



**NOAA
FISHERIES**

Alaska Fisheries Science Center

Protected Species Science Program Review

Theme 3: Phocid Pinniped Science

Ice-associated seals



Polar Ecosystems Program

Peter Boveng

16-20 March 2015

Introduction to Ice-associated Seals

- Bearded seal

Length: 2.4 m (7.9 ft)

Weight: 250 kg (550 lb)

Abundance: >300,000 U.S.; total unk

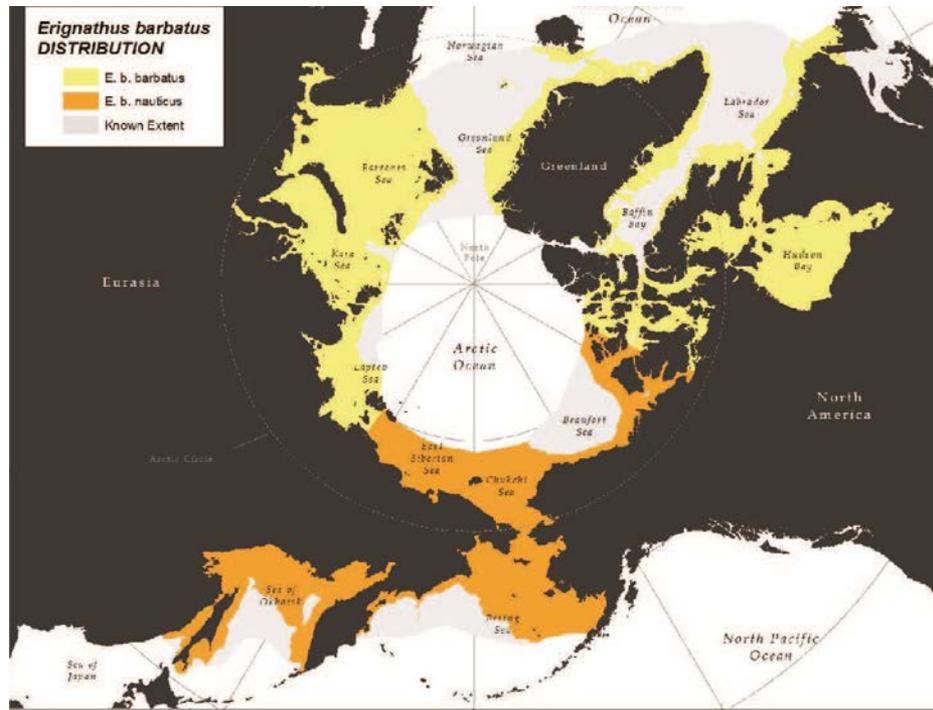
Trend: unknown

Habitat and life history: Pupping, mating and molting in broken ice; shallow, continental shelf waters year round; benthic feeding

Legal status, threats, mandates: ESA Threatened & MMPA Depleted, Beringia & Okhotsk DPSs; Beringia DPS vacated by District court; threatened by loss of ice in major portion of breeding range



P. A. Folkens



Introduction to Ice-associated Seals

- Ringed seal

Length: 1.1 m (3.6 ft)

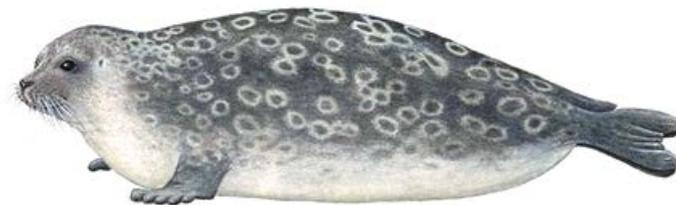
Weight: 79 kg (154 lb)

Abundance: unknown, >1M?

Trend: unknown

Habitat and life history: Pupping, mating and molting in shore-fast ice, low density in pack ice; widely dispersed in open-water period

Legal status, threats, mandates: ESA Threatened & MMPA Depleted (all marine sub-spp.); threatened by loss of sea ice and snow cover for breeding lairs



P. A. Folkens



Introduction to Ice-associated Seals

- Spotted seal

Length: 1.7 m (5.6 ft)

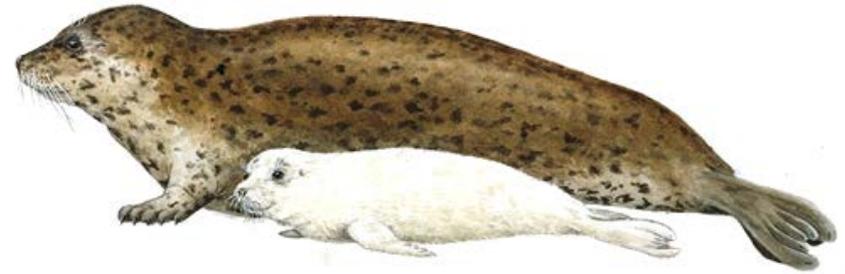
Weight: 123 kg (270 lb)

Abundance: 460,000 U.S.; total unk.

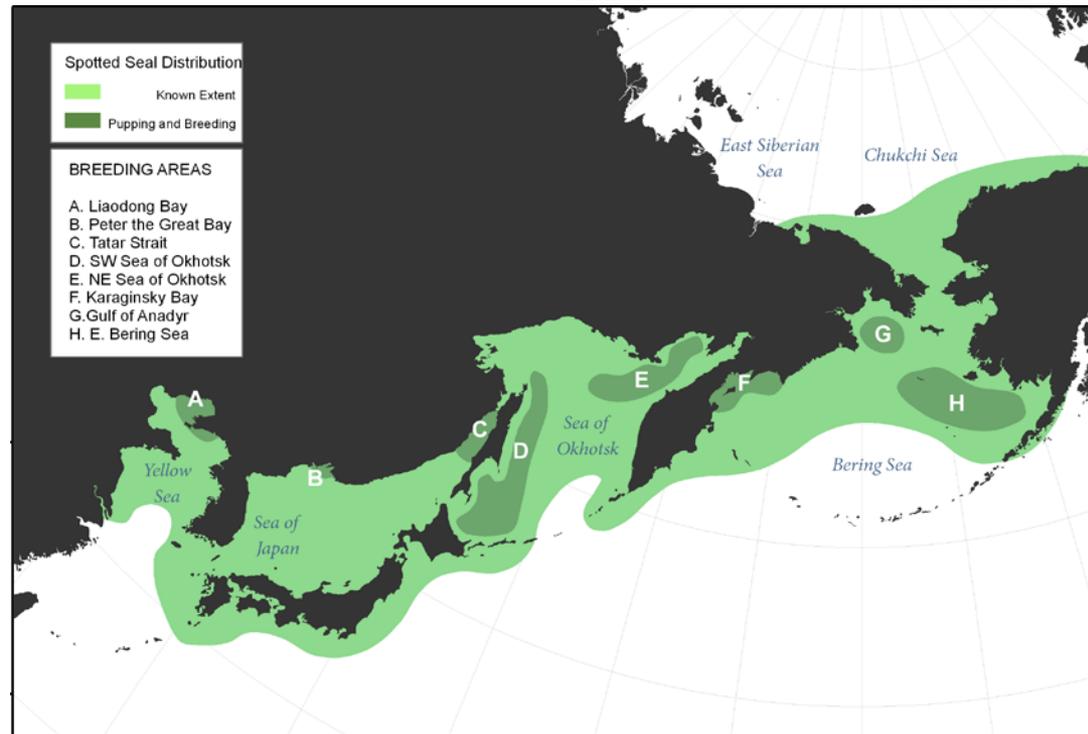
Trend: unknown

Habitat and life history: Pupping, mating and molting in marginal ice zone; open-water period in estuaries or offshore; continental shelf dweller year round

Legal status, threats, mandates: ESA Threatened & MMPA Depleted, Southern DPS only (not U.S. waters; least sensitive to loss of sea ice habitat?)



P. A. Folkens



Introduction to Ice-associated Seals

- Ribbon seal

Length: 1.7 m (5.6 ft)

Weight: 90 kg (200 lb)

Abundance: 184,000 U.S.; total unk.

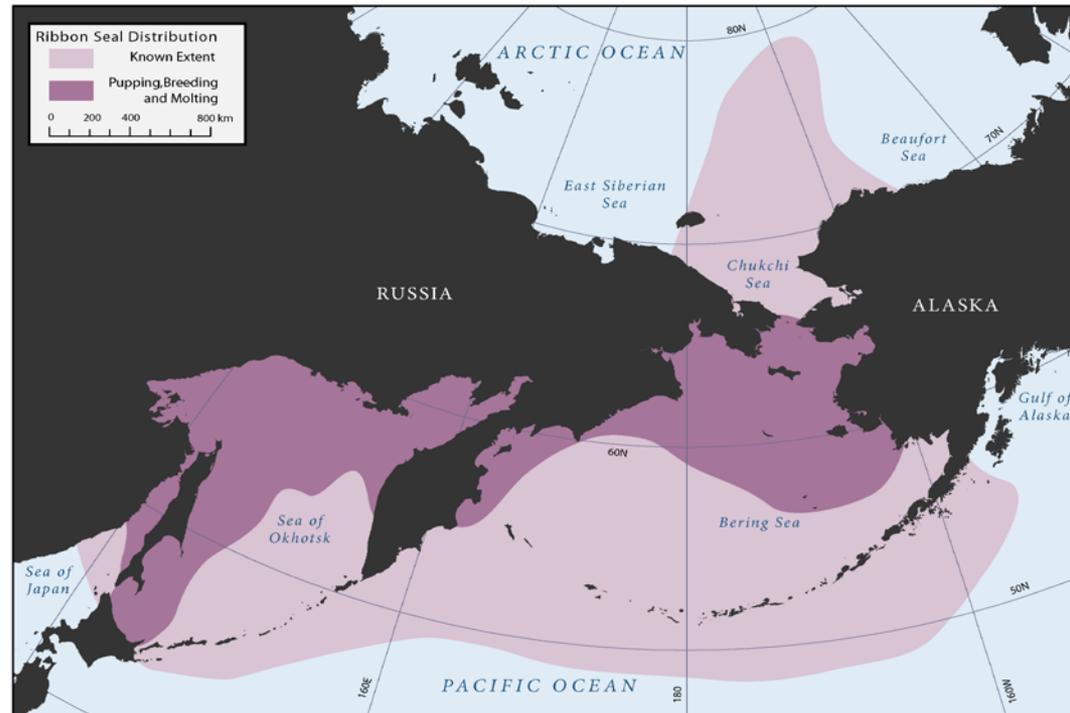
Trend: unknown

Habitat and life history: Pupping, mating and molting in marginal ice near shelf break; open-water period near shelf breaks or in deep ocean basins

