

2010

# Northern Bering Sea Groundfish and Crab Trawl Survey Highlights



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Alaska Fisheries Science Center

1/1/2010

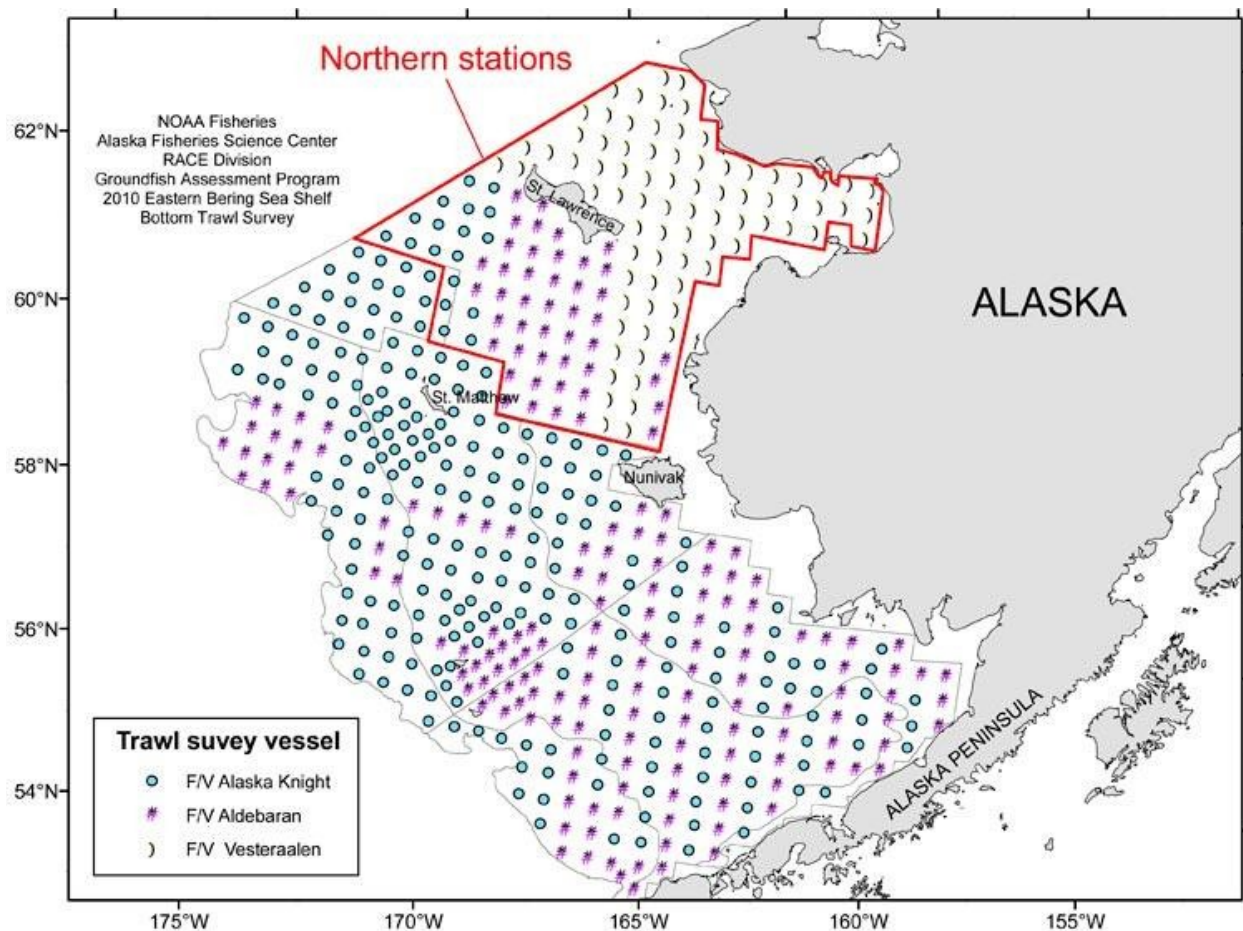
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## Synopsis

The 2010 northern Bering Sea (NBS) bottom trawl survey occurred as an extension of the annual eastern Bering Sea (EBS) shelf bottom trawl survey. The EBS shelf survey has been conducted annually during summer months since 1982. The 29th annual EBS shelf survey was conducted between June 2 and August 4, 2010 aboard three chartered-fishing vessels *F/V Alaska Knight*, *F/V Aldebaran*, and the *F/V Vesteraalen*. The northern Bering Sea survey took place using the same three vessels from July 23 to August 15, 2010.

The standard EBS shelf survey coverage area was expanded in 2010 to include the continental shelf of the NBS, which is bounded by the U.S.-Russian Maritime Boundary in the west, the Bering Strait in the north, Norton Sound in the east, and the historical boundary of the EBS shelf survey in the south.

These surveys assess marine fishes, invertebrates and other environmental variables of the surveyed region. Total bottom-dwelling animal biomass of the EBS shelf and NBS shelf was estimated at 15.6 million metric tons, of which 3.0 million metric tons was found in the northern survey area.



The original motivation behind the NBS survey was in response to concerns over diminishing seasonal sea ice observed during a warming period that lasted from 2001 to 2005. Climate

change is a concern for the entire Bering Sea because of its potential to fundamentally alter the biological community – fishes, crabs and marine mammals. This complex arctic ecosystem has provided food security for Alaska natives for millennia. In addition, the southeastern Bering Sea has provided resources for community development quota (CDQ), and commercial and recreational fisheries.

The Alaska Fisheries Science Center developed and published a Loss of Sea Ice Research Plan in 2007 to address concerns over diminishing sea ice. A primary objective of the research plan was to conduct a series of bottom trawl surveys in the NBS to collect baseline data and monitor the distribution, abundance, and general ecology of marine animals living on or near the seafloor. The research plan also contained surveys to collect data on midwater fish and invertebrate assemblages, oceanographic processes, and on distribution and abundance of ice-associated seals.

This addition of the NBS survey represents the greatest coverage of the Bering Sea shelf, since the official start of the time series. In 2010, researchers were able to apply consistent survey methods (i.e., an evenly spaced sampling design, standardized sampling gear, etc.) over the entire Bering Sea shelf region within the U.S. border. Having standardized data from the expanded survey area enabled scientists to generate a broader snapshot of the Bering Sea shelf for the first time. Repeating the same expanded survey over a period of many years will provide information for monitoring and investigating trends in bottom-dwelling animal populations and how they respond to changing environmental conditions and diminishing seasonal sea ice.

## Survey Design

Survey research trawl sampling of the NBS shelf was conducted in late July and early August. The F/V *Vesteraalen* conducted sampling in the NBS from 23 July to 15 August, the F/V *Aldebaran* from 30 July to 8 August, and the F/V *Alaska Knight* from 4 August to 8 August<sup>1</sup>. The NBS survey is based on a systematic 20 × 20 nautical mile (nm) grid using standardized techniques established during the annual EBS shelf survey, conducted since 1982. Sampling stations were spaced 20 nm apart along latitudinal and longitudinal axes. Scientists from the Alaska Fisheries Science Center, the Alaska Department of Fish and Game, the International Pacific Halibut Commission, Norton Sound Economic Development Corporation and Kawerak Inc. participated in the survey sampling 142 stations in the NBS. NBS stations were sampled after survey vessels finished their assigned EBS survey stations, which consists of 376 stations. All stations were sampled during daylight hours. The addition of the NBS survey expanded the overall area coverage from 144,493 square nautical miles (nmi<sup>2</sup>) to 200,088 nmi<sup>2</sup>, with depths ranging from 11 to 200 m.

