



Photo: Dave Shaw

ECOLOGICAL ATLAS OF ALASKA'S WESTERN ARCTIC

Third Edition

Benjamin Sullender and Melanie Smith

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Ecological Atlas of Alaska's Western Arctic

Alaska's Western Arctic is arguably the wildest, most remote land area in the United States today. Alaska's North Slope Borough is similar in size to the State of California, yet has less than 10,000 residents. The area boasts extraordinary wildlife and is the home of Alaska Native people who have been present in the area for thousands of years. The coastal plain is one of the largest wetland complexes in the circumpolar Arctic, attracting a globally significant abundance of waterfowl, shorebirds, and raptors, earning the name "America's Bird Basket." Birds from the Western Arctic disperse along all four major flyways of North America, as well as to Asia and beyond. A cohort of iconic Arctic mammals gather here, including caribou, muskoxen, and polar bears. This is also an area of major oil, gas, and coal resources. Central to the region is the 23-million acre National Petroleum Reserve-Alaska (NPR). The maps collected here help the reader explore the landscape, and better understand the overlap of wildlife, people, and development to inform conservation and management.

BACKGROUND OF THE ATLAS

Audubon Alaska published the first edition of this ecological atlas as part of the 2003 Western Arctic Synthesis, edited and published by John Schoen and Stan Senner. At the time, the use of GIS in conservation mapping was relatively new. Audubon contracted with EcoTrust and The Nature Conservancy to map spatial data across the Western Arctic. That set of maps was regarded as the first comprehensive spatial assessment of resource values for the region. The process brought a greater understanding of ecosystem patterns and important areas. As a result, places such as Teshekpuk Lake and Utukok Uplands drew the attention of many.

In 2009, Audubon used our in-house GIS capacity to collect the latest spatial data and update the set of maps. That

second edition was completed by Melanie Smith and Alan Baldivieso. Based on the updated spatial data, in 2011 Melanie Smith, Eric Myers, and John Schoen revised Audubon's Habitat Conservation Strategy for the NPR, including new and revised recommendations for special areas and development restrictions. Those maps were influential to the Bureau of Land Management's 2013 management plan for the NPR, speaking to the importance of investing in data and mapping as a key conservation tool.

This third edition was completed by Benjamin Sullender and Melanie Smith, with data support from Nathan Walker. It includes new datasets such as climate change projections, vegetation mapping, and future development scenarios. It also includes updated data such as Important Bird Areas, caribou habitat selection, pinniped distribution, and estimated oil resources. The process of developing an ecological atlas sheds light on landscape patterns and significant places. Some of the region's important areas are described below.



Photo: Gerrit Vyn

IMPORTANT AREAS

TESHEKPUK LAKE

The Teshekpuk Lake region is a globally-significant Important Bird Area for its very high density of many bird species of concern, such as Spectacled, Steller's, and King Eiders; Yellow-billed and Red-throated Loons; and Black Brant. The Teshekpuk Caribou Herd migrates to this area each year to calve their young and forage on abundant sedges. Geese gather in the tens of thousands in the fall to molt north of Teshekpuk Lake. A several-mile-wide coastal band is designated critical habitat for denning polar bears.

COLVILLE RIVER AND DELTA

The Colville River headwaters begin in the Brooks Range and the river ends over 300 miles downstream in a massive alluvial fan and delta plain stretching out toward the Beaufort Sea. The river itself marks an invisible but important boundary: a transition from the developed State of Alaska oil production lands to the federal NPRA which is just beginning to see its first oil production footprint. Known for its high density of raptors, the exposed Lower Cretaceous cliff banks of the Colville are tenanted by nesting Peregrine Falcons, Golden Eagles, Rough-legged Hawks, and Gyrfalcons. The delta is a globally-recognized Important Bird Area where a world-class gathering of shorebirds and waterfowl raise their chicks. Black Brant, Steller's Eiders, Stilt Sandpipers, and more than 60 other species breed there. Arctic foxes, muskoxen, wolves, caribou, and the occasional land-locked polar bear wander through the delta.

UTUKOK RIVER UPLANDS

These higher elevation foothills and uplands are the headwaters for the Utukok River as well as the Meade and Colville rivers. This excellent wolverine habitat has one of the highest densities of this hard-to-find species anywhere, as well as high densities of caribou, wolves, and grizzly bears. The uplands are the calving grounds of the Western Arctic Caribou Herd—the largest herd in Alaska. The area is also inhabited by moose, raptors, and anadromous fish.

DEASE INLET AND MEADE RIVER

The area around Dease Inlet and the Meade River is characterized by thousands of small thaw lakes, which are important habitat for nesting loons, waterfowl, and shorebirds. The inlet itself is home to ice seals, particularly ringed and spotted seals. The barrier islands are important for polar bears and nesting seabirds. The area also provides important insect

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maps in six chapters: Physical Setting, Biological Setting, Fish, Birds, Mammals, and Human Uses.

FOR MORE INFORMATION

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Related Report: Alaska's Western Arctic: A Summary and Synthesis of Resources (Schoen and Senner, eds. 2003)

On the Web: <http://ak.audubon.org/conservation/western-arctic-national-petroleum-reserve-alaska>

relief habitat for the Teshekpuk Caribou Herd. This area includes the densest Yellow-billed Loon nesting area in Alaska.

KASEGALUK LAGOON

Kasegaluk Lagoon is a highly productive shallow coastal lagoon and barrier island system spanning 125 miles of the Chukchi Sea coast. This is a very important area for coastal marine mammals and nesting, staging, and migrating waterbirds. Belugas whales calve and molt in the lagoon, and up to 35,000 walrus haul out near Point Lay.

IKPIKPUK RIVER

The Ikpikpuk and its tributary, the Titaluk River, host a high density of nesting Peregrine Falcons. The Ikpikpuk River is an anadromous fish stream and also has been identified as providing significant shorebird habitat. The delta of the Ikpikpuk is an important nesting area for snow geese.

PEARD BAY

Peard Bay and the surrounding wetland complex is a concentration area for three species of ice seals, polar bears, and various seabirds—particularly eiders. The habitat adjacent to Peard Bay is characterized by thousands of small thaw lakes, which provide important habitat for nesting loons, waterfowl, and shorebirds.

DELONG MOUNTAINS AND ARCTIC FOOTHILLS

The DeLong Mountains and Arctic Foothills are heavily used by migrating caribou, grizzly bears, wolves, and wolverines. This area adjoins the Noatak National Preserve and the Gates of the Arctic National Park, and is an important component for maintaining an undeveloped ecological corridor from interior Alaska, across the Brooks Range, to the Arctic Coastal Plain.

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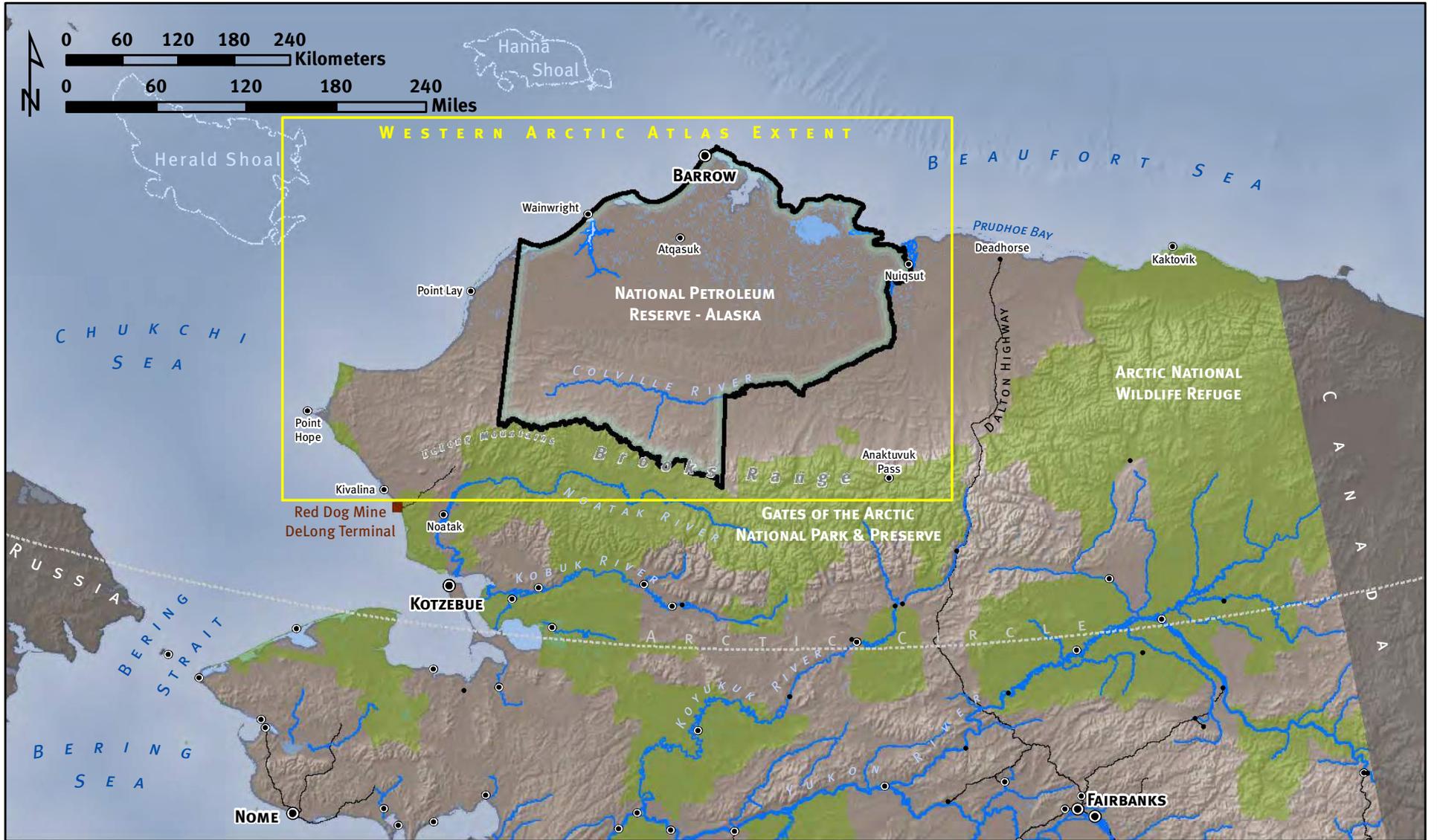
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REFERENCES

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C O N T E X T



NPRA BOUNDARY
 MAJOR RIVERS

NATIONAL PARKS AND WILDLIFE REFUGES
 MAJOR ROADS

TOWNS
POPULATION
 • < 100
 ○ 100 - 999
 ⊙ > 1,000



PLACE NAMES AND GEOGRAPHY



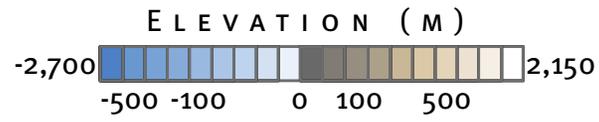
- TOWNS
- NPRA BOUNDARY
- ~ MAJOR RIVERS



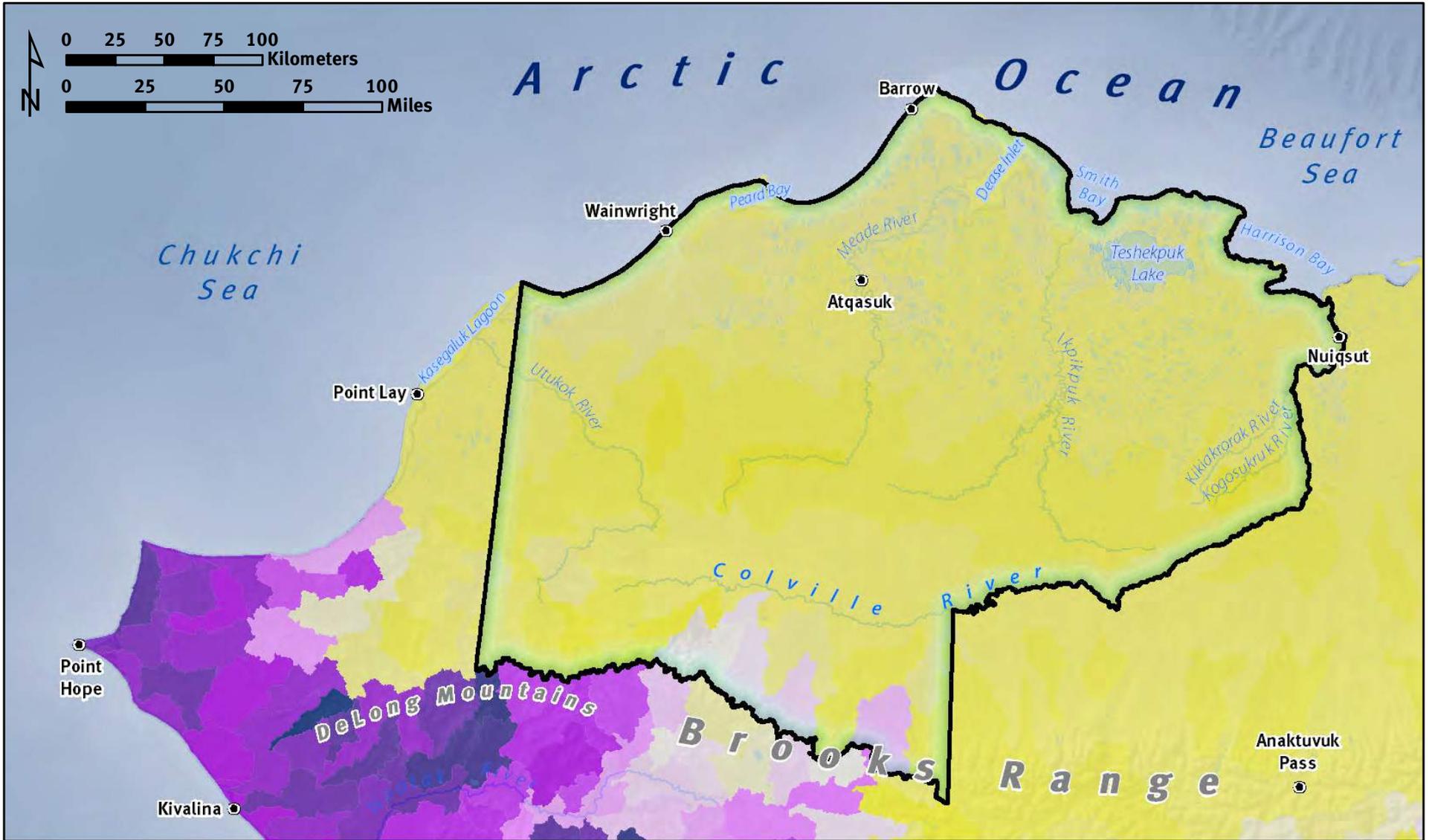
T O P O G R A P H Y



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS



TERRESTRIAL CLIMATE CHANGE ACTIVE LAYER THICKNESS



● TOWNS
 [Green outline] NPRA BOUNDARY
 [Blue wavy line] MAJOR RIVERS

CHANGE IN ACTIVE LAYER THICKNESS
 -3.09 0 0.77
 Thinner active layer Thicker active layer
 STANDARD DEVIATIONS FROM BASELINE

-3 -2 -1 0 1 2 3

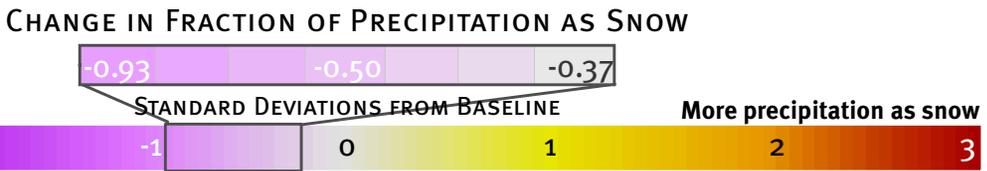
Active layer is the portion of soil above permafrost that freezes and thaws seasonally.

Sources: Smith and Walker 2014, based on Romanovsky and Marchenko 2014.

TERRESTRIAL CLIMATE CHANGE FRACTION OF PRECIPITATION FALLING AS SNOW



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS



Sources: Smith and Walker 2014, based on SNAP 2013.

TERRESTRIAL CLIMATE CHANGE

LENGTH OF GROWING SEASON



● TOWNS
 NPRA BOUNDARY
~ MAJOR RIVERS

CHANGE IN LENGTH OF GROWING SEASON
0.38 0.48 0.79
 STANDARD DEVIATIONS FROM BASELINE

Growing season is the length of time between the last frost of spring and the first frost of fall.

Shorter growing season
 Longer growing season

-3 -2 -1 0 1 2 3

TERRESTRIAL CLIMATE CHANGE PRECIPITATION



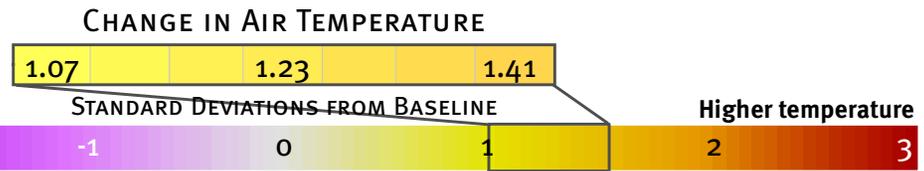
Sources: Smith and Walker 2014, based on SNAP 2013.

TERRESTRIAL CLIMATE CHANGE

AIR TEMPERATURE AT GROUND SURFACE

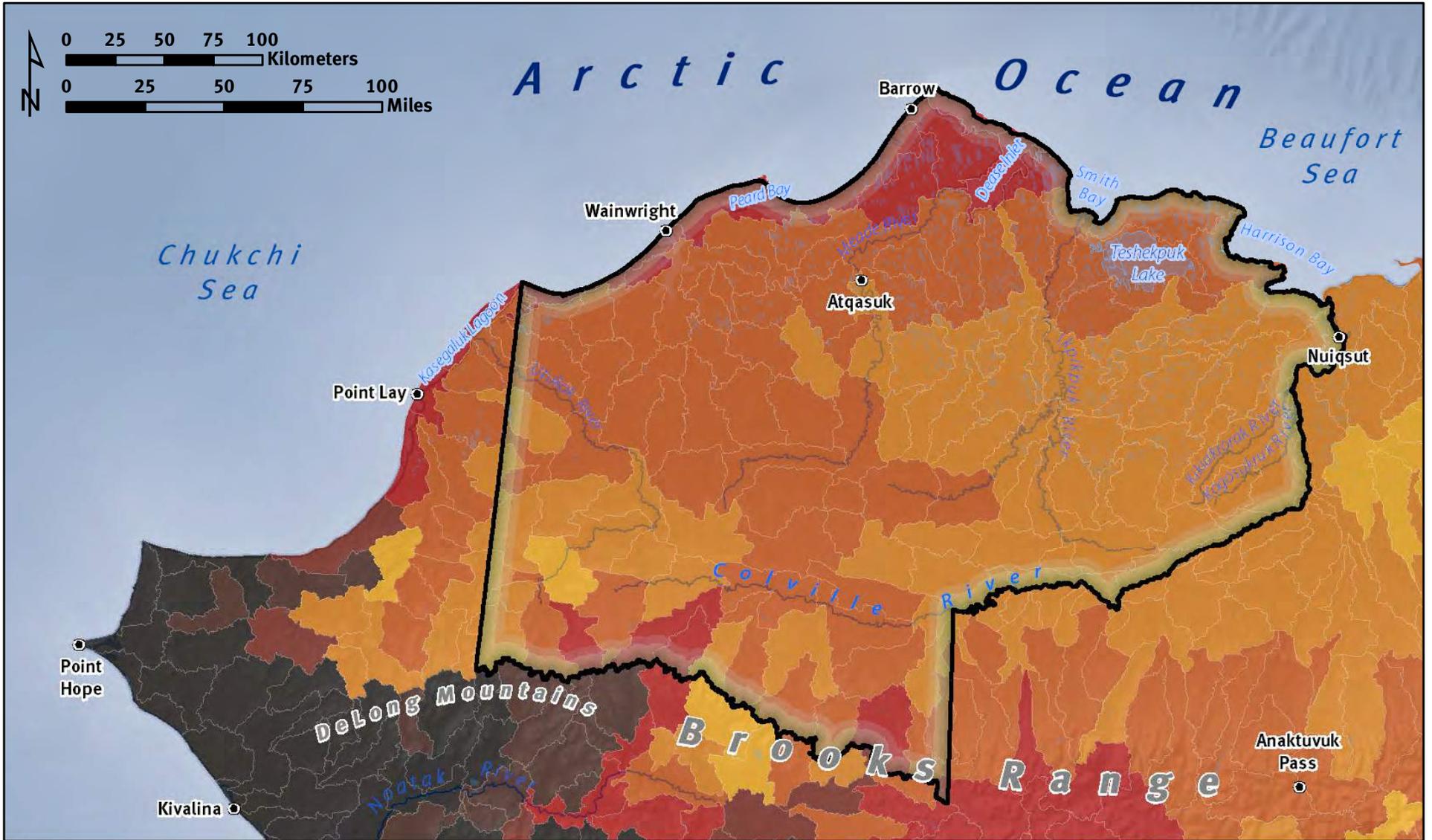


- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS



Sources: Smith and Walker 2014, based on SNAP 2013.