Legal status, threats, mandates:
Reviewed but not listed under ESA (Species of Concern); MMPA not Strategic or Depleted; threatened by loss of sea ice habitat



P. A. Folkens



Overview of AFSC Research on Ice Seals

- Abundance and distribution: Aerial surveys of the Bering, Chukchi, Beaufort, and Okhotsk Seas
- Movements and habitat: Bearded, spotted, and ribbon seals in the Bering, Chukchi, and Beaufort Seas
- Health, condition, stock structure & diet: Studies based on samples from live-captured ribbon, spotted, and bearded seals, and on skin and feces recovered from ice floes

Abundance and Distribution

- Partners
- Methods
- Data quality
- Strengths
- Weaknesses

Abundance and Distribution - Partners



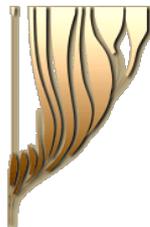
ChukotTINRO



Giprorybflot



КФ ТИГ ДВО РАН
Kamchatka Branch – Pacific
Geographical Institute, RAS



Severtsov Institute of
Ecology and Evolution, RAS



North Pacific Wildlife
Consulting, LLC

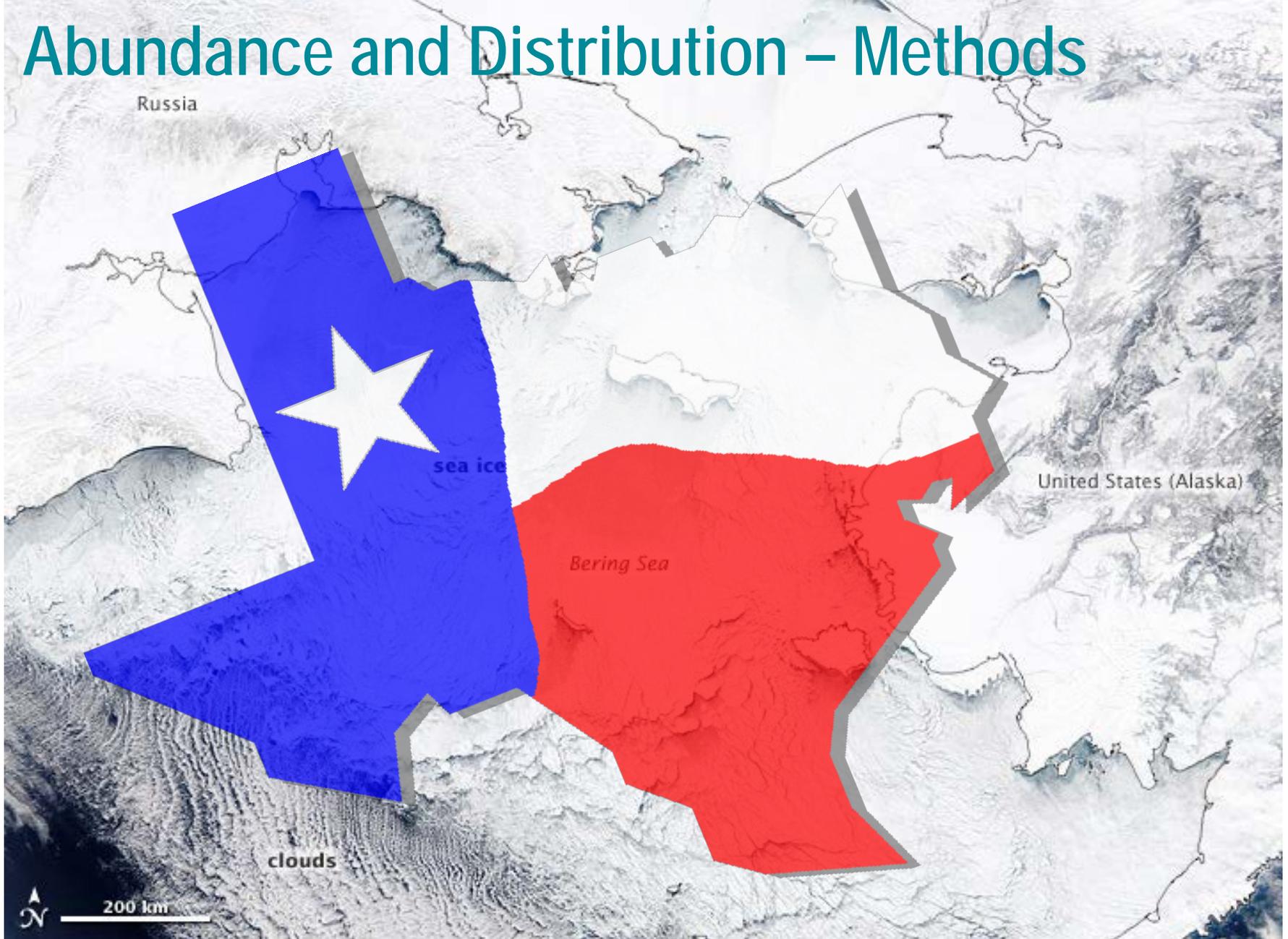


MagadanNIRO



Marine Mammal Council

Abundance and Distribution – Methods



Abundance and Distribution – Methods



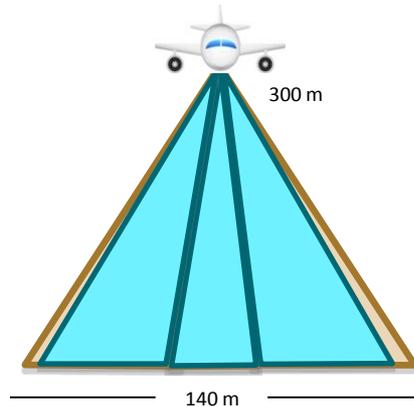
FLIR SC645

Canon 1Ds Mark III



700+ hours
thermal video

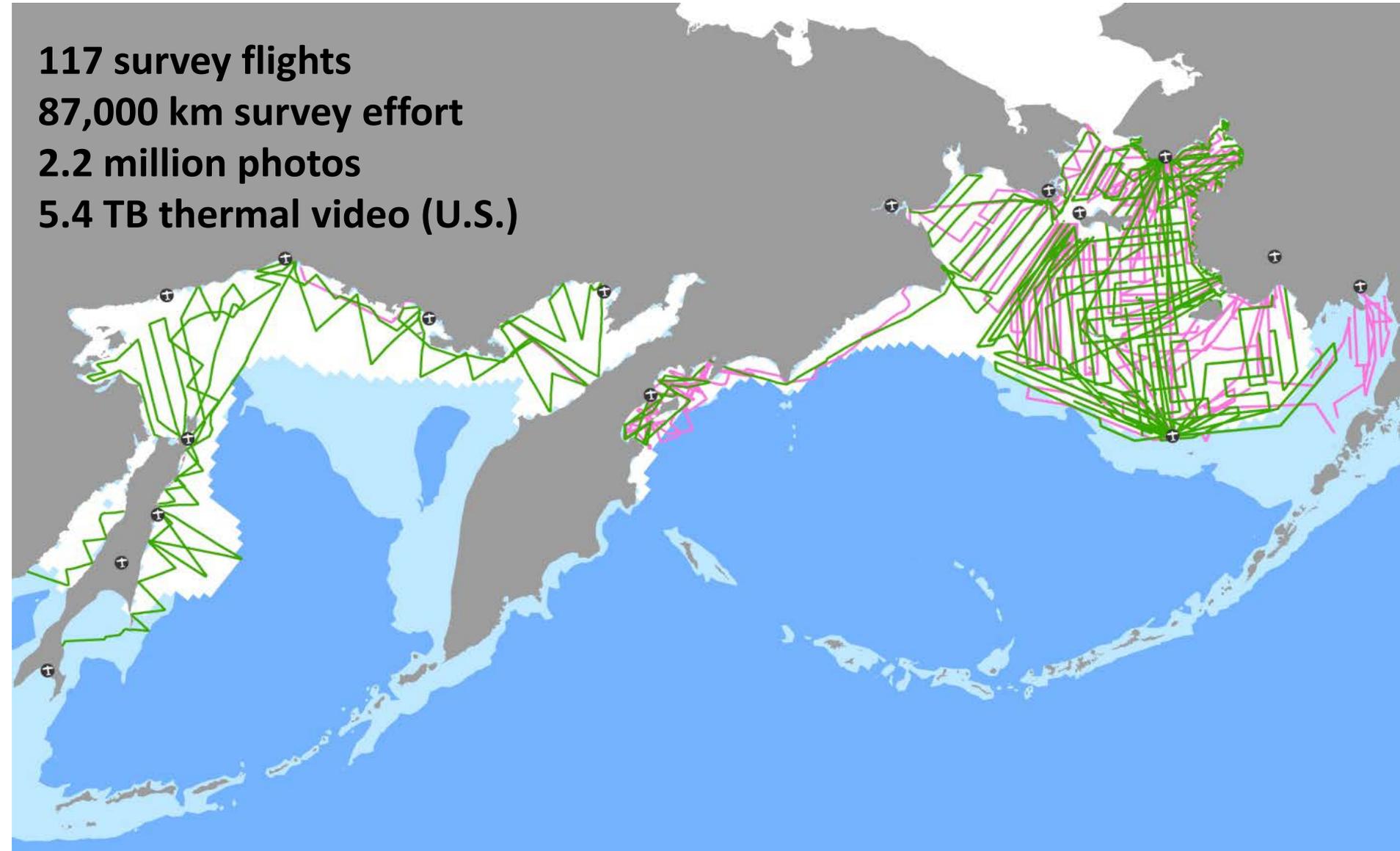
1.8 million
photos



- Coupled IR-Color Photo Surveys
- Permanent record
- Low disturbance

Abundance and Distribution – Methods

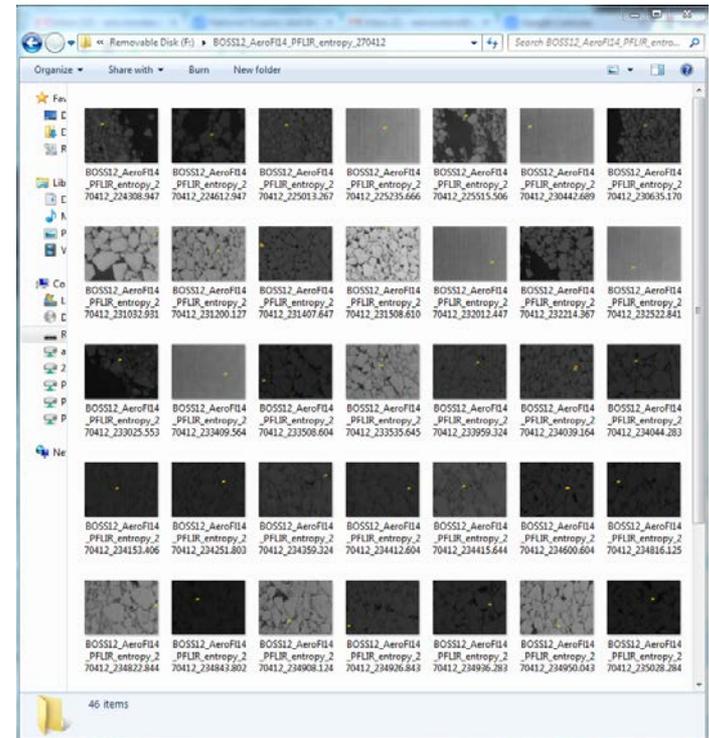
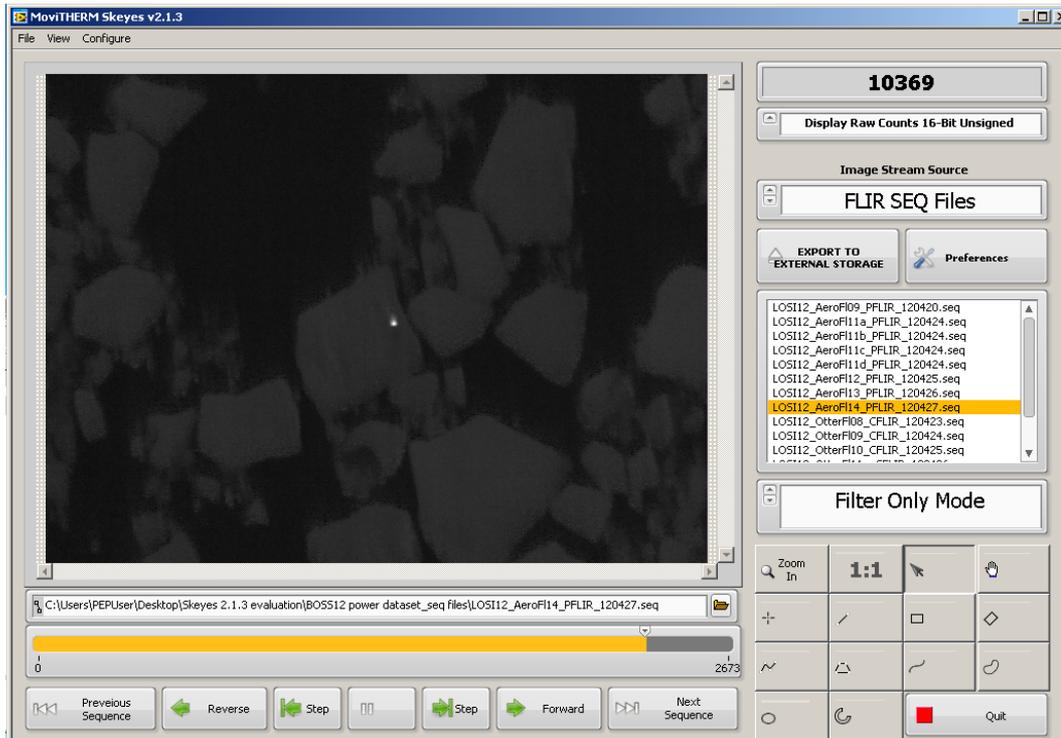
117 survey flights
87,000 km survey effort
2.2 million photos
5.4 TB thermal video (U.S.)





Abundance and Distribution – Methods

Semi-Automated Detection (post-process FLIR SEQ files)



Detection Rates:



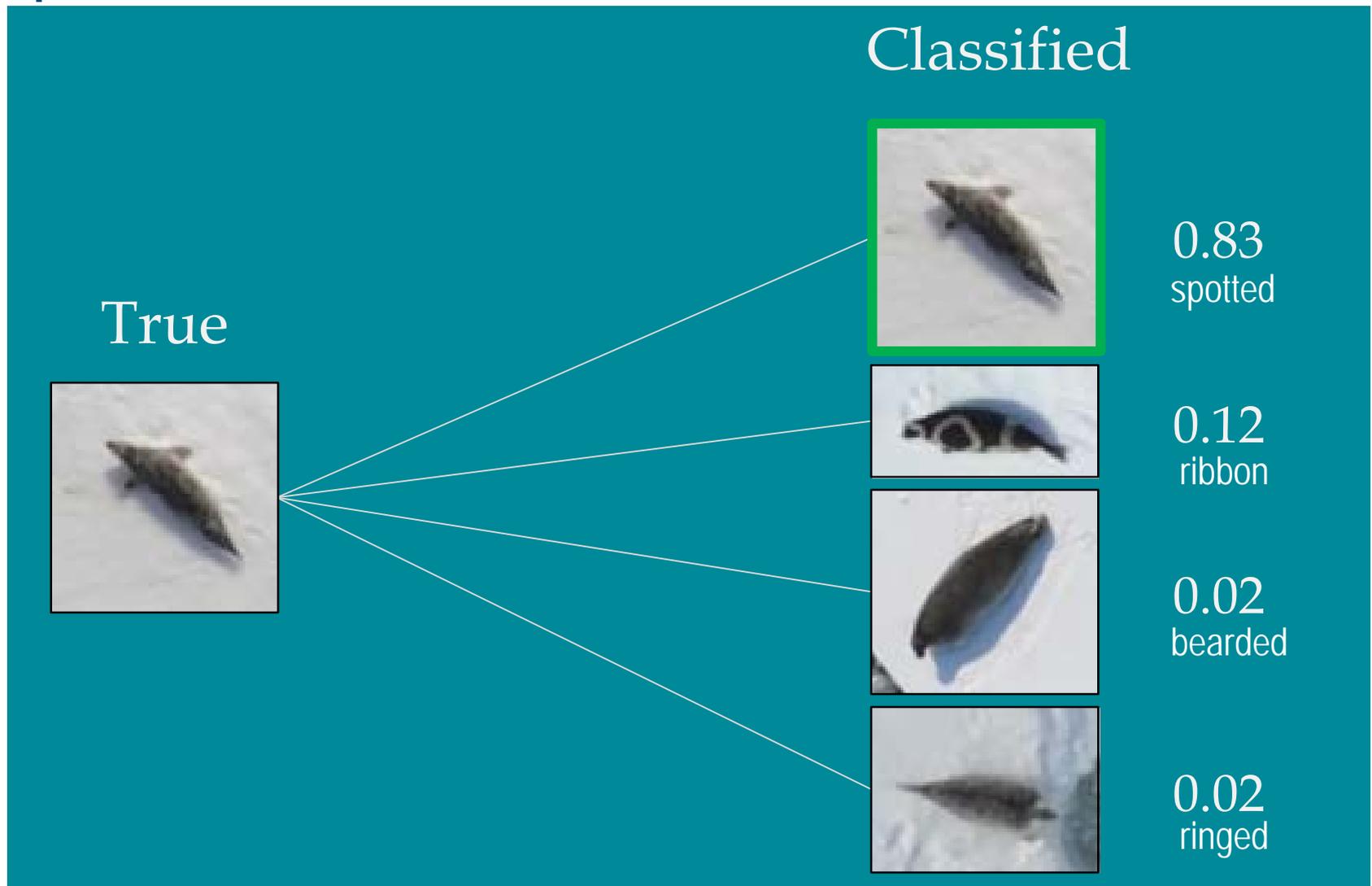
98%



81%

Abundance and Distribution – Methods

Species mis-classification

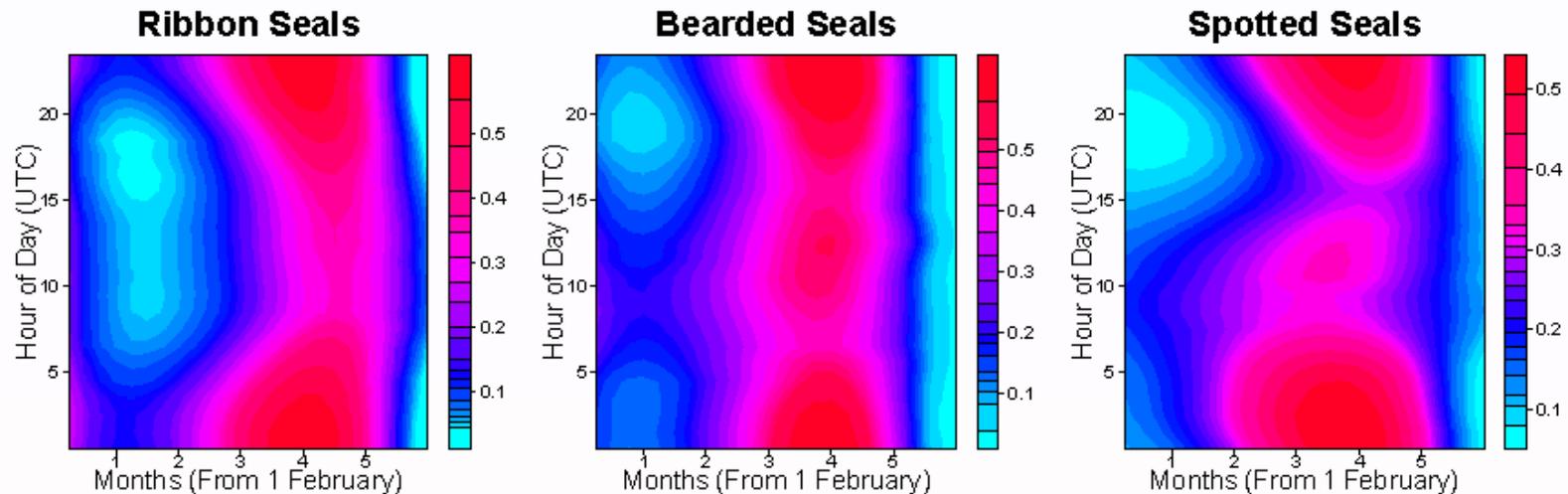


Abundance and Distribution – Methods

Accounting for availability (haul-out)

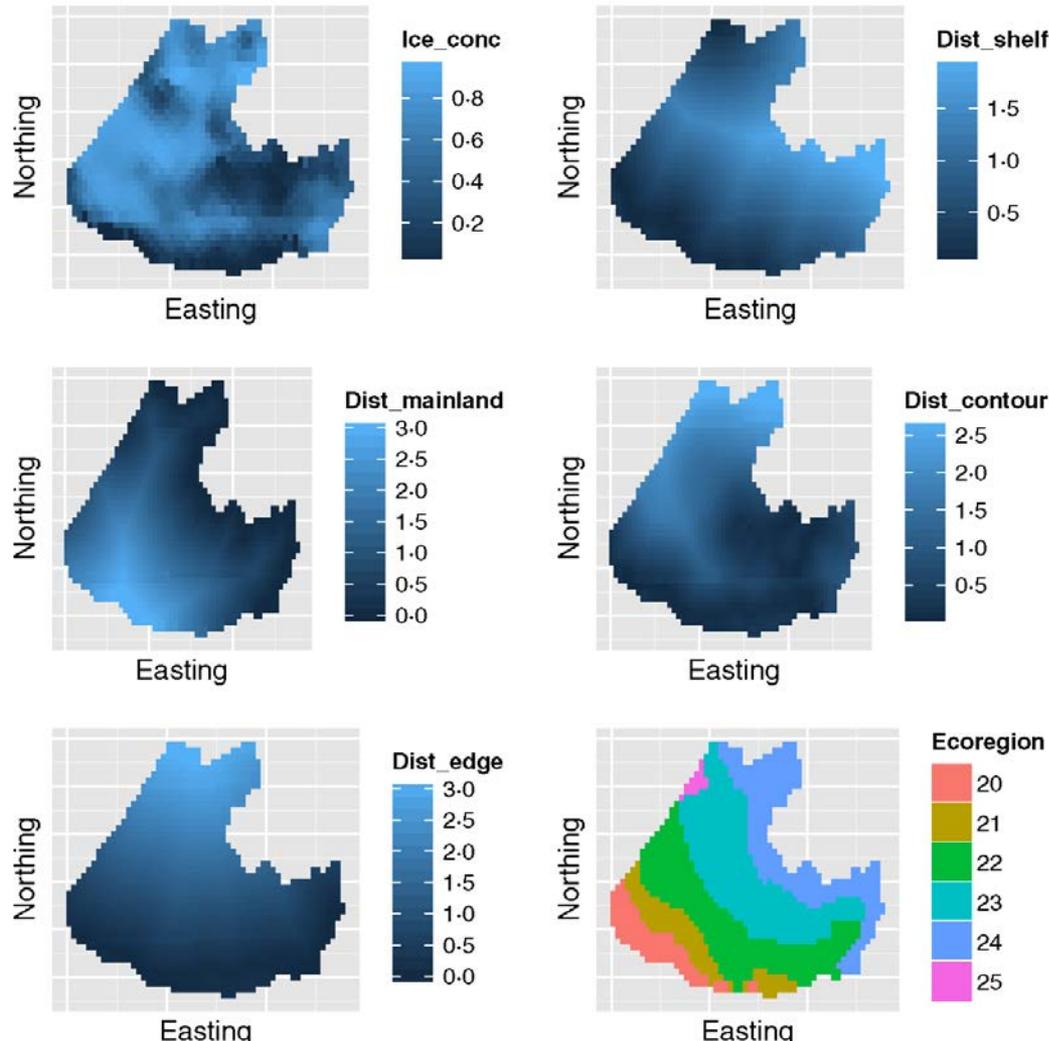


Satellite Linked Data Recorders attached to seals provide estimates of the proportion of seals that are hauled out on ice and available to be seen during the survey



