CRUISE RESULTS

Cruise 2006-01 F/V *Arcturus*
Cruise 2006-01 F/V *Northwest Explorer*

2006 Eastern Bering Sea Crab and Groundfish Survey

May - July 2006

The Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC) conducted the Eastern Bering Sea Crab and Groundfish Survey from May to July 2006. This was a continuation of the annual series of eastern Bering Sea crab and groundfish assessment surveys which began in 1971. The survey covers the Bering Sea shelf, between the depths of 20 m and 200 m, from Bristol Bay to St. Lawrence Island.

OBJECTIVES

The primary objective of this survey was to continue the annual series of surveys used to assess crab and groundfish stocks of the eastern Bering Sea to provide the following:

1. Data on the distribution, abundance, and biological condition of important groundfish and crab species for the North Pacific Fishery Management Council.
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 comprised:

1. Conducting additional sampling in areas of high king crab and Tanner crab abundance to reduce variability 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 specimens of fish and invertebrates to enhance the voucher database.
4. Collecting stomach samples for trophic interaction research.
5. Collecting and preserving both fish and invertebrate specimens for approved Special Project requests.
6. Resurvey stations in Bristol Bay at the end of the survey to document the delayed onset of molting (i.e. reproductive) red king crab.

VESSELS AND GEAR

Sampling at survey stations was coordinated between two chartered commercial fishing vessels, the F/V *Arcturus* and F/V *Northwest Explorer*. Both vessels are house-forward trawlers with stern ramps. The vessel LOAs were 39.6 m (130 ft) and 49.4 m (162 ft) in length respectively.

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 bathythermograph was attached to the headrope and deployed with each trawl, resulting in oblique depth/temperature profiles of the water column. Bottom contact sensors (inclinometers) provided data to assess bottom tending performance. Net mensuration sensors were also used to assess trawl performance and to provide net geometry data to calculate the area swept by the bottom trawl.

ITINERARY

The charters of the *Arcturus* and *Northwest Explorer* began in Dutch Harbor, Alaska on May 30, 2006. Intermediate port calls were made to Dutch Harbor on June 17 and July 7 to exchange scientific personnel. An additional port call for the *Arcturus* was scheduled at St. Paul Island on June 28 to exchange vessel personnel, but this was cancelled due to inclement weather, and the vessel crew were exchanged at Dutch Harbor on July 7. The standard survey was completed on July 27, 2006 and the *Arcturus* offloaded in Dutch Harbor, while the *Northwest Explorer* exchanged crew at St. Paul for a special project cruise. The *Northwest Explorer* ended the charter by offloading in Dutch Harbor on August 6.

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

SURVEY DESIGN AND METHODS

The total standard survey area encompassed approximately 463,400 km^2. Sampling stations were based on a 37.04 km (20 nm) square grid pattern established during previous surveys. However, more intensive sampling was conducted in the Pribilof Islands and St. Matthew Island regions to collect supplemental data on crab populations. When possible, the *Arcturus* and *Northwest Explorer* sampled alternate, longitudinal columns of stations proceeding from Bristol Bay westward to the shelf edge. Toward the end of the charter, the *Arcturus* returned to Bristol Bay to resurvey 30 stations in an effort to verify the reproductive status of red king crab in this area. Figure 2 details the distribution of standard sampling by vessel as well as the strata used for the standard survey design. Tows of 30 minutes in duration were made at most sampling stations. 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, size composition, and other biological data were collected for the major fish species encountered. 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 research projects were stored in appropriate fixatives or were frozen.

RESULTS

The *Arcturus* and *Northwest Explorer* conducted 457 bottom trawls during the survey, including 441 successfully completed trawls and 16 unsuccessful trawls.

Biological data collected from fish species are summarized in Table 1. The two vessels recorded 193,478 randomly selected length measurements by sex from priority fish species. Sagittal otoliths were extracted from 10,185 fish, stratified by size and sex per species, and preserved for age analysis. Correlated length/weight measurements were also recorded during the otolith collection process. A total of 3,468 fish stomachs were either scanned and recorded or preserved for feeding habit analysis.

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 contains 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. Catch rates of commercial fish and crab species are listed by Stratum and total survey area in Table 3.

Walleye pollock (*Theragra chalcogramma*) were the most abundant roundfish species and had an overall catch per unit effort (CPUE) of 61.41 kg/ha. Pollock were encountered at most sampling stations (Figure 3), with the largest mean catches (119.99 kg/ha) observed in Stratum 6 at depths of 81-171 m. The catch rate was much lower within relatively shallower Stratum 2 (8.31 kg/ha).

Yellowfin sole (*Limanda aspera*) and northern rock sole (*Lepidopsetta polyxystra)* were the most abundant flatfish species with overall CPUE values of 46.03 kg/ha and 47.82 kg/ha, respectively. The catch rates for yellowfin sole and northern rock sole were highest in Stratum 1, with respective CPUE values of 117.04 kg/ha and 130.43 kg/ha. Yellowfin sole were encountered at only the two southernmost stations in Stratum 5 and were not encountered at all in Stratum 6 (Figure 4).

