

Pacific Cod Satellite Tagging in the Bering Sea

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Cooperative partners:

AFSC survey charter vessels and crew (F/V Vesteraalen and F/V Alaska Knight)
Norton Sound Economic Development Corporation (Dawn Wehde, Wes Jones)

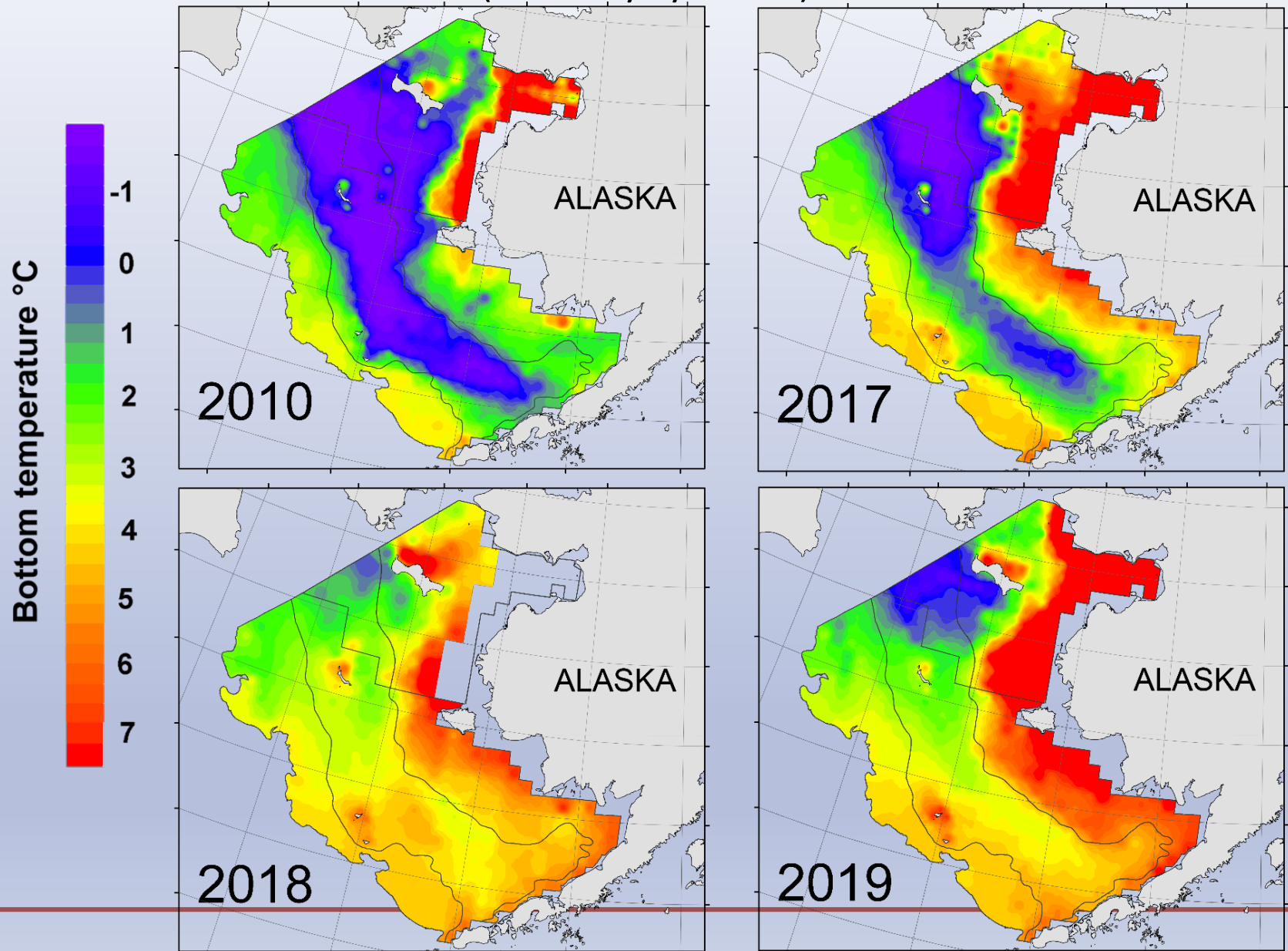
Savoonga fishermen and plant personnel:

Crew of the Adeline: Capt. Perry Pungowiyi and crew,
Crew of the Scarlett: Capt. Richmond Toolie and crew,
Orville Toolie, Plant manager



The Bering Sea water temperatures are changing

(Courtesy Lyle Britt)

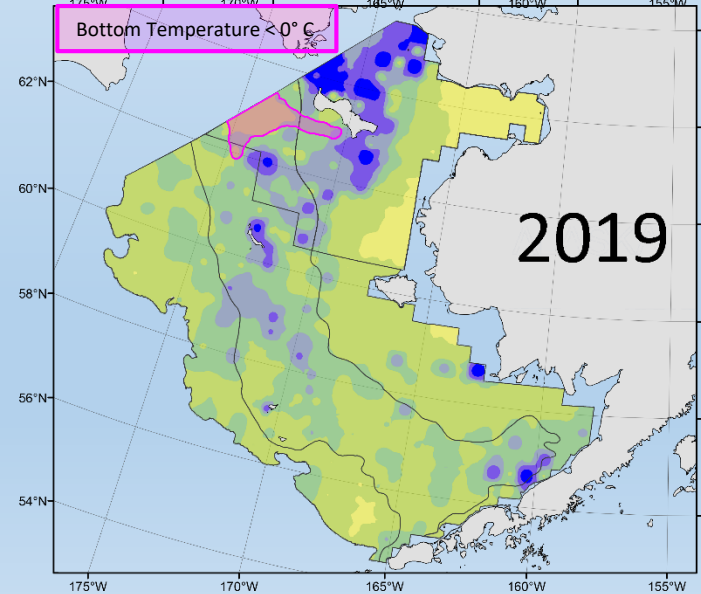
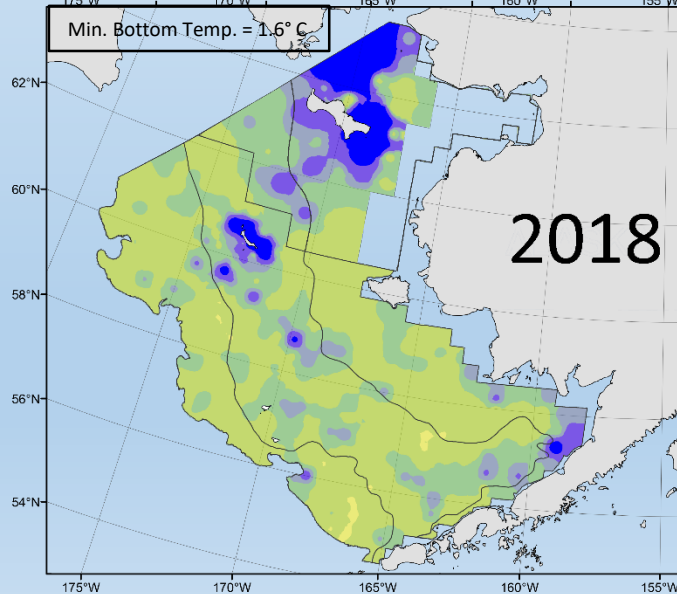
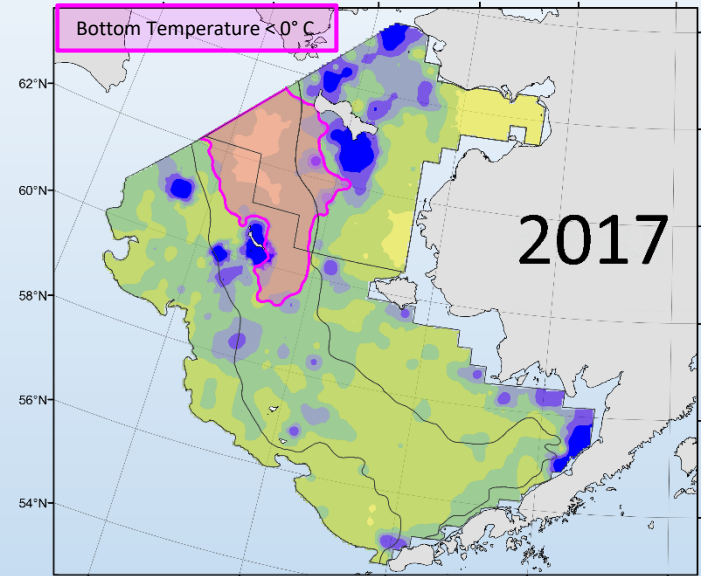
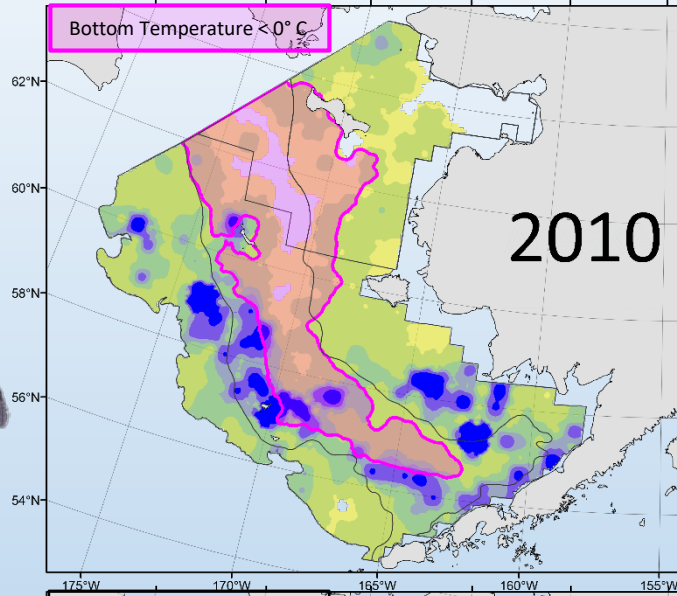
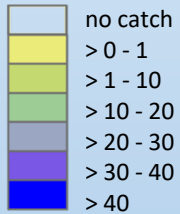


Bering Sea Pacific Cod Distribution

(Courtesy Lyle Britt)



Pacific Cod
(kg/ha)

