Welcome

ARCUS Arctic Research Seminar Series

"Diverse Responses and Emerging Risks for Marine Mammals in a Rapidly Changing Arctic"

25 March 2019

Presenter:
Donna Hauser
International Arctic Research Center,
University of Alaska Fairbanks

ARCTIC RESEARCH SEMINAR SERIES

#ARCUSwebinar

Background photo by Ute Kaden

Diverse responses & emerging risks for marine mammals in a rapidly changing Arctic

Donna DW Hauser

Research Assistant Professor

International Arctic Research Center, University of Alaska Fairbanks

Photo: P. Nicklen

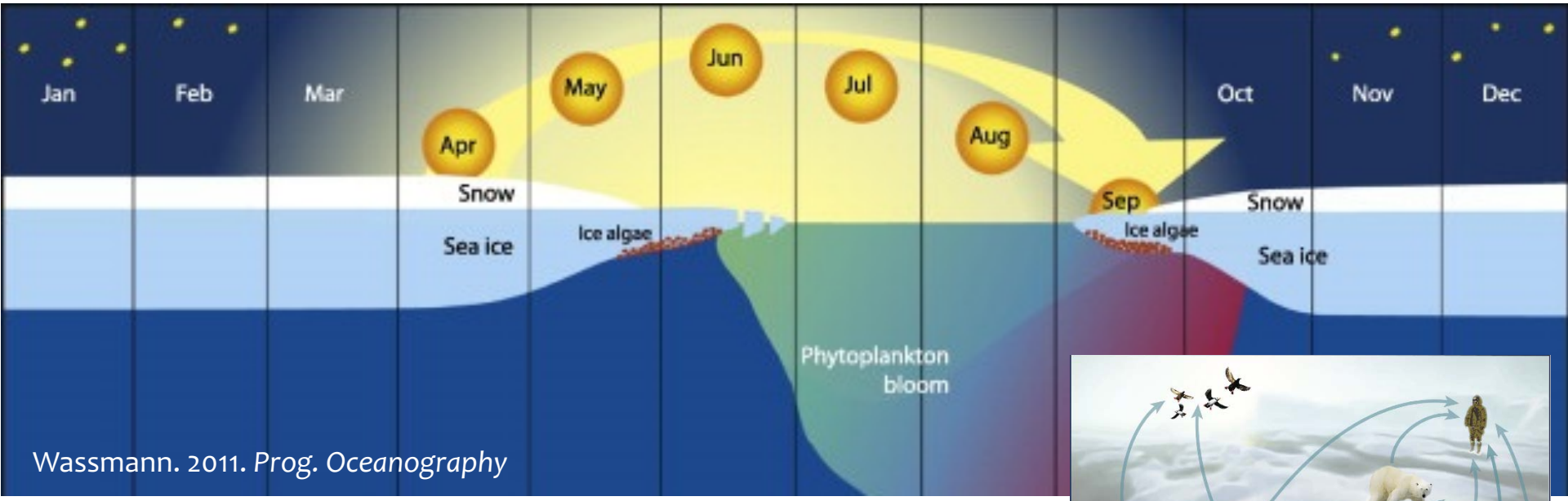
Animation: NASA Scientific Visualization Studio
https://climate.nasa.gov/vital-signs/arctic-sea-ice/

Sea Ice Extent, 23 Sep 2018

near-real-time data

National Snow and Ice Data Center, University of Colorado Boulder

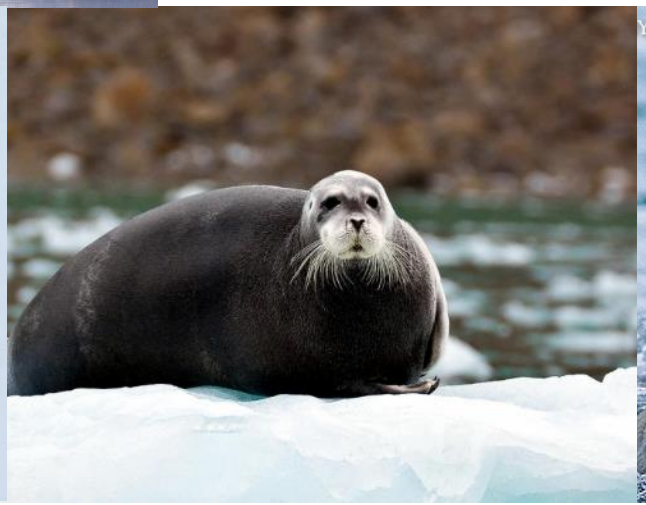
Sea ice structures localized productivity and fuels short food chains



Wassmann. 2011. *Prog. Oceanography*

Moore & Stabeno. 2015. *Prog. Oceanography*

Arctic marine mammals: sentinel, ice-adapted, culturally and ecologically critical species

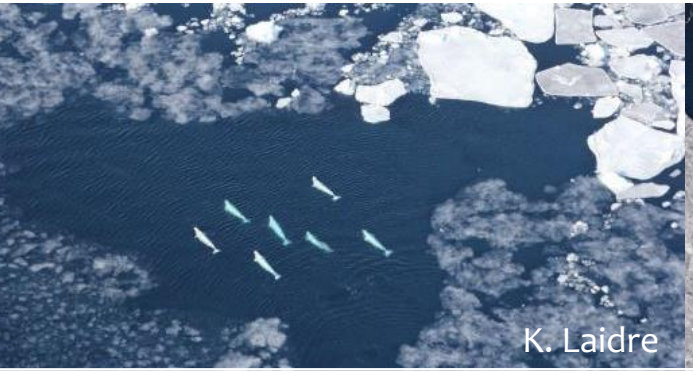


Photos: K Laidre, J Ross, P Nicklen, K Stafford, J Lindsay

Predicting climate impacts with limited baselines

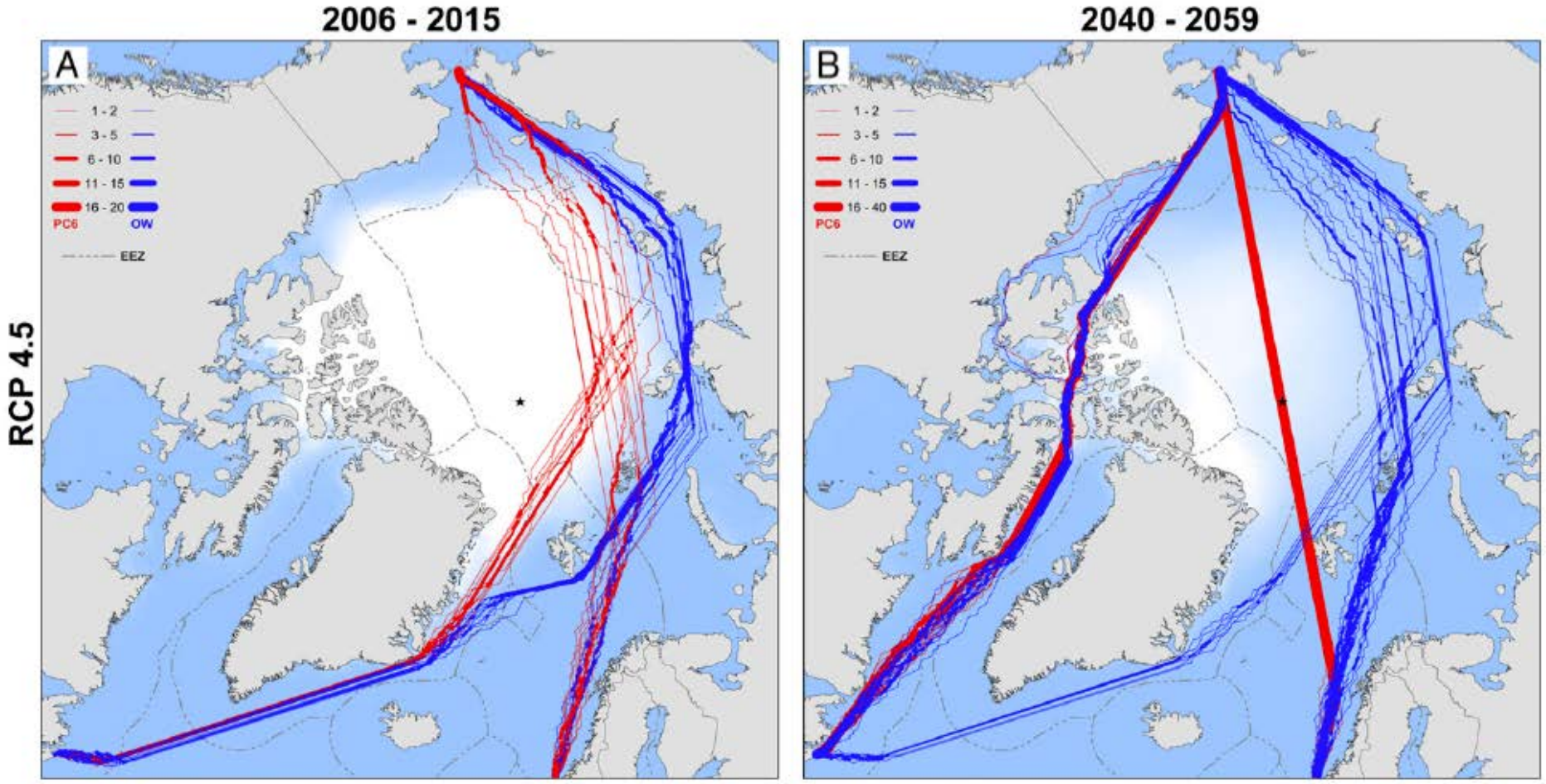


Ice-obligate: Ice is a platform for foraging, reproduction, rest



Ice-associated: Ice indirectly affects foraging and access

Increasing potential human influences



Smith & Stephenson 2013. *PNAS*

Photo: P Nicklen
Illustration: U Gorter

How are AK marine mammals responding to ice loss?

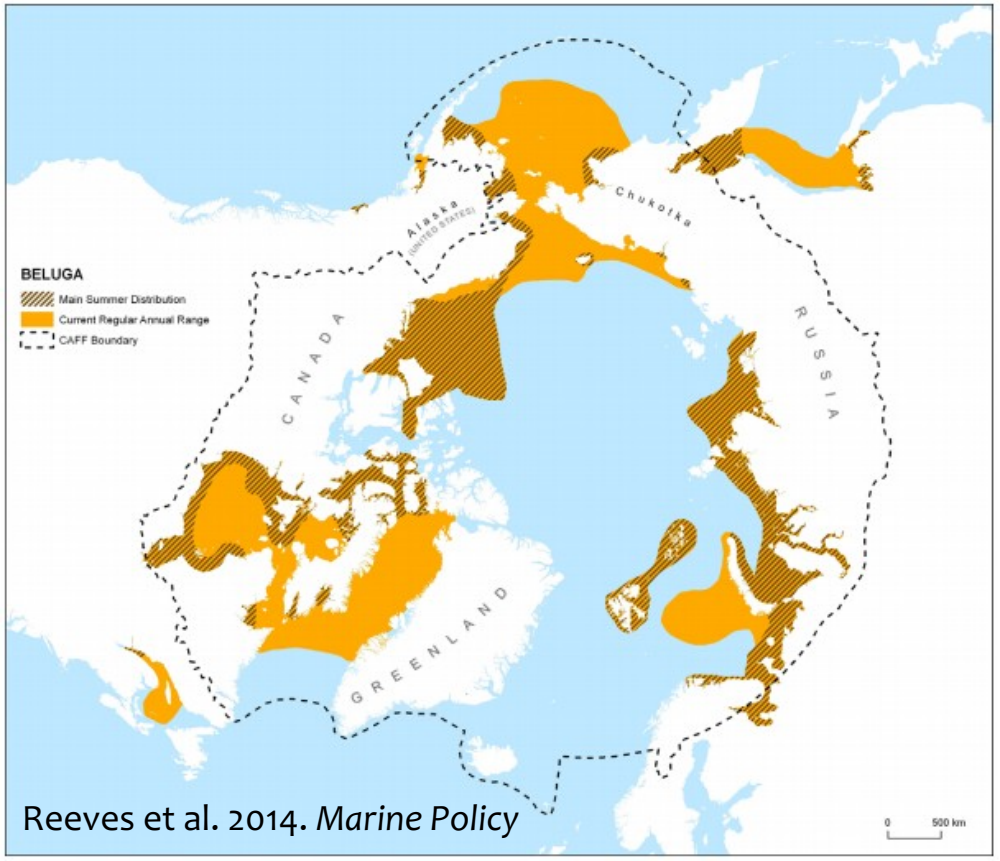
- Beluga whales

New risks with increasing open water

Future resilience

Beluga whales: a pan-Arctic marine predator

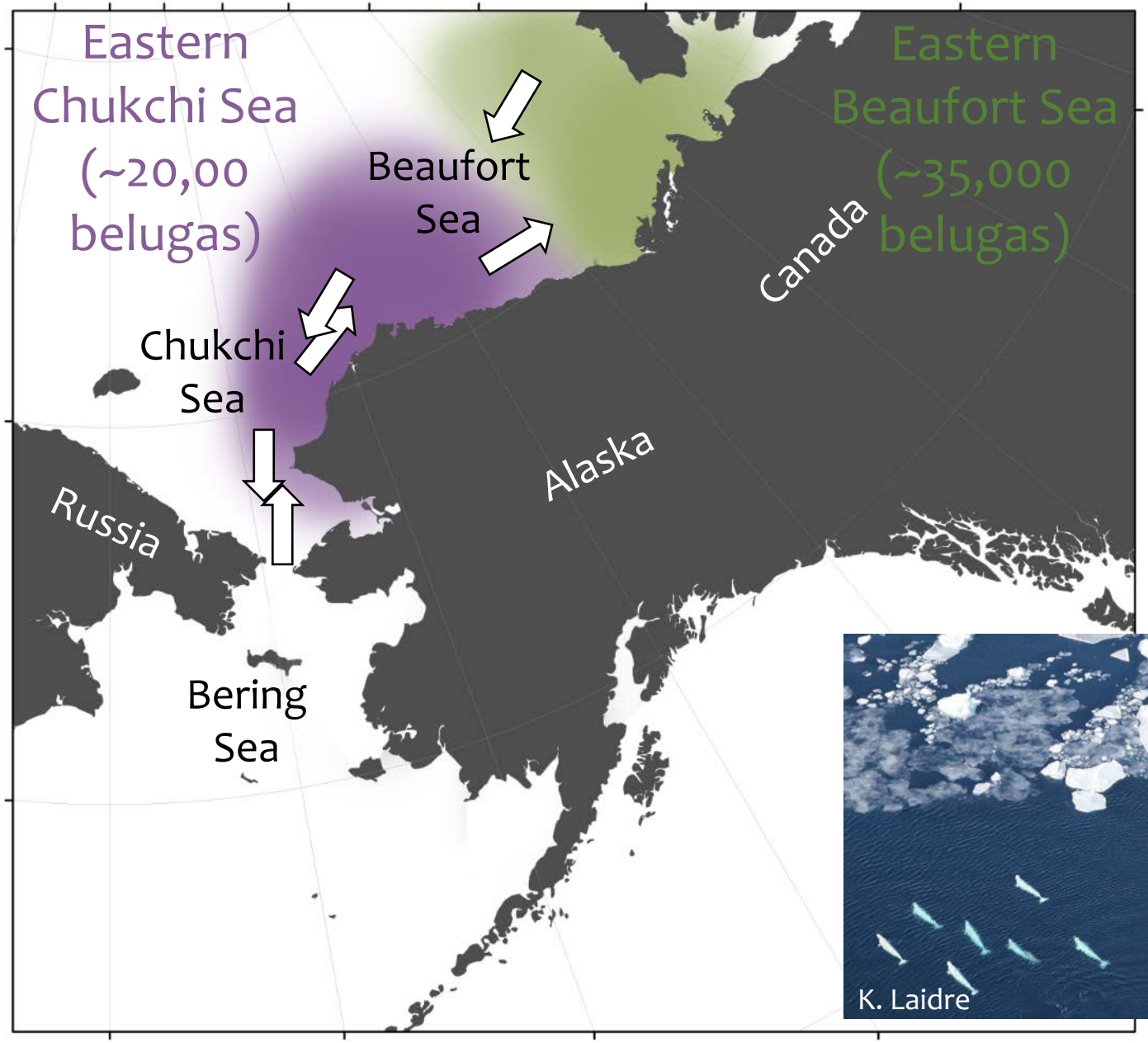
- Ice-associated, long-lived
- Wide, discontinuous Arctic & sub-Arctic range
- Exhibit summer philopatry & follow matrilineal migration paths



