Science Update for Chukchi Sea Polar Bears

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Overview

- Demographic parameter estimates from American capture-recapture research
- Harvest risk assessment
- Instrument-based aerial surveys
- CS-SB population delineation
- American-Russian studies on Wrangel Island

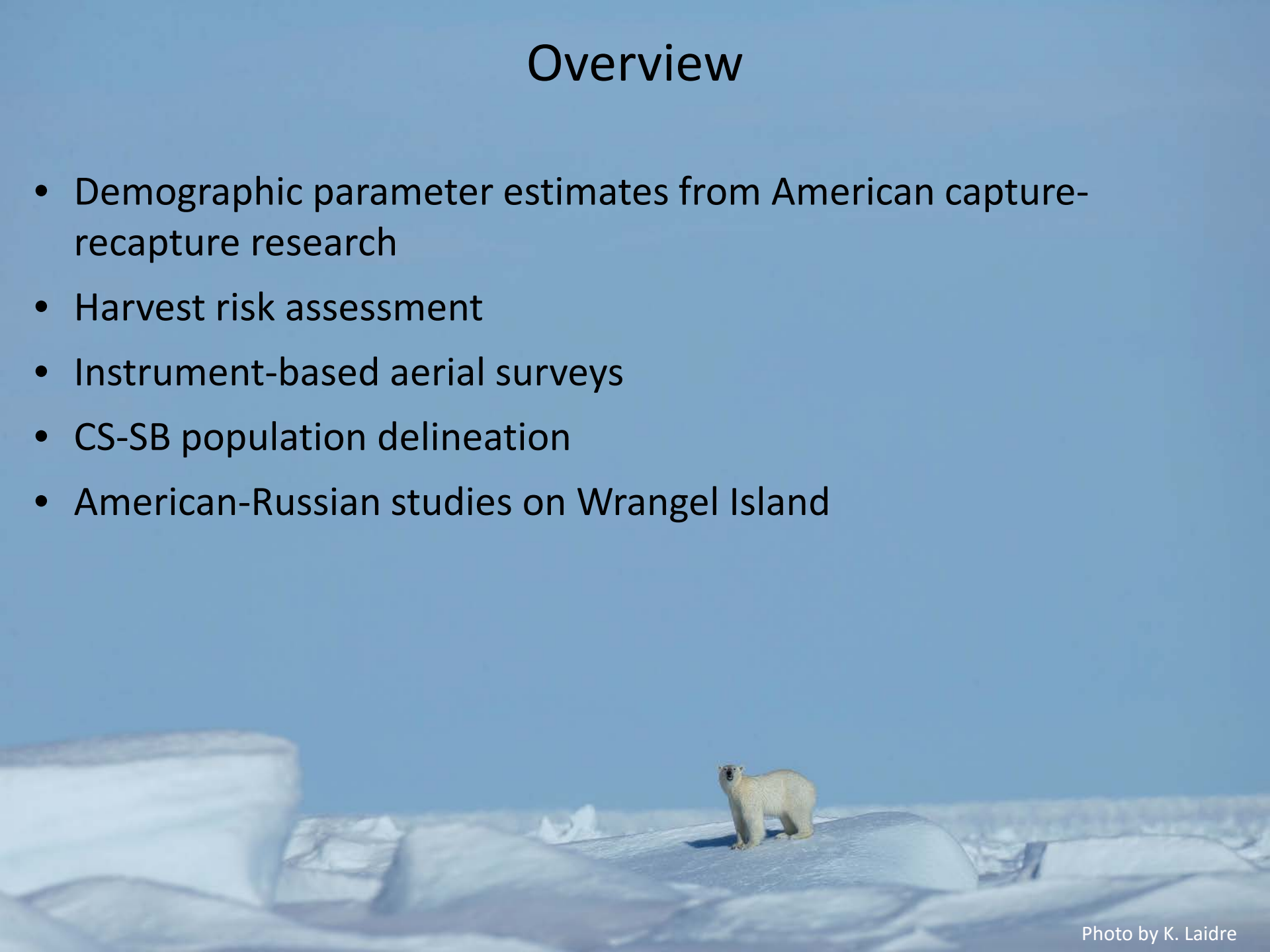


Photo by K. Laidre

Chukchi Sea polar bear research

- USFWS and partners performed 420 live-capture and releases of polar bears 2008-2011, 2013, 2015, and 2016 (work continued in 2017)
- Deployed 107 radiocollars and 77prototype satellite tags
- Lines of investigation:
  - Body condition, reproduction, health and nutritional ecology (e.g., Rode et al. 2014, 2015, 2017)
  - Habitat use and distribution (Wilson et al. 2014, 2016)
  - Abundance and vital rates (Regehr et al *in review*)
- Collaborative effort with USFWS, USGS, UW, ADFG, NSB, and others

Logistical base at Red Dog Mine port facility.

