



**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
NATIONAL MARINE FISHERIES SERVICE  
Northwest and Alaska Fisheries Center  
Resource Assessment and Conservation  
Engineering Division  
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January 24, 1989

**CRUISE RESULTS**  
**Cruise 88-1 Alaska**  
**Cruise 88-1 Ocean Hope 3**  
**Cruise 88-8 Miller Freeman**  
**1988 Triennial Eastern Bering Sea Crab and Groundfish Survey**  
**June-September 1988**

The Resource Assessment and Conservation Engineering (RACE) Division of the Northwest and Alaska Fisheries Center (NWAFC) completed the annual crab and groundfish survey of the eastern Bering Sea conducted during June-September 1988. This was a comprehensive triennial survey which extended sampling beyond the standard annual survey area to include the northern portion of the eastern Bering Sea, Norton Sound, and continental slope waters. These large scale triennial surveys are conducted on a rotating basis in the eastern Bering Sea, Gulf of Alaska, and the Pacific west coast regions. In intervening years, the standard annual survey area is sampled as shown in Figure 1. Research vessels from the Far Seas Fisheries Research Laboratory of Japan and the Soviet Union also cooperated in the 1988 survey.

**OBJECTIVES**

The primary objectives of this survey were to continue the annual series of assessment surveys of crab and groundfish in the eastern Bering Sea to provide information for:

1. the North Pacific Fishery Management Council on the abundance and condition of the resources for management purposes,
2. the U.S. fishing industry, and
3. scientific studies of the resources.

Secondary objectives were to:

1. examine crab and halibut by-catch in inshore trawling areas;
2. assess yellowfin sole abundance in spawning areas in Togiak Bay and Kuskokwim Bay where commercial fisheries have operated in recent years;



3. conduct side-by-side comparative fishing experiments between U.S., Japanese, and Soviet Union fishing vessels;
4. conduct comparative trawl experiments to evaluate the performance of past and present standard sampling nets;
5. evaluate trawl performance and configuration with mensuration equipment;
6. tag Pacific cod and Greenland turbot;
7. collect stomach samples for food habit studies;
8. evaluate jigging equipment for use in walleye pollock tagging studies;
9. collect and preserve specimens and tissue samples for special studies requests;
10. evaluate the extent and magnitude of marine debris in the study area; and
11. recover, examine, and reset two specially modified crab pots set in shallow waters near the Alaska Peninsula in 1987 to investigate settling of juvenile king crab.

#### VESSELS AND GEAR

Primary survey vessels were two NWAFC chartered vessels, the University of Washington research vessel Alaska and the commercial fishing vessel Ocean Hope 3, and the NOAA research vessel Miller Freeman. Sampling by the U.S.S.R. research vessel Darvin in the standard survey area and by the chartered Japanese landbased trawler Tomi Maru No. 51 on the continental slope was used to supplement data from the NWAFC survey vessels. Data collections made aboard the Tomi Maru No. 51 were used to relate 1988 survey results on the slope from the Miller Freeman to those obtained by Japanese landbased trawlers on the slope in previous years. Characteristics of the vessels used during the survey are given in Table 1. The standard bottom trawl used by all NWAFC vessels at standard continental shelf stations was an 83-112 Eastern trawl. These nets have a 25.3 m (83 ft) headrope and a 34.1 m (112 ft) footrope. They were towed behind 1,000 kg, 1.8 X 2.7 m, steel V-doors and 54.9 m paired dandyines. Each lower dandyline had a 0.61 m chain 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.

A Noreastern trawl with a 27.4 m (90 ft) headrope and 32.0 m (128 ft) footrope was used by the Miller Freeman to sample transect stations on the continental slope. The Noreastern trawl had three 54.9 m bridles from each wing and was also equipped with roller gear. Descriptions of the standard sampling nets used during the survey are given in Figures 2, 3, and 4.

The Alaska and Ocean Hope 3 participated in the survey from June 1 to August 9. The Miller Freeman began its portion of the survey on August 13 and finished on September 23.

### SURVEY DESIGN AND METHODS

The survey region was divided into the standard area, northern shelf and Norton Sound area, and the continental slope (Figure 1).

A tow 30 minutes in duration was made at each sampling site. All catches were sorted to the lowest possible taxon, weighed, and enumerated. Station data, including time, position, trawl specifications, distance fished as well as catch information, were entered onto floppy disks via shipboard computer systems. Size composition and age samples by sex-centimeter category and other biological data were collected from the major fish species encountered. Length-width measurements, shell condition, clutch size, and tissues and organs for various studies were collected from the major crab species. Special study collections were stored in appropriate fixatives or frozen.

Standard area: The standard survey area, sampled annually, included continental shelf waters north from Unimak Pass, along the 200 meter depth contour to approximately 61° N and east to the Alaska mainland. Sampling sites were established on the basis of a 20 x 20 nmi grid pattern used during previous surveys, although more intensive sampling was carried out in the Pribilof and St. Matthew Island regions to collect additional data on crab populations. Stations were also established in the Togiak Bay and Kuskokwim Bay areas to investigate reports of large spawning concentrations of yellowfin sole. Seven sampling locations were also scheduled between 160°-162° W in response to a request from the North Pacific Fishery Management Council to investigate incidence of crab and halibut in trawl catches relative to the possible expansion of the inshore trawl fishery from 25 to 30 fm. Additional stations northwest of the standard survey area were also established to estimate the abundance of Tanner crab (Chionoecetes opilio) in an area that has produced high commercial landings during previous years.

Northern Shelf and Norton Sound: This area included continental shelf waters of the northeastern Bering Sea from approximately

61° N and north through Norton Sound. Sampling locations were established on a 28 nmi diagonal grid in the northern shelf area due to time constraints and relatively low resource abundance in that region. In Norton Sound, stations were generally scheduled at 10 nmi intervals. However, sampling intensity was increased in the offshore areas near Nome to provide special samples for the Alaska Department of Fish and Game and the Minerals Management Service.

Continental slope: Survey sites were established along the continental slope from the U.S.-U.S.S.R. Convention Line to Unimak Pass at depths ranging from 200 m to 800 m.

## RESULTS

Standard Area: Survey activities in the standard area were conducted by the Alaska, Ocean Hope 3, and the U.S.S.R. vessel Darvin. The Darvin began its portion of the survey in mid-May, about two weeks earlier than the U.S. vessels, and sampled alternate rows of stations throughout the standard survey area sampled later by the U.S. vessels. The Alaska and Ocean Hope 3 sampled all standard survey stations with the vessels fishing alternate rows of designated stations during June-August to facilitate the determination of relative fishing powers of the two vessels.

