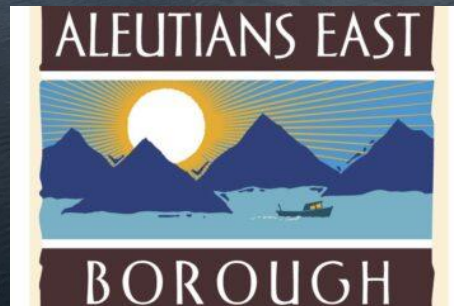


Pacific cod satellite tagging research in Alaska: FLC update

Susanne McDermott¹, Julie Nielsen², Charlotte Levy³, Kimberly Rand⁴, Bianca Prohaska¹, Sean Rohan¹, Alexandra Dowlin¹

¹Alaska Fisheries Science Center, ²Kingfisher Marine Research, ³Aleutians East Borough, ⁴Lynker Technologies





Background

- Warming ocean conditions 2017 - 2019 changed Pacific cod distribution patterns in Alaska waters
 - Bering sea: Northward shift
 - Year-round or seasonal?
 - Gulf of Alaska: Large population decline
 - Migration into Bering sea waters?
- Need information on Pacific cod movement patterns
 - Migration timing, pathways, extent

Studying seasonal movement Pacific cod with Pop-up Satellite Archival Transmitting tags (PSATs)

PSATs

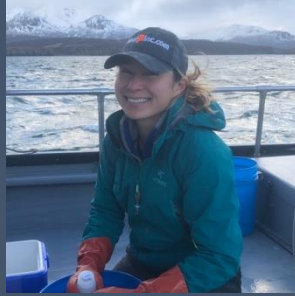
- Fishery independent locations
- Detailed information on migrations
- Information on fish behavior



The Pacific Cod Tagging (PACT) Team



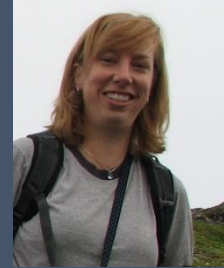
Susanne McDermott
NOAA AFSC



Charlotte Levy
Aleutians East
Borough



Julie Nielsen
Kingfisher Marine
Research



Kim Rand
Lynker
Technologies



Sean Rohan
NOAA AFSC



Alexandra Dowlin
NOAA AFSC



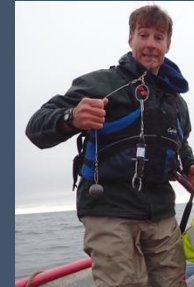
Bianca Prohaska
NOAA AFSC



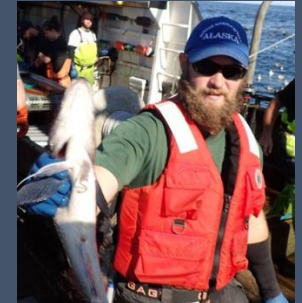
Steve Barbeaux
NOAA AFSC



Ingrid Spies
NOAA AFSC



David Bryan
NOAA AFSC



Pete Hulson
NOAA AFSC

Researchers: Biology, ecology, habitat, movement modeling,
physiology, genetics, otolith chemistry, stock assessment

PACT Collaborators and Funding Sources

Collaborators:

- Pacific Cod Harvesters
- Aleutians East Borough
- Freezer Longline Coalition
- Norton Sound Economic Development Corporation
- Native Village of Savoonga
- Adak Community Development Corporation

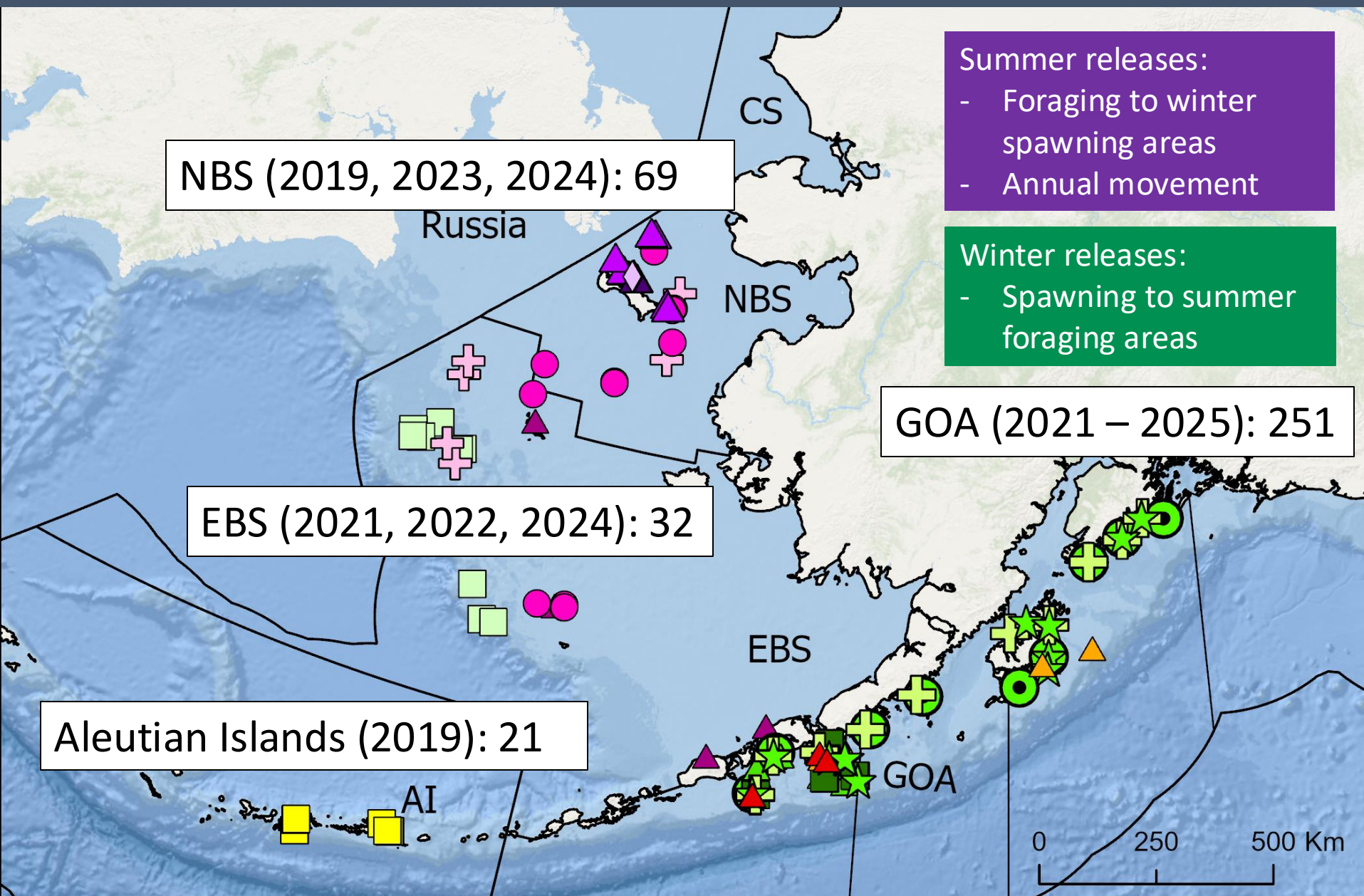
Other Funding Sources:

- Pacific Cod Harvesters
- North Pacific Research Board
- National Cooperative Research Program
- MSA funding
- Gulf of Alaska Pacific cod disaster relief funds



Pacific cod PSAT releases to date:

n = 373



PSAT release platforms

Bering Sea (summer)



NOAA summer survey:
- Capture by rod and reel



Native village of Savoonga:
- Capture by hand line

PSAT release platforms

Gulf of Alaska (winter)



Chartered survey:
F/V Decision



- Capture in pots and brought to surface in 4 stages
- Depths < 100 m
- Released with descender
- Biological samples collected
- Conventional tags released

PSAT release platforms

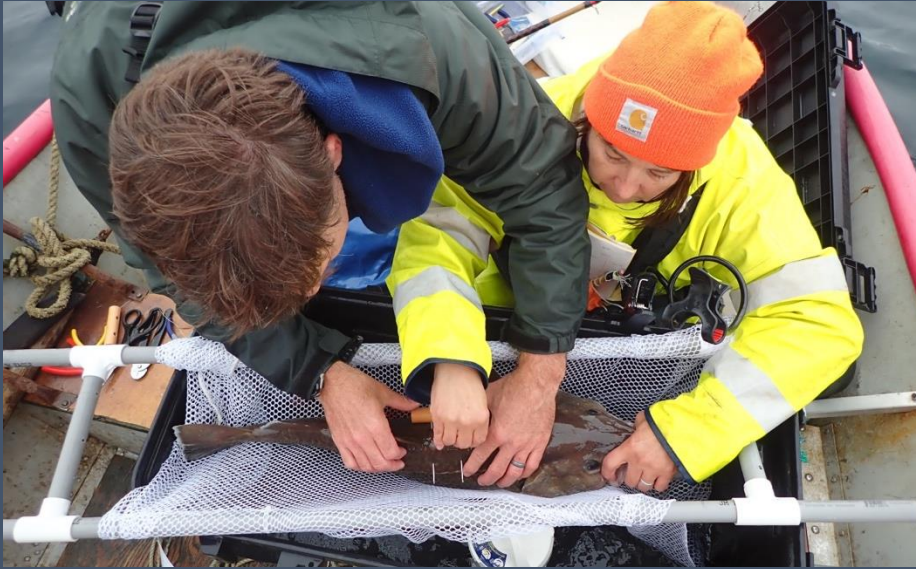
Bering Sea (winter)



F/V Beauty Bay

- Capture on commercial longline vessel
- Depths < 100 m

Attach tag with “backpack” harness



Pop-up Satellite Archival Tags (PSATs)