Chukchi Sea polar bear research

Integrated Population Model

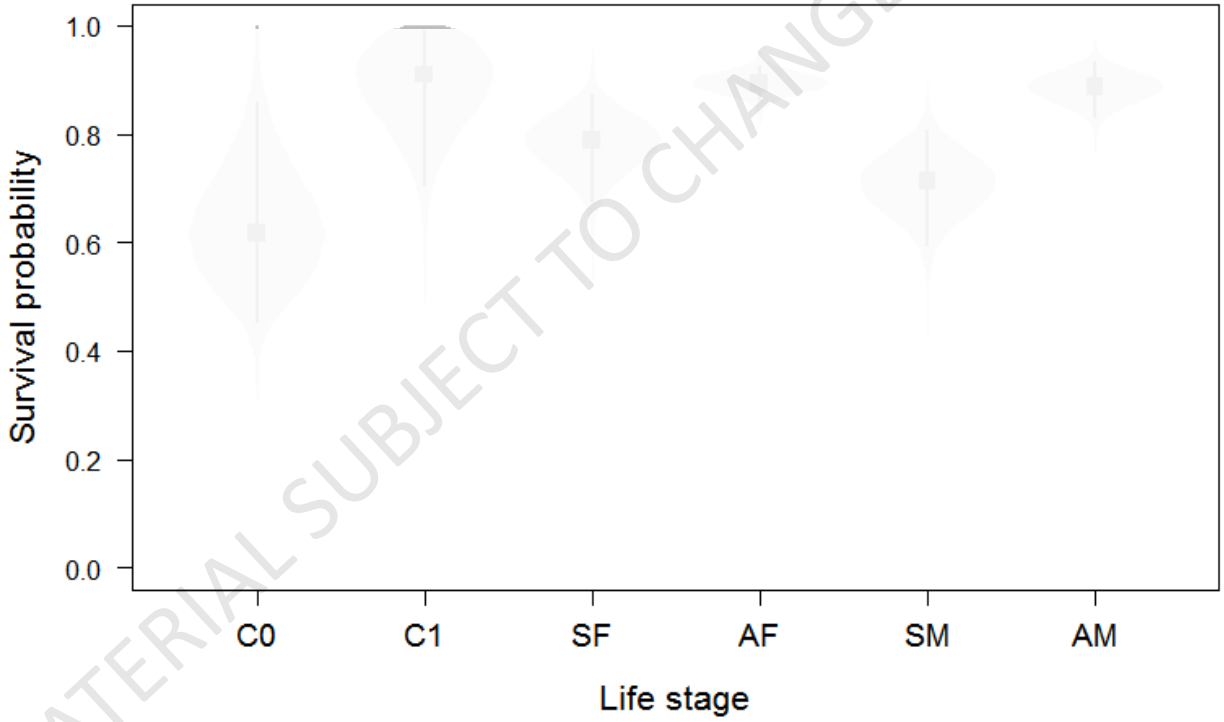
- Efficient use of all available data
  - Capture-recapture, radiotelemetry, and count data
  - Link demographic rates to population processes
  - More demographic rates become estimable (e.g., C0 survival)
  - Increased precision of estimates
- Mitigate bias common to capture-recapture studies of polar bears
- Incorporate auxiliary information or hypotheses (e.g., from TEK and other polar bear studies) as informative priors

All results are preliminary and subject to change until publication in peer-reviewed journal

Photo by K. Laidre

Results

- Informative priors increased estimates and decreased uncertainty
- Modeling movements increased accuracy, but some negative bias still likely
- Population density is uncertain



Results

- Breeding probability and cub-of-the-year survival were average
- Cub-of-the-year litter size and yearling survival were high
- Yearlings per adult female stable 2008 – 2016, and similar to values estimated from the 1980s and 1990s (Rode et al. 2014)