The Alaska and Ocean Hope 3 successfully completed 429 bottom hauls, including a total of 44 side-by-side comparative trawls to examine relative fishing efficiencies of the 83-112 eastern trawl and the 400 mesh eastern trawl used during previous surveys (Figure 1). The Ocean Hope 3 completed an additional 7 trawl hauls in the Port Moller region to collect information for crab and Pacific halibut by-catch between 160° and 162° W and 20 and 25 fathoms. The Darvin also conducted 18 side-by-side tows with the Alaska while the Alaska fished standard survey stations to assess trawling effectiveness between the two vessels.

The two U.S. vessels recorded approximately 120,000 length measurements by sex-centimeter category from the major fish species and over 4,000 age structures were collected and preserved. Individual length-weights were also recorded from the rock sole age sample. Biological data collected from fish species on the Alaska and Ocean Hope 3 are summarized in Table 2. About 3,100 stomachs were preserved from various taxa for feeding habit analysis. Nearly 200 Pacific cod were tagged and released to provide information on stock movements. Very few viable Greenland turbot were encountered and, subsequently, no specimens were tagged. Red king crab were tagged and released to provide information for growth and movement studies. Approximately 500 whole specimens of various species were preserved for identification, training, and other purposes. All

marine debris were identified and documented from each catch in an initial attempt to determine the extent and magnitude of discarded plastics and other pollutants.

Sea water temperature profiles were collected at each station using expendable bathythermograph (XBT) probes. These data, as well as additional meteorological data, were collected aboard the Alaska and transmitted to shore-based users via the Geostationary Operational Environmental Satellite (GOES) network.

Scanmar net mensuration systems aboard both vessels provided gear configuration and performance data to be used in area swept calculations.

A jigging machine was installed on the Ocean Hope 3 during the third leg to evaluate methods of obtaining viable walleye pollock specimens for use in tagging studies. Few walleye pollock (approximately 100) were captured and released due to equipment malfunctions and relatively low abundance in some areas fished.

Only one of the two special crab pots set in 1987 was located by the Alaska. No evidence of king crab settling was found, although a valuable long-term temperature recorder was recovered. Two sets of pots were set in the same general locations for recovery in 1989.

The total standard survey area region encompassed approximately 136,000 nmi<sup>2</sup> and overall catches averaged nearly 355 kg/ha trawled. Fish comprised about 79% (281 kg/ha) of the total catch, while invertebrates accounted for the remaining 21% or 73 kg/ha trawled.

Walleye pollock was the most abundant species encountered, with an overall CPUE of 160.5 kg/ha trawled (Table 3). They were taken at nearly all sampling sites occupied, with largest mean catches (291.0 kg/ha) observed in outer shelf waters at depths of 100-200 m (Figure 5). Mean catches were greatly reduced at depths less than 50 m (13.6 kg/ha).

Yellowfin sole and rock sole were the most abundant flatfish species, with overall CPUE values of 28.4 kg/ha and 24.3 kg/ha, respectively. Yellowfin sole were primarily restricted to central and inner shelf waters, while rock sole were more broadly distributed with major concentrations in Bristol Bay and near the Pribilof Islands (Figures 6 and 7). Yellowfin sole catches decreased sharply with increased depth, from 85.2 kg/ha in waters less than 50 m to <0.1 kg/ha in waters greater than 100 m. A similar depth-related decrease in rock sole abundance was also observed.

Pacific cod were encountered at nearly all sites sampled (Figure 8). Catch rates varied by depth zone from 10.4 kg/ha trawled at depths less than 50 m to 27.0 kg/ha at depths of 100-200 m, with an overall average of 18.5 kg/ha trawled.

Alaska plaice, flathead sole, arrowtooth flounder, and Pacific halibut had a combined catch rate of approximately 28.3 kg/ha. Alaska plaice was the most abundant species of this group, with highest catch rates (12.9-13.5 kg/ha) in waters less than 100 m. Highest catch rates of arrowtooth flounder (11.7 kg/ha) and flathead sole (15.7 kg/ha) were located in waters 100-200 m.

Tanner crab (*C. opilio*) was the most abundant commercially important crab species encountered, with a total average catch rate of 10.5 kg/ha. Red king crab, blue king crab, and Tanner crab (*C. bairdi*) had catch rates of 2.3 kg/ha or less.

Northern Shelf and Norton Sound: The research vessel Miller Freeman completed the bottom trawl survey of the north shelf area from approximately 61° N through Norton Sound during August. A total of 126 tows were completed. This included 42 tows in the north shelf area and 85 tows in Norton Sound (Figure 1).

Length measurements were recorded from nearly 20,000 fish of various species (Table 4). In addition, approximately 9,000 carapace measurements were taken from the commercially important crab species encountered. Other biological data included otoliths from selected finfish, starfish measurements, collections of whole shrimps, reproductive tracts from crabs, spiral valves from skates, histological specimens for pathological research, tissue specimens for DNA/RNA analysis, and collections of whole organisms for various studies. Net performance was evaluated through mensuration systems. Sea water temperature profiles were also collected at each station.

Overall catches averaged about 111 kg/ha trawled. Invertebrates comprised nearly 63% (70 kg/ha) of the overall catch, with fish taxa accounting for the remaining 37% (41 kg/ha). The purple-orange sea star was the dominant species encountered contributing 18% of the total catch. Saffron cod was the next most abundant species with a mean CPUE value of 13.8 kg/ha (Table 5). Yellowfin sole, walleye pollock, Alaska plaice, starry flounder and Pacific cod each represented less than 7% of the catch. Tanner crab (*C. opilio*) were relatively abundant (9.3 kg/ha), while red king crab and blue king crab were encountered in small amounts (0.6 kg/ha or less).

Continental slope: Upon completion of the northern shelf and Norton Sound study area, the Miller Freeman conducted the slope portion of the survey in September. The Northeastern bottom trawl with roller gear was the standard sampling net used. A total of

103 bottom trawls were conducted, including 2 unsuccessful trawls (Figure 1). Size composition by sex, otoliths, whole specimens, and other biological data were collected from species of interest. Biological data collected on fish and squid during this portion of the survey are summarized in Table 6. Size, maturity, and/or molting data from about 600 crab specimens of various species were also recorded.

