

Building an Ecological Atlas

*From spatial data to conservation
across dynamic Arctic seas*

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Erika Knight, and Ben Sullender*
Audubon Alaska

Arctic Biodiversity Congress
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Audubon Alaska

is a science-based conservation organization that works to protect birds, other wildlife, and their habitats across the Great Land of Alaska. We use science to identify conservation priorities and support conservation actions and policies, with an emphasis on public lands and waters, and through education we seek to raise public awareness about the natural ecosystems of Alaska.



Why map the Arctic seas?

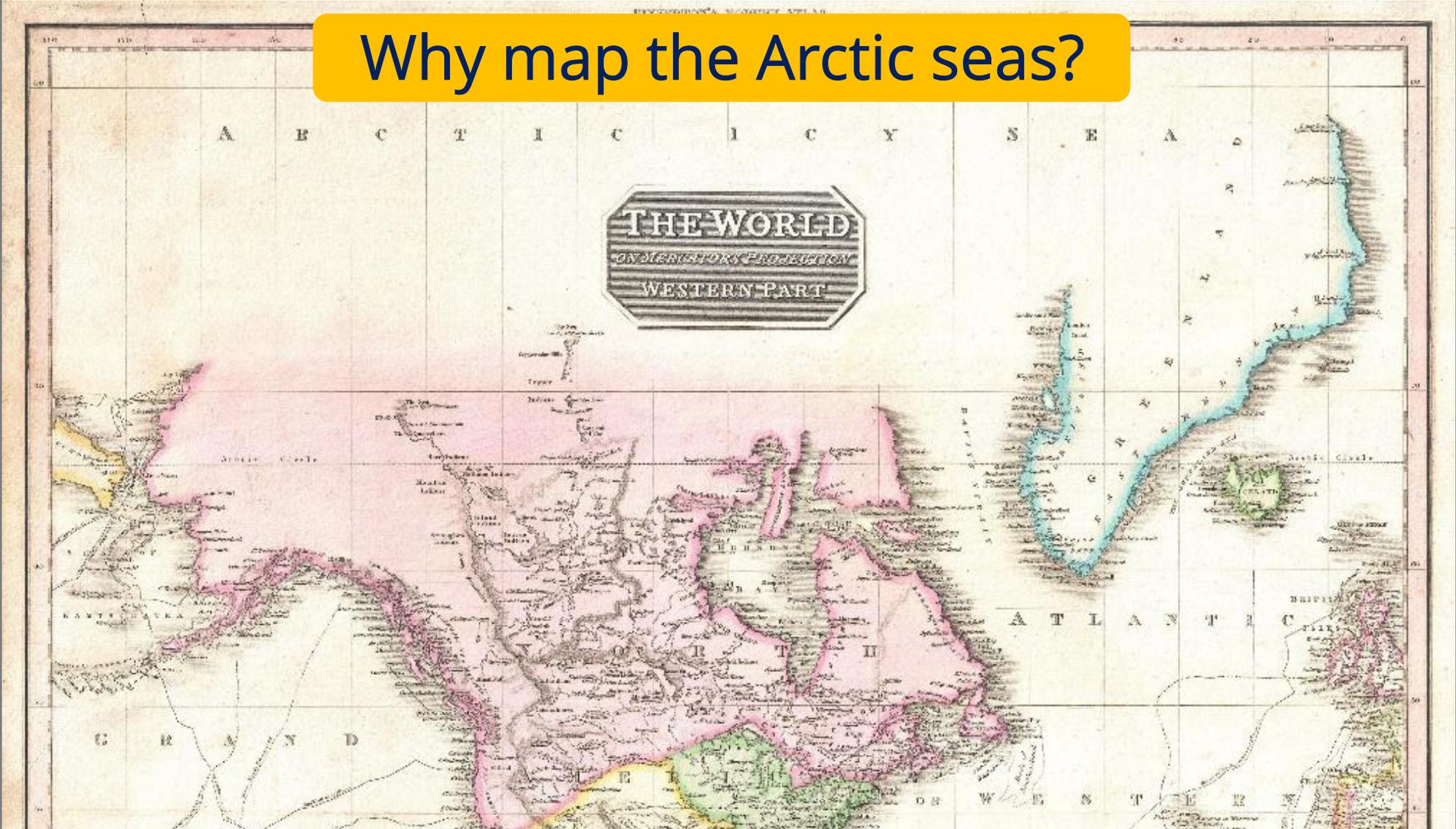




Image: Corey Accardo/NOAA



Image: Captain Budd Christman/NOAA



Image: Kim Shelden/NOAA



Image: William Larned/USFWS



Image: Milo Burcham



Image: Phil Clapham/NOAA

Overview of Presentation

Part 1 Data to design:
building an ecological atlas

Part 2 Atlas overview:
what's inside

Part 3 Next steps:
identifying ecological
hotspots and stressors



Image: Milo Burcham

Data to Design

Data Gathering

Identify available data

Acquire and organize

Design

Annual cycle maps

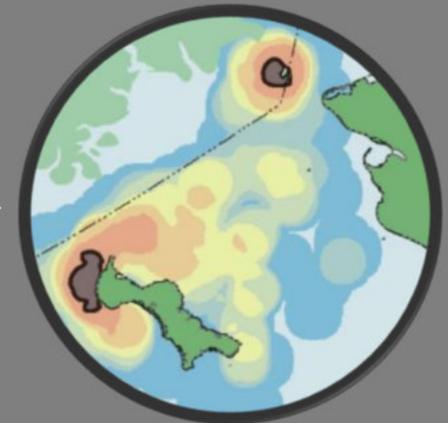
Identify patterns

Assessment & planning

Data Synthesis

Spatial analysis

Composite data layers



Data to Design



Census

- Seabird colony
- Pinniped haulout



Survey Transects

- At-sea
- Aerial



Telemetry

- GPS
- Geolocator

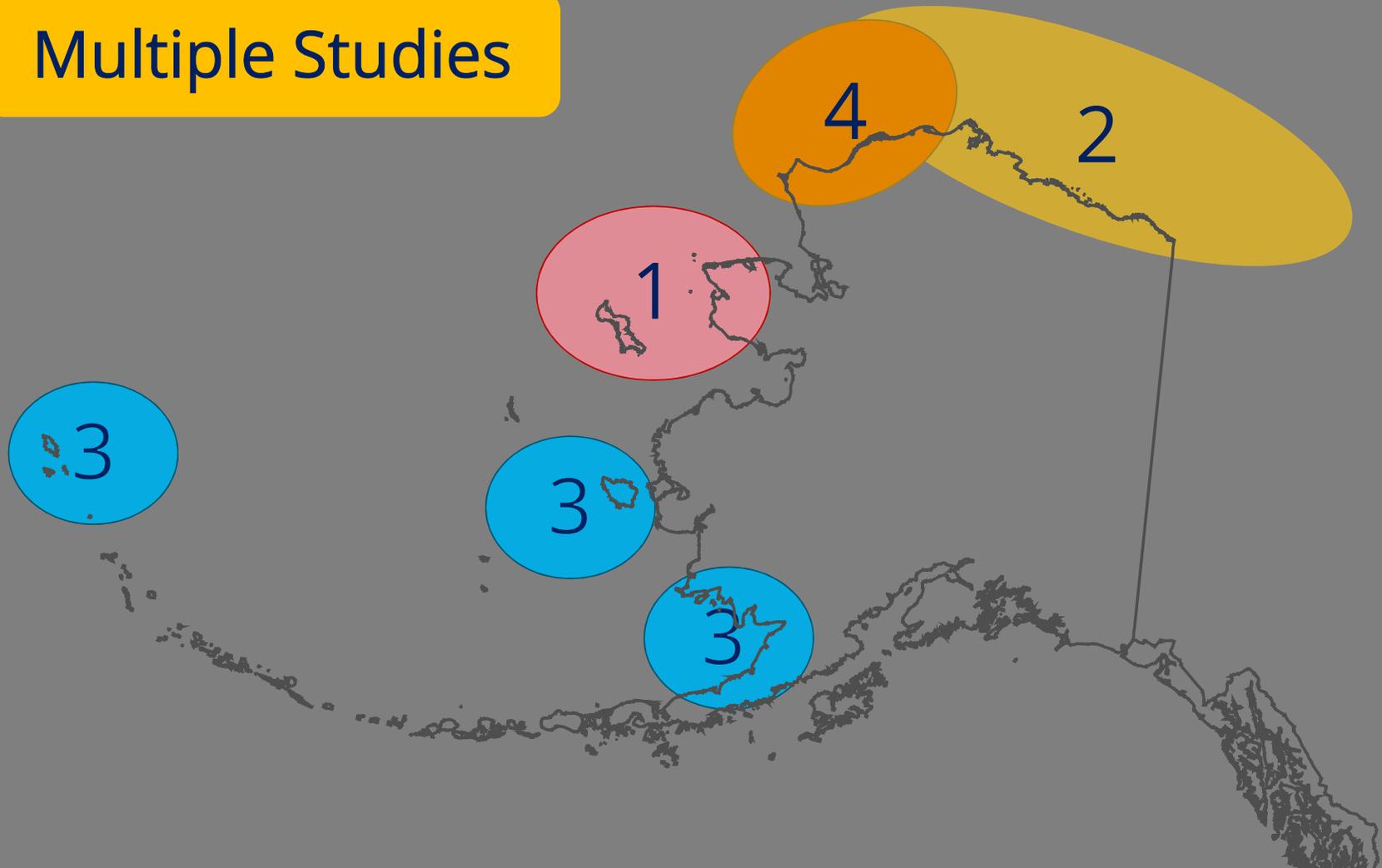


Expert

- Indigenous/traditional knowledge
- Citizen science

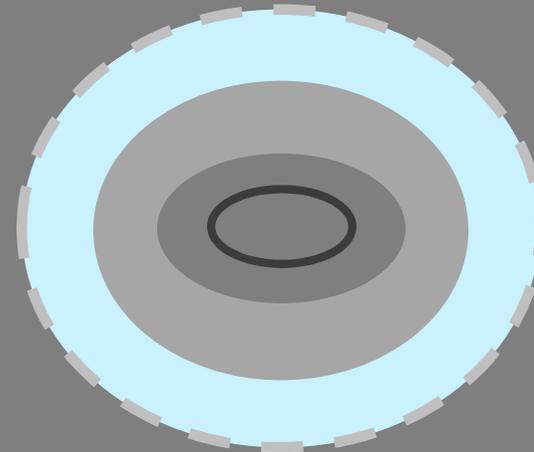
Images: Milo Burcham, Laura Morse, USFWS, Martha de Jong Lantik