Parameter	Mode (95% CRI)
ϕ_{C0}	0.62 (0.45 – 0.86)
ϕ_{C1}	0.85 (0.71 – 0.99)
ϕ_{SF}	0.79 (0.68 – 0.87)
ϕ_{AF}	0.90 (0.86 – 0.92)
ϕ_{SM}	0.72 (0.59 – 0.81)
ϕ_{AM}	0.89 (0.83 – 0.93)
ψ_1^{II}	0.56 (0.40 – 0.73)
ψ_1^{OO}	0.78 (0.64 – 0.89)
ψ_2^{II}	0.07 (0.00 – 0.12)
ψ_2^{OO}	0.96 (0.89 – 0.99)
B_1	0.82 (0.71 – 0.90)
B_2	0.18 (0.02 – 0.39)
W	0.34 (0.24 – 0.44)
l_{L0}	2.18 (1.71 – 2.82)
l_{L1}	1.63 (1.46 – 1.80)

Results

- Study area density *in prep*, similar to 1980s-era estimate
- Abundance within CS subpopulation boundary estimated by extrapolating densities using a spatially-explicit habitat quality metric from RSFs (Wilson et al. 2014, 2016)
- Average abundance 2008 – 2016: *in prep*
- Abundance not estimated for AC mgmt. area

Contact information: Eric Regehr <eregehr@uw.edu>

Key messages

- First empirical estimates of population size and vital rates for Chukchi Sea polar bears
- Findings suggest the population was productive during 2008 – 2016; consistent with other scientific data and with TEK, but future uncertain
- Estimates of abundance and vital rates have large statistical uncertainty, and potential bias in some parameters
- Information needed for management and conservation

Regehr EV, Hostetter NJ, Wilson RR, Rode KD, St. Martin M and SJ Converse. Integrated Population Modeling Provides the First Empirical Estimates of Vital Rates and Abundance for Polar Bears in the Chukchi Sea. *In review*.

Partners, collaborators, and supporters

U.S. Fish and Wildlife Service

U.S. Geological Survey

University of Washington

Alaska Department of Fish and Game

Alaska Nanuuq Commission (former co-management partner to USFWS)

Communities of Point Hope, Kotzebue, Barrow, and Kaktovik

North Slope Borough

Bureau of Ocean and Energy Management

National Park Service

Bureau of Land Management

National Fish and Wildlife Foundation

Teck Inc.

Department of Defense, U.S. Air Force

National Oceanic and Atmospheric Administration

Environment Canada

Russian Ministry of Natural Resources and the Environment

Marine Mammal Council and CHAZTO (Russia)

Academic institutions (Washington State University, University of Washington, York, Dalhousie)

Industry (Shell, British Petroleum, Conoco Phillips)

Zoos (Detroit, Alaska, Oregon)

Nongovernmental organizations (WWF, Defenders of Wildlife, Polar Bears International)

Chukchi Sea harvest risk assessment

Objectives

- Evaluate demography based on parameters from Regehr et al. (In review)
- Evaluate biological risk for wide range of harvest strategies
- Provide findings to US-Russia Polar Bear Commission, to inform determination of SHL

Harvesting wildlife affected by climate change

The assessment uses a coupled modeling-management framework for polar bears (Regehr et al. 2015, 2017): a science-based approach to balancing the population-level effects of harvest with continued opportunities for use

Regehr, EV, Wilson, RW, Rode, KD, Runge, MC and H Stern. 2017. Harvesting wildlife affected by climate change: a modeling and management approach for polar bears. Journal of Applied Ecology **54**:1534-1543.

How to harvest polar bear populations facing current or future declines due to habitat loss?

