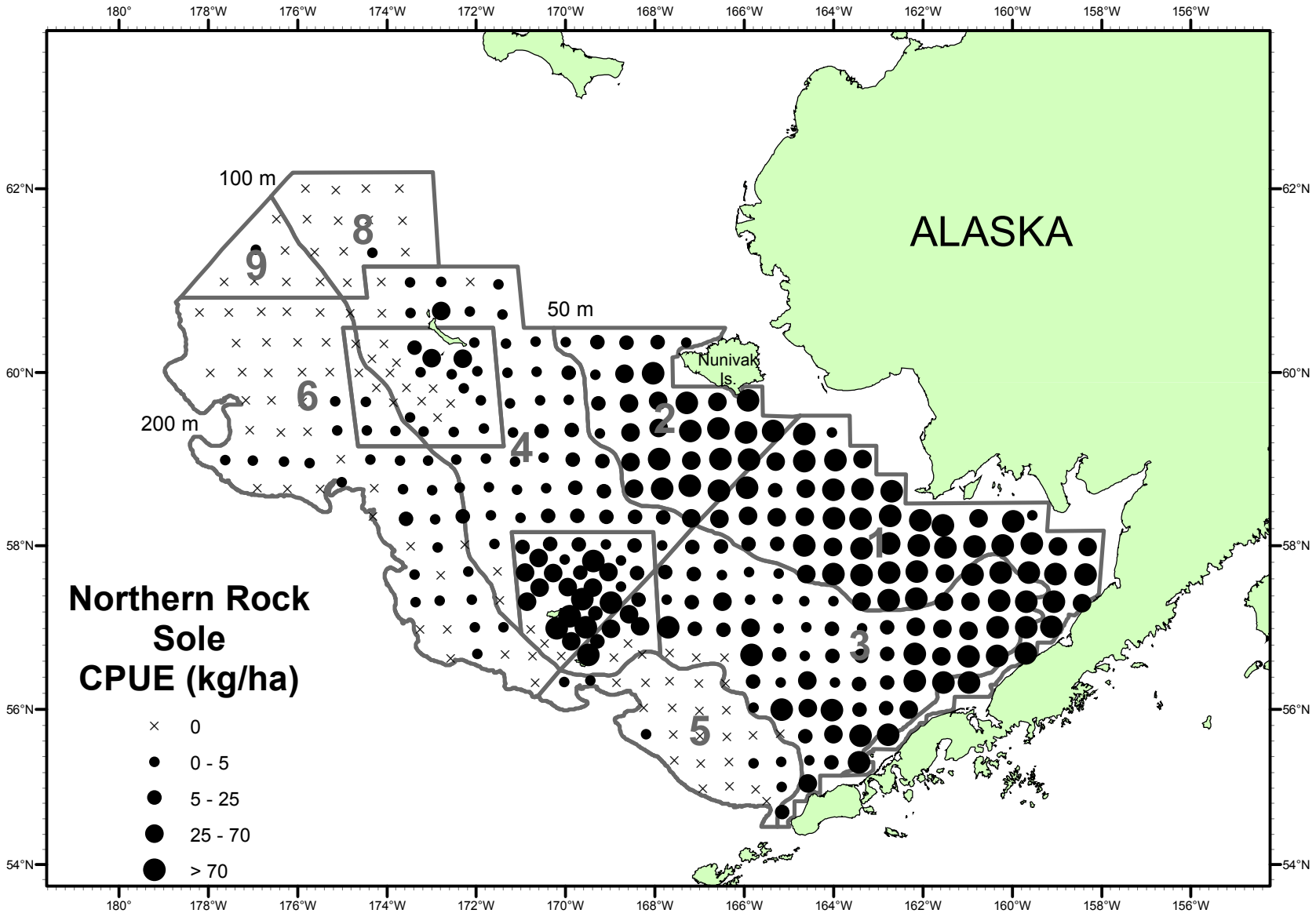

Figure 5 - Catch rates (kg/ha) of northern rock sole during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.