TERRESTRIAL CLIMATE CHANGE CUMULATIVE VULNERABILITY



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

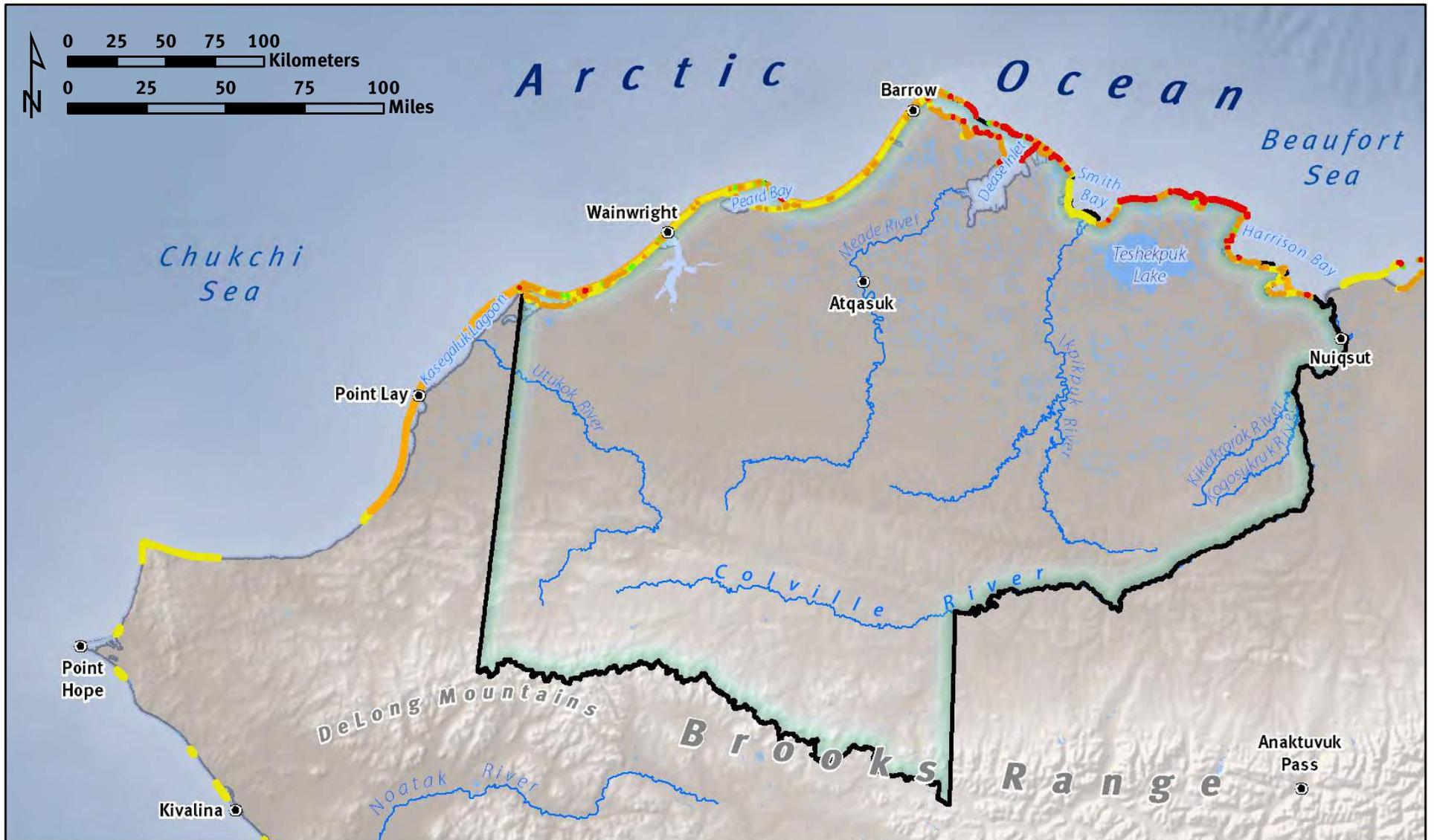


Sum of predicted changes in active layer thickness, fraction of precipitation falling as snow, length of growing season, precipitation, and air temperature at ground surface.



Sources: Smith and Walker 2014, based on SNAP 2013 and Romanovsky and Marchenko 2014.

C O A S T A L E R O S I O N

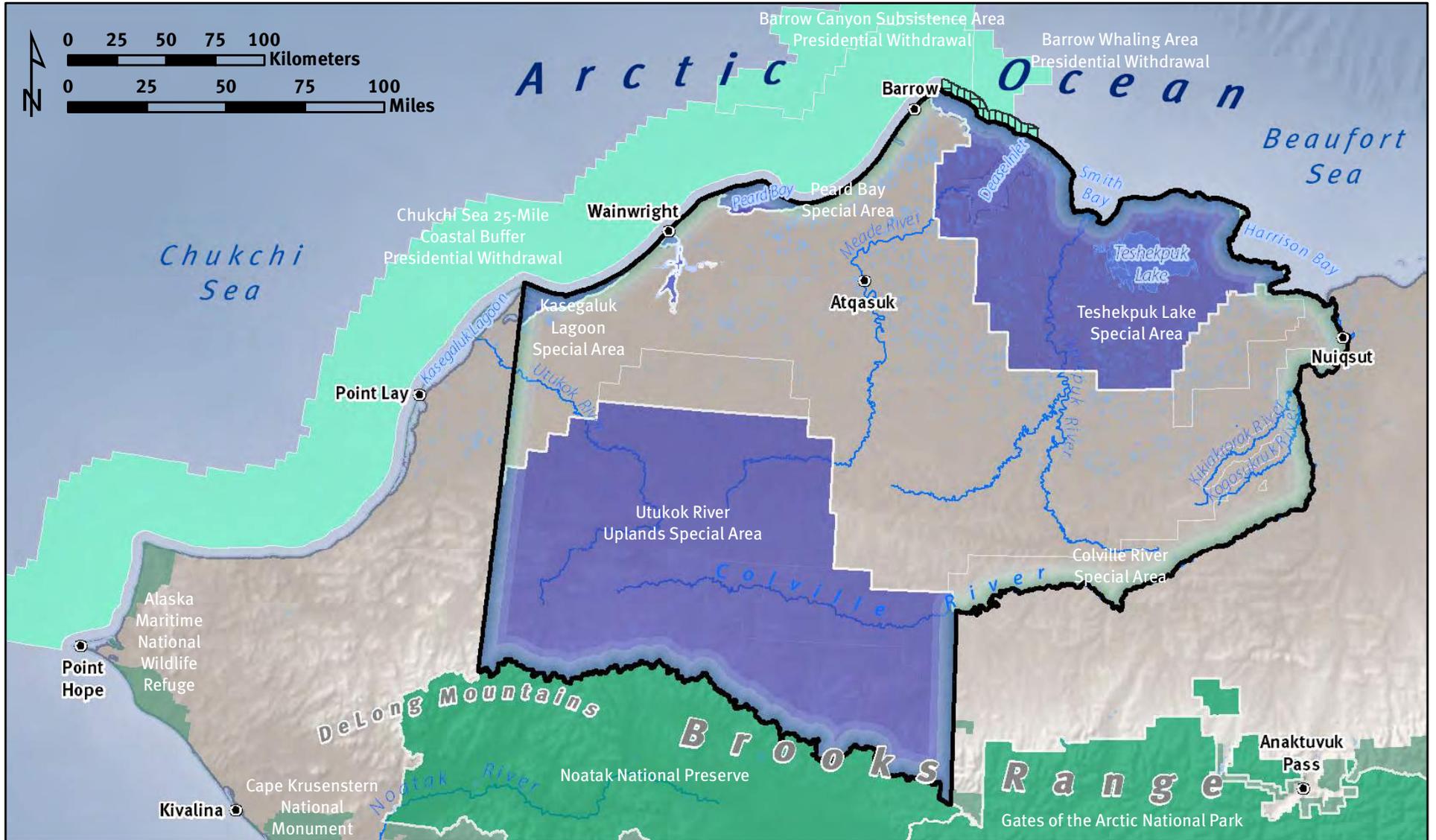


- TOWNS
 - ▭ NPRA BOUNDARY
 - ~ MAJOR RIVERS
 - ACCRETION
 - STABLE
 - MODERATE EROSION
 - SEVERE EROSION
- ANNUAL RATE OF SHORELINE CHANGE^{1,2}



Sources: 1) Gibbs et al. 2015; 2) Gutierrez et al. 2014.

CONSERVATION AREAS

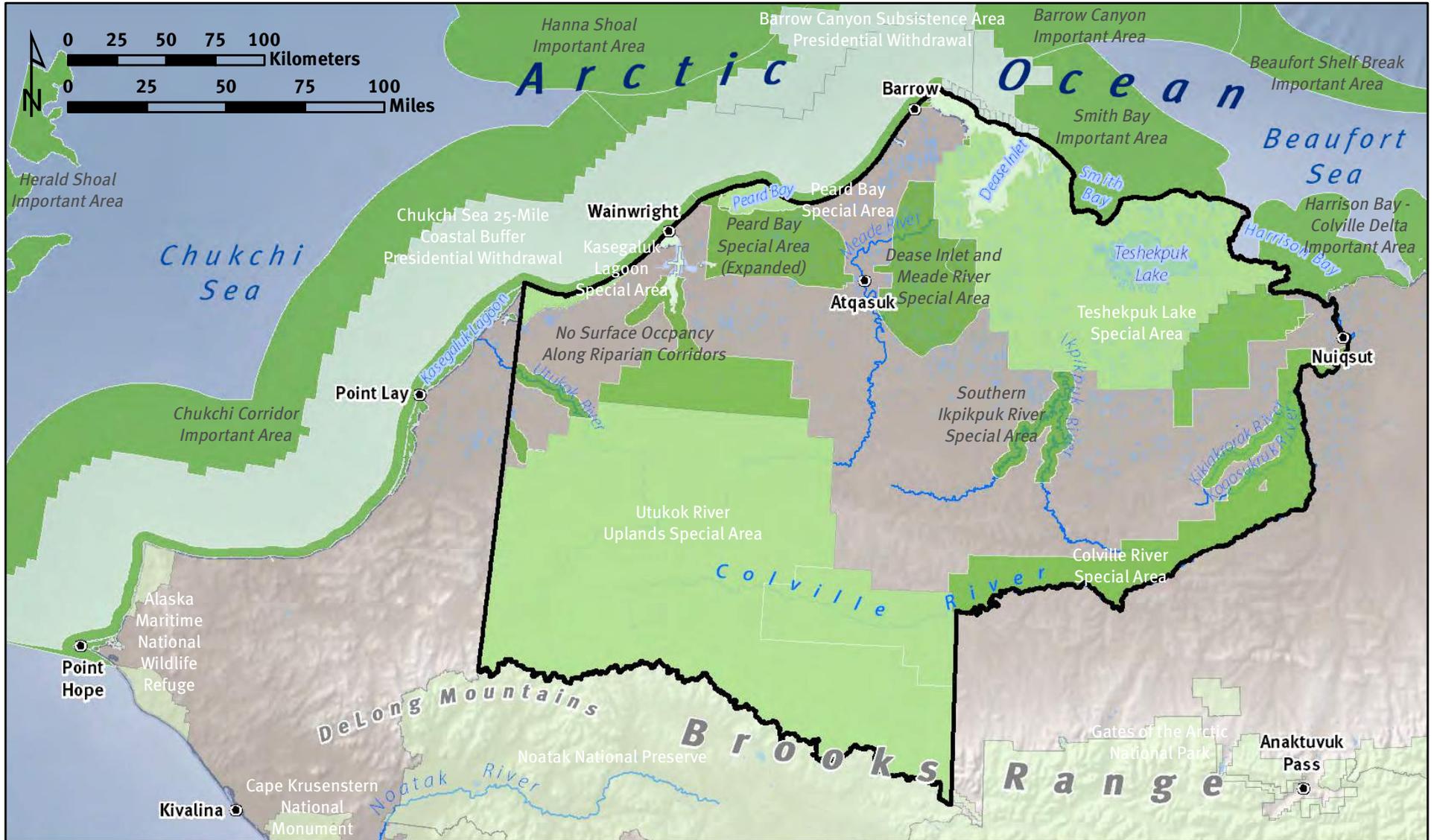


TOWNS	WILDERNESS AREAS ¹	NON-WILDERNESS PROTECTED AREAS ¹
NPR A BOUNDARY	WITHDRAWN FROM OIL AND GAS LEASING ^{2,3}	NPR A SPECIAL AREAS
MAJOR RIVERS	DEFERRED FROM OIL AND GAS LEASING ⁴	UNAVAILABLE FOR LEASE ³



Sources: 1) University of Montana 2015; 2) BOEM 2015; 3) BLM 2013; 4) Alaska DNR 2015.

CONSERVATION PRIORITIES



<p>● TOWNS</p> <p> NPRA BOUNDARY</p> <p> MAJOR RIVERS</p>	<p>BIologically IMPortant AREAS</p> <p>LACKING PROTECTION</p> <p>INCLUDES IMPORTANT AREAS IN THE ARCTIC OCEAN¹ AND PROPOSED NPRA SPECIAL AREAS / DEVELOPMENT RESTRICTIONS²</p>	<p>AREAS WITH SOME LEVEL OF PROTECTION OR ADMINISTRATIVE RECOGNITION^{3,4,5,6}</p> <p>INCLUDES NPRA SPECIAL AREAS³, AREAS WITHDRAWN FROM OIL AND GAS LEASING⁴, AREAS DEFERRED FROM OIL AND GAS LEASING⁵, AND NATIONAL PARKS⁶</p>	
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Sources: 1) Audubon Alaska 2016; 2) Audubon Alaska 2011; 3) BLM 2013; 4) BOEM 2015; 5) Alaska DNR 2015; 6) University of Montana 2015.

E C O R E G I O N S

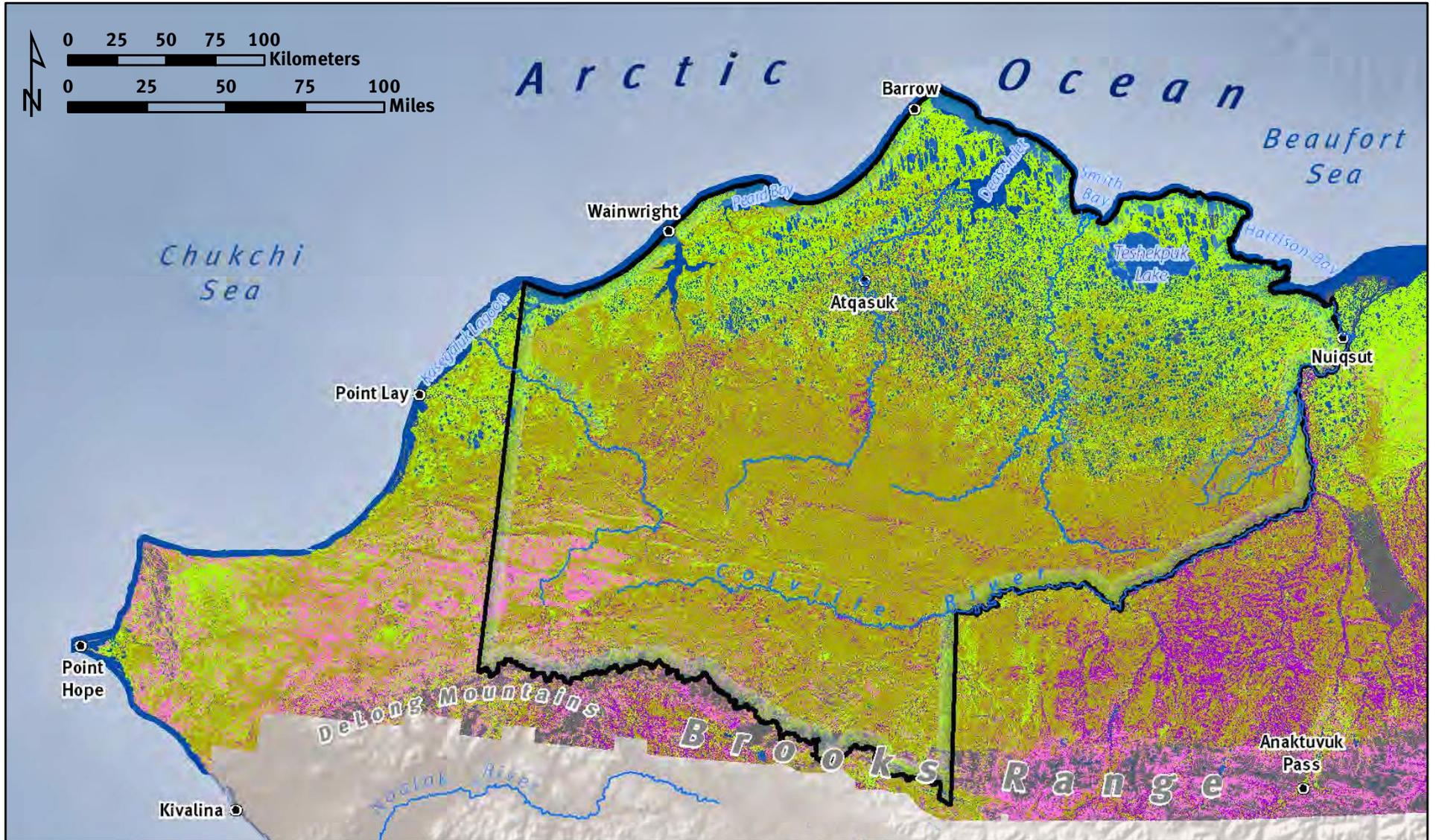


● TOWNS
 [Green outline] NPRA BOUNDARY
 [Blue wavy line] MAJOR RIVERS

E C O R E G I O N S
 [Light blue] ARCTIC COASTAL PLAIN
 [Light green] BROOKS RANGE
 [Light grey] BROOKS FOOTHILLS
 [Dark green] KOBUK RIDGES AND VALLEYS



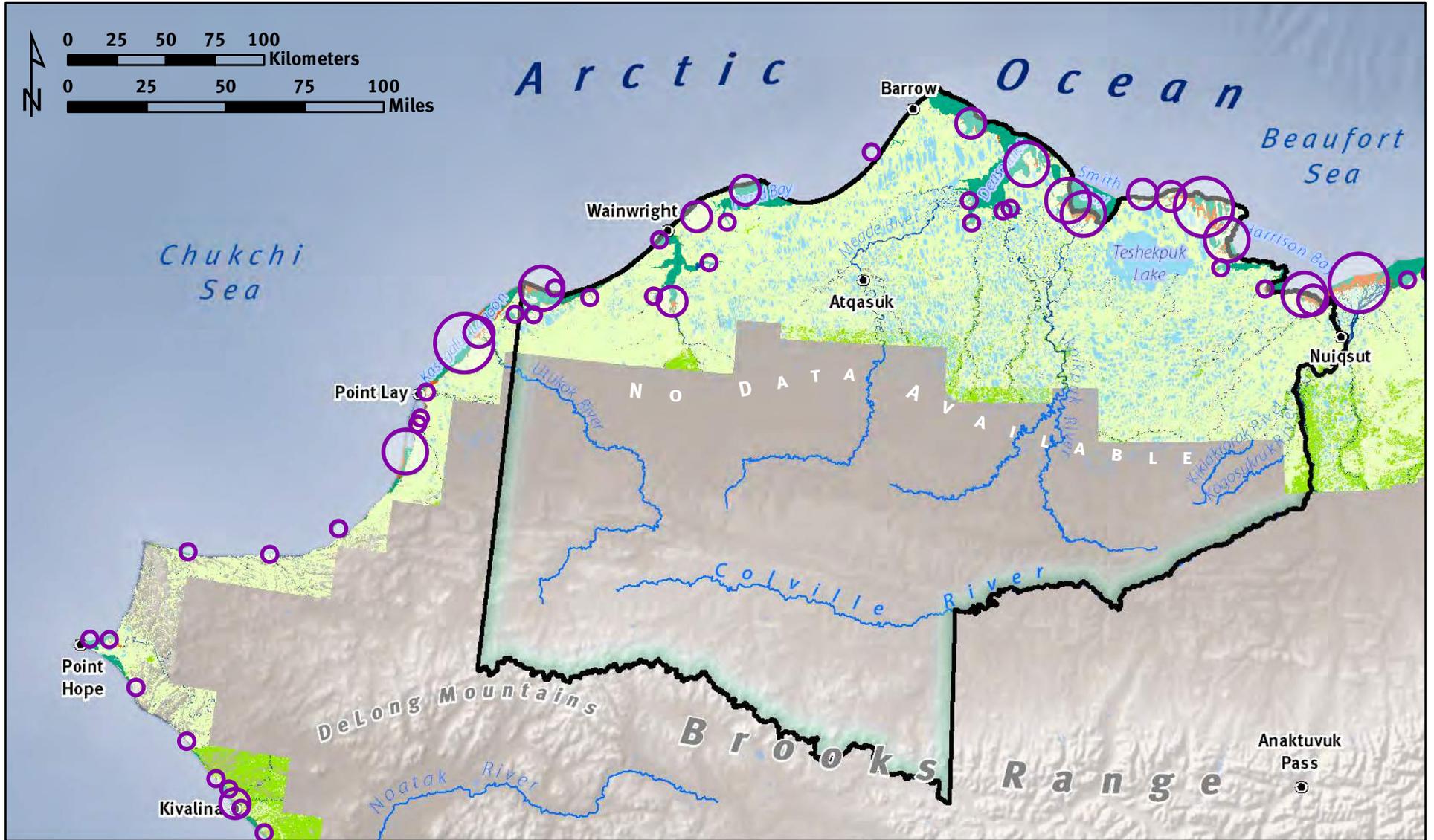
V E G E T A T I O N



● TOWNS	LAND COVER CLASSES		
▭ NPRA BOUNDARY	■ WET SEDGE-GRASS	■ OPEN WATER	■ LOW TO TALL SHRUB
~ MAJOR RIVERS	■ TUSSOCK TUNDRA	■ DWARF SHRUB	■ UNVEGETATED/ OTHER MISC