Photo by K. Laidre

Matrix-based population model

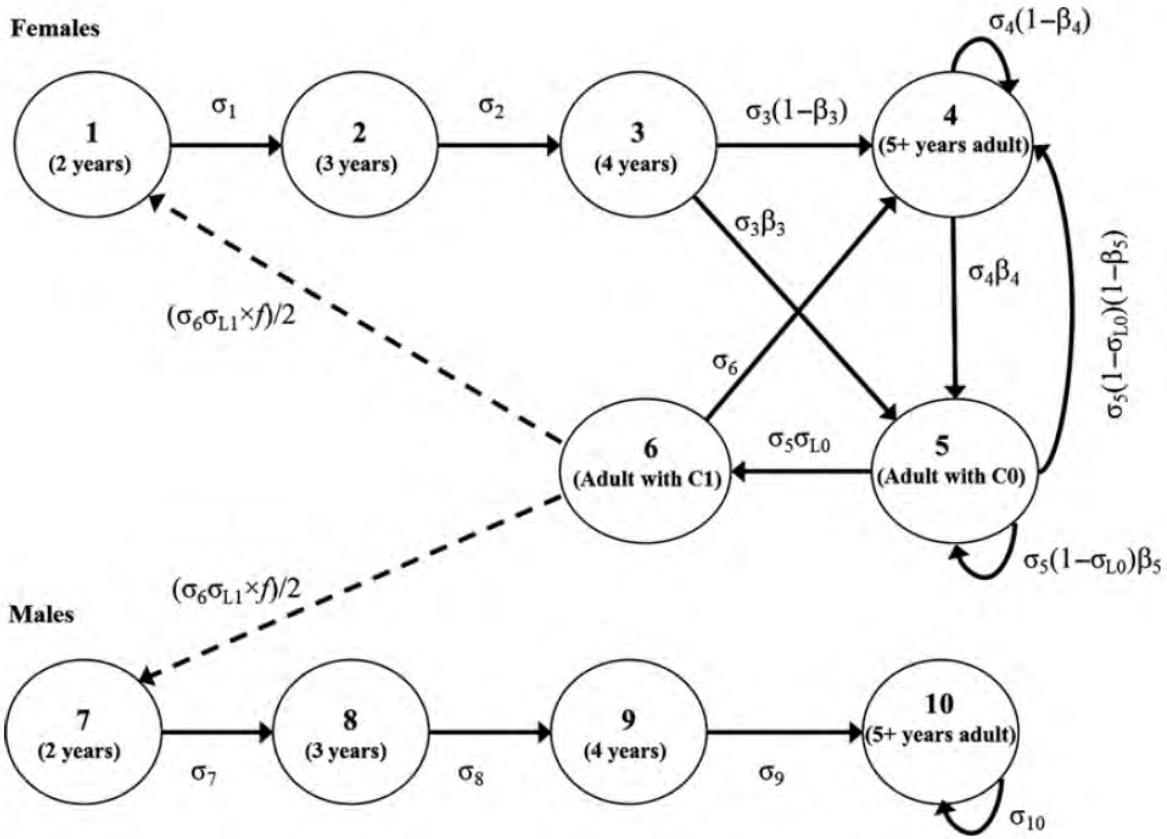
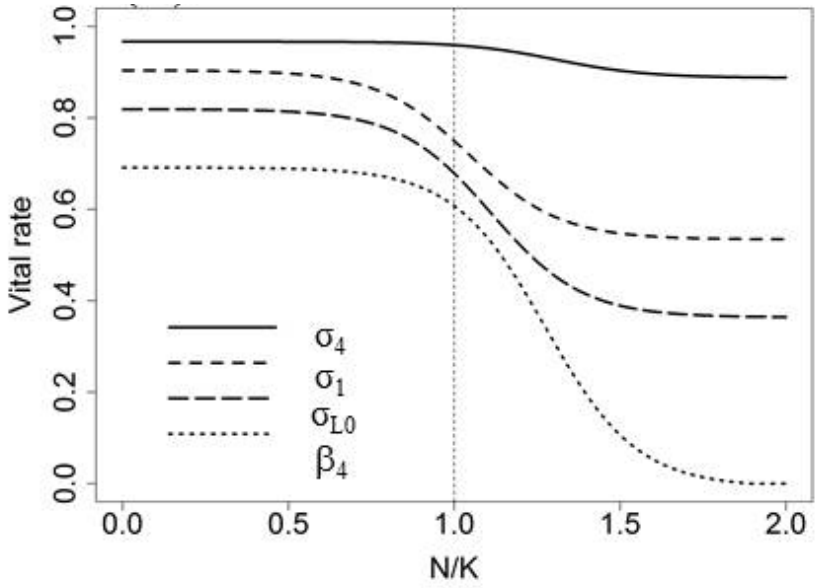


Fig. 1. The polar bear life cycle graph underlying the matrix-based projection model. Stages 1–6 are females and stages 7–10 are males; σ_i is the annual probability of survival of an individual in stage i, σ_{L0} and σ_{L1} are the probabilities of at least one member of a cub-of-the-year (C0) or yearling (C1) litter surviving, f is the expected size of C1 litters that survive to 2 years, and β_i is the probability, conditional on survival, of an individual in stage i breeding, thereby producing a C0 litter with at least one member surviving. Solid lines are stage transitions and dashed lines are reproductive contributions.

