



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
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F/AKC1:DN

CRUISE RESULTS

Cruise 91-1 Alaska
Cruise 91-1 Ocean Hope 3
Cruise 91-10 Miller Freeman
Cruise 91-3 Novodrutsk

1991 Eastern Bering Sea Crab-Groundfish Survey May-September 1991

The Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC) conducted the annual crab-groundfish survey of the eastern Bering Sea from May through September 1991. This was a more comprehensive survey which is conducted triennially extending sampling beyond the standard annual survey area to include the northern portion of the eastern Bering Sea (EBS), Norton Sound, and continental slope waters.

As in 1990, a cooperative survey was conducted aboard a U.S.S.R. research vessel of the Pacific Research Institute of Fisheries and Oceanography (TINRO). The Soviet vessel sampled the same shelf areas south of St. Matthew Island as did the U.S. vessels but also sampled west of the U.S.-U.S.S.R. convention line into Soviet waters. That survey complemented previous cooperative surveys in providing a set of standardized data to study the distribution, abundance, and biological characteristics of groundfish and invertebrates in both the western and eastern Bering Sea regions.

In addition, a nearshore beam trawl survey was conducted along the Alaska peninsula and in inner Bristol bay (May 15-June 1) to examine potential long-term monitoring sites for juvenile red king crab and flatfish.



OBJECTIVES

Primary objective of this survey was to collect distribution, abundance, and biological information on crab and groundfish resources in the Bering Sea. Results from this data, which were presented to the North Pacific Fishery Management Council, provide one of the primary information sources used to assess groundfish stocks and manage fisheries in the eastern Bering Sea. Results are also provided to the U.S. fishing industry.

Secondary objectives were to:

1. conduct an exploratory survey of juvenile fish and crab in nearshore waters,
2. assess the condition of juvenile red king crab near Port Heiden and Kvichak Bay,
3. reduce variability of king and Tanner crab population estimates by increasing sampling effort in areas of high crab concentrations,
4. assess spawning yellowfin sole abundance in inshore waters of Togiak Bay and the area near Cape Newenham,
5. evaluate trawl performance and configuration with net mensuration equipment,
6. assess yellowfin sole maturity and determine location and timing of spawning,
7. collect stomach samples for food habit studies,
8. collect tissue samples to examine diseases affecting various crab species and assess parasite abundance and diversity in selected fish species, and
9. collect and preserve specimens and tissue samples for special studies requests.

VESSELS AND GEAR

The primary vessels surveying the EBS shelf were two U.S. chartered vessels, the 30.5-m University of Washington research vessel Alaska and the 31.4-m commercial fishing vessel Ocean Hope 3. The 65.5-m NOAA research vessel Miller Freeman sampled the EBS continental slope and the 101.6-m Soviet vessel Novodrutsk extended the survey to Soviet waters.

Two gears were used by the Ocean Hope 3 for the nearshore juvenile crab and flatfish survey. A 10 X 2 ft rigid frame beam trawl with a 3.18-cm stretch mesh web and a 1.27-cm mesh codend

liner was used on flat bottom and a 4 X 2 ft scallop small mesh liner was used on less suitable bottom type.

For the standard triennial survey, the two U.S. chartered were equipped with 83-112 eastern trawls. These nets have 25.3-m headrope and a 34.1-m footrope (Fig. 1). They were behind ~~816~~-kg, 1.8 X 2.7-m steel V-doors and 54.9-m paired dandylines (bridles). Each lower dandyline had a 0.61-m cha. extension connected to the lower wing edge to improve bottom tending characteristics. The 83-112 eastern trawl has been the standard sampling net used during annual eastern Bering Sea surveys since 1982 when it replaced the 400 mesh eastern trawl.

The Miller Freeman sampled all stations using a poly-Noreastern trawl net. These four seam trawls had a 27.2-m headrope and 37.4-m footrope. The nets were equipped with 998-kg, 1.8 X 2.7-m steel V-doors and 35.6-cm bobbin roller gear. An additional 6 m of cable was attached to each end of the roller gear. Three 54.9-m dandylines extended from each wing. The codend consisted of 8.9-cm stretch mesh with a 3.2-cm mesh liner (Fig. 2)

The Novodrutsk used a trawl net with a 69-m headrope and 94-m (160.8-ft) footrope. It was towed behind 1,200-kg round doors and 75-m dandylines. The net had an estimated vertical and horizontal opening of 8 m and 27 m, respectively.

Net mensuration systems aboard the U.S. vessels were used to provide tow-by-tow gear configuration and performance data to be used in area-swept calculations.

ITINERARY

The Ocean Hope 3 departed Dutch Harbor, Alaska, on May 15 and returned on September 3 upon the completion of the shelf portion of the eastern Bering Sea crab-groundfish survey. Intervening port calls were made in Dutch Harbor on June 1, June 25, July 19, and August 12 and on St. Paul Island on August 15 to obtain supplies and exchange scientific personnel (Table 1).

The Alaska departed Dutch Harbor on June 17 and completed its portion of the survey on August 18. Port calls were made on July 11 and August 4 in Dutch harbor and August 12 on St. Paul Island to obtain supplies and exchange scientific personnel (Table 1).

The Miller Freeman departed Dutch Harbor on August 31 and returned September 26 after surveying along the continental slope. A port call was made in Dutch harbor from September 9-10 to pick up parts for a damaged winch and another was made September 20 on St. Paul Island to disembark an injured crew member. Scientific personnel are listed in Table 1.

The Novodruzsk departed from Dutch harbor on May 4 and finished the survey on July 3 on arrival in Kodiak, Alaska. An exchange of U.S. scientific personnel was made in Dutch harbor on May 17 (Table 1).

SURVEY DESIGN AND METHODS

The nearshore juvenile crab and fish survey included seven predetermined transect lines, oriented perpendicular to the coastline, between Port Moller and Kvichak Bay (Fig. 3). Each of four stations per transect were sampled three times, twice in the day and once during the night.

The standard survey area sampled by U.S. vessels included eastern Bering Sea continental shelf and slope waters from Unimak pass north along the U.S.-U.S.S.R. convention line to St. Lawrence Island and east to the Alaska mainland. Norton sound waters were also sampled (Fig. 3). As in previous surveys, sampling sites on the continental shelf were based on a 20 x 20 nmi grid with sampling density increased around the Pribilof Islands and St. Matthew Island regions to collect additional data on crab populations. One station in Togiak Bay and two in Kuskokwim Bay were also sampled, primarily to investigate spawning yellowfin sole. Additional tows were conducted near stations where high concentrations of king crab and/or adult bairdi Tanner crab were encountered to provide data for more precise abundance estimates.

The Alaska and Ocean Hope 3 sampled alternate north/south rows of stations, for the majority of the survey, proceeding from Bristol Bay westward to the shelf edge. Thirty-minute tows were made at most station locations. All catches were sorted to the lowest possible taxon, weighed, and enumerated. Station data including time, position, trawl performance, and distance fished, as well as catch and length-frequency information, were entered into microcomputers at sea. Age data, sampled by sex-centimeter category, and other biological data were collected from the major fish species encountered. Information on length-width relationships, shell condition, and clutch size, as well as tissues and organs, were collected from the major crab species. Special study collections were stored in appropriate fixatives or were frozen. Sea water temperature profiles were collected at most stations using expendable bathythermograph (XBT) probes.