WETLANDS AND ESTUARIES



FISH SPECIES RICHNESS



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

- NUMBER OF FISH SPECIES PRESENT**
- ~ 1-3
 - ~ 4-6
 - ~ 7-8

SPECIES PRESENT IN STUDY AREA:
 ARCTIC CISCO, BERING CISCO, BROAD WHITEFISH, CHINOOK SALMON, CHUM SALMON, COHO SALMON, DOLLY VARDEN, HUMPBACK WHITEFISH, LEAST CISCO, PINK SALMON, RAINBOW SMELT, SHEEFISH, SOCKEYE SALMON, WHITEFISH (UNDIFFERENTIATED)



PACIFIC SALMON DISTRIBUTION

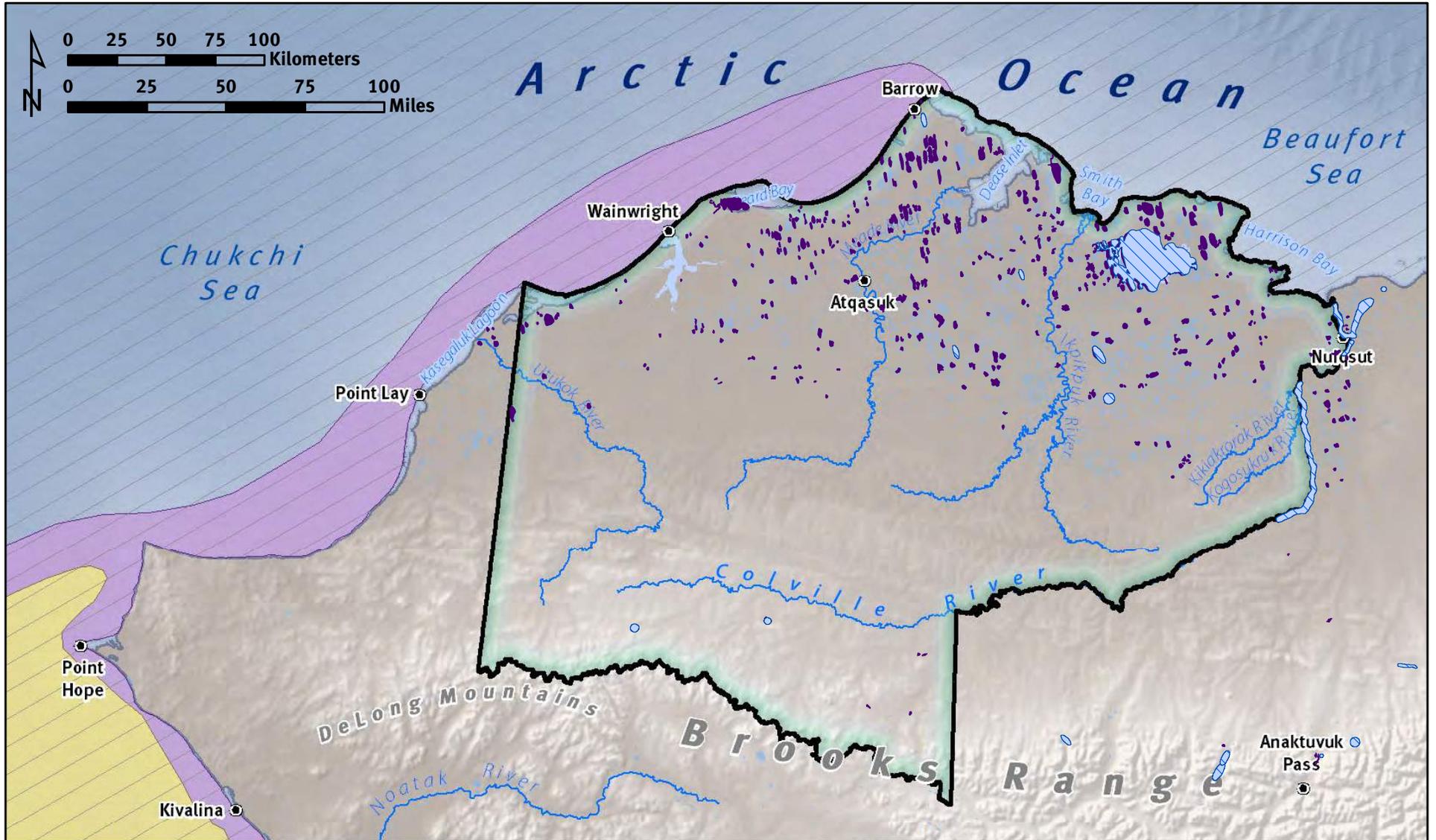


● TOWNS	SALMON SPECIES PRESENT		
▭ NPRA BOUNDARY	— CHINOOK (KING)	— COHO (SILVER)	— SOCKEYE (RED)
— MAJOR RIVERS	— CHUM (DOG)	— HUMPY (PINK)	



Source: ADF&G 2015.

F I S H H A B I T A T



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<p>ESSENTIAL FISH HABITAT¹</p> <ul style="list-style-type: none"> ▨ ARCTIC COD ▨ SNOW CRAB ▨ SAFFRON COD 	<p>FISH WINTER HABITAT²</p> <ul style="list-style-type: none"> ▨ POTENTIAL AND KNOWN FISH WINTER USE AREAS ● DEEP WATER LAKES 	
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Source: 1) North Pacific Fishery Management Council 2009; 2) USFWS 1977.

IMPORTANT BIRD AREAS (IBAS)



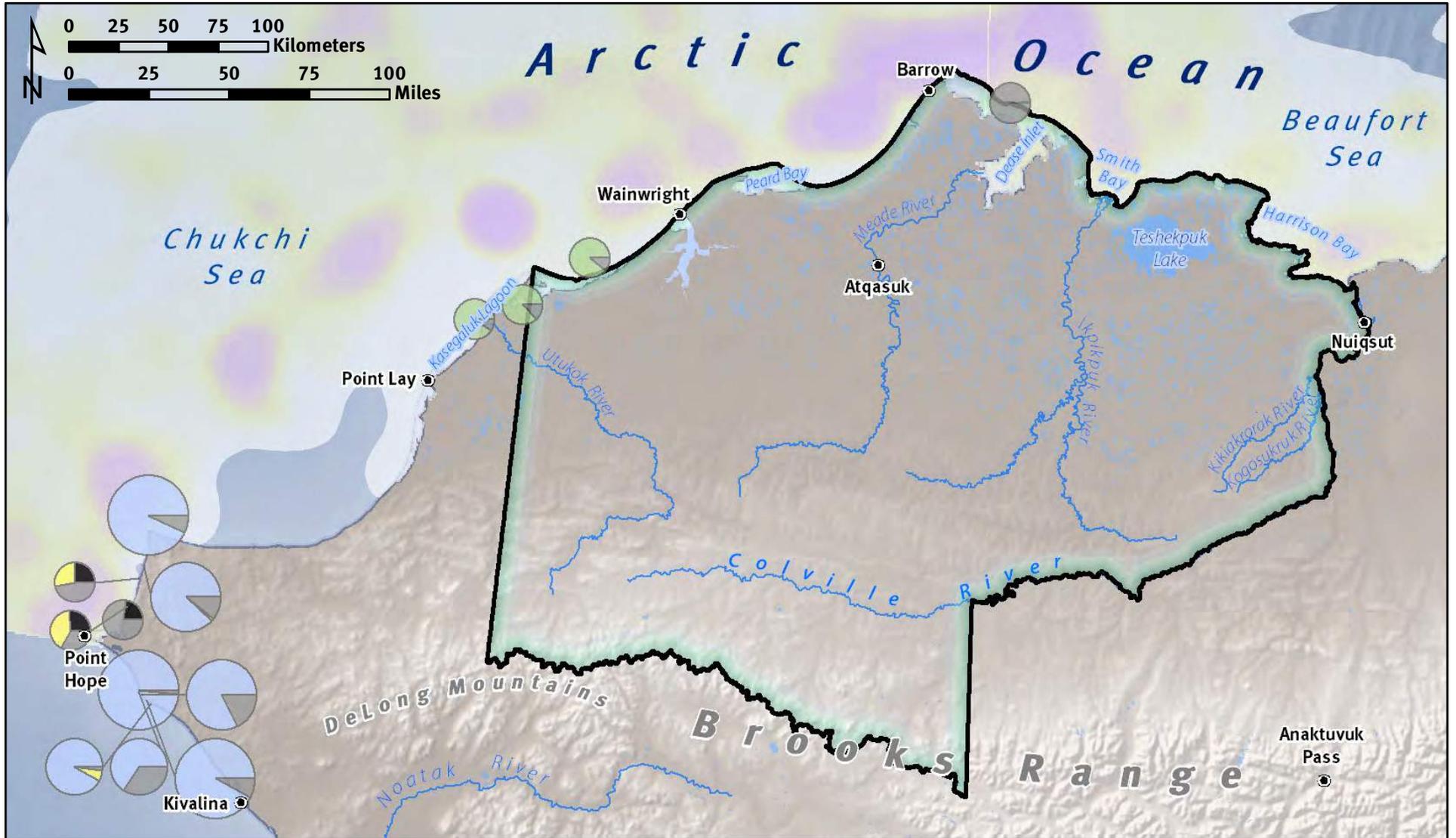
- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

- IBAS
- IBAS WITH WATCHLIST SPECIES

- BIRD SPECIES PRESENT**
- GLOBALLY SIGNIFICANT ABUNDANCE
 - CONTINENTALLY SIGNIFICANT ABUNDANCE
 - STATE-SIGNIFICANT ABUNDANCE
 - * DENOTES WATCHLIST SPECIES



MARINE BIRD COLONIES AND AT-SEA USE AREAS

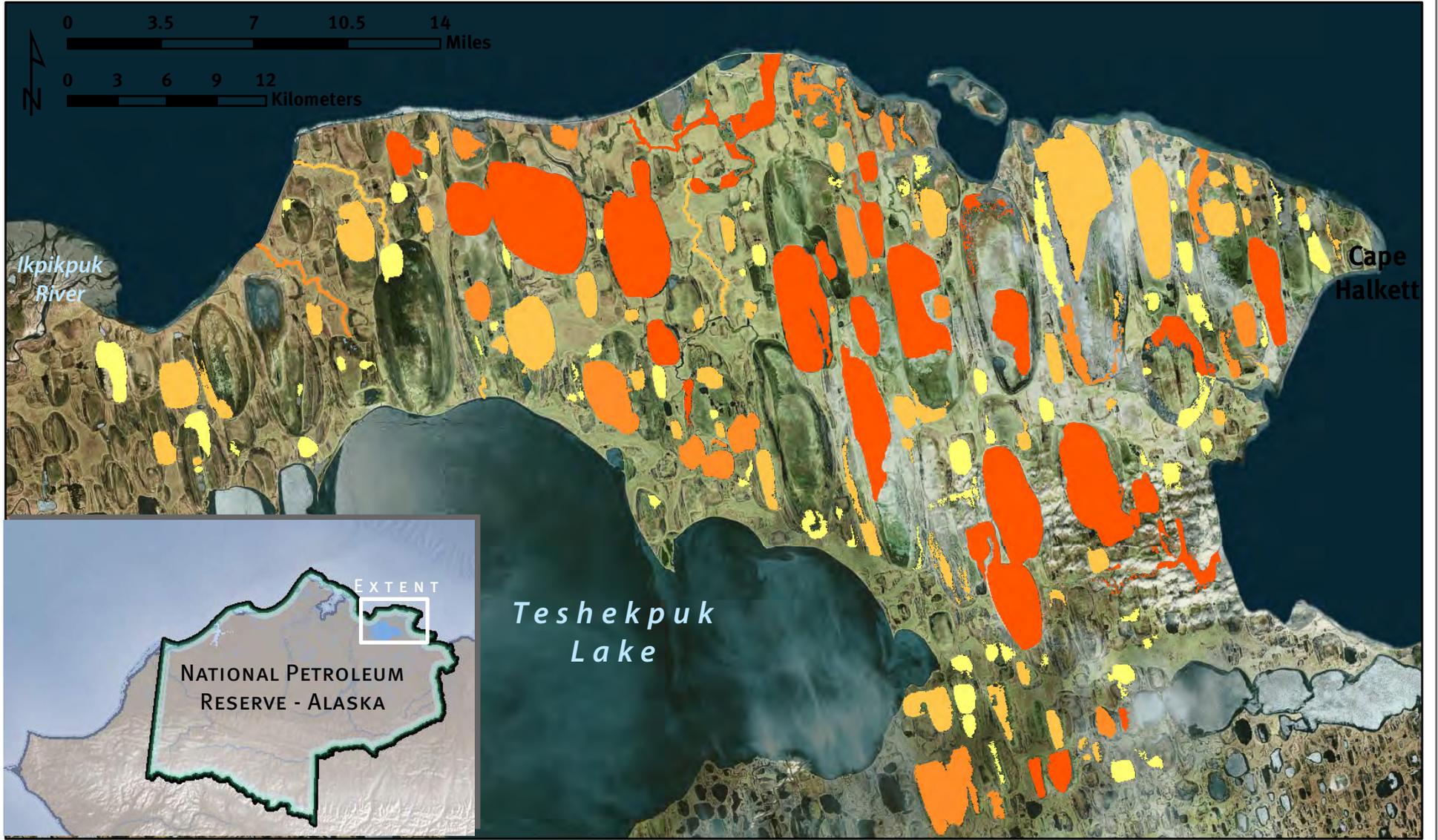


● TOWNS	MARINE BIRD COLONIES¹	■ EIDERS	10% ISOPLETH	■ HIGHEST DENSITY
▭ NPRA BOUNDARY	● SCALED BY ABUNDANCE	■ CORMORANTS	50%	■ LOWEST DENSITY
~ MAJOR RIVERS		■ MURRES	SUMMER USE AREAS²	
		■ PUFFINS	RELATIVE DENSITY, ALL SPECIES	
		■ GULLS AND TERNS	90% ISOPLETH	

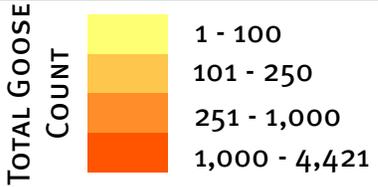


Sources: 1) USFWS 2008; 2) Audubon Alaska 2016, based on Drew and Piatt 2013, Walker and Smith 2014, and USFWS 2016.

M O L T I N G G O O S E D I S T R I B U T I O N



- ⊙ TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS



INCLUDES BRANT, CANADA GOOSE, GREATER WHITE-FRONTED GOOSE, PACIFIC LOON, RED-THROATED LOON, TUNDRA SWAN, SNOW GOOSE, AND YELLOW-BILLED LOON



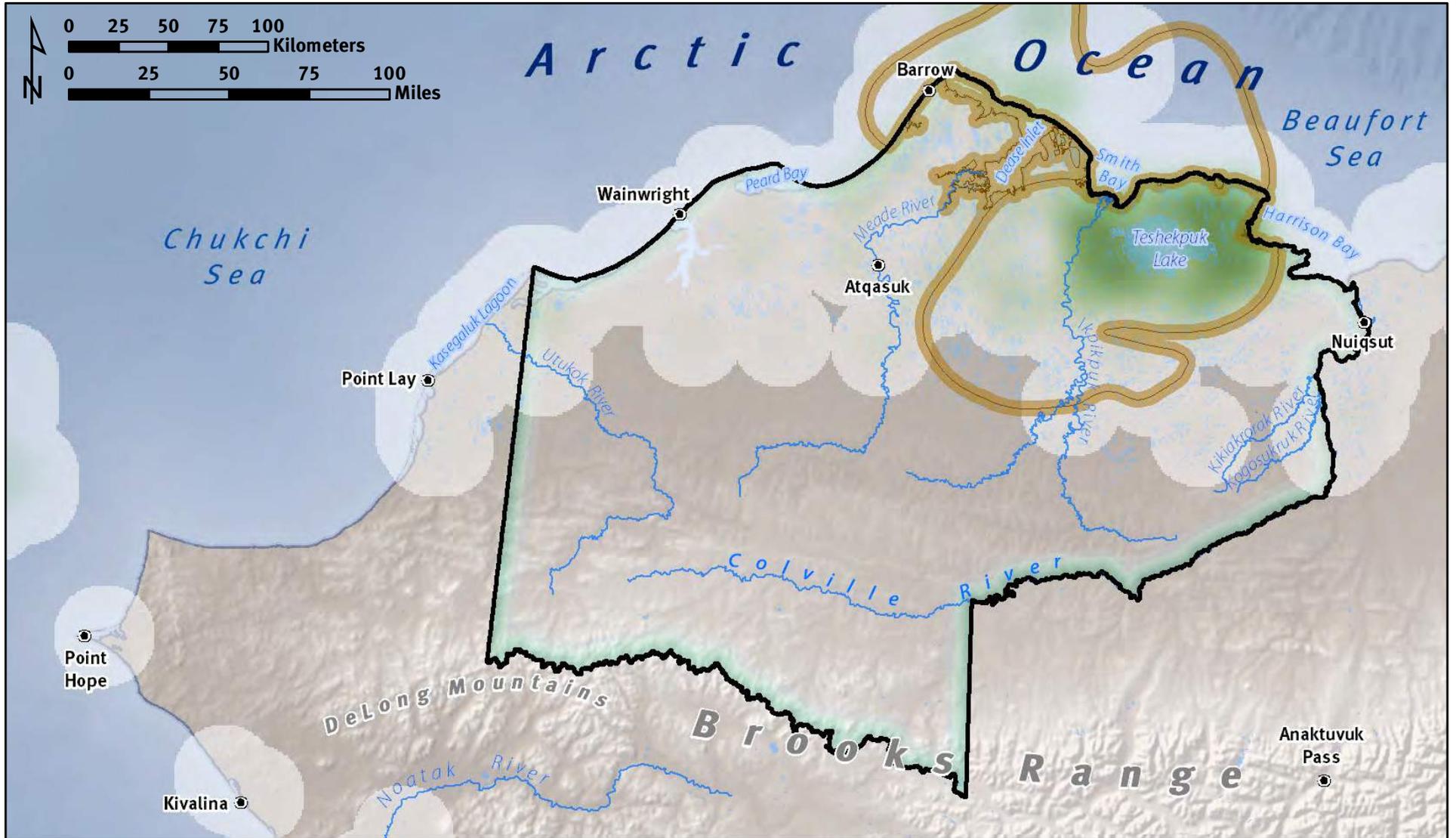
RAPTOR NEST SITES IN NPRA



- TOWNS
 - ▭ NPRA BOUNDARY
 - ~ MAJOR RIVERS
- | SPECIES | | | |
|---------|--------------|---|-------------------|
| ◆ | GOLDEN EAGLE | ◇ | PEREGRINE FALCON |
| ◆ | GYRFALCON | ◆ | ROUGH-LEGGED HAWK |