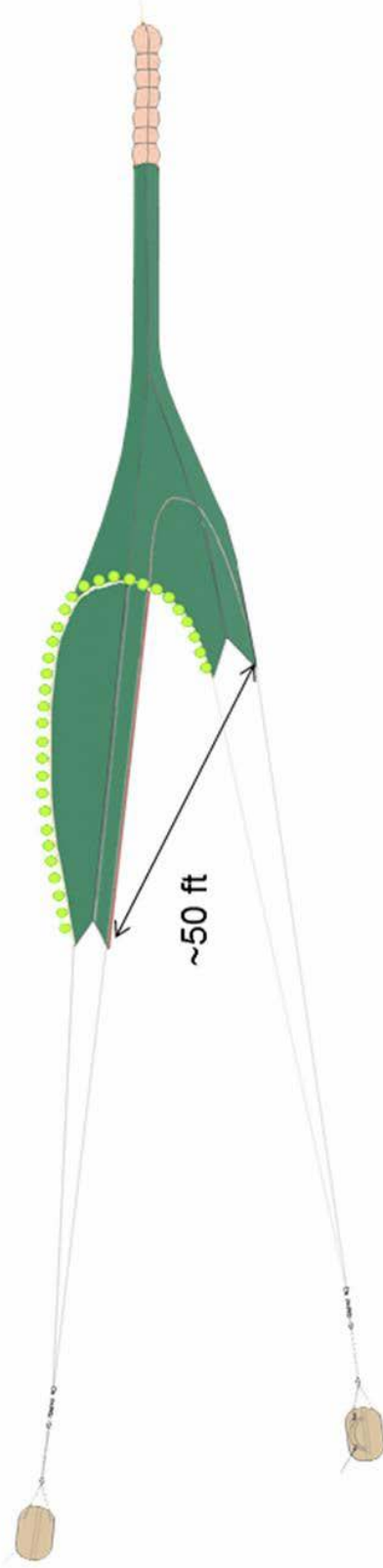
Sampling was conducted using a research bottom trawl, called an 83/112 Eastern otter trawl (see diagram on next page), which is smaller and lighter weight than commercial trawls used for fishing in Alaska. One 30-minute tow at a vessel speed of 3 knots was conducted at each of the 142 stations, cumulatively covering a total area of about 1.75 nmi<sup>2</sup> or only 0.003 % of the total area of the NBS. Samples of fish and crab were retained to gather information that included their size, weight, sex, age, reproductive state, health, and stomach content/diet information.

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<sup>1</sup>See photos of vessels on page 4

# Bering Sea Shelf Research Bottom Trawl

83-112 Eastern



## Characteristics

- Similar size and type used for Norton Sound red king crab survey
- Designed for being towed on smooth bottom
- Light footrope and bare wires with no ground gear - skims across bottom
- 6' X 9' doors for spreading trawl
- 0.75" braided nylon with 4" mesh body, 3.5" intermediate and 1.25" codend liner
- 83 ft headrope and 112 ft footrope
- Towed 30 minutes at 3 knots
- Area swept = net width (~50') X distance fished (~1.5 nm)

## Survey Data Collections

Data collections from the combined EBS and NBS shelf trawl survey included 188,698 individual length measurements representing 49 fish taxa; 10,132 age structures (otoliths) representing 17 fish taxa; 5,843 stomach samples representing 56 fish taxa; and 2,132 pathobiology (disease) samples from 42 different fish and invertebrate taxa.

NBS survey catch samples were smaller compared those from the EBS, but distributions of some predominant species such as Alaska plaice (*Pleuronectes quadrituberculatus*), Bering flounder (*Hippoglossoides robustus*), yellowfin sole (*Limanda aspera*), and snow crab (*Chionoecetes opilio*) extended throughout much of the NBS shelf. Several key forage fish species were also found in the northern portion of the shelf, including saffron cod (*Eleginus gracilis*) and Arctic cod (*Boreogadus saida*). Water column profiles of temperature and salinity at each trawl location were measured using a trawl-mounted Conductivity, Temperature, and Depth profiler (CTD).



## Meet the Scientists who conducted the survey

### Bob Lauth, Research Survey Chief Scientist



Bob is a Supervisory Research Fisheries Biologist with NOAA Fisheries Alaska Fisheries Science Center in Seattle, Washington. Bob has been with the Center for 26 years and leads a team of scientists that coordinate standardized bottom trawl surveys in the Bering Sea and Alaska Arctic regions. Bob's team conducts annual surveys of the eastern Bering Sea shelf (10 – 200 m) and biennial surveys of the Bering Sea upper continental slope (200 -1,200 m). He is also responsible for managing the time-series of legacy survey data from the Bering Sea and providing results from survey analyses to all interested individuals or groups. Survey results are essential for monitoring the marine ecosystem as well as for assessing trends in populations of marine bottom fishes, crabs and other marine life.

### Lyle Britt, Survey Coordinator

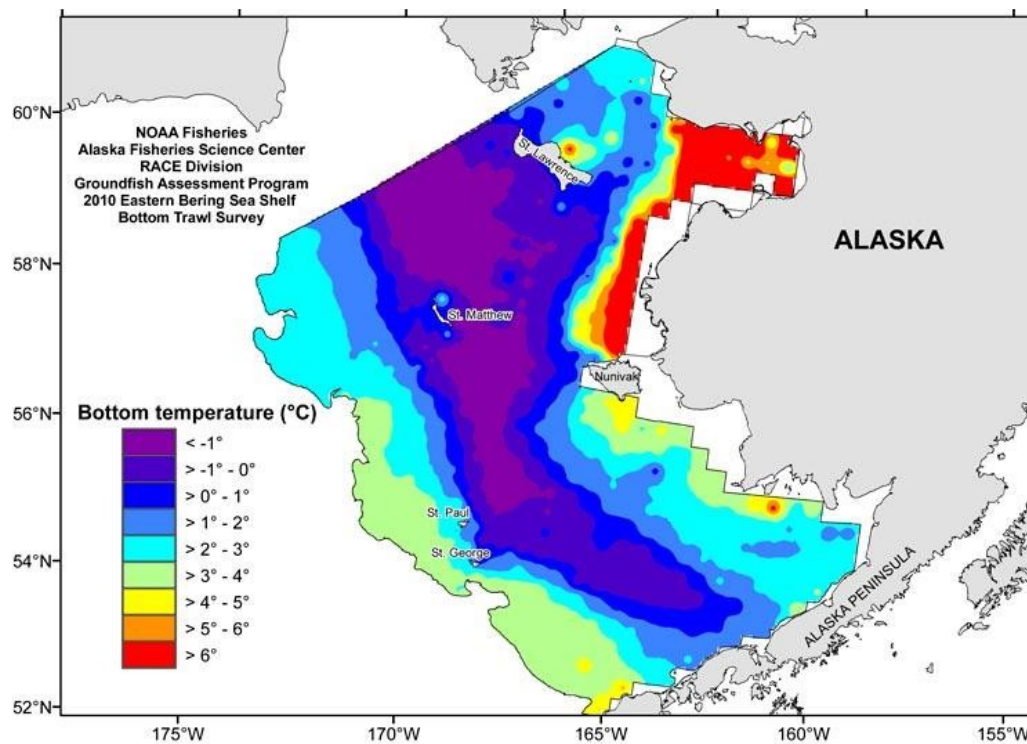


Lyle is a Research Fisheries Biologist with the NOAA Fisheries Alaska Fisheries Science Center in Seattle, Washington. Lyle has been with the Center for 20 years where he is a survey coordinator for the eastern Bering Sea shelf and northern Bering Sea bottom trawl surveys. As the survey coordinator, he is responsible for staffing and logistics for the surveys and serves as a chief scientist on one of the vessels during survey operations. He also serves as the special projects and collections manager for these surveys, where he works with other NOAA scientists and outside researchers on the scope and design of their scientific requests to maximize the utility and scientific impact of the bottom trawl surveys. In addition to his survey responsibilities, Lyle is also a leading researcher in the study of light and optics in the ocean and its role in determining the visual capability and behavior of marine organisms

## 2010 Survey Results

### Bottom Temperatures

Bottom temperatures measured during the survey ranged from -1.6° to 12.3°C. Mean bottom temperatures in the EBS shelf were slightly warmer (1.33°C) than in 2009 (1.21°C). However, the cold trend that began in 2006 continued in 2010. The cold pool (defined by bottom temperatures <2°C) extended southward into the middle shelf and east into Bristol Bay. In the northern shelf area, the cold pool covered most of the area between St. Matthew Island and St. Lawrence Island. However, nearshore waters north of Nunivak Island and all of Norton Sound were relatively warm with bottom temperatures exceeding 6°C.