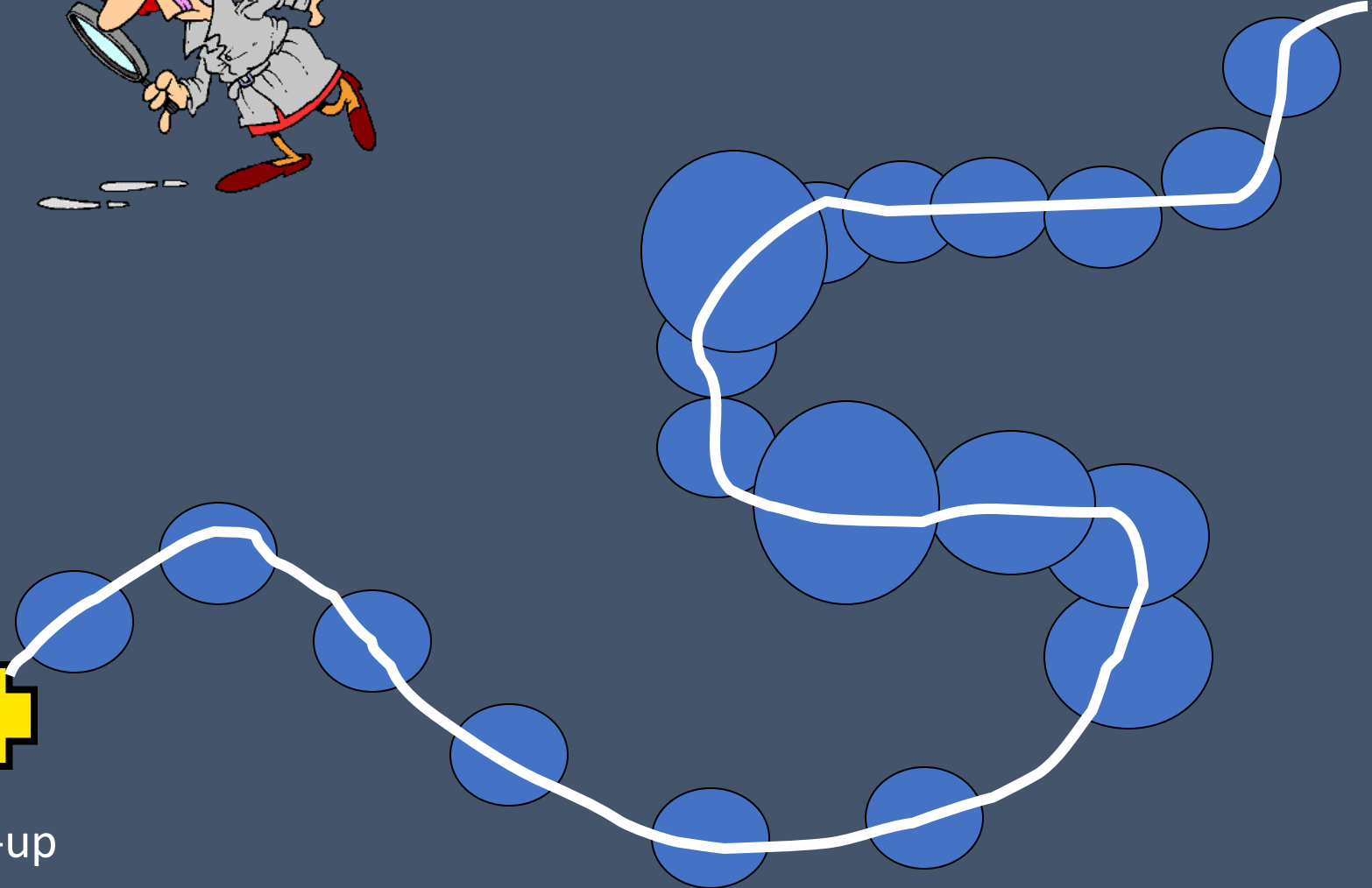
- Wildlife Computers MiniPAT
- Measure depth, temperature, light, acceleration
- Programmed to pop up at different times throughout the year
- Pop-up location and estimated travel paths (geolocation)
- Genetic samples from all tagged fish

Geolocation with PSAT data

Release



Pop-up

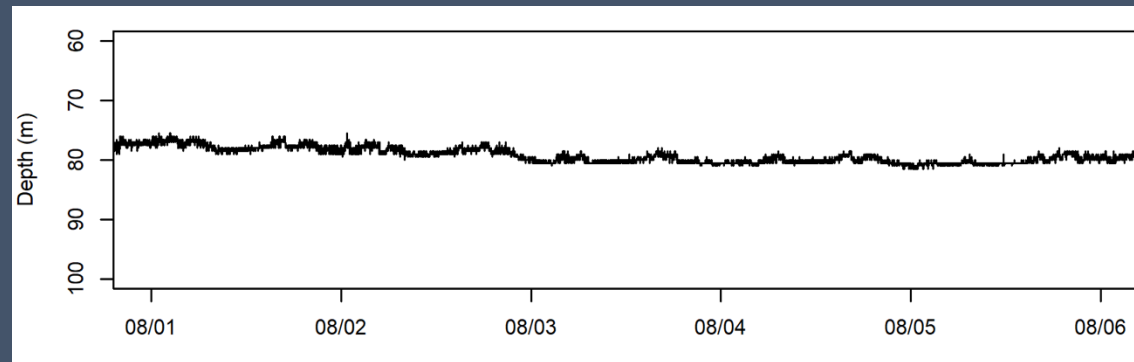


PSAT data “clues”



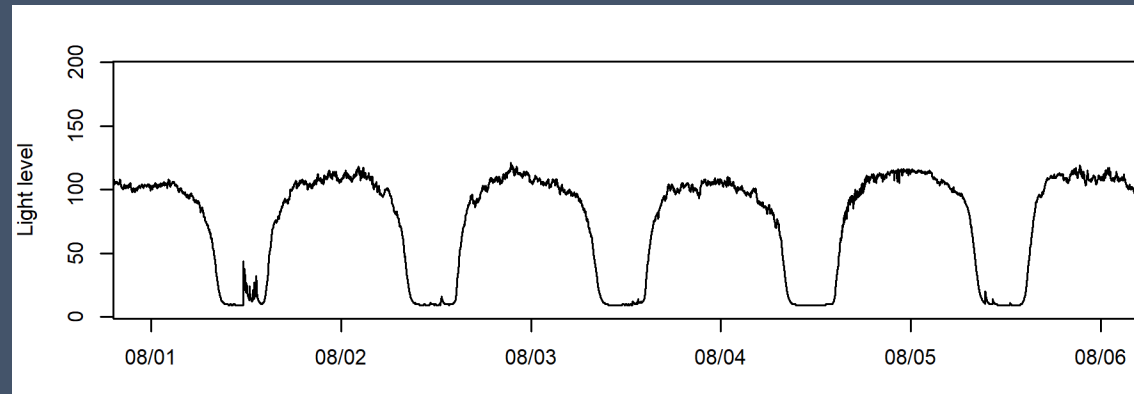
Depth:

- Maximum daily depth = ocean bottom
- Link to bathymetric map



Light:

- Time of local noon = longitude
- Time of dusk and dawn = latitude



Geolocation model

Hidden Markov model (HMM)

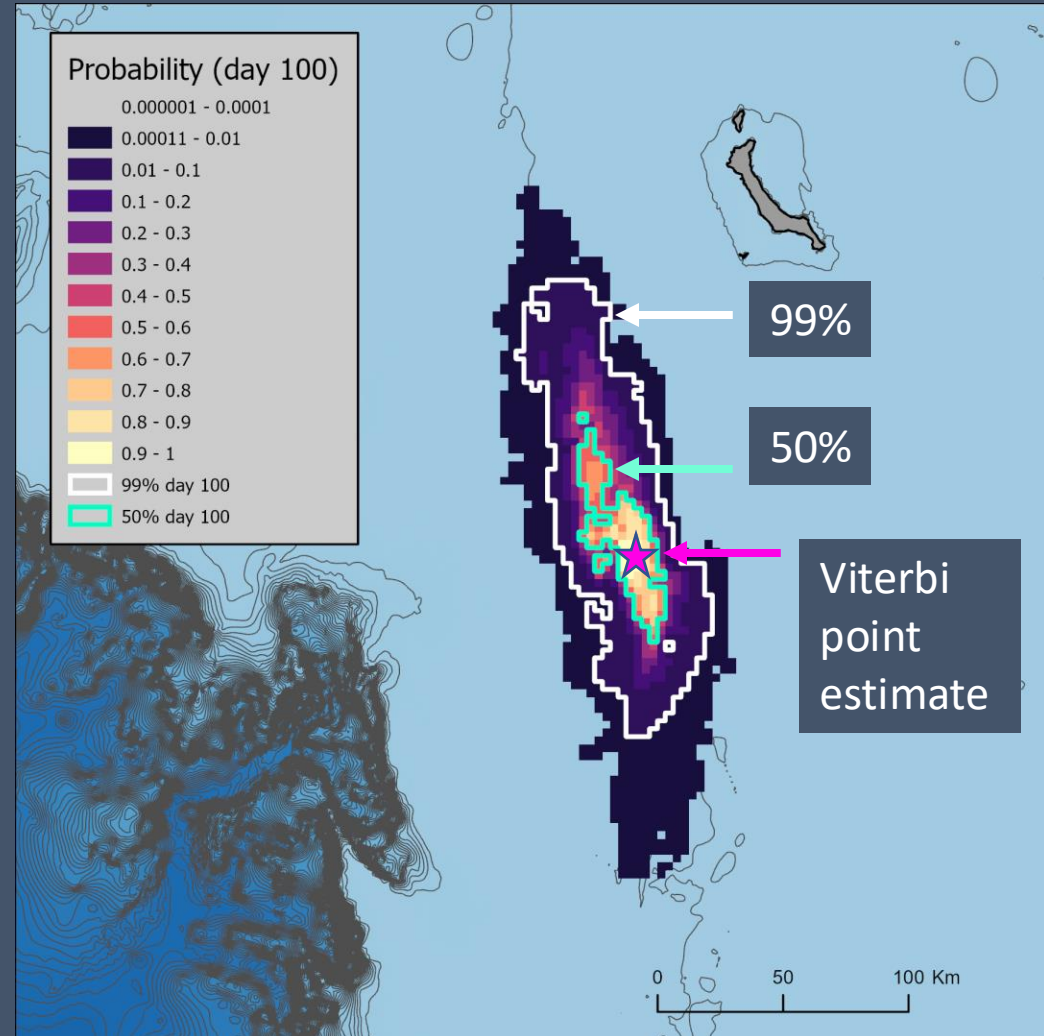
- Developed by Martin Pedersen et al. for Atlantic cod
 - **Pedersen et al., 2008.** Geolocation of North Sea cod (*Gadus morhua*) using hidden Markov models and behavioural switching. CJFAS.
- Adapted for use with Pacific cod in North Pacific Ocean using PSAT data
 - **Nielsen et al., 2023.** Geolocation of a demersal fish (Pacific cod) in a high-latitude island chain (Aleutian Islands, Alaska). Animal Biotelemetry.