Abundance and Distribution – Methods

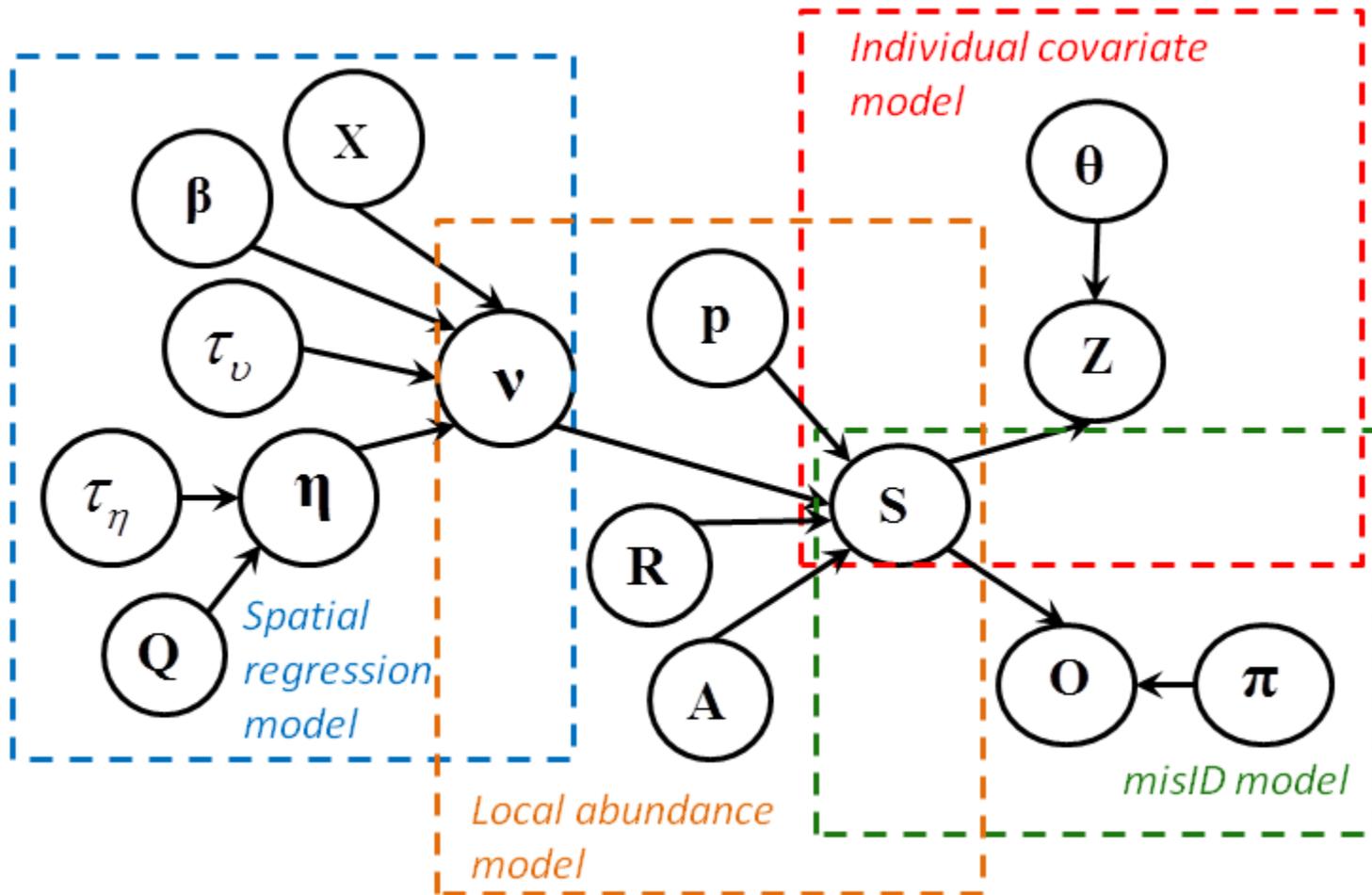
Spatial Regression Model



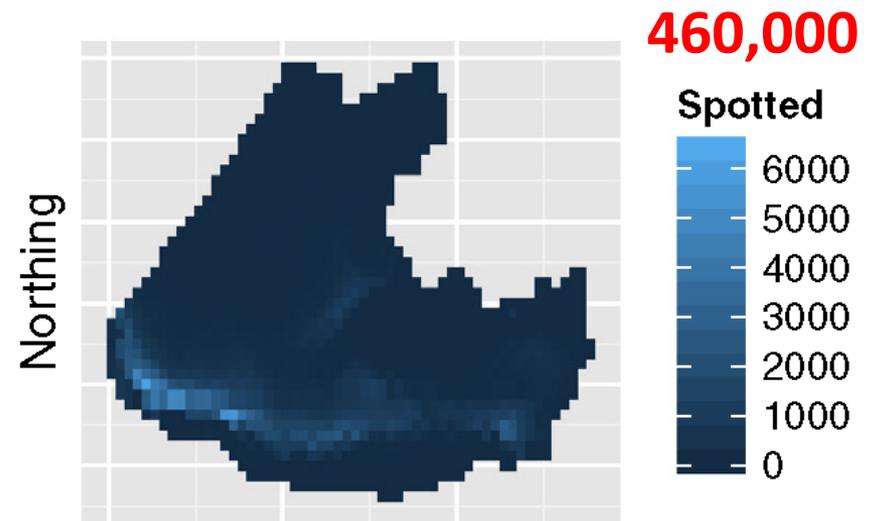
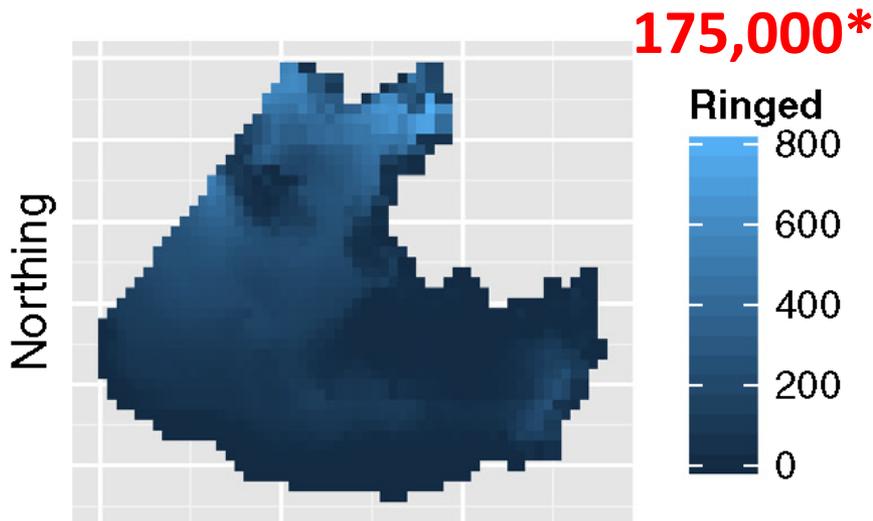
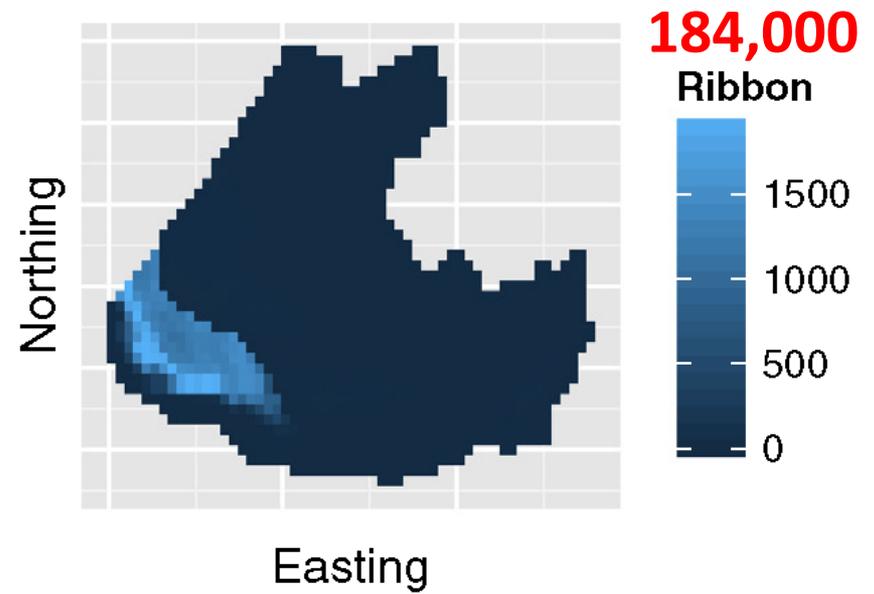
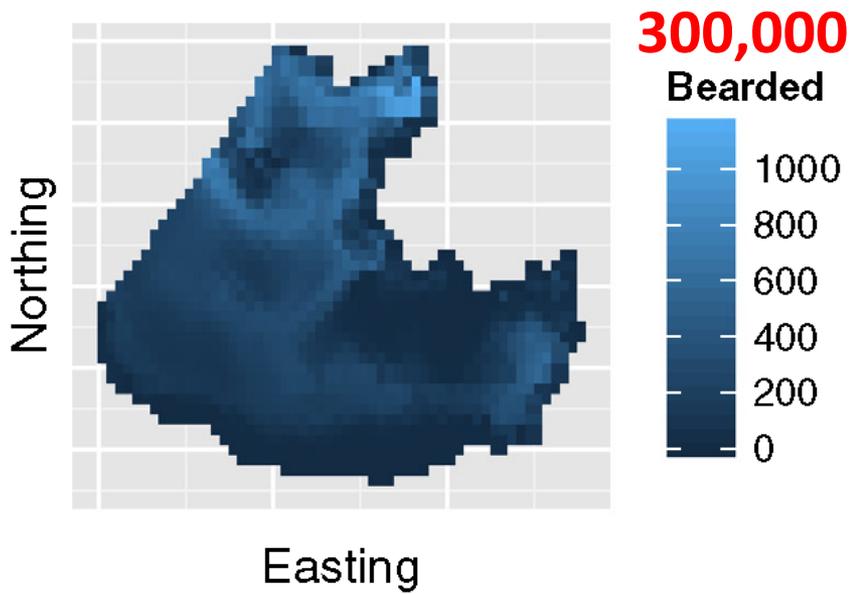
- Gridded study area (25x25 km)
- Modeled abundance from counts based on relationships with:
 - Sea ice Concentration
 - Distance to shelf
 - Distance to coast
 - Distance to 10% ice
 - Distance to south 0% ice
 - Ecoregion

Abundance and Distribution – Data Quality

Bayesian Hierarchical Model

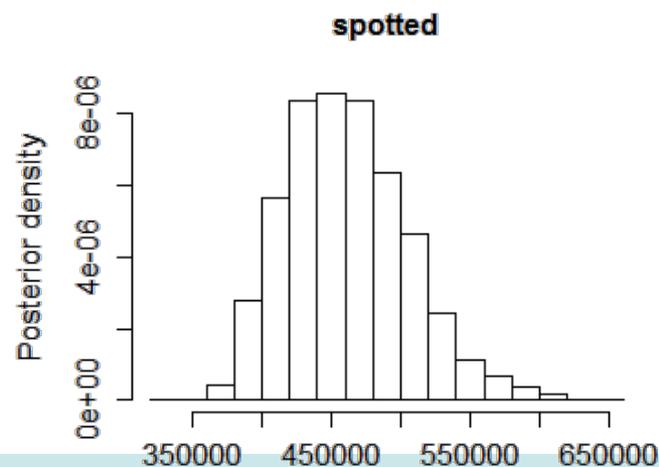
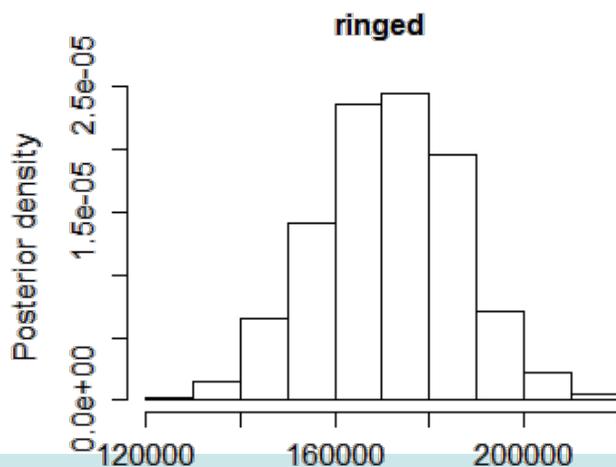
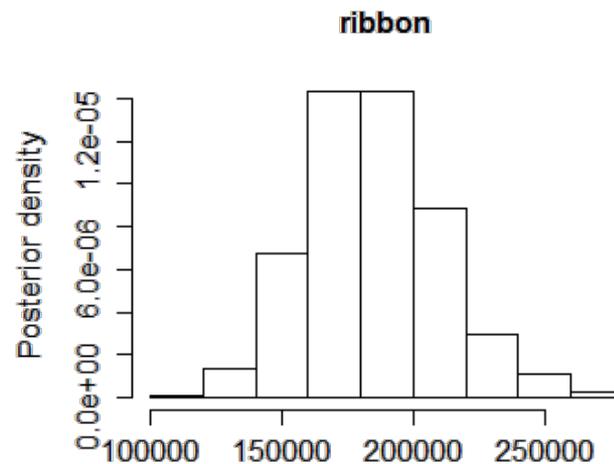
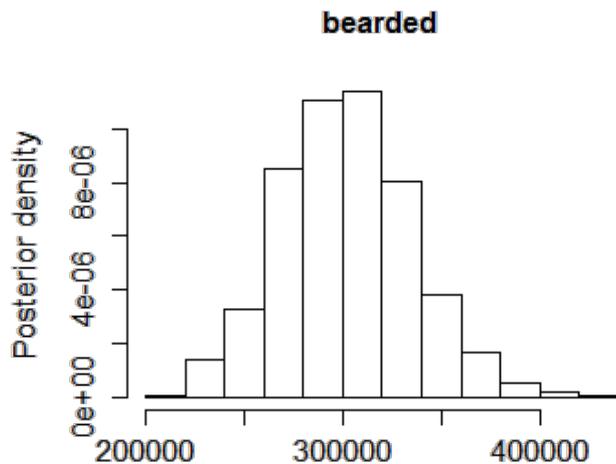