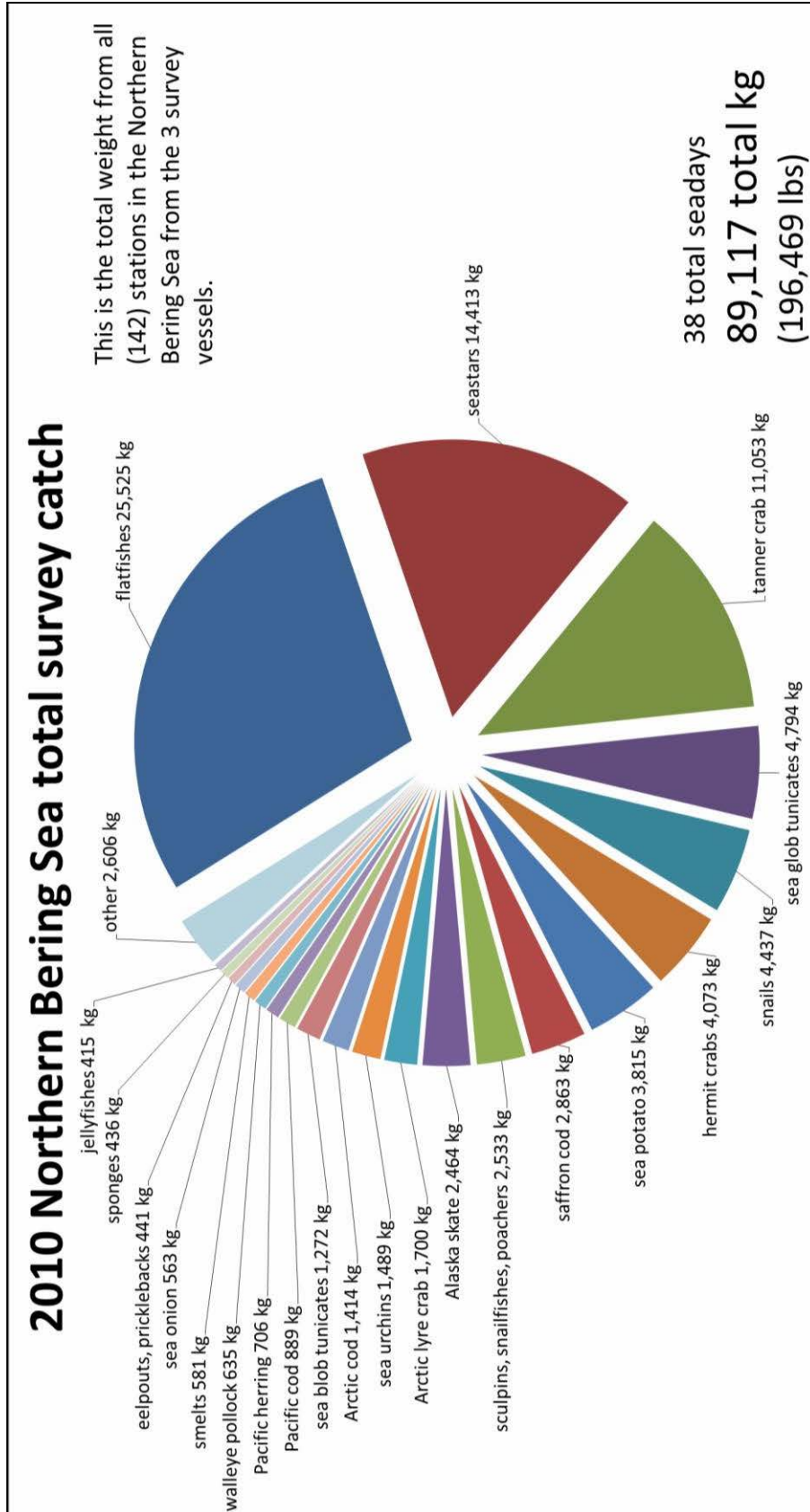


### Fish and Invertebrate Abundance in the Northern Bering Sea

Invertebrates (i.e., crabs, shrimps, sea squirts, sea stars and urchins) made up the majority of the biomass (59%). In general, fish biomass decreased with increasing latitude and flatfishes (i.e., yellowfin sole and other flounders) comprised most (67%) of the fish catch. There were a total of nine flatfish species, with yellowfin sole (36%) and Alaska plaice (25%) making up a majority of the total fish biomass. Arctic flounder (*Liopsetta glacialis*) was only present in the northernmost portion of the survey area. Walleye pollock (*Gadus chalcogrammus*<sup>2</sup>) and Pacific cod (*Gadus macrocephalus*) together comprised just 5 percent of the total fish biomass in the NBS while two other cod taxa, Arctic cod and saffron cod, were among the 12 most abundant fish species. Echinoderms (seastars, urchins, basket stars, and sea cucumbers) and Crustaceans (crabs and shrimps) were the major invertebrate taxa comprising 62 percent of the total animal biomass.