S H O R E B I R D S



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

ESTIMATED SUMMER DENSITY¹

13,879
BIRDS PER
100 KM²

1

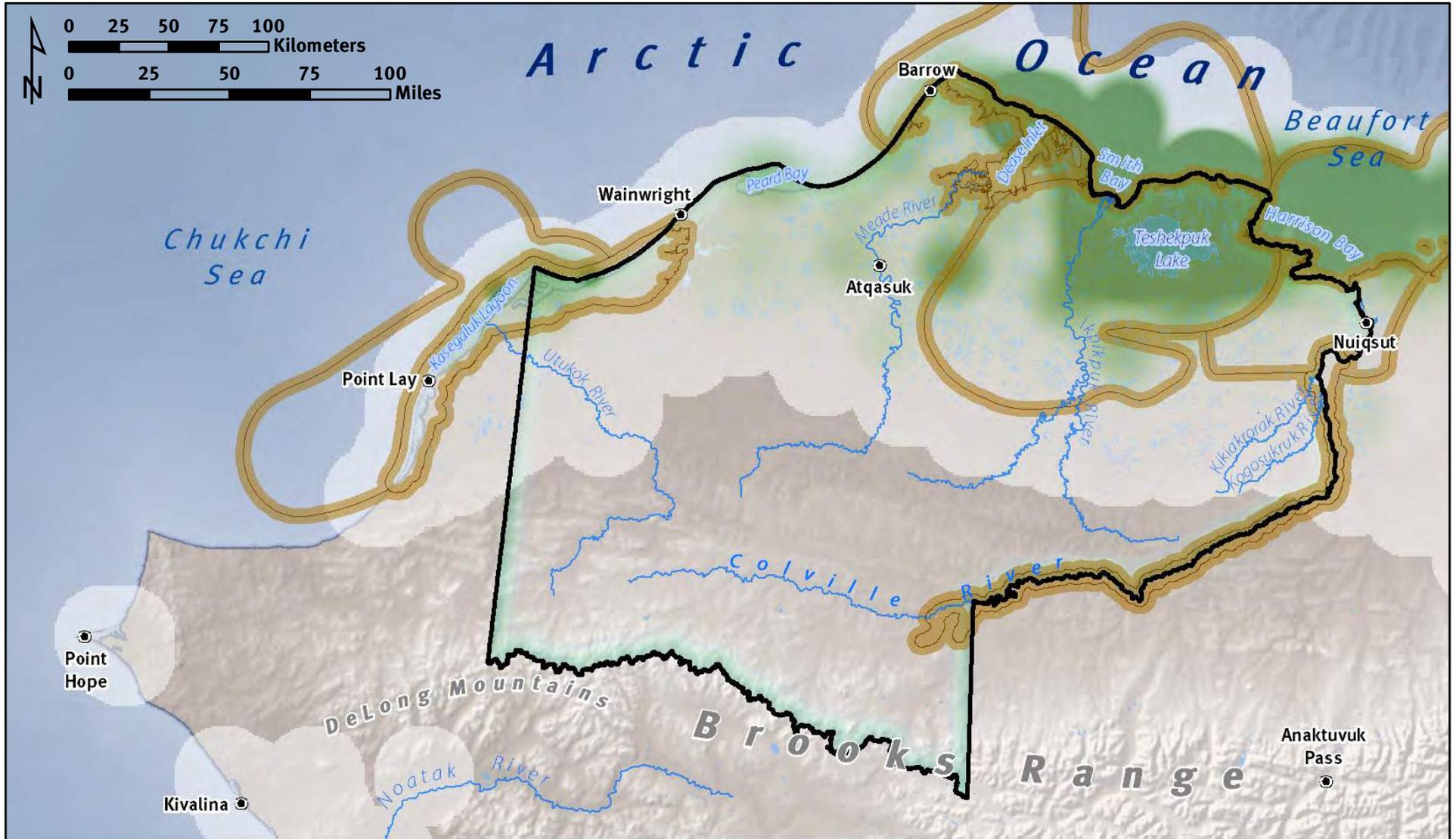
SHOREBIRD IBAs²

GLOBALY SIGNIFICANT ABUNDANCE



Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014.

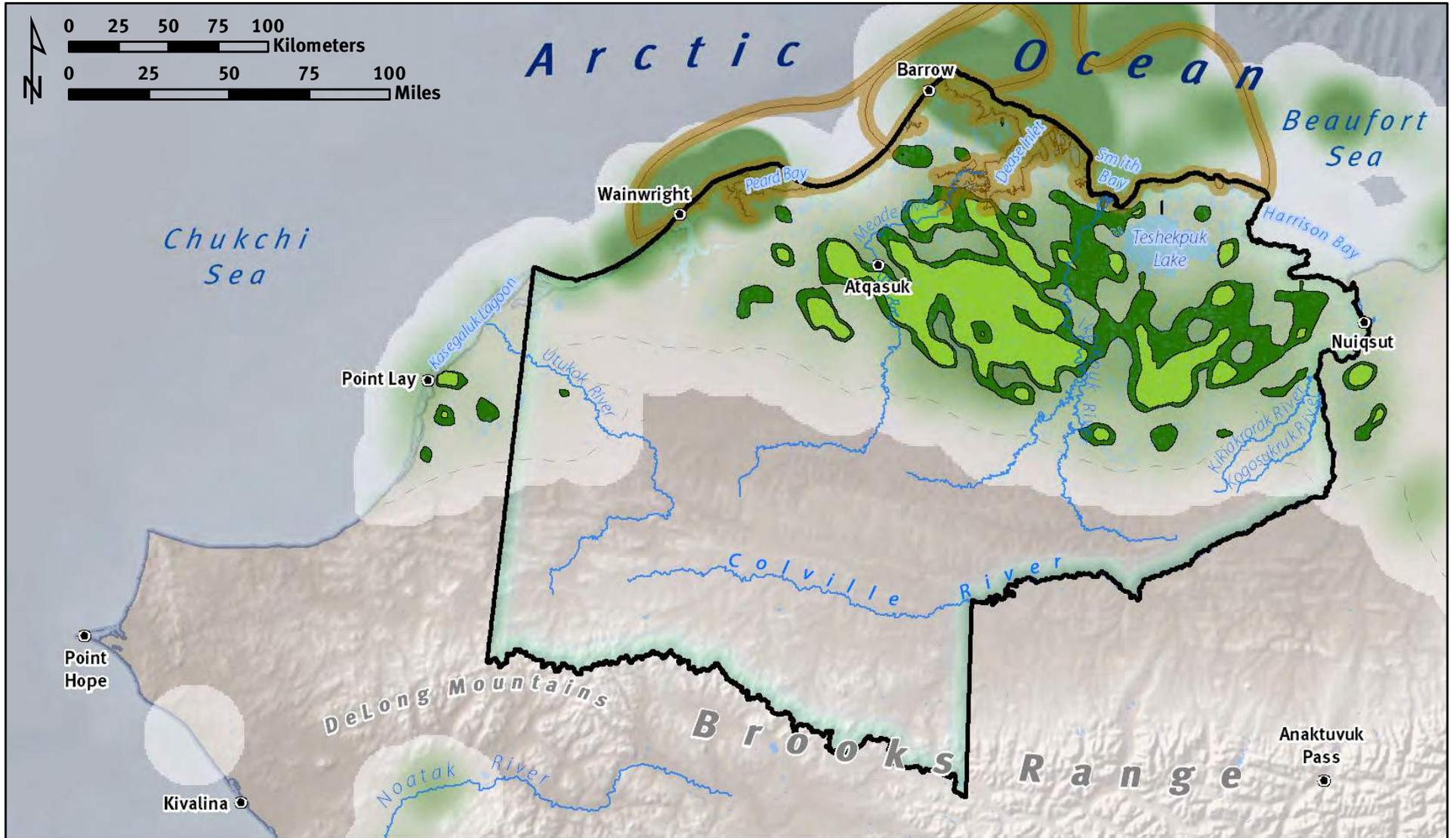
WATCHLIST SPECIES



<p>● TOWNS</p> <p>▭ NPRA BOUNDARY</p> <p>~ MAJOR RIVERS</p>	<p>ESTIMATED SUMMER DENSITY¹</p> <p>7,714 BIRDS PER 100 KM²</p> <p>1</p>	<p>WATCHLIST IBAS²</p> <p>GLOBALY SIGNIFICANT ABUNDANCE</p> 	<p>WATCHLIST BIRDS IN STUDY AREA: ALEUTIAN TERN, AMERICAN GOLDEN-PLOVER, BUFF-BREASTED SANDPIPER, BLACK BRANT, BLACK SCOTER, BAR-TAILED GODWIT, COMMON EIDER, DUNLIN, EMPEROR GOOSE, KING EIDER, RED-THROATED LOON, SPECTACLED EIDER, STELLER'S EIDER, AND YELLOW-BILLED LOON.</p>	
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Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014.

A R C T I C T E R N

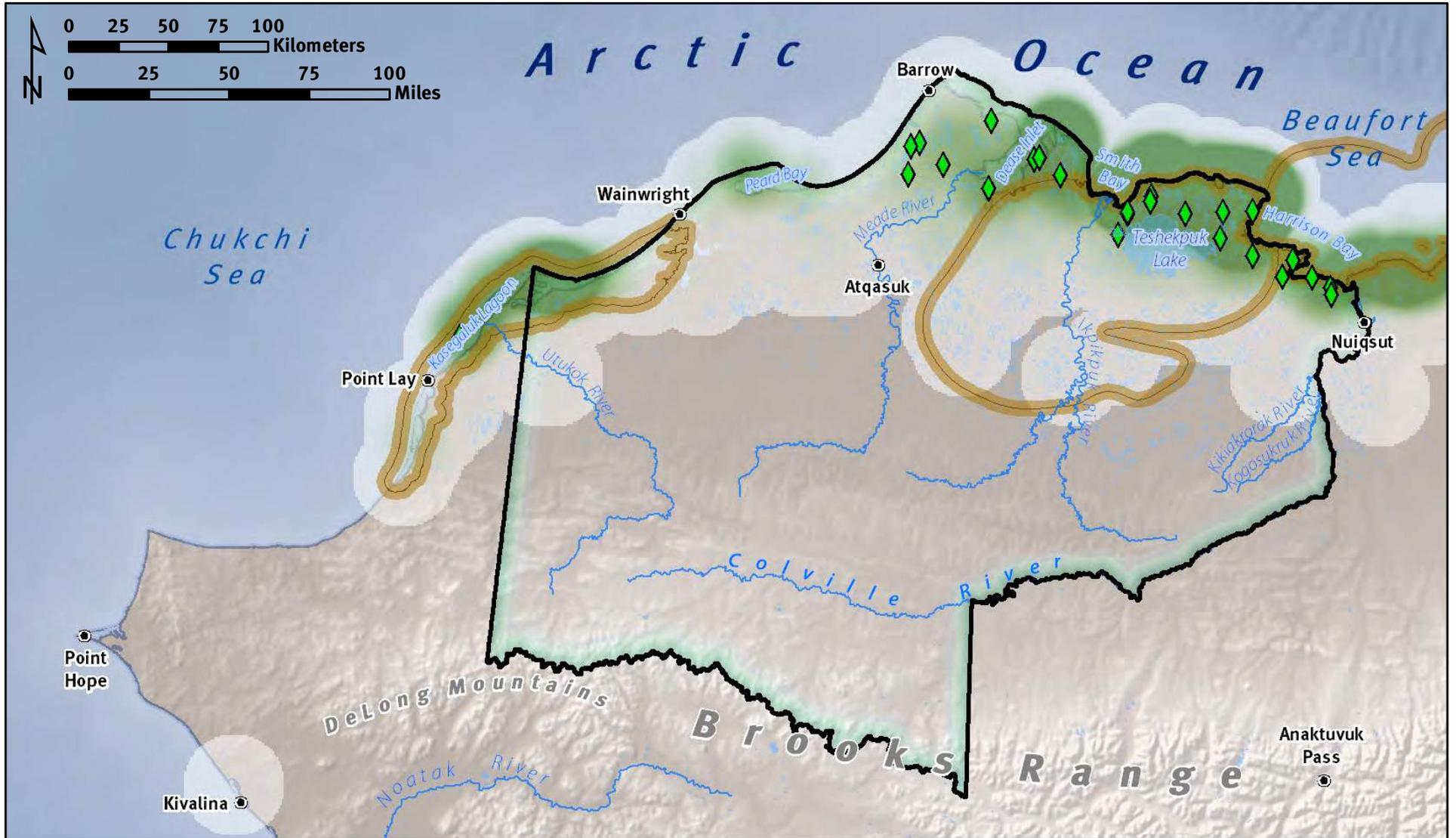


● TOWNS	ESTIMATED SUMMER DENSITY ¹	ARCTIC TERN IBAS ²	HIGHEST BREEDING DENSITY ³
▭ NPRA BOUNDARY	3,250 BIRDS PER 100 KM ²	GLOBALLY SIGNIFICANT ABUNDANCE	COASTAL PLAIN BREEDING SURVEY BOUNDARY ³
~ MAJOR RIVERS	1		



Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

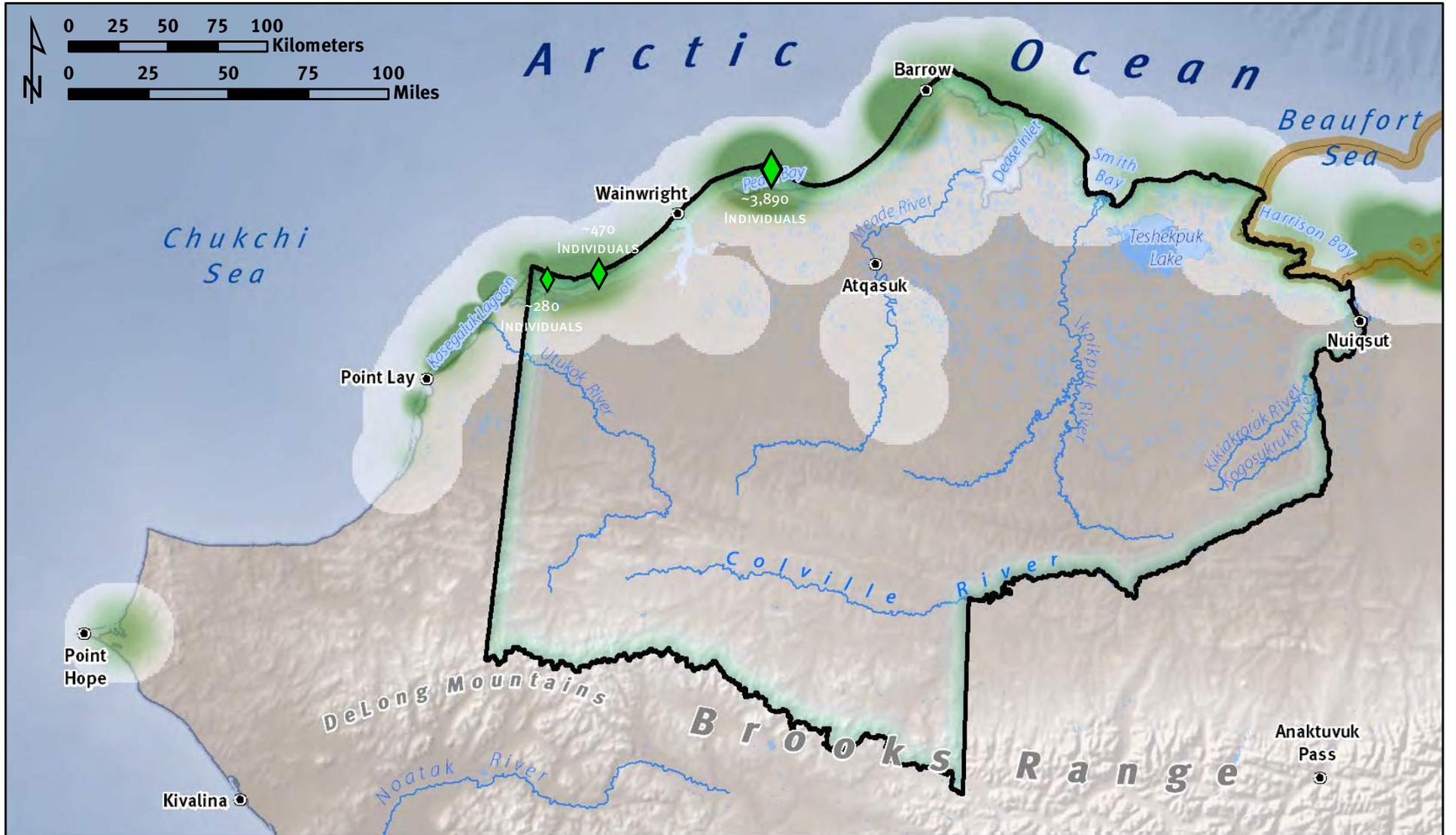
B R A N T



● TOWNS
 [Green Outline] NPRA BOUNDARY
 [Blue Wavy Line] MAJOR RIVERS
 ESTIMATED SUMMER DENSITY¹
 [Green Gradient] 1,720 BIRDS PER 100 KM²
 [Light Green] 1
 [Orange Outline] BRANT IBAS² GLOBALLY SIGNIFICANT ABUNDANCE
 [Green Diamond] KNOWN BRANT COLONIES³ SITES WITH >10 NESTS, 1994-1998

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) Alaska Biological Research 2002.

C O M M O N E I D E R



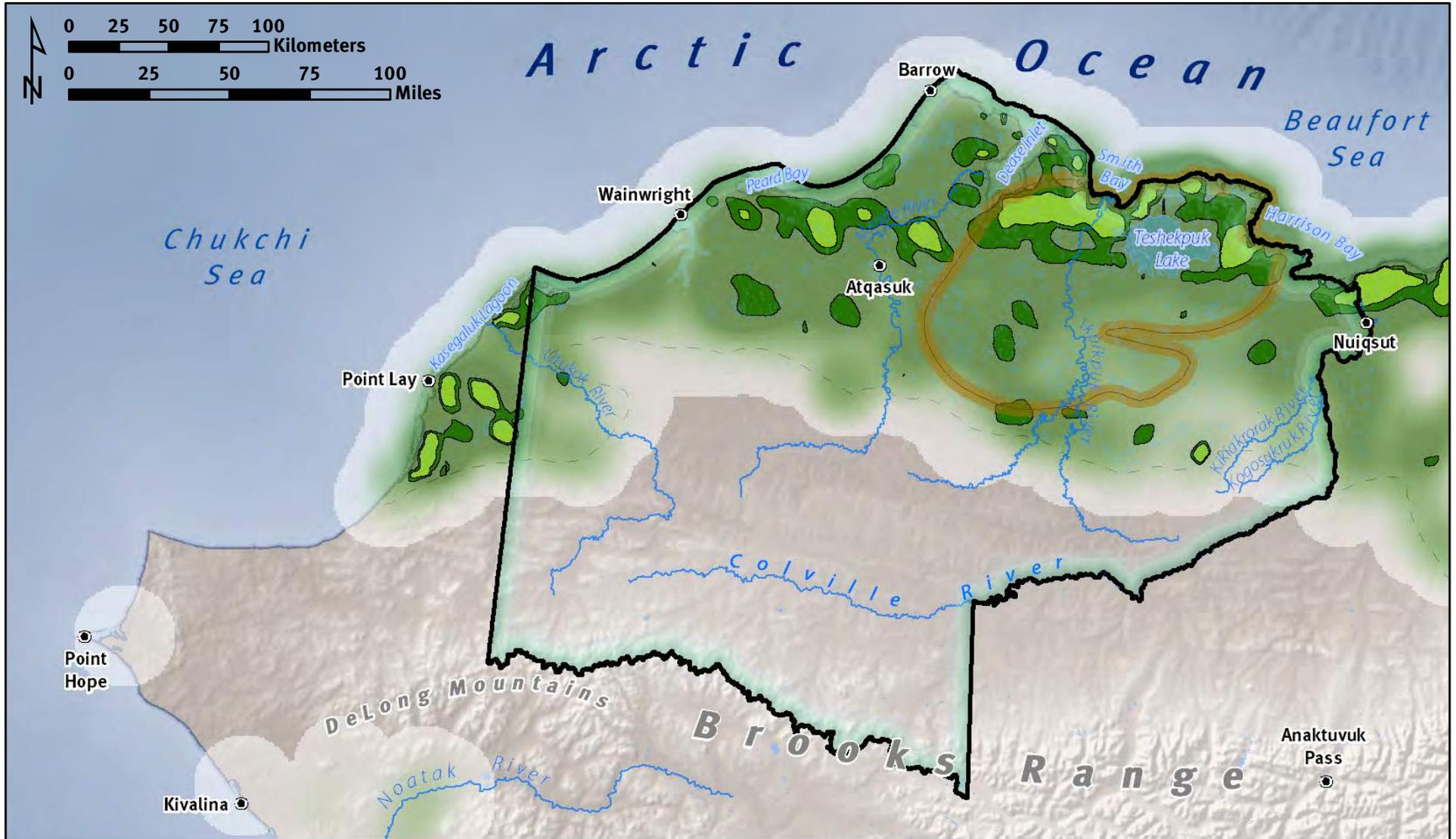
● TOWNS
 [Green Outline] NPRA BOUNDARY
 [Blue Wavy Line] MAJOR RIVERS

ESTIMATED SUMMER DENSITY¹
 [Green Gradient] 1,032 BIRDS PER 100 KM²
 [Green Gradient] 1

[Orange Outline] COMMON EIDER IBAS²
 GLOBALLY SIGNIFICANT ABUNDANCE
 [Green Diamond] MAJOR COMMON EIDER COLONY AREAS³
 SITES WITH >200 INDIVIDUALS

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2003.