The Miller Freeman conducted the slope portion of the survey in September. Thirty-minute tows were made at stations ranging in depth from 200 to 800 m (Fig. 3). Catches were processed in the same manner as on the chartered vessels; however, no crab measurements were taken.

The Novodruzsk sampled alternate station rows throughout the U.S. shelf area and shelf waters west of the U.S.-U.S.S.R. convention line to latitude 58°30'N along the Soviet coast (Fig. 4). Sampling procedures at each site were adapted from the standard

U.S. methodology to provide continuity between the U.S. and U.S.S.R. data collections. The AFSC provided a global positioning system (GPS) to provide accurate haul position and distance fished information.

RESULTS

During the nearshore juvenile crab and fish survey, the Ocean Hope 3 conducted 75 beam trawls and 2 scallop dredge tows at depths ranging from 18 to 33 fathoms of water (Fig. 3). Red king crabs in the 4-11 mm carapace length category, most likely the 1990 year-class, were almost always attached to a biological substrate such as mussels, bryozoans, or hydroids. Preliminary comparisons revealed insignificant differences in catch rates between day and night. Data on juvenile fish species, which were a significant part of the catch, have not been examined yet. The survey demonstrated that a beam trawl can be used successfully to index the abundance of juvenile king crab. Use of a scallop dredge for this purpose, however, was not considered feasible.

The Alaska and Ocean Hope 3 successfully completed 405 bottom trawls in the eastern Bering Sea area and 52 stations in Norton Sound (Fig. 3). Biological data collected from fish species captured by the Alaska and Ocean Hope 3 are summarized in Table 2. The two U.S. vessels collected 167,906 length measurements and 5,080 age structures from the major fish species. Individual length-weight data on walleye pollock were recorded for specimens sampled for age structures. A total of 7,193 stomachs from various fish taxa were preserved for feeding habit analysis. Red king crab were tagged and released to provide information for growth and movement studies. Numerous whole specimens of various species were preserved for identification, training, and other purposes. Yellowfin sole maturity was recorded for 655 specimens. In addition, 100 yellowfin sole ovary pairs were collected to examine ovarian development by means of histology.

The Miller Freeman sampled 94 stations on the eastern Bering Sea slope (Fig. 3). A total of 19,624 fish lengths were recorded. Collections included 1,012 fish otoliths and 350 fish stomachs (Table 3).

The Novodrutsk completed 163 trawls in the eastern Bering Sea and 55 trawls in the western Bering Sea (Fig. 4). A total of 65,000 length measurements were recorded from various fish taxa (Table 4). Otoliths from 764 walleye pollock and 509 Pacific cod were collected for age determination. The data collected during the Soviet portion of the survey have not been analyzed; therefore, preliminary results are not presented here.

Catch results from data collected aboard U.S. vessels are presented below, by region.

Standard area: The standard U.S. shelf survey area (lat. 54°40'-61°00'N) encompassed 135,099 nmi² and overall catches by the U.S. vessels averaged 360 kg/ha trawled. Catch rates of commercially-important fish and crab species taken by the U.S. vessels are shown in Table 5.

Walleye pollock was the most abundant species encountered, with an overall CPUE of 143 kg/ha trawled. They were encountered at nearly all sampling sites, although the largest concentrations were found at bottom depths greater than 100 m (Fig. 5).

Yellowfin sole and rock sole were the most abundant flatfish species, with overall CPUE values of 39.4 kg/ha and 30.2 kg/ha, respectively. Yellowfin sole were primarily restricted to central and inner shelf waters (Fig. 6). Rock sole were most abundant in the inner shelf and around the Pribilof Islands but were broadly distributed with a range extending to the outer shelf (Fig. 7).

Pacific cod were encountered at nearly all sites sampled (Fig. 8). Catch rates varied from 8.1 kg/ha at depths less than 50 m to 15.7 kg/ha at depths of 100-200 m.

Other relatively abundant commercial fish species included Alaska plaice, flathead sole, arrowtooth flounder, and Pacific halibut (Table 5).

Tanner crab, Chionocetes opilio, was the most abundant commercially-important crab species encountered, with a total average catch rate of 16.3 kg/ha. Red king crab, blue king crab, and Chionocetes bairdi were caught at significantly lower rates of 1.2 kg/ha, 1.1 kg/ha, and 1.3 kg/ha, respectively.

North shelf: The most abundant commercially-important fish species on the northern shelf were walleye pollock (20.0 kg/ha), yellowfin sole (16.2 kg/ha), Alaska plaice (8.2 kg/ha), Bering flounder (3.0 kg/ha), and rock sole (2.8 kg/ha). Yellowfin sole was the most abundant fish species at depths less than 50 m, whereas walleye pollock predominated at depths from 100-200 m (Table 6).

C. opilio was clearly the most abundant invertebrate species with a mean CPUE of 20.7 kg/ha over the entire north shelf (Table 6).

Norton Sound: Purple-orange sea stars contributed a significant portion of the overall catch in Norton Sound with a mean CPUE of 30.6 kg/ha. Saffron cod was the most abundant fish species, captured at a rate of 13.6 kg/ha. Various other fish species, including plain sculpins, walleye pollock, starry flounder, and yellowfin sole, were captured at moderate rates (Table 7). Red king crab was the only commercially-abundant invertebrate (1.8 kg/ha).

Continental slope: Walleye pollock was the most abundant fish species on the continental slope, concentrated at depths between 200 and 500 m (57.2 kg/ha). Giant grenadiers accounted for a large proportion of the fish catch (40.7 kg/ha) captured at depths from 500-800 m. Greenland turbot were uniformly distributed over the slope depths sampled, with a mean catch rate of 17.8 kg/ha. Arrowtooth flounder, flathead sole, Pacific ocean perch, and Kamchatka flounder were most frequently encountered at depths from 200-500 m, whereas sablefish and other Coryhaenoides species were most abundant from 500-800 m (Table 8).

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Table 1.--Itinerary and scientific personnel^a for RACE groundfish cruises conducted in the Bering Sea in 1991.