Catches averaged approximately 141 kg/ha trawled. Fish taxa comprised about 98% of the total catch, while invertebrates were taken in relatively small numbers partially due to the use of roller gear at sampling stations. The giant grenadier (39.1 kg/ha), walleye pollock (34.3 kg/ha), and Pacific grenadier (15.8 kg/ha) combined represented over 60% of the total catch (Table 7). Giant grenadier abundance increased by depth from 21.6 kg/ha trawled at 100-400 fm to 56.7 kg/ha at depths of 400-600 fm, while walleye pollock decreased sharply from 68.4 kg/ha to 0.1 kg/ha with depth. Pacific grenadier were encountered in small amounts at depths of 100-400 fm (4.2 kg/ha), although abundance increased to 27.4 kg/ha at 400-600 fm. The next most common species were Greenland turbot and sablefish with overall CPUE values of 11.6 kg/ha and 8.2 kg/ha, respectively. Golden king crab and Tanner crab were taken in trace amounts.

The Japanese landbased trawler Tomi Maru No. 51 also surveyed the slope area and completed 34 trawl hauls. All tows were side-by-side comparative trawls with the Miller Freeman to collect data to relate abundance estimates with those from past slope surveys which have been conducted by Japanese vessels.

SCIENTIFIC PERSONNEL<sup>a</sup>AlaskaLeg 1

(G) Walters<sup>b</sup>  
 D. Molenaar  
 K. Chumbley  
 B. Stevens<sup>c</sup>  
 L. Cherepow

Leg 2

P. Raymore<sup>b</sup>  
 J. Sassano  
 H. Linn  
 D. Milward  
 E. Munk<sup>c</sup>

Leg 3

(G) Walters<sup>b</sup>  
 D. Baker  
 M. Yang  
 P. Cummiskey<sup>c</sup>  
 F. Hartsock<sup>c</sup>

Ocean Hope 3Leg 1

(T) Sample<sup>b</sup>  
 D. Fisk  
 P. Wyman  
 F. Hartsock<sup>c</sup>  
 P. Cummiskey<sup>c</sup>

Leg 2

R. MacIntosh<sup>bc</sup>  
 (M) Wilkins  
 M. Bohle  
 M. Bailey  
 T. Armetta

Leg 3

T. Sample<sup>b</sup>  
 D. Fisk  
 F. Bonde  
 (B) Dew<sup>c</sup>  
 F. Blau<sup>d</sup>  
 (L) Haaga

Miller FreemanLeg 1

(R) Otto<sup>bc</sup>  
 P. Anderson<sup>c</sup>  
 R. MacIntosh<sup>c</sup>  
 T. Armetta  
 J. Sassano  
 C. Rose  
 M. Bohle  
 D. Molenaar  
 (M) Dorn

Leg 2

P. Raymore<sup>b</sup>  
 P. Anderson<sup>c</sup>  
 L. Cherepow  
 D. King  
 A. Kimball  
 J. Lang  
 J. Norenberg<sup>e</sup>  
 A. Flerchinger<sup>e</sup>

- a Personnel from NWAFC, Seattle, unless otherwise noted  
 b Field Party Chief  
 c Personnel from NWAFC, Kodiak Laboratory  
 d Personnel from ADFG, Kodiak  
 e Personnel from Smithsonian Institution, Washington, D.C.

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Table 1.--Characteristics and timing of vessels used during the 1988 triennial eastern Bering Sea survey.

Vessel	Nation	Overall Length (m)	Survey Period	
			Start	Finish
<u>Alaska</u>	U.S.	30.5	June 1	August 9
<u>Ocean Hope 3</u>	U.S.	31.4	June 1	August 9
<u>Miller Freeman</u>	U.S.	65.5	August 13	September 23
<u>Darvin</u>	U.S.S.R.	101.6	May 16	July 3
<u>Tomi maru No. 51</u>	Japan	51.0	September 4	September 16

Table 2.--Biological data collected by the Alaska and Ocean Hope 3 during the 1988 eastern Bering Sea crab-groundfish survey.

Species	Length measurements	Age structures <sup>1/</sup>	Stomach samples	Number tagged
Walleye pollock	40,408	1,125	805	100
Pacific cod	8,004	649	586	198
Sablefish	3	--	--	--
Yellowfin sole	31,695	598	657	--
Rock sole	30,350	471 <sup>2/</sup>	209	--
Flathead sole/ Bering flounder	19,558	375	380	--
Pacific halibut	992	--	--	--
Alaska Plaice	8,036	348	116	--
Arrowtooth flounder/ Kamchatka flounder	8,480	263	201	--
Greenland turbot	414	105	152	--
Rex sole	394	--	--	--
Pacific ocean perch	27	--	--	--
Northern rockfish	121	--	--	--
Saffron cod	418	--	--	--
Arctic cod	199	--	--	--
Longhead dab	18	--	--	--
Misc. species	32	--	--	--
Total	119,146	4,034	3,106	298

<sup>1/</sup> Scale scrape samples, in addition to otoliths, were collected from Pacific cod. Only otoliths were taken from all other species.

<sup>2/</sup> Individual length-weight data were also recorded for rock sole.

Table 3.--Catch rates (kg/ha) by depth zone of commercially important fish and crab species taken in the standard area during the 1988 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	13.6	141.0	291.0	160.5
Yellowfin sole	85.2	22.8	<0.1	28.4
Rock sole	48.2	27.2	2.6	24.3
Pacific cod	10.4	16.7	27.0	18.5
Alaska plaice	12.9	13.5	2.2	10.0
Flathead sole	0.8	9.9	15.7	9.8
Arrowtooth flounder	0.1	5.9	11.7	6.5
Pacific halibut	2.2	1.5	2.7	2.0
Opilio Tanner crab	1.8	15.8	7.4	10.5
Red king crab	0.7	0.9	0.0	0.6
Bairdi Tanner crab	0.3	4.1	0.6	2.3
Blue king crab	<0.1	0.4	0.1	0.2
Total effort (hectares)	404.7	785.3	434.2	1624.2

Table 4.--Biological data collected by the Miller Freeman in the northern shelf and Norton Sound areas during the 1988 Bering Sea triennial crab-groundfish survey.

Species	Length measurements	Age structures <sup>1</sup>
Walleye pollock	1,882	263
Pacific cod	187	--
Yellowfin sole	8,419	--
Rock sole	498	--
Flathead sole/ Bering flounder	1,904	--
Pacific halibut	27	--
Alaska Plaice	2,943	184
Starry flounder	487	--
Greenland turbot	32	31
Arctic flounder	50	--
Longhead dab	436	--
Sakhalin sole	246	--
Saffron cod	1,894	--
Arctic cod	968	--
Total	19,973	478

<sup>1</sup>/ Otoliths were collected from all species.

Table 5.--Catch rates (kg/ha) of the most abundant fish and commercially important invertebrate species taken during the north shelf and Norton Sound portion of the 1988 eastern Bering Sea crab-groundfish survey.