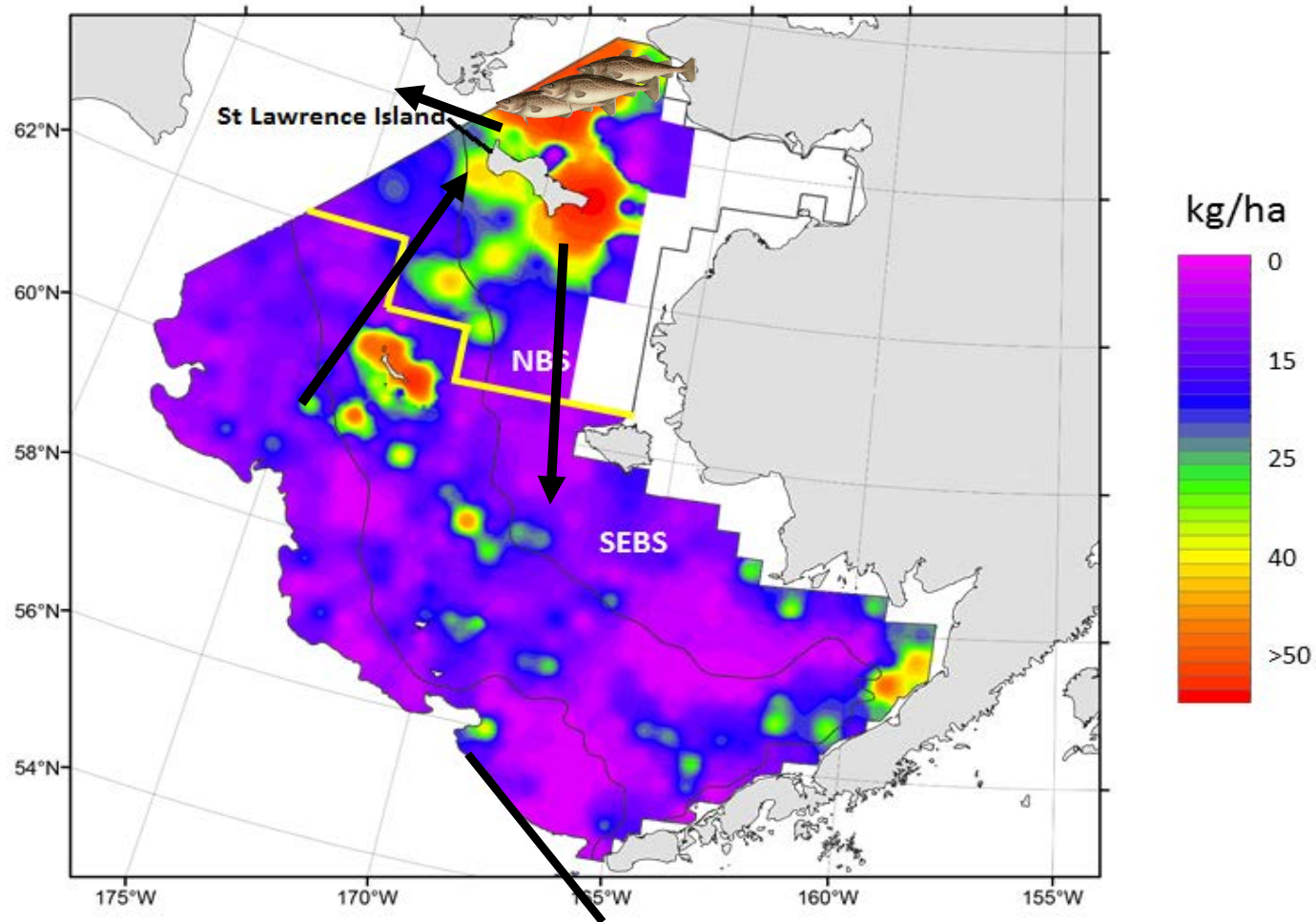


Changes in cod distribution have posed several research questions

What are the basic movement patterns of adult cod between winter spawning and summer feeding grounds?

1. What is the movement between Northern and Southern Bering sea cod?
 2. Do cod move between the US and Russian Border?
 3. Do cod stay under ice in the winter in the Northern Bering sea?
 4. Can cod spawn successfully in the Northern Bering sea?
 5. Do cod return to Northern Bering sea in the following summer?
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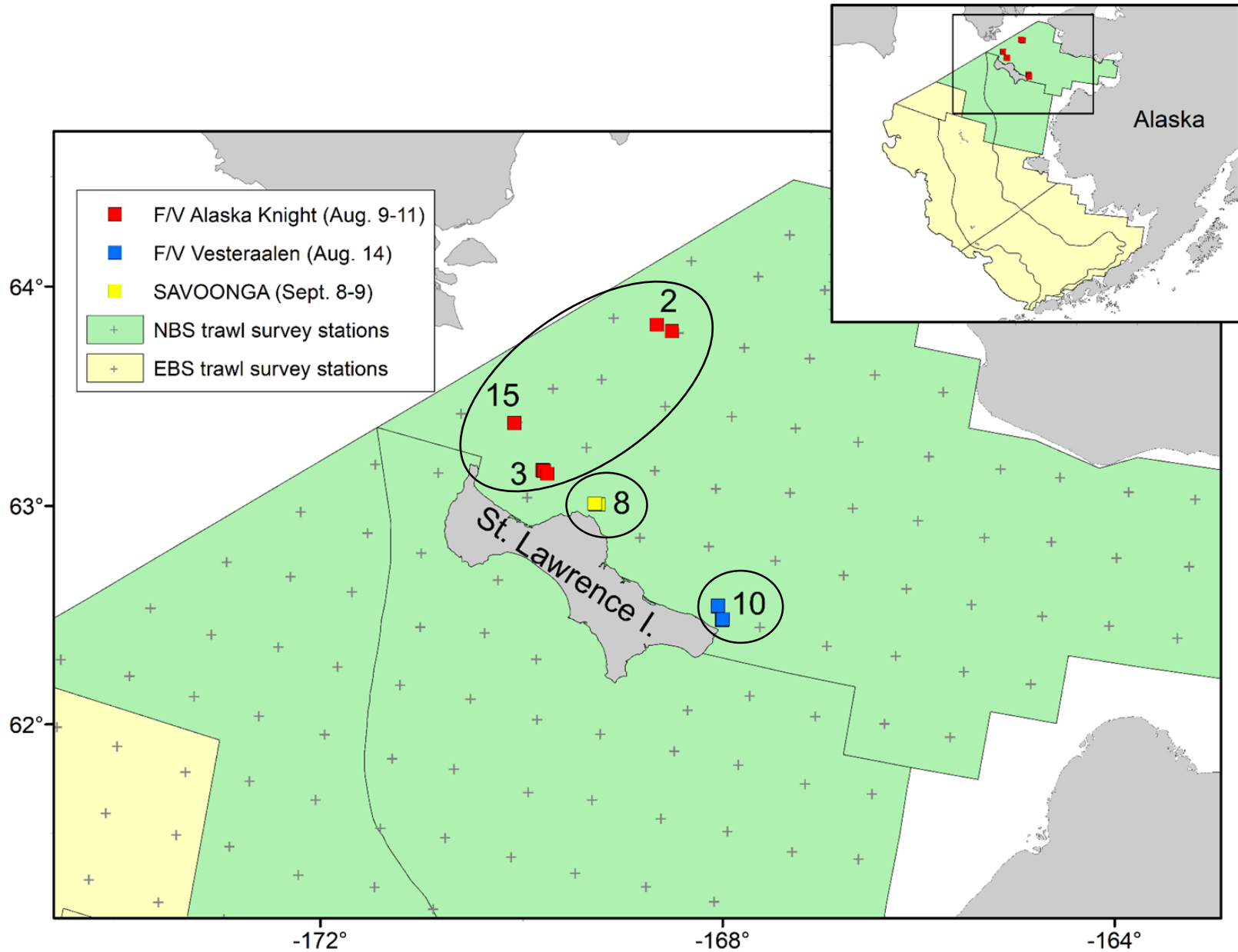
Population structure



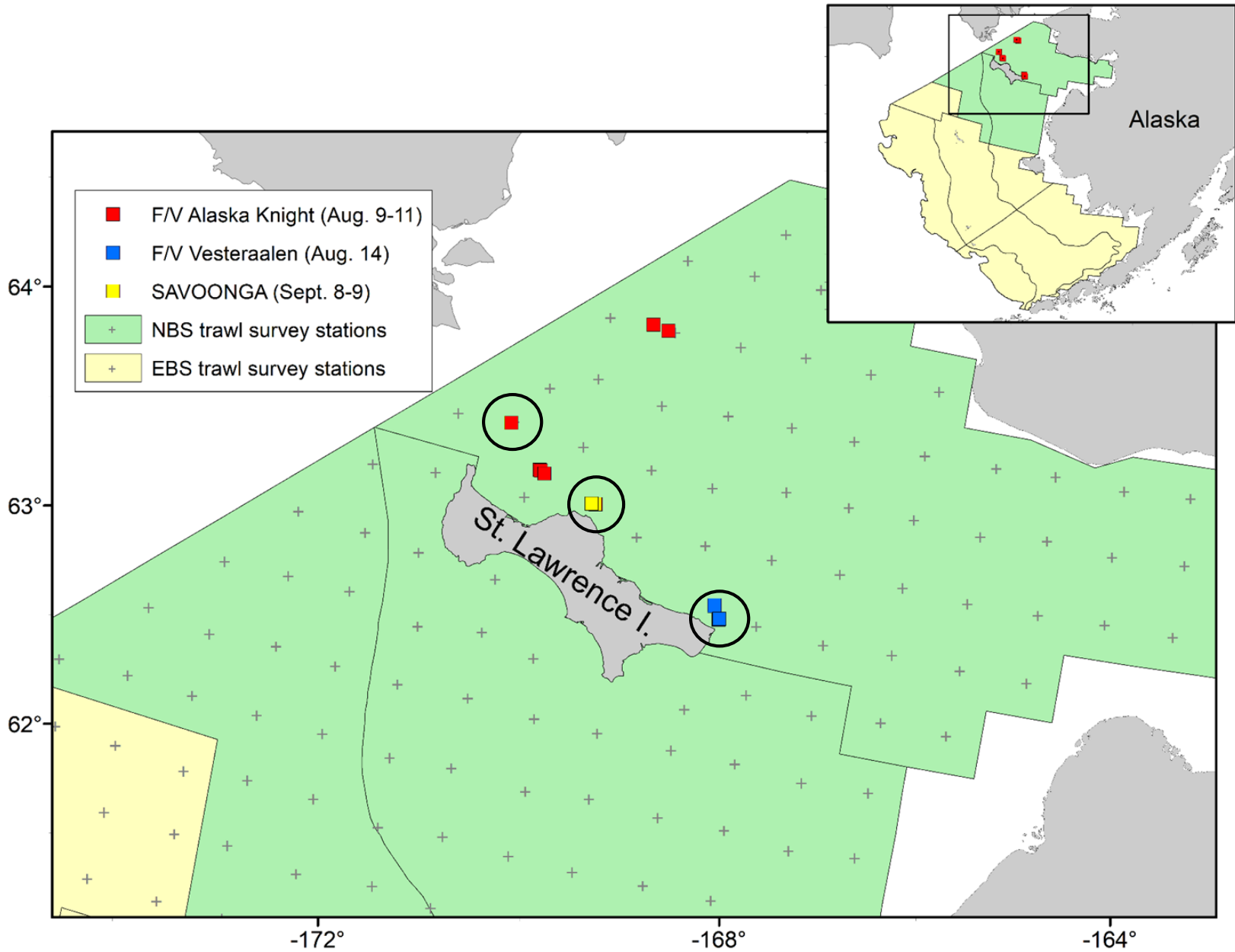
Methods

A wide-angle landscape photograph showing a coastal scene. In the foreground, there is a grassy hillside. The middle ground features a large body of water, possibly a bay or fjord, with a small peninsula or headland extending into it. The background consists of dark, rolling hills under a sky filled with large, white, fluffy clouds. The lighting suggests a bright day with some shadows.