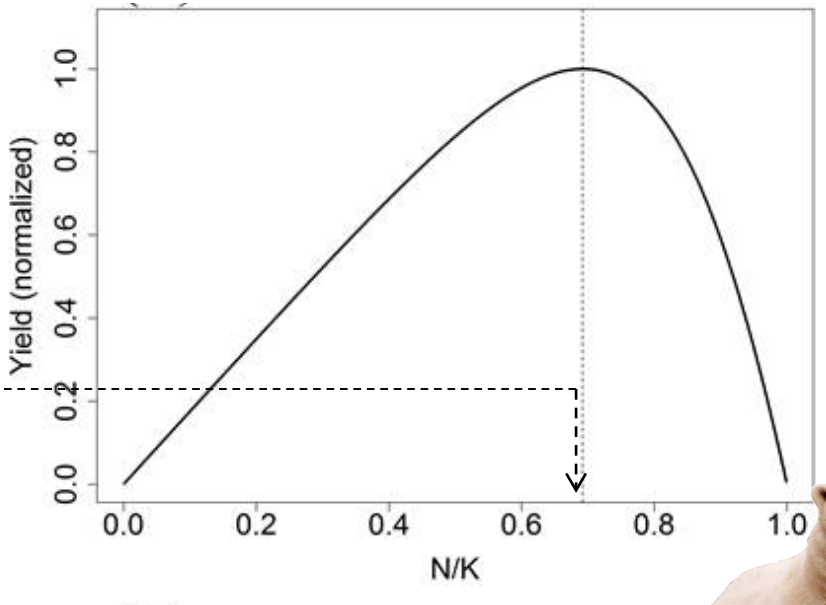
Regehr et al. (2015, 2017)

Density-dependent functions

The model describes how polar bear populations respond when it gets crowded (e.g., when there are more bears, or is less sea ice)



MNPL (maximum net productivity level): population size below K with greatest net increment in abundance



Key messages

- State-dependent (i.e., dependent on current conditions) management approach: requires research-mgmt. link
- Only modeling framework to consider density-dependence, mgmt. interval, quality of population data, and the effects of habitat loss due to climate change through proxy for *K*
- Managers will be provided with probabilities of meeting mgmt. objectives for harvest strategies defined by level (bears/year), composition, mgmt. interval, precision, habitat trends
- Collaborative process involving American and Russian SWG

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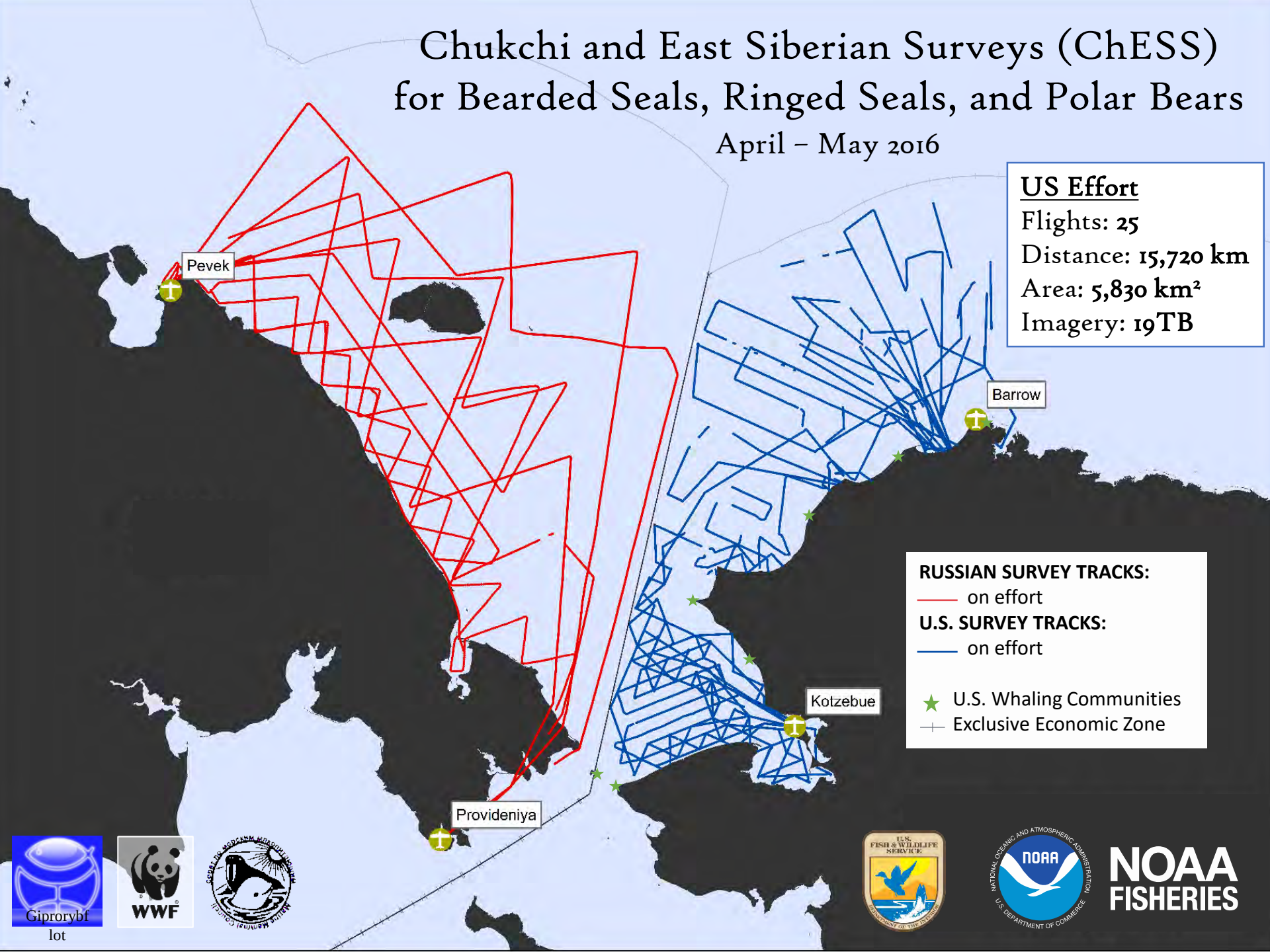
Chukchi and East Siberian Surveys (ChESS) for Bearded Seals, Ringed Seals, and Polar Bears