Ocean Hope 3

May 15-June 1	June 4-June 25	June 25-July 19	July 19-Aug 12	Aug 12-Sept 3
B. Stevens ^{bc}	C. Armistead ^b	B. Stevens ^{bc}	C. Armistead ^b	① Sample ^b (Aug 15-Sept 3)
④ Walters	② Goddard	D. Fisk	④ Nichol	② Goddard
R. MacIntosh ^c	J. Weber	B. Pacunski	A. Ward	H. Kenney
	L. Cherepow	D. McFee	L. Cherepow	D. McFee
	F. Hartsock ^c	④ Zimmerman	J. Haaga ^c	J. Haaga ^c
	J. Haaga ^c	P. Cumiskey ^c	E. Munk ^c	

Alaska

June 17-July 11	July 11-Aug 4	Aug 4-Aug 18
C. Rose ^b	④ Walters ^b	④ Sample ^b (Aug 4-15)
G. St Pierre ^d	G. St Pierre ^d (July 11-20)	S. Thomas ^d
④ Lang	S. Thomas ^d (July 20-Aug 4)	D. Smith
R. MacIntosh ^c	J. Parkhurst	P. Anderson ^c
K. Smith ^c	② Otto ^c	K. Smith ^c
	R. Elner ^c	

Miller Freeman

Aug 31-Sept 26

④ Morado ^b	④ Nichol
D. Fisk	④ Zimmerman
J. Weber	J. Forresburg ^d
D. Bishop	C. Aadlan ^e

Novodrutsk

May 4 (Dutch) -July 3 (Kodiak)

④ Benjamin (May 4-17) ^b
L. Faughnan
④ Roetcisoender (May 4-17)
D. Kessler (May 17-July 3) ^b
L. Powell (May 17-July 3)

^a Personnel from AFSC, Seattle, unless otherwise noted

^b Field Party Chief

^c Personnel from AFSC, Kodiak laboratory

^d Personnel from International Pacific Halibut Commission (IPHC), Seattle

^e Personnel from Bucknell University, Pennsylvania

Table 2.--Biological data collected by the Alaska and Ocean Hope 3 during the 1991 eastern Bering Sea crab-groundfish survey.

Species	Length measurements	Age structures ¹	Stomach samples
Walleye pollock ²	43,406	1,110	2,986
Pacific cod	7,067	836	1,663
Yellowfin sole	33,388	804	734
Rock sole	32,189	625	274
Flathead sole/ Bering flounder	21,776	420	798
Pacific halibut	2,256	649	234
Alaska Plaice	10,284	300	232
Arrowtooth flounder/ Kamchatka flounder	6,776	117	193
Greenland turbot	658	219	79
Rex sole	392	--	--
Pacific ocean perch	80	--	--
Starry flounder	461	--	--
Saffron cod	6,945	--	--
Arctic cod	145	--	--
Longhead dab	1,009	--	--
Misc. species	1,074	--	--
Total	167,906	5,080	7,193

¹ Otoliths were collected for age determination. Scale scrape samples were also collected from Pacific cod.

² Individual length-weight data were also collected from walleye pollock sampled for age structures.

Table 3.--Biological data collected by the Miller Freeman during the 1991 eastern Bering Sea (slope) crab-groundfish survey.

Species	Length measurements	Age structures ¹	Stomach samples
Walleye pollock ²	5,369	263	140
Pacific cod	186	110	76
Sablefish	248	--	29
Rock sole	86	--	--
Flathead sole	4,645	--	65
Pacific halibut	44	43	--
Arrowtooth flounder	1,991	188	5
Kamchatka flounder	1,183	120	--
Greenland turbot	1,812	171	35
Rex sole	550	--	--
Dover sole	6	--	--
Pacific ocean perch	987	117	--
Shortraker rockfish	141	--	--
Rougheye rockfish	102	--	--
Shortspine thornyhead	615	--	--
Giant grenadier	1,083	--	--
<u>Coryphaenoides</u> sp.	578	--	--
Misc. species	3	--	--
Total	19,629	1,012	350

¹ Otoliths were collected for age determination. Scale scrape samples were also collected from Pacific cod.

² Individual length-weight data were also collected from walleye pollock sampled for age structures.

Table 4.--Biological data collected by the Novodruzsk during the 1991 Bering Sea crab-groundfish survey.

Species	Length measurements	Age structures ¹	Stomach samples
Walleye pollock	33,602	509	140
Pacific cod	8,975	764	76
Yellowfin sole	13,114	--	--
Rock sole	12,583	--	--
Flathead sole	5,938	--	--
Bering flounder	1,052	--	--
Pacific halibut	1,221	--	--
Alaska Plaice	4,541	--	--
Arrowtooth flounder	1,793	--	--
Kamchatka flounder	293	--	--
Starry flounder	41	--	--
Arctic cod	191	--	--
Pacific herring	163	--	--
Sakhalin sole	155	--	--
Total	83,662	1,273	216

¹ Otoliths were collected for age determination. Scale scrape samples were also collected from Pacific cod.

Table 5.--Mean catch rates (kg/ha) by depth zone of commercially important fish and crab species taken aboard the Alaska and Ocean Hope 3 in the standard area during the 1991 eastern Bering Sea crab-groundfish survey.

Species	Inner shelf < 50 m	Central shelf 50-100 m	Outer shelf 100-200 m	Total area
Walleye pollock	15.3	163.3	195.8	143.4
Yellowfin sole	119.7	30.9	0.1	39.4
Rock sole	78.1	27.5	2.8	30.2
Pacific cod	8.1	10.6	15.7	11.6
Alaska plaice	14.3	15.0	2.0	11.0
Flathead sole/ Bering flounder	1.5	9.9	14.1	9.5
Arrowtooth flounder/ Kamchatka flounder	<0.1	3.7	16.1	6.7
Pacific halibut	4.1	1.4	1.2	1.9
Pacific herring	1.6	0.2	0.2	0.5
<u>opilio</u> Tanner crab	0.2	22.5	16.8	16.3
<u>bairdi</u> Tanner crab	1.5	4.4	3.2	3.4
Red king crab	0.8	2.2	0.0	1.2
Blue king crab	<0.1	1.7	0.9	1.1
Total effort (hectares)	394.1	749.9	431.6	1575.7

Table 6.--Mean catch rates (kg/ha) by depth zone of commercially important fish and crab species taken aboard the Alaska and Ocean Hope 3 in the north shelf area during the 1991 eastern Bering Sea crab-groundfish survey.

Species	Inner shelf < 50 m	Central shelf 50-100 m	Outer shelf 100-200 m	Total area
Walleye pollock	11.5	3.8	61.0	20.0
Yellowfin sole	49.6	7.5	0.0	16.2
Alaska plaice	18.4	7.2	0.0	8.2
Pacific cod	3.0	0.8	15.7	5.1
Bering flounder	0.6	2.4	6.8	3.0
Rock sole	5.2	2.8	0.4	2.8
Greenland turbot	0.0	<0.1	1.9	0.5
Pacific halibut	1.6	<0.1	<0.1	0.4
Pacific herring	1.0	<0.1	<0.1	0.3
Flathead sole	0.0	<0.1	0.9	0.2
Kamchatka flounder	0.0	0.0	0.2	<0.1
<u>opilio</u> Tanner crab	13.7	28.0	13.2	20.7
Blue king crab	<0.1	<0.1	0.0	<0.1
Red king crab	<0.1	0.0	0.0	<0.1
Total effort (hectares)	87.1	50.3	33.1	234.0

Table 7.--Mean catch rates (kg/ha) by depth zone of the most abundant fish and commercially important crab species taken aboard the Ocean Hope 3 in the Norton Sound area during the 1991 eastern Bering Sea crab-groundfish survey.