Multiple Studies



Intensity

- Extent of range
- Regular use
- Concentration
- High concentration



Data to Design



Survey Transect



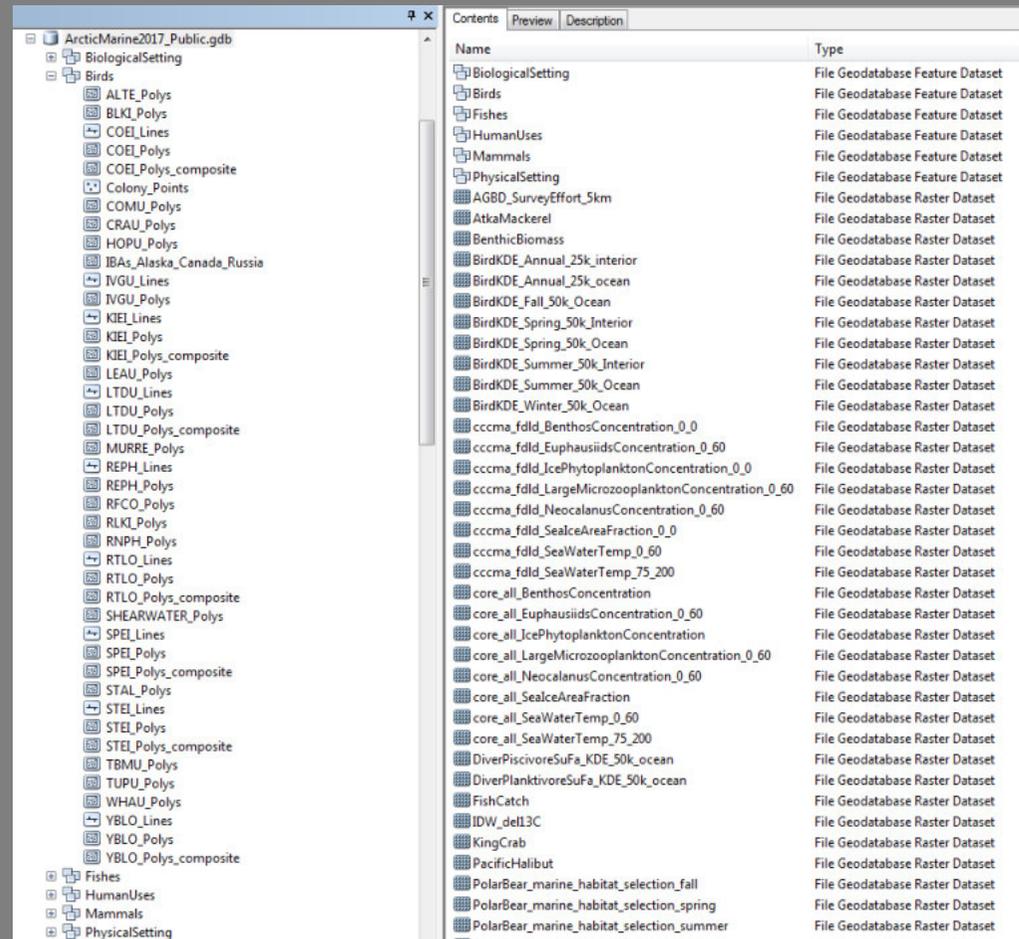
Telemetry



Census



Expert

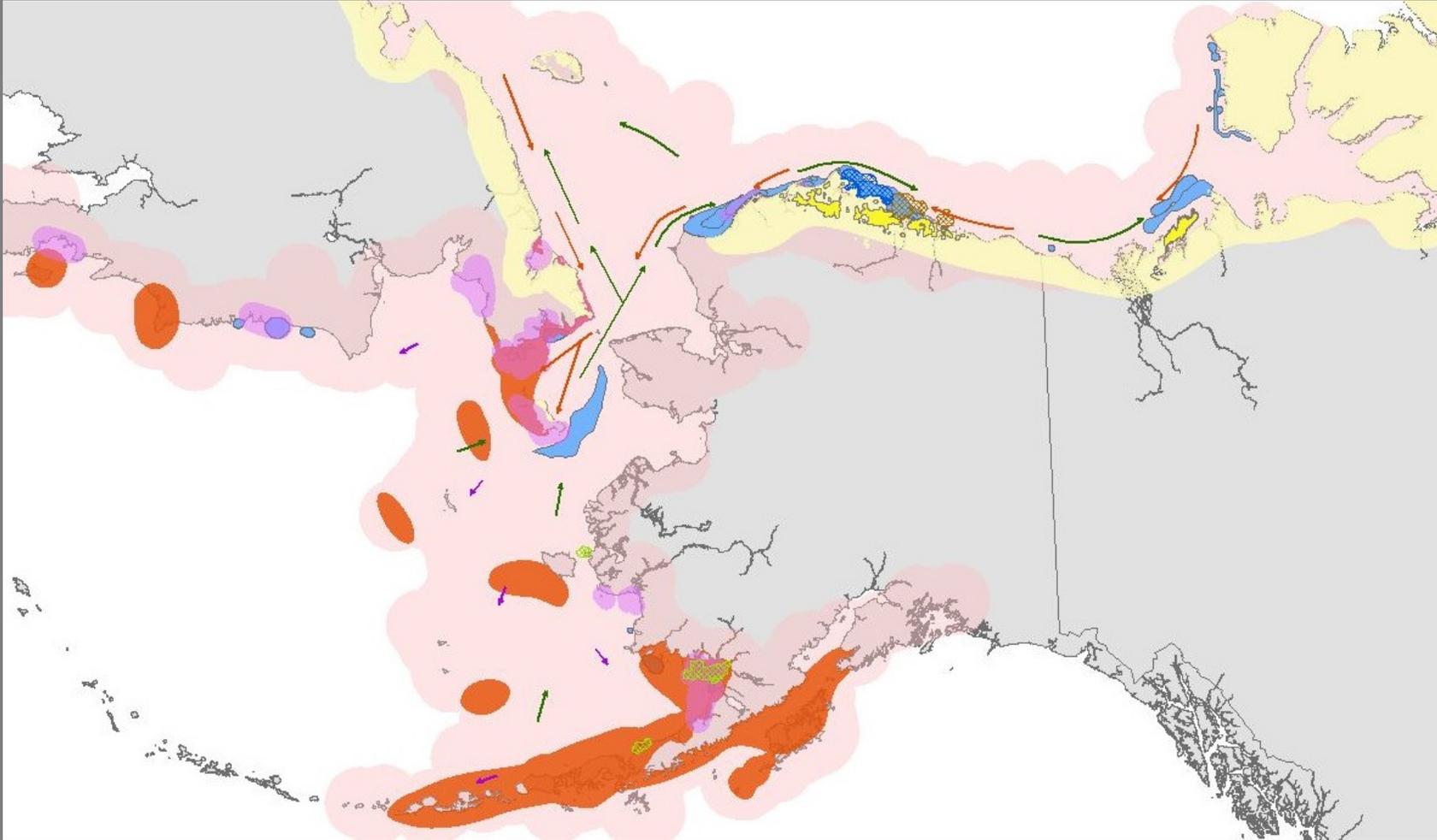


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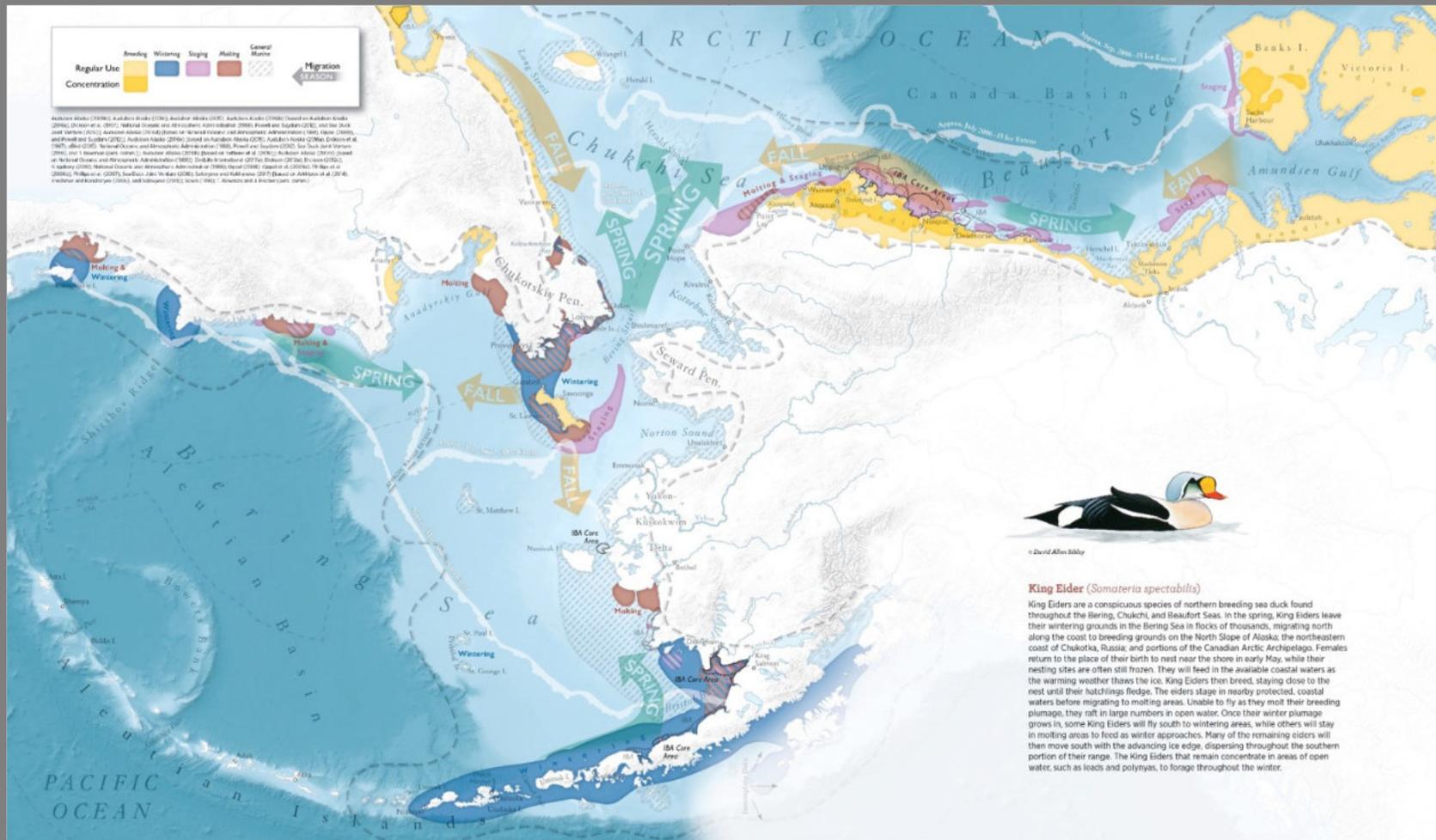
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- Birds
 - ALTE_Polys
 - BLKI_Polys
 - COEL_Lines
 - COEL_Polys
 - COEL_Polys_composite
 - Colony_Points
 - COMU_Polys
 - CRAU_Polys
 - HOPU_Polys
 - IBAs_Alaska_Canada_Russia
 - IVGU_Lines
 - IVGU_Polys
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 - KJEL_Polys_composite