Pacific cod (*Gadus macrocephalus*) were encountered at most of the sites sampled (Figure 6). Mean catches were smallest in Stratum 1 (3.98 kg/ha), even though Pacific cod were not caught in several stations in Stratum 5. The greatest mean catches occurred in Stratum 6 (20.25 kg/ha) with a total CPUE of 11.17 kg/ha over all strata.

Catch rates for Pacific halibut (*Hippoglossus stenolepis*) were highest in Stratum 3 (4.61 kg/ha), but were fairly consistent between all strata with a total CPUE of 3.38 kg/ha. The highest catch rates for Alaska plaice (*Pleuronectes quadrituberculatus*) occurred in Stratum 4 (27.41 kg/ha). The highest combined catch rates for flathead sole (*Hippoglossoides elassodon*) and Bering flounder (*H. robustus*) occurred in Strata 5 and 6 (22.68 kg/ha and 22.18 kg/ha respectively). Combined catch rates for arrowtooth flounder (*Atherestes stomias*) and Kamchatka flounder (*A. evermanni*) peaked in Stratum 5 (50.02 kg/ha).

Tanner crab (*Chionocetes opilio*) was the most abundant commercial crab species encountered, having a total CPUE of 4.70 kg/ha with the largest mean catches occurring in Stratum 4 (15.27 kg/ha). The catch rate for bairdi Tanner crab (*C. bairdi*) was less overall (2.67 kg/ha), but it was considerably higher in Stratum 5 (7.8 kg/ha) than Tanner crab (0.37 kg/ha). Red king crab (*Paralithodes camtschatica*) had a total CPUE of 1.87 kg/ha and was most abundant in Stratum 3 (4.84 kg/ha), but none were caught in Strata 5 and 6. Blue king crab (*P. platypus*) had an overall catch rate of 0.11 kg/ha and occurred only in Strata 4 and 6.

The mean near-bottom temperature (measured as the average temperature at the depth of the headrope while the trawl was on-bottom) was significantly colder in 2006 than in the previous 5 years (Figure 7) at the same time of year. The cold bottom temperatures may have delayed the molting and spawning of female red king crab. This led to a resurvey of 30 stations (31 trawls) in Bristol Bay toward the end of the charter, allowing time for females to molt successfully and develop clutches. The mean temperature for these stations had increased from 2.2 °C to 4.3 °C between the original survey and the resurvey, and greater numbers of gravid females were observed.

In addition to standard survey sampling, 21 approved Special Projects were undertaken on the 2006 Eastern Bering Sea Crab and Groundfish Survey (Table 4). The deadline for Special Project proposals was March 27, 2006. The proposals were reviewed by the Bering Sea Subtask of the RACE Division's Groundfish Assessment Program and were accepted based on feasibility, scientific value, and impact to standard operating procedures. Projects submitted by 6 institutions were approved. Data for these projects were collected at sea and disseminated to the requesting principle investigator(s). To receive details of a Special Project, please contact the investigator(s) designated in Table 4.

SCIENTIFIC PERSONNEL[a]

F/V Arcturus

Leg 1[b]	Leg 2	Leg 3
K.Weinberg[c]	L. Britt[c]	D.Nichol[c]
D.Nichol[d]	S. Kotwicki[d]	J. Conner[d]
C. Armistead[e]	C. Armistead[e]	P. Cummiskey[e]
A. Vijgen	D. Benjamin	D. Benjamin
C. Blood[f]	P. Logan[f]	P. Logan[f]
A. Whitehouse	K. Dodd	J. Clark

F/V Northwest Explorer

Leg 1[b]	Leg 2	Leg 3
B. Lauth[c]	D. Stevenson[c]	S. Kotwicki[c]
D. Stevenson[d]	J. Hoff[d]	E. Acuna[d]
S. VanSant[e]	E. Munk[e]	J. Haaga[e]
J. Brogan	M. Litzow[e]	L. Chilton[e]
F. Morado	C. Shavey	V. Lowe
G. Mundell	K. DeMorett[e]	A. Whitehouse

[a] Personnel from the AFSC, Seattle, unless otherwise noted
[b] Leg dates: Leg 1 (5/30 - 6/17); Leg 2 (6/18 – 7/7); Leg 3 (7/8 –7/28)
[c] Field Party Chief
[d] Deck Boss
[e] Personnel from the AFSC, Kodiak Laboratory
[f] Personnel from the International Pacific Halibut Commission

For further information contact Russell Nelson, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, NOAA Fisheries, at 7600 Sand Point Way NE - Building 4, Seattle, WA 98115-0070. Telephone: (206) 526-4170

Table 1 - Biological data collected during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

Species	Length Measurements	Age Structures[1]	Stomachs Collected	Stomachs Scanned
Walleye pollock	39,630	1,582	536	217
Pacific cod	12,540	1,323	751	–
Yellowfin sole	29,339	445	–	–
Northern rock sole	35,476	540	208	–
Flathead sole/ Bering flounder[2]	21,332	656	–	132
Pacific halibut	3,907	2,955	79	171
Alaska plaice	13,369	451	157	–
Arrowtooth flounder/ Kamchatka flounder[3]	17,049	602	324	–
Greenland turbot	427	261	161	7
Rex sole	1,187	–	–	–
Longhead dab	1,823	–	–	–
Plain sculpin	3,702	445	169	–
Great sculpin	932	398	167	–
Warty sculpin	588	187	53	–
Yellow Irish lord	823	169	83	–
Starry flounder	834	–	–	–
Alaska skate	4,796	–	–	253
Bering skate	214	–	–	–
Pacific Ocean perch	285	–	–	–
Misc. skates	26	–	–	–
Misc. species	5,199	171	–	–
Total	193,478	10,185	2,688	780

[1] Individual length-weight data were also collected.
[2] Age structures were collected from flathead sole only.
[3] Age structures were collected from arrowtooth flounder only.