PSAT Tag Releases on Pacific Cod



3 Stationary Tags



PSAT Deployments in the Northern Bering Sea

<u>Platform</u>	<u>Programmed Duration</u>	<u>Number of Tags</u>
NBS Survey	90 days	6
(Released Aug. 9 – 14)	150 days	3
	210 days	9
	300 days	3
	360 days	9
St. Lawrence I. (Savoonga)	90 days	2
(Released Sept. 8 - 9)	180 days	3
	360 days	3
		Total= 38

** Plus 3 Stationary Tags deployed at the 3 major release sites (360 days)*

Pacific Cod Capture



NBS Survey vessel, Hook and line



Savoonga halibut fishermen, hand long line



Tagging Process during AFSC Northern Bering Sea Survey

Average time between capture and release: 11 minutes

Average time of tagging (fish out of water): 3 minutes



Savoonga Island Cooperative Tag Release Effort

- Deployed tags off research charter vessels and with local halibut fishermen in Savoonga.
- Cooperative partners: Norton Sound Economic Development Corporation (Dawn Wehde)
- Savoonga Plant manager and local Halibut Fishermen



Savoonga

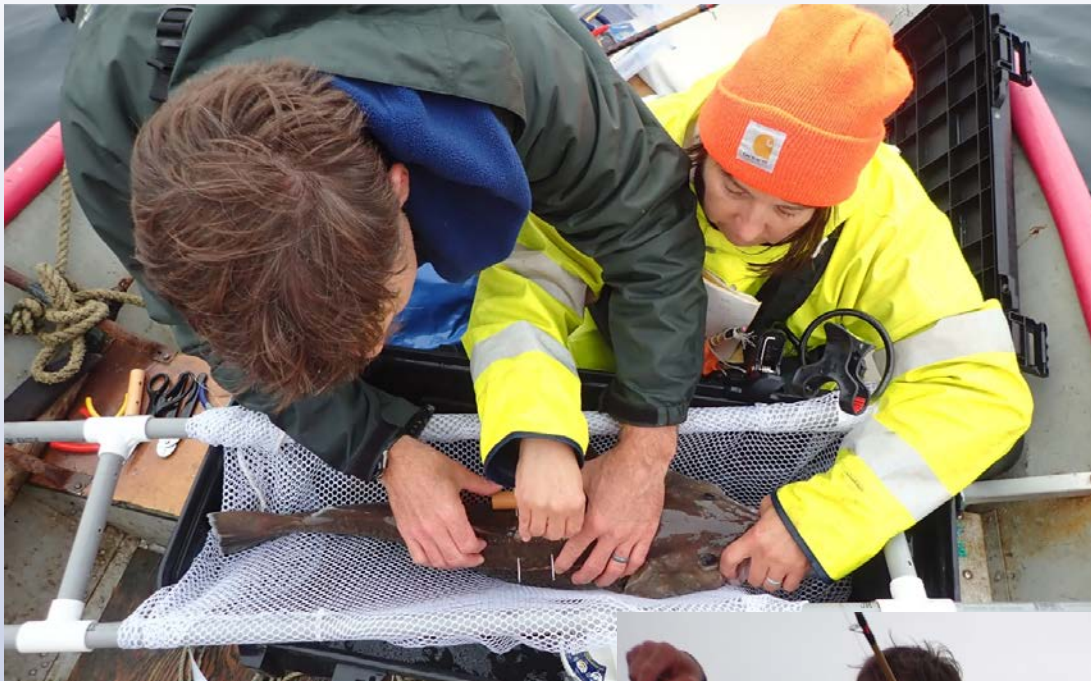


Plant Manager Orville Toolie

FV Adeline (Captain Perry, Ty and Donald)

FV Scarlet (Capt. Richmond, Josephine, Wagner)





**In 2 days we released
8 Pacific cod with
satellite tags and 75
cod with conventional
tags.**



Summary of Tag recoveries to date

Scheduled popup Month	# Tags Released	# Tags Recovered	On time	Early popup	Fleet recovery	Missing Tags
Nov-19	6	6	6			
Dec-19	2	2	2			
Jan-20	3	3	3			
Mar-20	12	11	6	4	1	1
Jun-20	3	3	2	1		
Aug-20	9	6		4	2	3
Sep-20	3	2		1	1	1
Total	38	33	19	10	4	5

Pacific cod Tag Popup locations by Month



September 2019

Russia

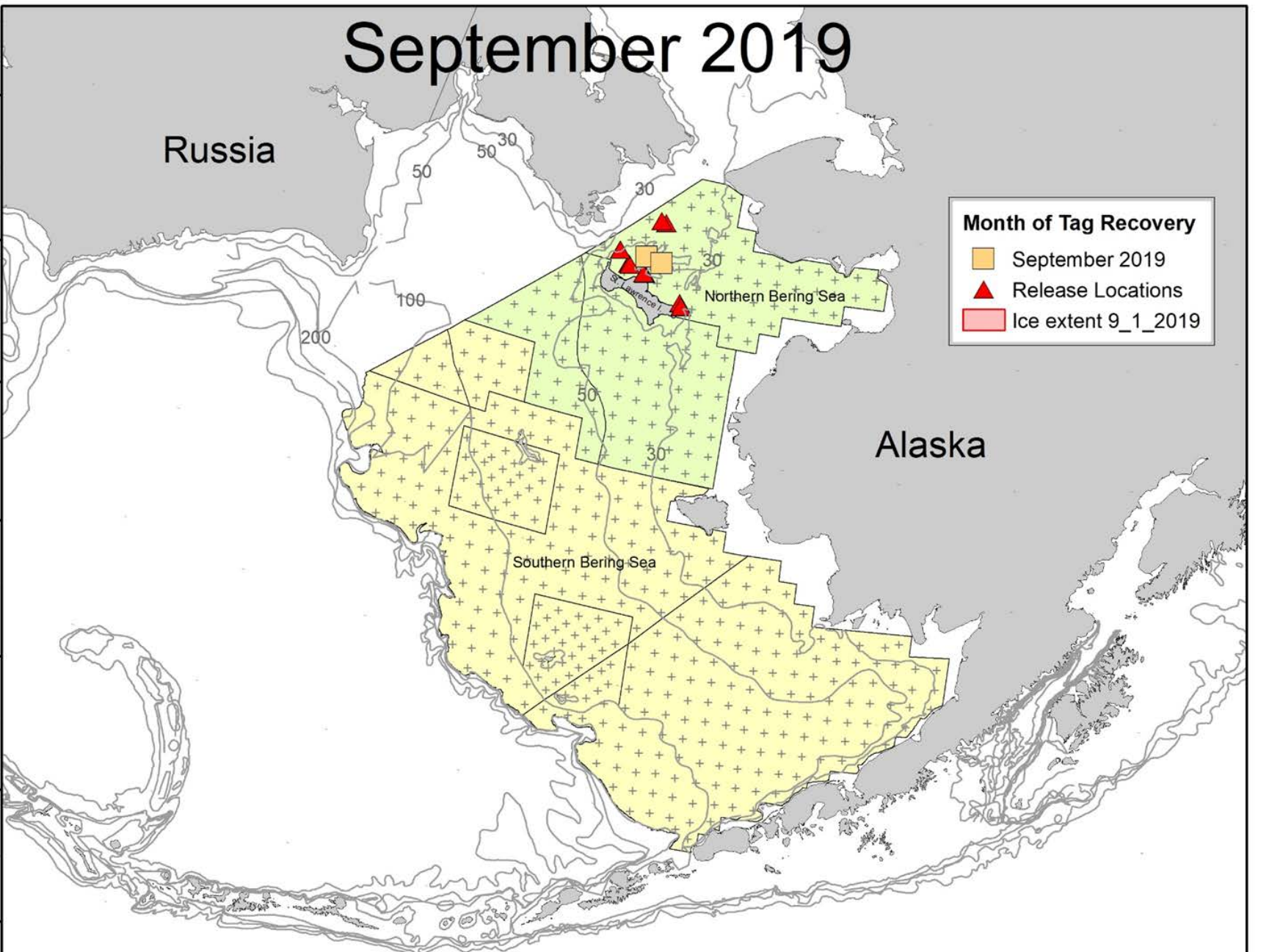
Alaska

Month of Tag Recovery

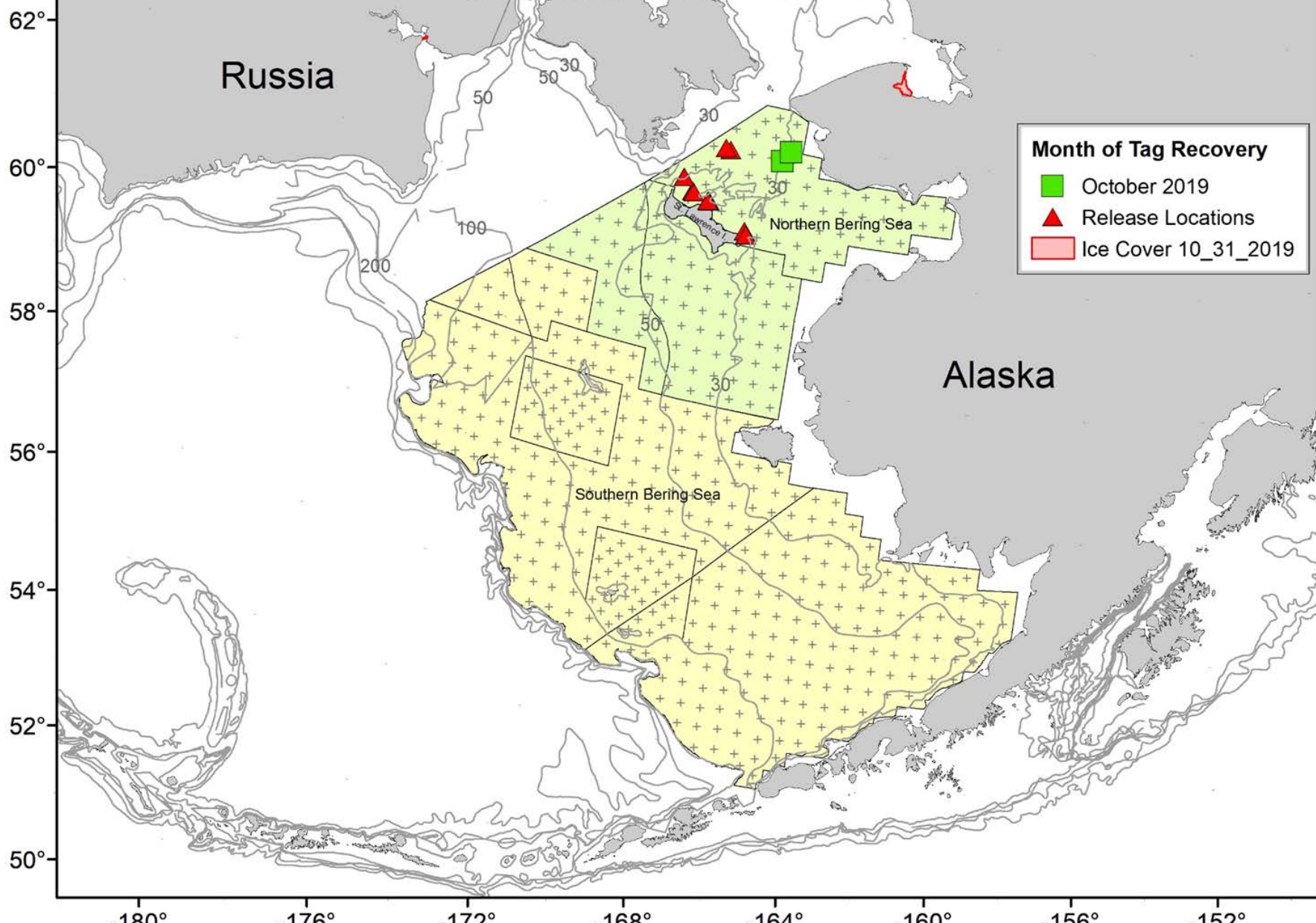
- September 2019
- Release Locations
- Ice extent 9_1_2019