Abundance and Distribution – Data Quality



Abundance and Distribution – Data Quality

ABUNDANCE (Posterior Distributions)



Abundance and Distribution – Strengths

- Recent developments in navigation, remote sensing, and statistical methods have been combined for the first attempt at comprehensive surveys of ice seals since the 1970s and 1980s
- The results have credible and adequate precision despite accounting for many more sources of uncertainty than any previous effort
- The species distributions match previous natural history descriptions and will provide Bering-Sea-wide data for understanding habitat characteristics when compared with other biological and environmental data

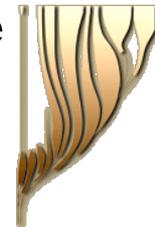
Abundance and Distribution – Weaknesses

- Our estimates will provide a baseline for judging substantial changes in abundance, but quantitative estimates of trend for these species are unlikely to be available for at least a decade
 - Modest survey effort expended annually in a sampling fashion would be the most effective for monitoring trends
- Our methods remain costly, labor intensive, and potentially risky for field personnel
 - Efforts to increase automation and to utilize more capable aircraft, such as the NOAA King Air, should be pursued and supported
- Reliant on outside funding for substantial portion of the work

Movements and Habitat – Partners



North Pacific Wildlife Consulting, LLC



Severtsov Institute of Ecology and Evolution, RAS



MagadanNIRO

Movements and Habitat – Methods

ARGOS satellite telemetry



Head-mounted satellite-linked trackers and dive recorders: 8-10 months of multiple daily locations before being shed in the annual molt.

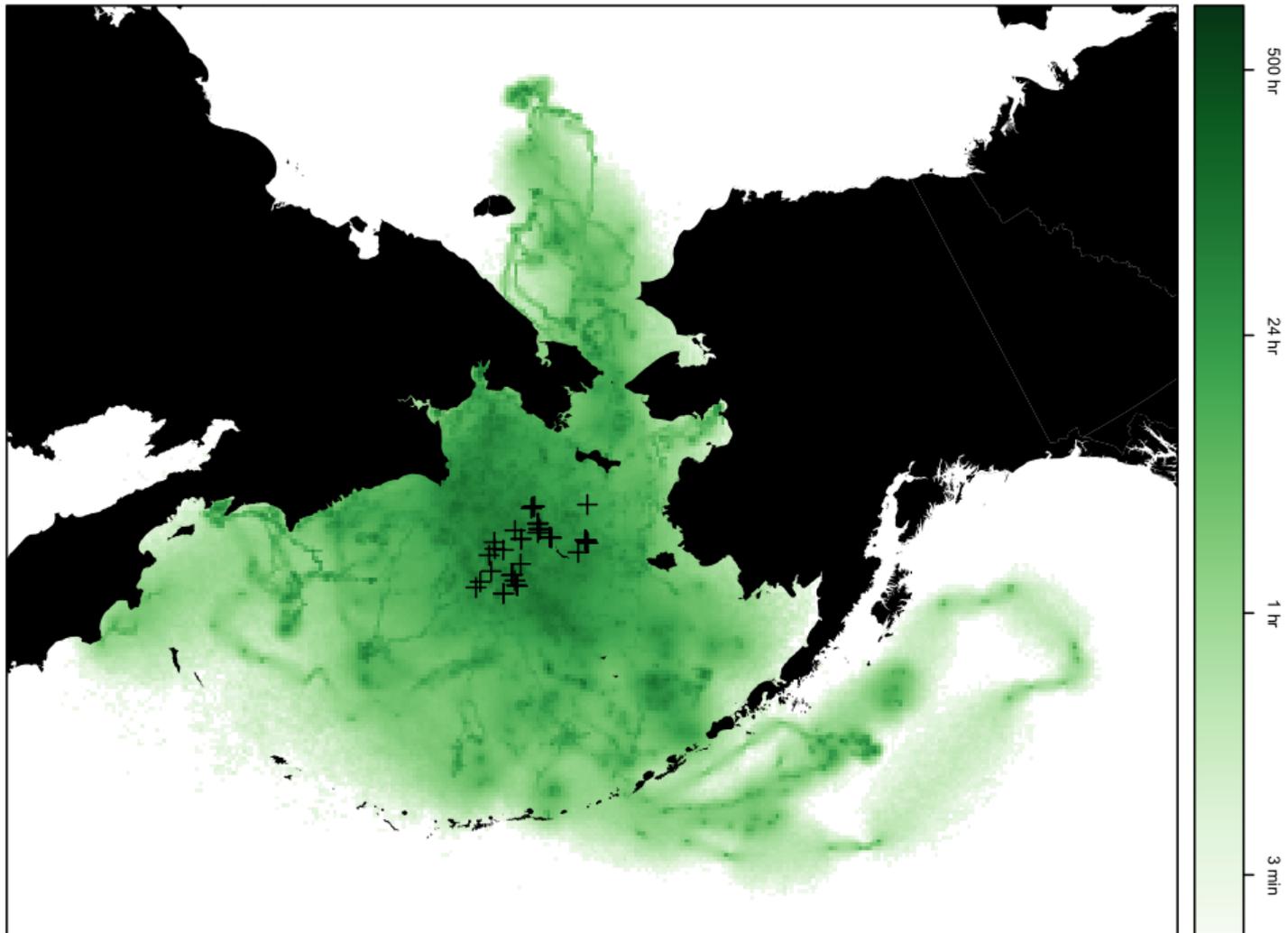




Flipper-mounted satellite-linked trackers: Locations for several years, but only when hauled out and only 5 days month (Feb – Jun) or 2 days/month (Jul-Jan).