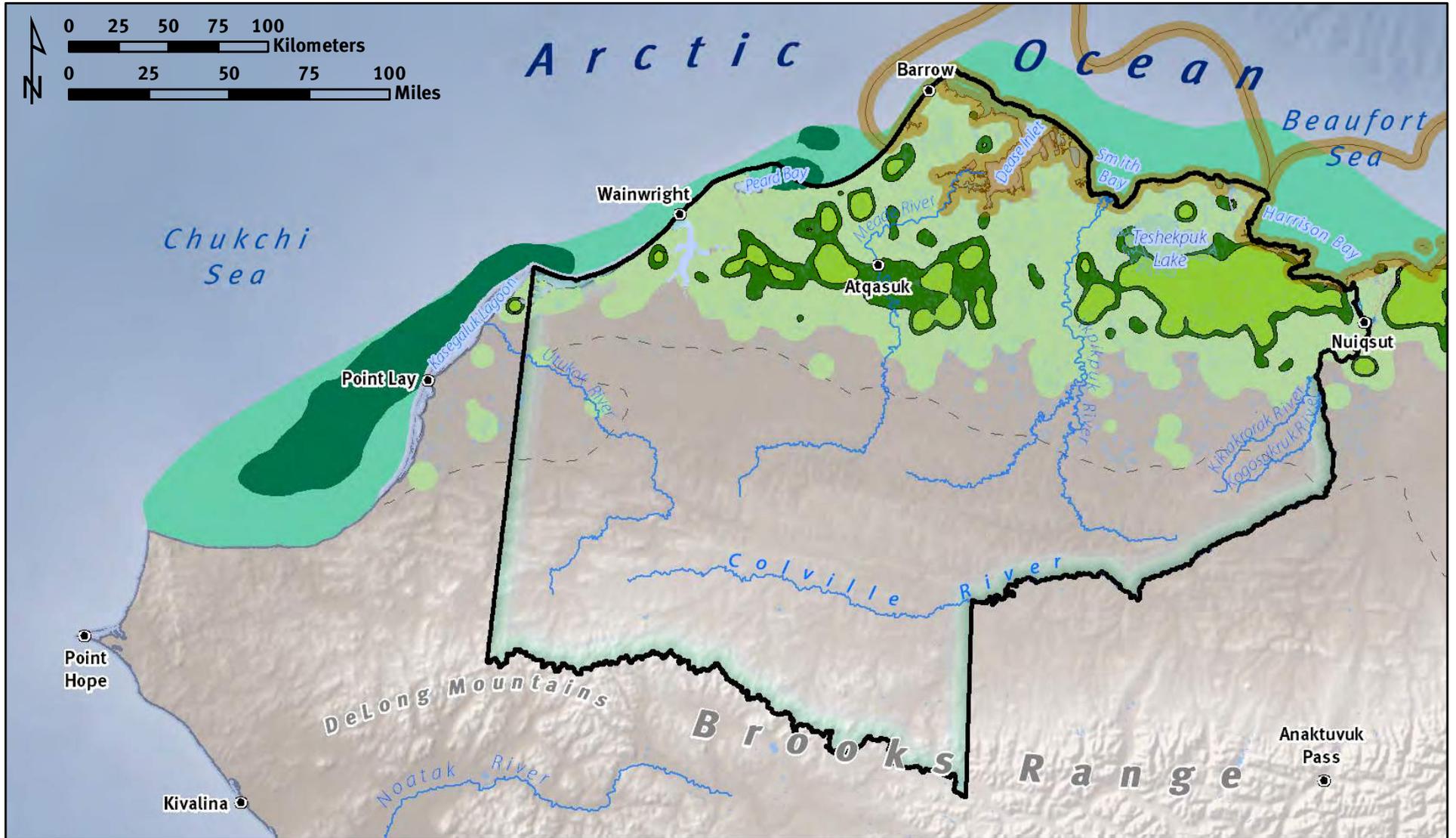
GREATER WHITE-FRONTED GOOSE



● TOWNS	ESTIMATED SUMMER DENSITY ¹	GREATER WHITE-FRONTED GOOSE IBAS ²	HIGHEST BREEDING DENSITY ³
▭ NPRA BOUNDARY	1,939 BIRDS PER 100 KM ²	○ GLOBALLY SIGNIFICANT ABUNDANCE	▭ COASTAL PLAIN BREEDING SURVEY BOUNDARY ³
~ MAJOR RIVERS	1		

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

K I N G E I D E R

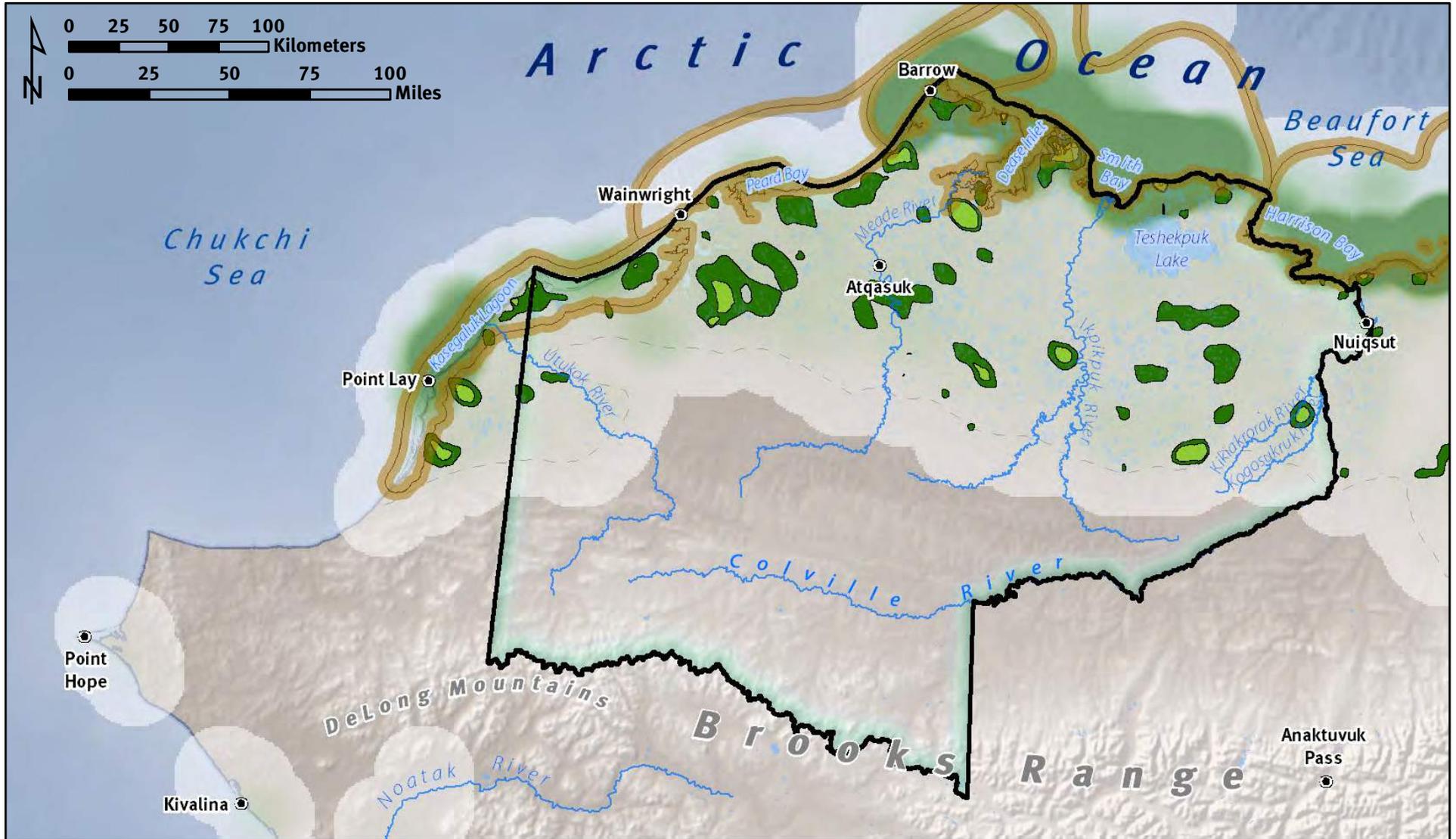


● TOWNS	OFFSHORE STAGING AREAS ^{1,2}	KING EIDER IBAS ³	BREEDING AREAS ⁴
■ NPRA BOUNDARY	■ HIGH CONCENTRATION	○ GLOBALLY SIGNIFICANT ABUNDANCE	■ 25/50% CORE AREAS
~ MAJOR RIVERS	■ REGULAR USE		■ 99% HOME RANGE
			○ COASTAL PLAIN BREEDING SURVEY BOUNDARY ⁵



Sources: 1) Oppel 2008; 2) Oppel et al. 2009; 3) Audubon Alaska 2014; 4) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 5) USFWS 2010.

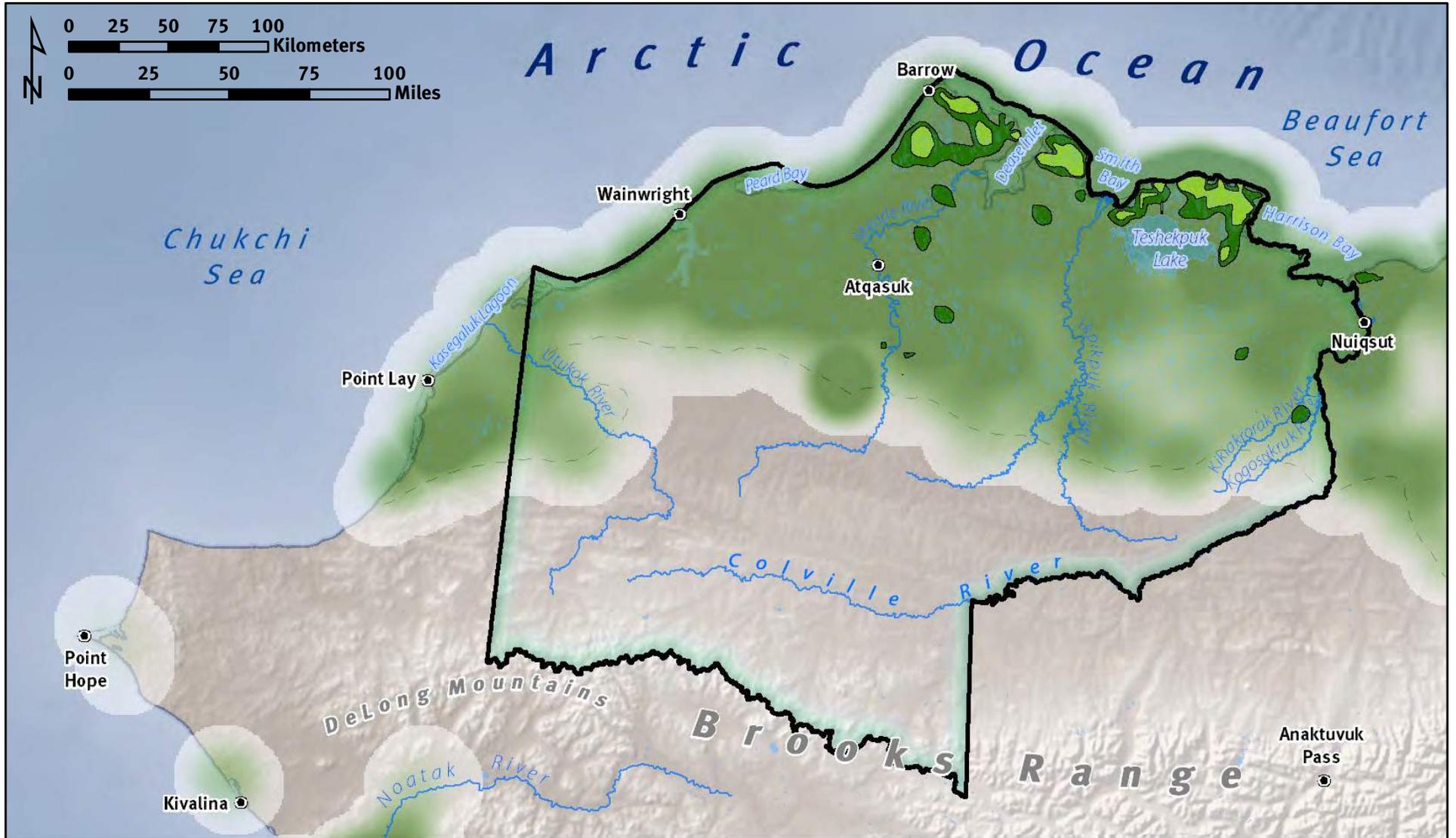
L O N G - T A I L E D D U C K



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<p>ESTIMATED SUMMER DENSITY¹</p> <p>14,716 BIRDS PER 100 KM² 1</p>	<p>LONG-TAILED DUCK IBAS²</p> <p>GLOBALY SIGNIFICANT ABUNDANCE</p>	<ul style="list-style-type: none"> ▭ HIGHEST BREEDING DENSITY³ ▭ COASTAL PLAIN BREEDING SURVEY BOUNDARY³ 	
--	---	--	--	--

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

N O R T H E R N P I N T A I L



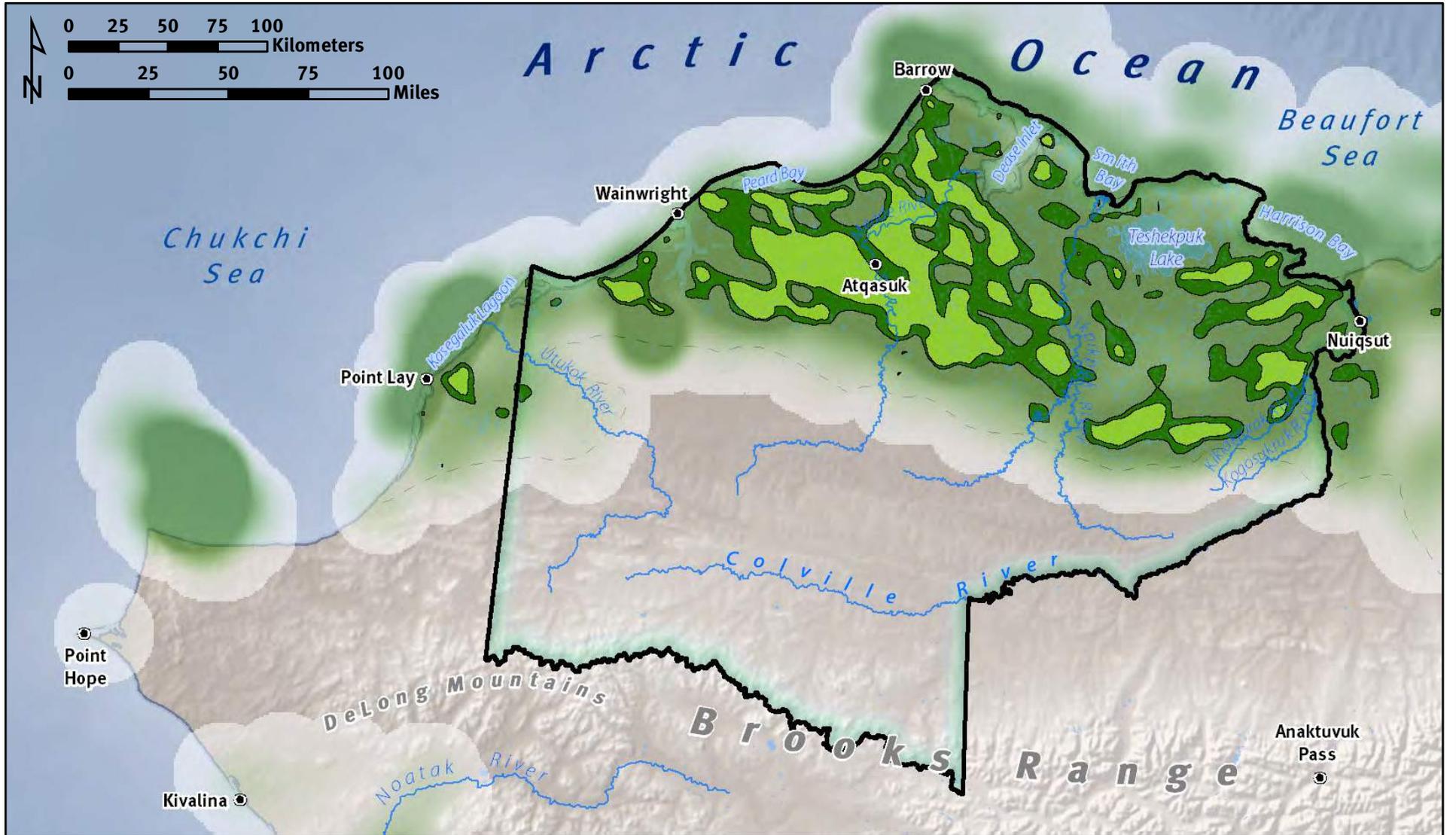
● TOWNS
 ■ NPRA BOUNDARY
 ~ MAJOR RIVERS

ESTIMATED SUMMER DENSITY¹
 343
 BIRDS PER 100 KM²
 1

■ HIGHEST BREEDING DENSITY²
 --- COASTAL PLAIN BREEDING SURVEY BOUNDARY²

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) USFWS 2010.

P A C I F I C L O O N



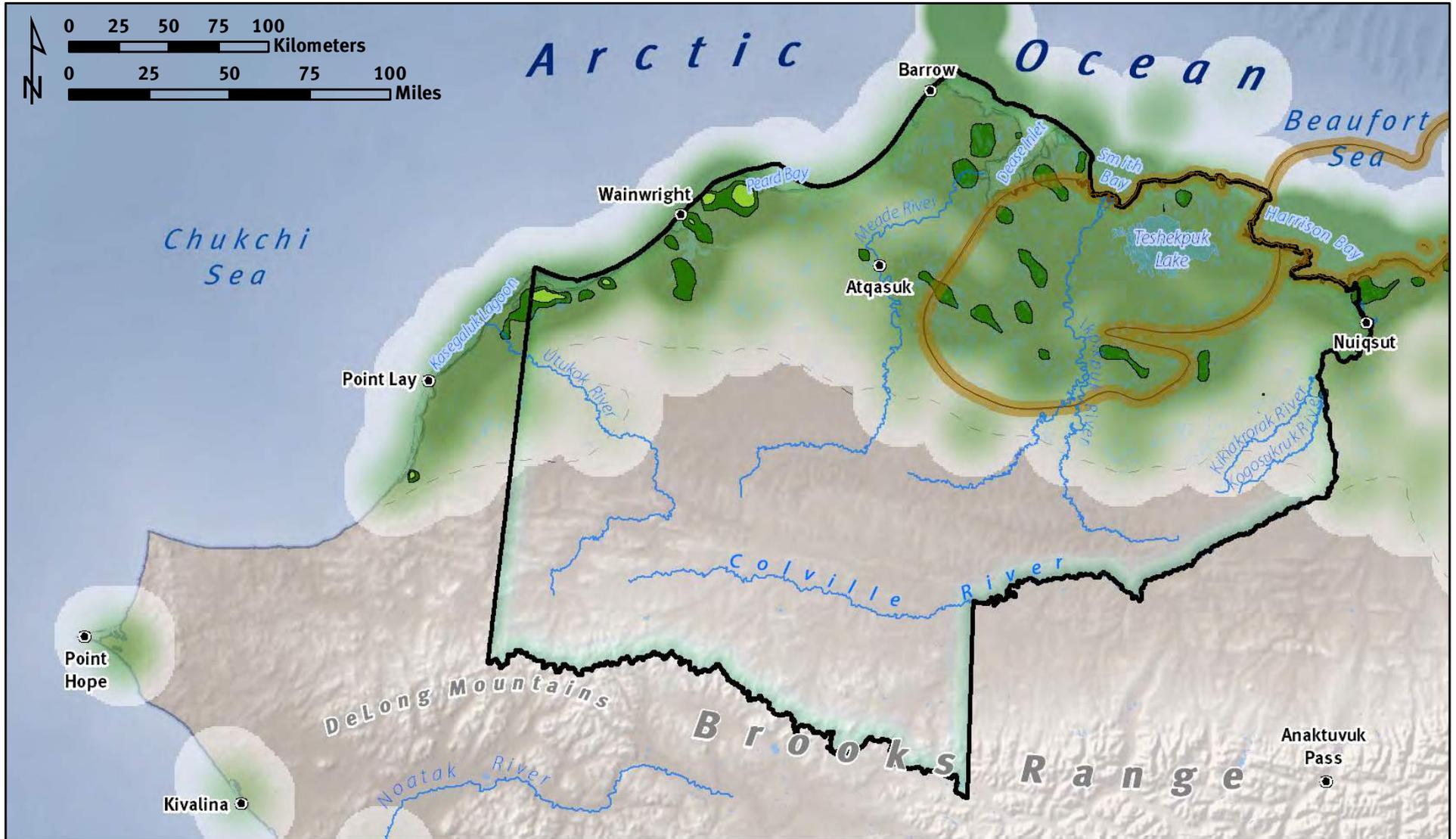
● TOWNS
 ■ NPRA BOUNDARY
 ~ MAJOR RIVERS

ESTIMATED SUMMER DENSITY¹
 441
 BIRDS PER 100 KM²
 1

■ HIGHEST BREEDING DENSITY²
 --- COASTAL PLAIN BREEDING SURVEY BOUNDARY²

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) USFWS 2010.