Species	Total area
Saffron cod	13.6
Plain sculpin	4.6
Walleye pollock	2.9
Starry flounder	2.1
Yellowfin sole	1.9
Alaska plaice	1.2
Pacific halibut	1.0
Rainbow smelt	0.7
Pacific cod	0.7
<u>Myoxocephalus</u> sp.	0.6
<u>Gymnocanthus</u> sp.	0.3
Rock sole	<0.1
Pacific herring	<0.1
Bering flounder	<0.1
Red king crab	1.8
Blue king crab	0.1
Total effort (hectares)	185.2

Table 8.--Mean catch rates (kg/ha) by depth zone of the most abundant fish and commercially important crab species taken aboard the R/V Miller Freeman in the slope area during the 1991 eastern Bering Sea crab-groundfish survey.

Species	Inner slope 200-500 m	Outer slope 500-800 m	Total area
Walleye pollock	57.2	0.4	28.8
Giant grenadier	6.3	40.7	23.5
Greenland turbot	19.3	16.3	17.8
Arrowtooth flounder	13.8	0.8	7.3
Flathead sole	11.9	0.6	6.2
Pacific Ocean Perch	8.5	0.2	4.3
Kamchatka flounder	6.1	1.5	3.8
Sablefish	0.7	4.0	0.0
Other			
<u>Coryphaenoides</u> sp.	<0.1	3.9	1.9
Pacific cod	3.9	0.0	1.9
Skate unidentified	2.6	0.2	1.4
Pacific sleeper shark	0.6	1.8	1.2
Shortraker rockfish	2.0	0.1	1.1
Shortspine thornyhead	0.4	1.4	0.9
Pacific halibut	1.4	0.1	0.8
Rex sole	1.1	<0.1	0.6
Twoline eelpout	0.1	0.7	0.4
Rougheye rockfish	0.6	0.1	0.4
Golden king crab	<0.1	0.2	0.1
Brown king crab	<0.1	<0.1	<0.1
Total effort (hectares)	287.5	105.1	392.6

83-112 EASTERN BOTTOM TRAWL

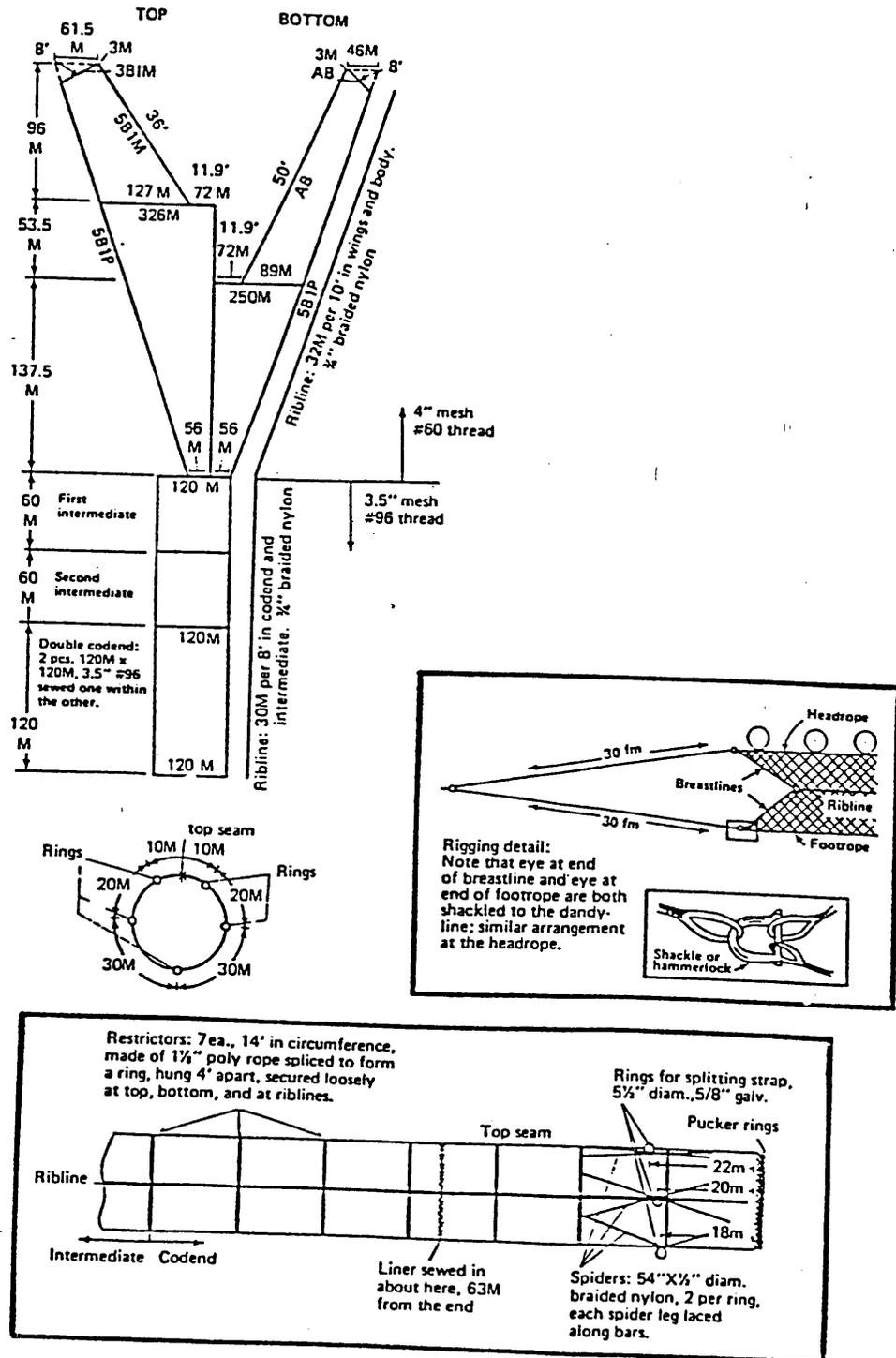


Figure 1.--Diagram of the 83-112 eastern bottom trawl used during the 1991 eastern Bering Sea crab-groundfish survey.