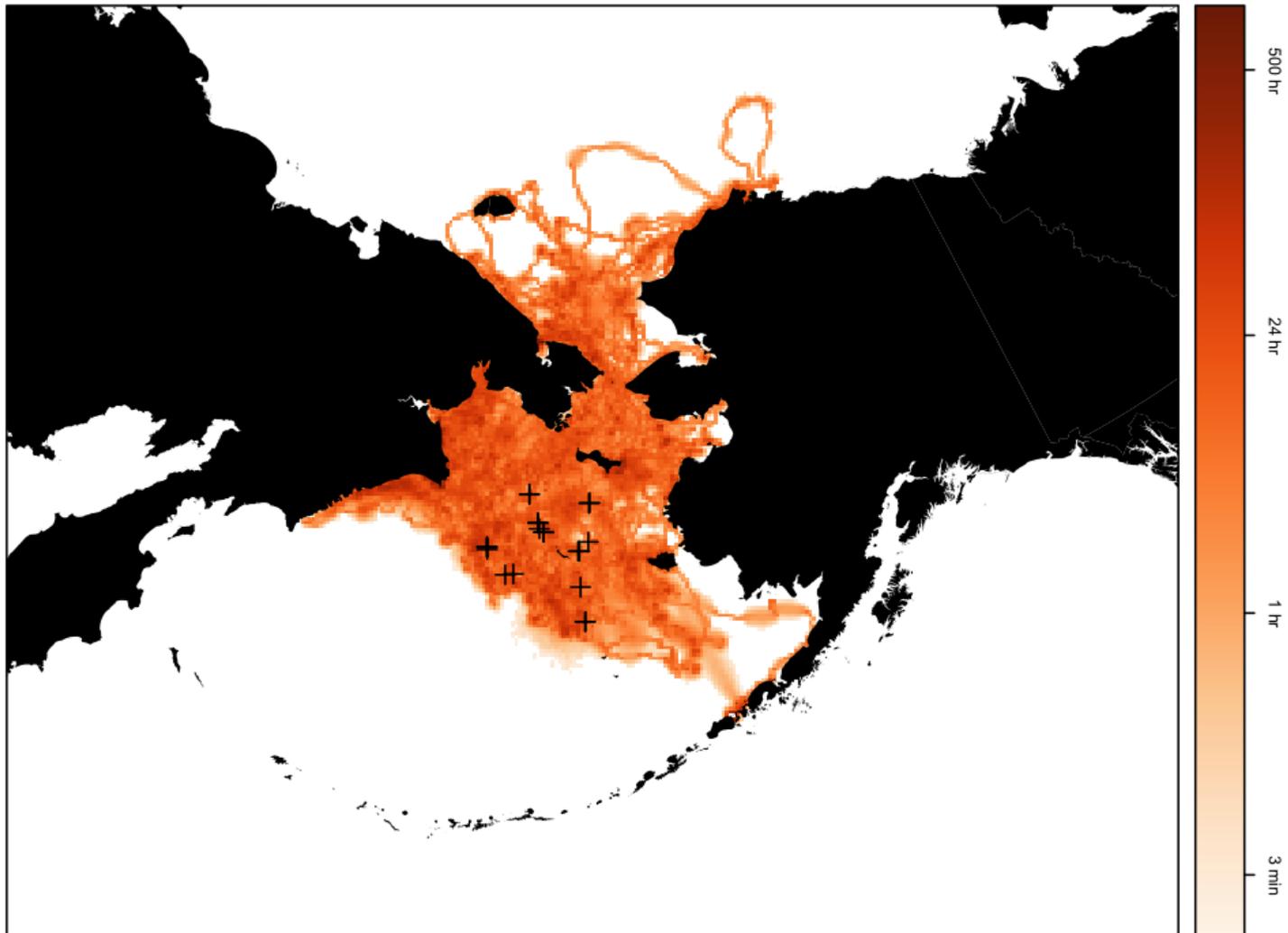
Movements and Habitat – Data Quality

Mean Hours of Use by Ribbon Seals
All Seasons (2007-2011) - 500 Simulations



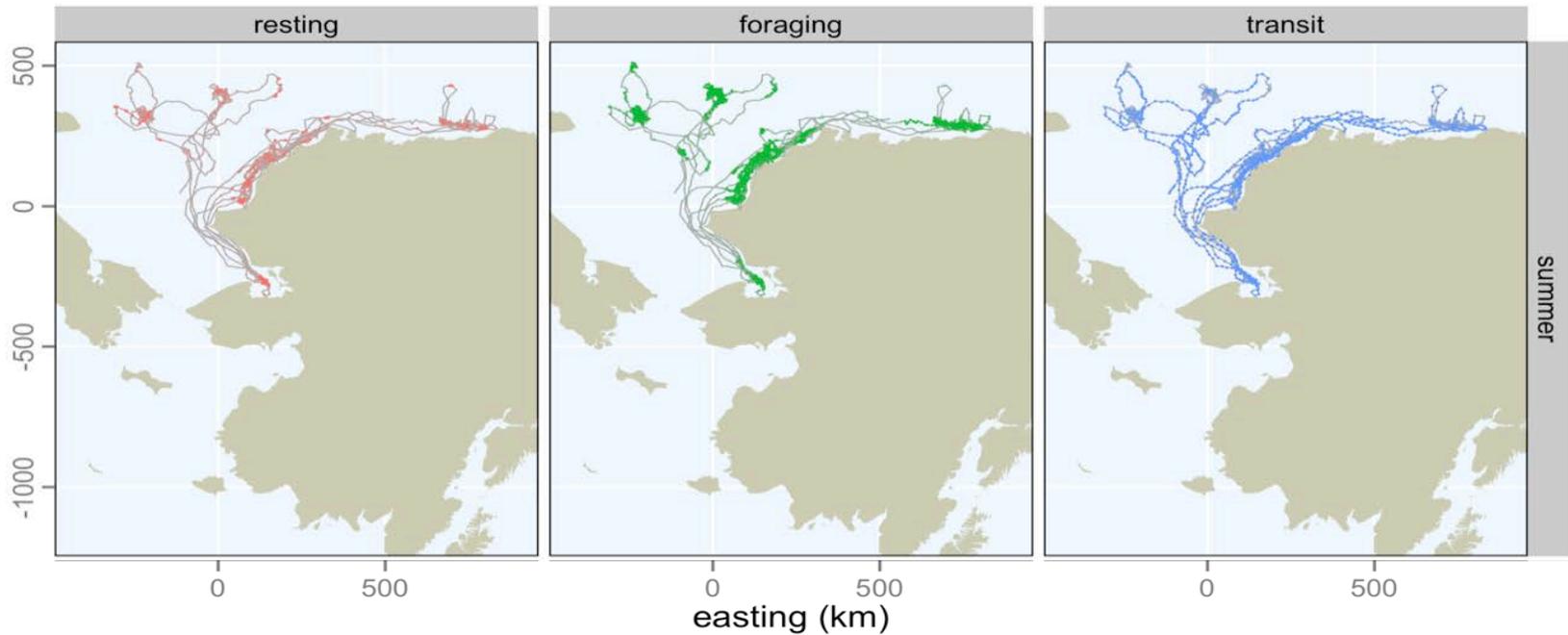
Movements and Habitat – Data Quality

Mean Hours of Use by Spotted Seals
All Seasons (2007-2011) - 500 Simulations

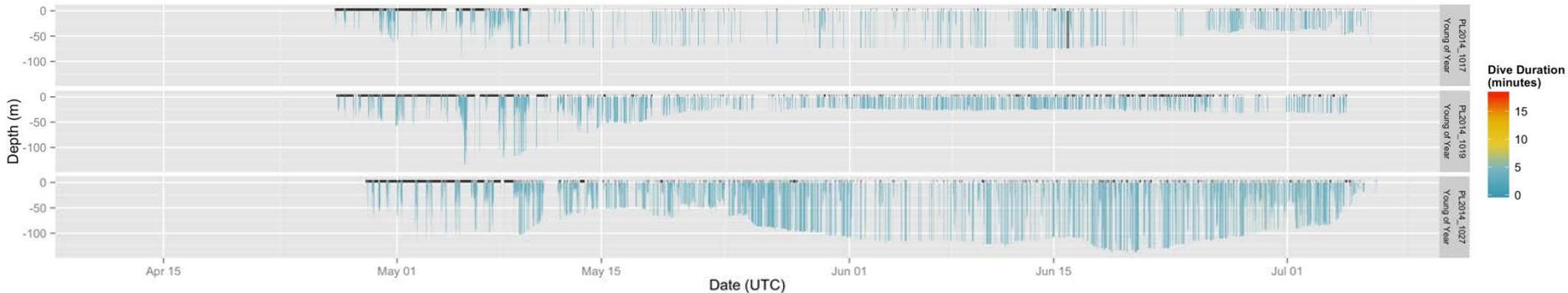


Movements and Habitat – Data Quality

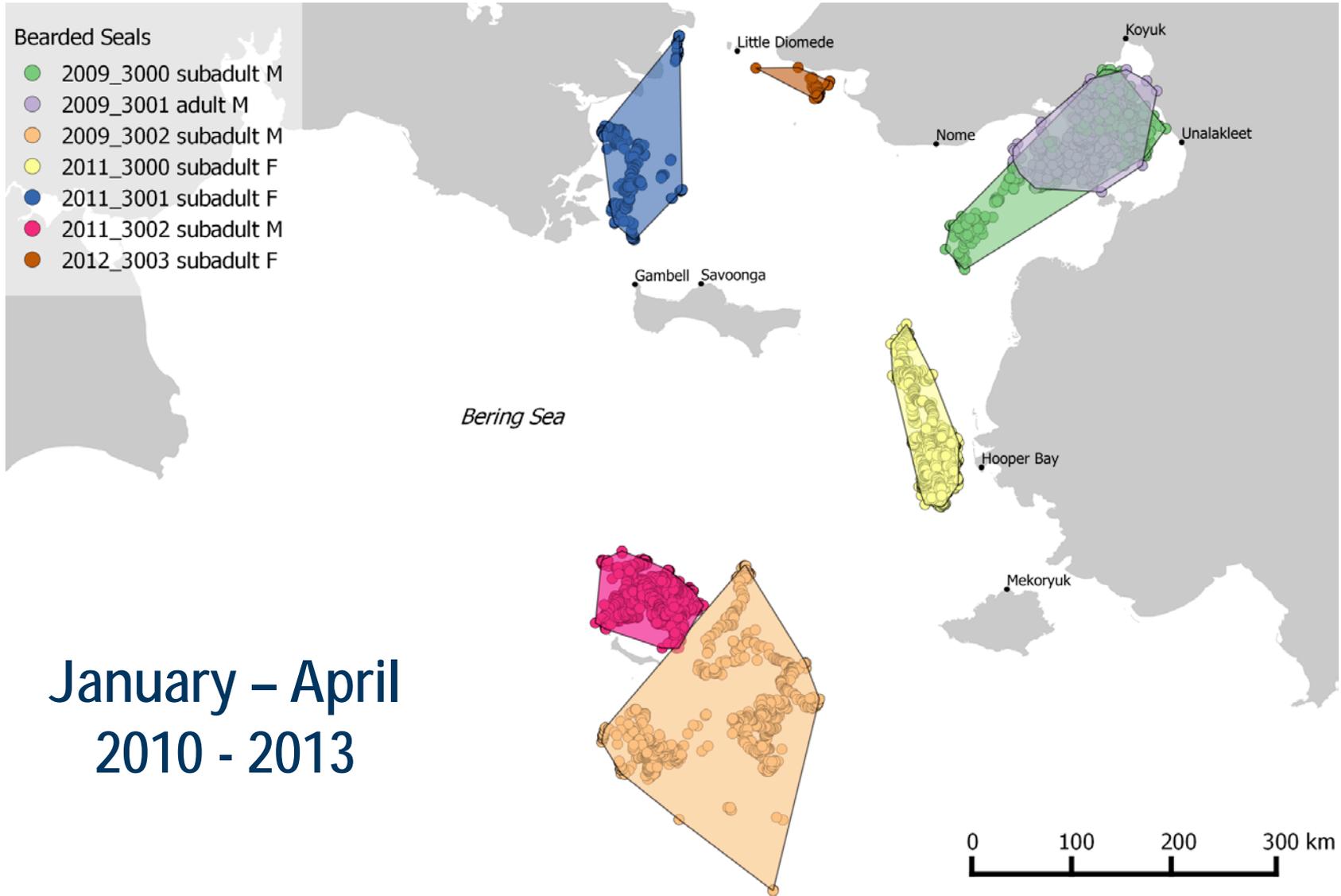
Bearded Seals: July - September



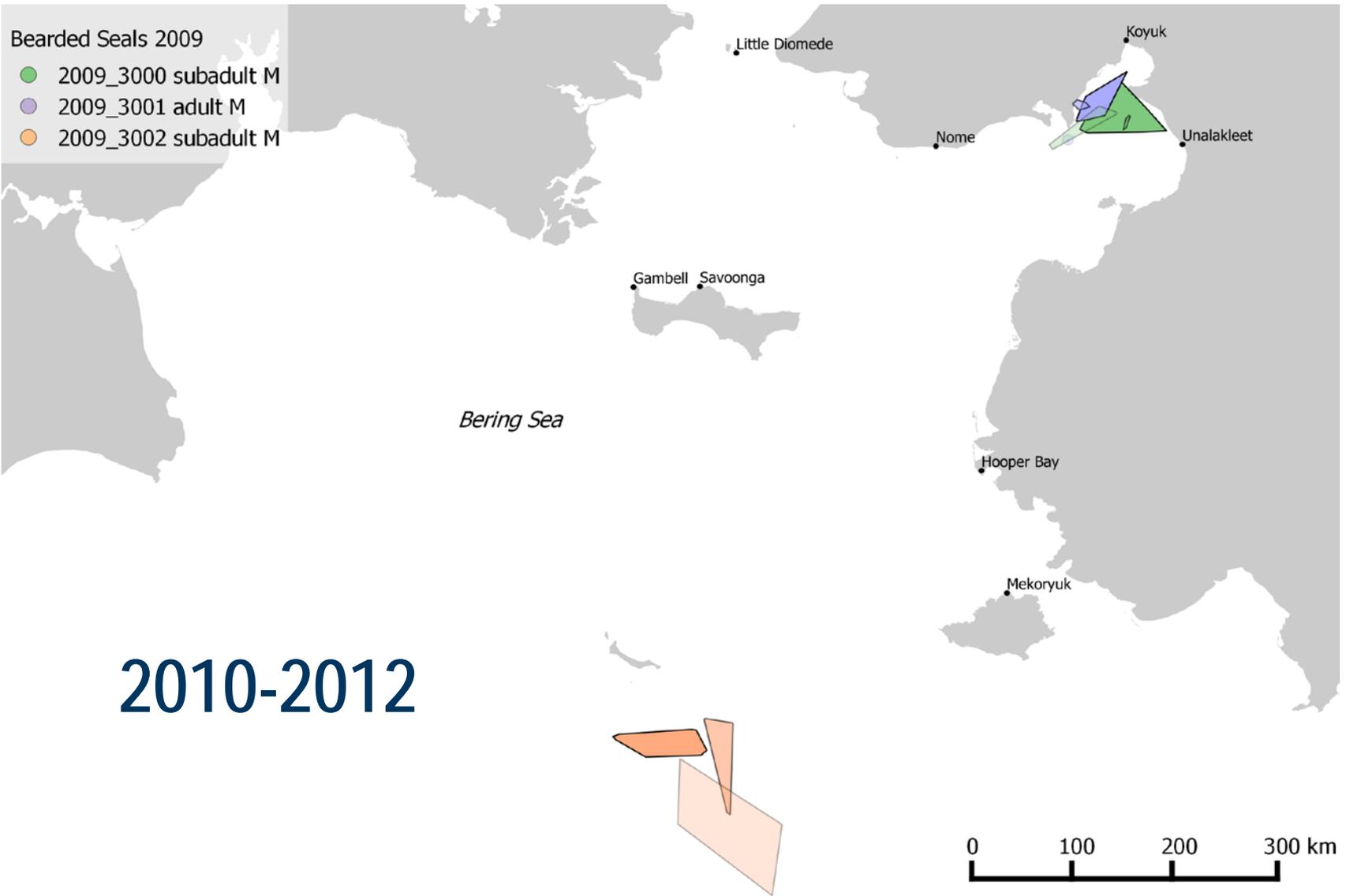
Spotted Seals (Dive Behavior): May - June



Movements and Habitat – Data Quality



Movements and Habitat – Data Quality



Movements and Habitat – Data Quality

- Satellite telemetry provides crucial information about haul-out time for estimation of abundance
- Movements (i.e., seasonal migration) are crucial for survey design and interpretation
- Development of novel transmitters allowed estimation of haul-out during peak molt
- Developing new methods for bearded seal capture
- Enterprise database for telemetry, with extensive data-quality checks for Argos data
- AFSC expertise in movement modeling provides a framework for statistical treatment of telemetry data

Movements and Habitat – Strengths

- Synergy between abundance, trends, movements, habitat objectives:
 - Satellite telemetry provides crucial haul-out information for estimation of abundance
 - Seasonal movement data are vital to stock structure and abundance estimation efforts
 - Distribution from surveys provides context for interpreting movements and habitat results
- Long tenure with Argos system supports deep understanding of the data process

Movements and Habitat – Weaknesses

- Live-capture of bearded, ringed, spotted, and ribbon seals is challenging and costly (small sample size)
- Vessel support has been sporadic and ice-capable ships unavailable
- Satellite telemetry studies in Alaska are currently fragmented, with several institutions doing similar work
- Long-standing need for a data manager has compromised our rate of timely publication of telemetry studies
- Reliant on outside funding for substantial portion of the work

Health, Condition, Stocks & Diet – Partners



The Marine
Mammal Center

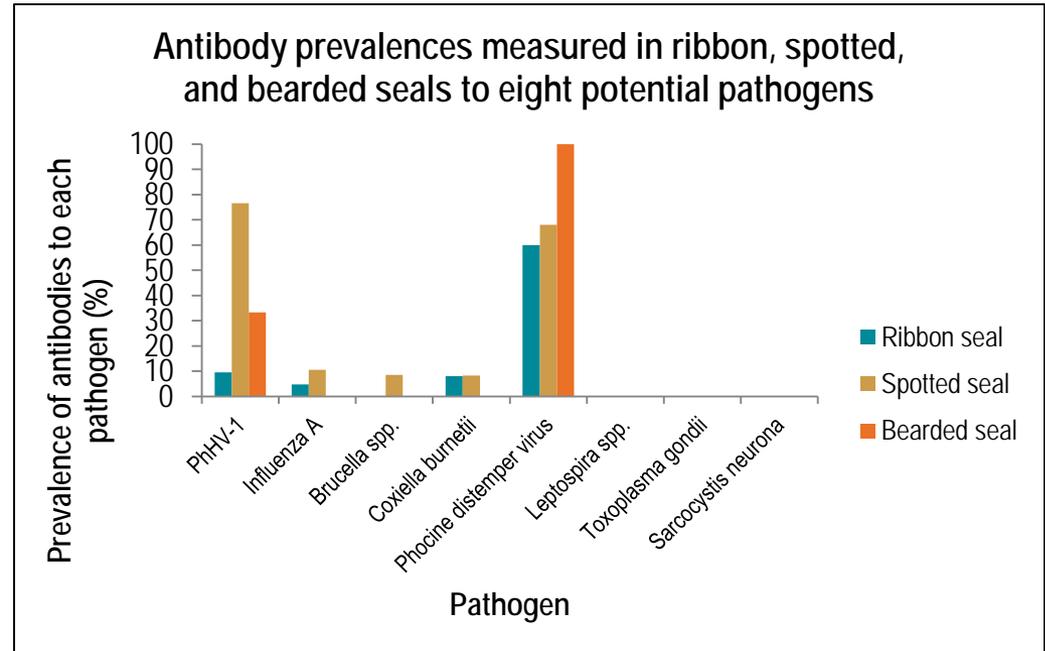
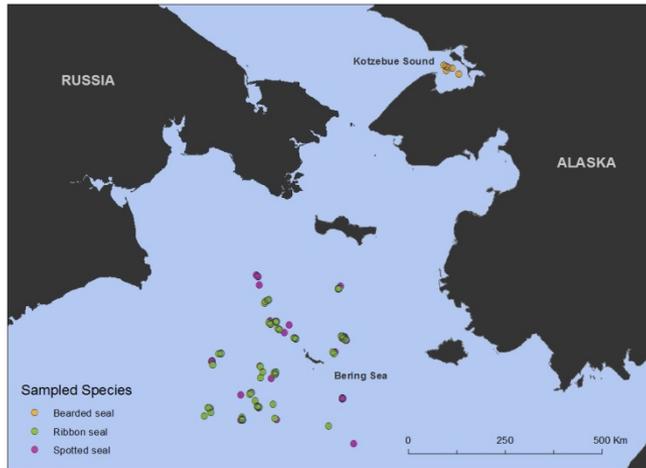


- NMFS Southwest Fisheries Science Center
- NMFS Marine Mammal Health and Stranding Response Program

Health, Condition, Stocks & Diet – Methods

- Measurements and samples collected during live-captures for telemetry studies
- Pathology, contaminants, and genetics lab analyses outsourced
- Collaborative interpretation and reporting

Health, Condition, Stocks & Diet – Data Quality



- Collected serum from ribbon, spotted, and bearded seals in the Bering and Chukchi Seas
- Used variety of serologic tests to determine if seals were positive for antibodies to 8 pathogens