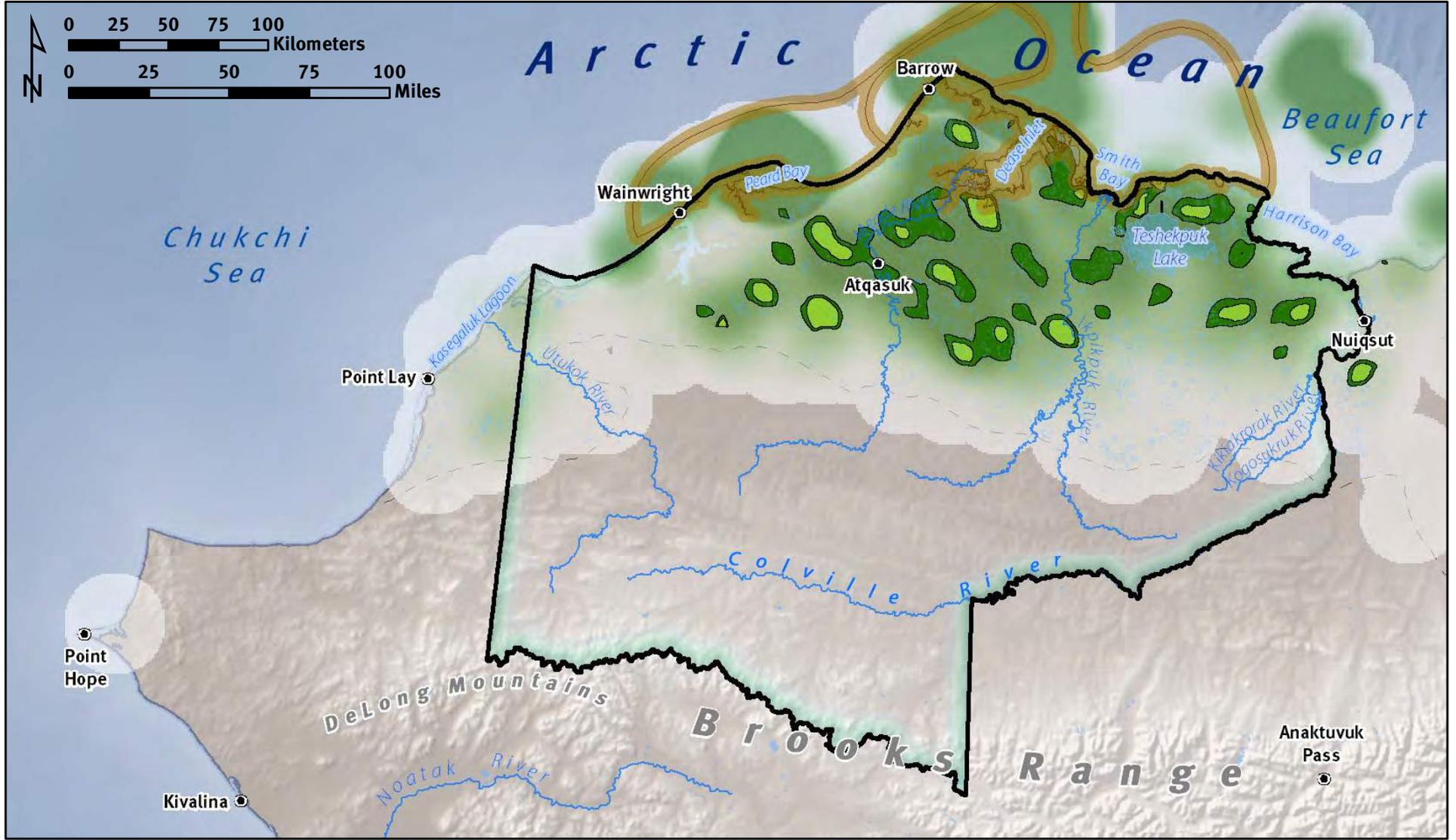
R E D - T H R O A T E D L O O N



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<p>ESTIMATED SUMMER DENSITY¹</p> <p>68 BIRDS PER 100 KM² 1</p>	<p>RED-THROATED LOON IBAS² GLOBALLY SIGNIFICANT ABUNDANCE</p>	<ul style="list-style-type: none"> ■ HIGHEST BREEDING DENSITY³ - - - COASTAL PLAIN BREEDING SURVEY BOUNDARY³ 	
--	---	---	--	--

Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

S A B I N E ' S G U L L

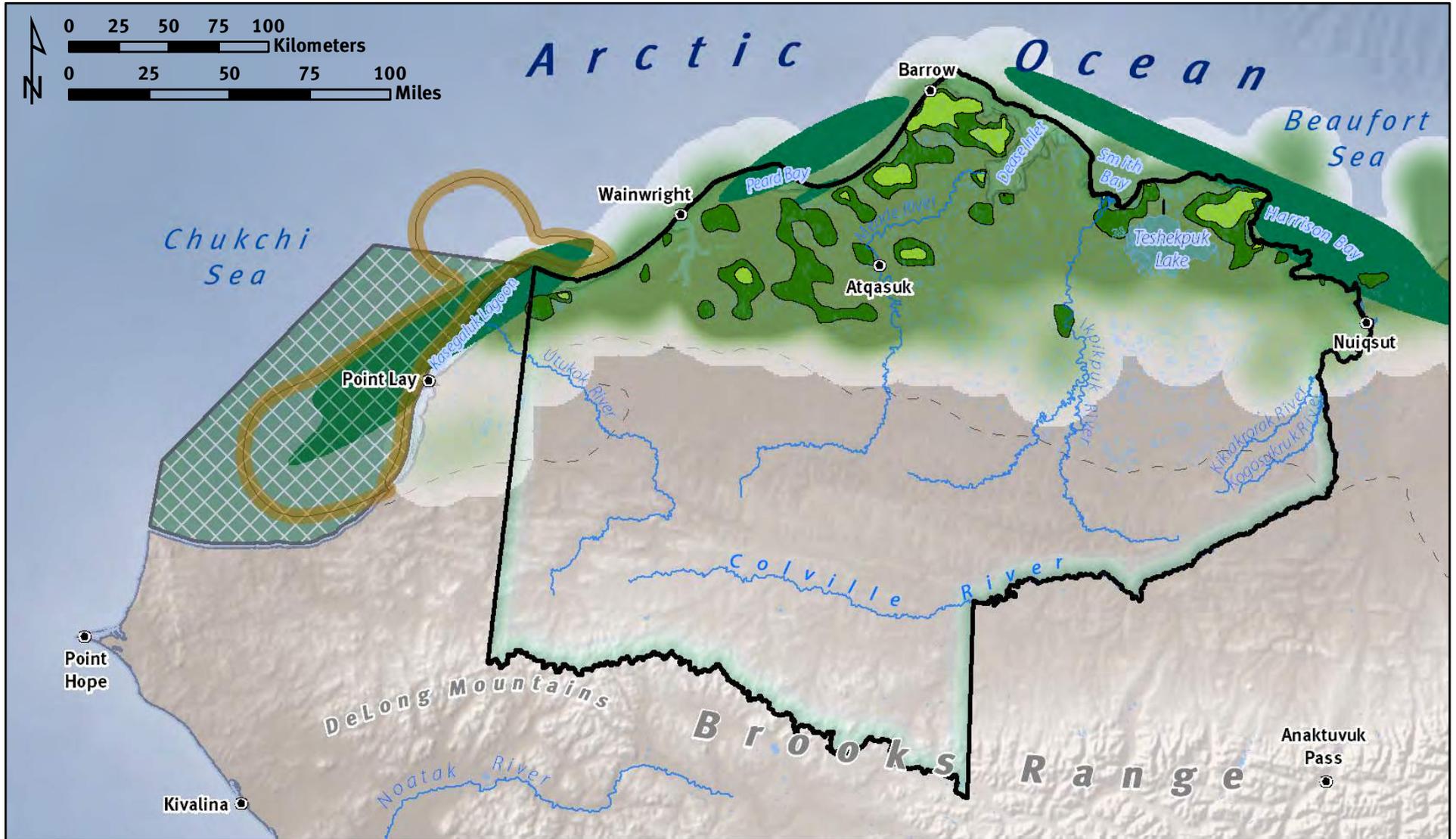


● TOWNS	ESTIMATED SUMMER DENSITY ¹	SABINE'S GULL IBAS ²	HIGHEST BREEDING DENSITY ³
▭ NPRA BOUNDARY	1,401	GLOBALLY SIGNIFICANT ABUNDANCE	○ BREEDING SURVEY BOUNDARY ³
~ MAJOR RIVERS	BIRDS PER 100 KM ²		
	1		



Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

S P E C T A C L E D E I D E R

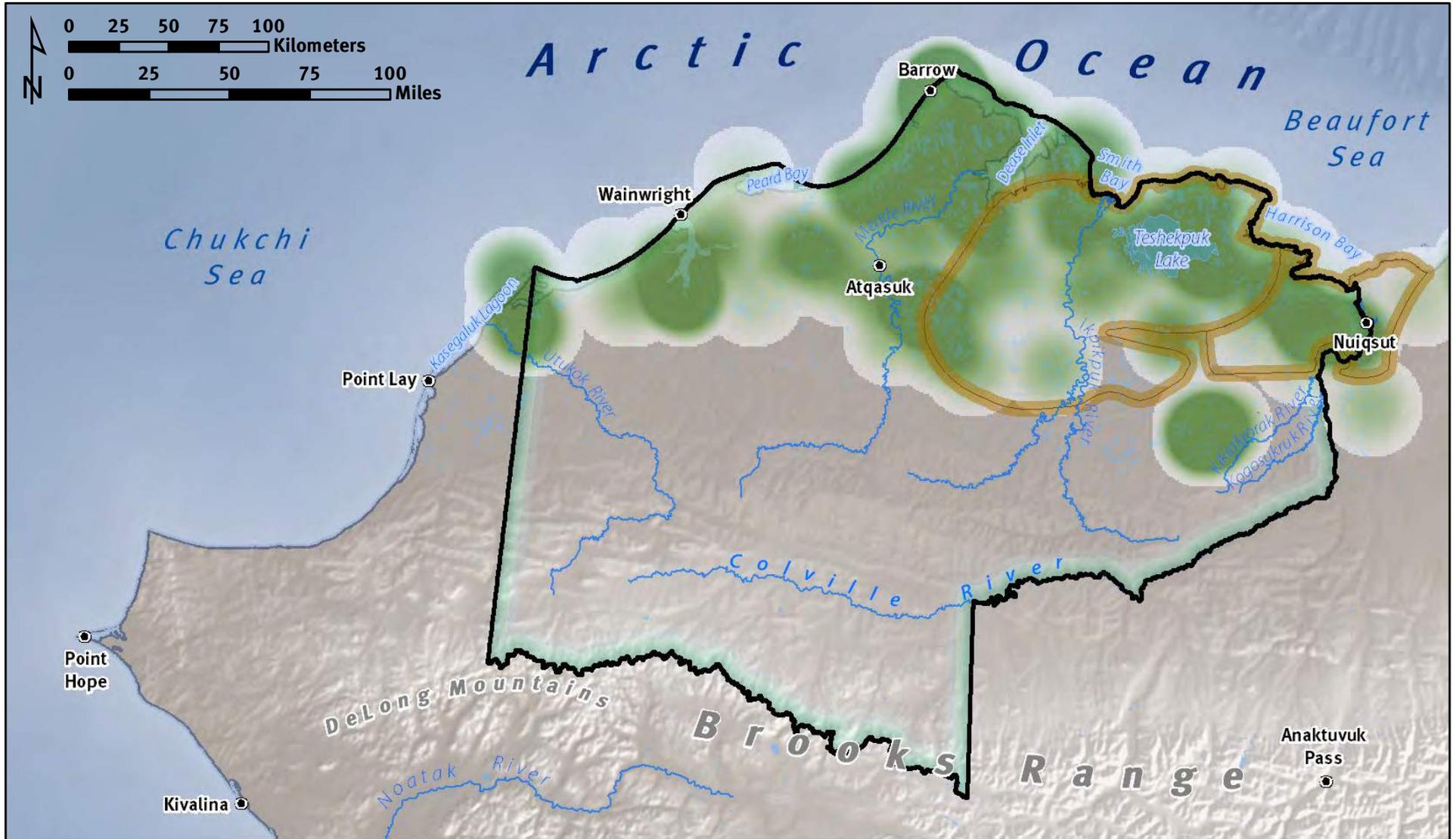


● TOWNS	ESTIMATED SUMMER DENSITY ¹	SPECTACLED EIDER IBAS ² GLOBALLY SIGNIFICANT ABUNDANCE	HIGHEST BREEDING DENSITY ⁵ BREEDING SURVEY BOUNDARY ⁵
NPRA BOUNDARY	29 BIRDS PER 100 KM ² 1	USFWS CRITICAL HABITAT ³	
MAJOR RIVERS		OFFSHORE CORE USE AREA ⁴	

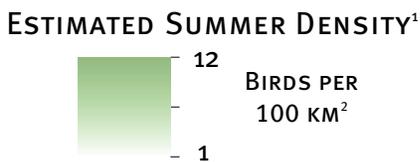
Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2001; 4) Sexson et al. 2012; 5) USFWS 2010.

1:2,850,000

S T E L L E R ' S E I D E R

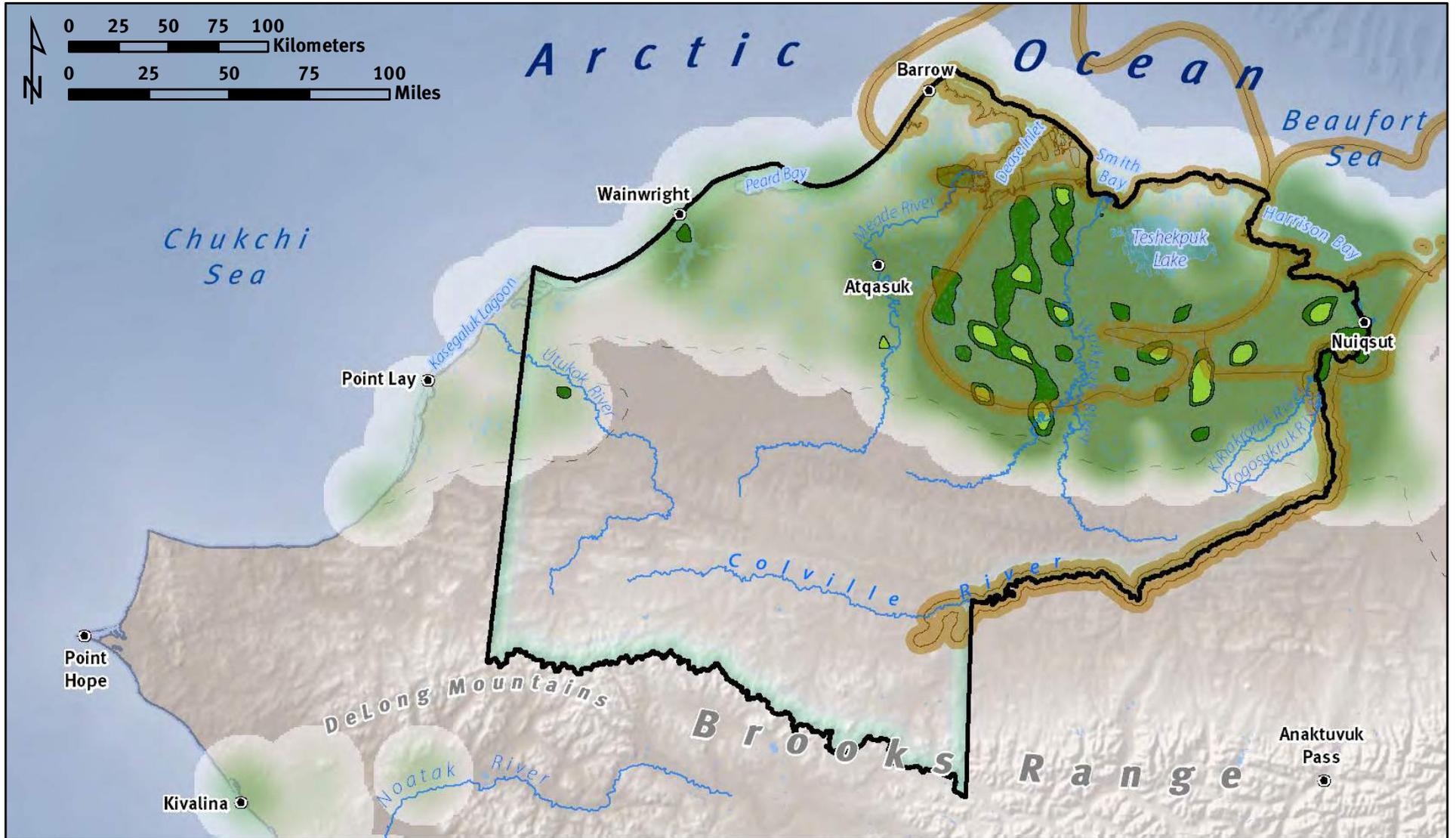


- TOWNS
- █ NPRA BOUNDARY
- ~ MAJOR RIVERS



Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014.