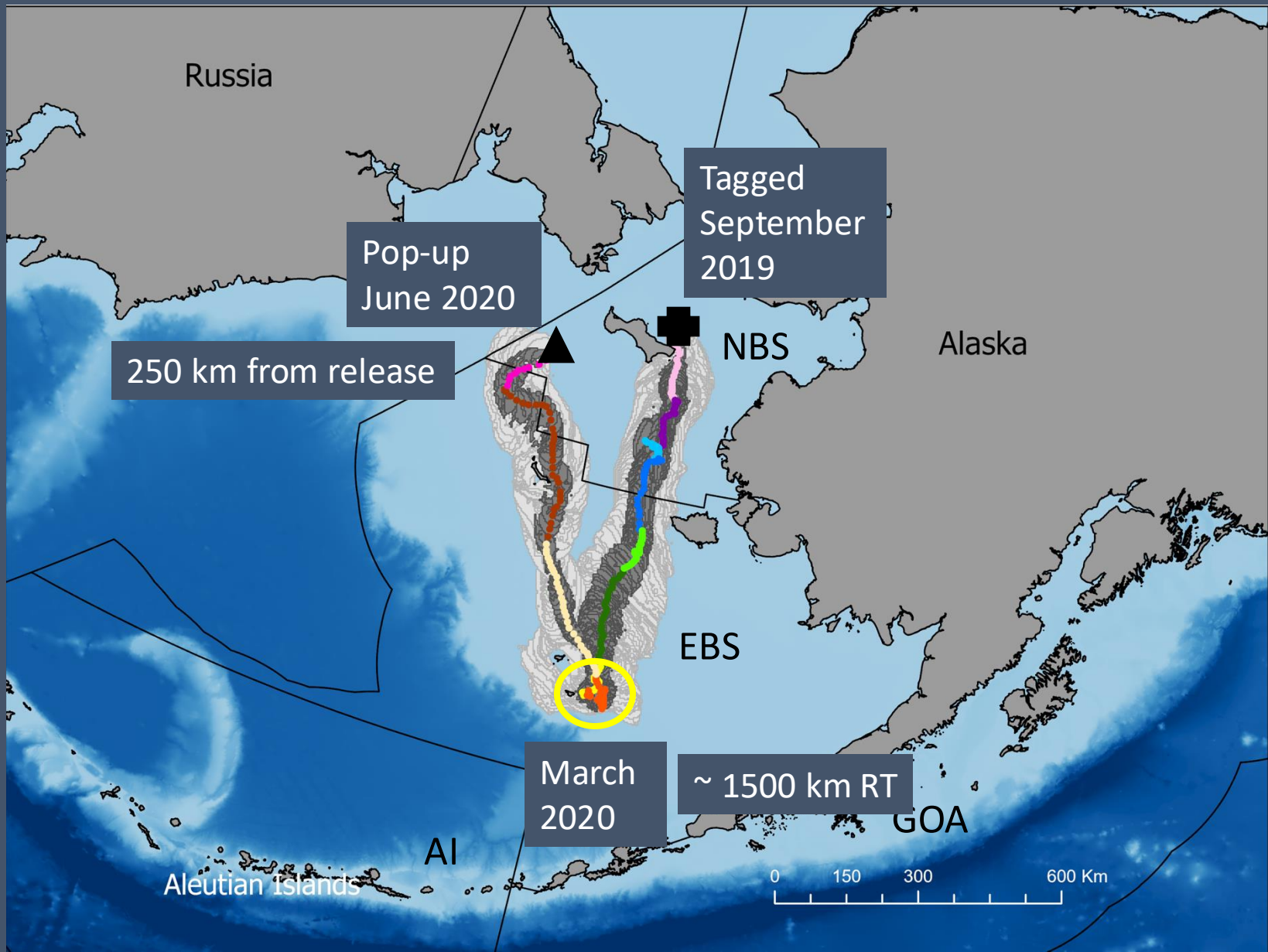
Geolocation model

Model outputs:

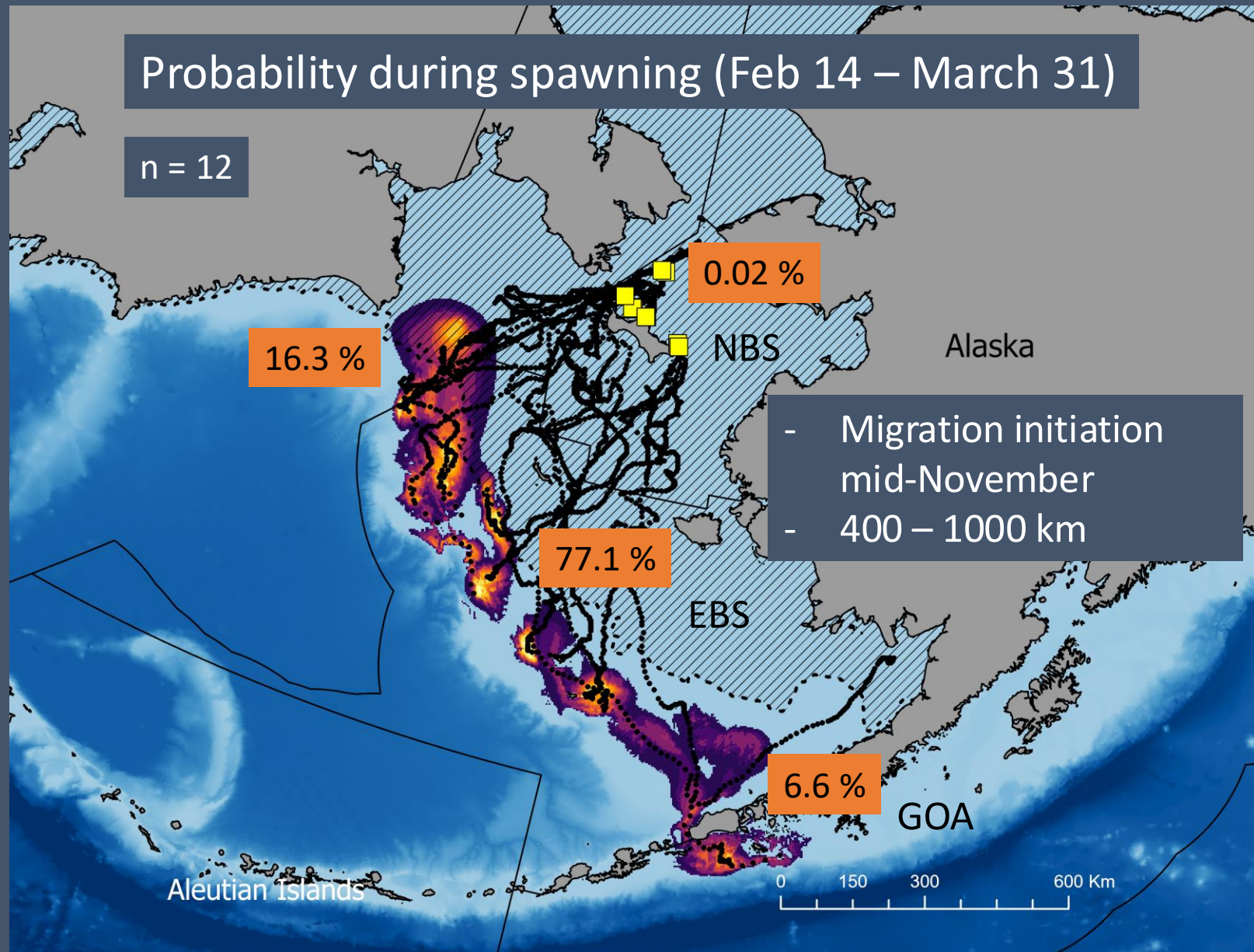
- Probability in each grid cell each day
- Individuals:
 - polygons that encompass highest 50% and 99% of the probability each day
 - Viterbi point locations each day
- All tags: combine probabilities cell-wise by time period
 - Monthly
 - Spawning
 - Summer foraging



Reconstructed pathways

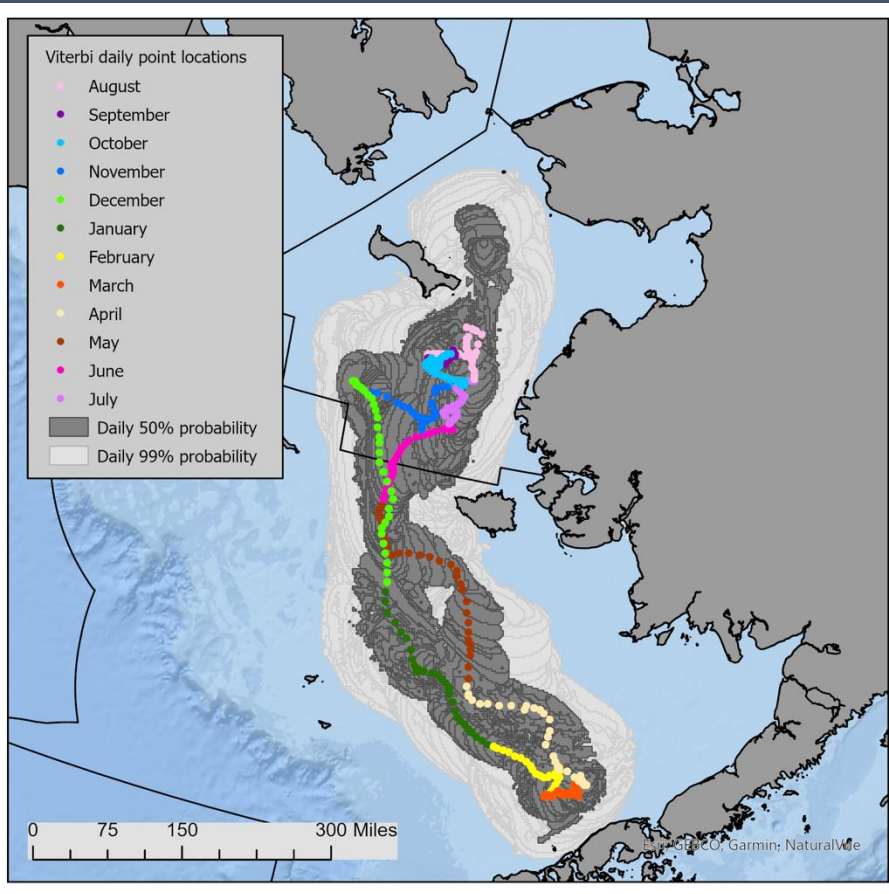


Movement to spawning areas from NBS (2019)