Table 2 – Percentage of all stations sampled where fish or commercial crab species accounted for the majority of the catch by weight during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

Species	Percent of Stations Sampled
Walleye pollock	28
Northern rock sole	19
Yellowfin sole	16
Snow crab	12
Arrowtooth flounder	9
Alaska plaice	7
Flathead sole	4
Pacific cod	1
Alaska skate	< 1
Pacific herring	< 1
Arctic cod	< 1
Pacific halibut	< 1
Bering flounder	< 1
Starry flounder	< 1
Warty sculpin	< 1
Plain sculpin	< 1
Marbled eelpout	< 1
Pacific ocean perch	< 1

Table 3 – CPUE (kg/ha) of commercially important species by Stratum during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

Species	Stratum						Total
	1	2	3	4	5	6	
Walleye pollock	10.45	8.31	65.77	63.13	60.61	119.99	61.41
Yellowfin sole	117.04	80.16	70.12	15.61	0.03	NC*	46.03
Northern rock sole	130.43	69.62	45.94	37.70	2.07	2.66	47.82
Pacific cod	3.98	4.10	8.66	15.59	5.37	20.25	11.17
Alaska plaice	11.97	23.44	14.39	27.41	0.05	0.34	13.75
Flathead sole/ Bering flounder	1.66	0.22	19.80	11.10	22.68	22.18	14.96
Arrowtooth flounder/ Kamchatka flounder	0.32	NC	21.63	3.15	50.02	22.69	15.68
Pacific halibut	3.97	2.79	4.61	2.60	2.62	2.99	3.38
Opilio Tanner crab	0.02	0.17	0.75	15.27	0.37	4.56	4.70
Bairdi Tanner crab	0.17	0.13	3.39	3.85	7.80	1.60	2.67
Blue king crab	NC	NC	NC	0.46	NC	0.01	0.11
Red king crab	3.52	0.43	4.84	0.67	NC	NC	1.87

* NC = None Caught within the Stratum.

Table 4 – Special projects and collections undertaken during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

Project Title	**Principle Investigator**	**Agency**
Trawl speed through water / Door spread and tilt monitoring	Ken Weinberg	AFSC - RACE
ES-60 transects at cruising speeds	Paul G. von Szalay	AFSC - RACE
Bottom contact sensor tests	Craig Rose	AFSC - RACE
Use of EBS bottom trawl survey acoustic data	Taina Honkalehto, Chris Wilson	AFSC - RACE
Light intensity on the distribution of walleye pollock	Stan Kotwicki	AFSC - RACE
Net swapping procedures on survey trawl performance	Stan Kotwicki	AFSC - RACE
Stationary seabird surveys	Shannon Fitzgerald	AFSC - REFM
Bering flounder ovary and otolith collection	Jim Stark	AFSC - RACE
Size composition of the eelpouts of the Bering Sea	Jason Conner	AFSC - RACE
Length-weight parameters	Gerald R. Hoff	AFSC - RACE
Bering Sea shelf *Enteroctopus dofleini* population study	Elaina Jorgensen	AFSC - RACE
Ovary, otolith, and stomach collections for sculpins	Kerim Aydin, Anne Hollowed	AFSC - REFM
Consequences of fur seal foraging strategies (COFFS)	Alison Banks	UAF
Stable isotope analysis	Kerim Aydin, Katie Dodd	AFSC - REFM
Parasites as indicators of ecosystem change	Frank Morado	AFSC - RACE
Bitter Crab Syndrome in North Pacific *Chionoecetes* spp.	Frank Morado	AFSC - RACE
Ichthyophonus in walleye pollock	Vanessa Lowe, Frank Morado	AFSC - RACE
DNA-based identification library of prey items	Pam Jensen, Frank Morado, Troy Buckley, Kerim Aydin, Bobette Dickerson	AFSC - RACE / REFM / NMML
IPHC sampler aboard one vessel to collect halibut data	Lauri Sadorus	IPHC
Forage fish collection	Ron Heintz, J.J. Vollenweider	AFSC - ABL
Summer zooplankton biomass on the eastern Bering Sea shelf	Jeff Napp, Jay Clark	AFSC - RACE