YELLOW-BILLED LOON

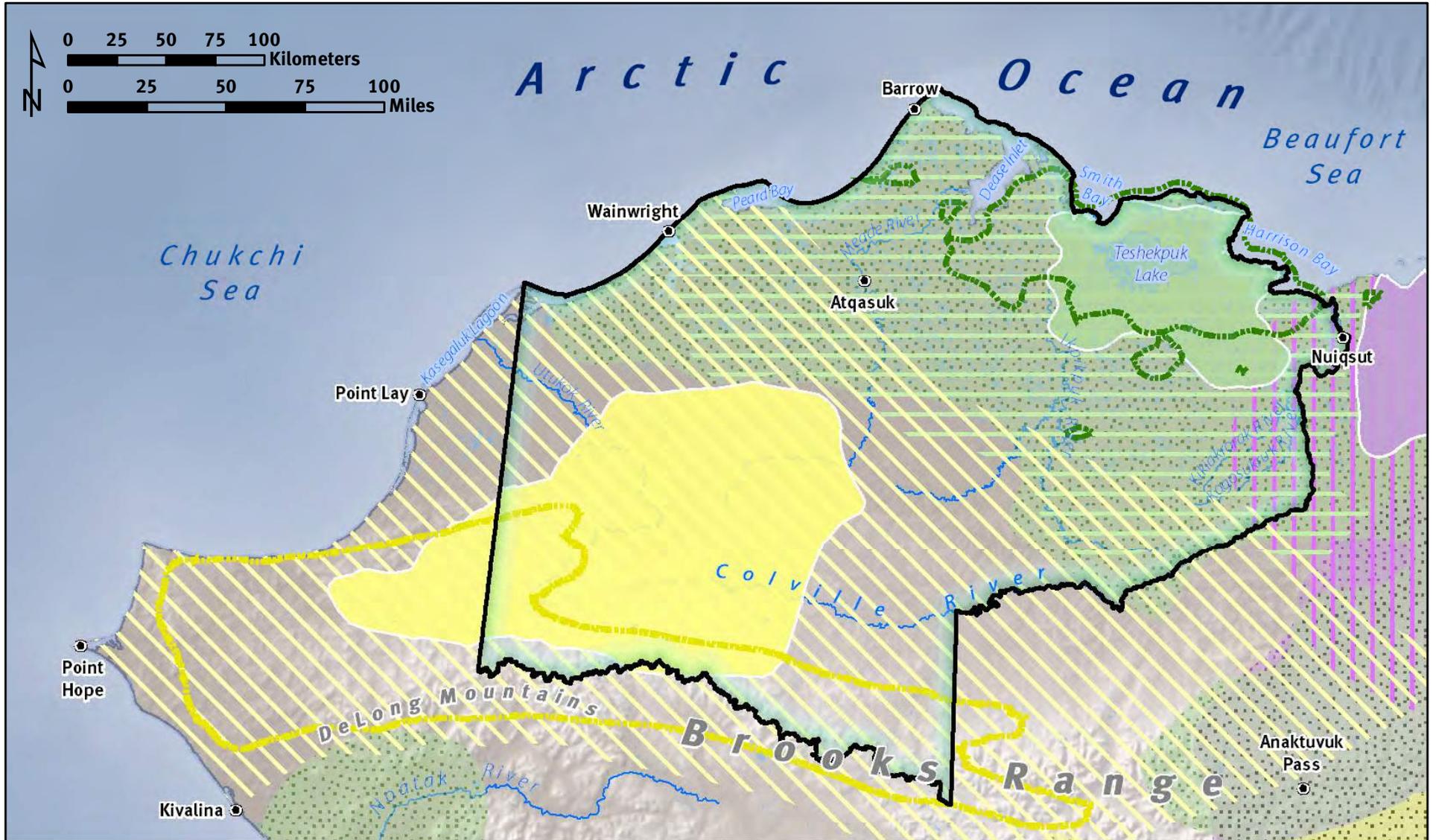


● TOWNS	ESTIMATED SUMMER DENSITY ¹	YELLOW-BILLED LOON IBAS ²	HIGHEST BREEDING DENSITY ³
▭ NPRA BOUNDARY	26 BIRDS PER 100 KM ²	GLOBALY SIGNIFICANT ABUNDANCE	BREEDING SURVEY BOUNDARY ³
~ MAJOR RIVERS	1		



Sources: 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013; 2) Audubon Alaska 2014; 3) USFWS 2010.

SEASONAL CARIBOU DISTRIBUTION

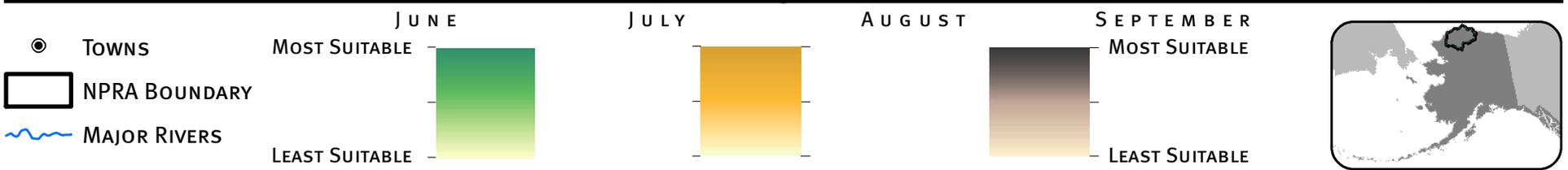
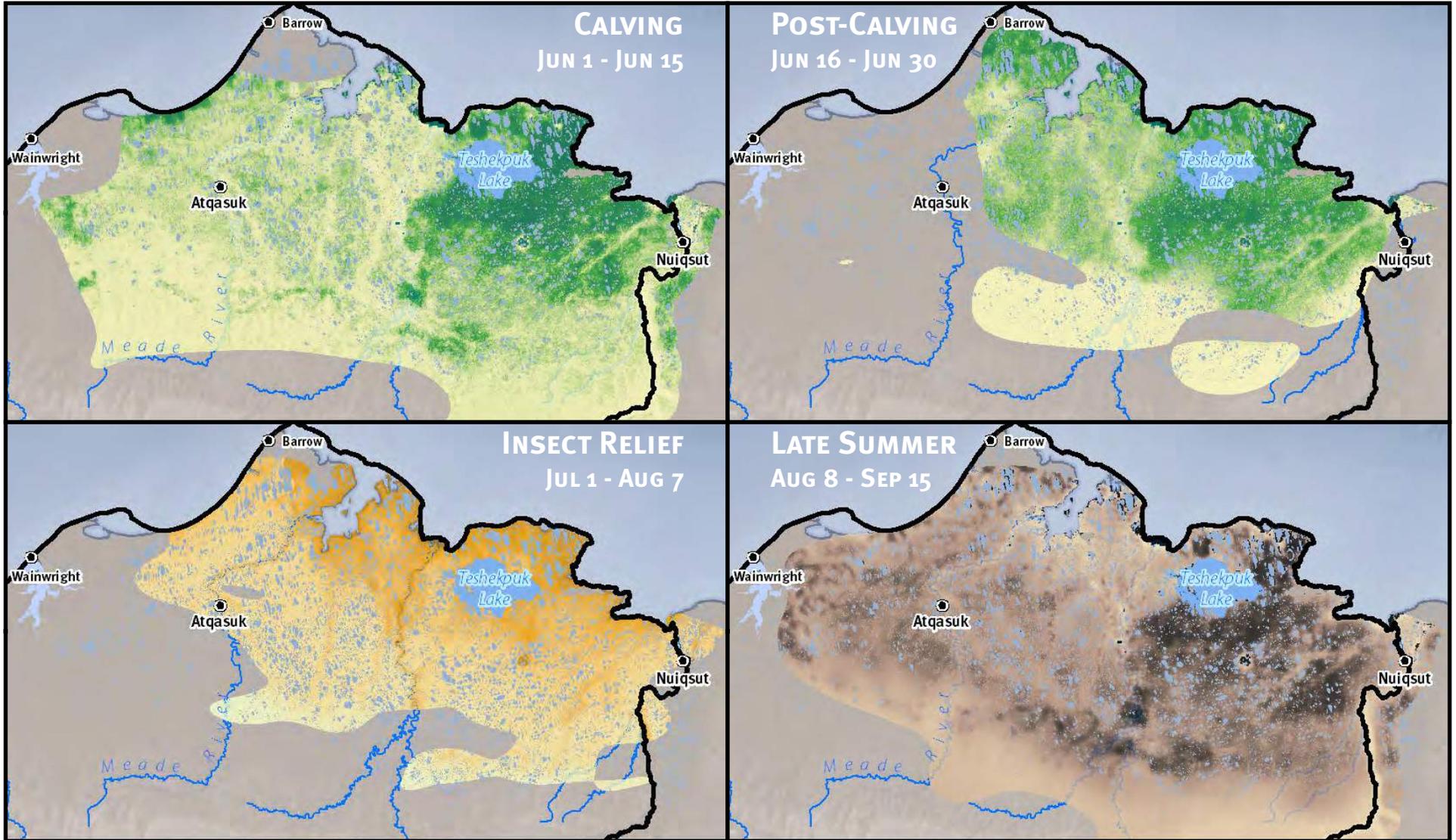


● TOWNS		CALVING RANGE ¹	INSECT RELIEF ²	SUMMER RANGE ¹	WINTER RANGE ¹
▭ NPRA BOUNDARY	CENTRAL ARCTIC HERD	▭	▭	▭	▭
~ MAJOR RIVERS	TESHEPUK HERD	▭	▭	▭	▭
	WESTERN ARCTIC HERD	▭	▭	▭	▭



Sources: 1) Gotthardt et al. 2014; 2) Audubon Alaska 2014.

HABITAT SUITABILITY BY SEASON TESHEKPUK CARIBOU HERD



Source: Wilson et al. 2012.

1:3,000,000

CETACEAN BIOLOGICALLY IMPORTANT AREAS



● TOWNS
 ■ NPRA BOUNDARY
 ~ MAJOR RIVERS

BIOLOGICALLY IMPORTANT AREAS
 ■ FEEDING
 BELUGA, BOWHEAD, AND GRAY WHALES
 ▨ REPRODUCTION
 BELUGA, BOWHEAD, AND GRAY WHALES
 ▩ MIGRATION
 BELUGA AND BOWHEAD WHALES



CETACEAN DISTRIBUTION



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

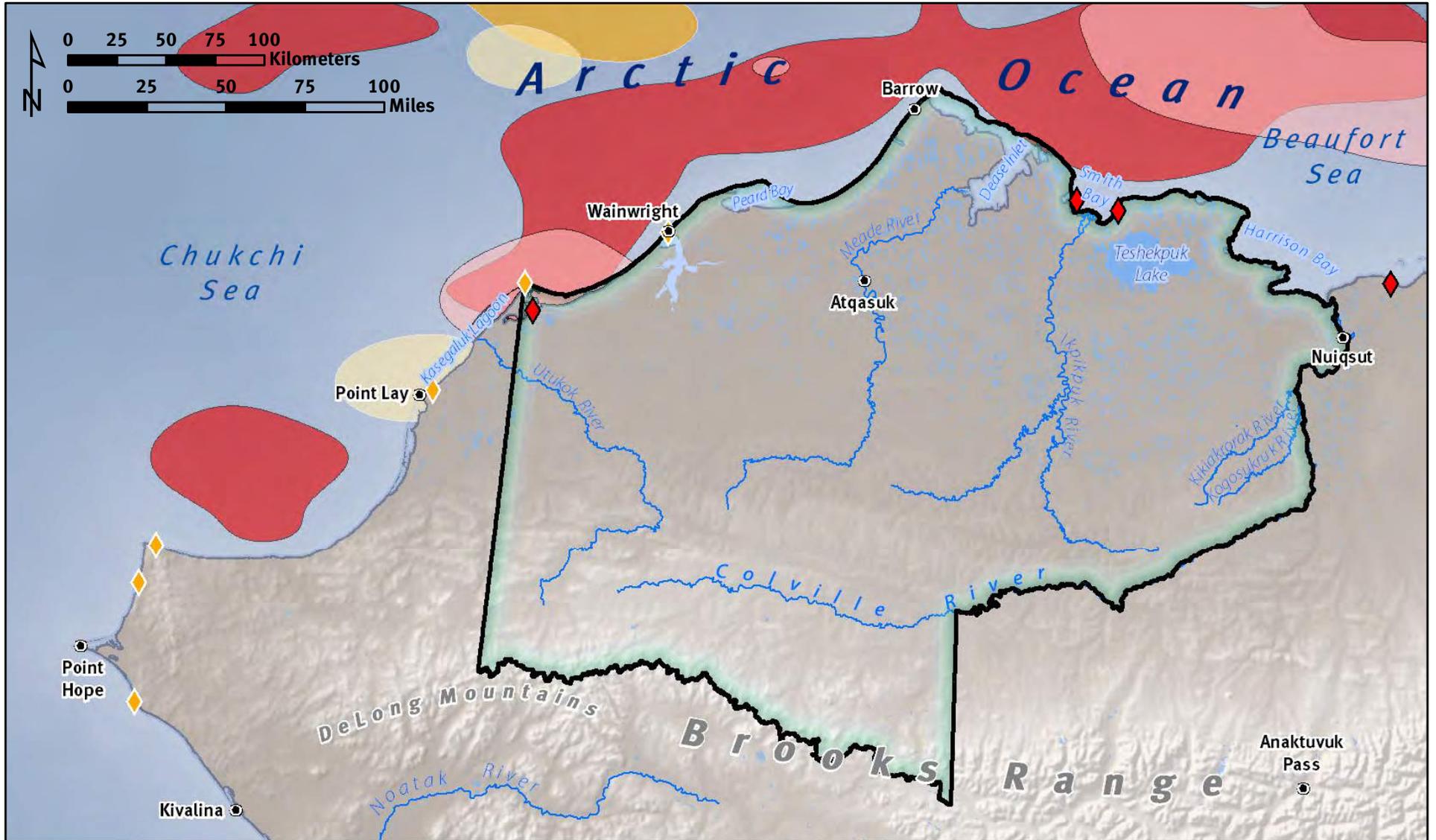
CORE AREAS	
SUMMER	FALL
 BELUGA WHALE	
 BOWHEAD WHALES	
 GRAY WHALES	

Core Area defined as 50% isopleth of observations.
 Summer defined as July and August, fall defined as September and October.



Source: Audubon Alaska and Oceana 2016, based on NOAA 2015.

PINNIPED DISTRIBUTION

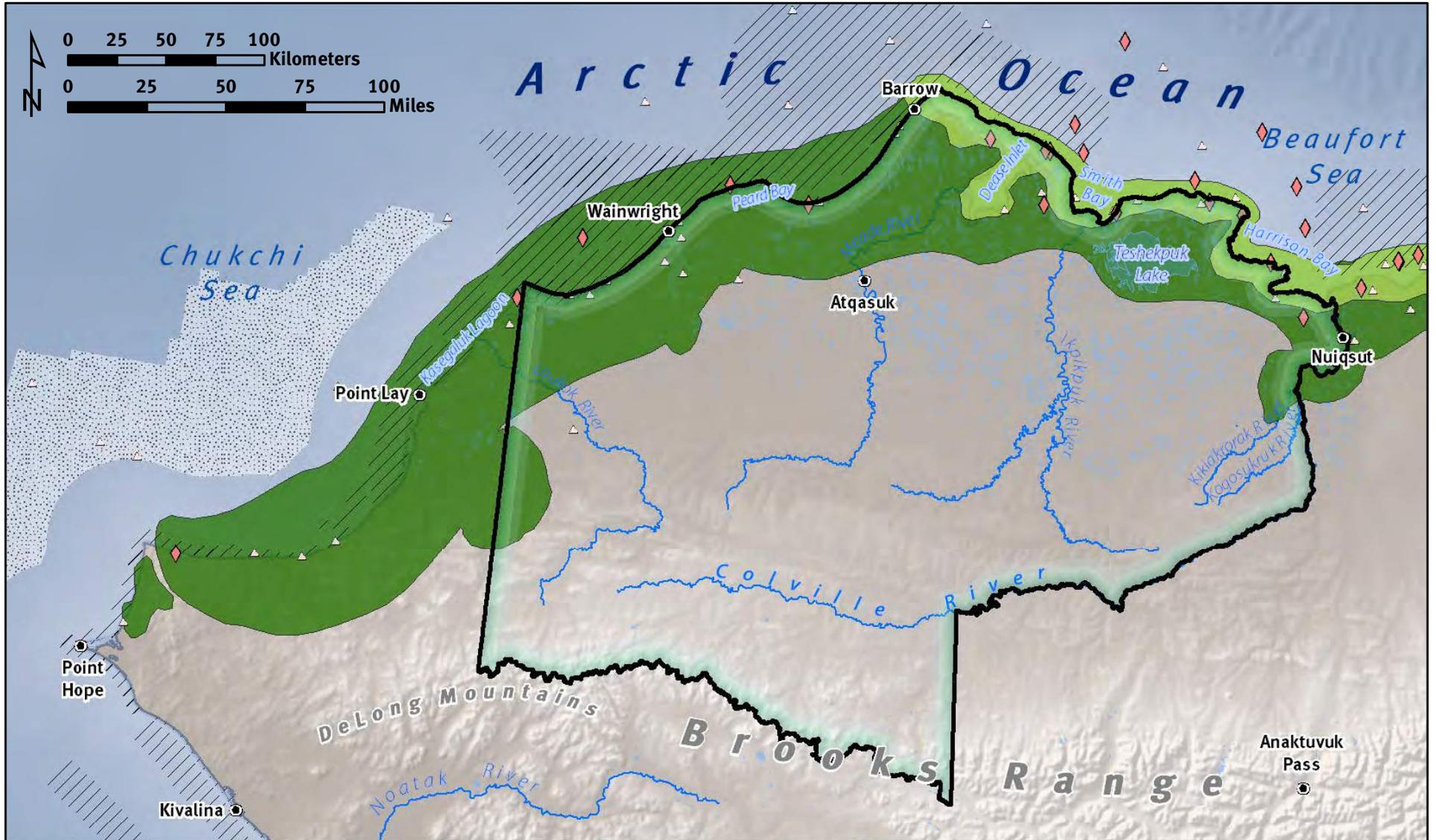


● TOWNS	CORE AREAS¹	◆ MAJOR WALRUS HAULOUTS ^{2,3}	Core Area defined as 50% isopleth of observations. Summer defined as July and August, fall defined as September and October.			
▭ NPRA BOUNDARY	SUMMER	◆ SPOTTED SEAL HAULOUTS ^{4,5,6,7}				
~ MAJOR RIVERS	<table border="0"> <tr> <td>■ WALRUS</td> <td>■ FALL</td> </tr> <tr> <td>■ OTHER PINNIPEDS</td> <td>■</td> </tr> </table>	■ WALRUS		■ FALL	■ OTHER PINNIPEDS	■
■ WALRUS	■ FALL					
■ OTHER PINNIPEDS	■					



Sources: 1) Audubon Alaska and Oceana 2016, based on NOAA 2015; 2) Robards et al. 2007; 3) NOAA 2014; 4) ADF&G 1997; 5) Huntington et al. 1999; 6) Lowry et al. 1998; 7) Rugh et al. 1997.

POLAR BEAR DENNING AND FEEDING AREAS



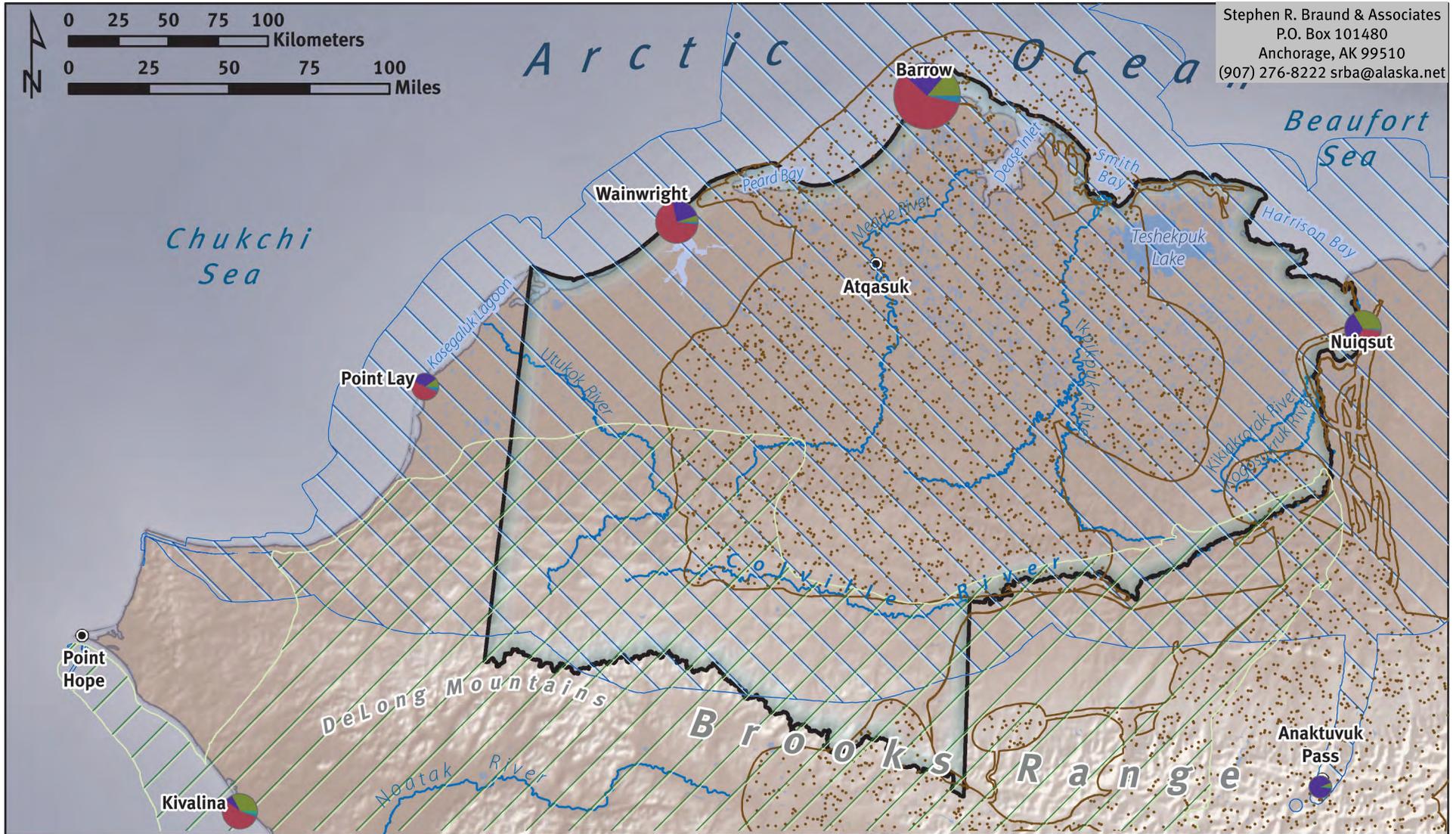
● TOWNS	POLAR BEAR DENNING^{1,2}	MATERNAL DEN LOCATIONS³	▨ HIGH USE AREA ⁴
▭ NPRA BOUNDARY	■ MAJOR DENNING AREA	▲ 1910 - 1999	▨ FEEDING AREAS ⁵
~ MAJOR RIVERS	■ DENNING AREA	◆ 2000 - 2010	



Sources: 1) NOAA 1988; 2) USFWS 1995; 3) Durner et al. 2010; 4) USFWS 2010; 5) Kalxdorff 1997.