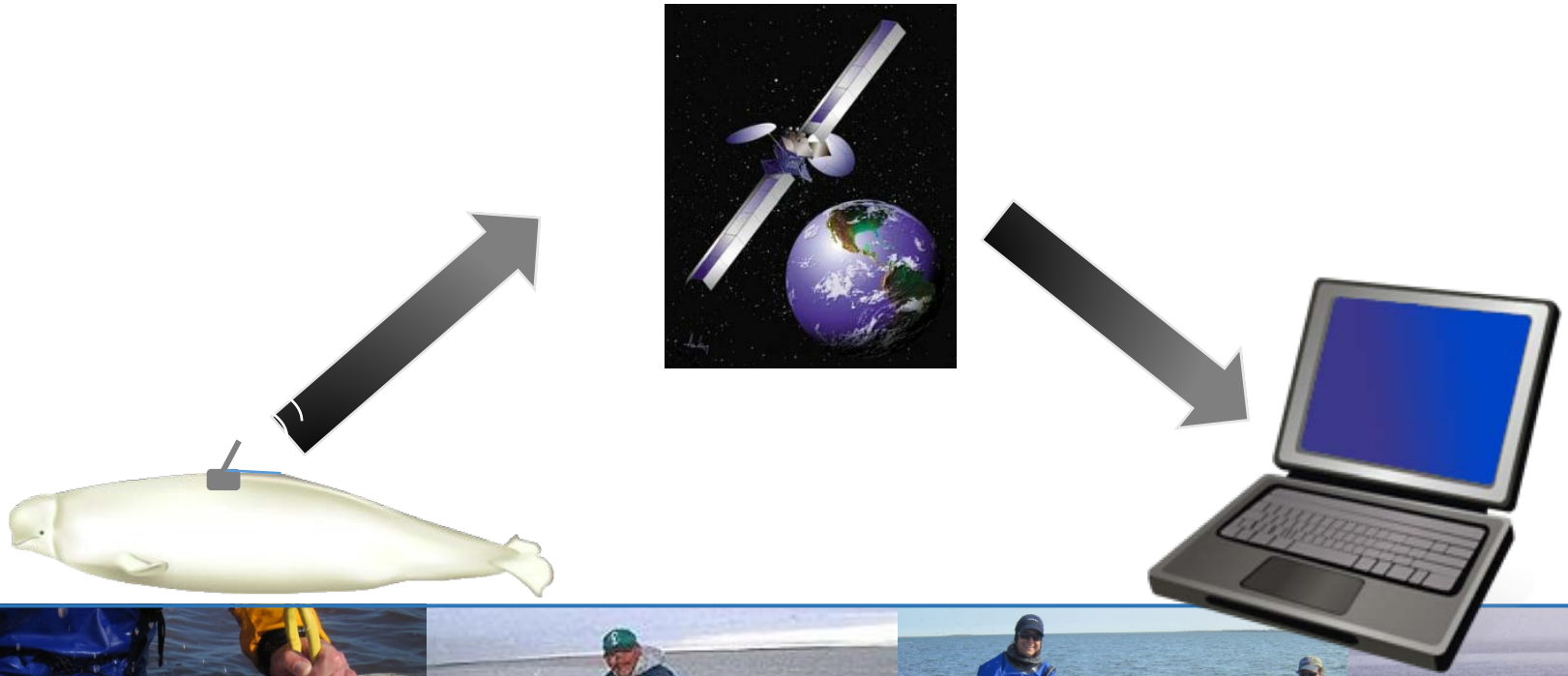
Reeves et al. 2014. *Marine Policy*

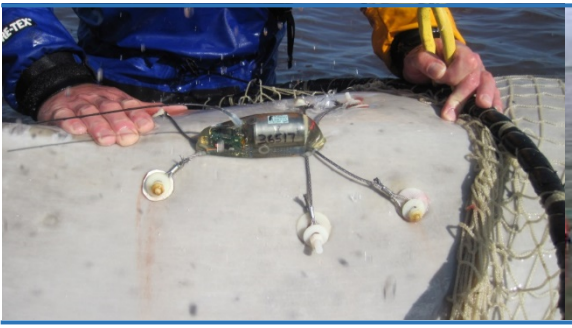

K. Laidre

Migratory Pacific Arctic belugas



Satellite-linked tags for location & diving data





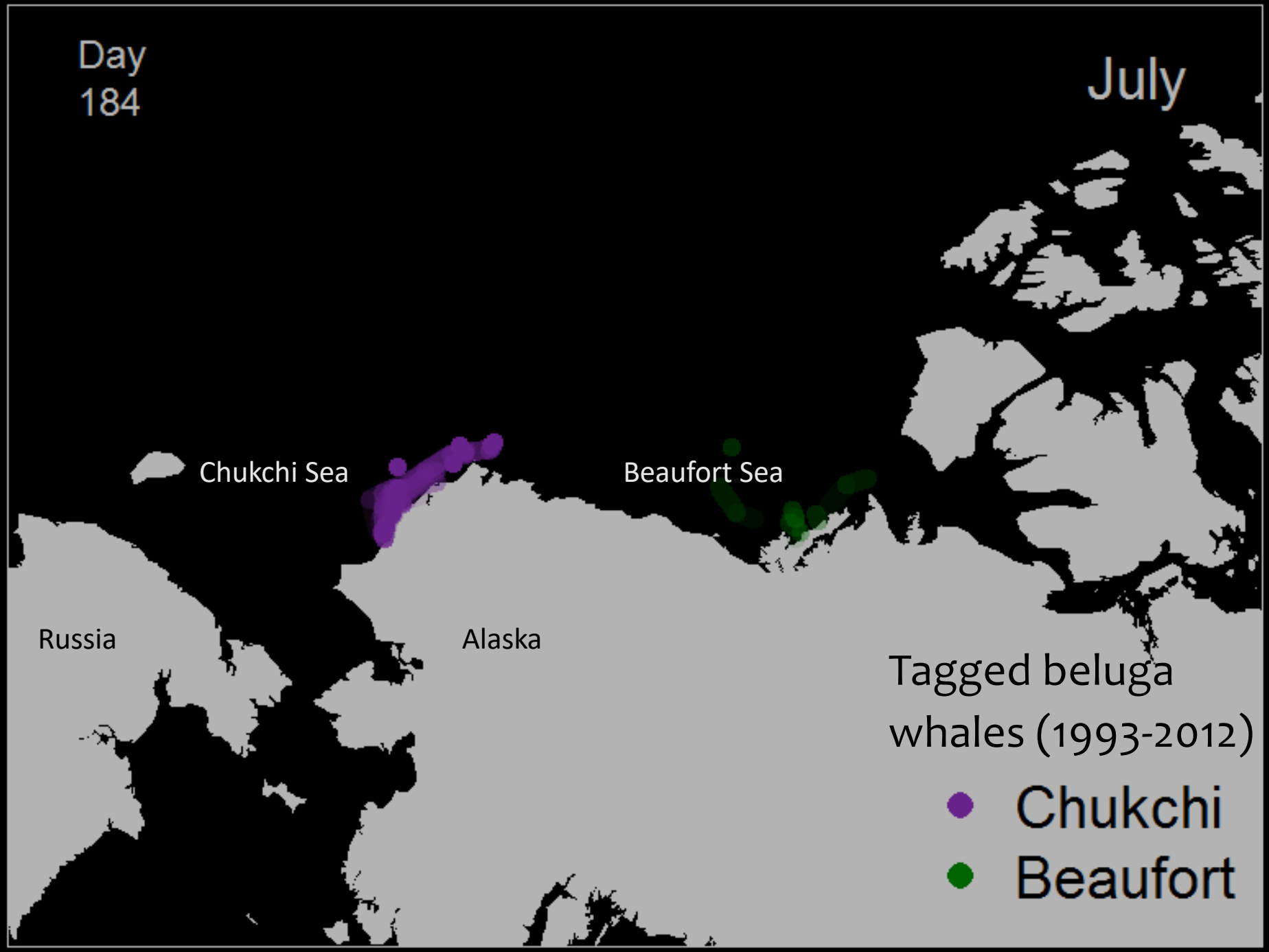
Images: L. Pierce, G. O'Corry-Crowe, NOAA, ARGOS, U. Gorter
Research permitted by DFO & NMFS (permits 14610, 782-1438, & 782-1719)

ALASKA BELUGA WHALE COMMITTEE

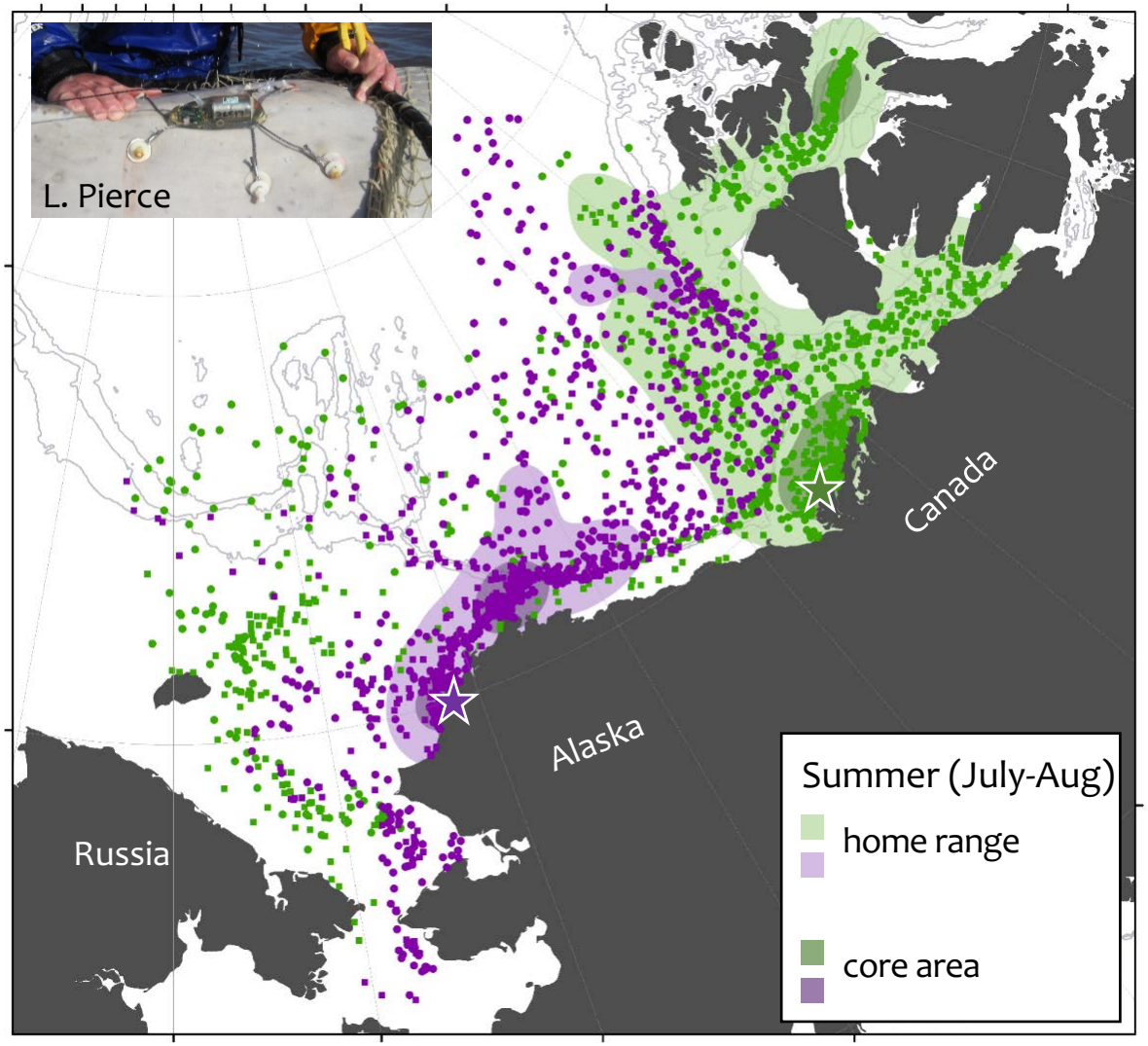
NORTH SLOPE BOROUGH DEPT. OF WILDLIFE MGMT.

Fisheries and Oceans Canada

Inuvialuit Game Council


Day
184
July
Chukchi Sea
Beaufort Sea
Russia
Alaska
Tagged beluga whales (1993-2012)
Chukchi
Beaufort

Beluga locations from tags, July - November



- Most tagged in early July
- Tags last 1 - 18 months

BEAUFORT Sea belugas
1993, 1995, 1997, 2004, 2005
n = 40 whales

CHUKCHI Sea belugas
1998, 1999, 2001, 2002, 2007, 2010, 2012
n = 27 whales

Hauser et al. 2014. *Polar Biology*

Shifting beluga habitat, behavior, and migration with changing ice?

- **Sea ice structures habitat:** Has habitat use or foraging behavior changed through time?
- **Sea ice affects access to preferred habitat:** Has fall migration timing changed as the timing of sea ice cover has shifted?