83/112 EASTERN

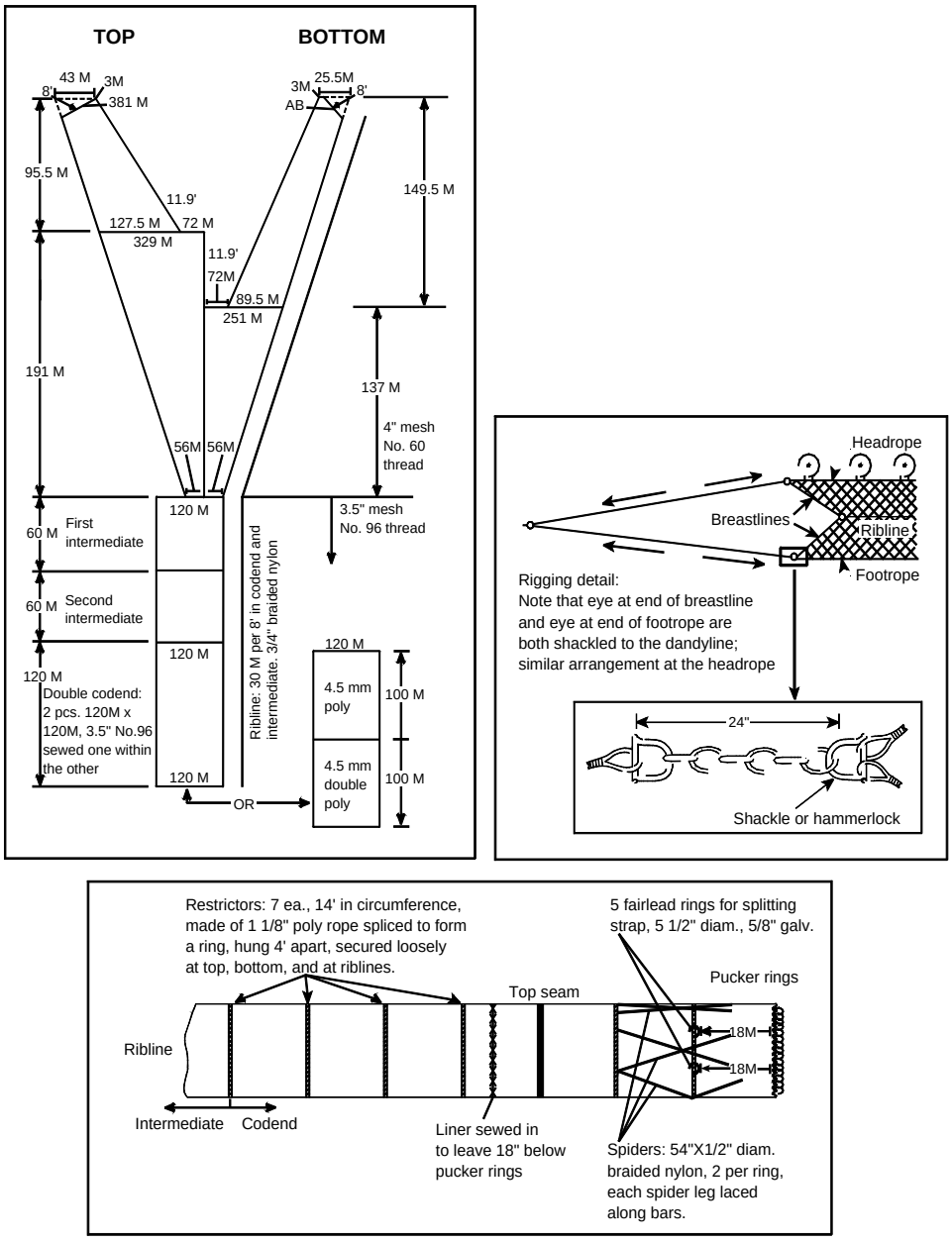

Figure 1 - Diagram of the 83-112 eastern bottom trawl used in the 2006 Eastern Bering Sea Crab and Groundfish Survey.