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 - SPEI_Lines
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 - TUPU_Polys
 - WHAU_Polys
 - YBLO_Lines
 - YBLO_Polys
 - YBLO_Polys_composite
- Fishes
- HumanUses
- Mammals
- PhysicalSetting

Name	Type
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Birds	File Geodatabase Feature Dataset
Fishes	File Geodatabase Feature Dataset
HumanUses	File Geodatabase Feature Dataset
Mammals	File Geodatabase Feature Dataset
PhysicalSetting	File Geodatabase Feature Dataset
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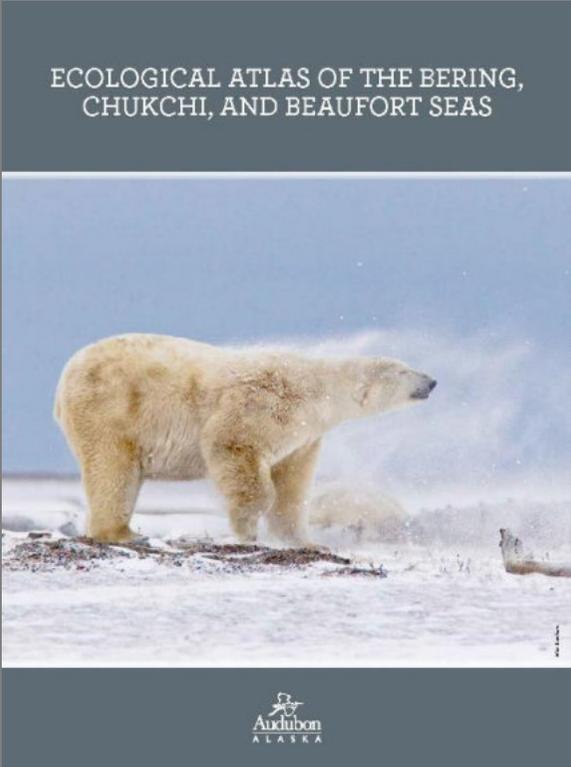
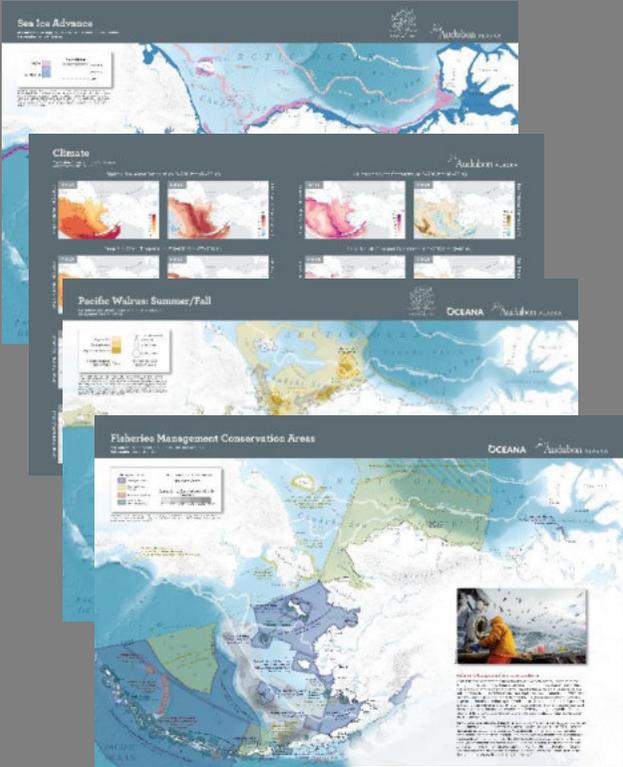
King Eider