Kristin Laidre Kate Stafford

Harry Stern Sue Moore

University of Washington

Robert Suydam

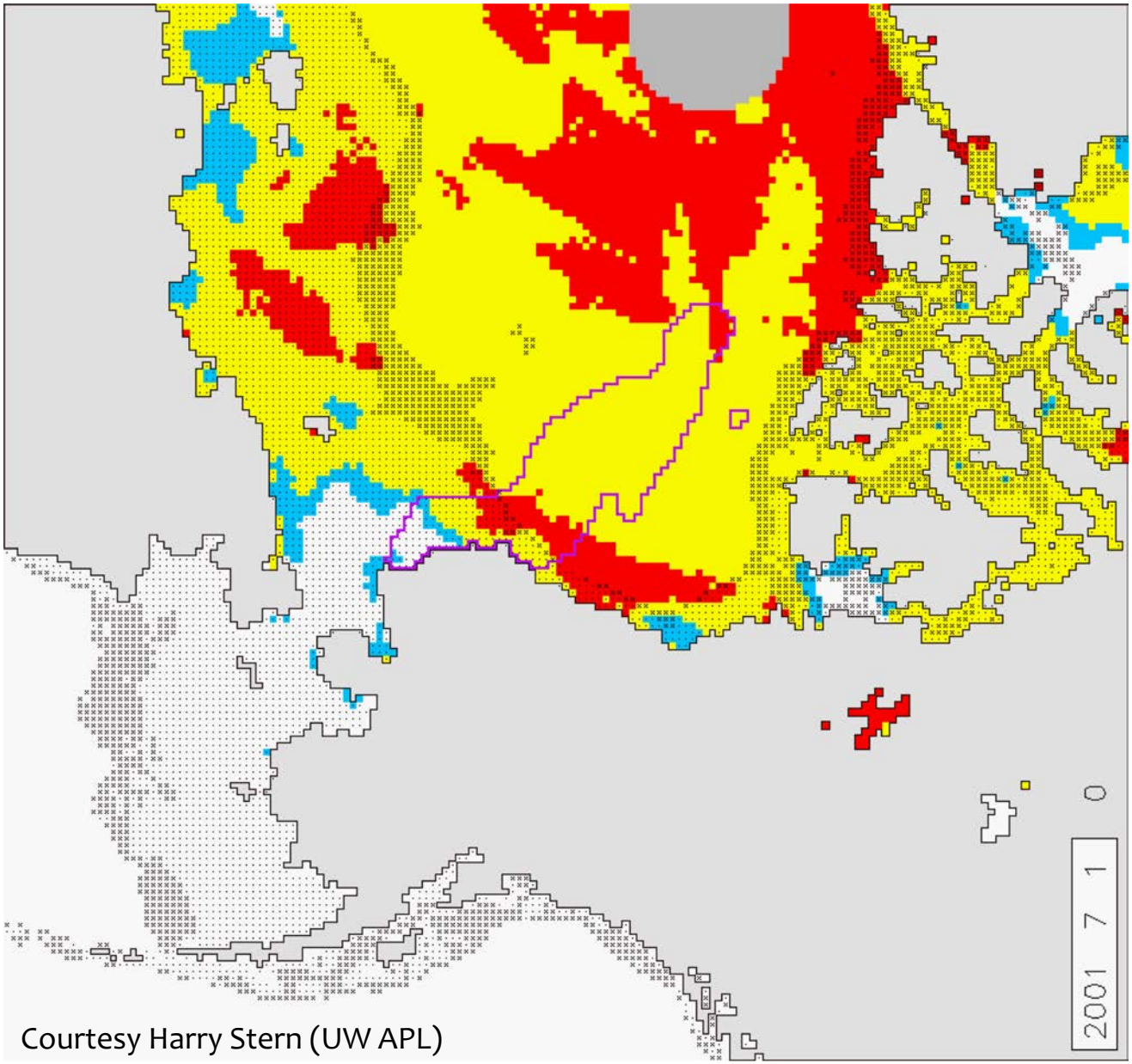
North Slope Borough

Pierre Richard

Fisheries & Oceans Canada

Photo: K. Laidre

Daily sea ice habitat: **2001**



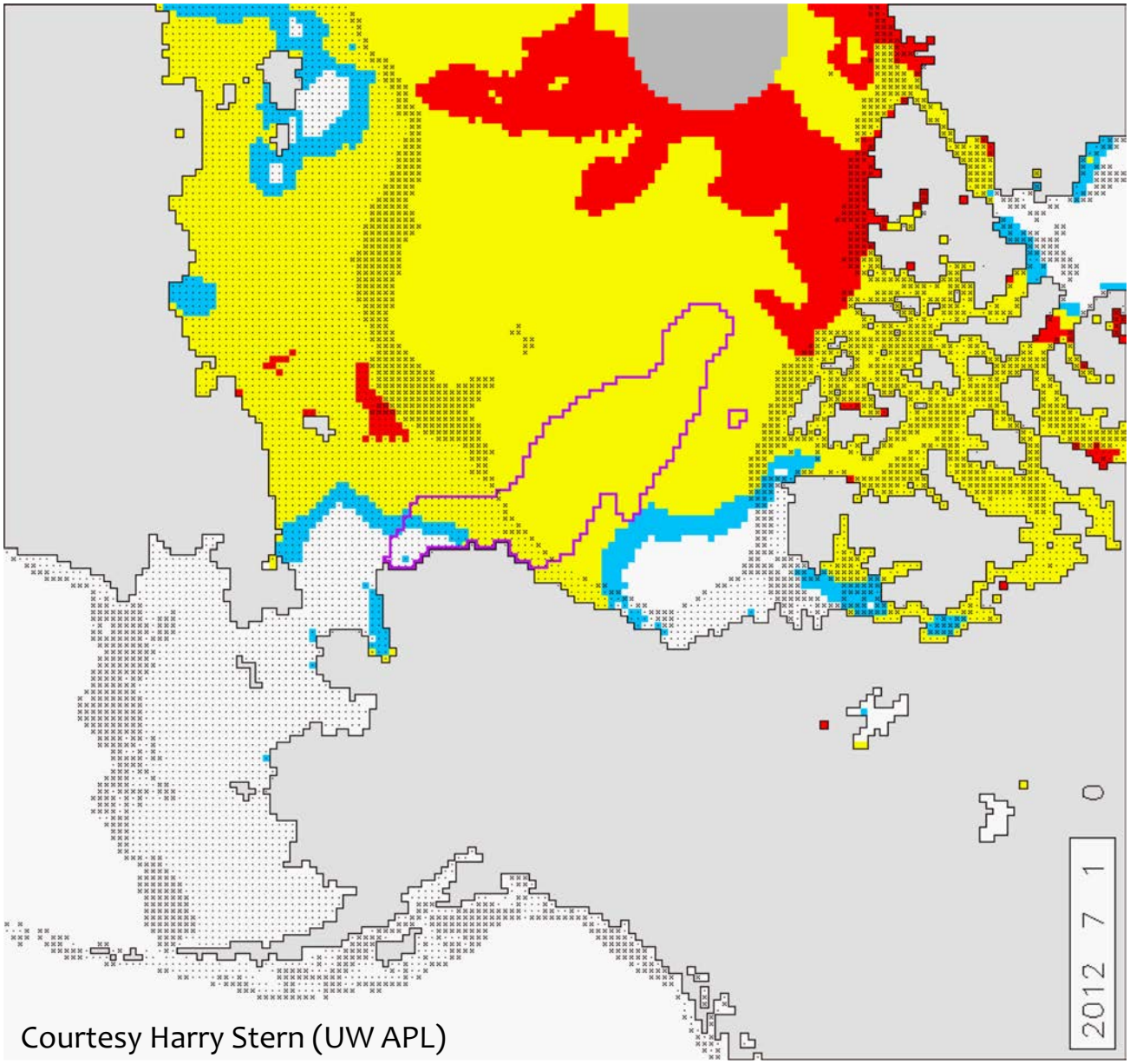
Courtesy Harry Stern (UW APL)

SSM/I sea ice data
(National Snow & Ice Data Center)

Sea ice concentration (%)

0 15 50 90

Daily sea ice habitat: **2012**



Courtesy Harry Stern (UW APL)

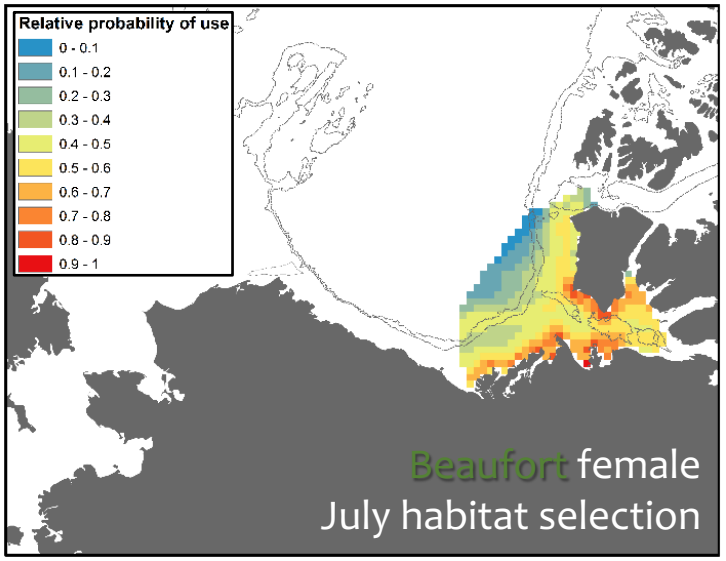
SSM/I sea ice data
(National Snow & Ice Data Center)

Sea ice concentration (%)

0 15 50 90

What environmental factors affect habitat selection?

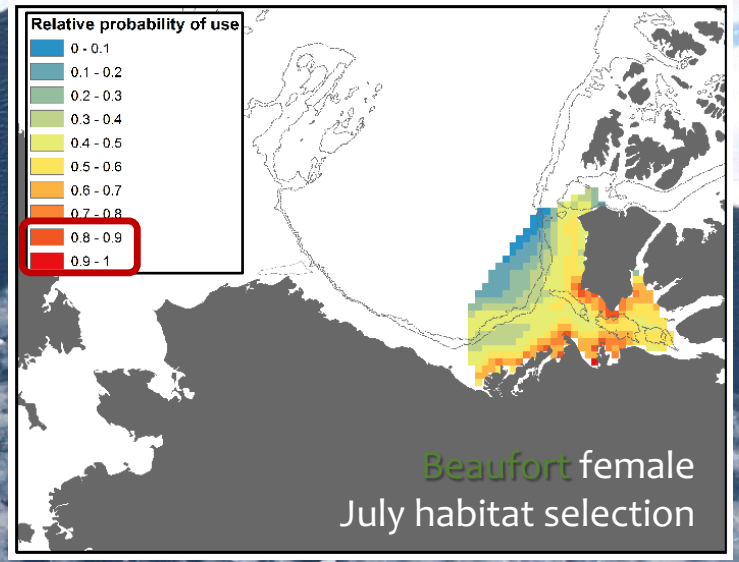
- Important habitat predictors vary seasonally
- Sea ice is one, but not the primary, predictor of habitat selection
- Proximity to ‘hotspots’ and bathymetry are typically stronger predictors
- Importance of recent sea ice loss?



Hauser et al. 2017. *Plos One*

Are belugas responding to changing sea ice habitat?

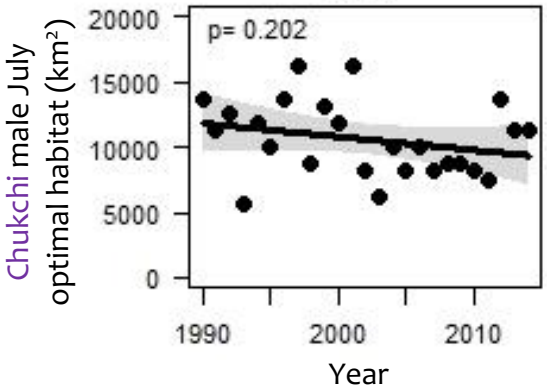
- Changes in resource selection
- Trends in optimal habitat 1990-2014

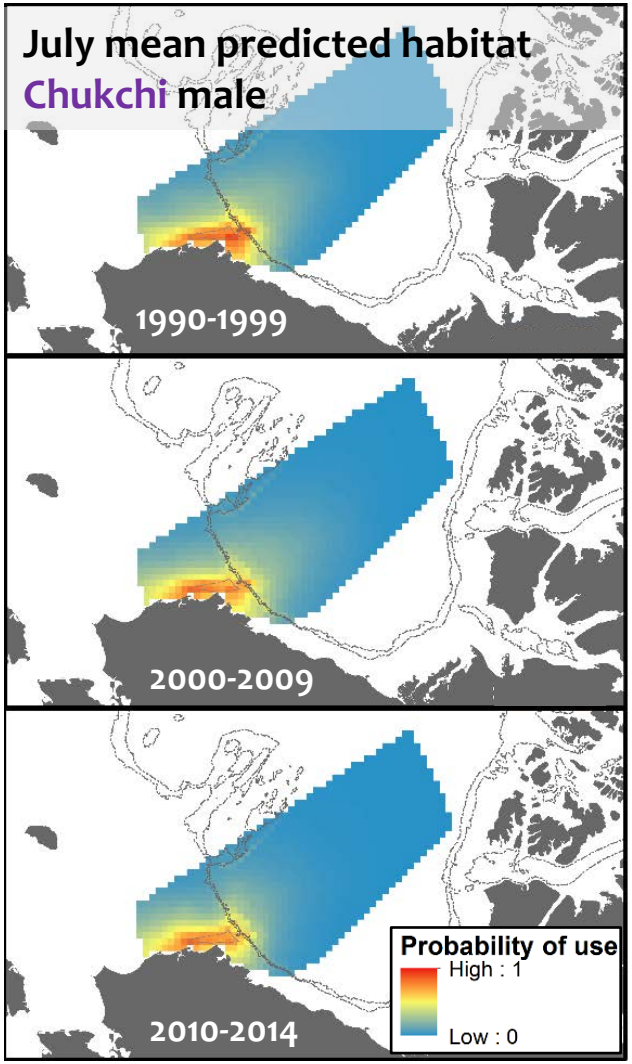


K. Laidre

No change in sea ice habitat selection

- Few significant changes in sea ice selection between 1990s & 2000s
- Few shifts in spatial distribution of predicted habitat, 1990-2014
- Few significant trends in amount of optimal habitat
- **Suggests limited effect of sea ice declines on beluga habitat use**





Hauser et al. 2018. *Diversity & Distributions*

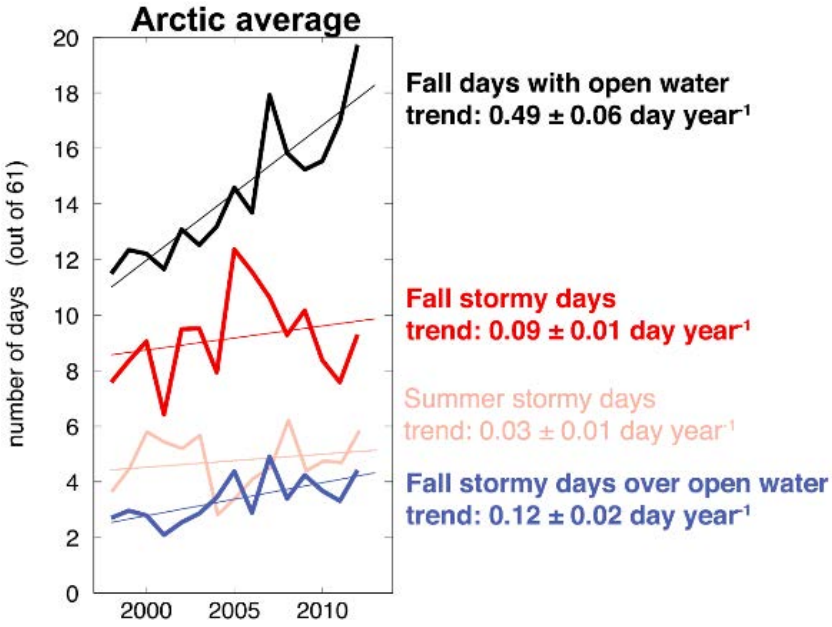
Habitat selection has not changed

Belugas appear to flexibly respond to changing sea ice habitat conditions

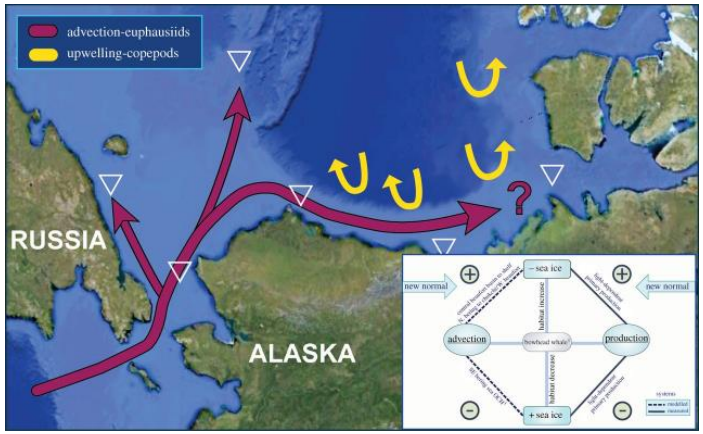
Are there other indirect effects of changing sea ice habitat on foraging?