Taxon	North Shelf	Norton Sound	Total area
Saffron cod	1.6	20.1	13.8
Yellowfin sole	15.9	2.7	7.2
Walleye pollock	9.4	1.5	4.2
Alaska plaice	9.2	1.4	4.0
Starry flounder	0.2	2.4	1.6
Pacific cod	3.6	0.5	1.6
Marbled eelpout	3.7	<0.1	1.3
Butterfly sculpin	2.6	0.0	0.9
Arctic cod	2.4	0.1	0.9
Bering flounder	2.0	<0.1	0.7
Tanner crab ( <i>Ch. opilio</i> )	26.5	0.5	9.3
Red king crab	<0.1	0.9	0.6
Blue king crab	0.0	<0.1	<0.1
Total effort (hectares)	208.2	406.9	615.2

Table 6.---Biological data collected by the Miller Freeman on the continental slope during the 1988 eastern Bering Sea triennial crab-groundfish survey.

Species	Length measurements	Age structures <sup>1/</sup>	Stomach samples
Walleye pollock	6,060	214	328
Pacific cod	267	--	107
Sablefish	1,321	--	--
Flathead sole/ Bering flounder	1,375	--	150
Pacific halibut	15	--	--
Arrowtooth flounder/ Kamchatka flounder	992	--	165
Greenland turbot	1,138	255	111
Arctic flounder	50	--	--
Rex sole	105	--	--
Pacific ocean perch	1,686	213	--
Rougheye rockfish	221	190	--
Shortraker rockfish	112	109	--
Shortspine thornyhead	1,156	281	--
Pacific grenadier	1,886	--	--
Giant grenadier	1,087	--	--
Red squid	675	--	--
Total	18,146	1,262	861

<sup>1/</sup> Otoliths were collected.

Table 7.---Catch rates (kg/ha) of the most abundant fish and commercially important invertebrate species taken during the continental slope portion of the 1988 eastern Bering Sea crab-groundfish survey.

Taxon	100-400 fm	400-600 fm	Total Area
Giant grenadier	21.6	56.7	39.1
Walleye pollock	68.4	0.1	34.3
Pacific grenadier	4.2	27.4	15.8
Greenland turbot	14.1	9.1	11.6
Sablefish	7.7	8.8	8.2
Pacific ocean perch	15.4	0.0	7.7
Arrowtooth flounder	12.8	0.6	6.7
Pacific cod	6.3	<0.1	3.2
Shortspine thornyhead	2.9	1.4	2.1
Flathead sole	3.8	0.0	1.9
Twoline eelpout	0.2	0.2	0.9
Golden king crab	<0.1	<0.1	<0.1
Tanner crab ( <i>C. bairdi</i> )	<0.1	<0.1	<0.1
Tanner crab ( <i>C. opilio</i> )	<0.1	<0.1	<0.1
Total effort (hectares)	361.5	54.4	415.8

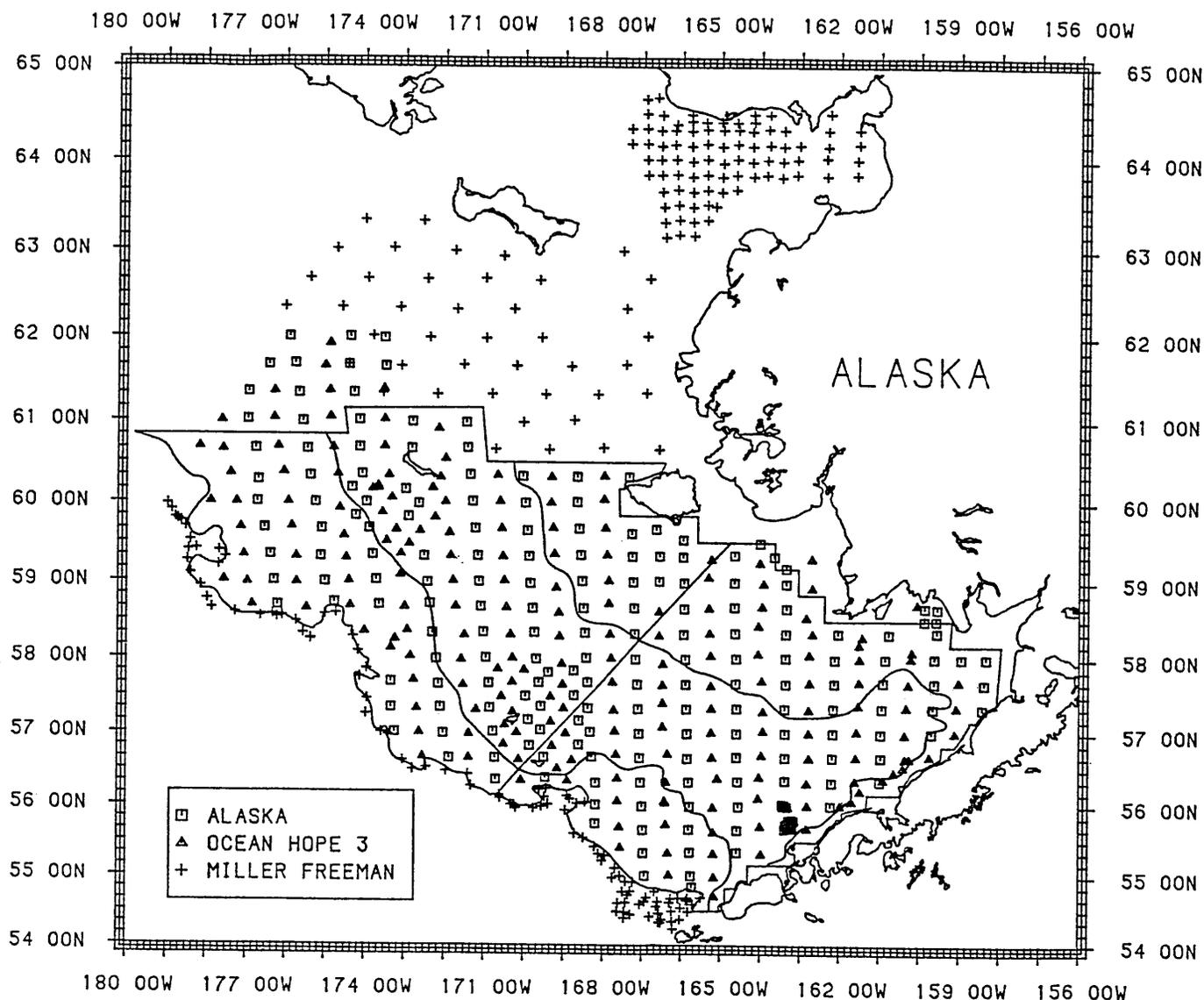
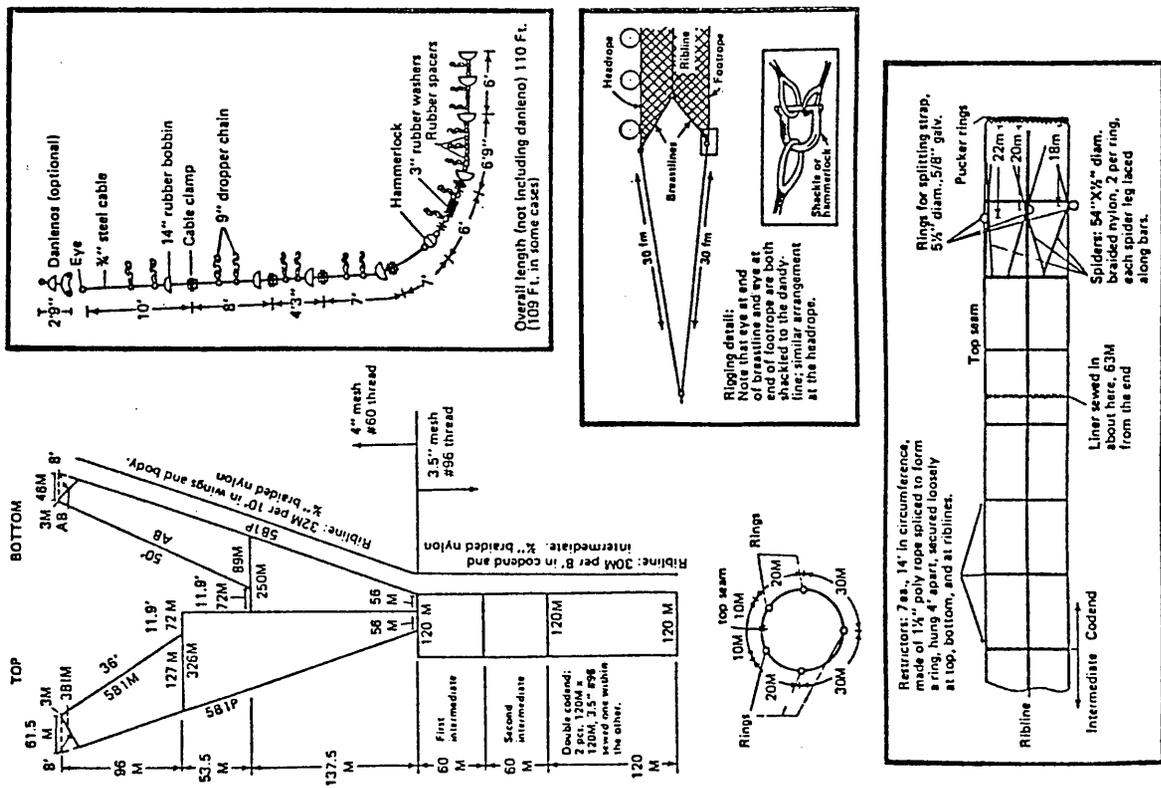