King Eider



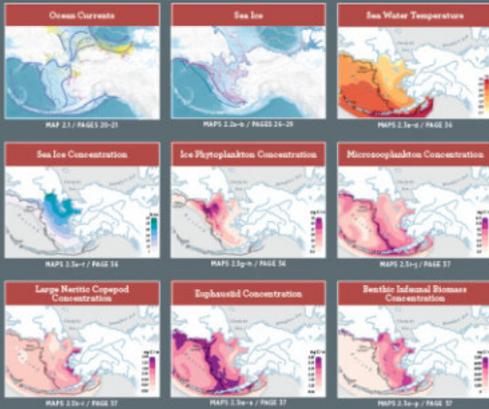
Atlas Published August 2017



<http://bit.ly/eco-atlas>

Physical Setting

PHYSICAL SETTING

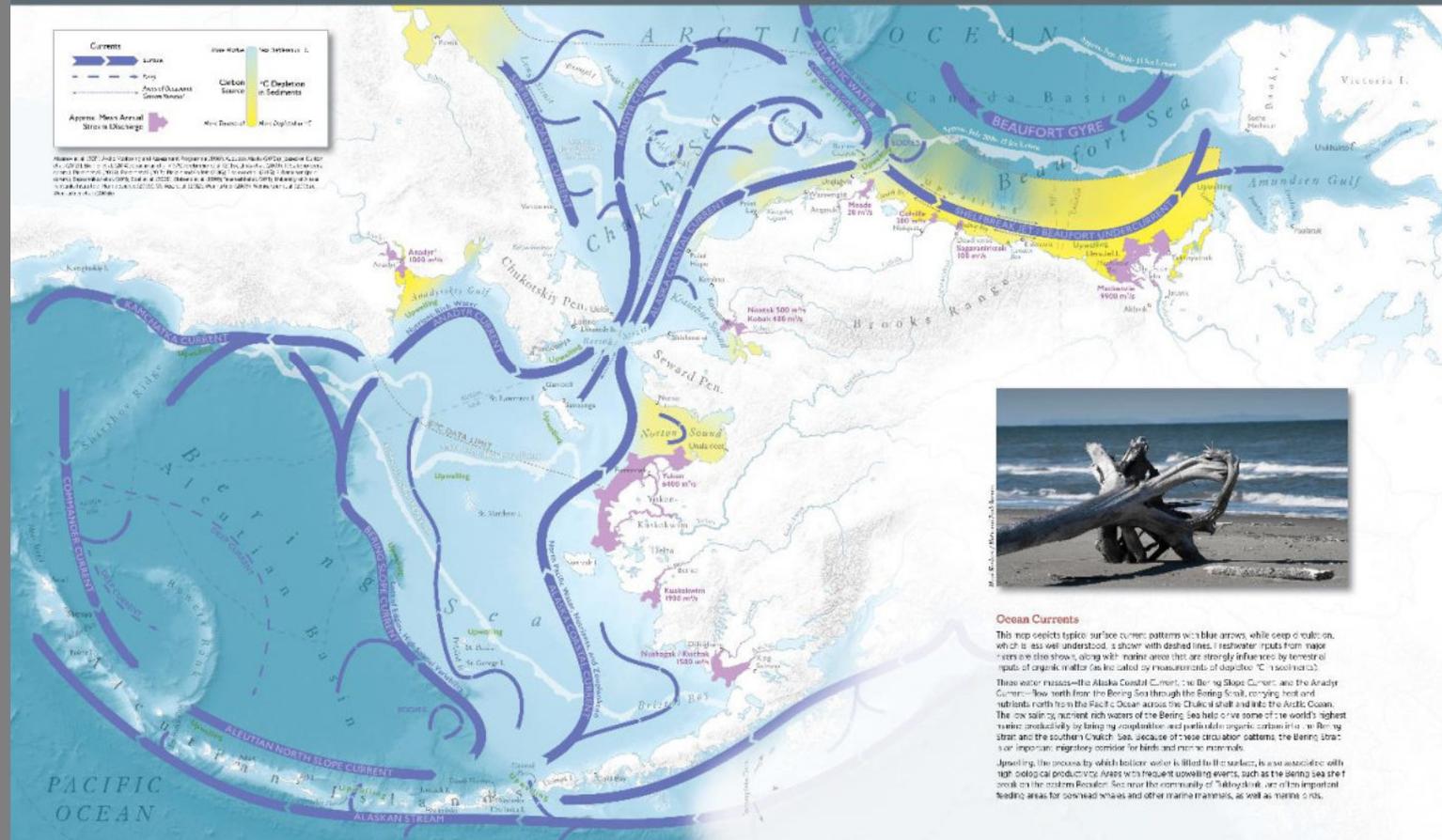


Ocean Currents

Map Authors: Steve Cooper, Krista Knight, and Mikalae Smith
Cartographer: Dan O'Riordan



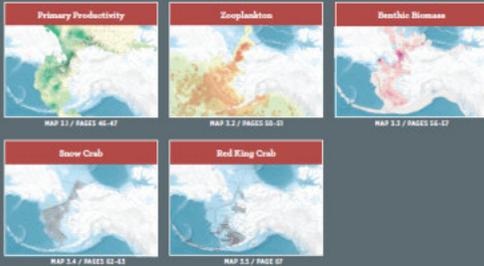
Map by M. S. Cooper, K. Knight, and M. Smith. Topographic data from the Arctic Digital Data Center (ADCDC) and the Arctic Digital Data Center (ADCDC). Sea surface temperature (SST) data from the National Oceanic and Atmospheric Administration (NOAA). Carbon sequestration data from the National Oceanic and Atmospheric Administration (NOAA). Arctic mean annual snowmelt discharge data from the National Oceanic and Atmospheric Administration (NOAA). Mean depth data from the National Oceanic and Atmospheric Administration (NOAA).



Ocean Currents
This map depicts typical surface current patterns with blue arrows, while deep circulation, which is less well understood, is shown with dashed lines. Freshwater inputs from major rivers are also shown, along with marine areas that are strongly influenced by terrestrial inputs of organic matter (as indicated by measurements of dissolved ^{14}C in soft sediments). These water masses—the Alaskan Coastal Current, the Bering Slope Current, and the Anadyr Current—flow north from the Bering Sea through the Bering Strait, carrying food and nutrients north from the Pacific Ocean across the Chukchi shelf and into the Arctic Ocean. The low salinity, nutrient rich waters of the Bering Sea help drive some of the world's highest water productivity by being upwelled and periodically exported eastward into the Bering Strait and the southern Chukchi Sea, because of these circulation patterns the Bering Strait is an important migratory corridor for birds and marine mammals. Upwelling, the process by which bottom water is lifted to the surface, is also associated with high ecological productivity. Areas with frequent upwelling events, such as the western sea shelf north of the northern Bering Sea near the community of Tikleykik, are vital to important feeding areas for bowhead whales and other marine mammals, as well as marine birds.