62°
60°
58°
56°
54°
52°
50°

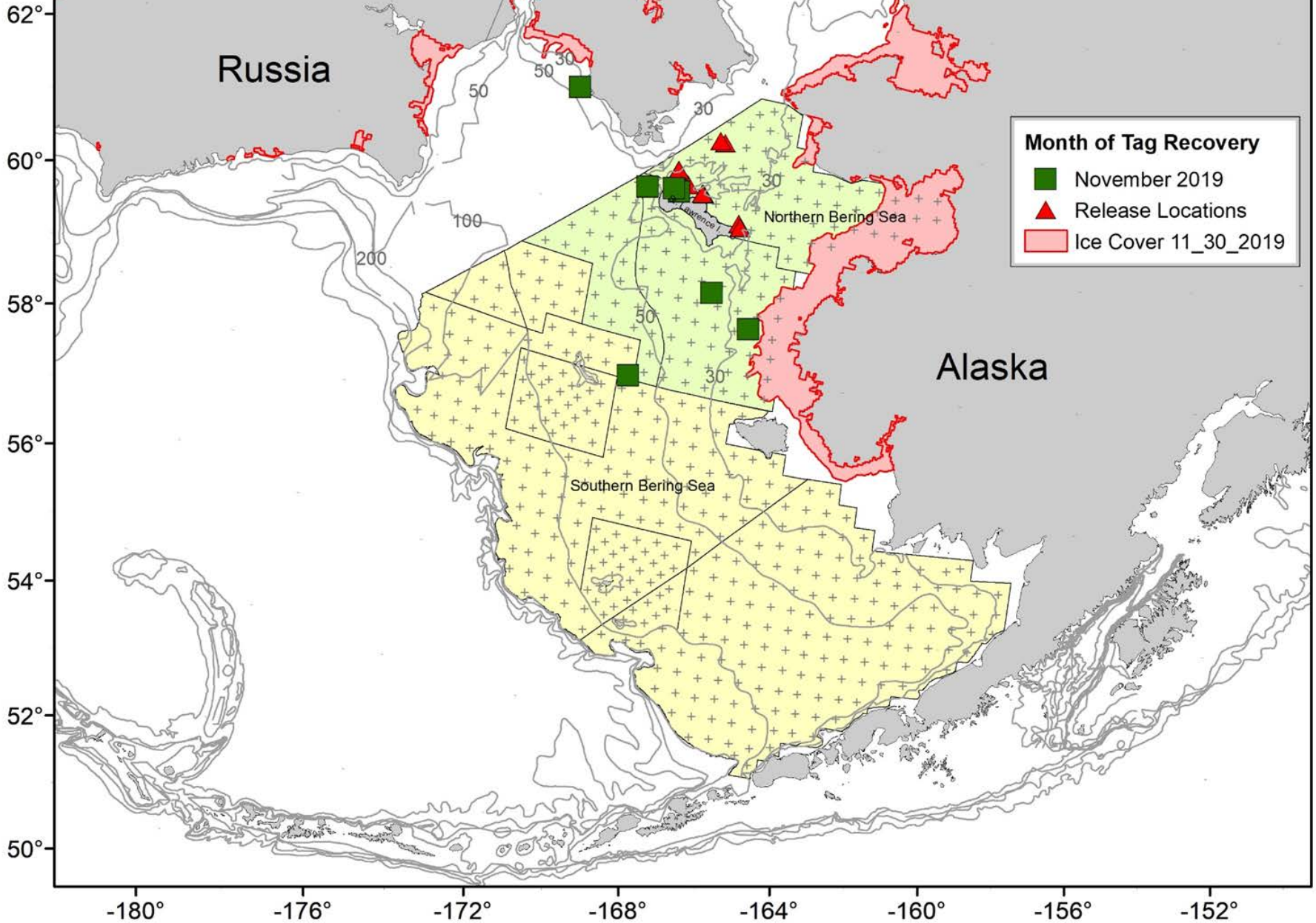
-180° -176° -172° -168° -164° -160° -156° -152°



October 2019



November 2019



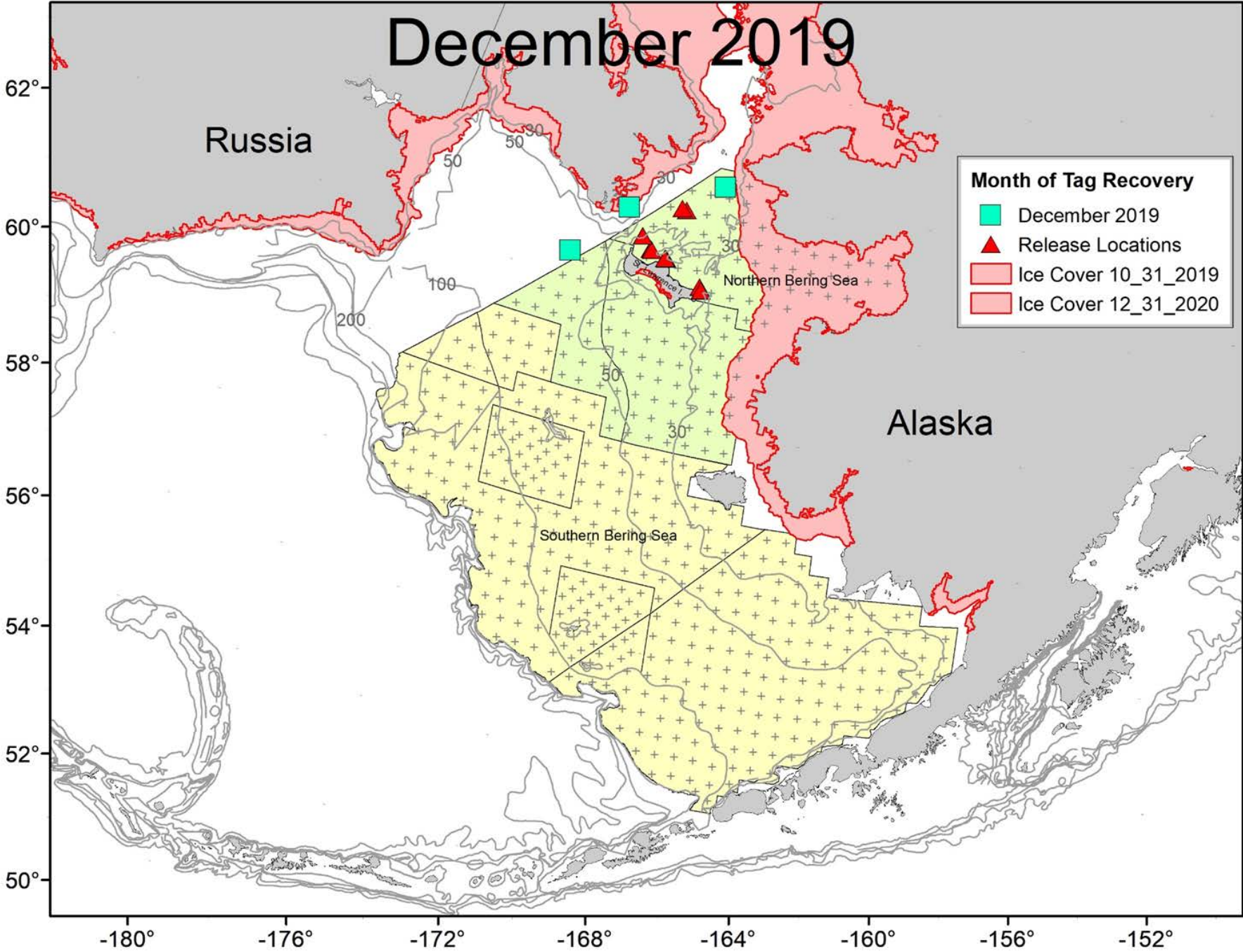
December 2019

Russia

Alaska

Month of Tag Recovery

- December 2019
- Release Locations
- Ice Cover 10_31_2019
- Ice Cover 12_31_2020