Figure 1.--Distribution of total sampling effort by the Alaska, Ocean Hope 3, and Miller Freeman during the 1988 eastern Bering Sea survey. The solid lines indicate the standard survey area boundary and subareas. The dense concentration of stations in the vicinity of  $163^{\circ}$  W and  $55^{\circ} 30'$  N shows the locations of side-by-side trawling between the Alaska and Ocean Hope 3 to compare past and present standard survey trawls.



- Netting - nylon, preshrunk and dyed green
- Headrope - 83.9 ft., 1/2" diam. 6 x 19 galv. wire rope, wrapped with 5/16 inch polypropylene rope.
- Footrope 111.9 ft., 5/8" diam. 6 x 19 galv. wire rope wrapped with 5/16 inch polypropylene rope, the whole wrapped with split pieces of heavy rubber hose; 172 ft of 5/16" galv. chain hung to footrope, every tenth link seized to the footrope at eight-inch intervals, the lower edges of the wings and throat hung to the loops of chain thus formed.
- Breastlines - 8' upper and 8' lower sections, joined with a "hammer-lock," made of 1/2" diam. galv. wire rope, wrapped with 1/4" poly rope. Breastline lengths may vary slightly.
- Riblines - 3/4" diam. braided nylon or equivalent extending the length of the first intermediate or beyond on some trawls.
- Flotation - 17 8" aluminum floats along each wing and 7 8" floats in the bosom. Total = 41 floats, all floats spaced 24-1/4" apart.

- Codend liner - 1-1/4" mesh, No. 18 nylon, 360 meshes around, 200 meshes deep, laced to inner bag 63 meshes from the end, three liner meshes to each bag mesh. Actual mesh counts of liners encountered in the field may vary, but when the bag is empty and the codend untied and the bag and liner are stretched out, the liner should protrude some 2-3 feet beyond the end of the codend.
- Chafing gear - varies, may be 3/8" diam. poly rope, hog-ringed to form 9 1/2" meshes, each piece 46 meshes deep x 55 meshes around. Alternatively may be 1/2" diam. poly rope, interwoven into 9" meshes, 18 meshes deep x 36 meshes around. In either case, chafing gear should be laced to the bag with 2 ft. of bag protruding.

- Sideseams - upper and lower wing panels and body panels laced together gathering 2 meshes (3 knots) from each panel. These plans allow for this, giving mesh counts for each panel as it should be cut out; mesh counts on panels in finished trawls will be reduced accordingly.
- Rigging - Dandyline: 30 fathoms double, all wires 5/8" galv. Trawls used in the Bering Sea surveys should have a 24" chain extension inserted between the lower dandyline and the footrope on each side.

Doors 6 ft. x 9 ft. V-doors, 2000 pounds.

Figure 2.--Description of the 83-112 Eastern bottom trawl used during the 1988 eastern Bering Sea crab-groundfish survey. Roller gear shown was not used during this survey.