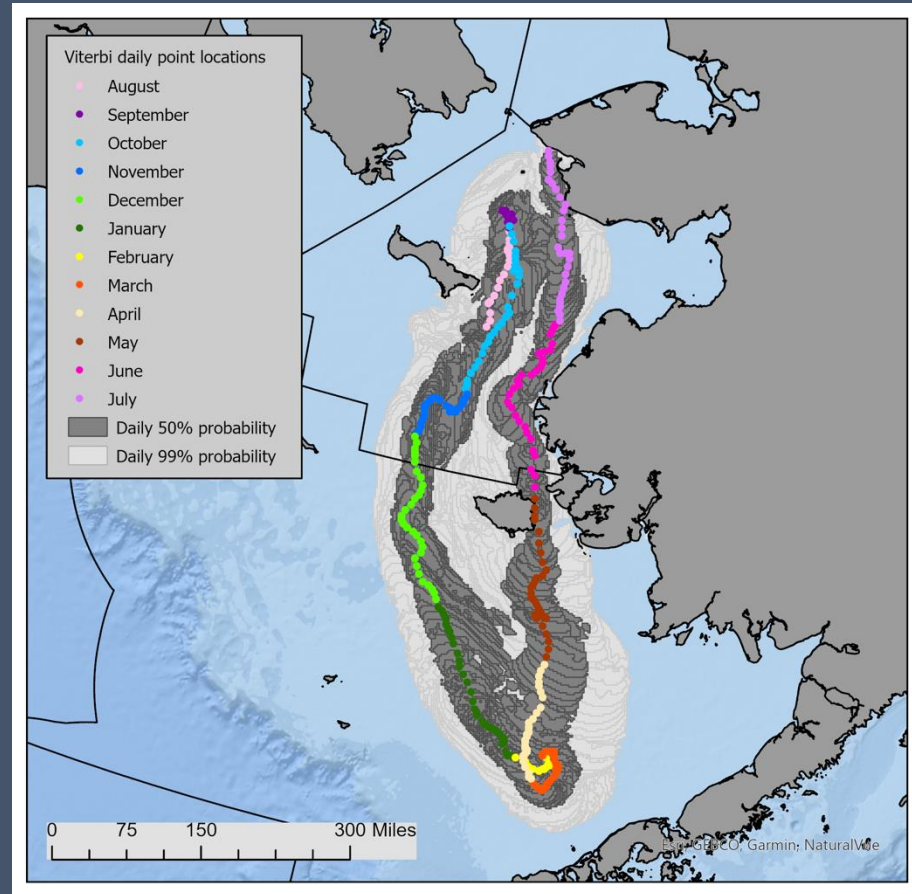


NBS tagging – summer to summer

Leave NBS Nov/Dec

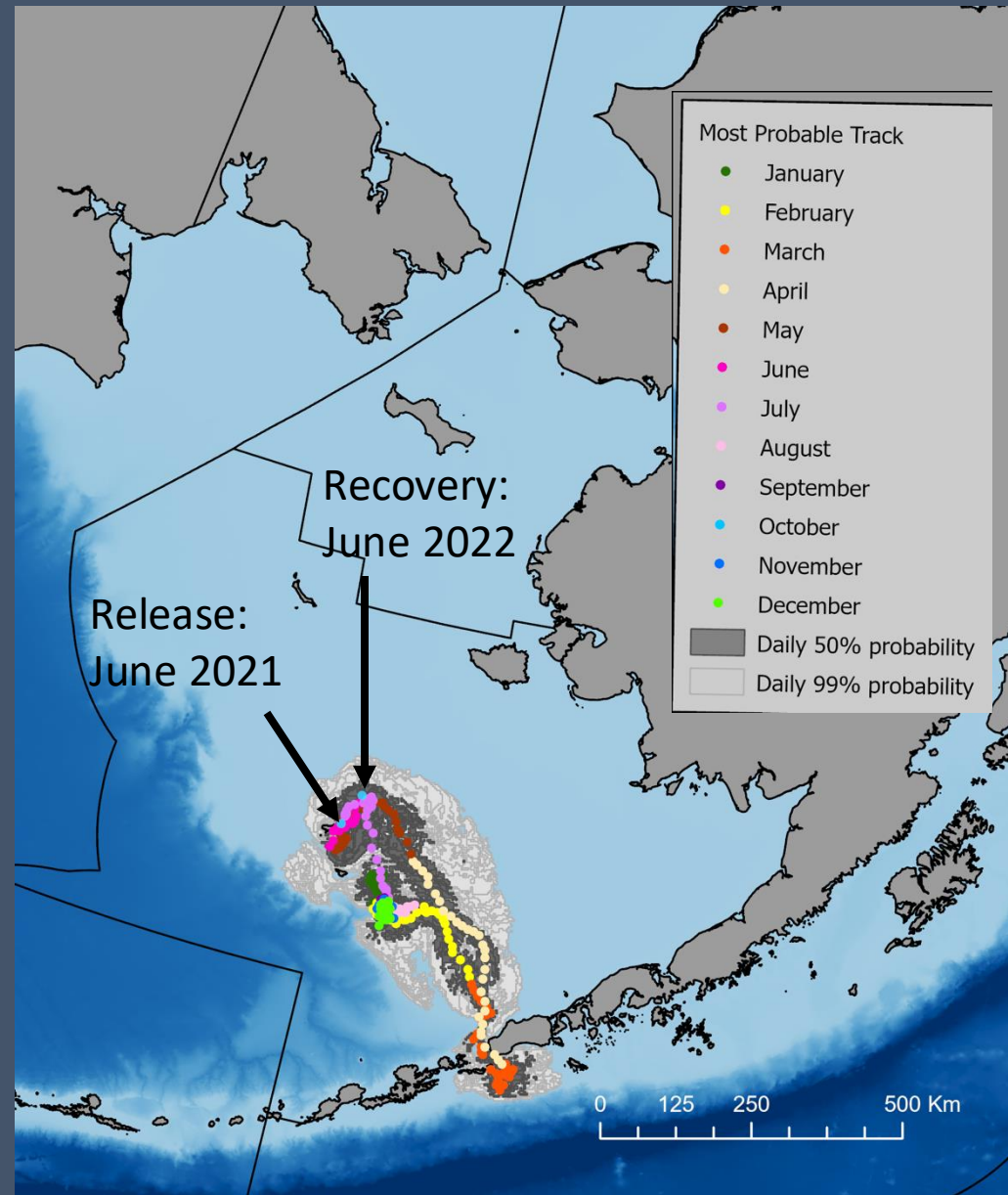


Return in June



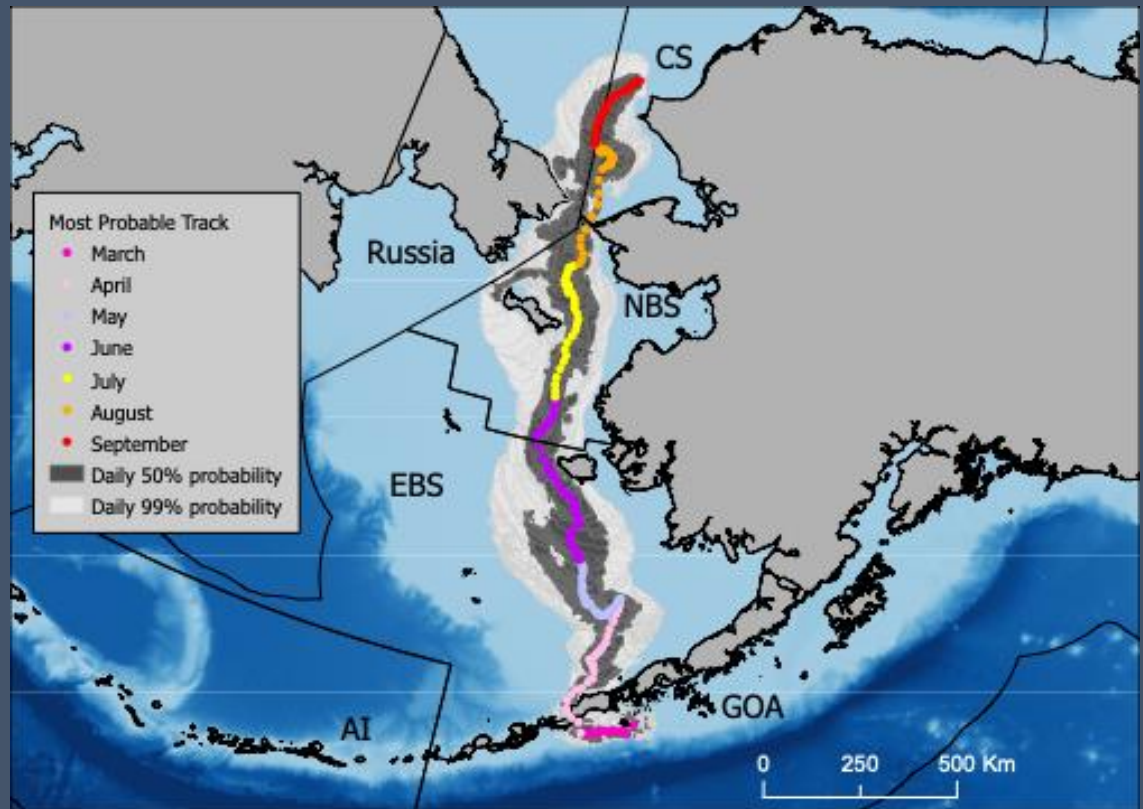
EBS tagging – summer to summer

- Migration to areas within EBS or to WGOA
- Summer site fidelity