January 2020

Russia

Month of Tag Recovery

■ January 2020

▲ Release Locations

■ Ice Cover 1_31_2020

Alaska

Northern Bering Sea

Southern Bering Sea

-180°

-176°

-172°

-168°

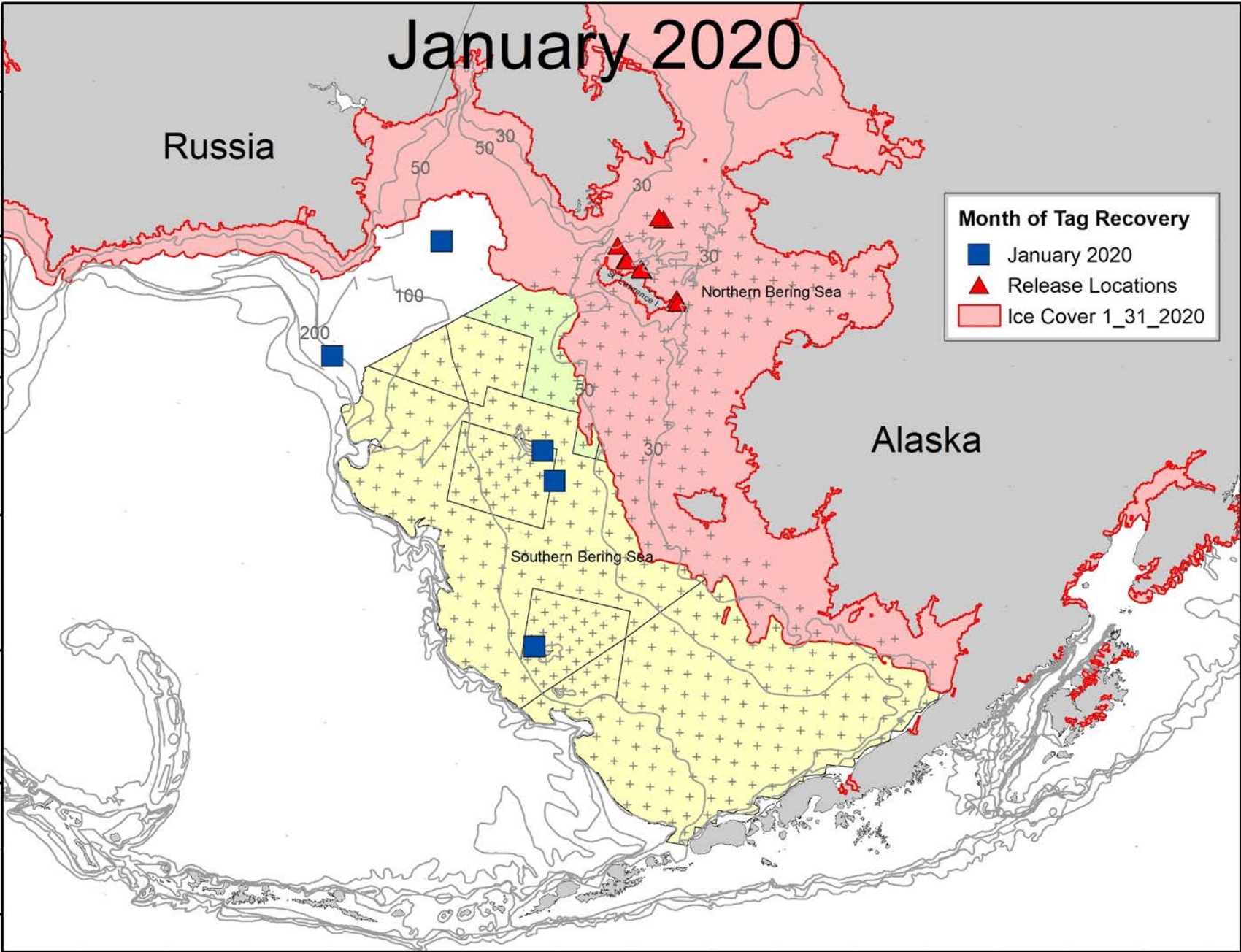
-164°

-160°

-156°

-152°

62°
60°
58°
56°
54°
52°
50°



February 2020

Russia

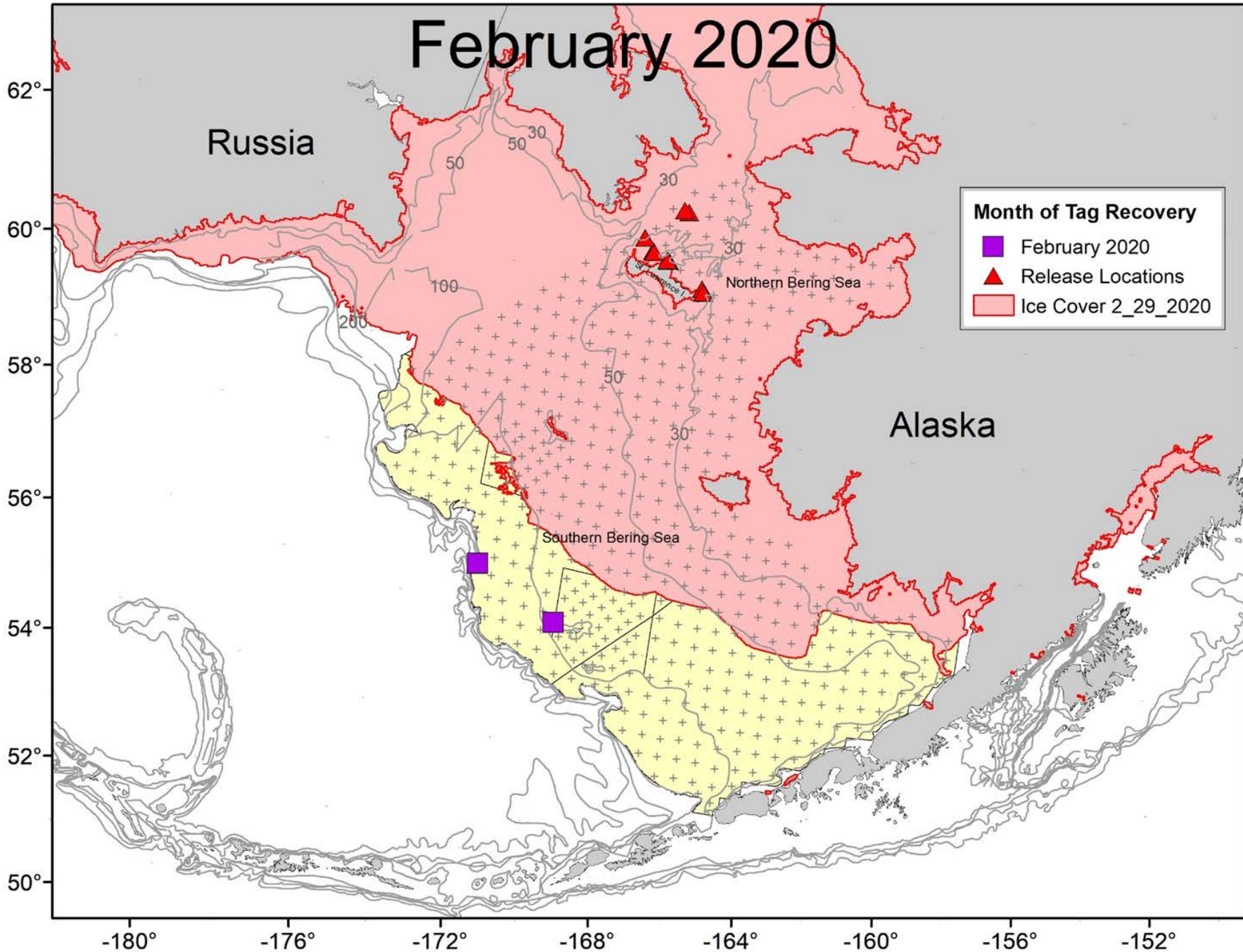
Month of Tag Recovery

- February 2020
- Release Locations
- Ice Cover 2_29_2020

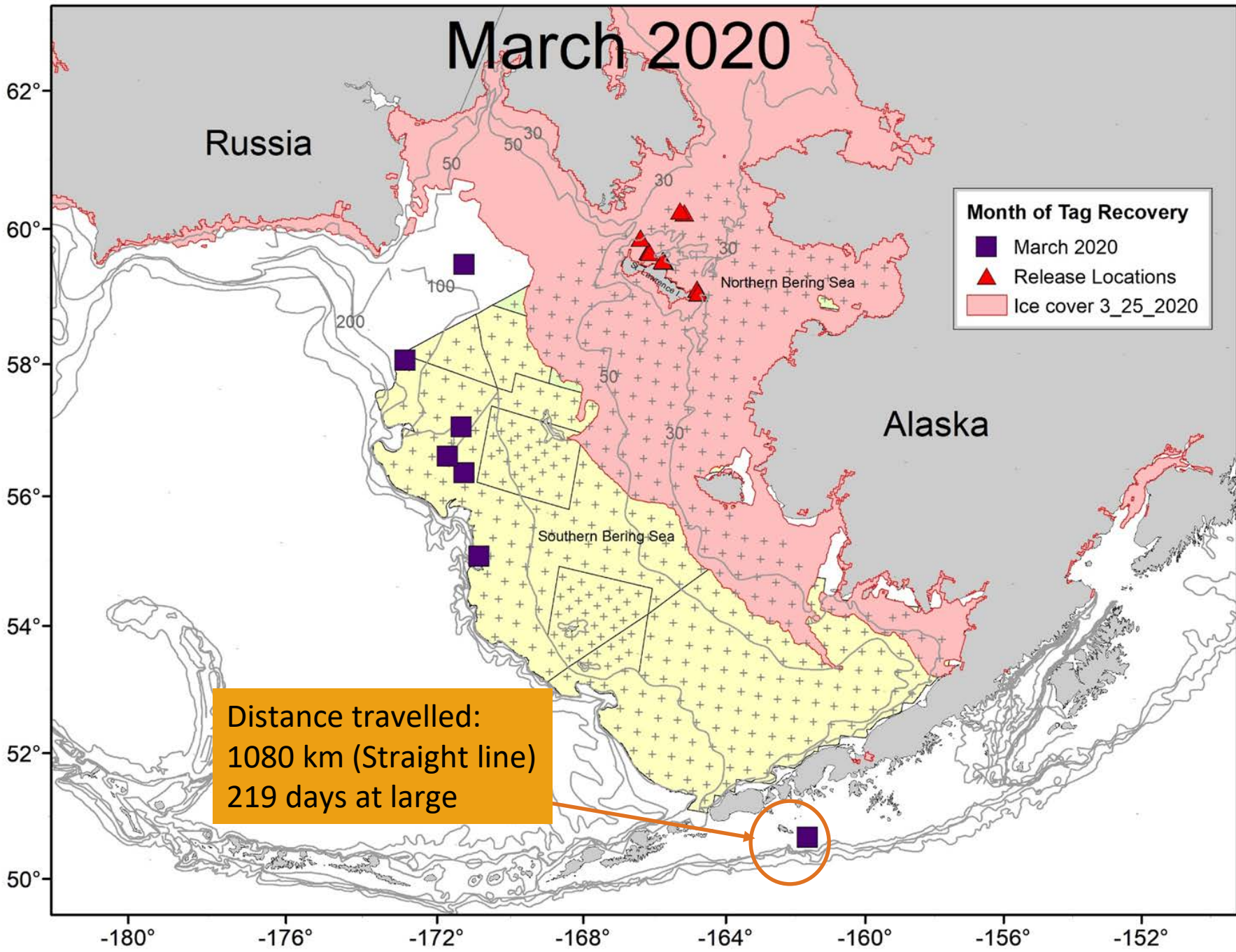
Alaska

Northern Bering Sea