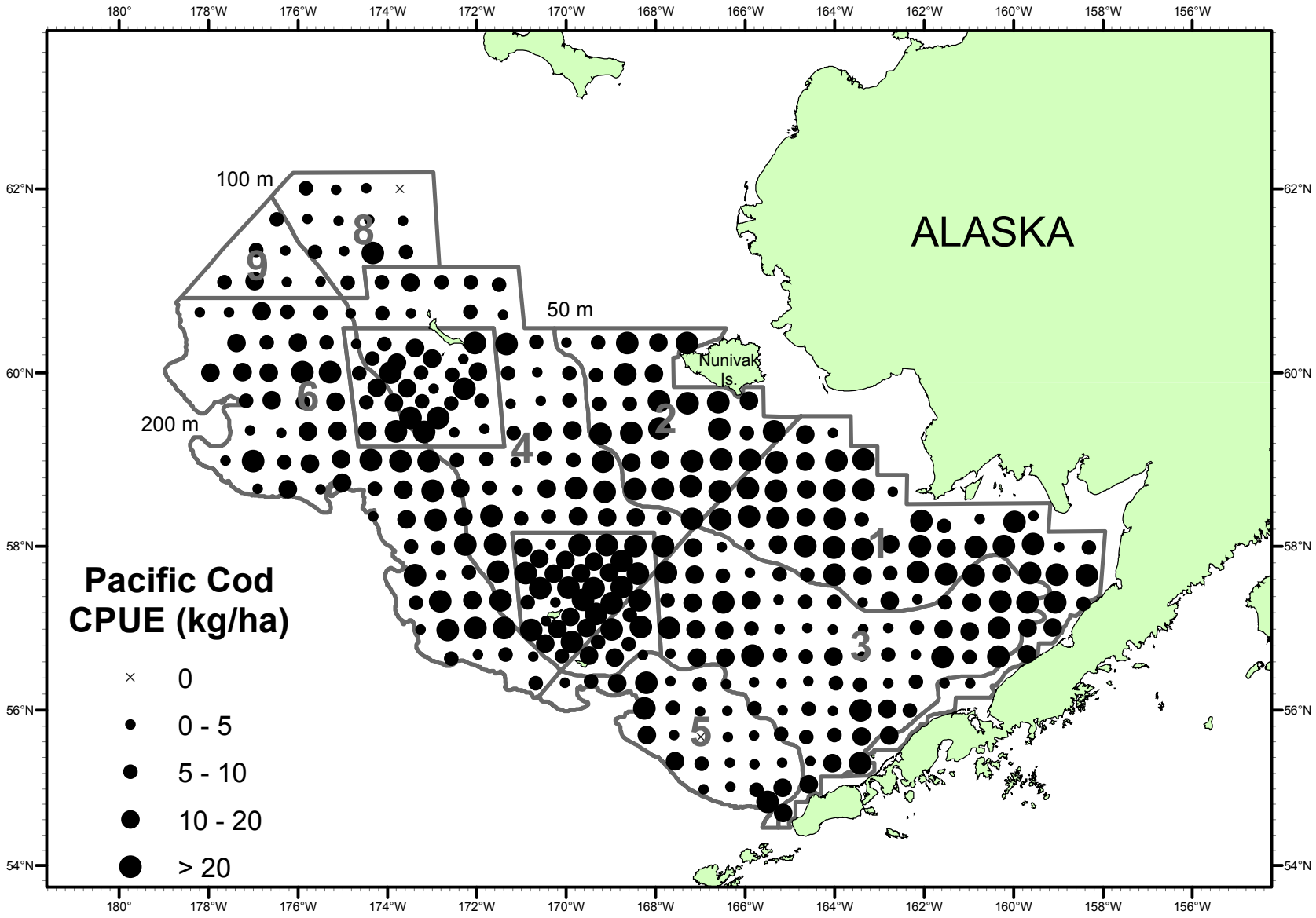

Figure 6 - Catch rates (kg/ha) of Pacific cod during the 2014 Eastern Bering Sea Continental Shelf Bottom Trawl Survey of Groundfish and Invertebrate Resources.