April – May 2016



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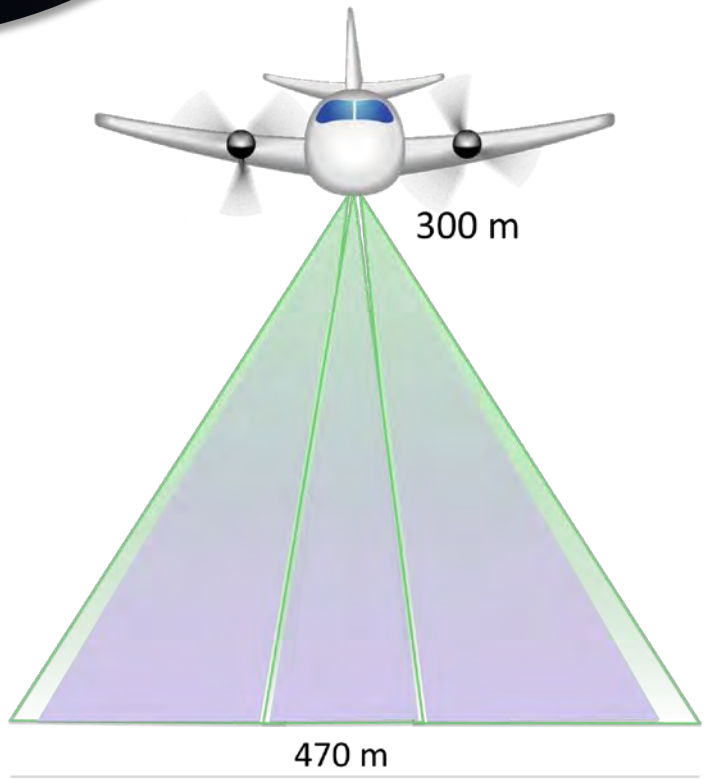
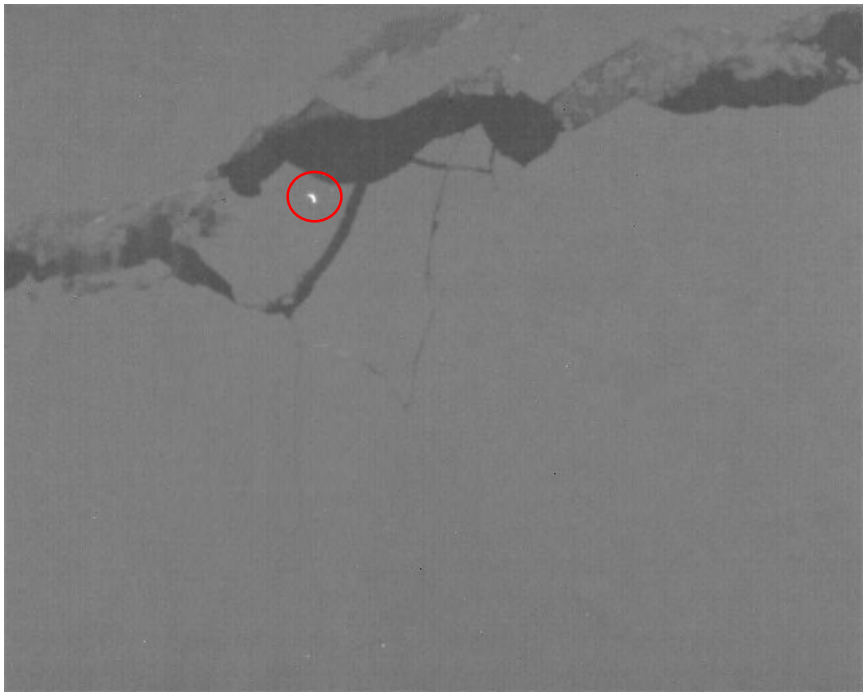
Aircraft:	King Air A90
Target altitude:	300 m
Thermal camera:	cooled LWIR 25mm lens
Color camera:	machine vision 29 MP, 100mm lens
Swath width:	470 m
Survey speed:	160-170 kts
Resolution-thermal:	20-23 cm/pixel
Resolution-color:	1.71-2.13 cm/pixel