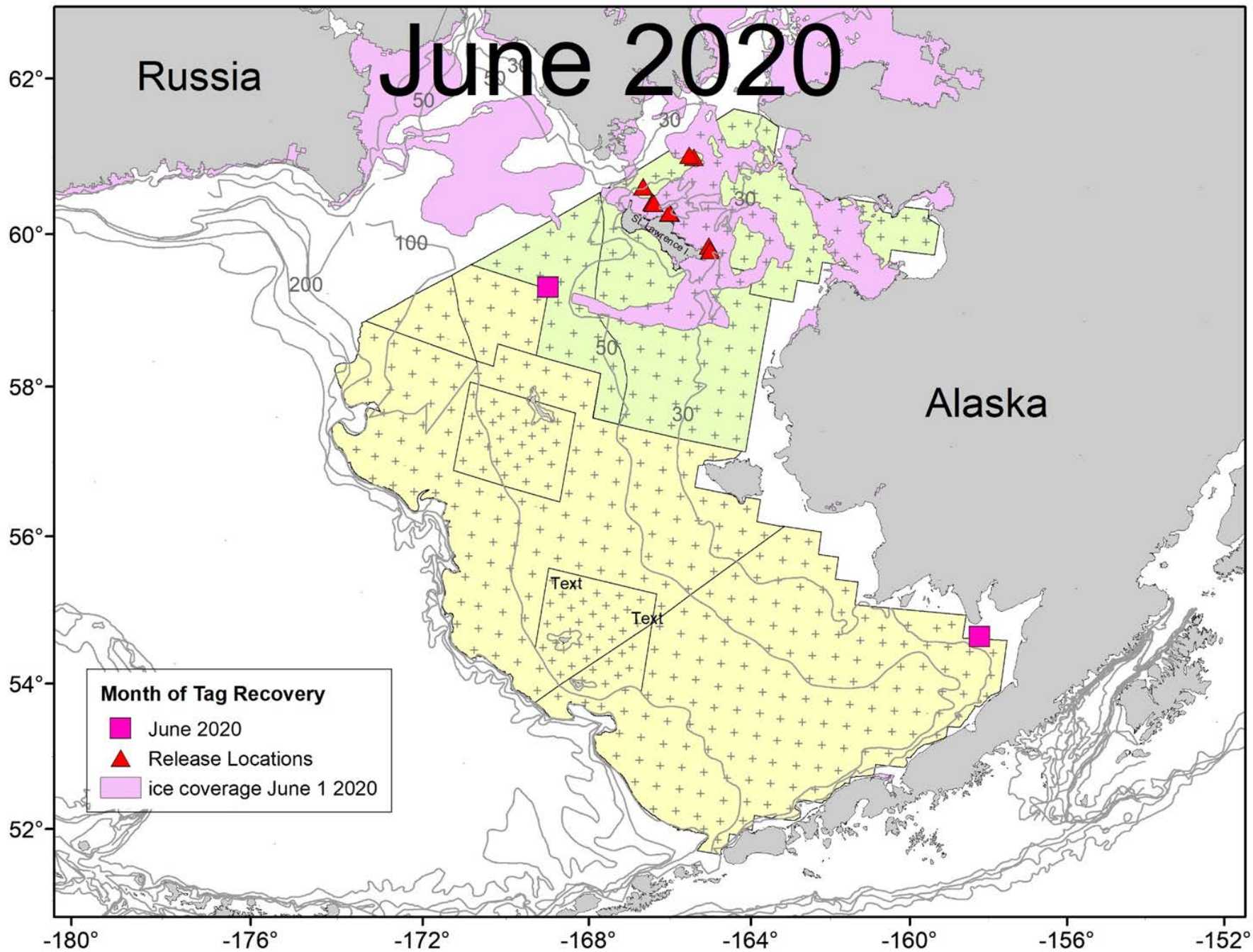
Southern Bering Sea



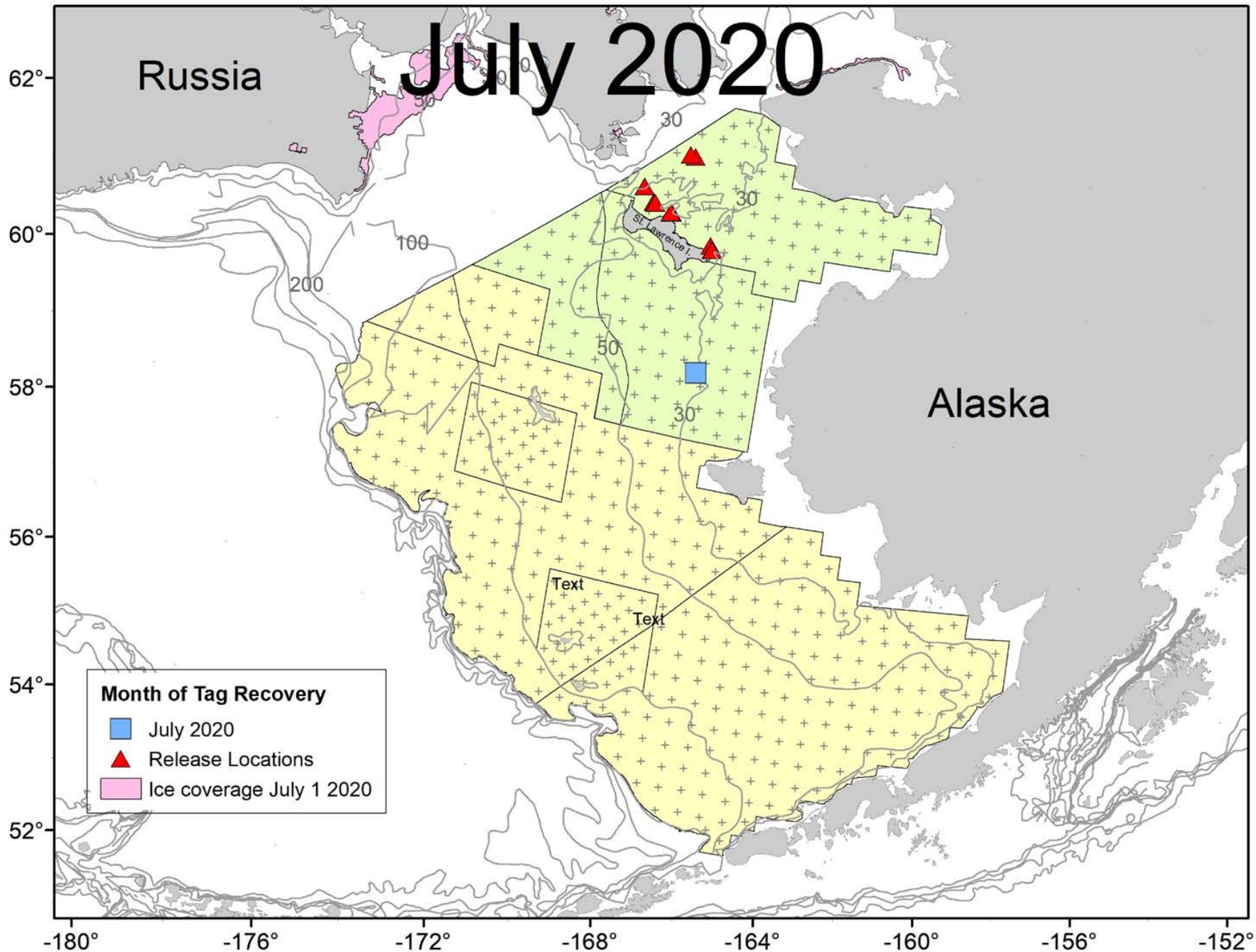
March 2020



June 2020



July 2020



Russia

All Recoveries

62°
60°
58°
56°
54°
52°

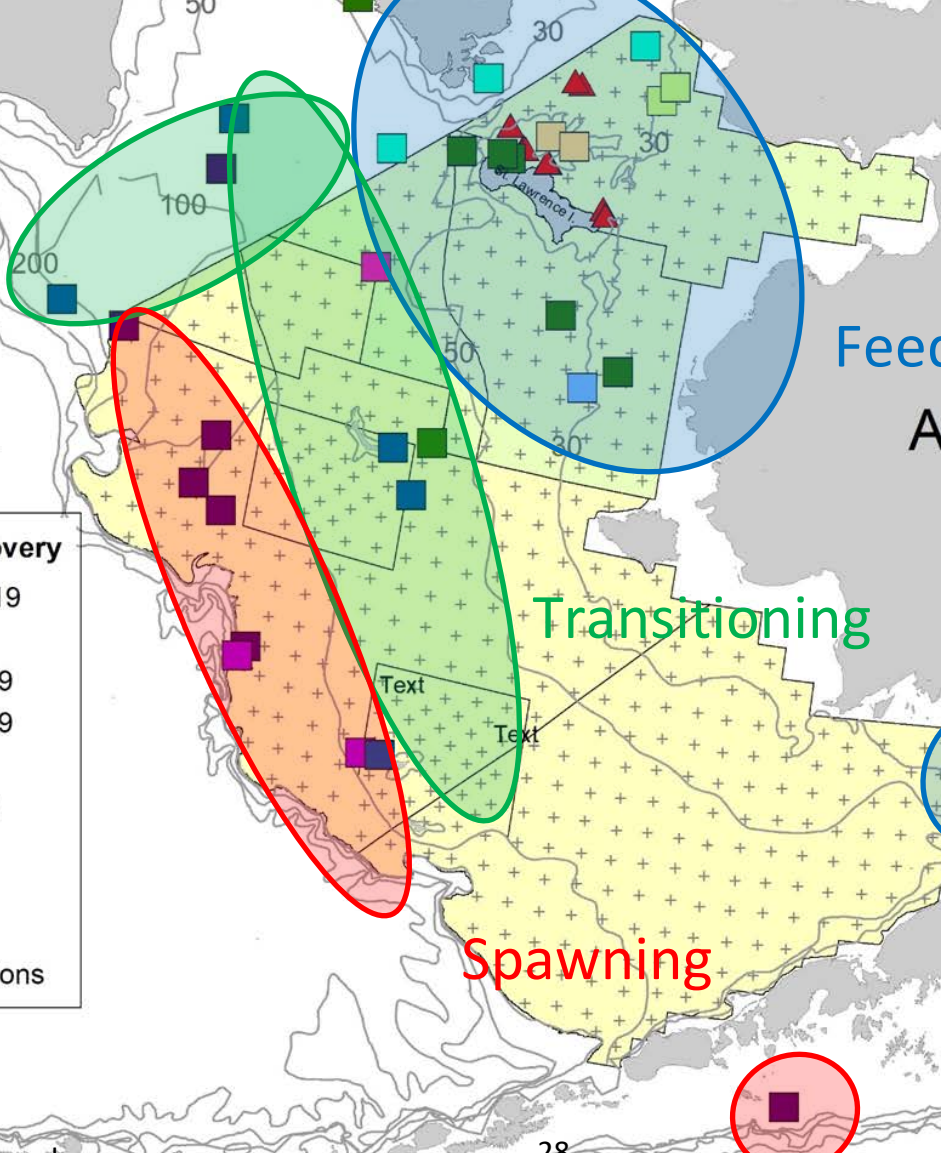
Feeding
Alaska

Transitioning

Spawning

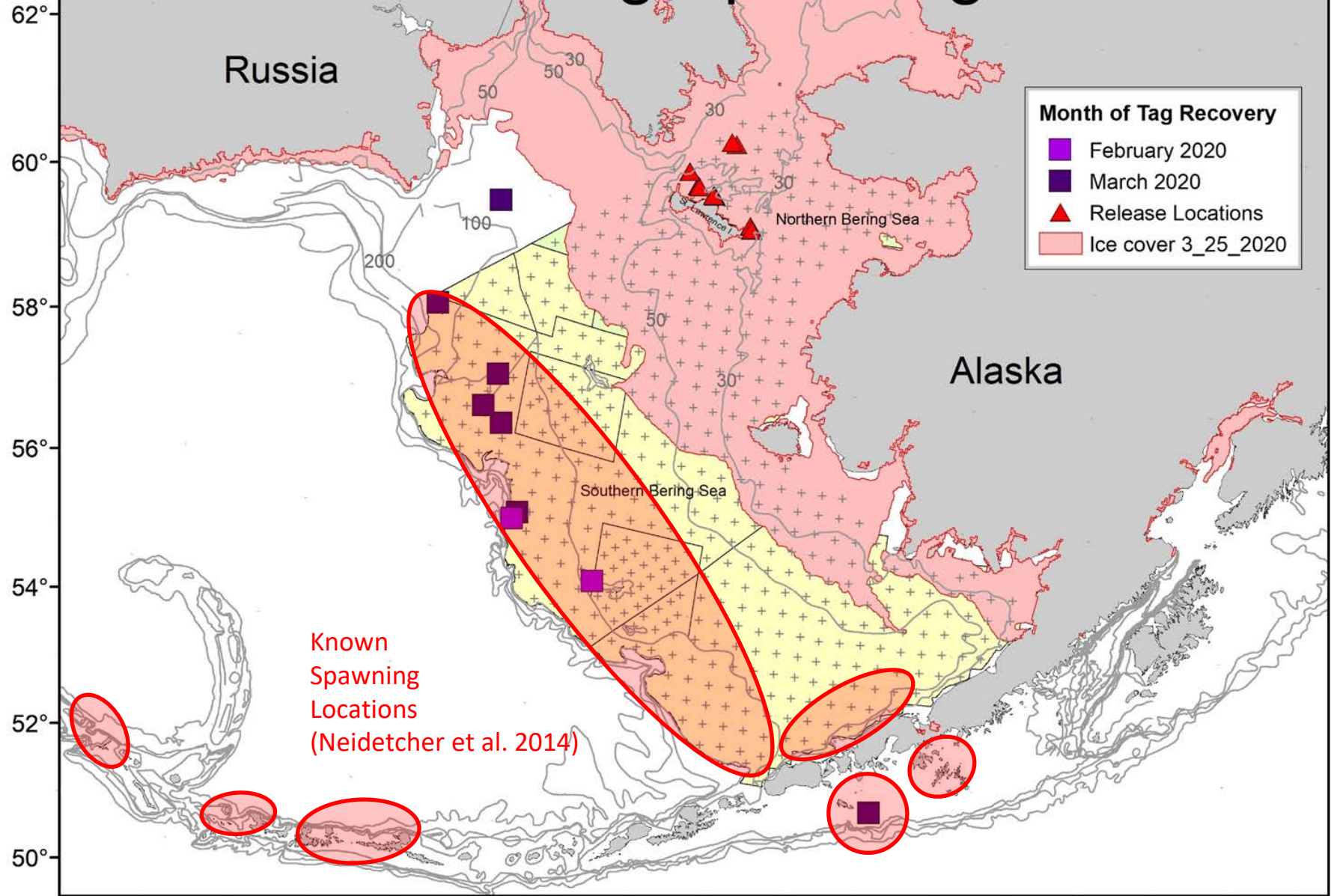
Month of Tag Recovery

- September 2019
- October 2019
- November 2019
- December 2019
- January 2020
- February 2020
- March 2020
- June 2020
- July 2020
- Release Locations