Photo: K. Laidre

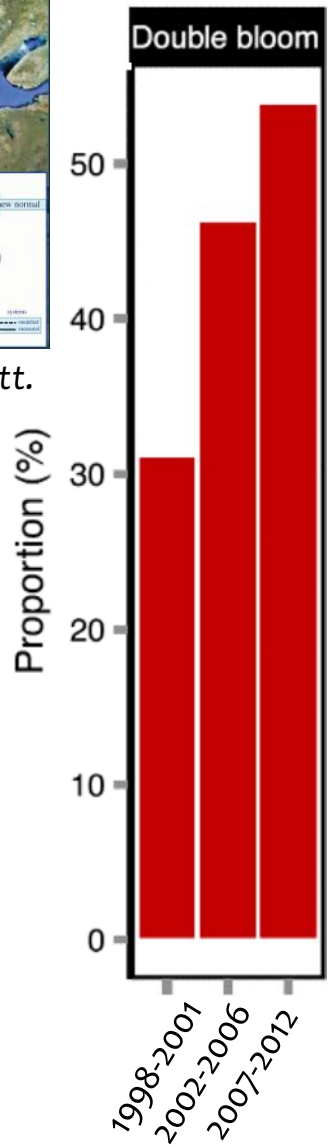
Shifts in productivity?



Ardyna et al. 2014 *Geophys. Res. Lett.*



Moore 2016 *Biol. Lett.*



Open water duration
Thinner ice
Storms, winds
Atmospheric & upper ocean heat
Freshwater

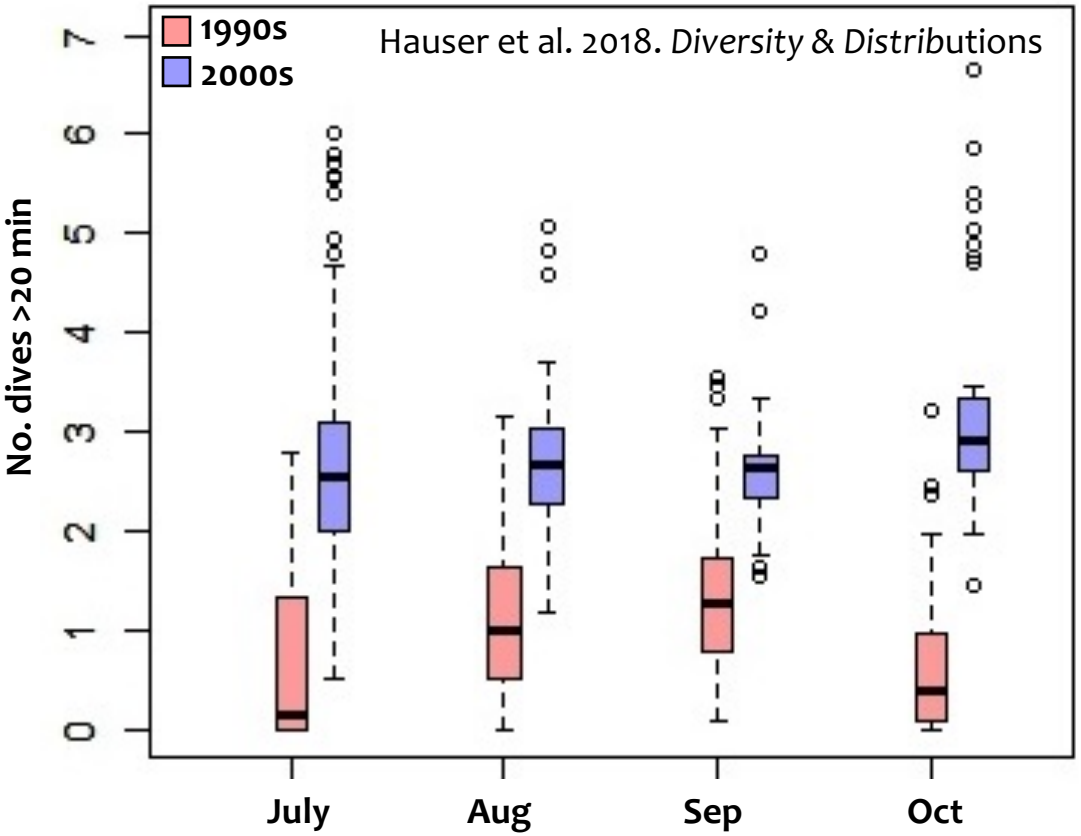
Has diving behavior changed?

Shifting foraging opportunities = behavioral changes?

Photo: K. Laidre

Chukchi belugas spend more time at depth in recent years

- More long duration dives
- Fewer short dives, less shallow dives, deeper dives
- Corresponds to regional oceanographic shifts in productive depths



Changes in foraging behavior

Sea ice structures habitat

Loss of sea ice cover did not affect habitat selection, but there are indirect behavioral effects presumably related to foraging

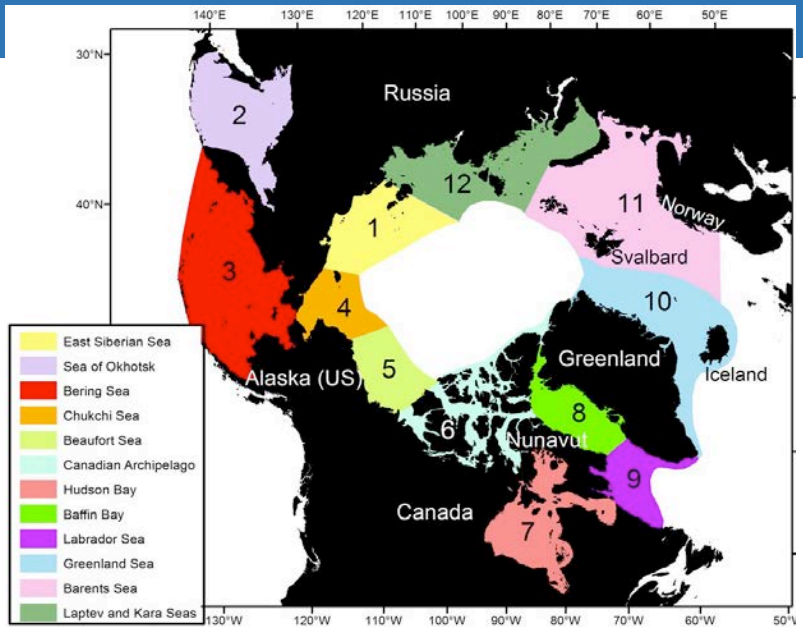
Sea ice affects access to preferred habitat

Has migration timing shifted in response to delayed freeze-up?

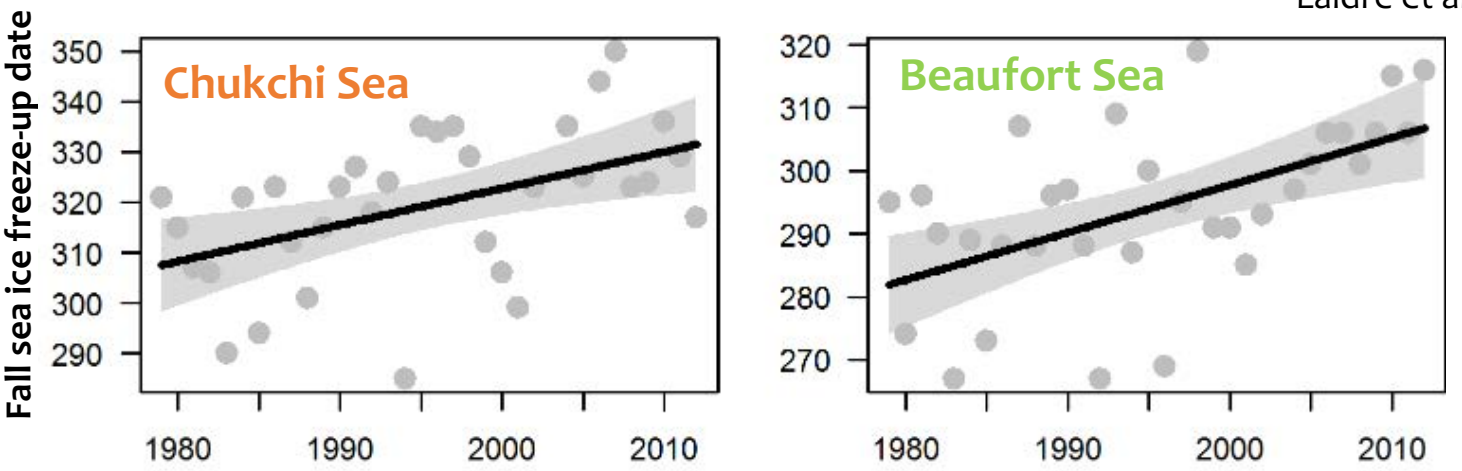
Photo: K. Laidre

Is fall migration related to freeze-up timing?

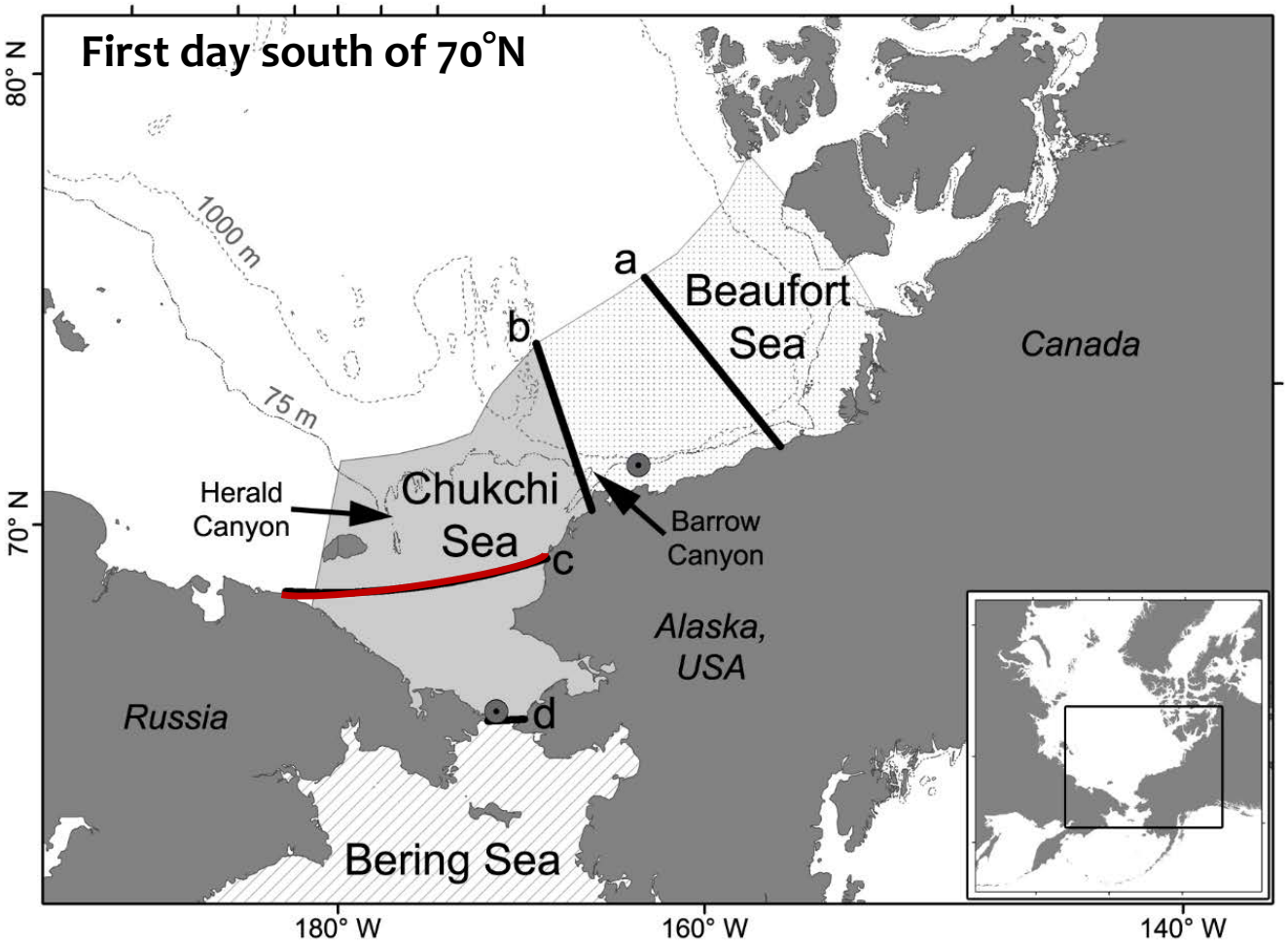
Timing of regional sea ice freeze-up is 7-8 days later per decade