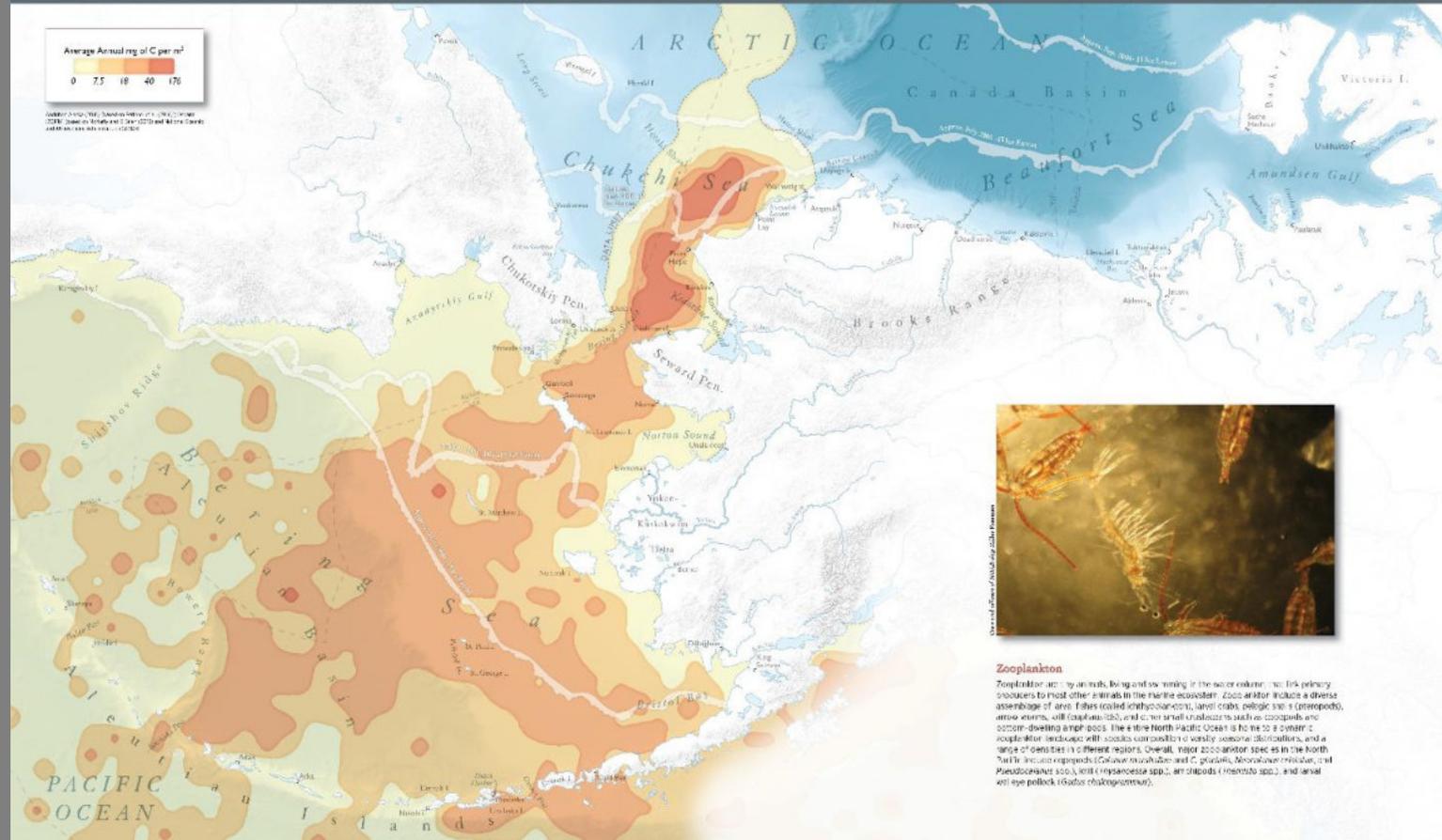
Biological Setting

BIOLOGICAL SETTING



Zooplankton

Map Authors: Elaine MacLean, Marvin Zeeck, and Jon Waterchuk
Cartographer: Daniel D. Sullivan



Zooplankton

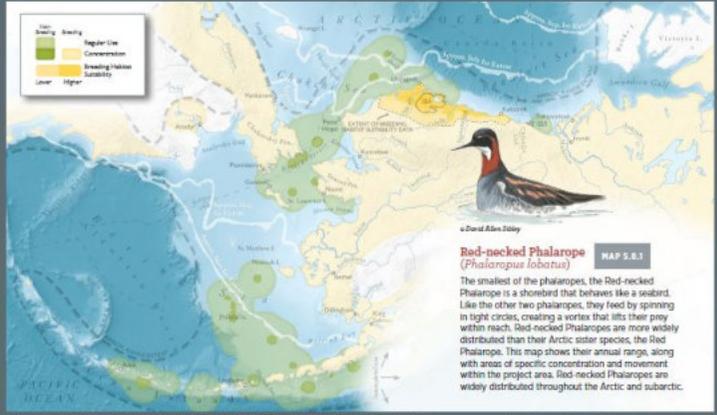
Zooplankton are tiny animals, living and swimming in the water column, that link primary producers to most other animals in the marine ecosystem. Zooplankton include a diverse assemblage of animals: fish larvae (ichthyoplankton), larval crabs, pelagic copepods (copepods), arrow worms, and (especially important) small crustaceans such as copepods and copepod-eating amphipods. The entire North Pacific Ocean is home to a diverse zooplankton community with species composition varying seasonally, spatially, and among different regions. Overall, major zooplankton species in the North Pacific include copepods (*Calanus finmarchicus* and *C. packardii*), *Neocalanus cristatus*, and *Pseudocalanus* spp., with *Hyasides* spp., amphipods (*Parasita* spp.), and larval walleye pollock (*Gadus chalcogrammus*).

Birds

BIRDS

 MAP 5.1.1 / PAGES 18-17	 MAPS 5.1.2-4 / PAGES 18-18	 MAP 5.2 / PAGES 122-123	 MAP 5.3.1 / PAGE 124
 MAPS 5.3.2 / PAGE 124	 MAPS 5.3.3-4 / PAGE 125	 MAPS 5.4.1-4.4 / PAGES 152-159	 MAP 5.5 / PAGES 164-165
 MAPS 5.4.4.4.2 / PAGES 160-163	 MAP 5.7 / PAGE 164	 MAPS 5.8.1-8.2 / PAGE 165	 MAP 5.9 / PAGE 163
 MAPS 5.10.1-10.2 / PAGE 167	 MAP 5.11 / PAGE 170	 MAPS 5.12.1-12.3 / PAGES 176-175	 MAPS 5.13.1-13.2 / PAGE 179
 MAPS 5.14.1-14.4 / PAGES 186-187	 MAP 5.15 / PAGE 190	 MAP 5.16 / PAGE 194	

Phalaropes



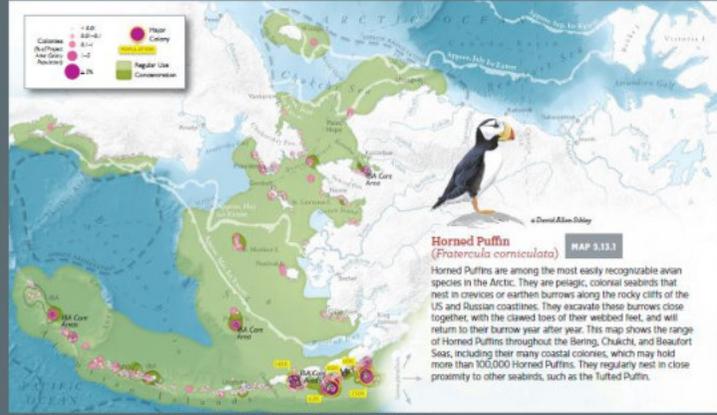
Audubon Alaska (2016), Audubon Alaska (2016) (Based on Feltner et al. (2012)), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015), Central and Eastern Europe and Northern Asia (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Feltner et al. (2012), (2016)),

Map Authors: Malene Smith and Eric Knight
Cartographer: Daniel P. Huffman



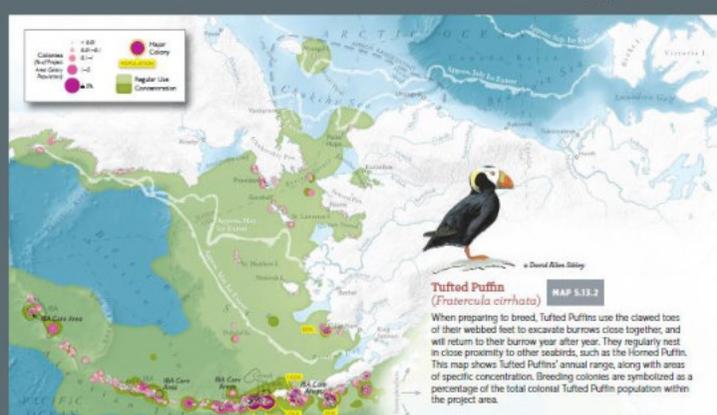
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Puffins



Audubon Alaska (2016), Audubon Alaska (2016) (Based on Feltner et al. (2012)), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015), Central and Eastern Europe and Northern Asia (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Feltner et al. (2012), (2016)),

Map Authors: Malene Smith and Eric Knight
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Audubon Alaska (2016), Audubon Alaska (2016) (Based on Feltner et al. (2012)), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015), Central and Eastern Europe and Northern Asia (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Audubon Alaska (2017) (Based on Audubon Alaska (2016), Bird International (2015)), Bird International (2015), Central and Eastern Europe and Northern Asia (2015), Feltner et al. (2012), (2016)),