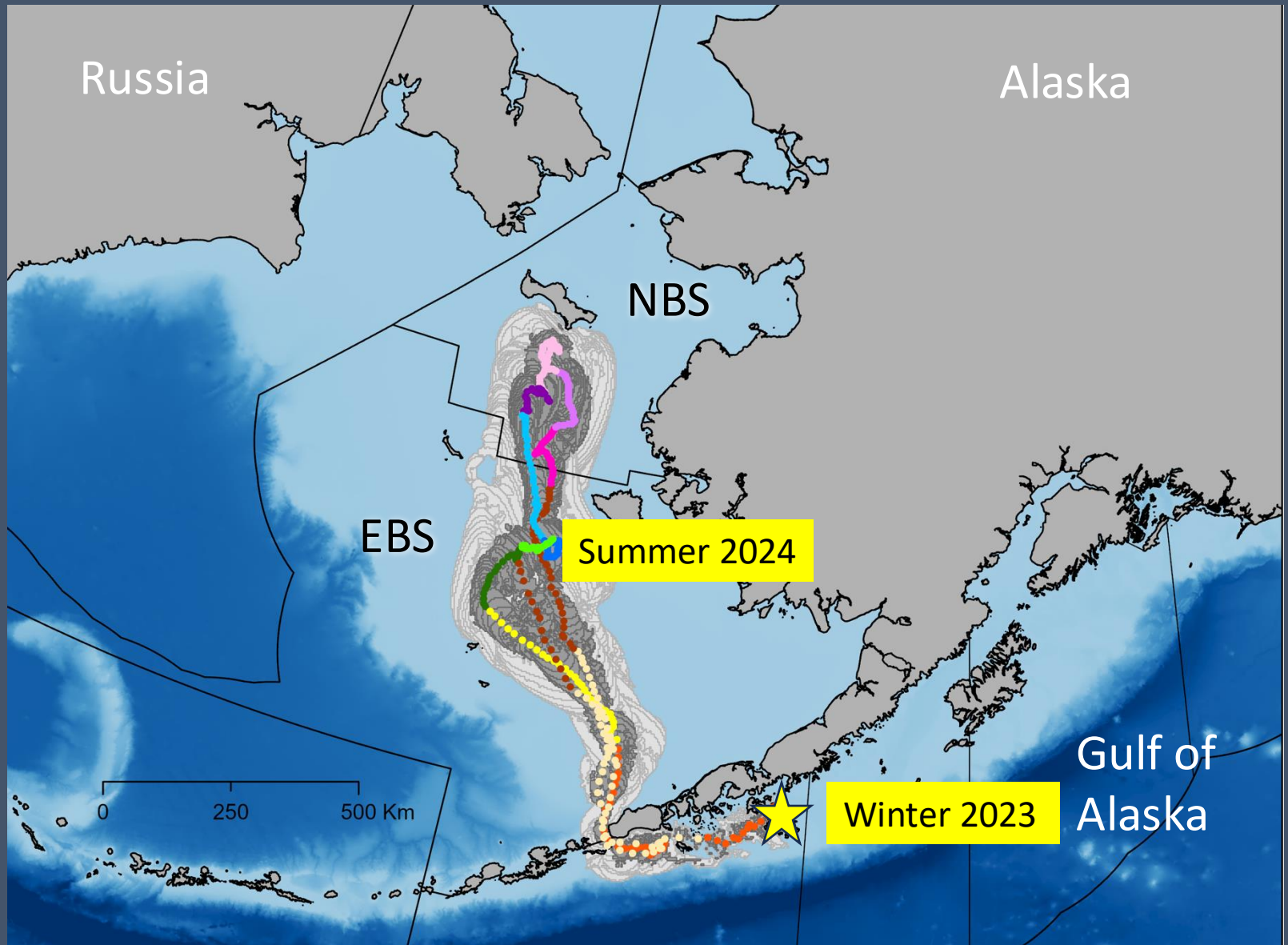


GOA tagging – winter to summer

- Migration to Bering Sea
- Year-round residents

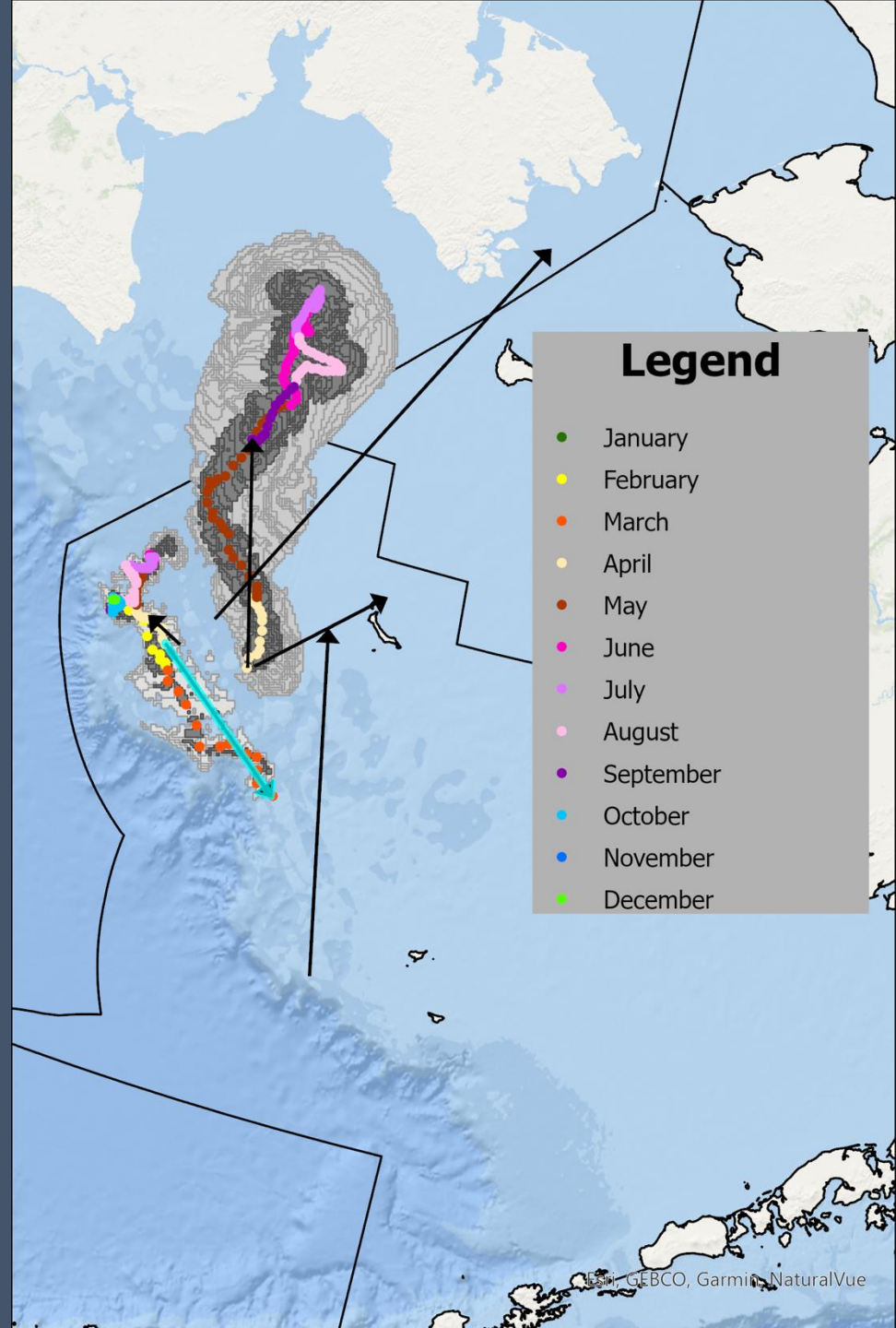


GOA tagging – winter to summer



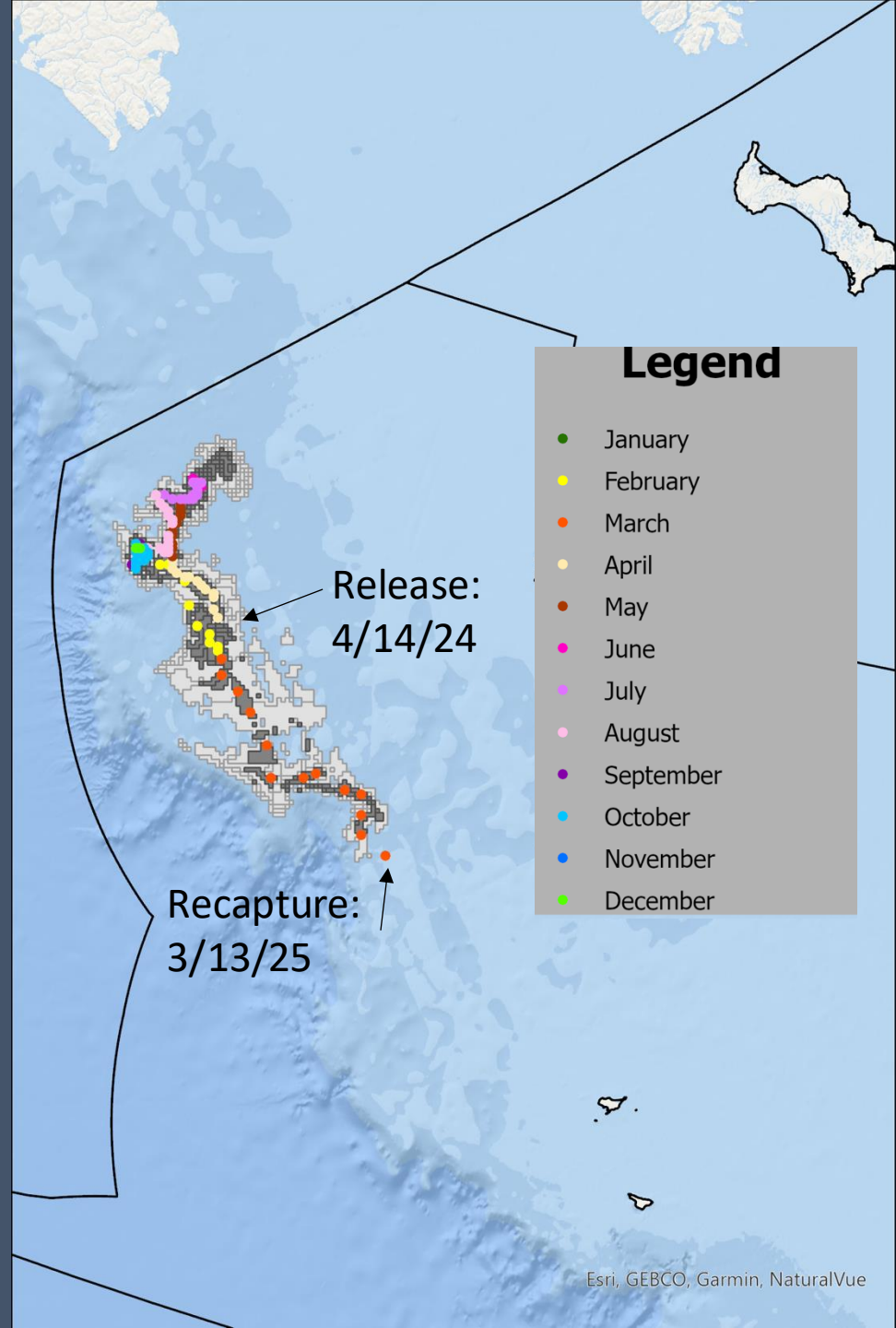
EBS – winter tagging

10 tags deployed April 2024