Laidre et al. 2015. *Cons Biol*



Fall passage points: Southbound migration

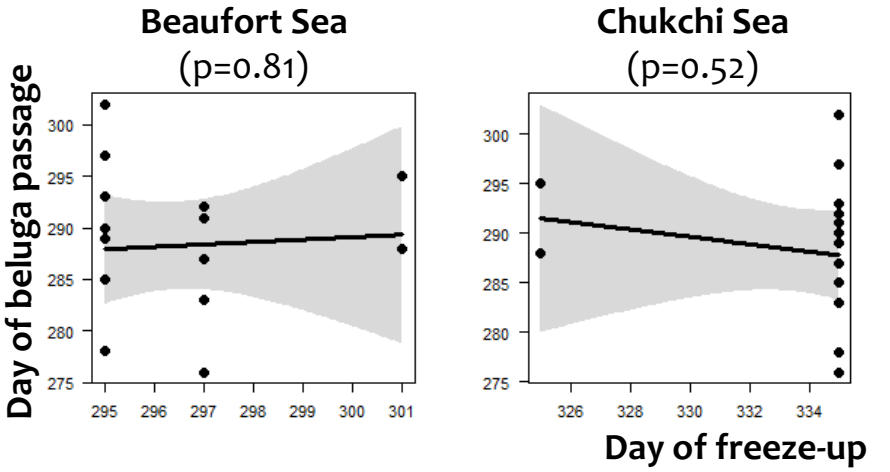


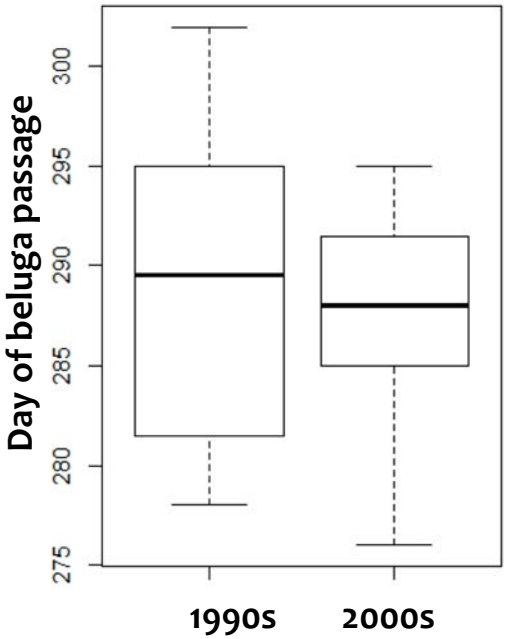
Hauser et al. 2017. *Global Change Biol.*

Fall passage points: Southbound migration

Beaufort belugas: First day south of 70°N

- No difference between periods
- Not correlated with freeze-up timing





1 day difference in median date

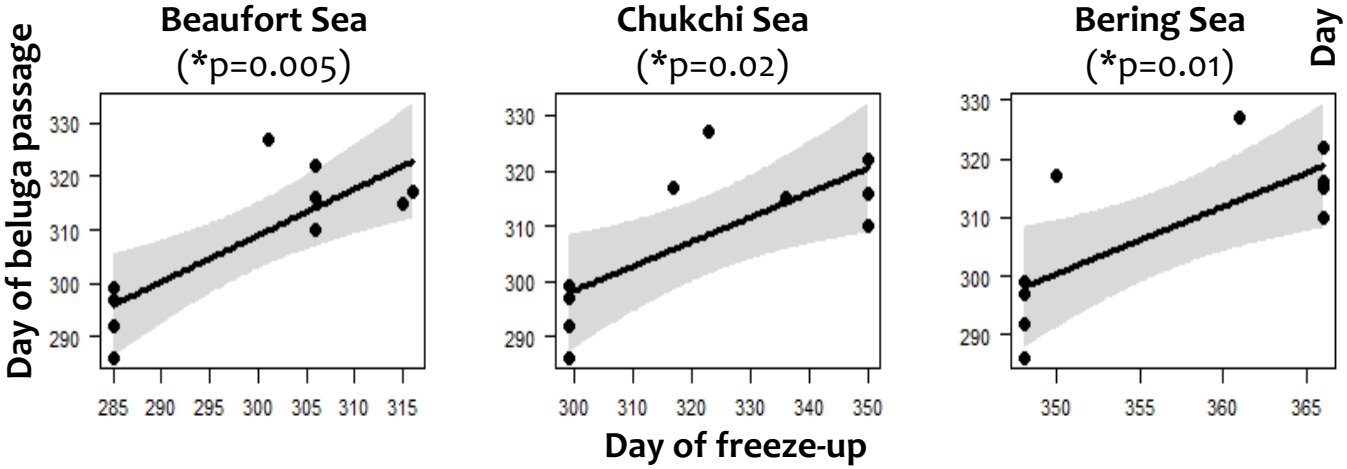
(p = 0.64)

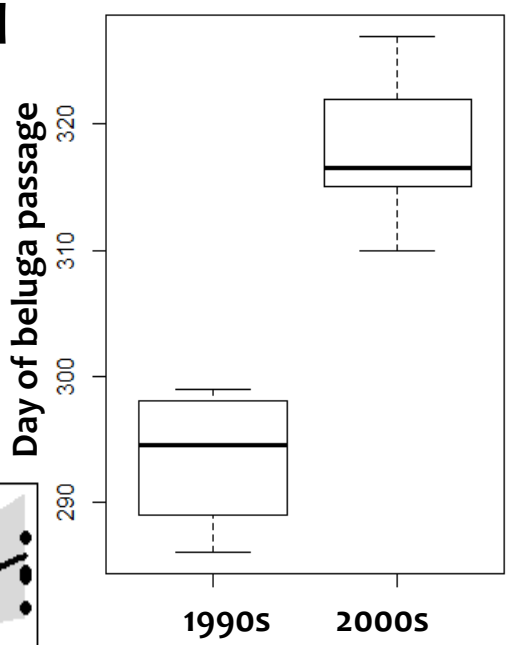
Hauser et al. 2017. *Global Change Biol.*

Fall passage points: Southbound migration

Chukchi belugas: First day south of 70°N

- Delayed during late period
- Correlated with freeze-up timing





22 day difference in median date

(p = 0.01)

Hauser et al. 2017. *Global Change Biol.*

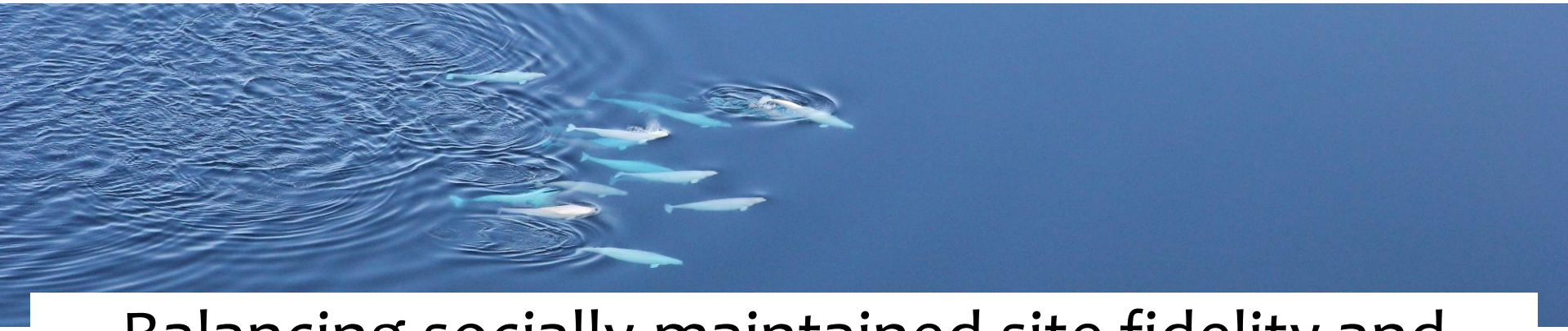
Distinct responses at decadal scales in fall migration timing

Migration timing appears to have shifted for Chukchi belugas in response to delayed fall sea ice freeze-up

No response was detected for Beaufort belugas

Photo: K. Laidre

Conclusions: Pacific Arctic belugas



Balancing socially-maintained site fidelity and behavioral plasticity in habitat and migration

Photos: K. Laidre

Conclusions: Responses to ice loss by Pacific Arctic belugas

Photos:
V. Beaver (NSB, NOAA)

- Good time to be a beluga?
- Making the best of it?
- Need population level metrics
- Not all populations respond the same

Photo: P Nicklen
Illustration: U Gorter

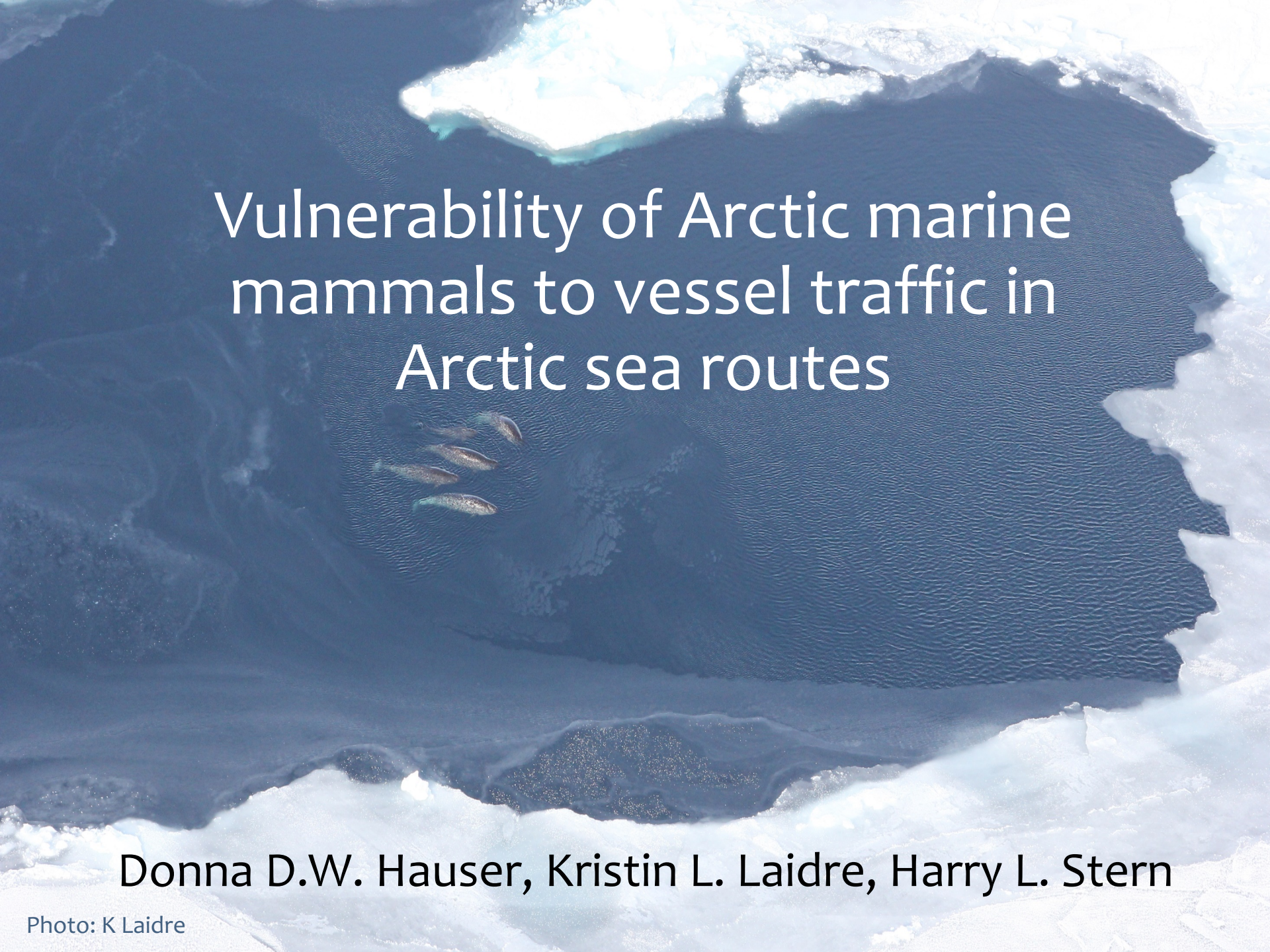
How are AK marine mammals responding to ice loss?

- Beluga whales

New risks with increasing open water

Future resilience

Vulnerability of Arctic marine mammals to vessel traffic in Arctic sea routes



Donna D.W. Hauser, Kristin L. Laidre, Harry L. Stern

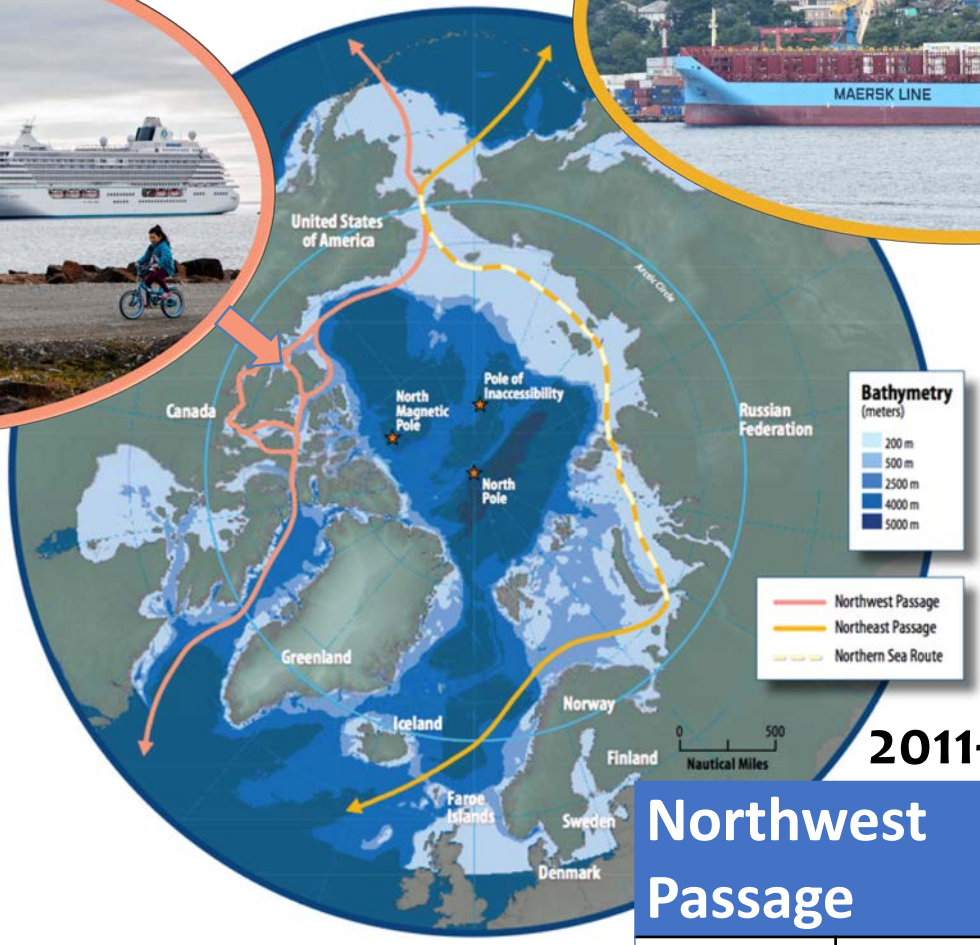
Photo: K Laidre

No longer Amundsen's Northwest Passage

Roald Amundsen, first to traverse Northwest Passage during 1903-1906 aboard 21 m wooden *Gjøa*