Contact information: Erin Moreland <erin.moreland@noaa.gov>

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- Our survey design was based on extensive statistical modeling* to determine the appropriate level of survey effort and allocation of effort to achieve usable results.

- Our coverage exceeded this target, however, our measured detection of polar bears is lower than anticipated (~70%). Only 3 bears were detected "on-effort."

- Efforts to improve detection include developing an advanced algorithm using both thermal and color data. This will require more imagery with which to train the algorithm.

- We are also considering expanding the spectral range (UV, hyperspectral) to eliminate the potential effect of behavior on visual and thermal detection.

- We hope to test a new algorithm in flight in 2019 and conduct surveys for seals and polar bears in the Beaufort Sea in 2020.

* Conn PB, *et al*. 2016. Using simulation to evaluate wildlife survey designs: polar bears and seals in the Chukchi Sea. Royal Society Open Science. 3: 150561. http://dx.doi.org/10.1098/rsos.150561

Polar Bear Boundaries

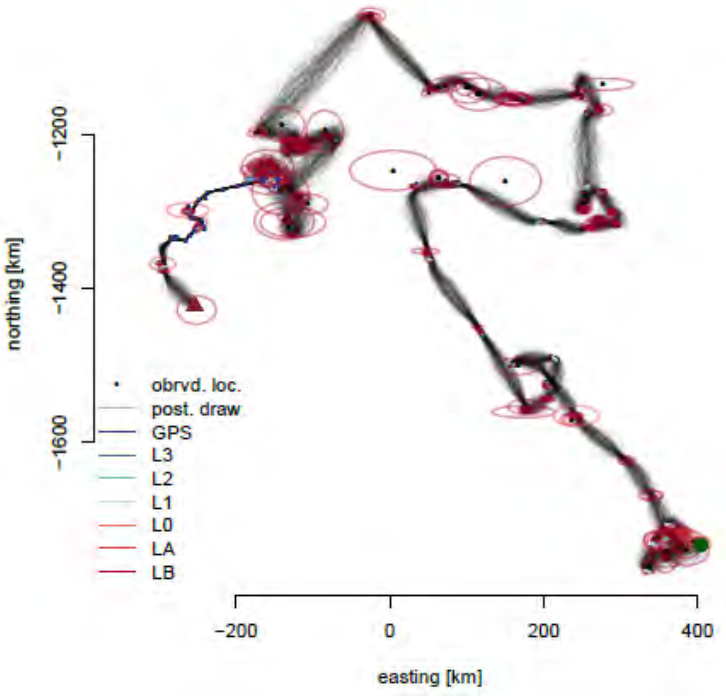
Updated methodology for delineating sub-populations