Mammals



MAMMALS

Polar Bear MAP 6.5a-f / PAGES 252-253	Pacific Walrus MAPS 6.2a-b / PAGES 220-221	Bearded Seal MAP 6.5.1 / PAGE 230
Ribbon Seal MAP 6.5.2 / PAGE 230	Ringed Seal MAP 6.5.3 / PAGE 231	Spotted Seal MAP 6.5.4 / PAGE 231
Stellar Sea Lion MAP 6.4 / PAGES 234-235	Northern Fur Seal MAP 6.5 / PAGE 236	Beluga Whale MAP 6.5.5-6.5.7 / PAGES 245-246
Bowhead Whale MAPS 6.7a-f / PAGES 250-251	Gray Whale MAP 6.8 / PAGE 254	Humpback Whale MAP 6.9 / PAGE 257

Bowhead Whale

Map Authors: Helene Smith, Linda Knight, and Max Goldman
Cartographer: Derek P. Hoffman

Bowhead Whale
(*Balaena mysticetus*)

Winter MAP 6.7a

Bowhead whales are the only whales endemic to Arctic and subarctic waters. With 11 blubber humples of varying size and a massive head with tusks for filtering and breaking ice, bowheads are adapted to winter life in the rigid waters of the far north. They spend this time hauled in feeding in the Spring Sea. In this dark, ice-covered world, navigation is difficult, and bowhead whales use song extensively, with seasonal, variable songs that are improved and passed down from generation to generation. Bowheads live 70 years in the wild.

Bowhead Whale
(*Balaena mysticetus*)

Spring MAP 6.7b

In spring, as the ice begins to melt, bowheads, bowhead whales have already begun to migrate to their summer feeding grounds. Along the way, calves are born. Spring migrations include, every 10th, with the majority of bowheads traveling through the sea ice that passes the Korymbos of Alaska, and dispersing along the southern Beaufort shelf as far east as Anvil Point. Although a smaller portion of the population needs to travel to the northern coast of Chukotka, the spring passage of bowheads is an opportunity for Native subsistence hunters along the Chukchi coast, who offer late whaling during this time.

Bowhead Whale
(*Balaena mysticetus*)

Summer MAP 6.7c

After migrating northward from the Beaufort Sea through the Strait of Chukotka to the eastern Beaufort Sea in spring, most bowhead whales spend the summer feeding on copepod nauplii in the eastern Beaufort Sea and northern Chukotka coast. In the bowhead calves, some in spring spend this time developing in protected coastal waters with their mothers, whom they will accompany for the next year. Later in summer, bowheads loop back west along the nearshore waters of the US Beaufort shelf toward Barrow Canyon, bringing them to the fall feeding grounds.

Bowhead Whale
(*Balaena mysticetus*)

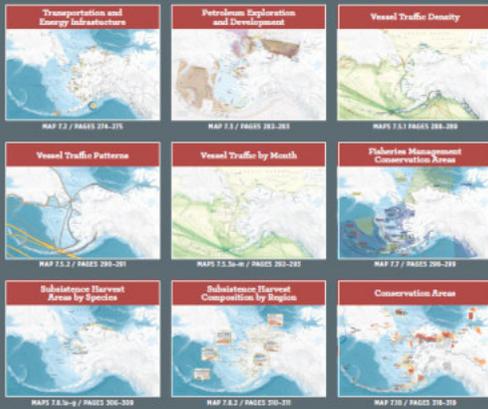
Fall MAP 6.7d

Fall marks the start of the journey to return to the southern portion of their range. As colder temperatures mean ice begins to form in the Beaufort Sea and food becomes scarce, reemerging the bowhead whales fall migratory bowheads path to the nearshore waters along the US Beaufort shelf to feed in the fall, before crossing the Chukchi Sea to converge on fall feeding areas along the northern Chukotka coast. Later in the fall, the leads forming can merge, slow gash the whales' bodies away from their feeding, breeding, and calving grounds until they reach the frozen and polynar they will rely on for coming winter months. Bowhead calves use the thick ice to stay away from their birthplace for the first time, but will return again when the winter ends and the ice melts away.



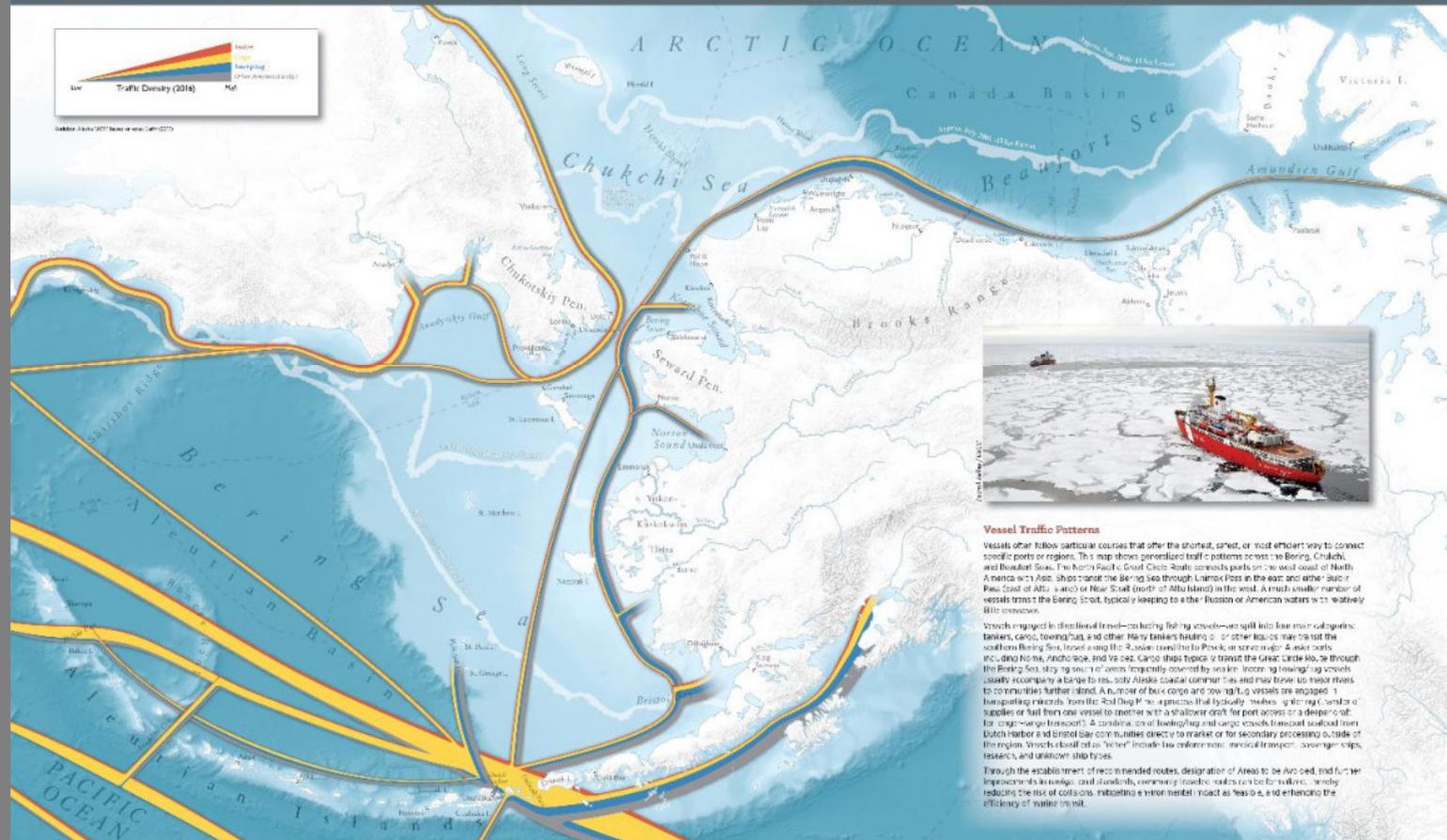
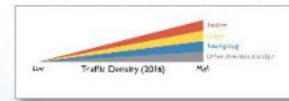
Human Uses

HUMAN USES



Vessel Traffic Patterns

Map Authors: Daniel R. Huffman and Benjamin Stalkeder
Cartographer: Daniel R. Huffman



Vessel Traffic Patterns

Vessels often follow particular courses that offer the shortest, safest, or most efficient way to connect specific ports or regions. This map shows generalized traffic patterns across the Bering, Chukchi, and Beaufort Seas. The Arctic Circle's Great Circle route connects ports on the west coast of North America with Asia. Ships transit the Bering Sea through Linné's Pass in the east, and other routes (such as the coast of Alaska) or near the coast of Alaska (north of the Aleutian Islands) in the west. A much smaller number of vessels transit the Bering Strait, typically stopping to either Russian or American waters with relatively little consequence.