6 trajectories, 1 still at liberty

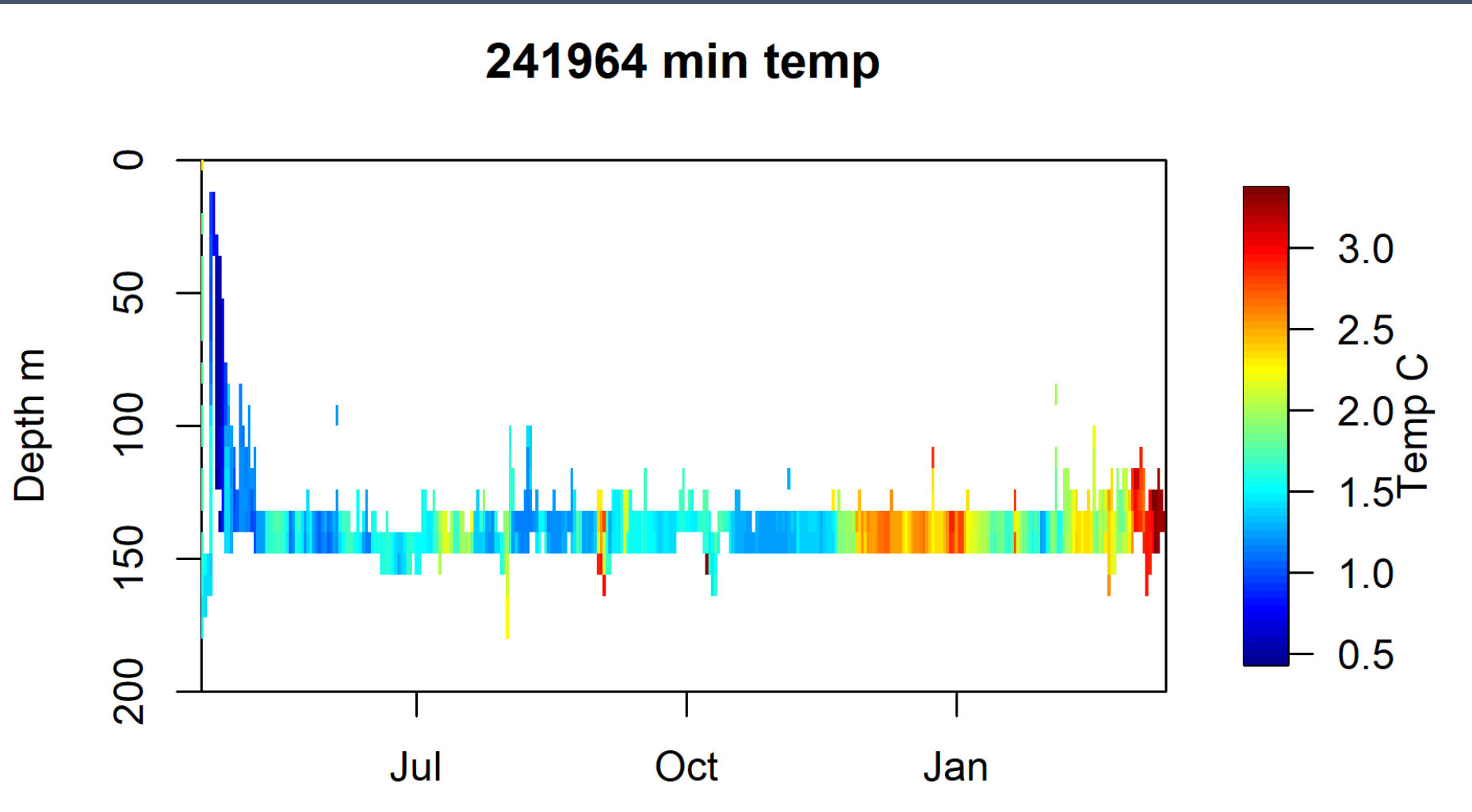


Physically recovered tag

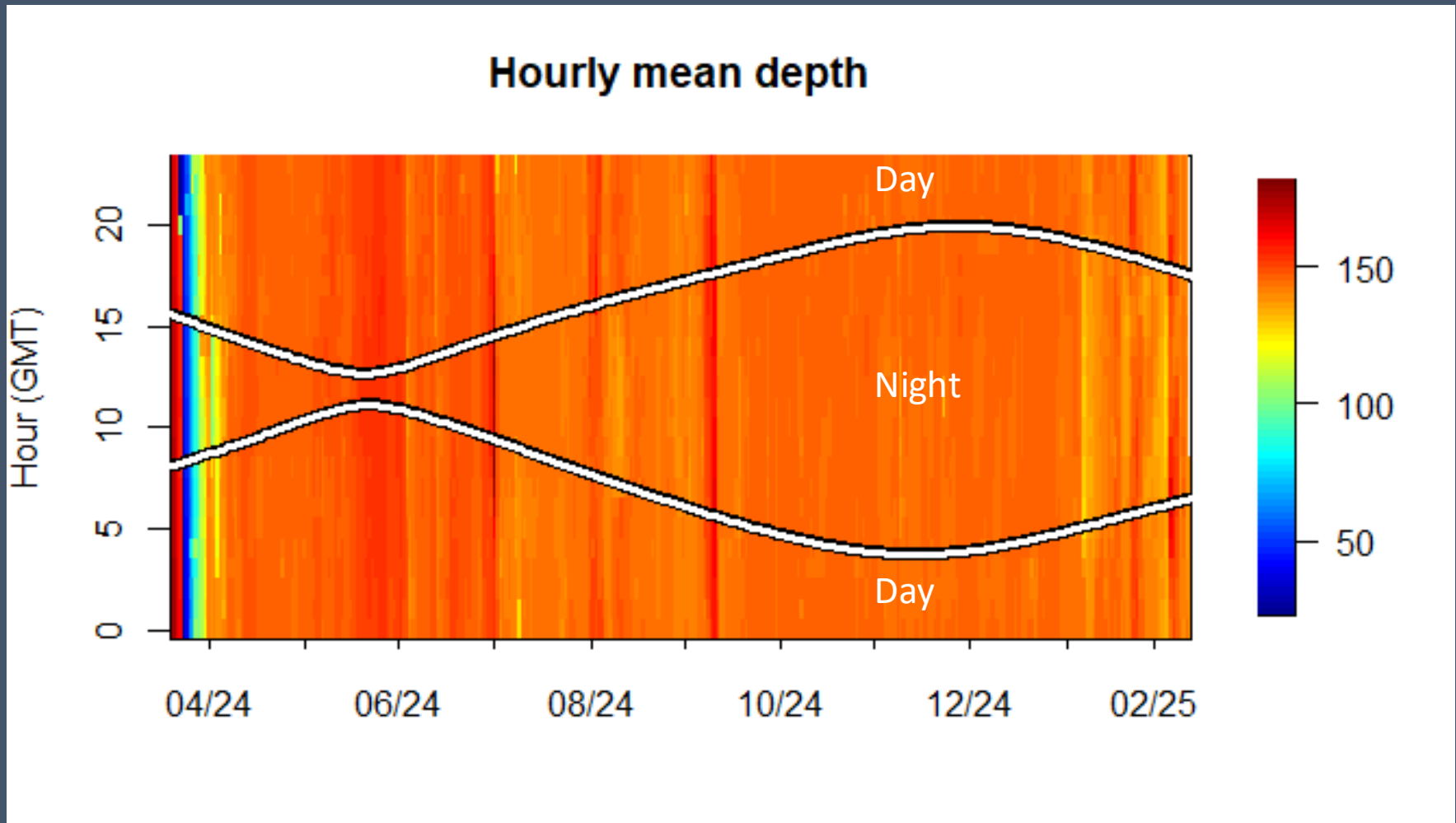
- Released 4/14 Beauty Bay
- Recaptured 3/13 Clipper Epic
 - Female, pre-spawn



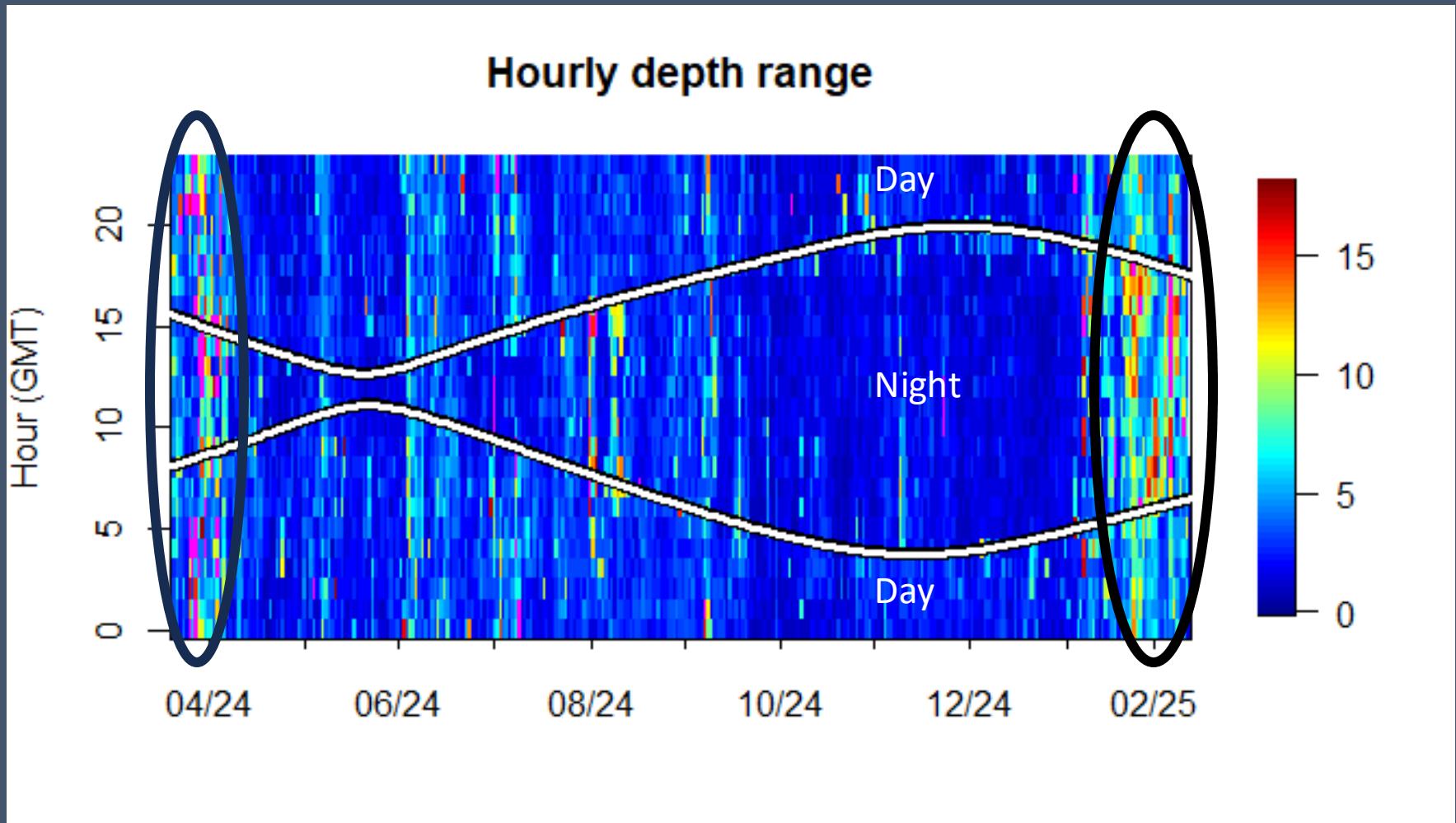
Detailed data set: depth and temperature records