Contact information: Ryan Wilson <ryan_r_Wilson@fws.gov>

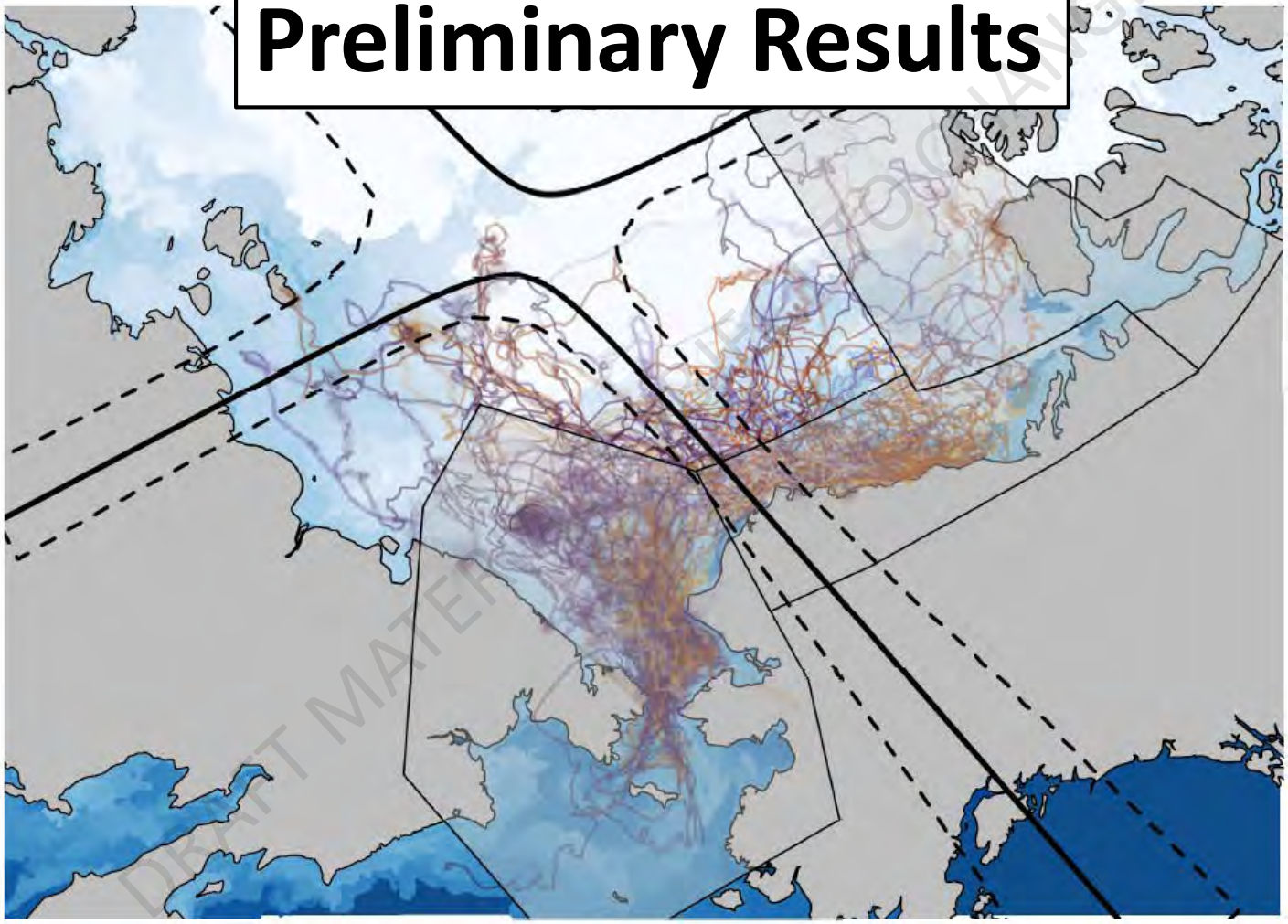
Henry Sharf, Colorado State University
Mevin Hooten, Colorado State University, USGS
Ryan R. Wilson, U.S. Fish and Wildlife Service
George Durner, USGS
Todd Atwood, USGS

Updated Method

- Developed a new method that relies on hierarchical Bayesian statistics to:
  - Accounts for location error
  - Allows inclusion of all location data
  - Accounts for sea ice movements in estimating population membership and boundary
  - Estimates a boundary jointly with data from both sub-populations
  - Estimates probability of sub-population membership
  - Provides estimate of boundary uncertainty



Preliminary Results



Polar bear studies on Wrangel Island

- Wrangel is critical for maternity denning and resting during summer; more bears spending a longer time there
- First on-the-ground US-Russia collaboration in several decades
- Study methods:
  - Ground-based observational surveys for numbers, distribution, habitat use, body condition, behavior, reproductive indices, composition
  - Non-invasive genetic sampling
- Understand ecology during ice-retreat season; population demography

Polar bear studies on Wrangel Island

- Fieldwork completed in 2016 (179 bears) and 2017 (589 bears)
- Will continue 2018 – 2020
- Collaborative effort between WISNR, UW, USFWS, MNRE, NSB and ADFG (planned for 2018)

Contact information: Eric Regehr <eregehr@uw.edu>

Thank you