250 m, 1700 person *Crystal Serenity* in Ulukhaktok, Canada August 2016

200 m container ship *Venta Maersk* in Vladivostok, Russia August 2018



2011-2016 transits

Northwest Passage		Northern Sea Route	
≤ 20 m	> 20 m	≤ 20 m	> 20 m
66	39	0	247

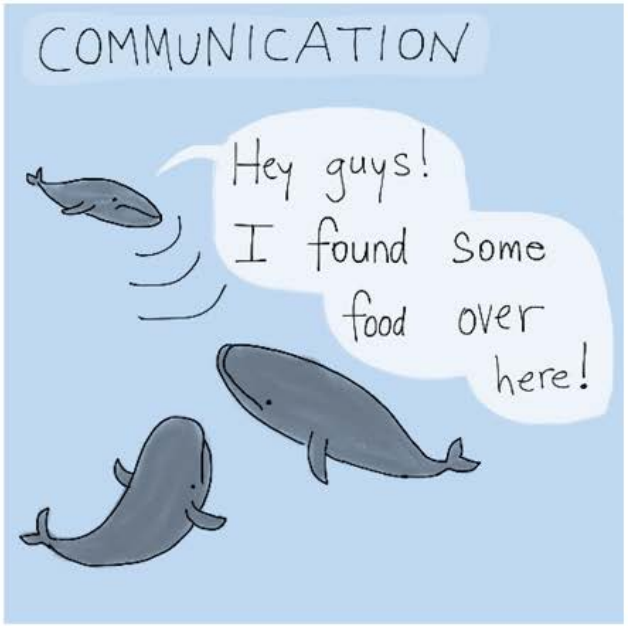
Photos: K Orlinsky, Y Maltsev

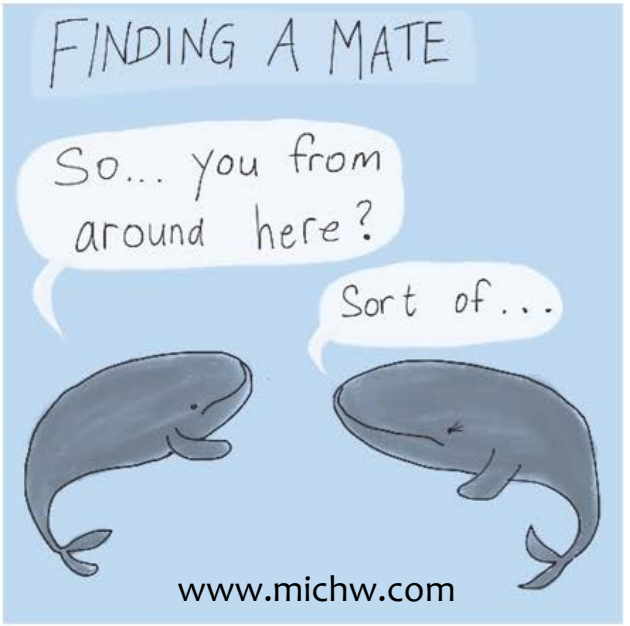
Sources: Headland 2017, CHNL 2017

Right whale and ship

Photo: Florida Fish & Wildlife Conservation Commission


FINDING FOOD
Here, fishy-fishy!


COMMUNICATION
Hey guys! I found some food over here!


FINDING A MATE
So... you from around here?
Sort of...
www.michw.com


WHOI

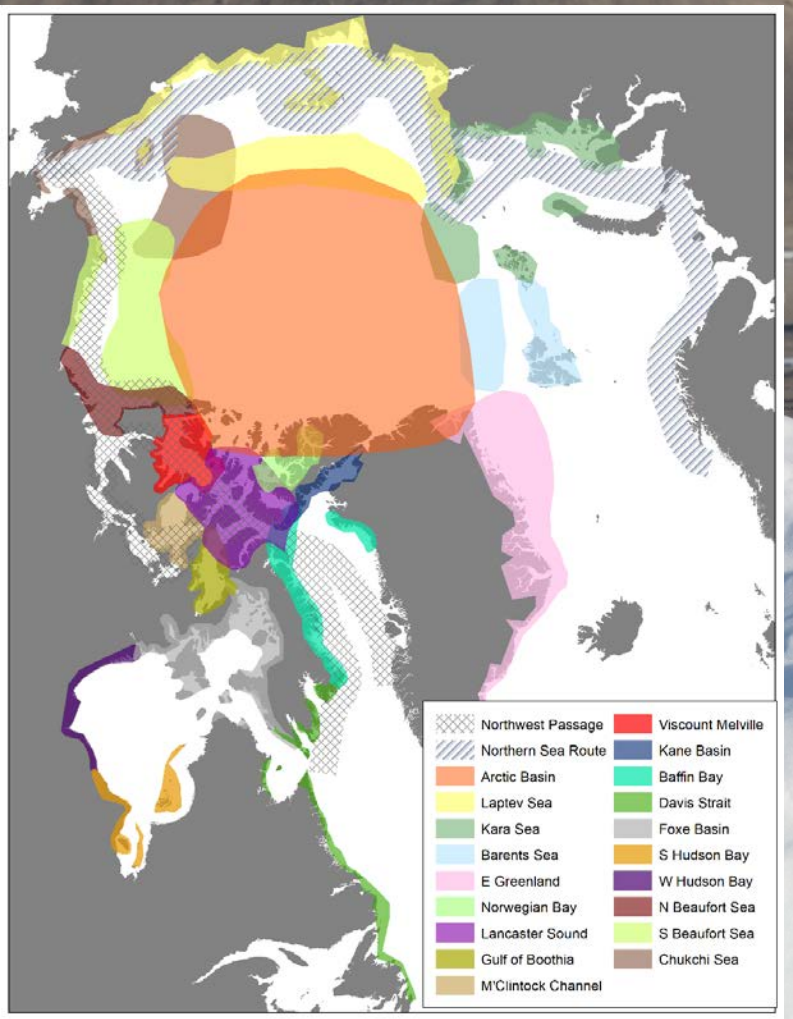

Sea North Tours

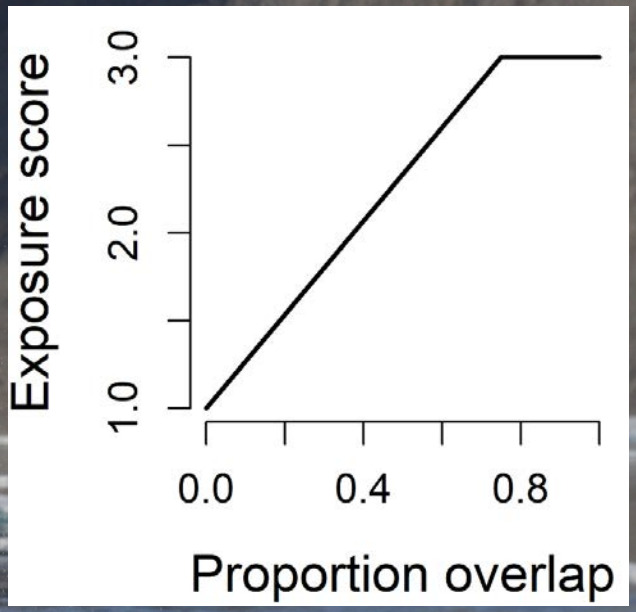
Vulnerability measures the risk of a population to impact, defined as the combined effect of **exposure** and **sensitivity**

Vulnerability = Exposure x Sensitivity

Photo: K. Sheldon, NOAA

Population-specific exposure





Spatial overlap of NWP & NSR and the September range for each of the 80 populations

Photo: K Laidre

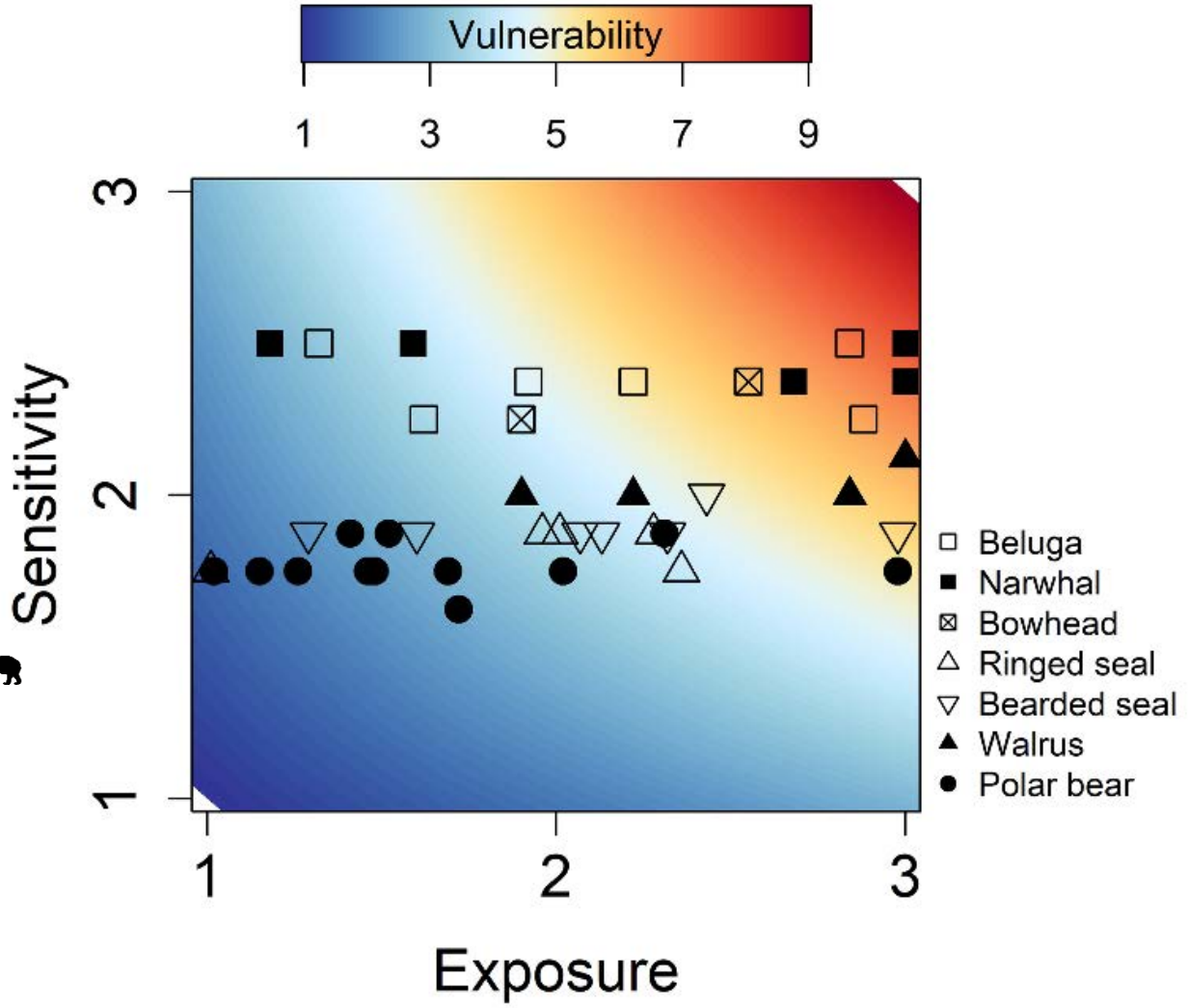
Population-specific sensitivity

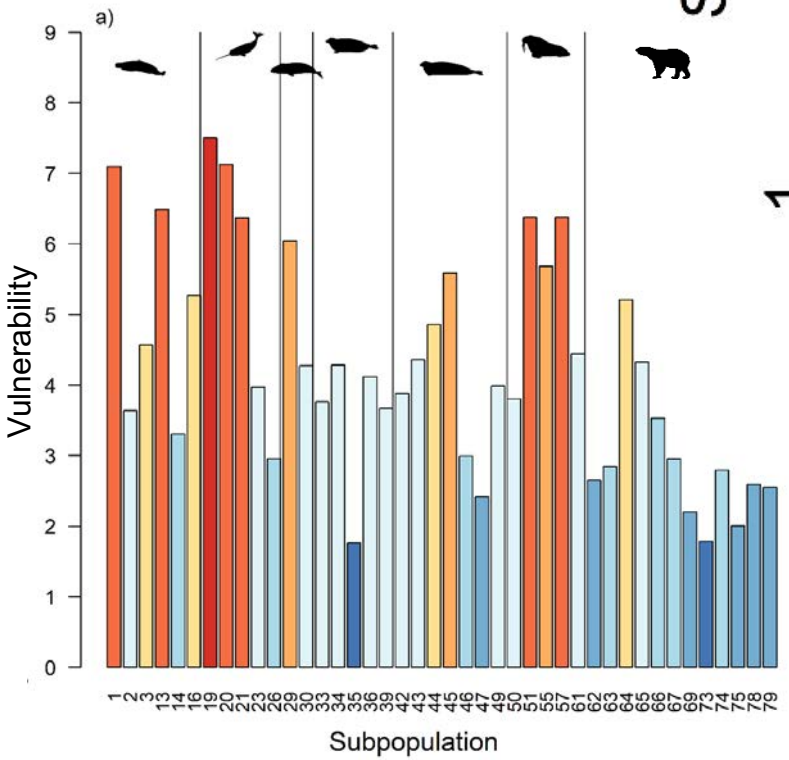
- Seven variables that consider:
  - Vessel effects
  - Frequency of exposure
  - Ecological factors that affect population responses to vessels

Sensitivity variables	Score for Beaufort Sea belugas
Effect of behavioral disturbance	3
Effect of vessel collision	3
Acoustic impacts	3
Frequency of vessel exposure (2011-2016)	2.5
Susceptibility to ice loss (Laidre et al. 2008)	2
Relative abundance (CAFF 2017)	1
Population trend (CAFF 2017)	2
Mean **Sensitivity Score**	**2.38**