- Headrope - 71 feet plus thimble eyes, of 3/8" 6 x 19 galvanized wire rope wrapped (full wrap) with 3/8" polypropylene rope.
- Footrope - 94 feet plus thimble eyes of 1/2" 6 x 19 galvanized wire rope wrapped with 9/16" polypropylene rope.
- Breast lines - 6 feet of 1/4" galv. proof coil chain.
- Riblines - 6 each, of 1/2" nylon; one each center top and bottom from headrope and footrope through entire net including codend. Four, one from each junction of wing and body extending to approximately the intermediate.
- Seams - Side seams shall consist of lacing 3 knots (2 meshes) from each panel with No. 36 nylon twine. Tie each full mesh.
- Hanging - Headrope: Wings - 2 meshes to 6" Bosom - 4 meshes to 5 1/4"
- Footrope: Wings - 4 bars to 7 9/16 inches Lower bosom - 4 meshes to 7 inch
- Footrope weight - 112.5 feet of 1/4" galv. proof coil chain. 9 inches chain per 7 1/2" hanging.
- Puckering rings - 5/16" by 2 1/4" galv. steel (approx. 33 pieces), 5 secured with No. 48 braided polypropylene.
- Splitting rings - 1/2" by 4" galv. steel (5 pieces)
- Liner in intermediate and bag sections - 1 1/4" mesh, No. 18 nylon; 280-340 meshes around, 200-240 meshes deep secured 15 meshes up from bottom of intermediate (leave about 2 feet of liner extending from end of bag).
- Chafing gear - Standard commercial construction (approx. 4 inch mesh 1/4-inch polypropylene). 110 meshes around, 55 meshes deep, secured at junction of intermediate and codend.
- Webbing Nylon, preshrunk, dyed green, with full mesh selvage.
- Floats 15, 8 inch Deep Sea Floats, evenly spaced (5.5 lbs buoyancy each)
- Dandylines - 1. Normal - 20 fathoms double 2. Bering Sea groundfish/crab - 15 fm single, 10 fm double.

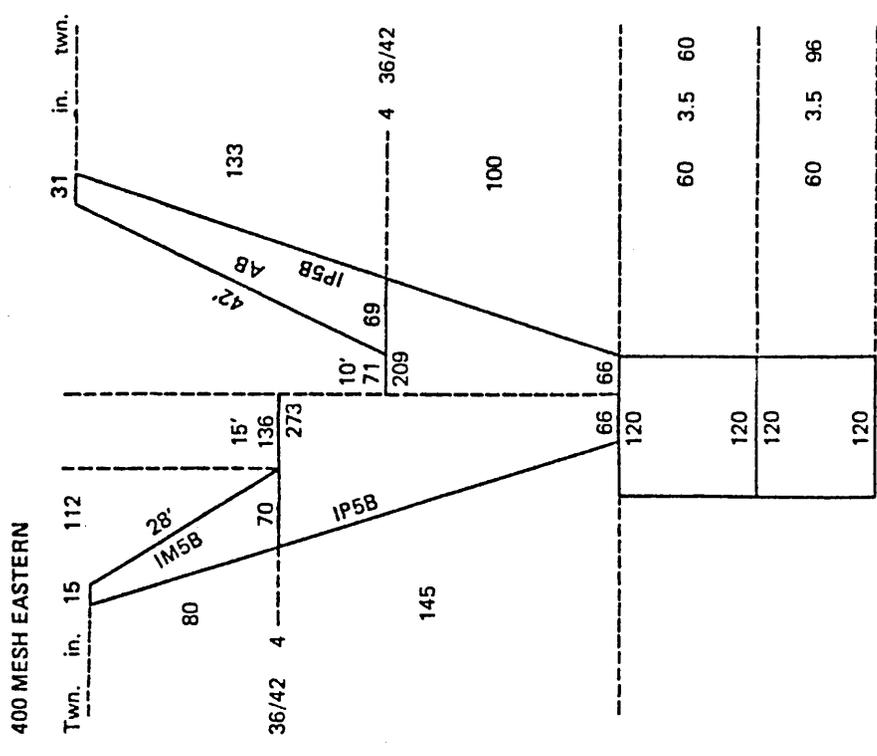


Figure 4. --Description of the 400-mesh Eastern bottom trawl used during the 1988 eastern Bering Sea crab-groundfish survey.