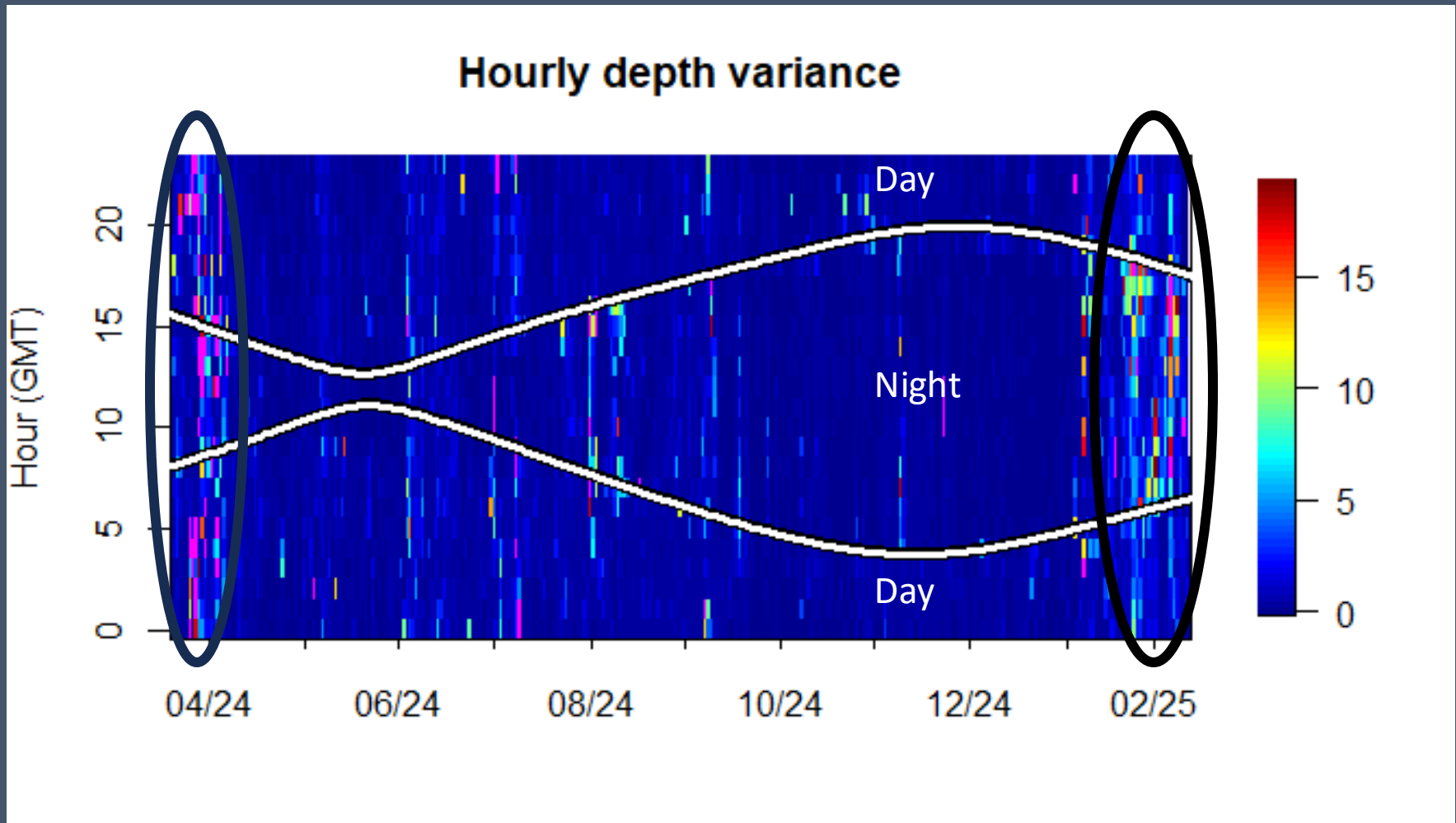
Detailed data set: activity patterns



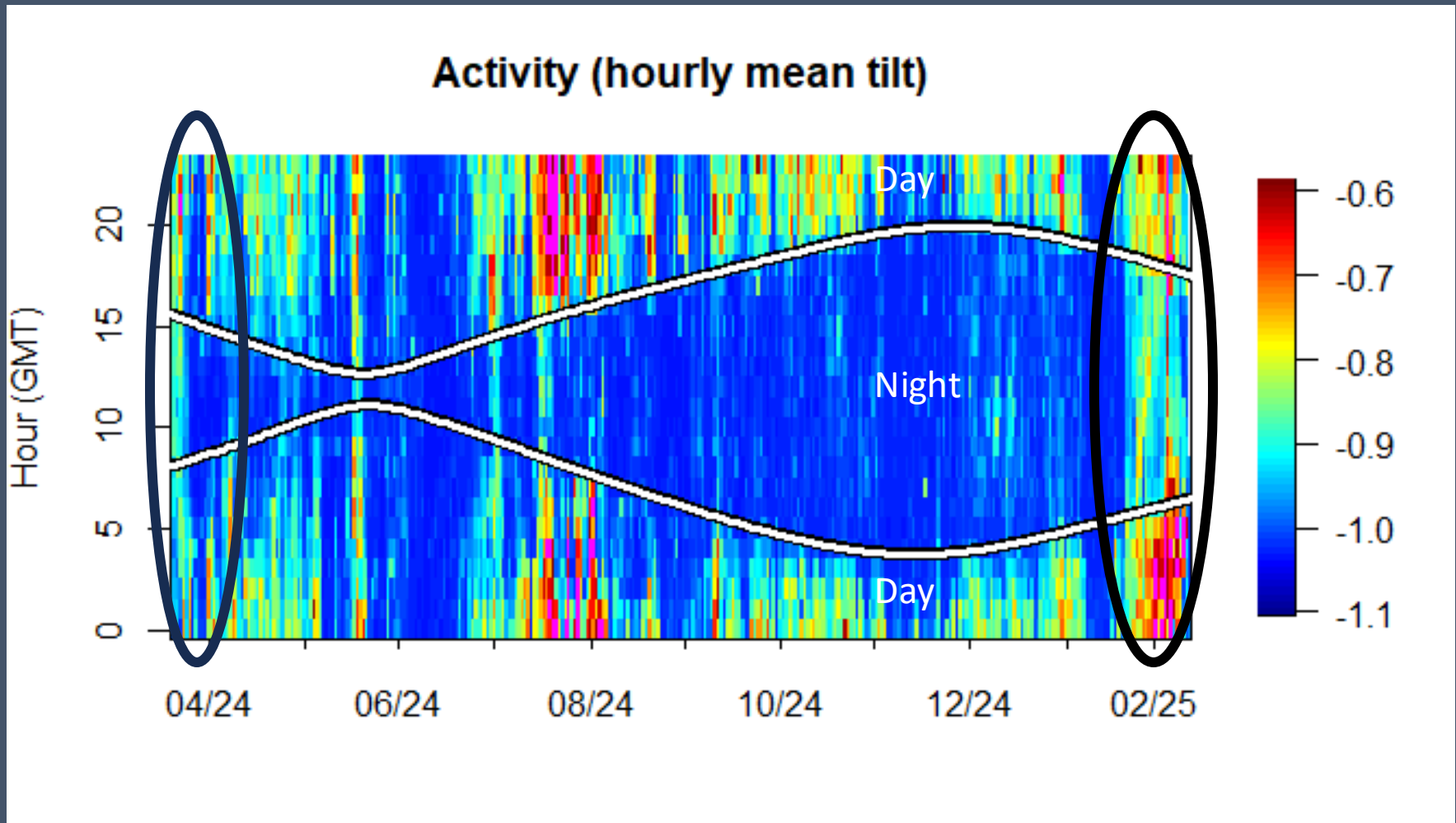
Detailed data set: activity patterns



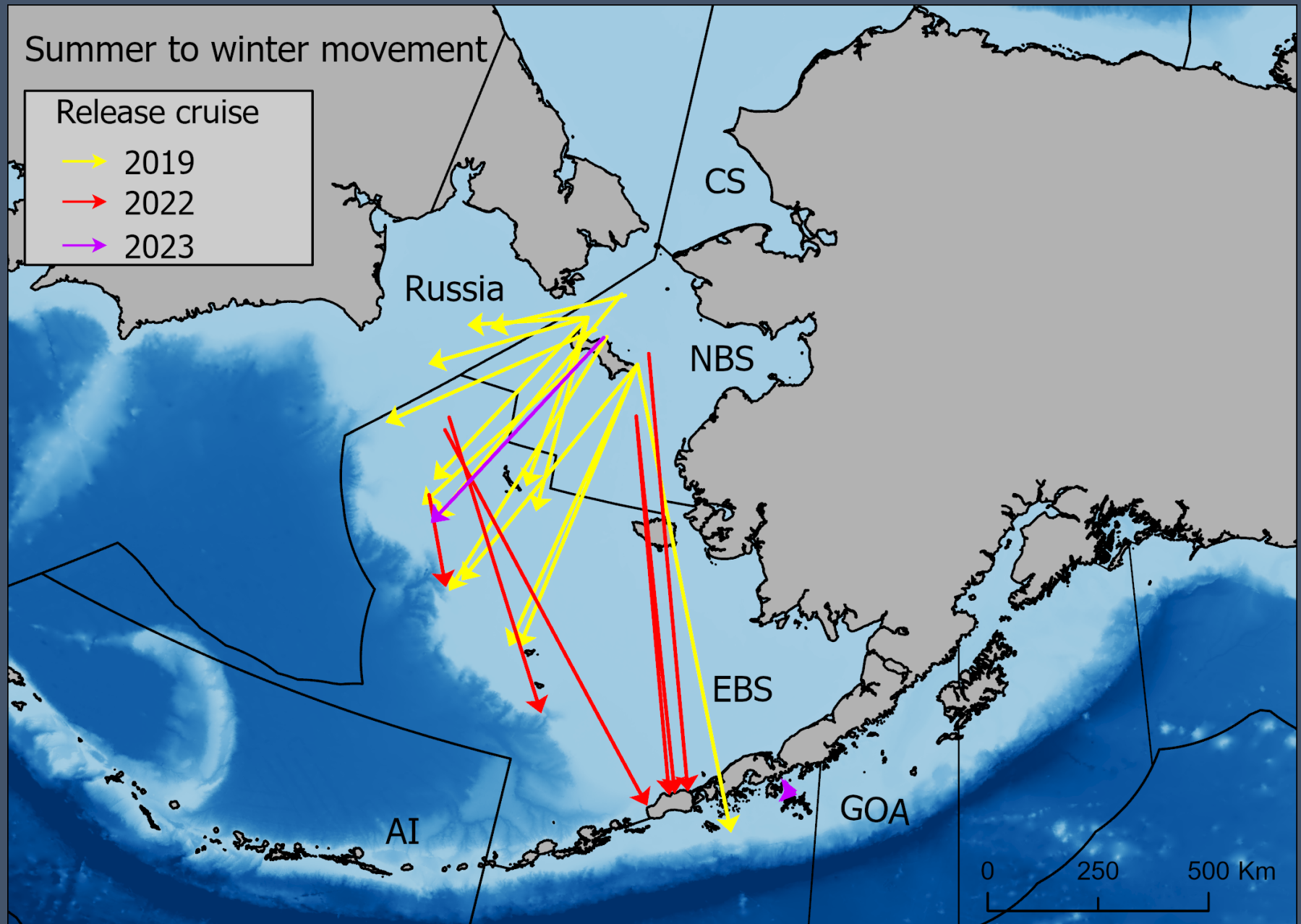
Detailed data set: activity patterns



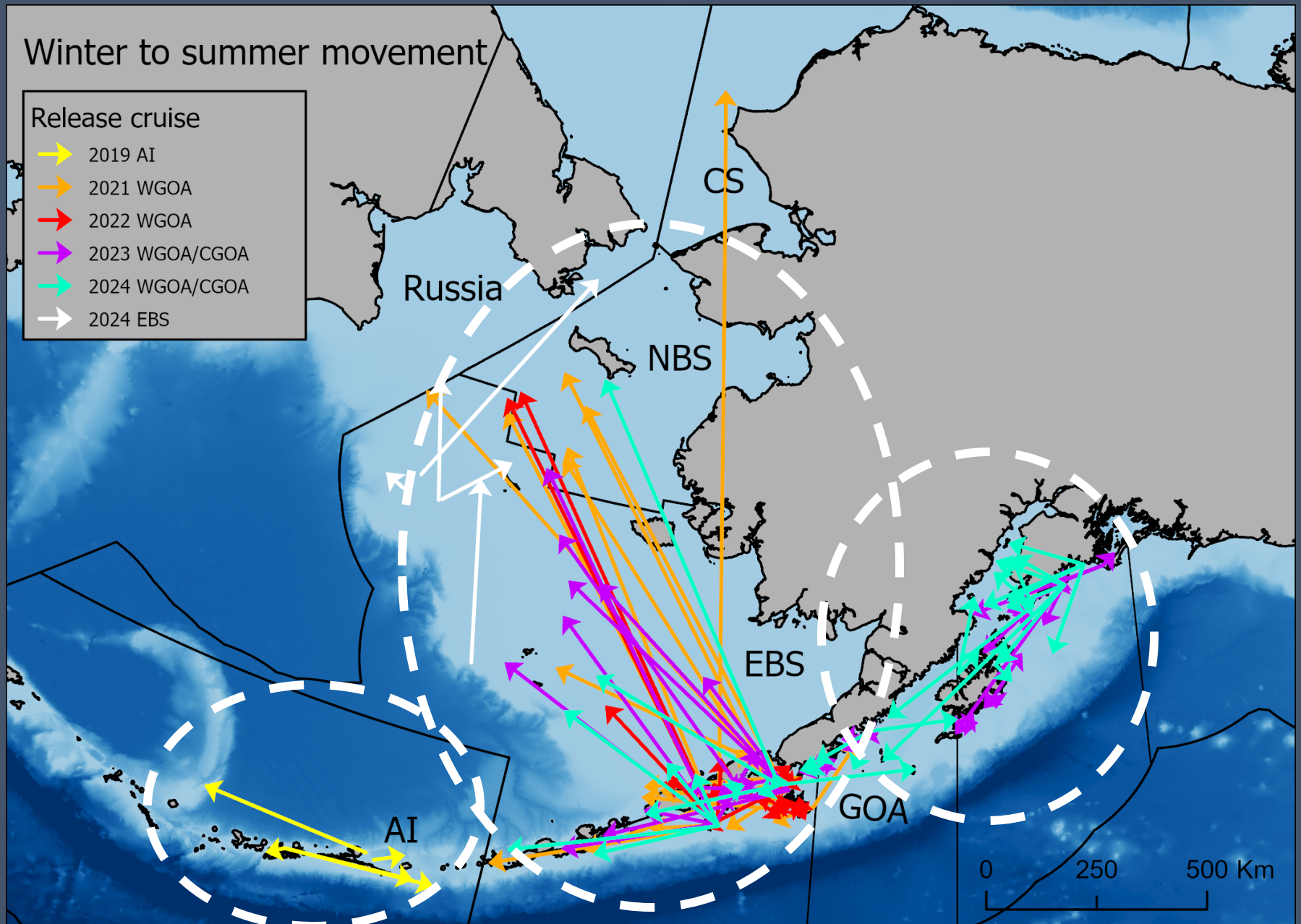
Detailed data set: activity patterns



Summer to winter



Winter to summer



PSAT insights

- NBS – currently summertime destination
 - No fish observed to remain there in winter
 - Too cold on shallow shelf under sea ice (-1.8 C)
 - Fish from EBS, WGOA, Russia
- Seasonal connectivity
 - Western Gulf and Bering Sea
- Year-round connectivity with Russian waters
 - Greater during summers with warmer temperatures

PSAT advantages

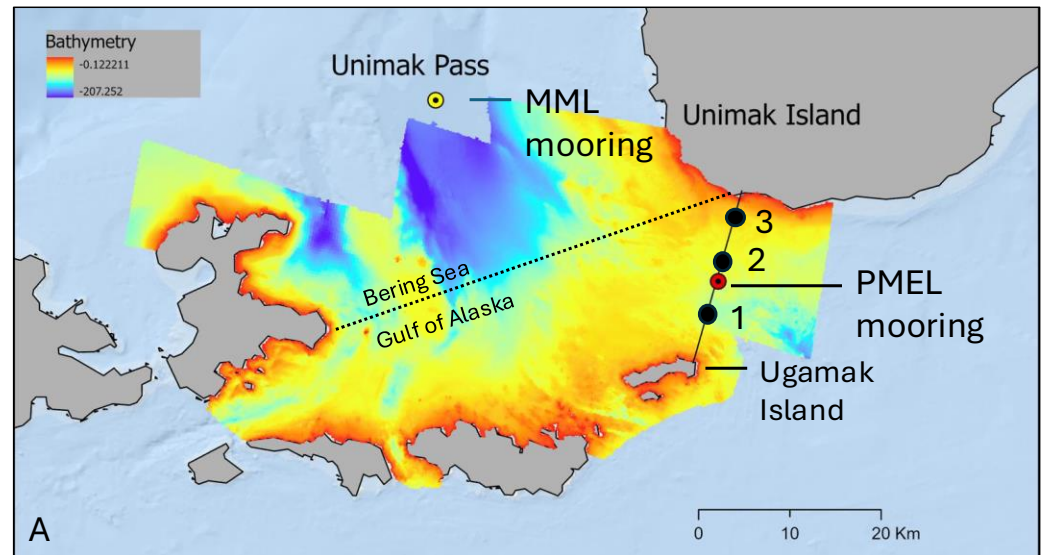
- Migratory vs. residents → work with Ingrid
- Timing of migration
- Migration pathways
- Time on spawning grounds
- Return to summer foraging areas
- Temperatures and depths occupied
- Behavior
 - Day/night
 - Depth changes
 - Activity patterns

PSAT limitations

- Tag battery/programming issues (2023/2024)