Framing lines 89'1"/120'7"

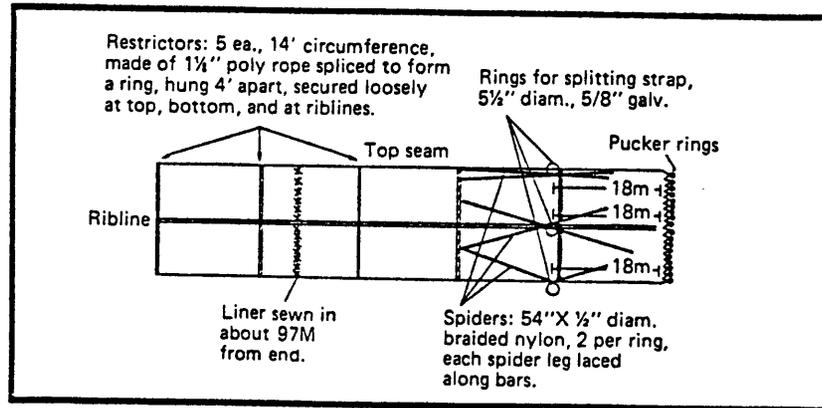
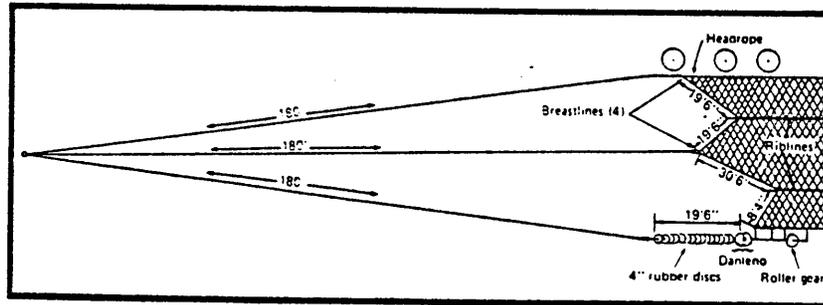
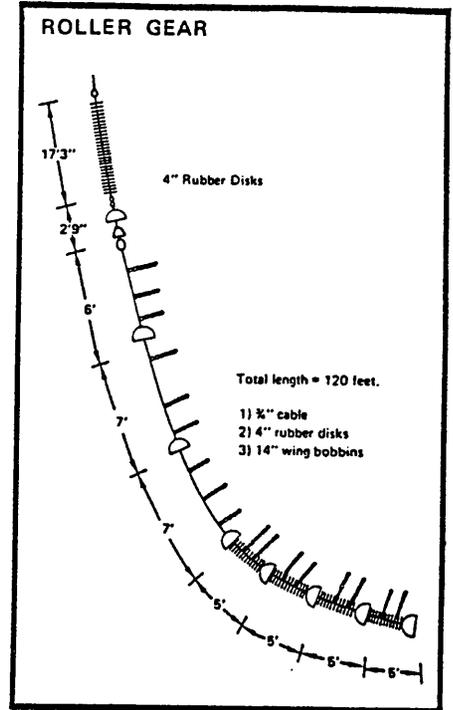
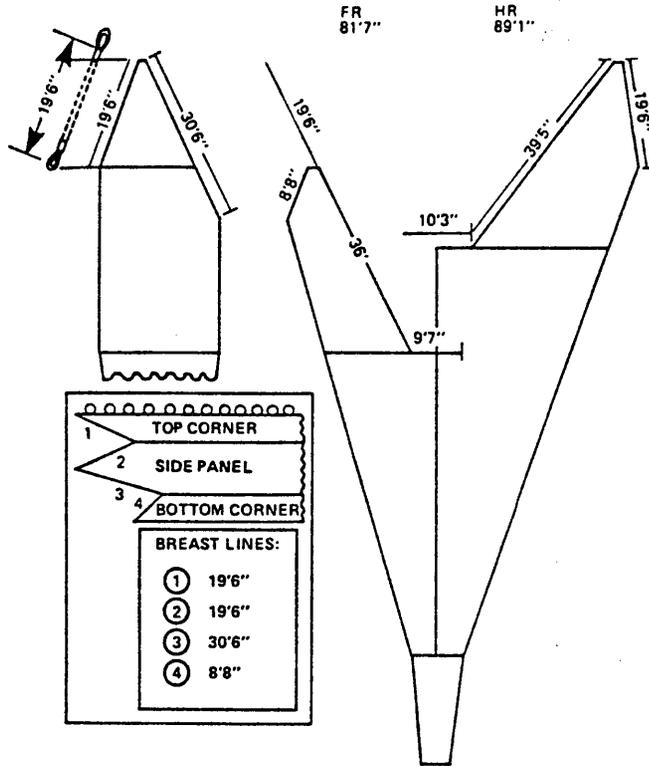


Figure 2.--Specifications of the poly-Noreastern bottom trawl used aboard the R/V Miller Freeman during the 1991 eastern Bering Sea crab-groundfish survey.

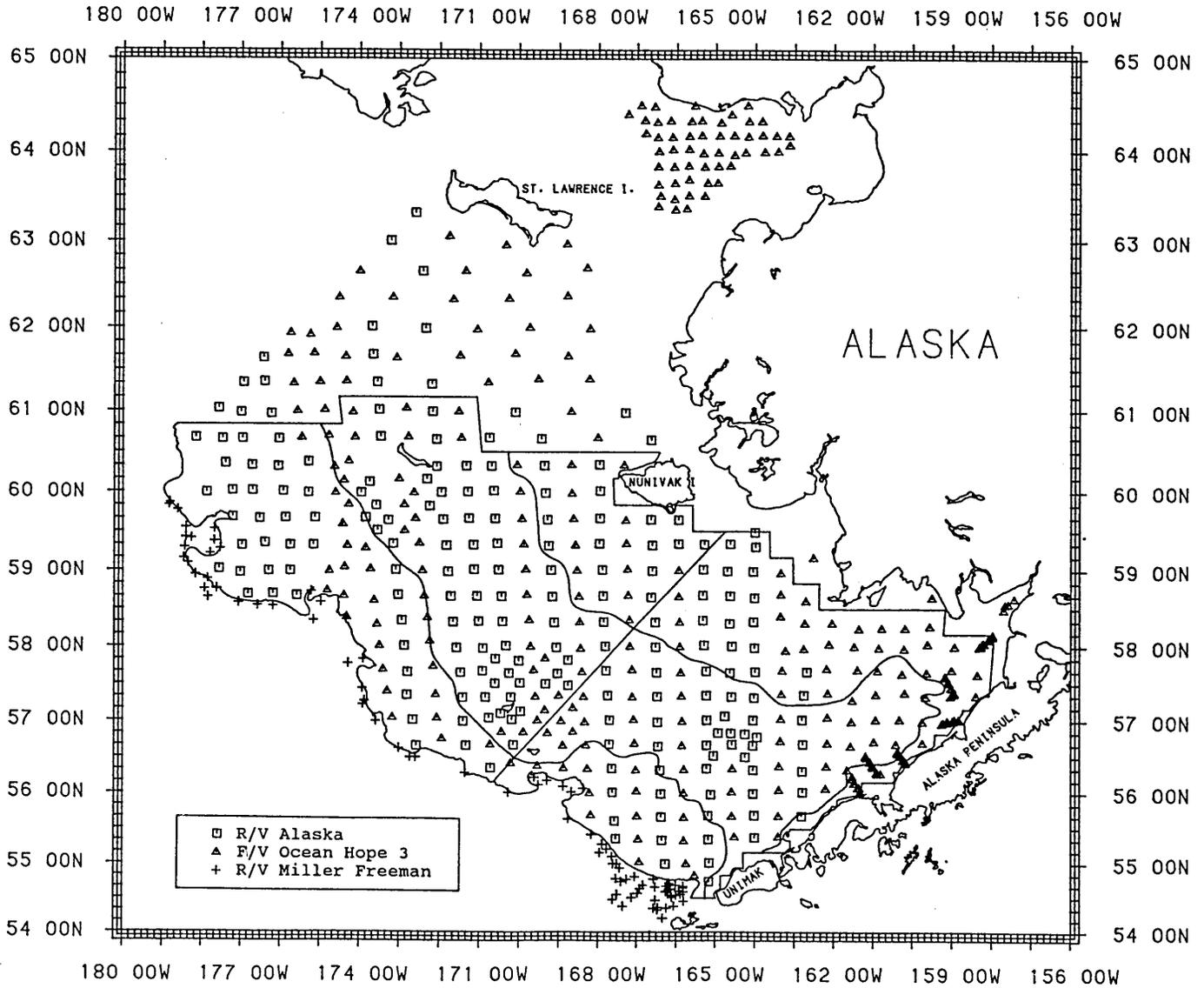


Figure 3.--Distribution of sampling effort by the Alaska, Ocean Hope 3, and Miller Freeman for the 1991 eastern Bering Sea survey area. Solid lines indicate the standard survey area boundary and subareas.