 - PhHV-1, influenza A, *Brucella* spp., *Coxiella burnetii*, phocine distemper virus (PDV), *Leptospira* spp., *Toxoplasma gondii*, *Sarcocystis neurona*

- PhHV-1 prevalence was much higher in spotted seals than ribbon or bearded seals
- PDV prevalence was high in all 3 species
- Results indicate that these ice seals have been exposed to multiple pathogens, but 6 of the 8 pathogens tested showed low or zero antibody prevalences
- Low antibody prevalences to known zoonoses (*Brucella* spp., influenza A, and *Coxiella burnetii*)

Health, Condition, Stocks & Diet – Data Quality

- Most spotted & ribbon serum samples positive for evidence of phocine distemper virus exposure and infection
- Routinely collaborating with a veterinarian on all live-capture studies
- Highly-developed protocols for animal handling and sampling

Health, Condition, Stocks & Diet – Strengths

- Studies of seals sampled in their breeding season/habitat complement results from larger samples that are obtained from seals harvested near communities, typically at other times of the year
- Health and condition data provide context & covariates for analysis of movements and behavior

Health, Condition, Stocks & Diet – Weaknesses

- Sample sizes, especially for ringed and bearded seals, are small; poor power to assess stock structure and establish baseline condition
- Methods for assessment of diet all have severe limitations: low resolution of stable isotopes, high cost & difficulty of interpretation of fatty acid signatures, feces limited to short period of ice-cover

Communication

- Results of AFSC monitoring and research on ice-associated seals are applied in assessments of population status under the MMPA and ESA
- AFSC monitoring and research results are communicated through peer-reviewed publications and publicly available reports (69 total publications by PEP authors in past 10 years; 17 on ice-associated seals and related methods)
- AFSC monitoring and research results are communicated to the public at large via presentations to Alaska communities, Alaska Native organizations, and professional conferences

Access

- AFSC data on ice-associated seals are routinely provided in response to requests from AKRO, ADF&G, USCG, and other agencies and organizations
- A long-standing need for a program data manager has compromised our ability to make some data available in a timely manner

Recommendations

- Equipment and software development for further automation of thermal detection process should be supported
- Request NOAA Office of Marine Aircraft Operations support for aircraft with greater speed, range, and climb rate (e.g., King Air) for ice seal surveys
- A long-standing need for a program data manager has compromised our ability to make some data available in a timely manner; recruit data manager
- Reducing dependence on outside funding would make more effective use of staff time for publishing results