<sup>2</sup> Previously *Theragra chalcogramma*

Species composition



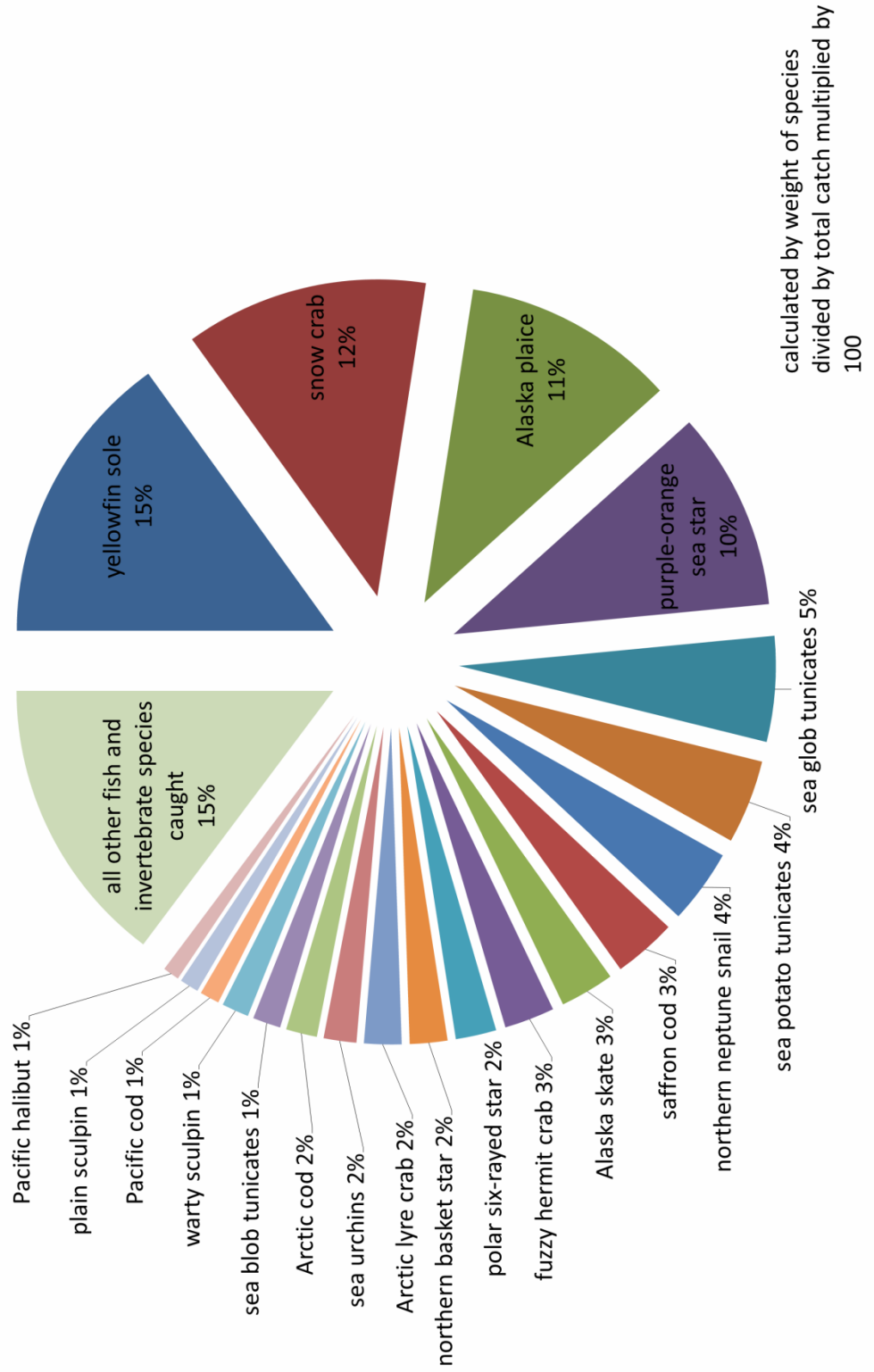


**Total catch weight for taxa in the “OTHER” category from the 2010 northern Bering Sea shelf bottom trawl survey**

<b>Species</b>	<b>Total weight (kg)</b>
soft corals	361
sea anemones	280
sea peach	275
paddle ascidian	263
brown-scaled sea cucumber	195
snail eggs	182
miscellaneous*	178
barnacles	152
king crabs	134
tunicates	112
hydroids	92
shrimps	91
helmet crab	84
bryozoans	63
clams and scallops	61
globular tunicates	29
chum salmon	19
chitons	11
horsehair crab	11
coho salmon	2
skate egg case	<1

\*The miscellaneous category contains all the invertebrate taxa that were under 9 kg and the unsorted debris category which contained 13.6 kg.

### 2010 Northern Bering Sea Survey Catch Top 20 Fish and Invertebrate Species



**Rank of fish and invertebrate taxa by weighted total catch per unit effort in kilograms per hectare (CPUE (kg/ha)) from the 2010 northern Bering Sea shelf bottom trawl survey**

<b>Rank</b>	<b>Species</b>	<b>CPUE (kg/ha)</b>	<b>Proportion</b>
1	yellowfin sole	21.36	14.55%
2	snow crab	15.9	10.83%
3	Alaska plaice	15.14	10.32%
4	purple-orange sea star	15.06	10.26%
5	sea glob tunicates	7.83	5.33%
6	sea potato	6.29	4.29%
7	northern neptune snail	5.74	3.91%
8	saffron cod	4.54	3.09%
9	Alaska skate	3.84	2.62%
10	fuzzy hermit crab	3.78	2.58%
11	polar six-rayed star	2.98	2.03%
12	Arctic lyre crab	2.98	2.03%
13	basket stars	2.89	1.97%
14	sea urchins	2.56	1.74%
15	sea blob tunicates	2.13	1.45%
16	warty sculpin	1.99	1.35%
17	Arctic cod	1.89	1.29%
18	sponge hermit	1.66	1.13%
19	Pacific cod	1.45	0.99%
20	plain sculpin	1.41	0.96%

**Appendix:**  
**A Closer Look at some of the Animals Caught  
During the 2010 Survey**

Note: The maps below include density estimates from the combined 2010 NBS and the EBS survey. The boundary between the surveys is represented on the maps.

## Yellowfin Sole



**Central Yup'ik**

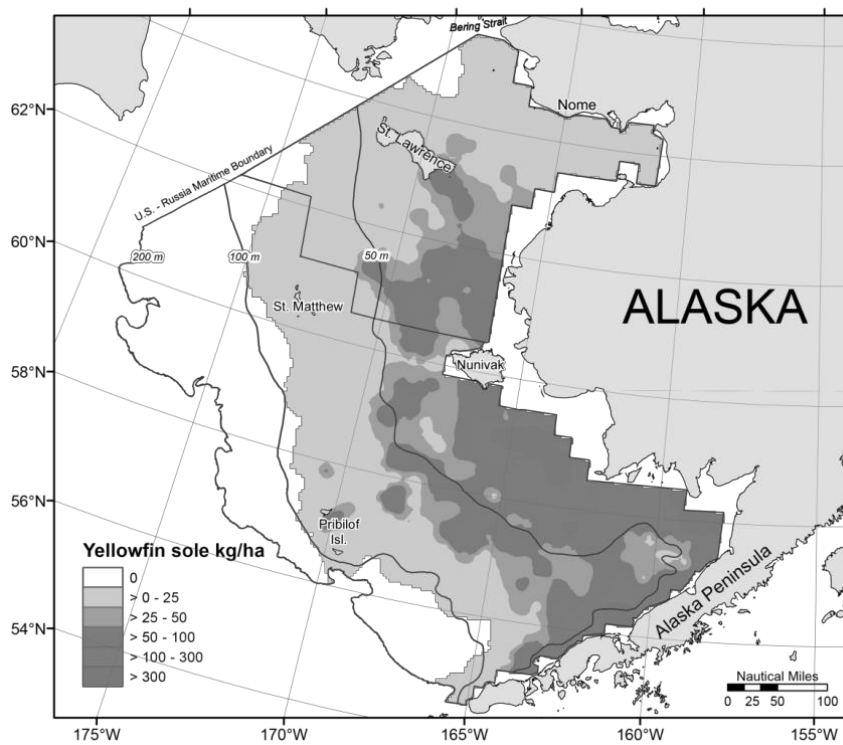
**Cup'ig**

**St. Lawrence Island Yupik**

**Inupiaq**

**Latin**

*Limanda aspera*



Yellowfin sole was the predominate species caught in the 2010 NBS survey comprising 15% (13,417 kg) of the total biomass. Sexually mature yellowfin sole adults undergo an annual spawning migration to nearshore waters during the spring and summer. Younger and sexually immature individuals, undergo an ontogenetic (age-based) migration rather than a spawning migration by moving deeper as they get older. Length or age at sexual maturity differs for males and females causing further size segregation among spawning and non-spawning portions of the population.

## Snow Crab



**Central Yup'ik**

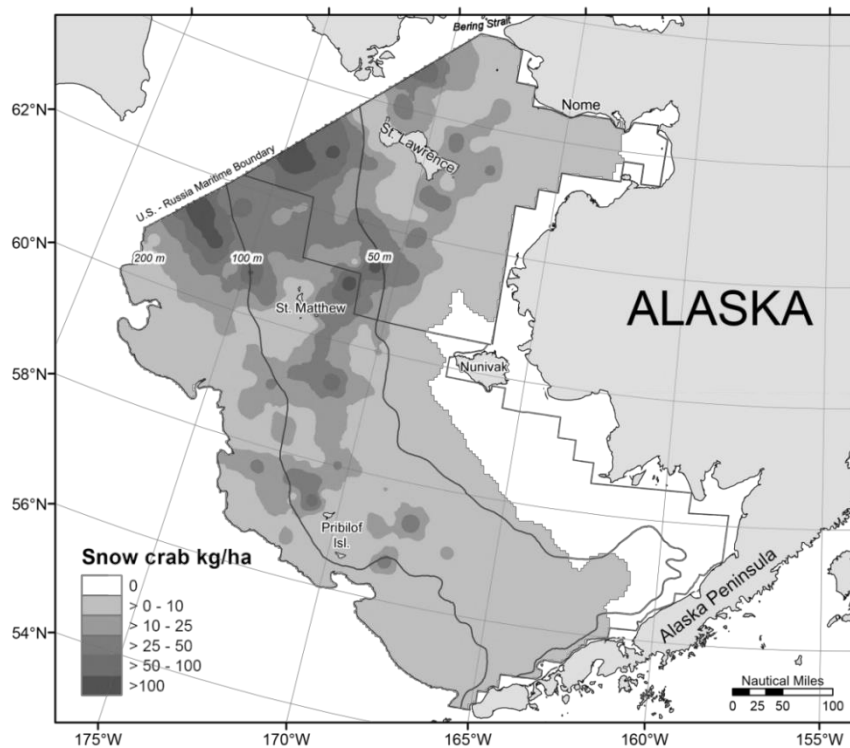
**Cup'ig**

**St. Lawrence Island Yupik**

**Inupiaq**

**Latin**

*Chionoecetes opilio*



Snow crab comprised 12% (11,053kg) of the research catch in the NBS survey area. This species was caught at 118 of the 142 total NBS survey stations. A majority of both the male and female snow crab in the NBS were sexually immature. Less than 0.01% (less than 1.1kg) of all male snow crab caught in the NBS were  $\geq 70$  mm carapace width.