Vessels engaged in the livelihood of subsistence fishing—especially small boats from coastal villages, tankers, cargo, towing, tug, and other heavy tankers hauling oil or other liquids—may transit the southern Bering Sea, transiting the Russian coast to the Bering Sea or Alaska coast, and Alaska coast, and the Beaufort Sea. The Great Circle route connects ports on the west coast of North America with Asia. Ships transit the Bering Sea through Linné's Pass in the east, and other routes (such as the coast of Alaska) or near the coast of Alaska (north of the Aleutian Islands) in the west. A much smaller number of vessels transit the Bering Strait, typically stopping to either Russian or American waters with relatively little consequence.

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Through the establishment of recommended routes, designation of Areas to be Avoided, and further improvements in navigational standards, emergency response routes can be further refined, thereby reducing the risk of collisions, mitigating a potential incident as best as possible, and enhancing the efficiency of marine transit.

Atlas Overview

Six Thematic Chapters + Summary

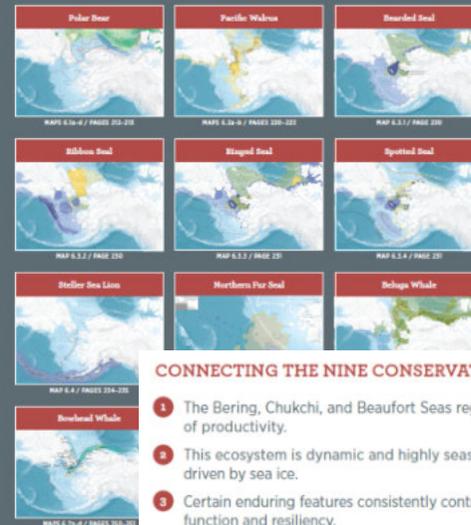
PHYSICAL SETTING



BIOLOGICAL SETTING

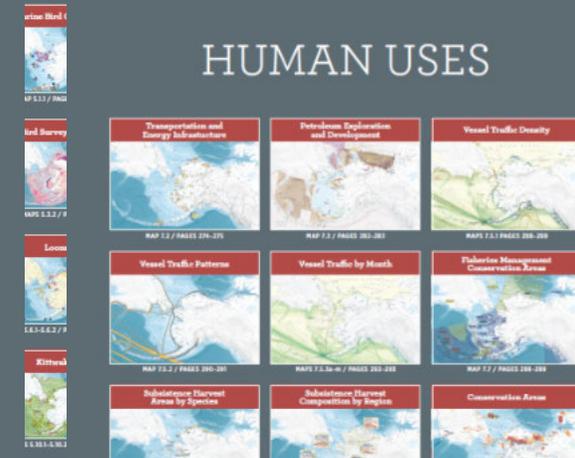
FISHES

MAMMALS



BIRDS

HUMAN USES



CONNECTING THE NINE CONSERVATION AND MANAGEMENT THEMES

- 1 The Bering, Chukchi, and Beaufort Seas region is a major hotspot of productivity.
- 2 This ecosystem is dynamic and highly seasonal, and especially driven by sea ice.
- 3 Certain enduring features consistently contribute to ecosystem function and resiliency.
- 4 The areas critical to ecosystem function are interconnected.
- 5 Climate change is shifting sea ice patterns and species ranges, and requires adaptation to a new normal condition.
- 6 There is intensifying development interest in the Arctic, requiring a better understanding of cumulative impacts at regional scales.
- 7 Among what we currently know, there are a number of outstanding data gaps and uncertainties.
- 8 The synthesizing, publishing, and sharing of spatial data greatly enhances understanding and decision-making abilities.
- 9 Managers should integrate the best available data across disciplines and broad geographic and temporal scales to assess cumulative effects and implement sustainable actions.