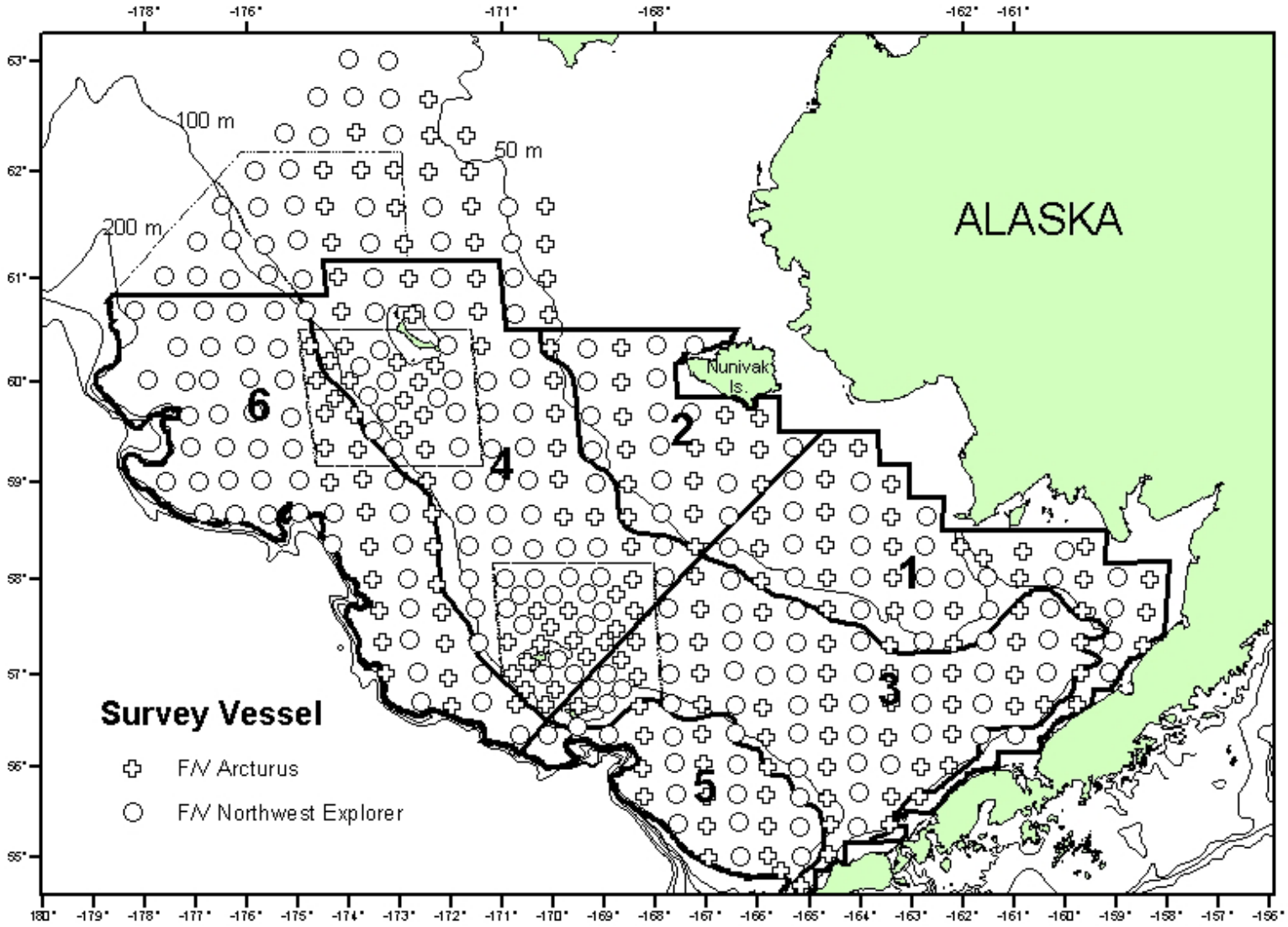

Figure 2 - Distribution of total sampling effort by the F/V *Arcturus* and F/V *Northwest Explorer* during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