Photo: K Laidre

53% of populations exposed



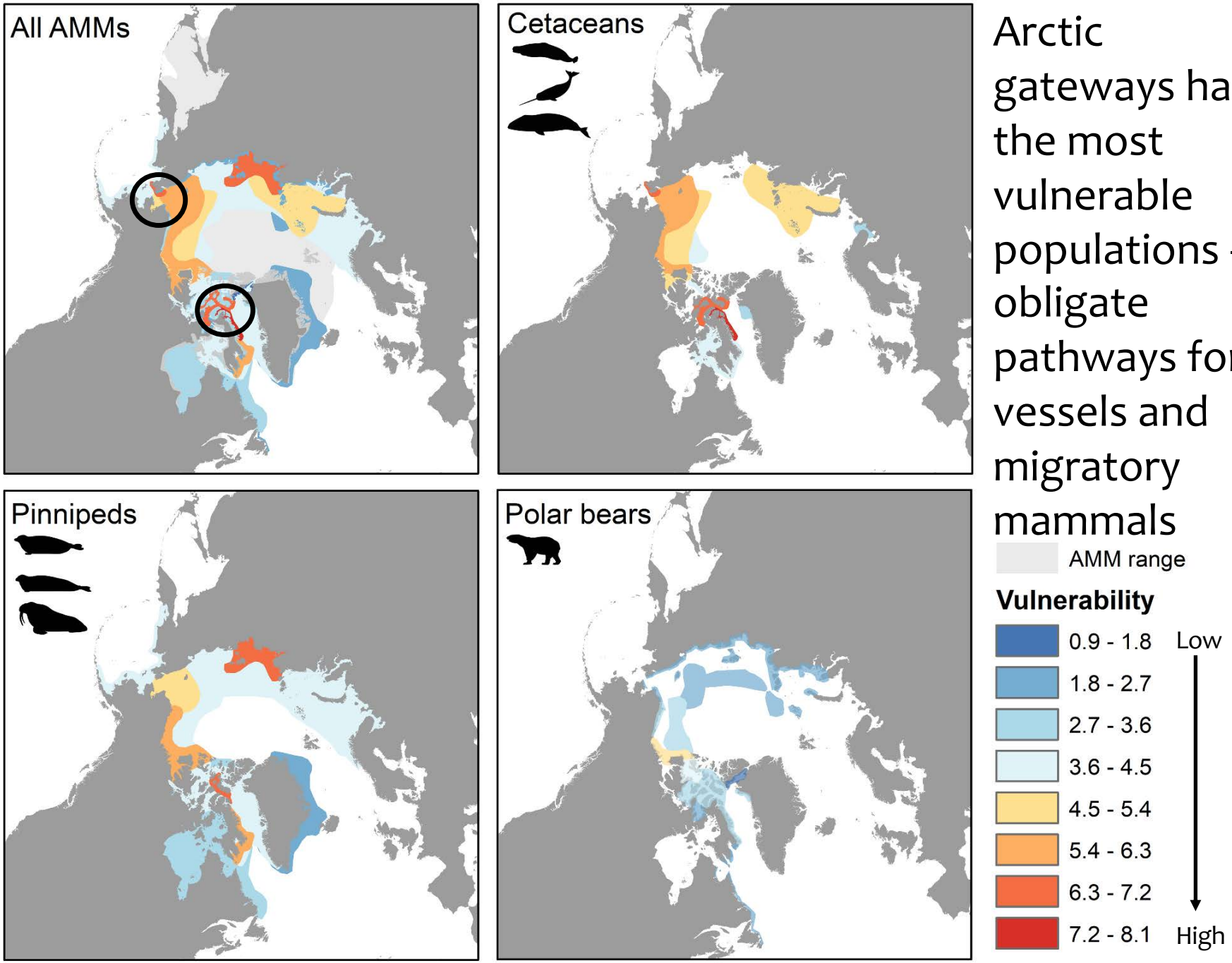


Hauser et al. 2018. *PNAS*

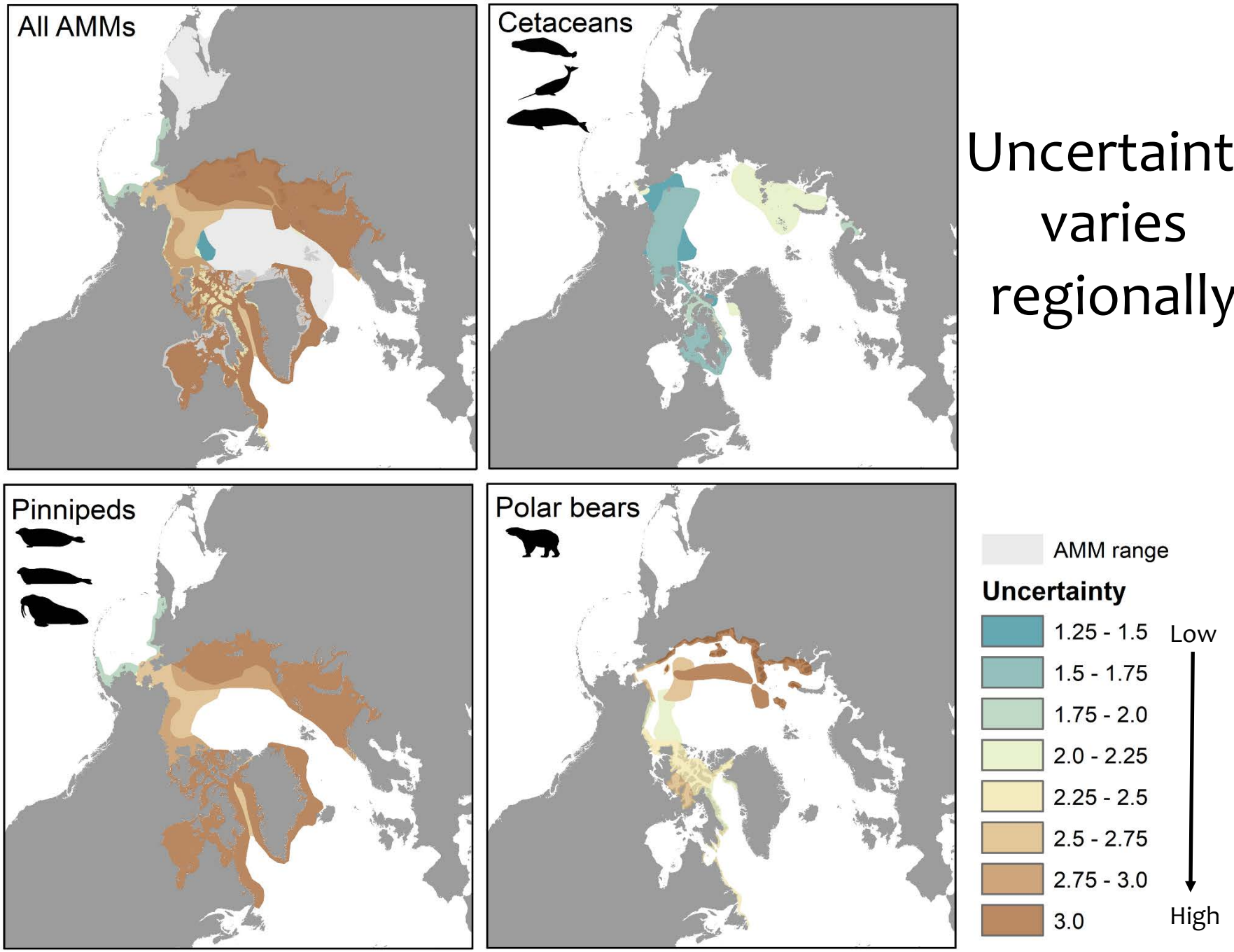
Table 1. Mean vulnerability assessment scores of AMMs to vessel traffic during the open-water period, averaged across subpopulations exposed to either or both the NWP or NSR

Species	Proportion of subpopulations exposed	Exposure	Sensitivity	Vulnerability	Uncertainty
Beluga	0.33	2.13	2.38	5.06	1.77
Narwhal	0.50	2.29	2.45	5.59	2.12
Bowhead	0.50	2.22	2.31	5.16	1.50
Ringed seal	0.63	1.92	1.83	3.52	2.64
Bearded seal	0.78	2.12	1.89	4.01	2.80
Walrus	0.42	2.59	2.05	5.34	2.04
Polar bear	0.63	1.67	1.77	2.95	2.52
All AMMs	0.53	2.05	2.02	4.20	2.32

Photo: K Laidre



Hauser et al. 2018. *PNAS*



Uncertainty varies regionally

Hauser et al. 2018. *PNAS*

Uncertainty also varies by species

Photo: J Lindsay

The Arctic is & will be increasingly navigable

Photo: JE Ross

The Arctic is & will be increasingly navigable

- Detailed case studies
- Examine broader regions and seasons
- Transparent, accessible vessel data
- Learn from vessel measures elsewhere

Photo: JE Ross

Photo: P Nicklen
Illustration: U Gorter

How are AK marine mammals responding to ice loss?

- Beluga whales

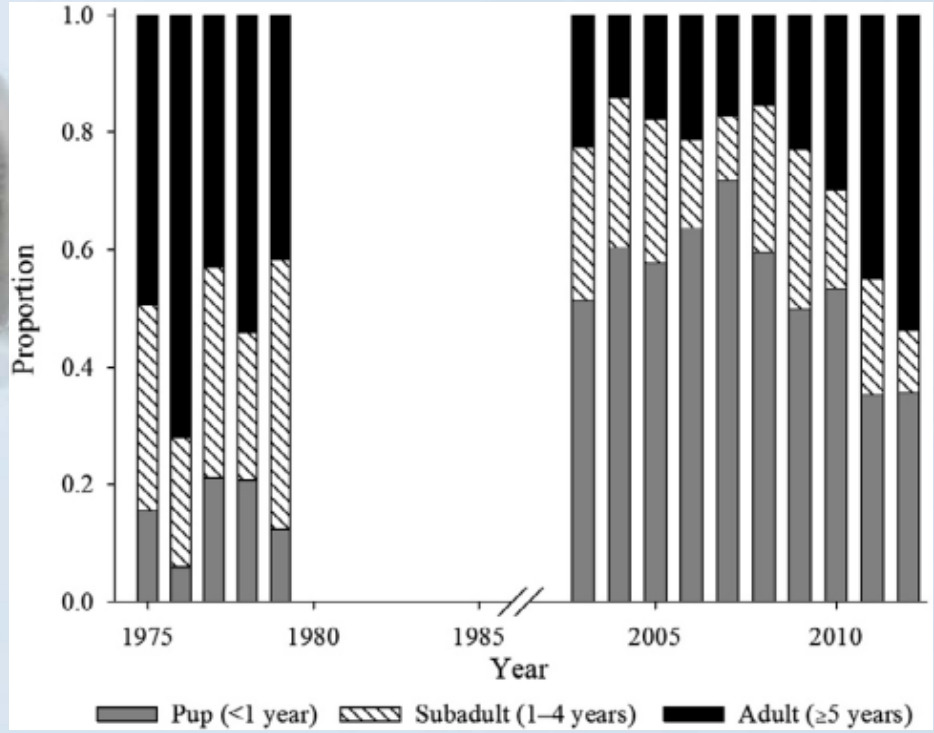
New risks with increasing open water

Future resilience

What about ice-obligate marine mammals?

Photo: J. Lindsay

Contrasting responses by adjacent populations



Crawford et al. 2015. *Prog. Oceanography*

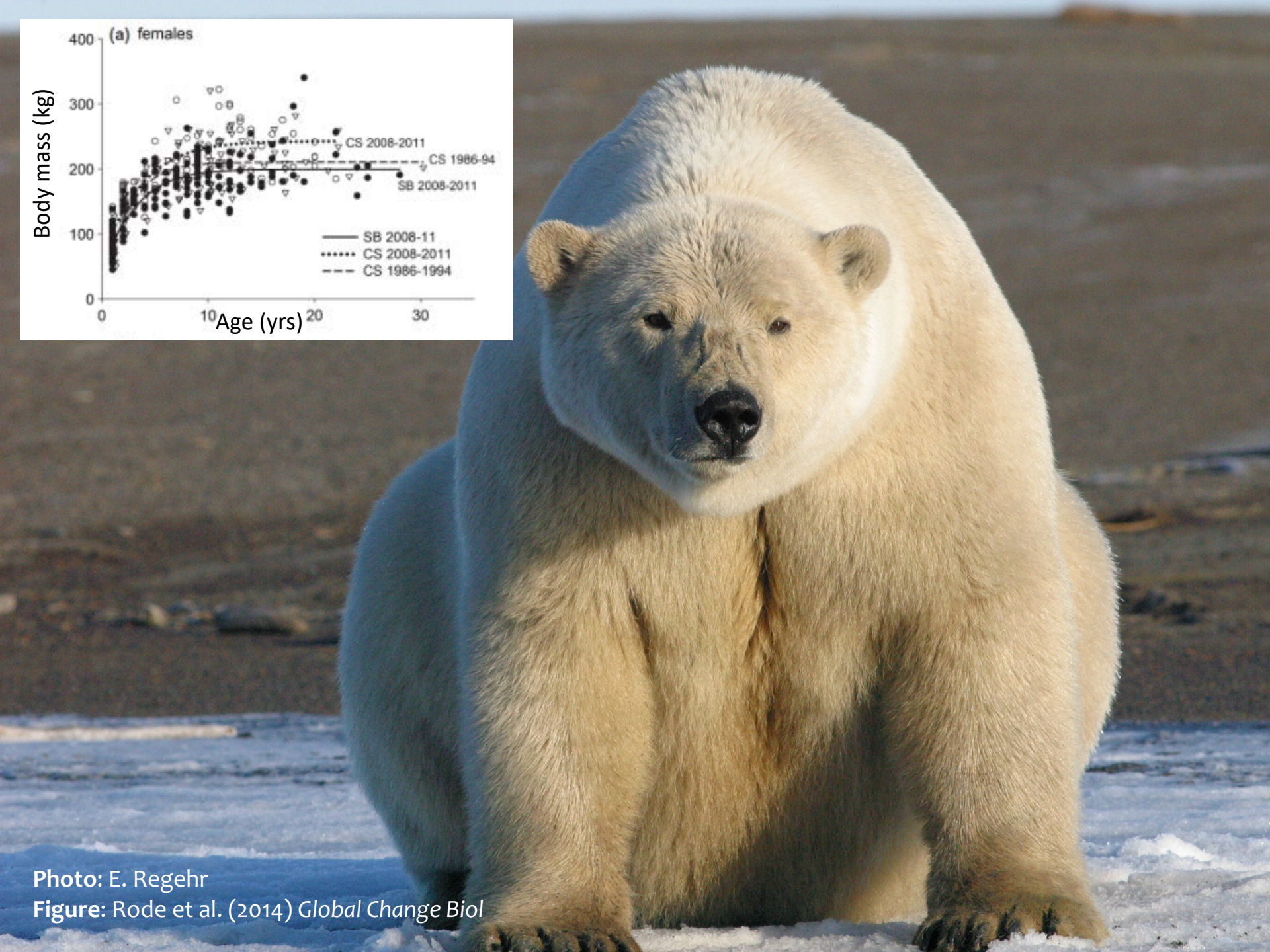
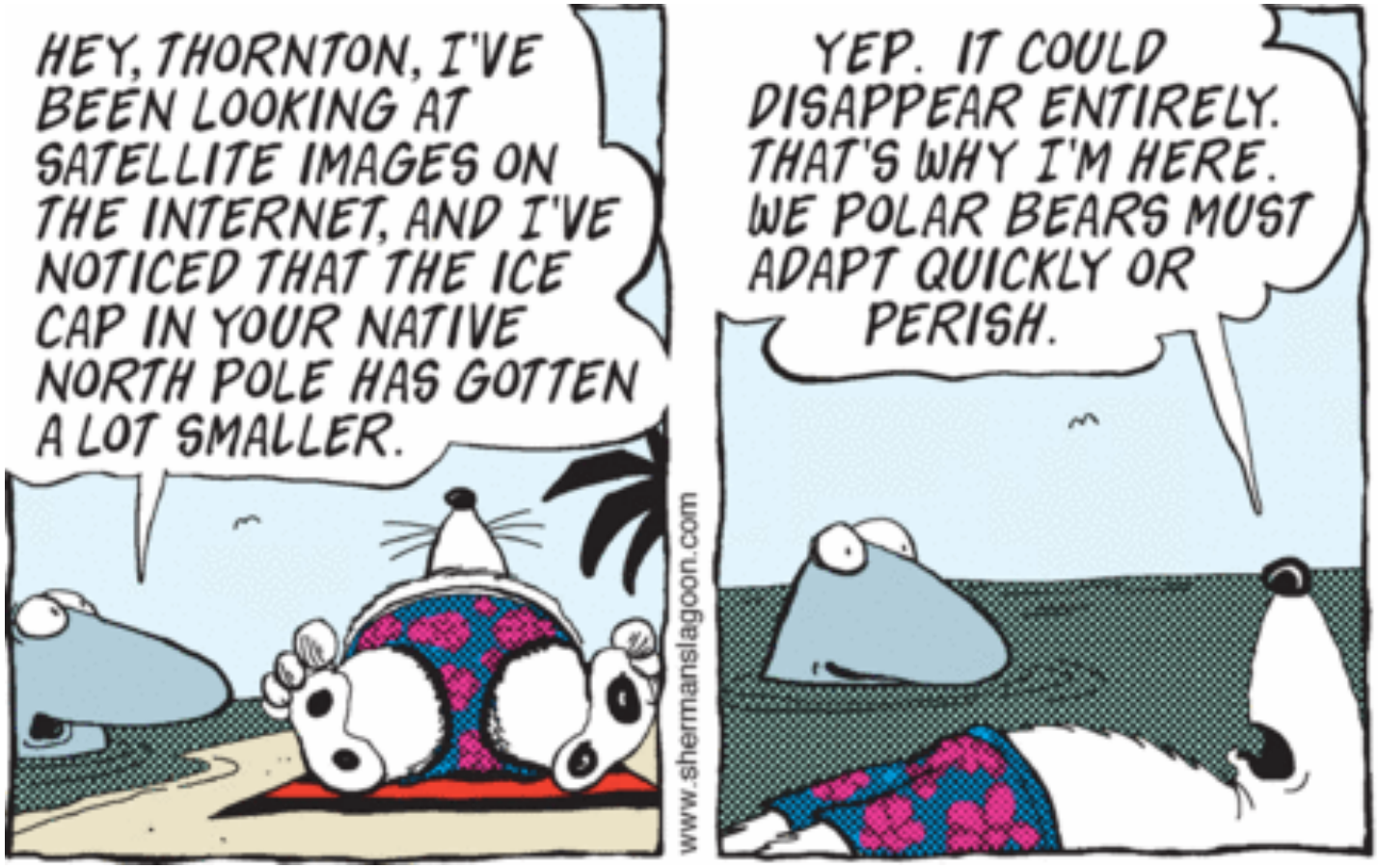
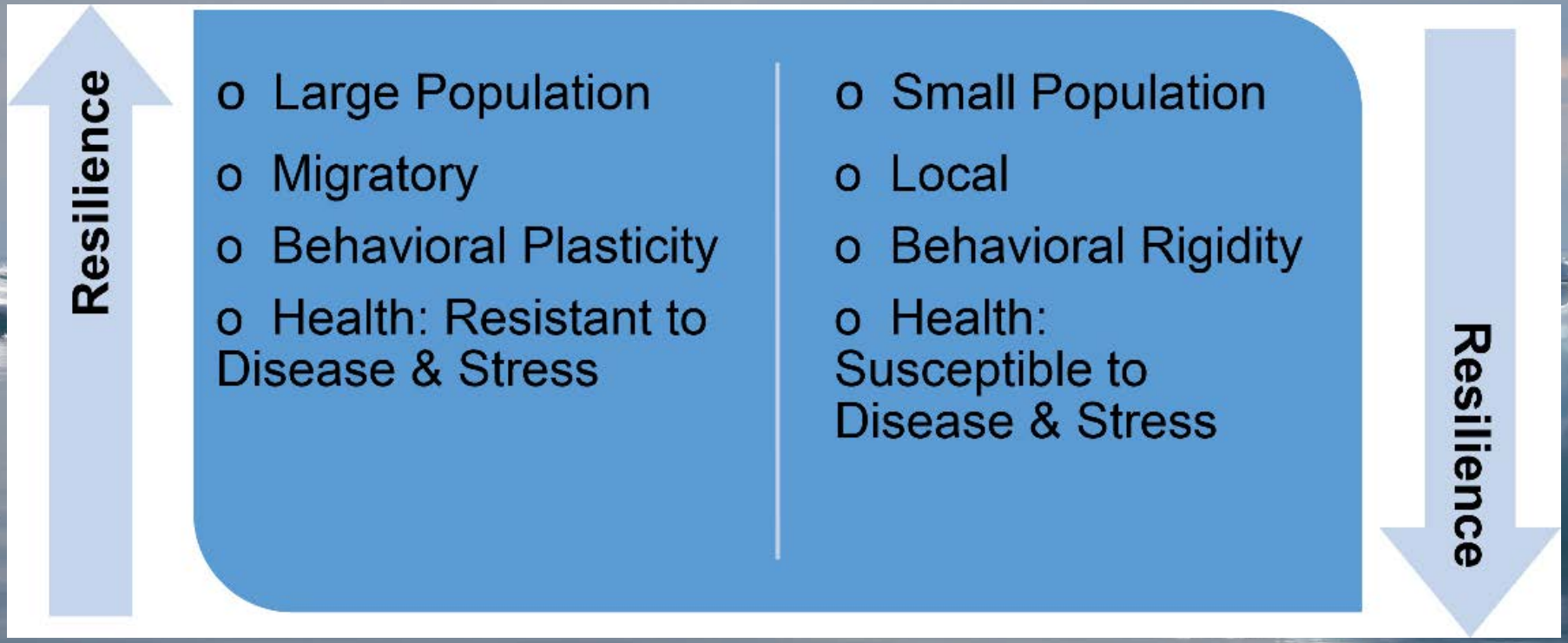