## Alaska Plaice



Central Yup'ik

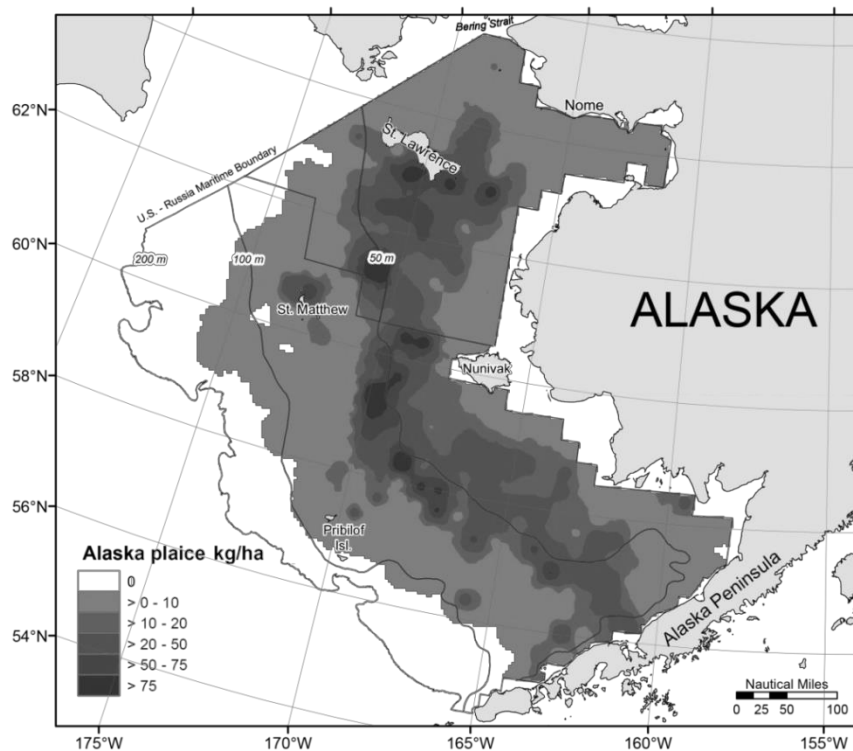
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Pleuronectes  
quadrituberculatus*



Alaska Plaice comprised 11% (9,698 kg) of the total NBS survey catch. Their distribution was highest along the 50 m contour between the inner and middle shelf inside the cold pool. Alaska plaice have a type of antifreeze in their blood that allows them to inhabit shelf areas where bottom temperatures are below freezing.

## Purple-orange seastar



Central Yup'ik

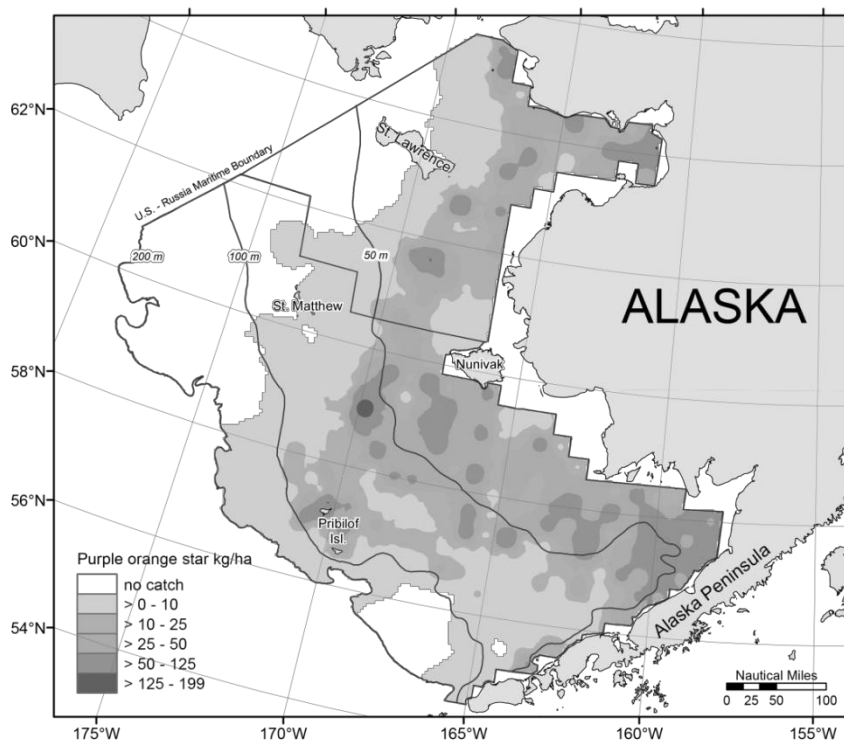
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Asterias amurensis*



The purple-orange sea star is also known as the Northern Pacific sea star. This species of seastar made up 10% (9,036 kg) of the total fish and invertebrate catch in the NBS.

Catch rates for the purple sea star were highest in the survey area along and inside the 50 m contour of the inner shelf from the Alaska Peninsula to Port Clarence.



## Northern neptune snail



Central Yup'ik

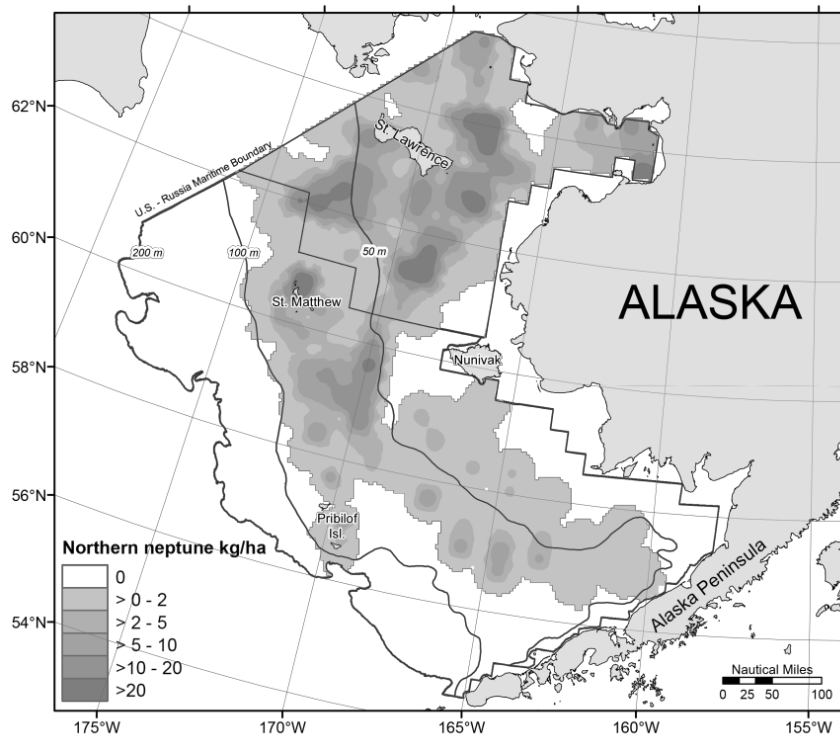
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Neptunea heros*



The northern neptune snails were caught in waters between 11 and 94 meters deep along the Bering Sea shelf. Highest concentrations were found around St. Lawrence Island.