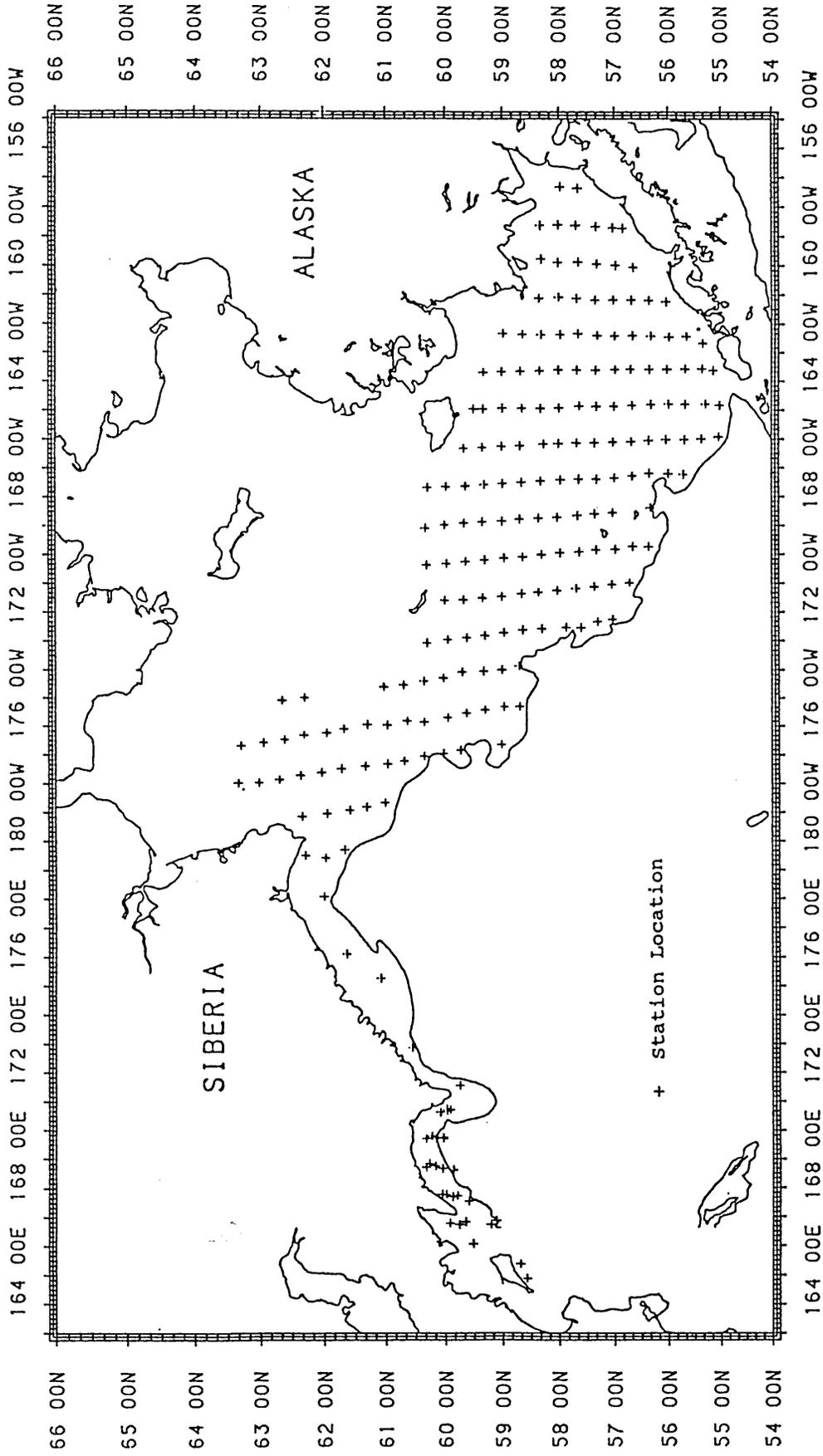


Figure 4. ---Distribution of total sampling effort by the U.S.S.R. Research Vessel Novodrutsk during the 1991 Bering Sea trawl survey.