- Poor transmission in winter months
- Latitude needed to determine movement into Gulf
- Limited to 1 or 1.5 years
- Expensive

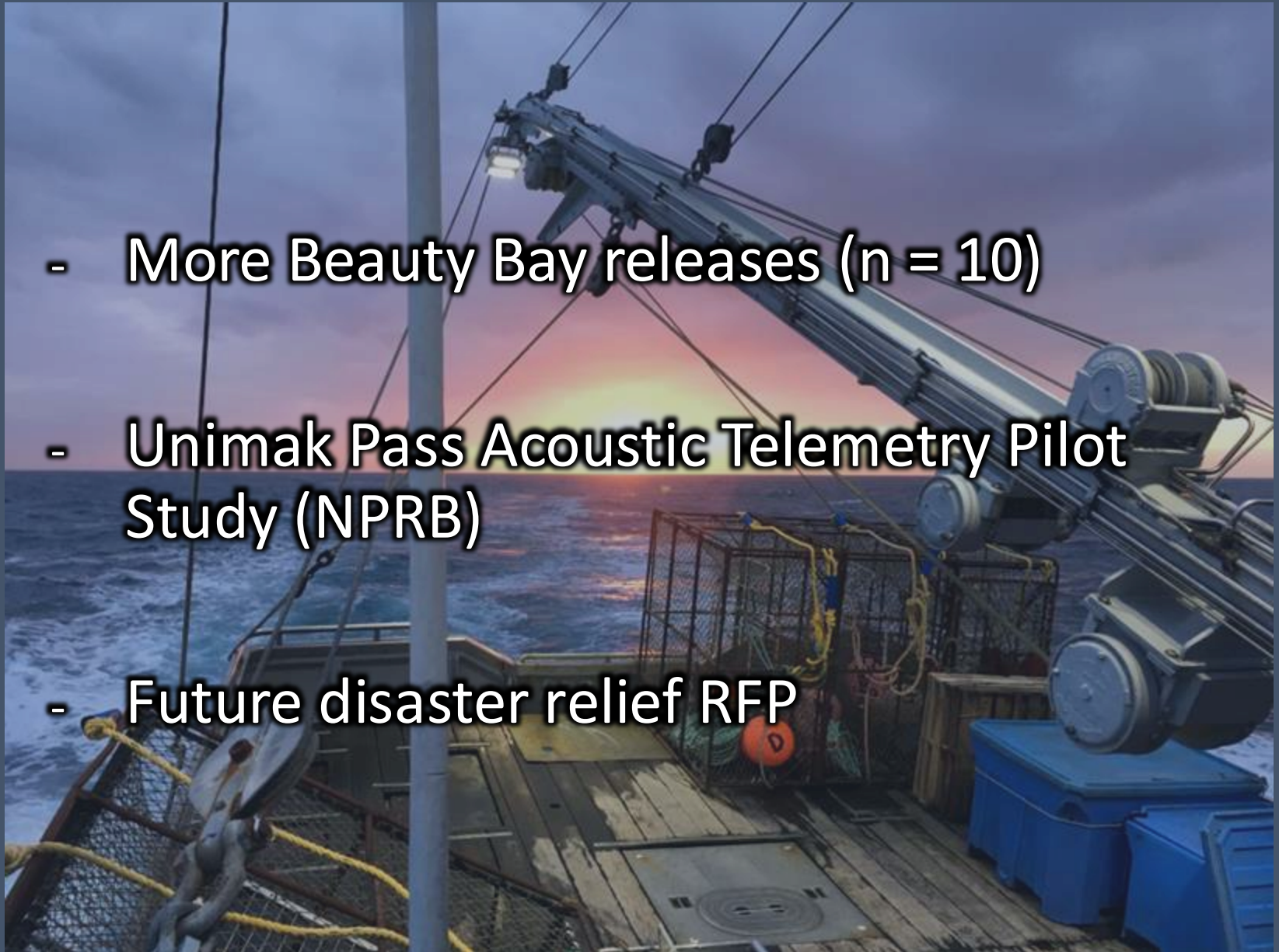
Proposed acoustic telemetry pilot study in Unimak Pass

- Kingfisher Marine Research
- Aleutians East Borough
- NOAA



Current and future research

- More Beauty Bay releases ($n = 10$)
- Unimak Pass Acoustic Telemetry Pilot Study (NPRB)
- Future disaster relief RFP



Thank you!

AFSC survey charter vessels and crew (F/V Vesteraalen and F/V Alaska Knight)

Native Village of Savoonga

Norton Sound Economic Development Corporation

F/V *Decision* (Capt. Kiley Thompson and crew)

F/V *Beauty Bay* (Capt. Scott Hansen and crew)

Jim Armstrong, FLC



Comments? Questions?
Julie.Nielsen@gmail.com
Susanne.McDermott@noaa.gov

NMFS Scientific personnel:

Duane Stevenson

Cecilia O'Leary

Ned Laman

Adriana Meyers

Sean Rohan

Bianca Prohaska

Nicole Charriere

Jennifer Gardner

Cynthia Yeung

Reyn Yoshioka

Lukas DeFilippo

Chris Long

Emily Ryznar

Emily Markowitz

Rebecca Haehn

Stan Kotwicki

Lyle Britt

Dan Nichol