## Saffron Cod



Central Yup'ik

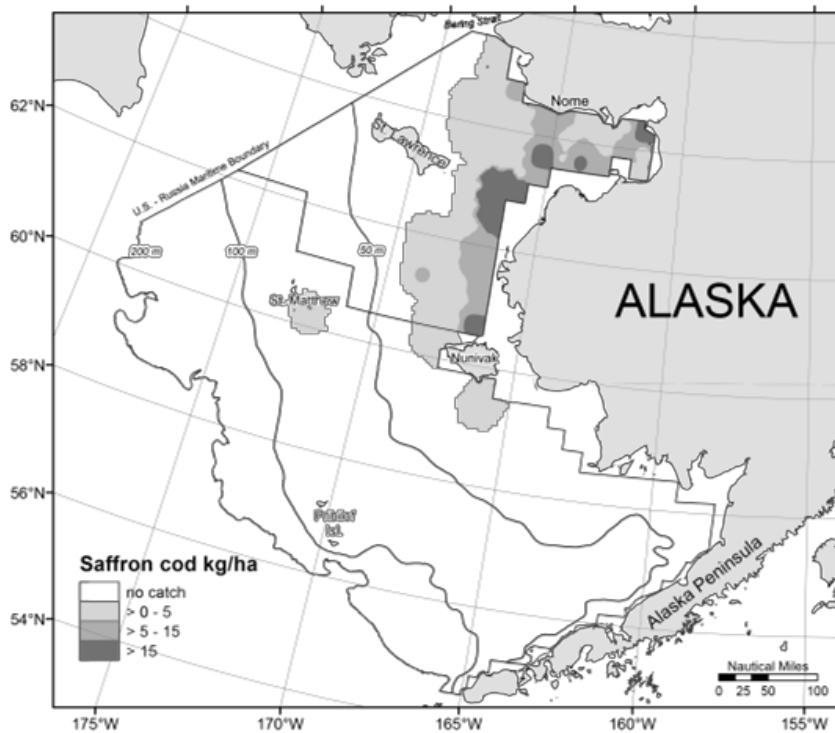
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Eleginus gracilis*



Saffron cod represented about 3% of the total catch in the NBS by weight. Saffron cod were most dense just north of Nunivak island, southeast of St. Lawrence Island and up into Norton Sound in waters between 11 and 58 meters deep.

## Arctic Cod



Central Yup'ik

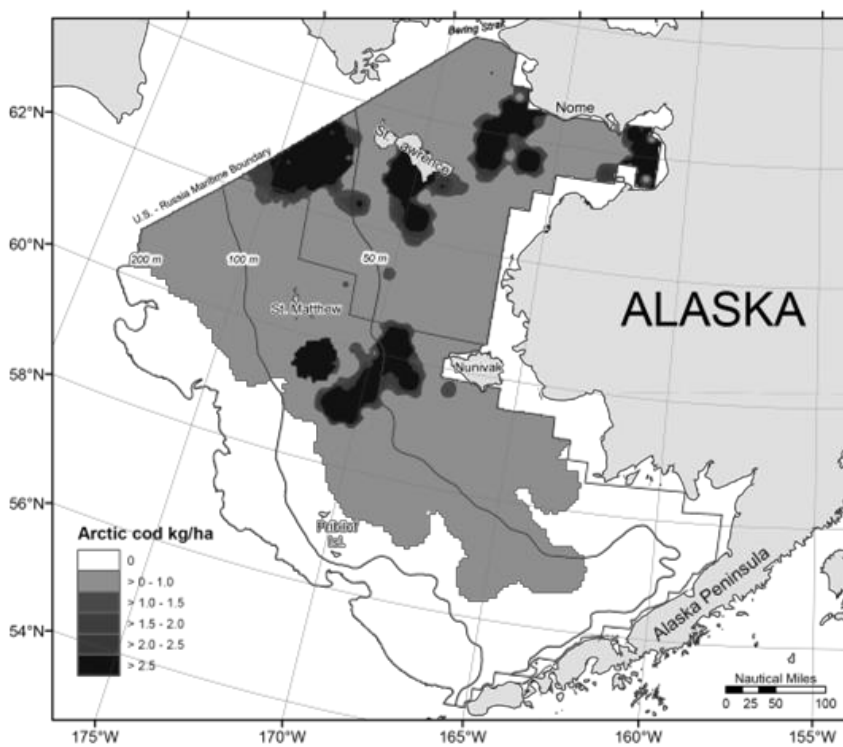
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Boreogadus saida*



Arctic cod represented about 2% of the total catch in the NBS by weight. Arctic cod were broadly distributed across the shelf in waters between 14 and 147 meters deep.

## Pacific Cod



**Central Yup'ik**

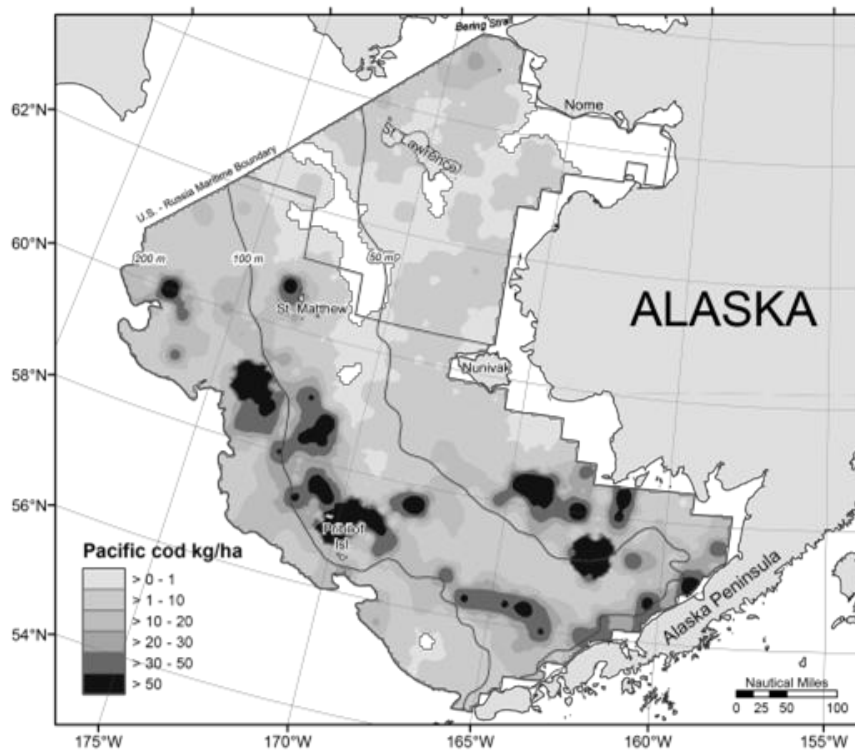
**Cup'ig**

**St. Lawrence Island Yupik**

**Inupiaq**

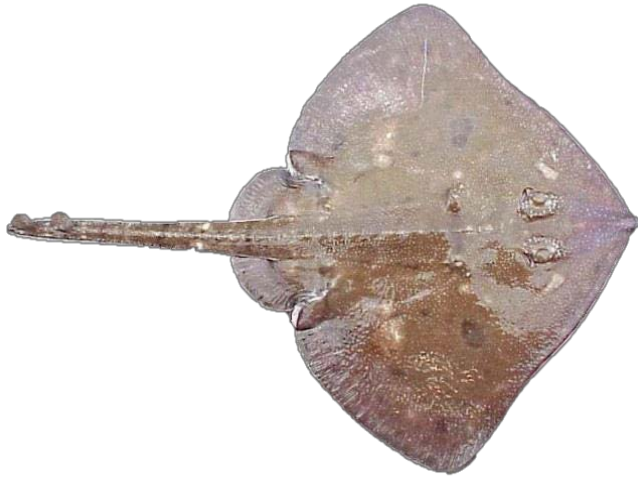
**Latin**

*Gadus macrocephalus*



Pacific cod represented about 1% of the total catch in the NBS by weight. Pacific cod were broadly distributed across the shelf, but only present at 41 percent of the survey stations in the NBS. Pacific cod were found to be less abundant where bottom temperatures were  $< 0^{\circ}\text{C}$ . More than 50% of the Pacific cod in the NBS were over 60 cm.