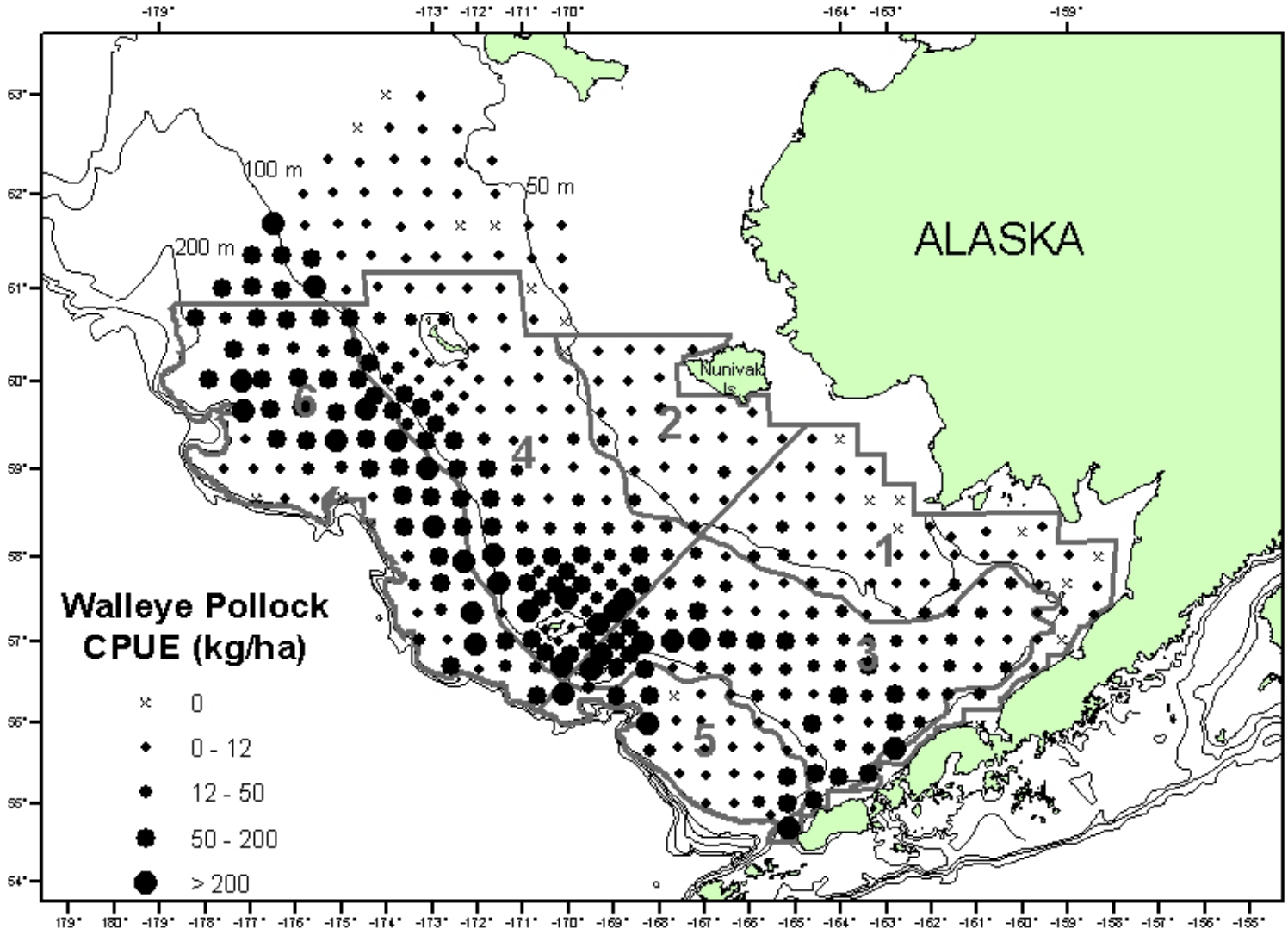

Figure 3 - Catch rates (kg/ha) of walleye pollock during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

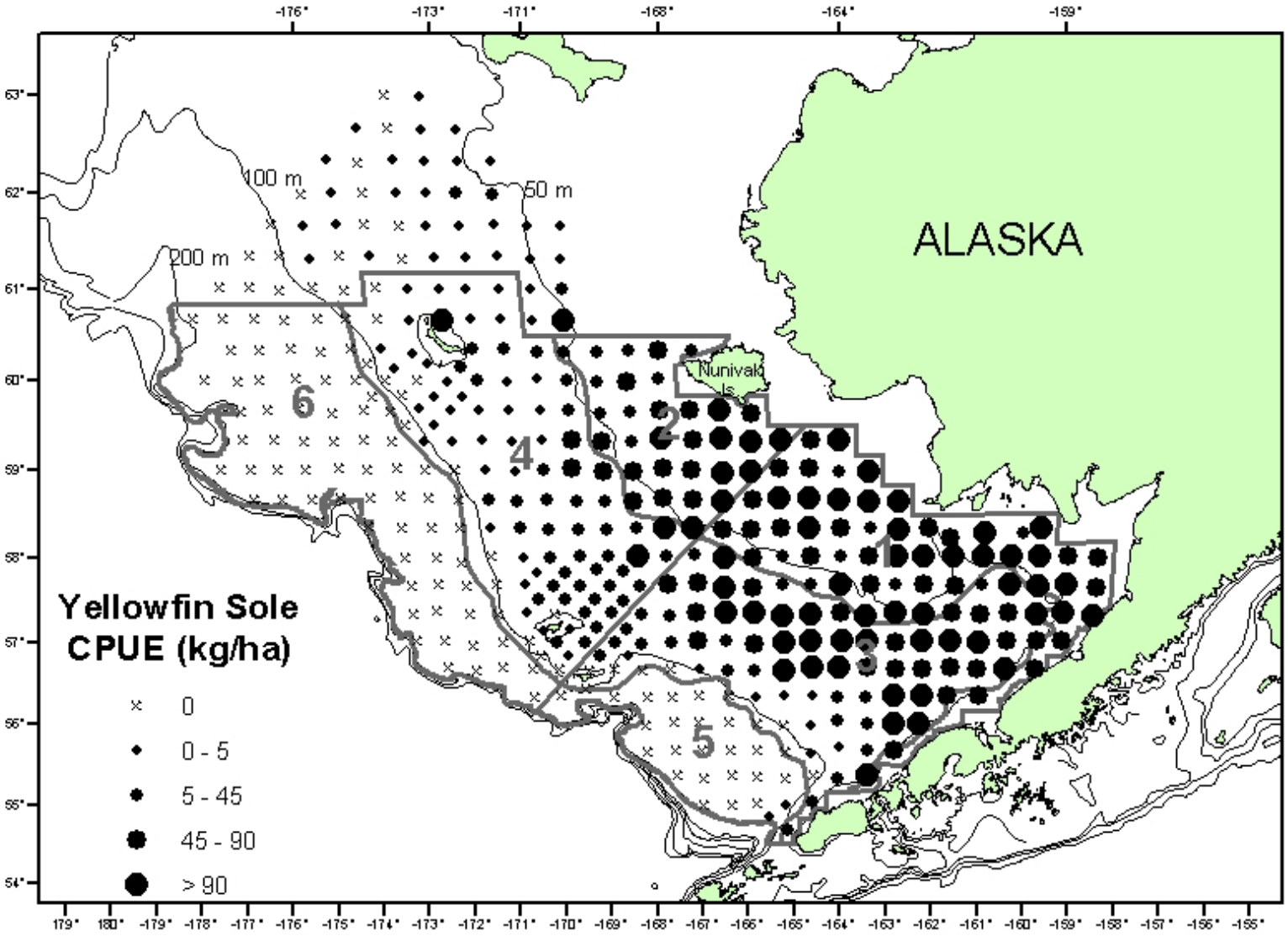

Figure 4 - Catch rates (kg/ha) of yellowfin sole during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