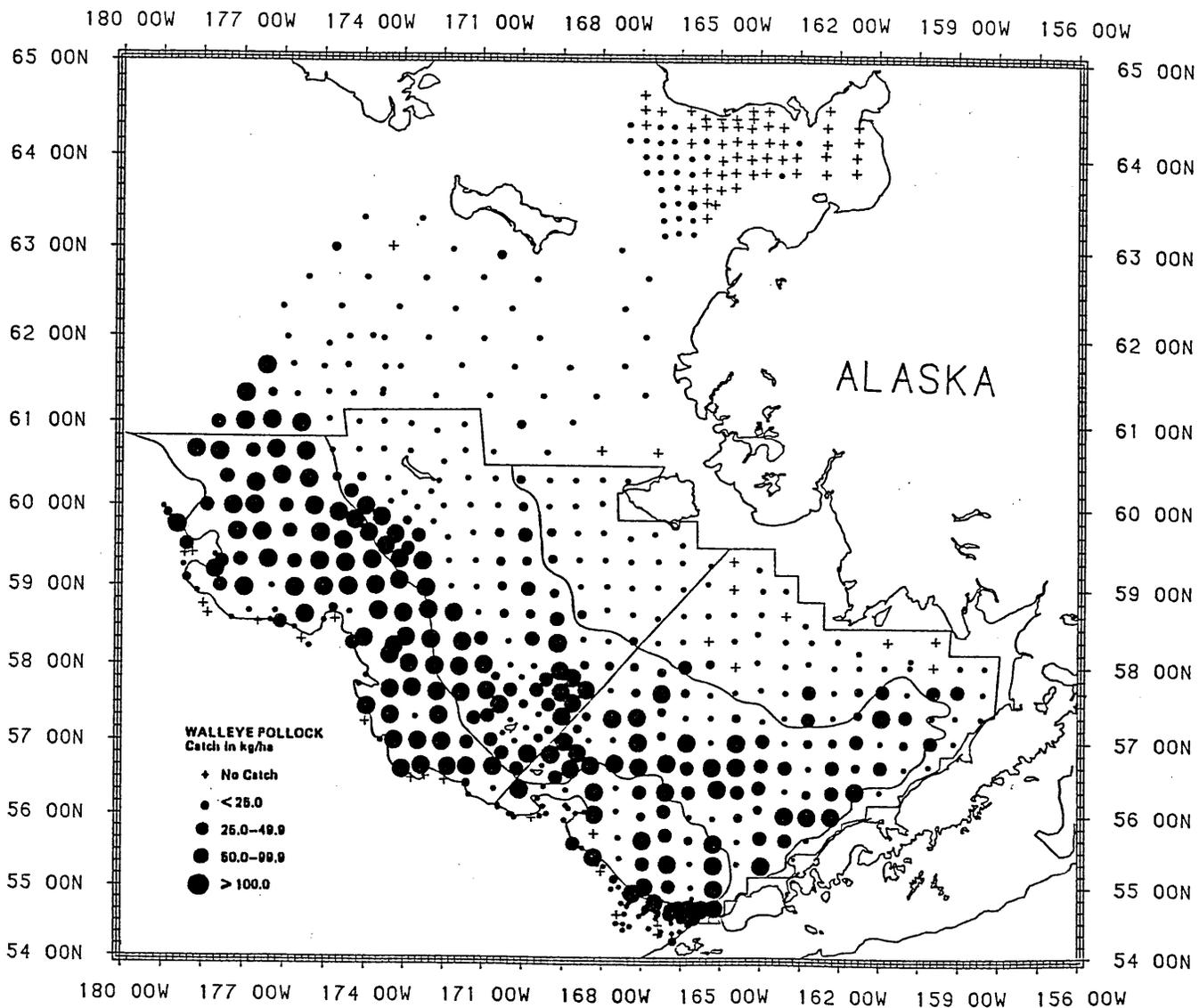


Figure 5.--Distribution of catch rates of walleye pollock during the 1988 eastern Bering Sea crab-groundfish survey.

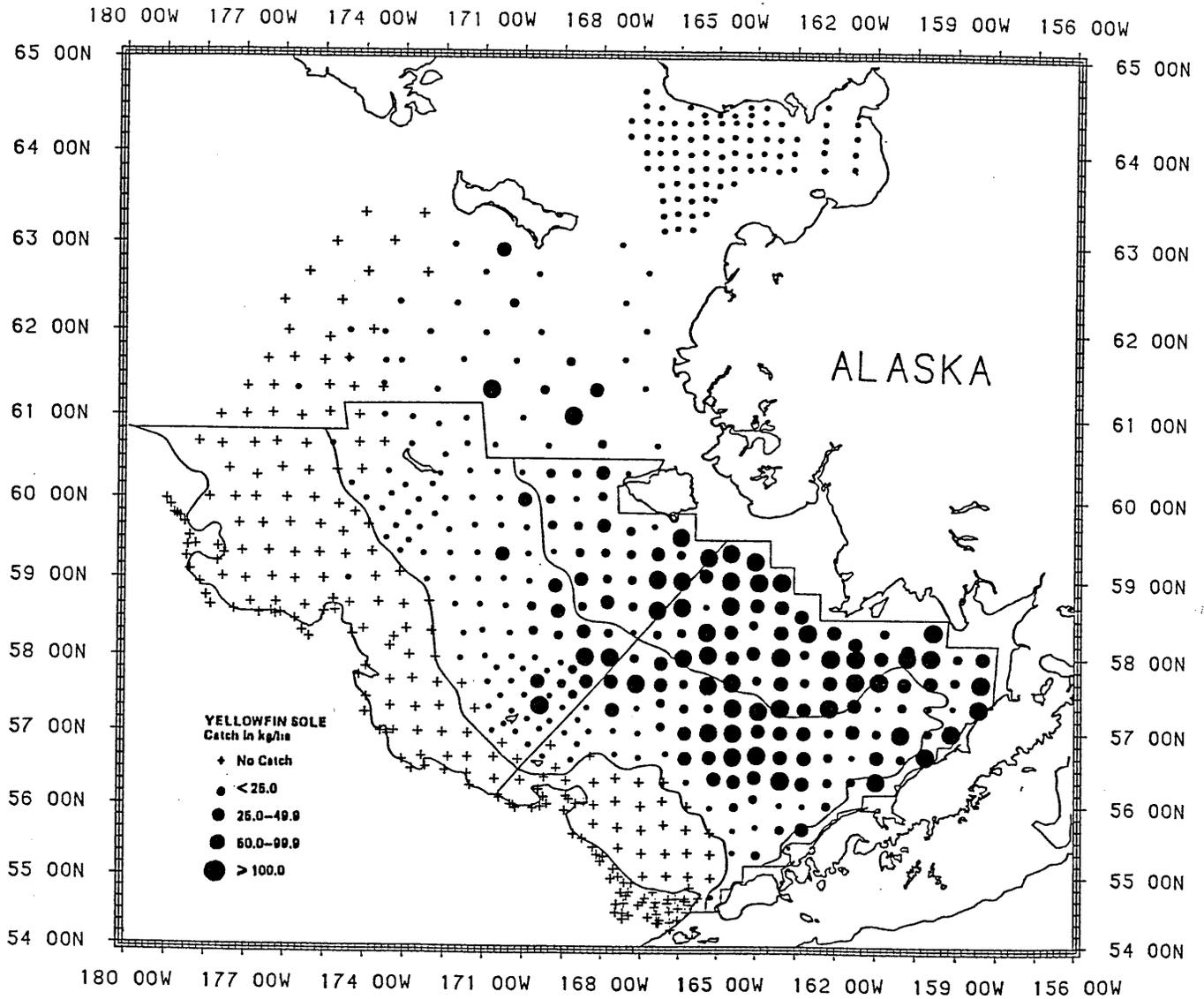


Figure 6.--Distribution of catch rates of yellowfin sole during the 1988 eastern Bering Sea crab-groundfish survey.