# Alaska Skate



**Central Yup'ik**

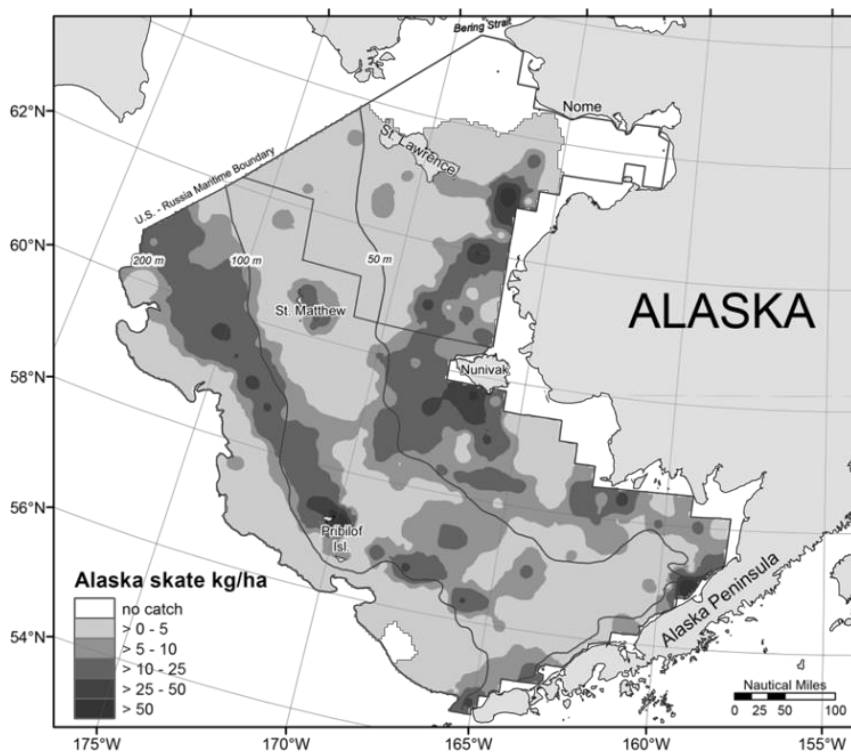
**Cup'ig**

**St. Lawrence Island Yupik**

**Inupiaq**

**Latin**

*Bathyraja parmifera*



Alaska skate were ubiquitous and found at 432 of the 518 stations in the combined EBS and NBS shelf survey areas. Alaska skate were present at station depths ranging from 19 to 192 m.

# Warty Sculpin



Central Yup'ik

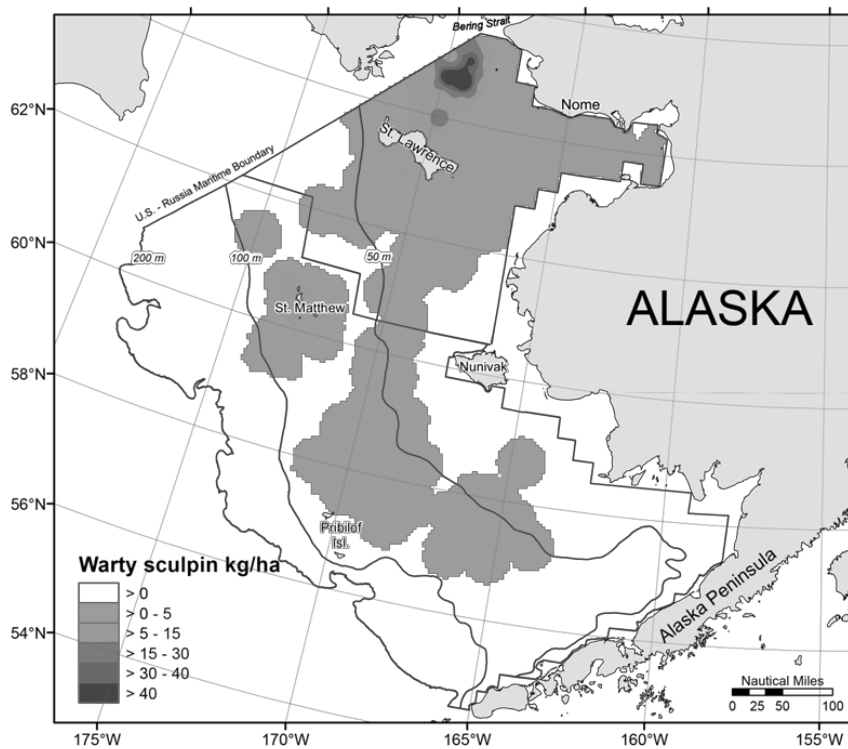
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Myoxocephalus scorpius*<sup>3</sup>



Warty sculpin were generally more numerous in the NBS than the EBS. The highest densities of warty sculpin occurred in the vicinity of St. Matthew Island and north of St. Lawrence Island at bottom depths between 15 m and 102 m.

<sup>3</sup> Previously *Myoxocephalus verrucosus*

# Plain Sculpin



Central Yup'ik

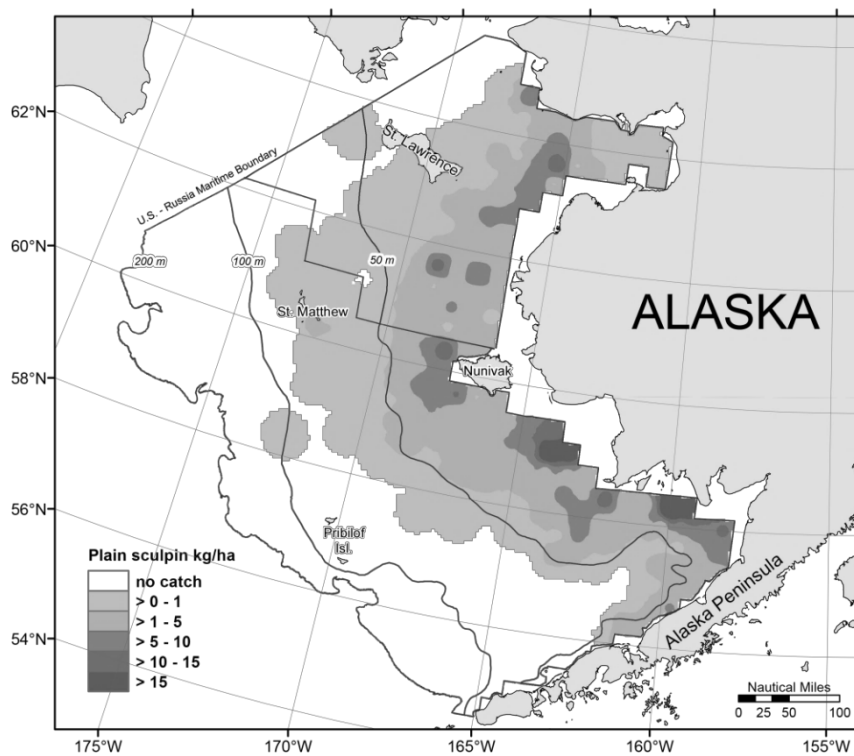
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Myoxocephalus jaok*



Plain sculpin were caught at bottom depths between 11 and 102 meters, with an average depth of 39 m. Densities of plain sculpin were highest along the inner shelf inside the 50 m contour.