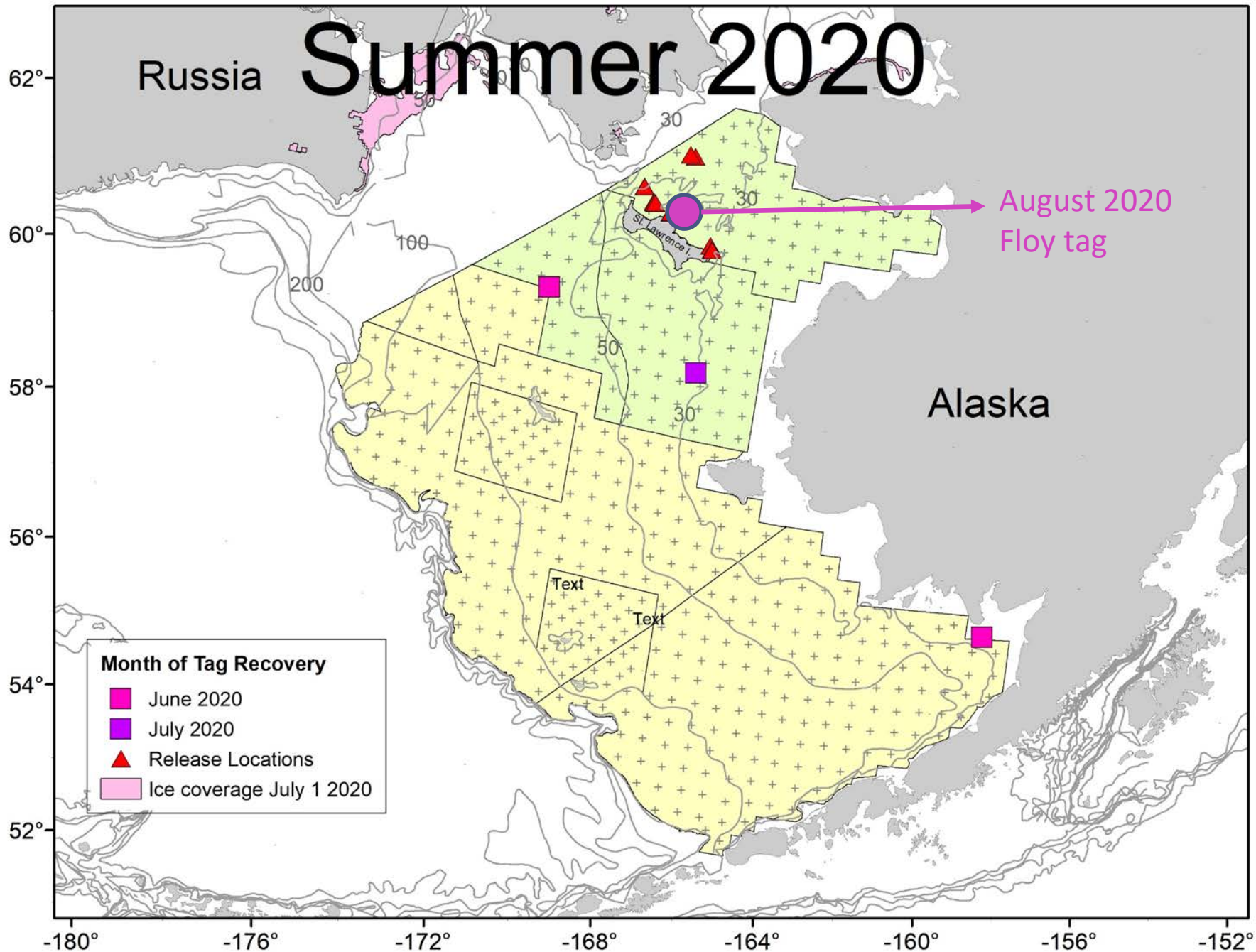


Pacific Cod Tagging Research
-180° -176° -172° -168° -164° -160° -156° -152°

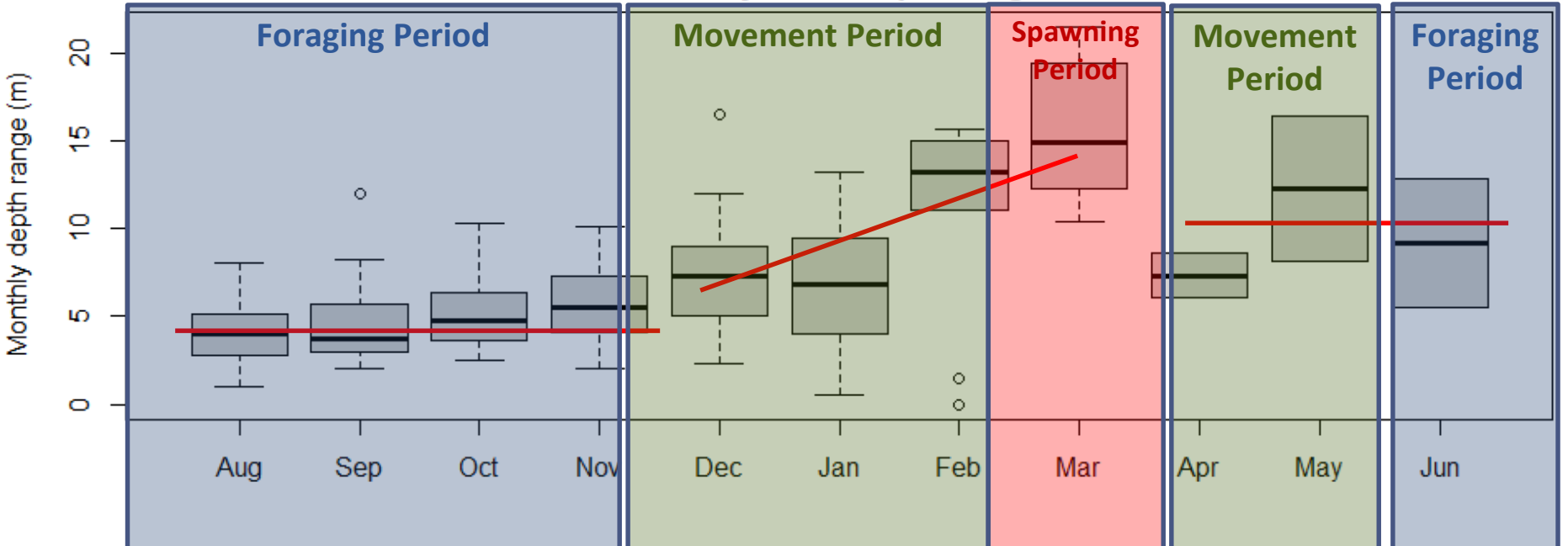
Recoveries during Spawning Season



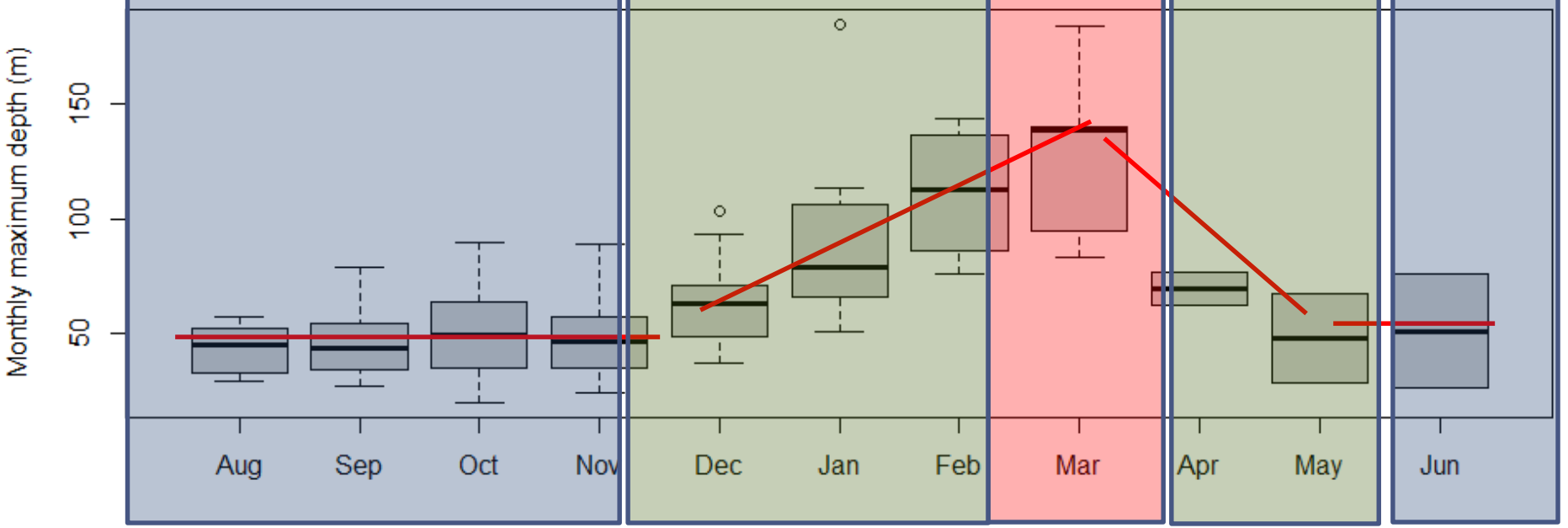
Summer 2020



Monthly mean depth range



Monthly mean maximum depth

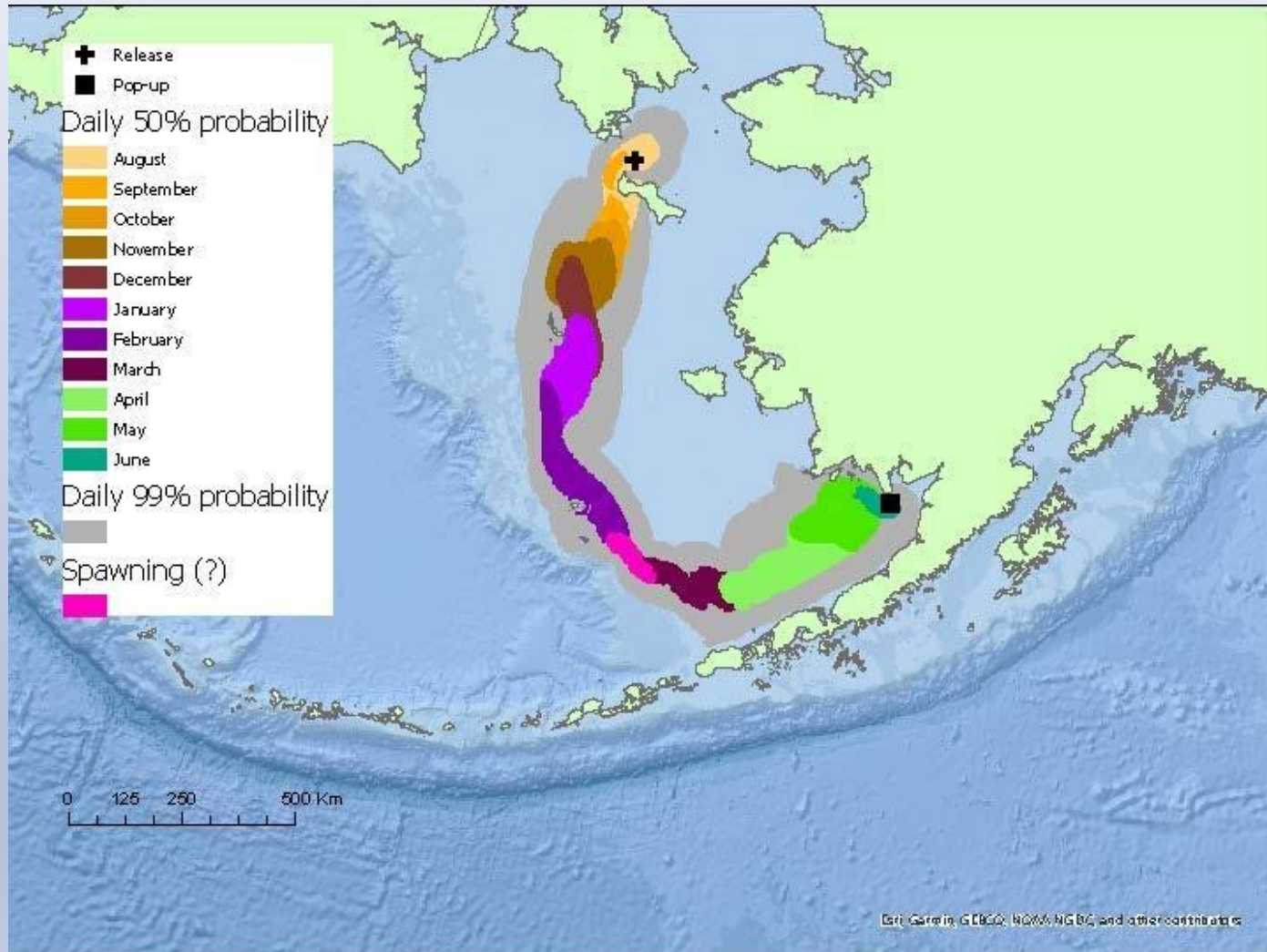


Individual Travel Path Geolocation model (Julie Nielsen)

- Light, Depth and temperature data will be incorporated into a geolocation model
- Hidden Markov Model will predict movement path over time
 - 99% error polygons modeling the movement path

Individual Travel Path

Preliminary Geolocation Model (depth and light only)



What we learned

- Pacific cod can be successfully tagged with Popup satellite tags
- Cooperative research with industry, tribal, and other partners essential
 - Tagging is possible on various fishing platforms
- Satellite tags can provide movement path and critical biological information on habitat use and temperature preferences
- Information can be gathered from all fish, independent of fishing effort or remoteness of popup location

1. What is the movement between Northern and Southern Bering sea cod?

- Spawning movement in March
 - 9 fish moved to Southern Bering Sea slope
 - 1 fish moved to Gulf of Alaska
 - 3 fish moved to Russian waters
- Return to summer feeding
 - 1 fish stayed in SBS and went to Bristol bay
 - 3 fish moved to NBS (one to it's place of release, St Lawrence Island)

2. Is there movement of cod between the US and Russian Border?

YES

6 out of 30 tags were recovered in Russian waters

3. Do cod stay under ice in the winter in the Northern Bering sea?

Rare occurrence

- One fish likely died in January under the ice-Its tag popped up in June after ice melt
- 4 (out of 38) Tags are missing--maybe some got stuck under the ice?

4. Can cod spawn successfully in the Northern Bering sea?