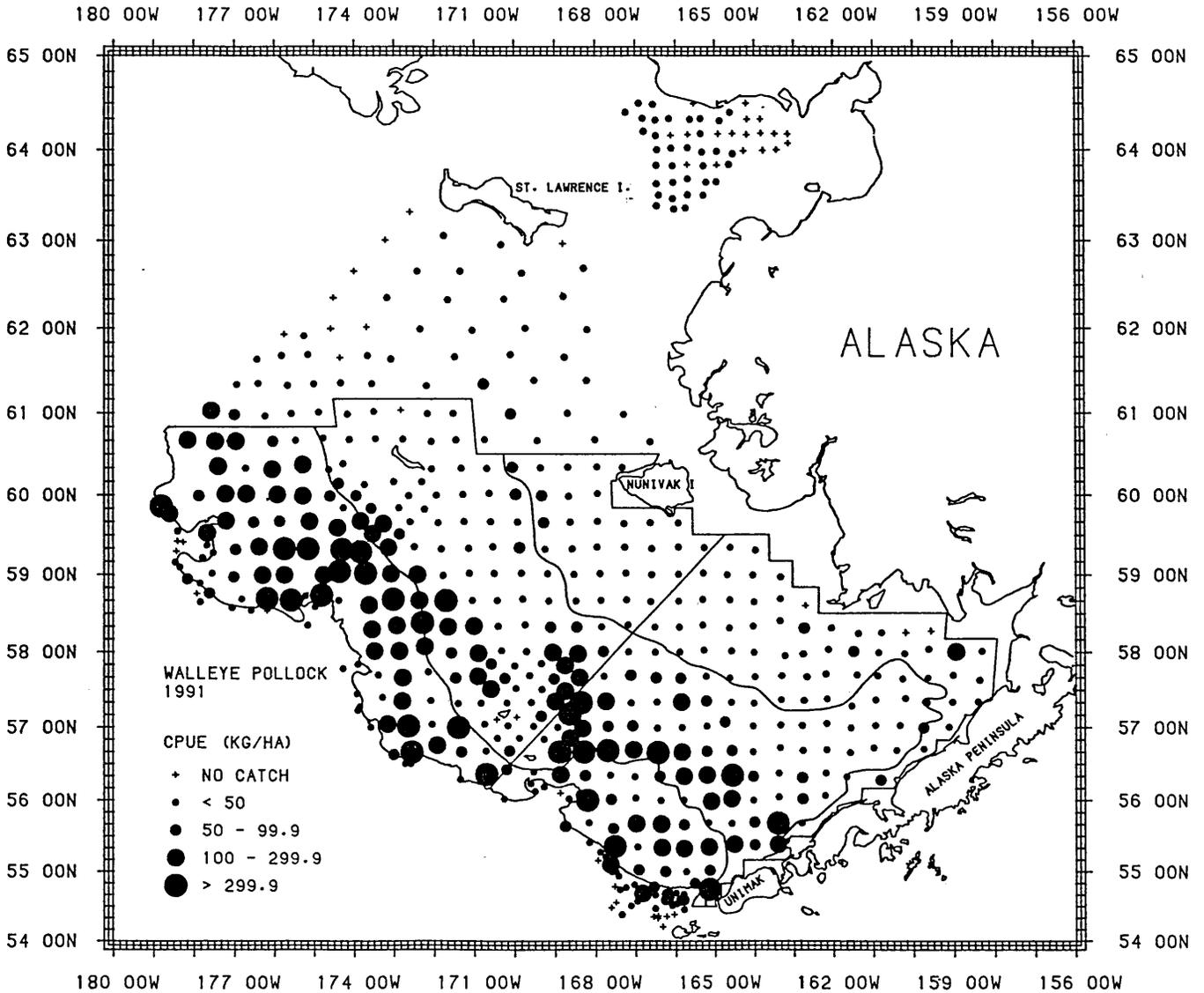


Figure 5.--Catch rate distribution of walleye pollock from the overall area surveyed by U.S. vessels during the 1991 eastern Bering Sea survey.

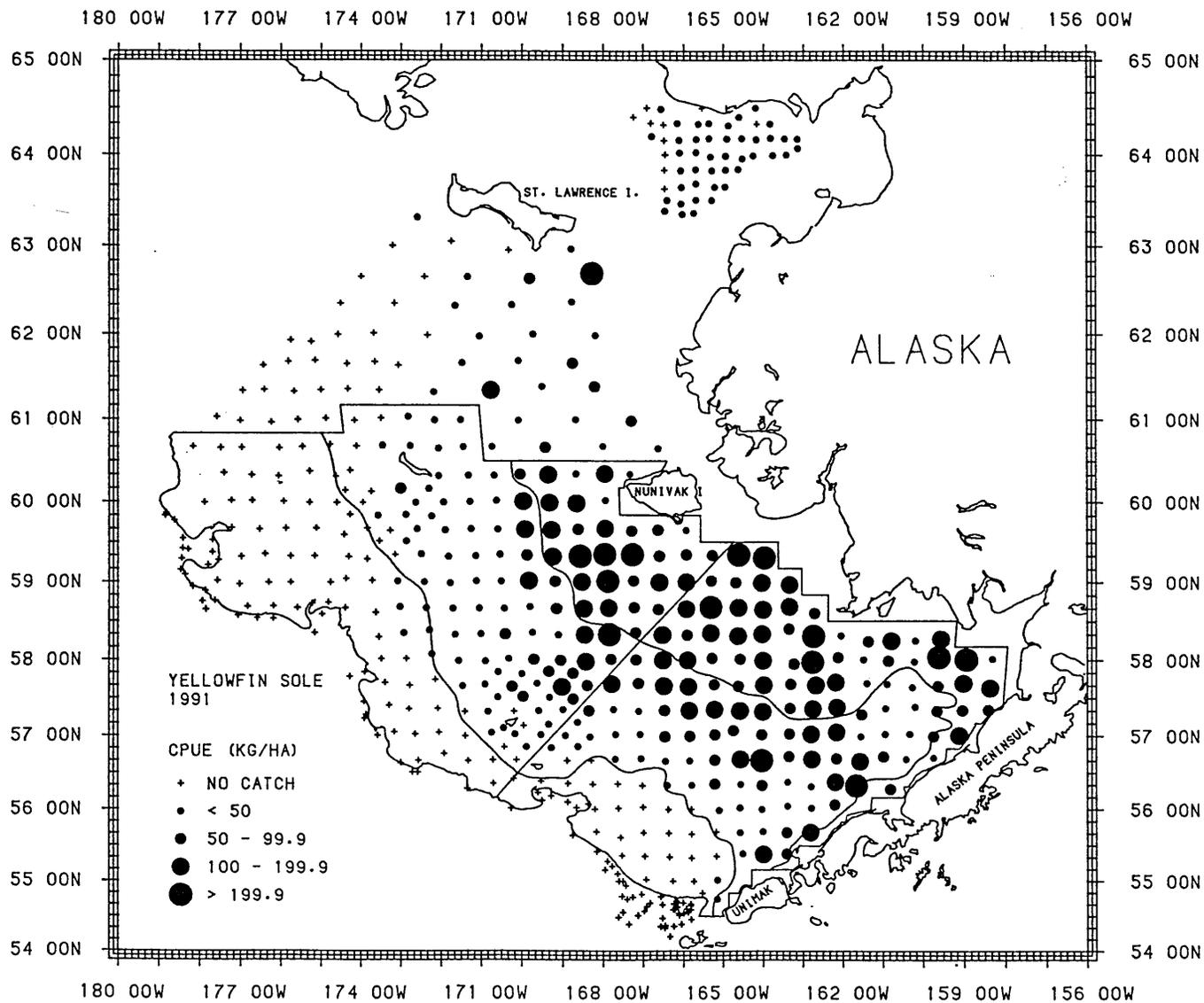


Figure 6.--Catch rate distribution of yellowfin sole from the overall area surveyed by U.S. vessels during the 1991 eastern Bering Sea survey.