## Red King Crab



Central Yup'ik

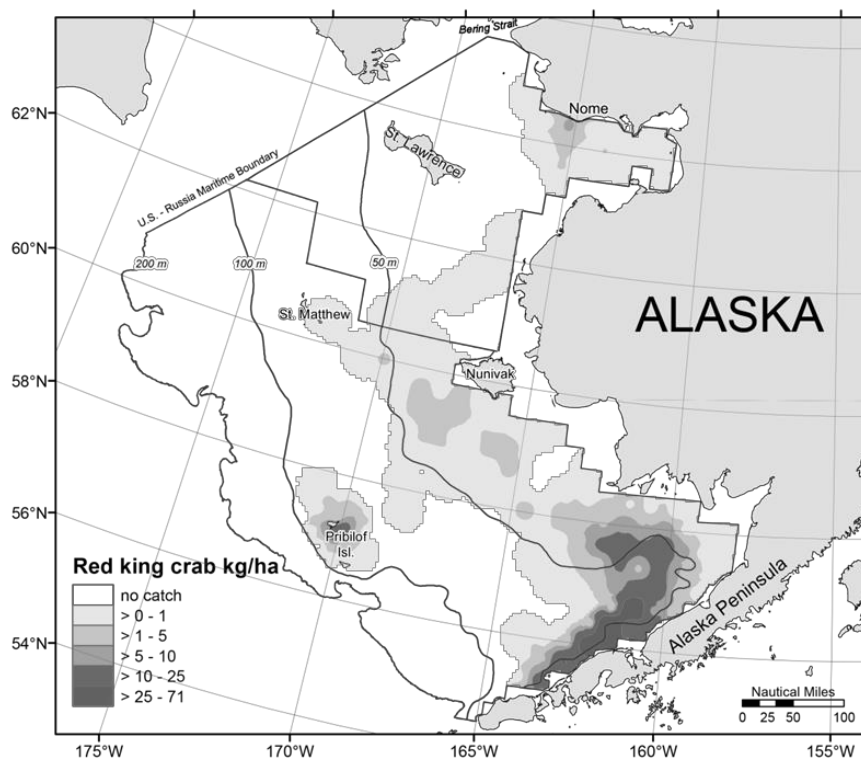
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Paralithodes camtschaticus*



Within the northern Bering Sea, Red king crab occur predominantly in Norton Sound. They were caught at 22 of the 44 total stations within the Norton Sound portion of the survey area.



## Blue King Crab



Central Yup'ik

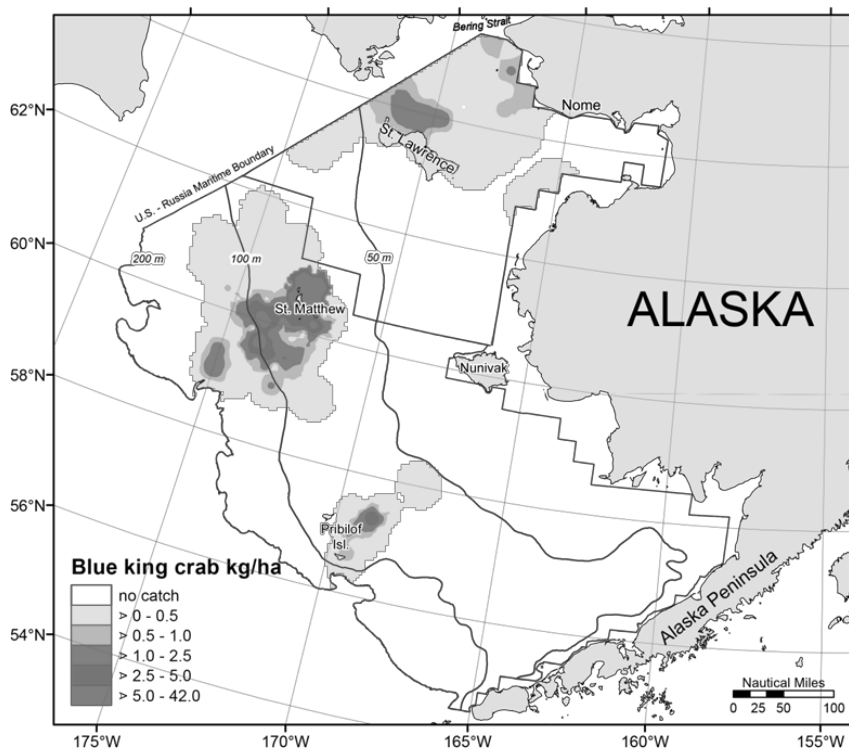
Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Paralithodes platypus*



The majority of both mature male and female blue king crab were distributed off the northwest coast of St. Lawrence Island and in shallow water south of the Bering Strait.

## Pacific halibut



**Central Yup'ik**

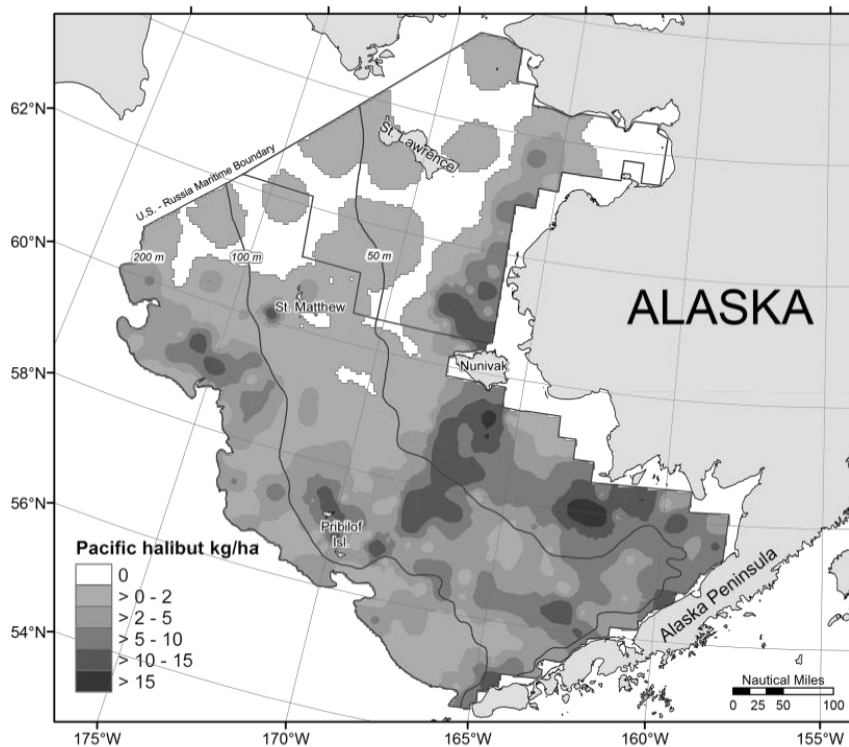
**Cup'ig**

**St. Lawrence Island Yupik**

**Inupiaq**

**Latin**

*Hippoglossus stenolepis*



A total of 235 (746 kg) Pacific halibut were caught during the NBS bottom trawl survey, accounting for 0.8% of the total catch in the NBS. Pacific halibut were caught at only 28% of the stations sampled in the NBS.

## Other organisms in high abundance:

### fuzzy hermit crab

2283 kg, 2%

Central Yup'ik

Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Pagurus trionocheirus*



### Arctic lyre crab

1700 kg, 2%

Central Yup'ik

Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Hyas coarctatus*



## Tunicates

### Sea globs

3815 kg, 5%



Central Yup'ik

Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Aplidium sp.*

### Sea potato

4794 kg, 4%



Central Yup'ik

Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Styela rustica*

### Sea blobs

1272 kg, 1%



Central Yup'ik

Cup'ig

St. Lawrence Island Yupik

Inupiaq

Latin

*Synoicum sp.*

If you have any questions or would like more information, please contact:

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