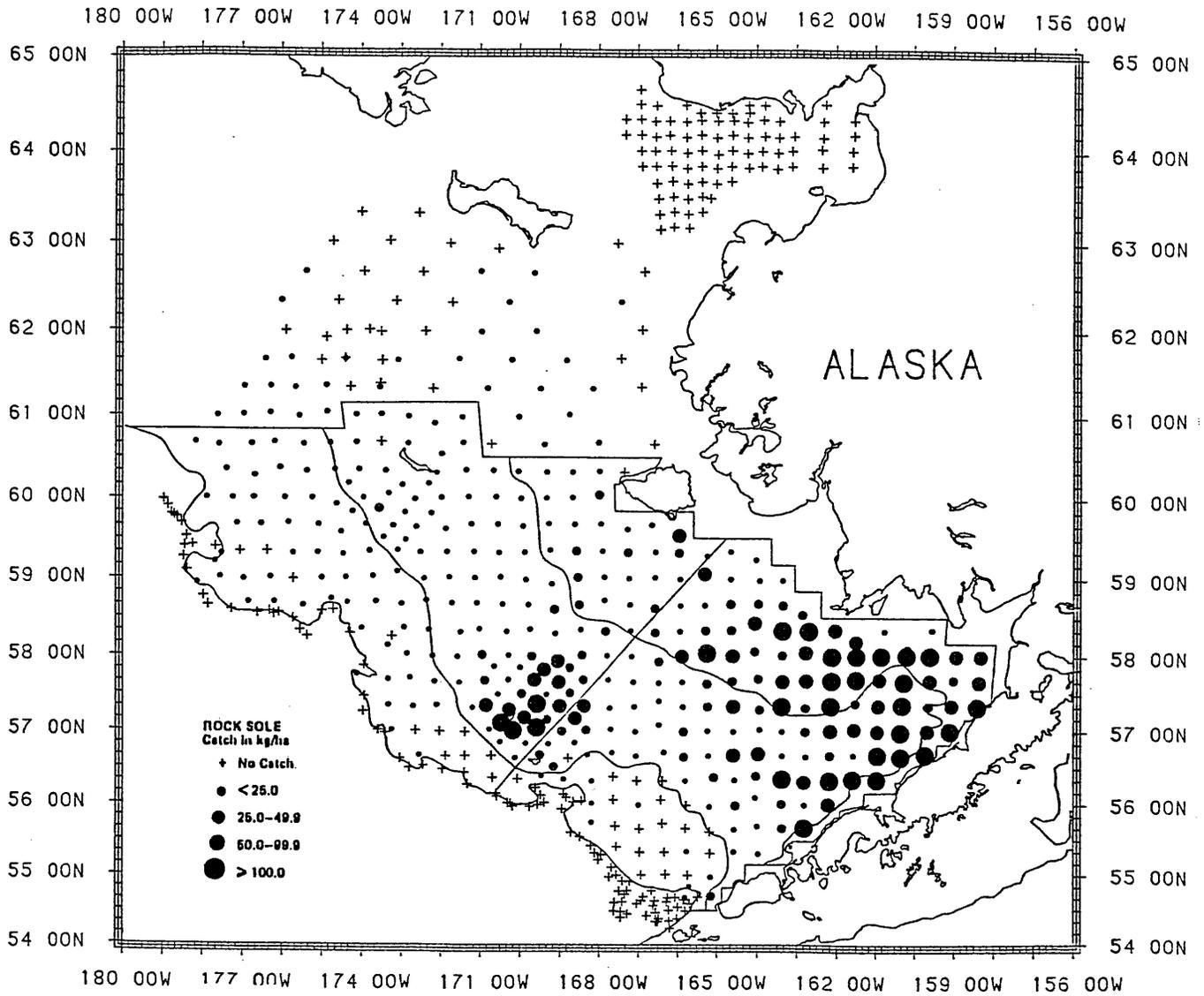


Figure 7.--Distribution of catch rates of rock sole during the 1988 eastern Bering Sea crab-groundfish survey.

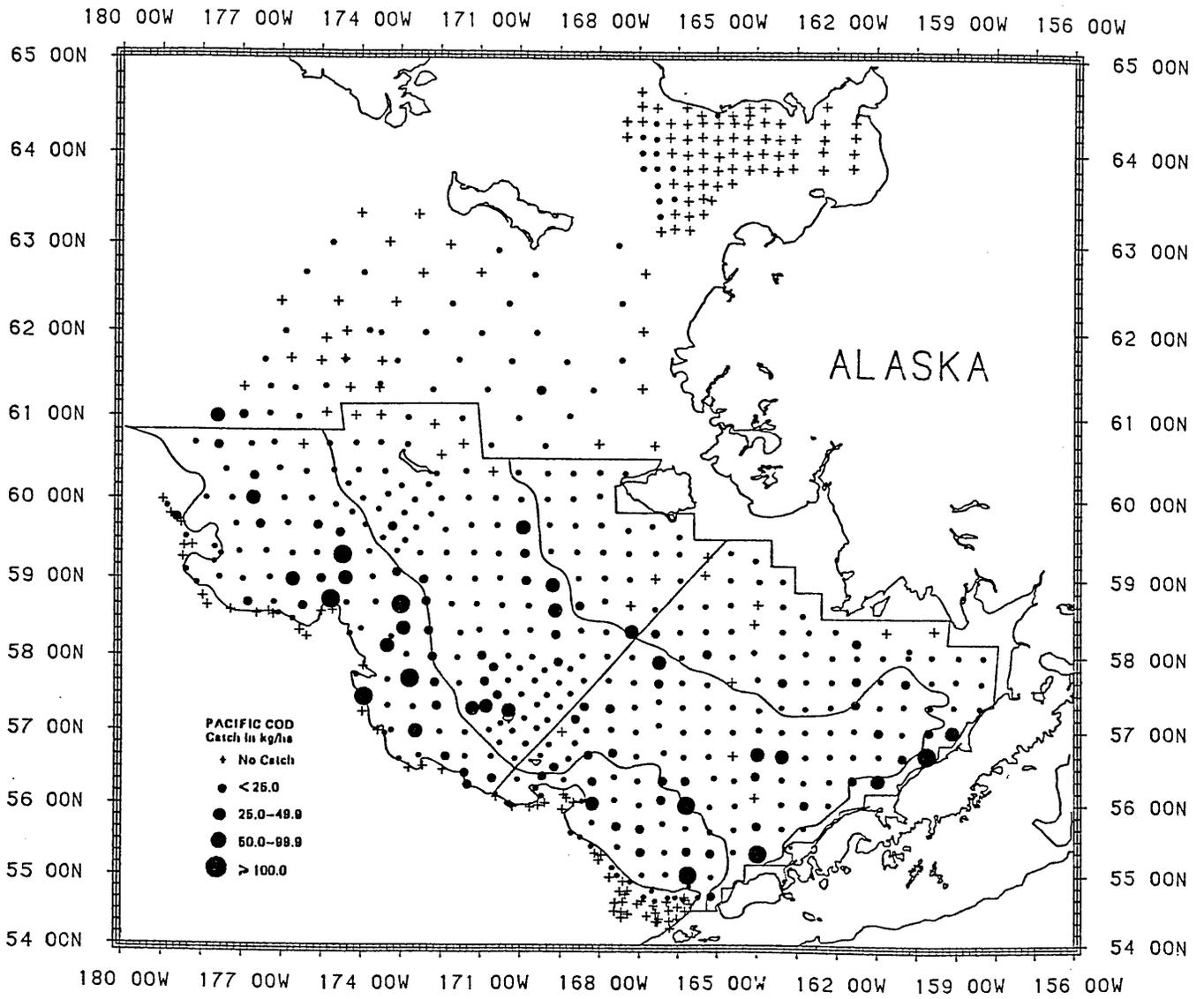


Figure 8.--Distribution of catch rates of Pacific cod during the 1988 eastern Bering Sea crab-groundfish survey.