Data to Design

Data Gathering

Identify available data

Acquire and organize

Design

Annual cycle maps

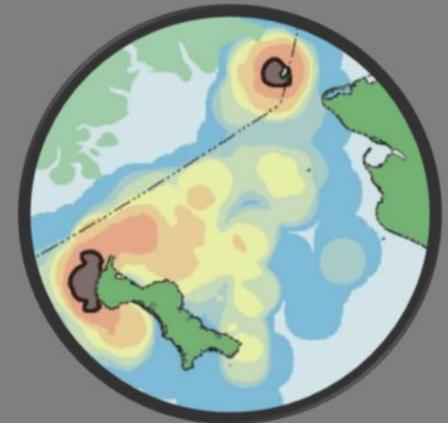
Identify patterns

Assessment & planning

Data Synthesis

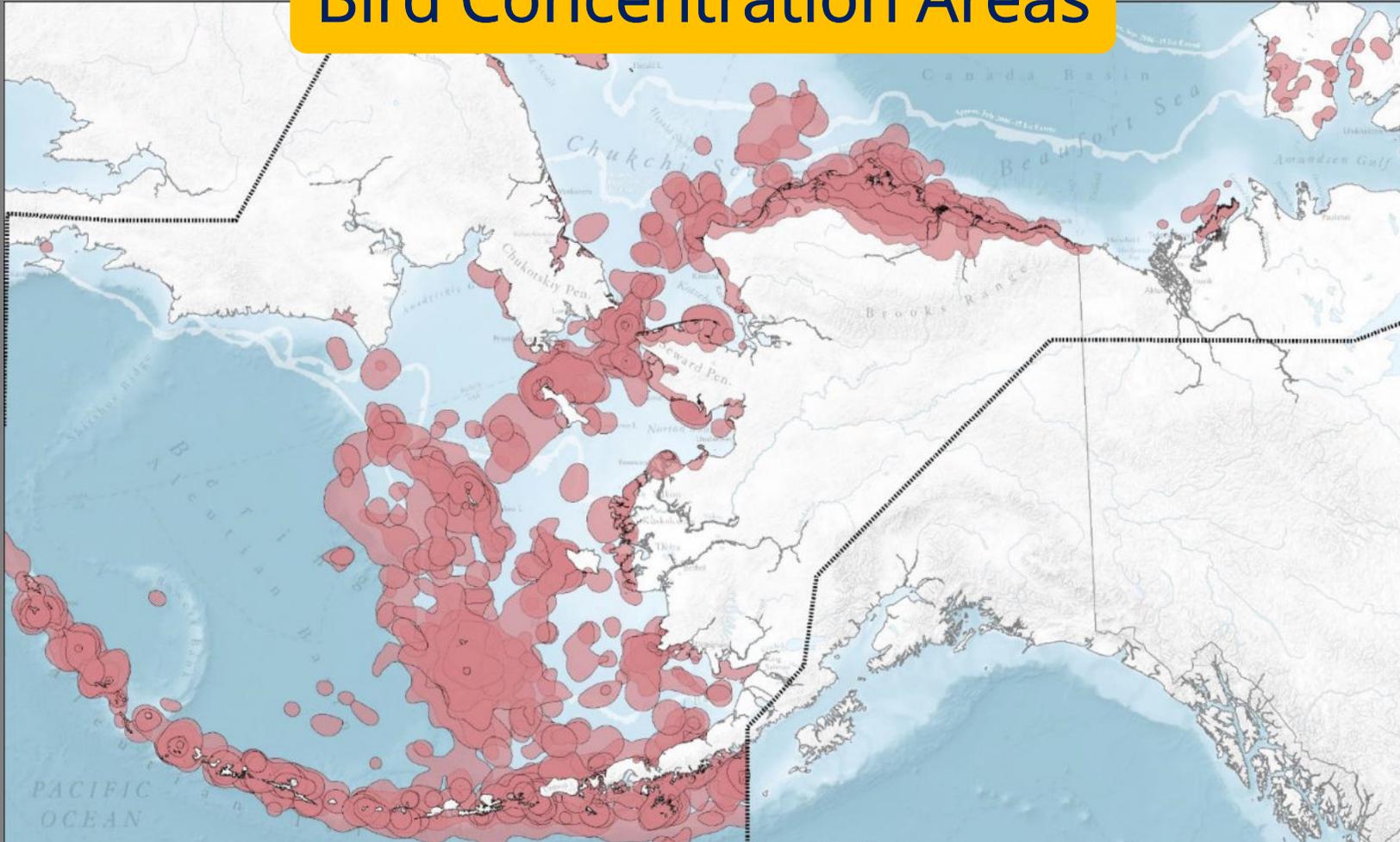
Spatial analysis

Composite data layers

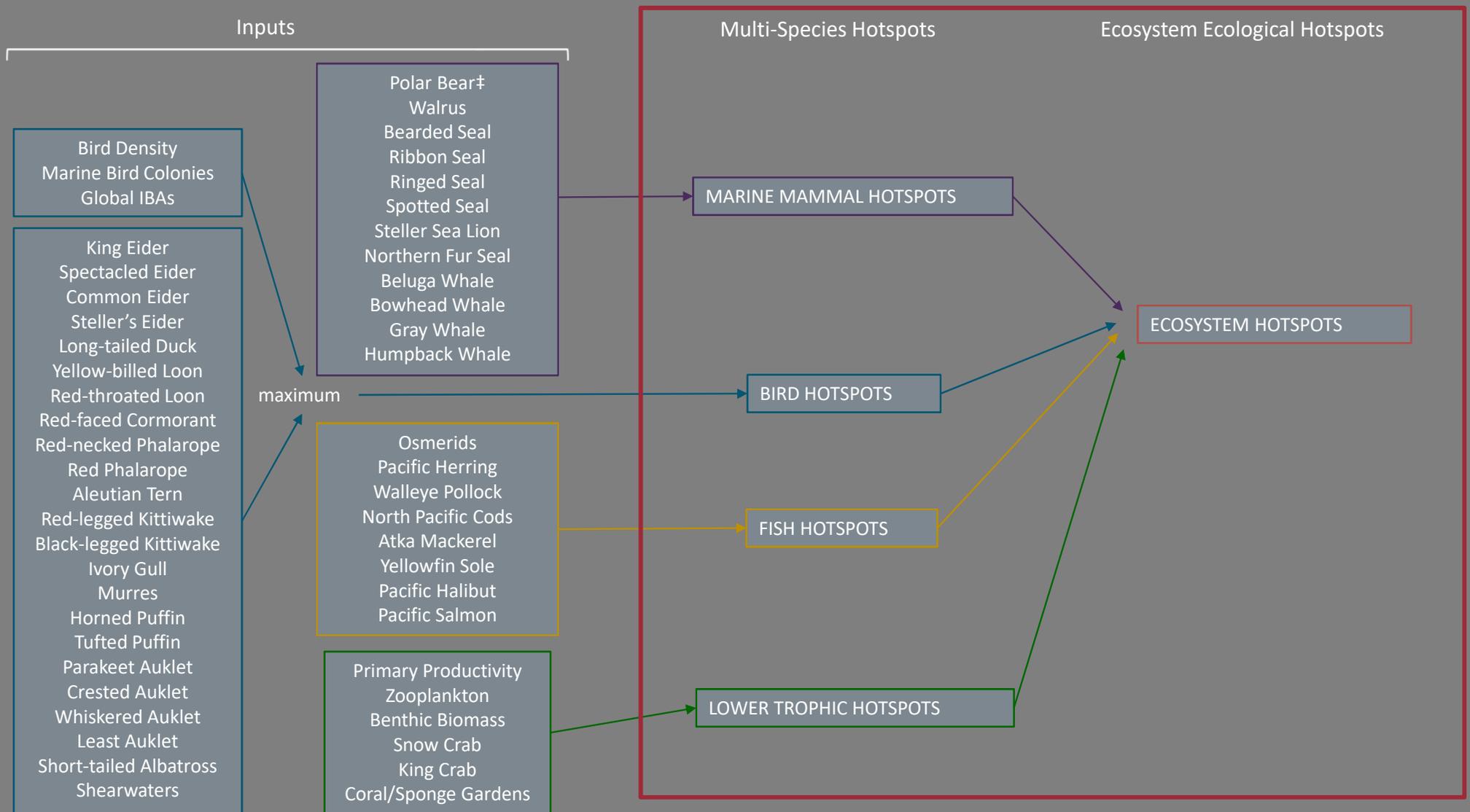


Identify Patterns

Bird Concentration Areas

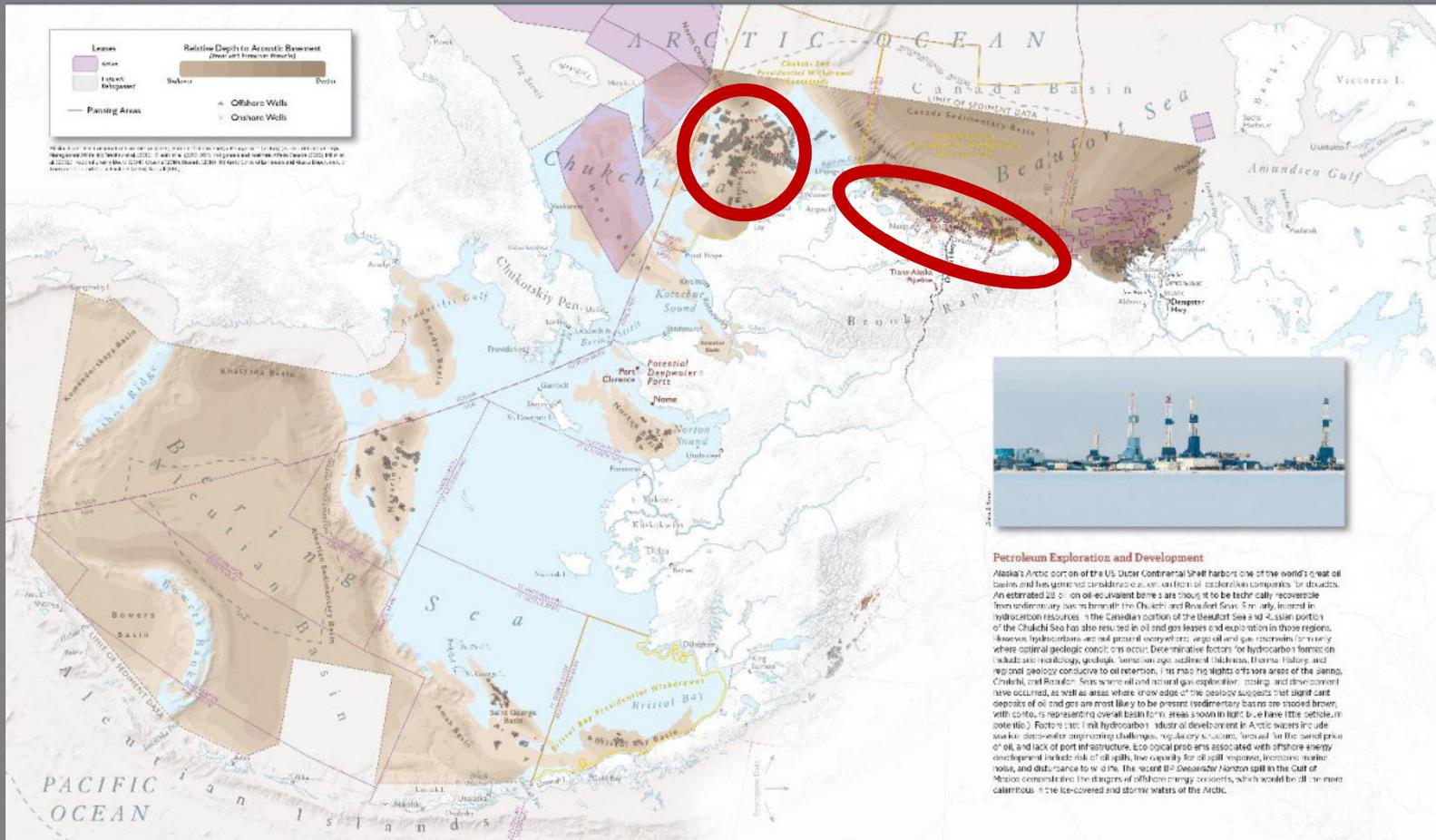


Identify Patterns



Identify Patterns

Energy Development



Assessing Vulnerability

- Four main stressors
 - Commercial fisheries
 - Offshore energy
 - Vessel traffic
 - Climate change
- Anticipated completion:
December 2018



Thank you!

Download the atlas at:

<http://bit.ly/eco-atlas>

Data on Alaska Ocean Observing System Arctic Portal (coming soon)

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daniel p huffman
somethingaboutmaps.com