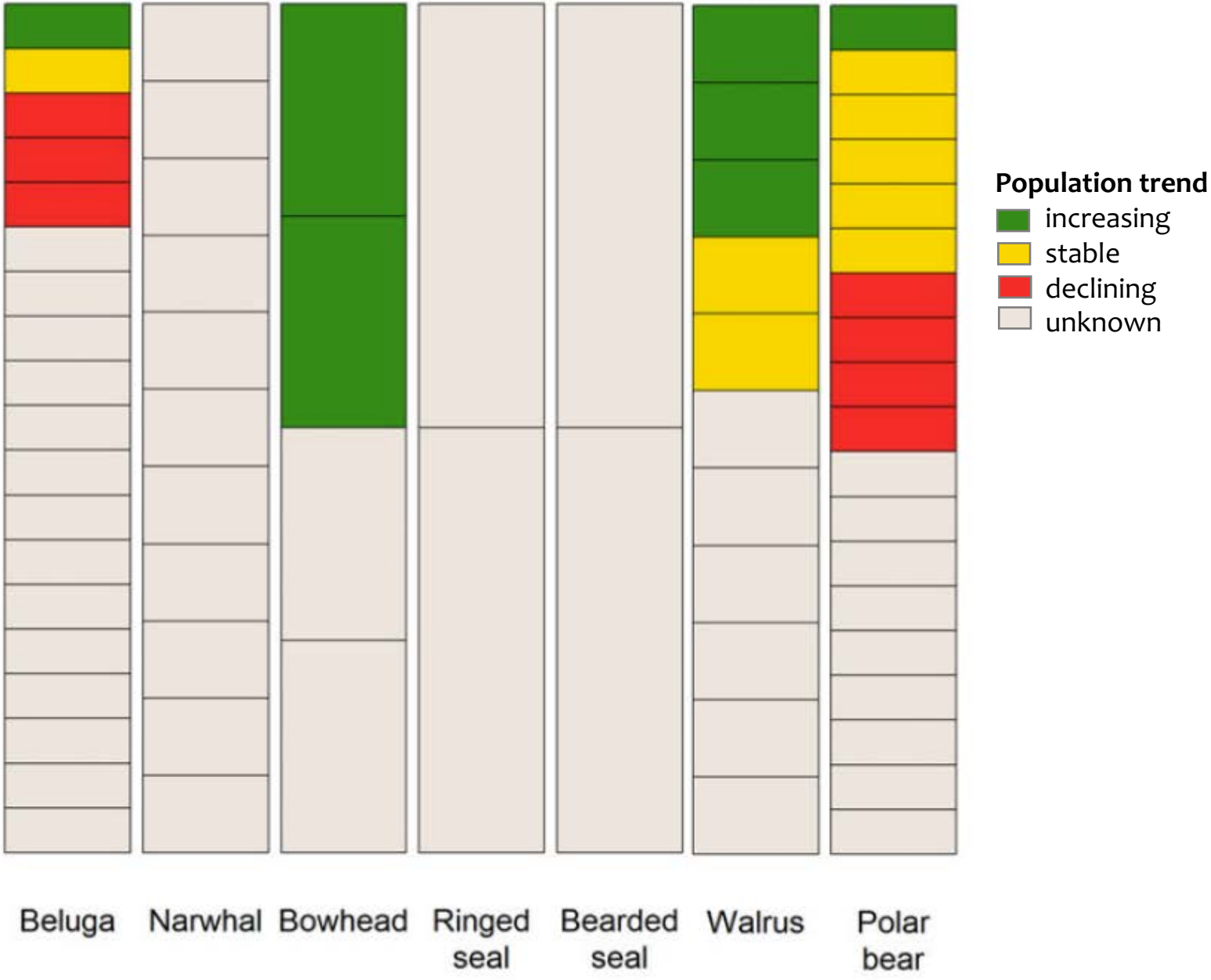
Photo: E. Regehr
Figure: Rode et al. (2014) *Global Change Biol*


HEY, THORNTON, I'VE BEEN LOOKING AT SATELLITE IMAGES ON THE INTERNET, AND I'VE NOTICED THAT THE ICE CAP IN YOUR NATIVE NORTH POLE HAS GOTTEN A LOT SMALLER.
YEP. IT COULD DISAPPEAR ENTIRELY. THAT'S WHY I'M HERE. WE POLAR BEARS MUST ADAPT QUICKLY OR PERISH.
www.shermanslagoon.com

Responses can be diverse, flexible, and sometimes positive… at least in the short term.



Moore & Reeves. 2018. *Plos Biology*



Data: Laidre et al. 2015. *Cons. Biol.*

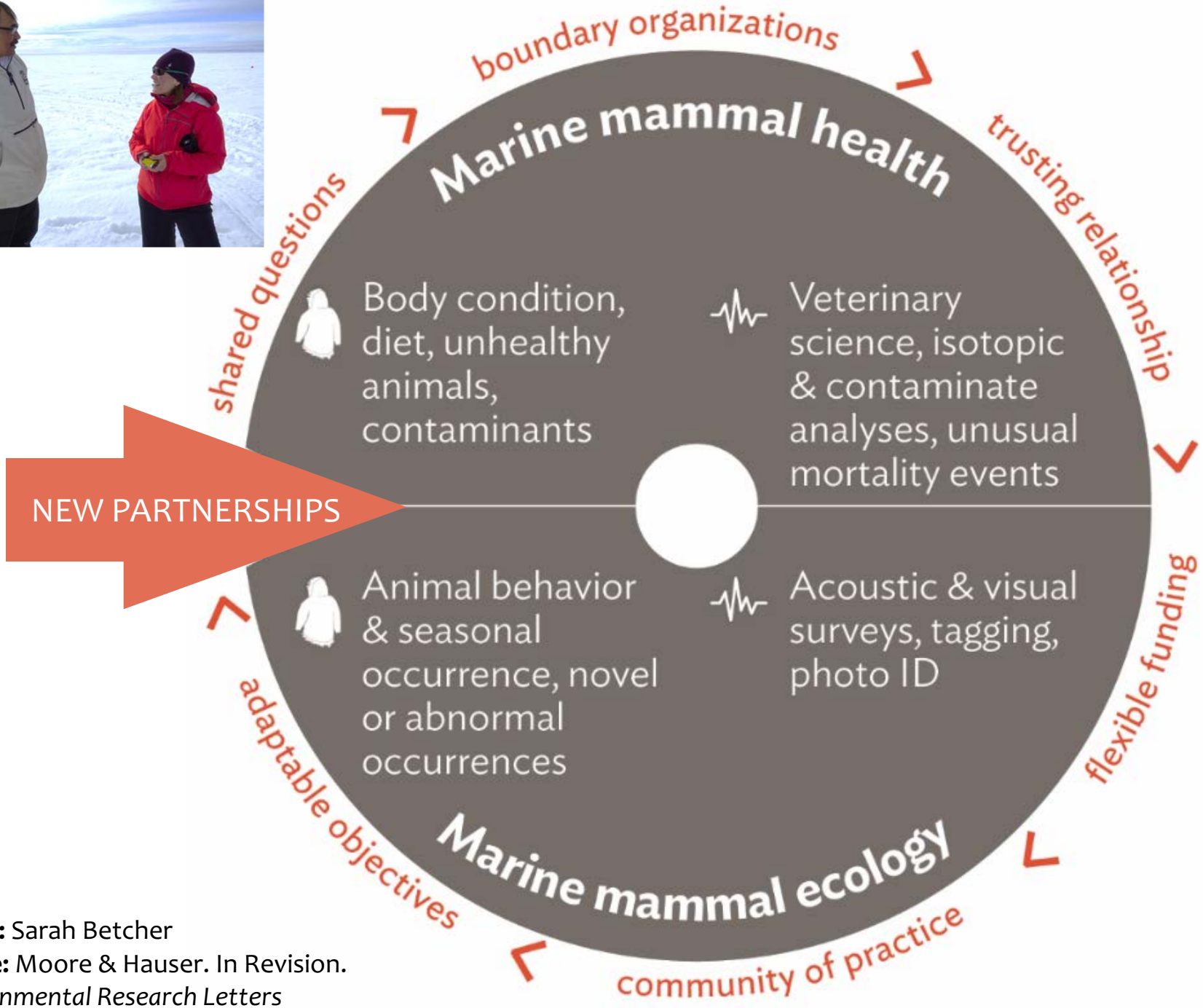


Photo: Sarah Betcher
Figure: Moore & Hauser. In Revision. *Environmental Research Letters*

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FIELD AND DATA ASSISTANCE

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BELUGA ILLUSTRATIONS: Uko Gorter

iPOC IGERT PROGRAM ON OCEAN CHANGE

NSF

UNIVERSITY OF WASHINGTON 1861

SAFS

ALASKA BELUGA WHALE COMMITTEE

Fisheries and Oceans Canada

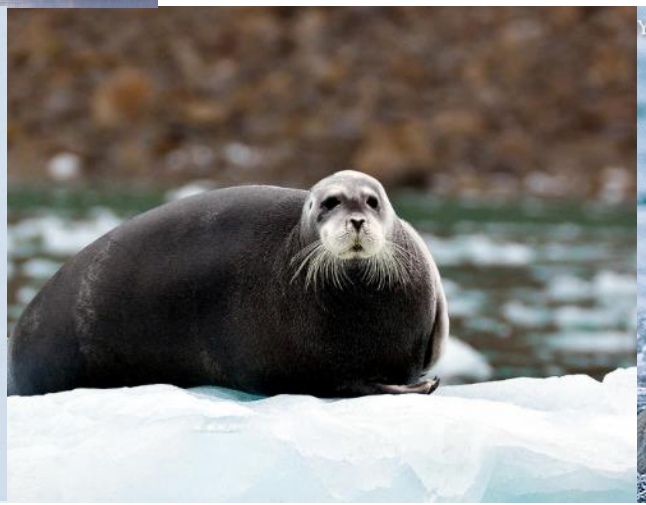
NASA

NORTH SLOPE BOROUGH DEPT. OF WILDLIFE MGMT. Incorporated July 2, 1972

AAOKH ALASKA ARCTIC OBSERVATORY AND KNOWLEDGE HUB

Questions?

Photos: K Laidre, J Ross, P Nicklen, K Stafford, J Lindsay



Thank You!

- The next Arctic Research Seminar will be:
  - 10 April 2019, 8:00-9:00 a.m. AKDT in Fairbanks, AK: *Civic Participation in Arctic Research and Observing: Where We Are and Where We're Going*

- Please visit ARCUS online to find:
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