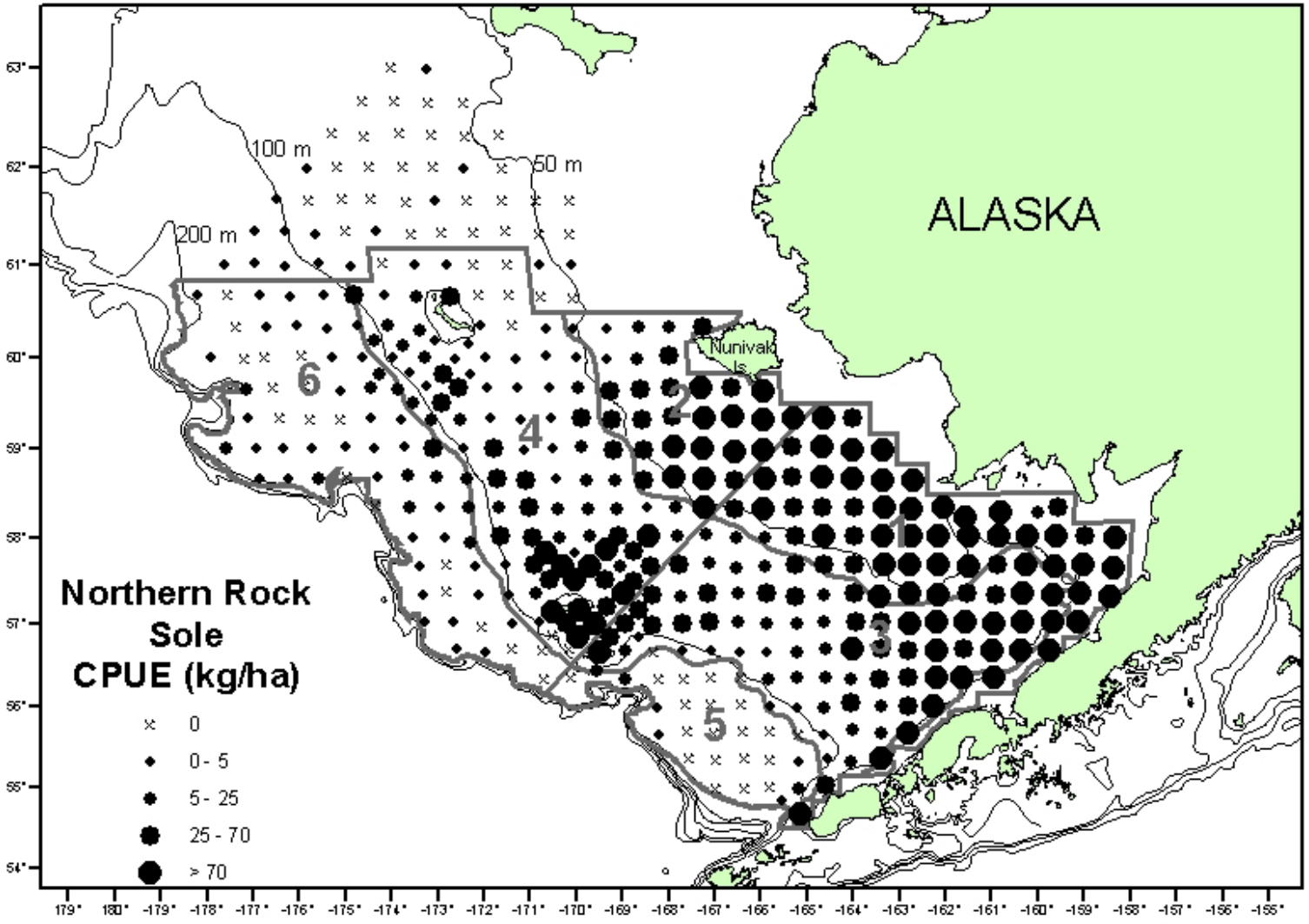

Figure 5 - Catch rates (kg/ha) of northern rock sole during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