No evidence so far

- No fish were observed to spawn in the NBS
 - 7 fish spawned on Southern Bering sea slope
 - 2 fish spawned in Russian waters
-

5. Do cod return to Northern Bering sea the following summer?

Yes

- 3 fish returned to the Northern Bering sea in June -August
 - 1 fish stayed in the Southern Bering sea and went to Bristol bay
-

Future Directions

- Model movement path over time with geolocation model for all Bering sea fish with enough data
- Validate Pacific cod spawning habitat model with tagging data
- Tag releases in summer 2020 in Northern Bering sea with help from NSEDC and ADF&G
 - Dawn Wehde, Myra Scholze and Jenefer Bell are our superheroes!
- 2021 and beyond:
 - Continuing collaboration with NSEDC, Tribal fishermen, Pacific cod fleet, and Halibut commission
 - Future Tag release project (Pilot) in winter in GOA
 - Planned NPRB proposal: Large scale tag release effort in NBS, SBS and GOA as cooperative project with industry

Questions?

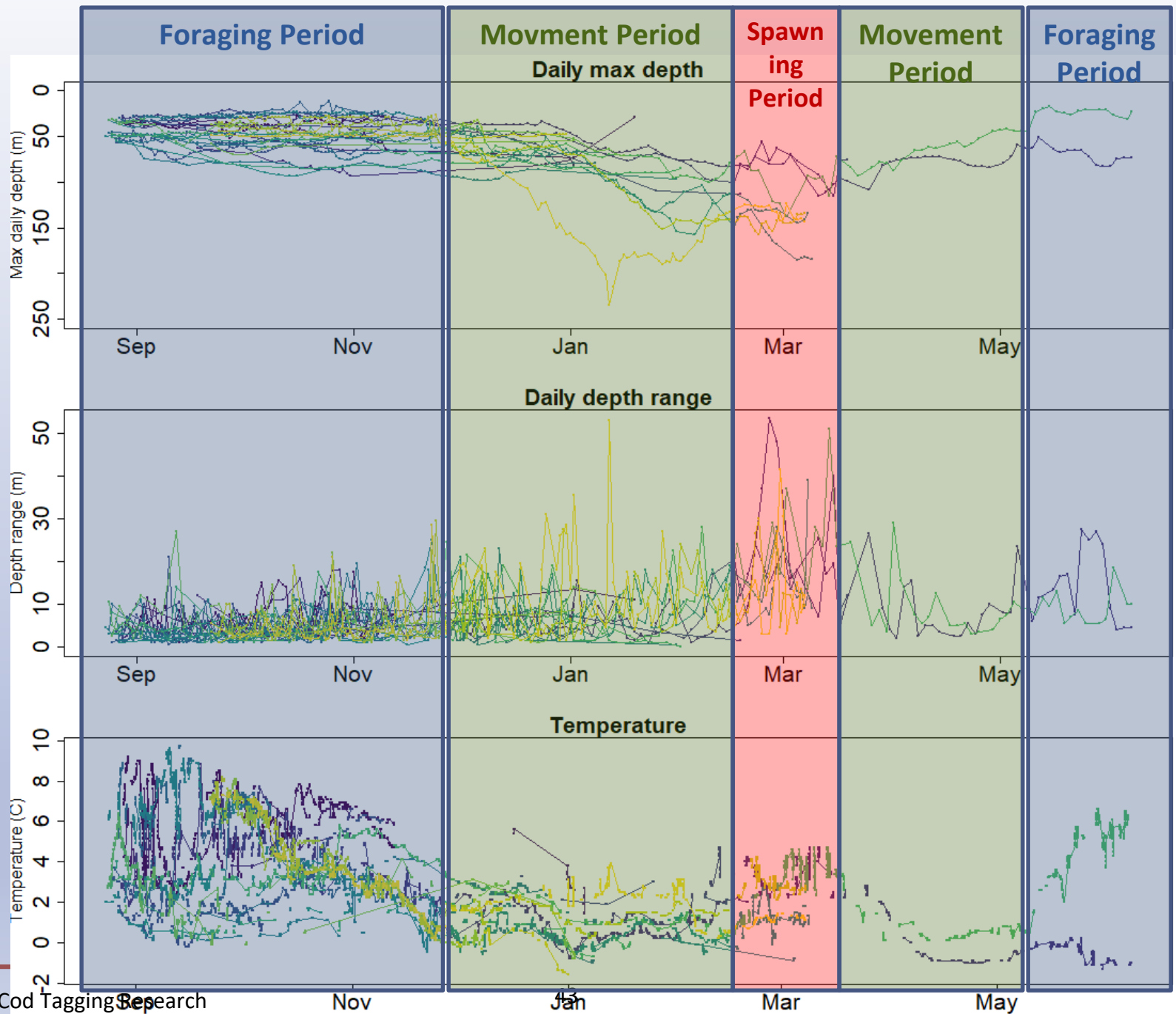


Thanks to
NSEDC, Wes Jones, Dawn Wehde
Savoonga fishermen and plant personnel:
Crew of the Adeline: Capt. Perry Pungowiyi and crew,
Crew of the Scarlett: Capt. Richmond Toolie and crew,
Orville Toolie, Plant manager
AFSC scientists Lyle Britt, Stan Kotwicki, Rebecca Haehn, Liz Dawson, and Duane
Stevenson

Susanne McDermott (susanne.mcdermott@noaa.gov)

Summary of Tag recoveries to date

Scheduled Popup month	# Tags released	Actual Popup month									Missing/ failed	Grand Total
		Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Jun-20	Jul-20		
Nov-19	6			6								6
Dec-19	2				2							2
Jan-20	3					3						3
Mar-20	12		1	1	1	1	1	6			1	12
Jun-20	3						1		2			3
Aug-20	9	1	1			1	1	2			3	9
Sep-20	3	1								1	1	3
Total	38			2	7	5	3	8	2	1	5	38



Pacific cod spawning distribution

AFSC observer data collection aboard fishing vessels with visual maturity key