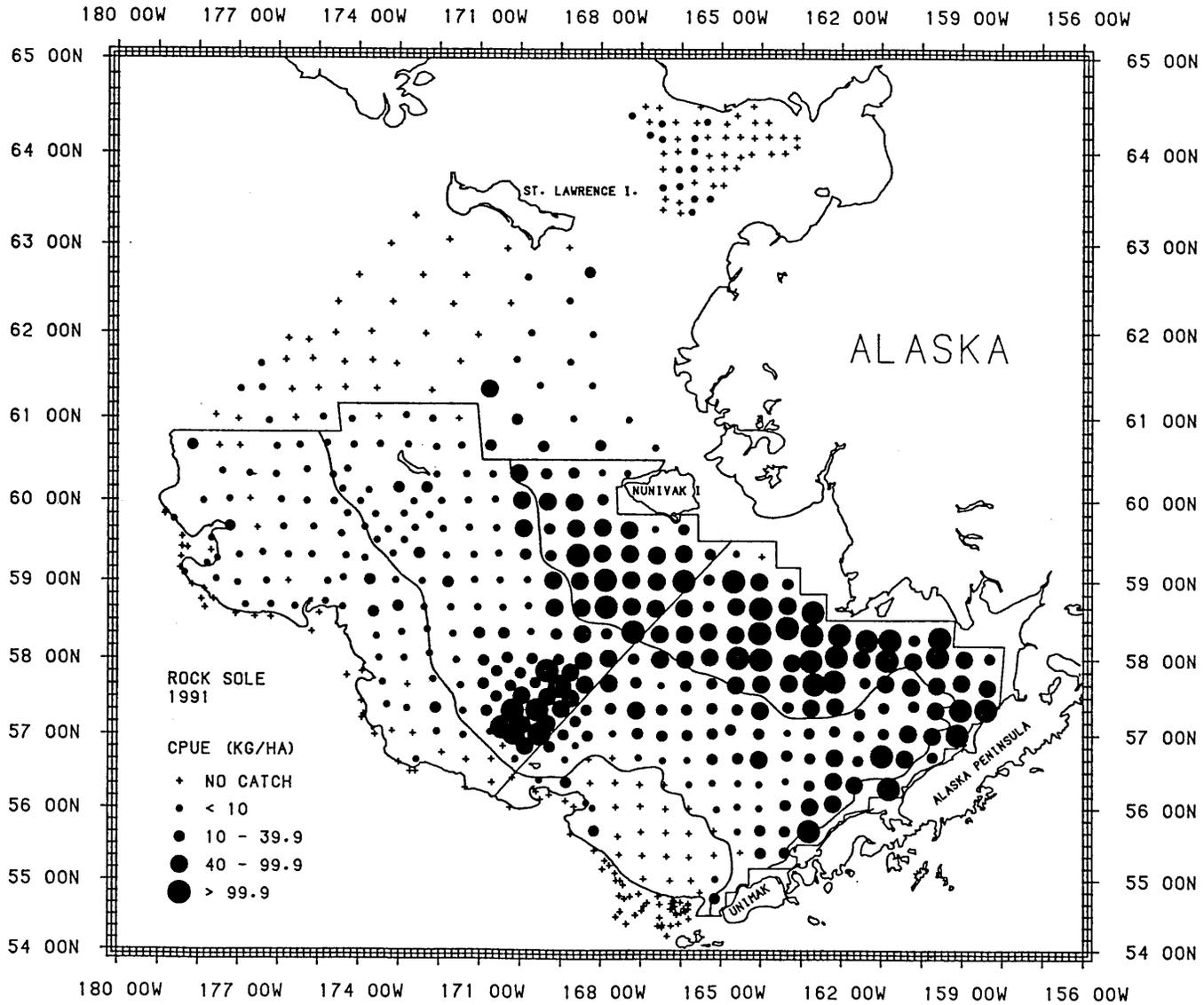


Figure 7.--Catch rate distribution of rock sole from the overall area surveyed by U.S. vessels during the 1991 eastern Bering Sea survey.

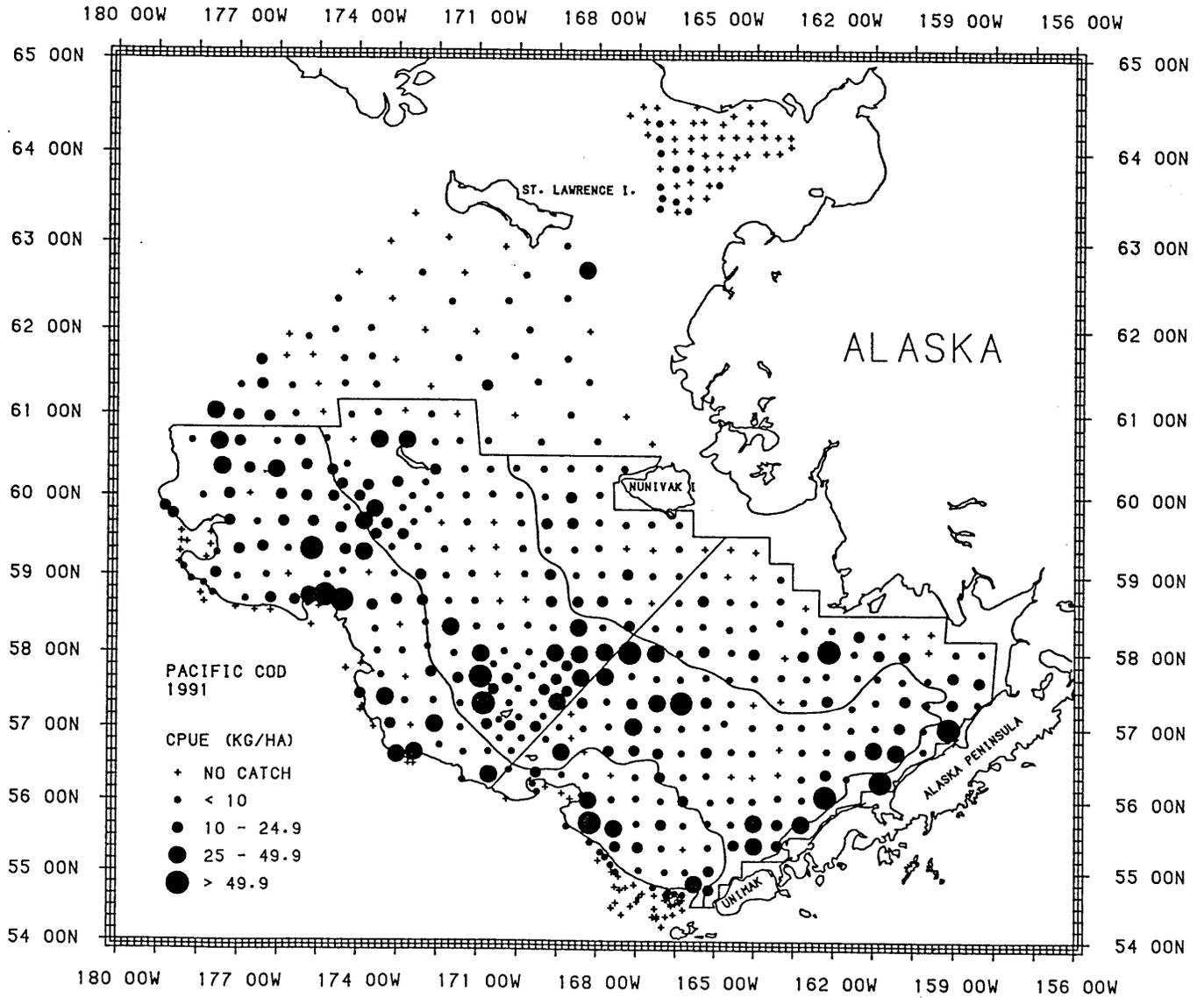


Figure 8.--Catch rate distribution of Pacific cod from the overall area surveyed by U.S. vessels during the 1991 eastern Bering Sea survey.