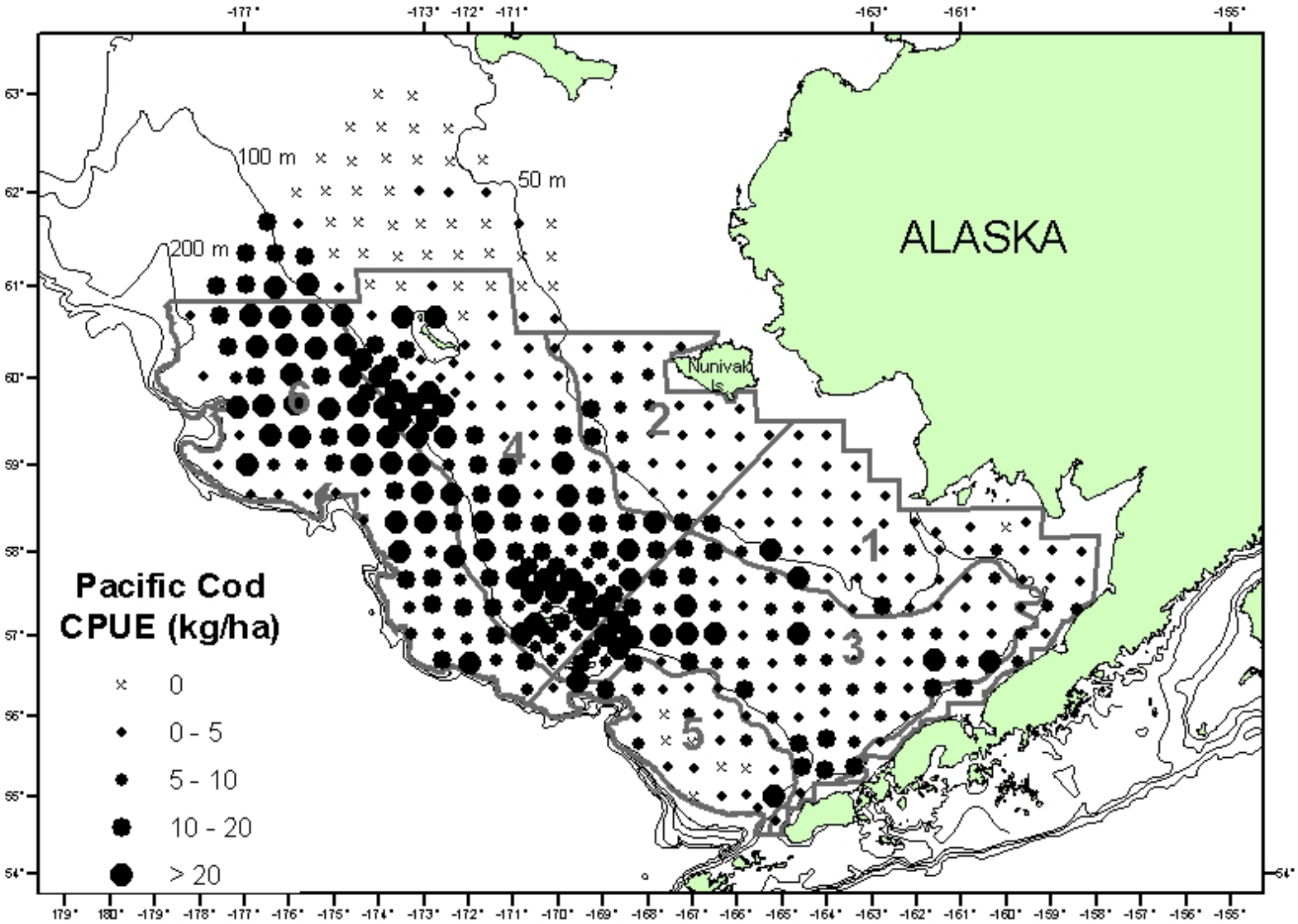

Figure 6 - Catch rates (kg/ha) of Pacific cod during the 2006 Eastern Bering Sea Crab and Groundfish Survey.

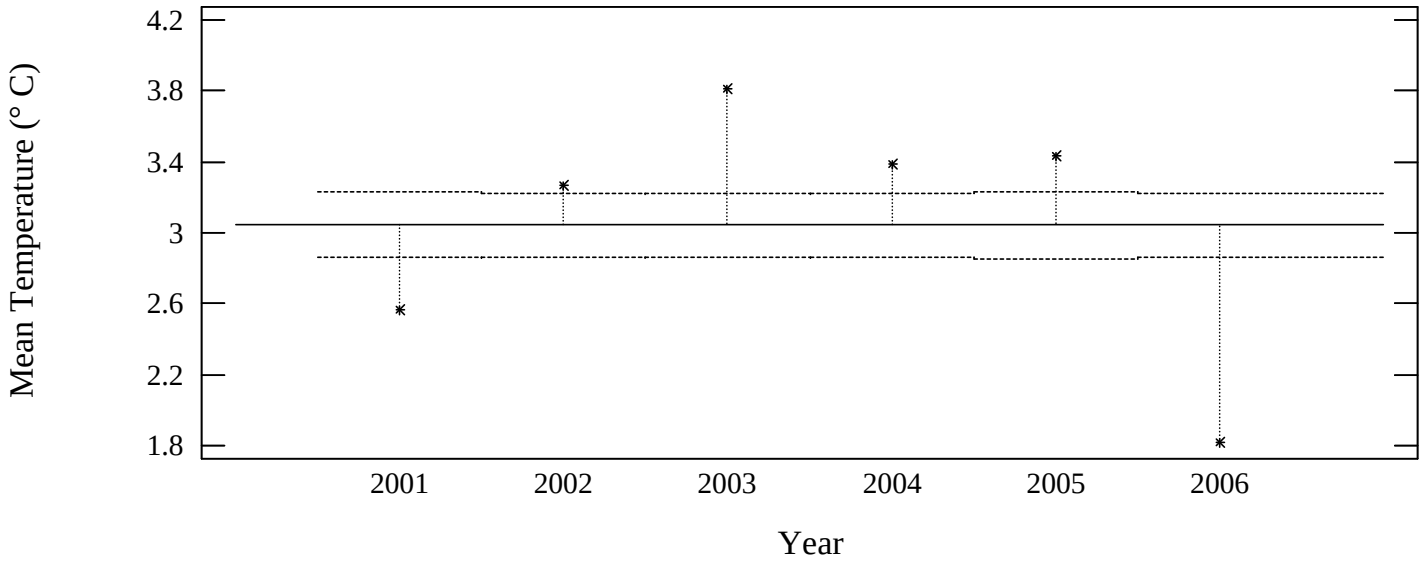

Figure 7 – Analysis of means of near-bottom temperatures (° C) recorded during the Eastern Bering Sea and Groundfish Survey for each of the years between 2001 and 2006. The dashed lines represent the 95% decision limits around the grand mean.