S U B S I S T E N C E U S E

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 Anchorage, AK 99510
 (907) 276-8222 srba@alaska.net



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<p>SUBSISTENCE HARVEST (MOST RECENT YEAR)¹</p> <ul style="list-style-type: none"> ■ FISH ■ LAND MAMMALS ■ OTHER (VEGETATION/INVERTEBRATES) ■ MARINE MAMMALS ■ BIRDS AND EGGS <p>Size of chart indicates cumulative amount harvested</p>	<p>SUBSISTENCE USE AREAS WITHIN THE NPRA²</p> <ul style="list-style-type: none"> NORTH SLOPE COASTAL COMMUNITIES (BARROW, KAKTOVIK, NUIQSUT, POINT LAY, WAINWRIGHT) NORTHWEST ALASKA COMMUNITIES (AMBLER, KIANA, KOBUK, NOATAK, NOORVIK, SHUNGNAK) NORTH SLOPE INLAND COMMUNITIES (ATQASUK, ANAKTUVUK PASS) 	
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Sources: 1) ADF&G 2015; 2) See Table A. Map created by Stephen R. Braund & Associates and Audubon Alaska.

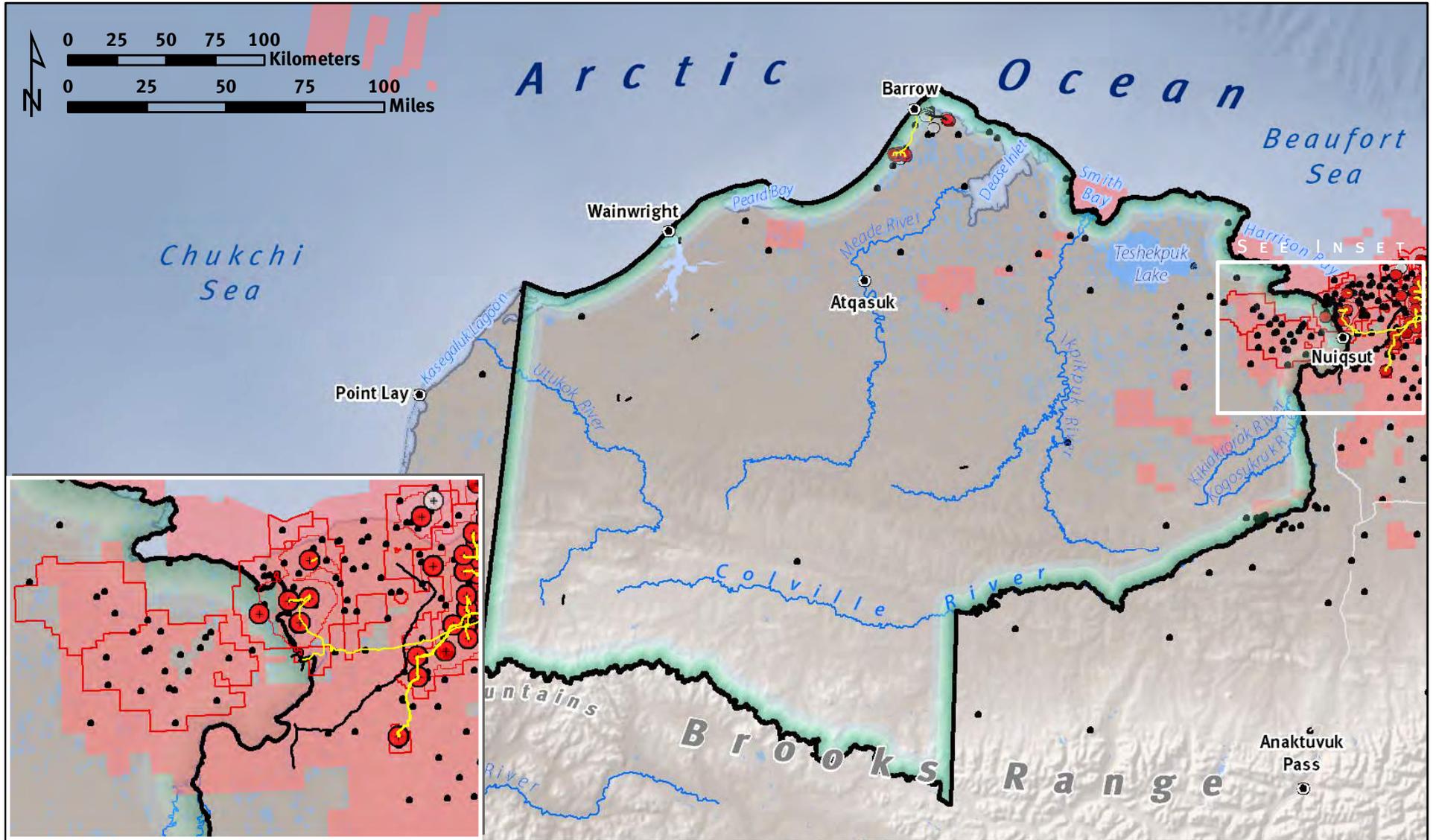
LAND OWNERSHIP



● TOWNS	LAND OWNERSHIP (SURFACE)		
▭ NPRA BOUNDARY	■ PRIVATE	■ NATIVE CONVEYED, INTERIM CONVEYED, PATENT, OR SELECTED	
~ MAJOR RIVERS	■ STATE	■ FEDERAL: BUREAU OF LAND MANAGEMENT	
		■ FEDERAL: FISH & WILDLIFE SERVICE OR NATIONAL PARK SERVICE	



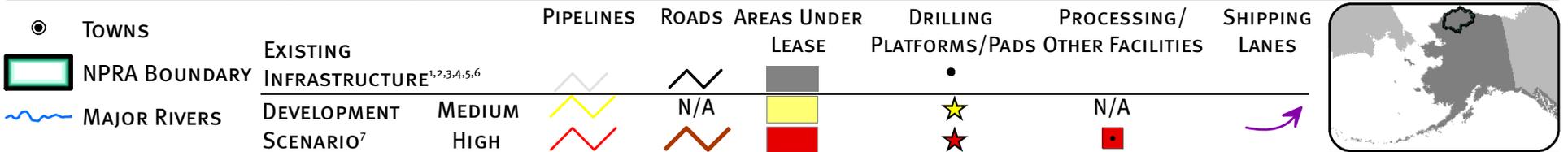
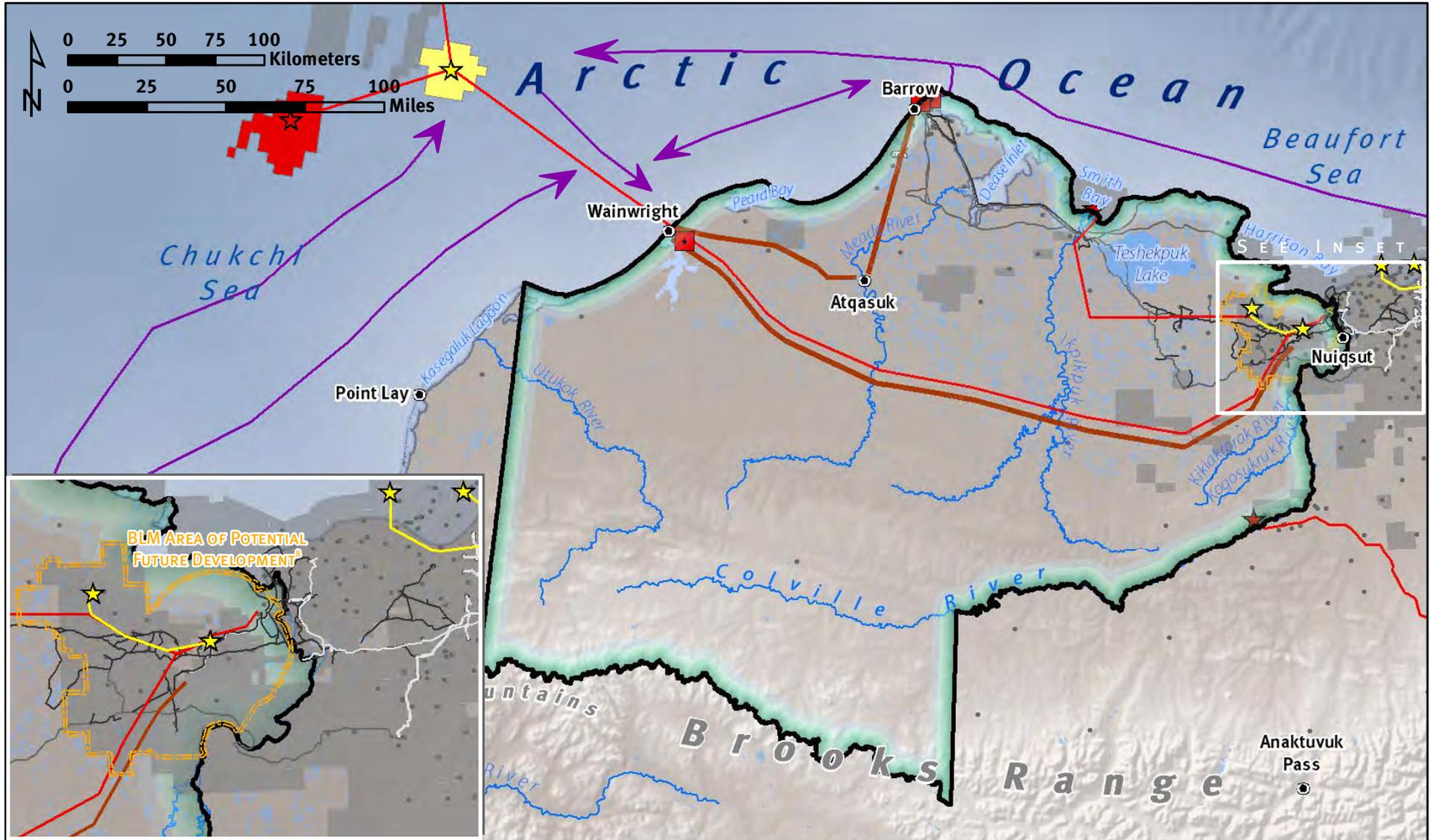
OIL AND GAS DEVELOPMENT



● TOWNS	EXISTING INFRASTRUCTURE ^{1,2}		● CURRENTLY PRODUCING WELLS ⁸	
▭ NPRA BOUNDARY	— ICE ROAD /	▭ CURRENTLY UNDER LEASE ^{3,4,5,6}	⊕ PREVIOUSLY PRODUCING WELLS ⁸	
~ MAJOR RIVERS	— ROLLIGON TRAIL	▭ PRODUCING UNIT BOUNDARIES ⁷	• EXPLORATION/OTHER WELLS ⁸	
	— PIPELINE			
	— ROAD			

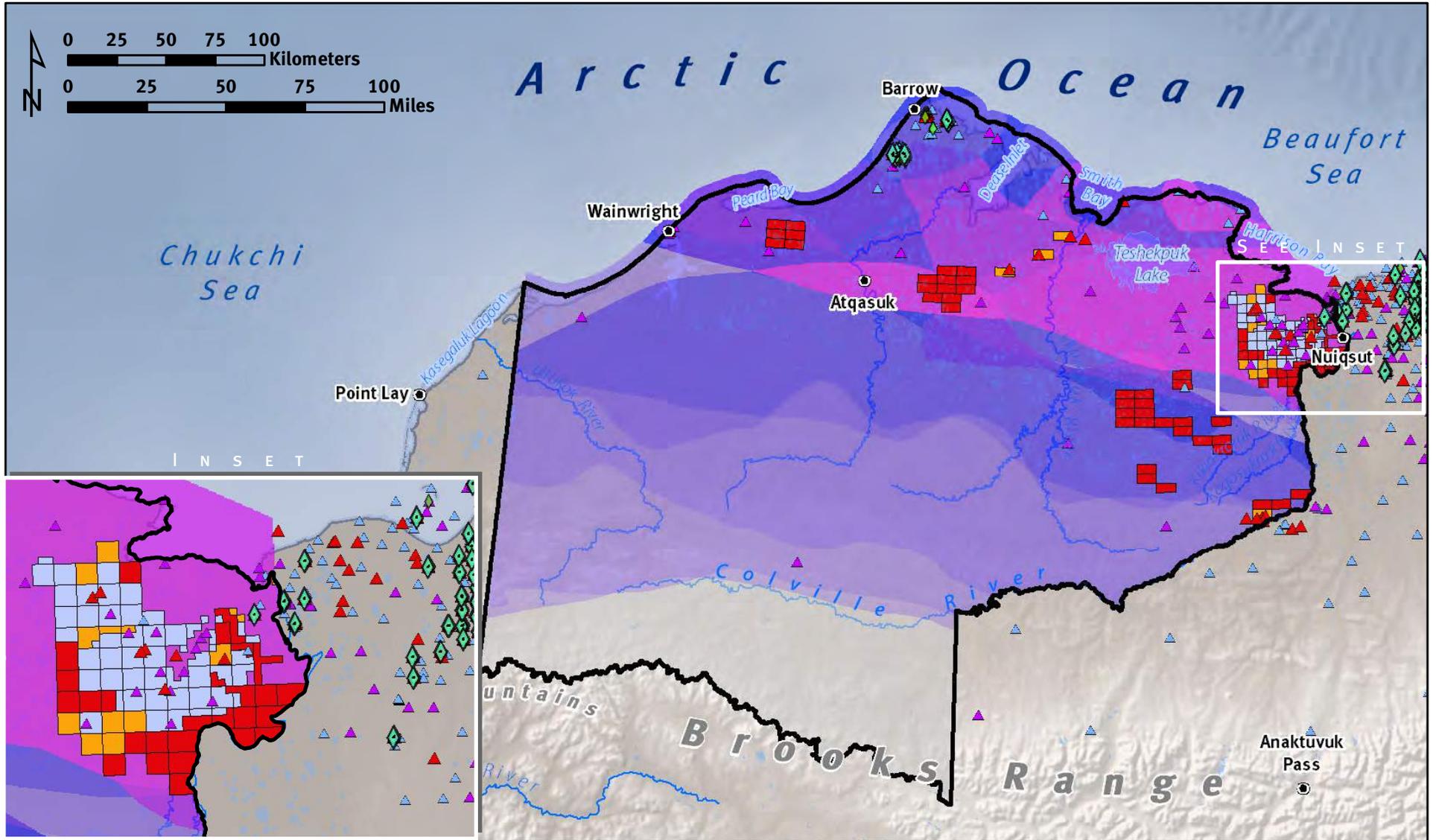
Sources: 1) Alaska Center for the Environment 2009; 2) AK DNR 2006; 3) BOEM 2016; 4) BLM 2016; 5) AK DNR 2016; 6) Oceana 2016; 7) BLM 2015; 8) AOGCC 2016. 1:2,850,000

OIL AND GAS DEVELOPMENT SCENARIOS



Sources: 1) Alaska Center for the Environment 2009; 2) BOEM 2016; 3) BLM 2016a; 4) AK DNR 2016; 5) Oceana 2016; 6) AOGCC 2016; 7) NSSI 2015; 8) BLM 2016b.

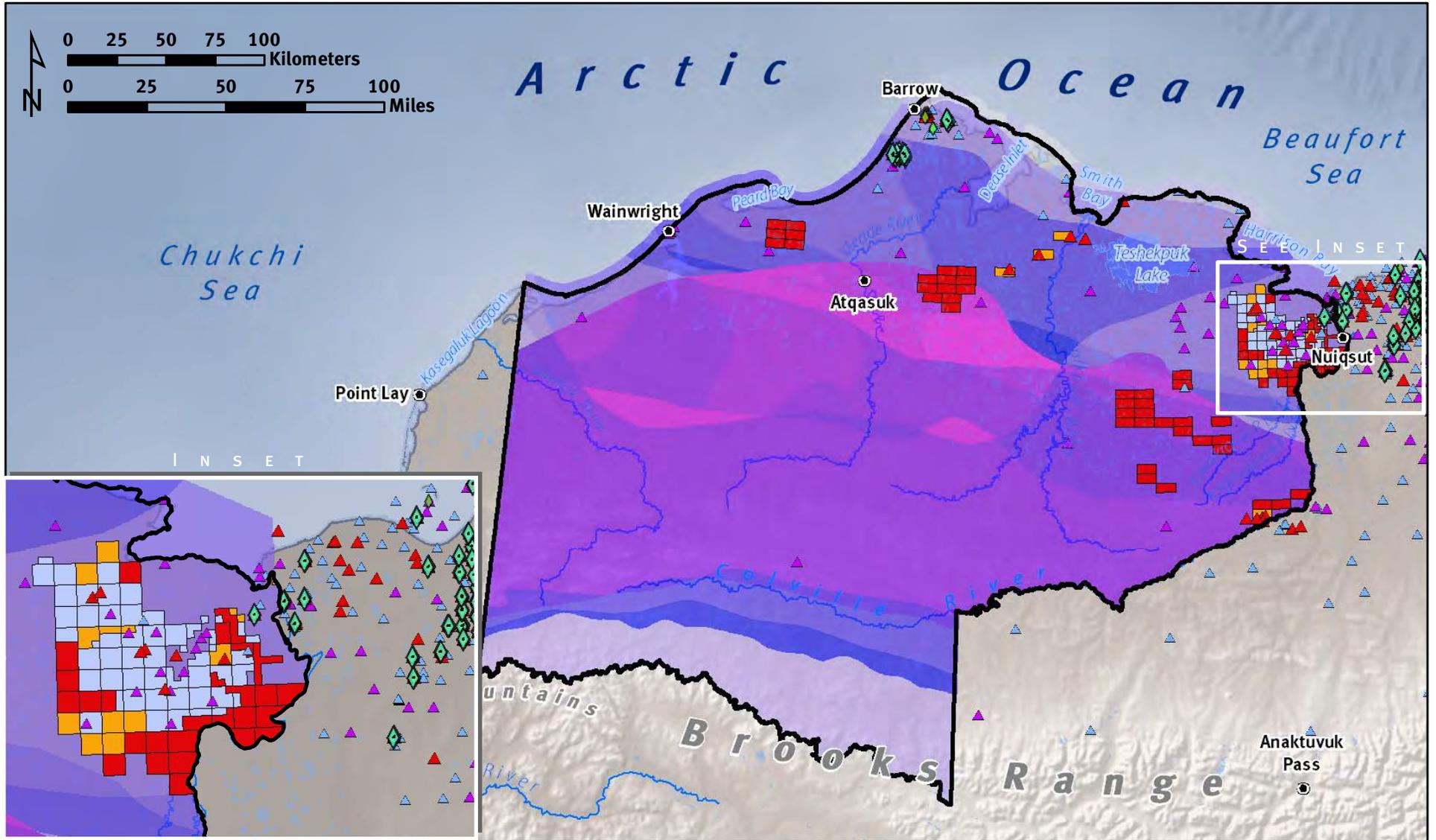
O I L R E S O U R C E S



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<ul style="list-style-type: none"> ◇ CURRENTLY PRODUCING WELLS¹ ◇ PAST PRODUCING WELLS¹ 	<p>DRILLED WELLS¹</p> <ul style="list-style-type: none"> ▲ PRE 2000 ▲ 2000 - 2009 ▲ 2010 - 2015 	<p>NPRA ACTIVE LEASES²</p> <ul style="list-style-type: none"> ■ PRE 2000 ■ 2000 - 2009 ■ 2010 - 2015 	<p>ESTIMATED NPRA OIL DENSITY³ (THOUSANDS OF BARRELS OF OIL PER MI²)</p> <p>■ HIGH: 42 ■ LOW: 1</p>	
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Sources: 1) AOGCC 2016; 2) BLM 2015; 3) Houseknecht et al. 2010.

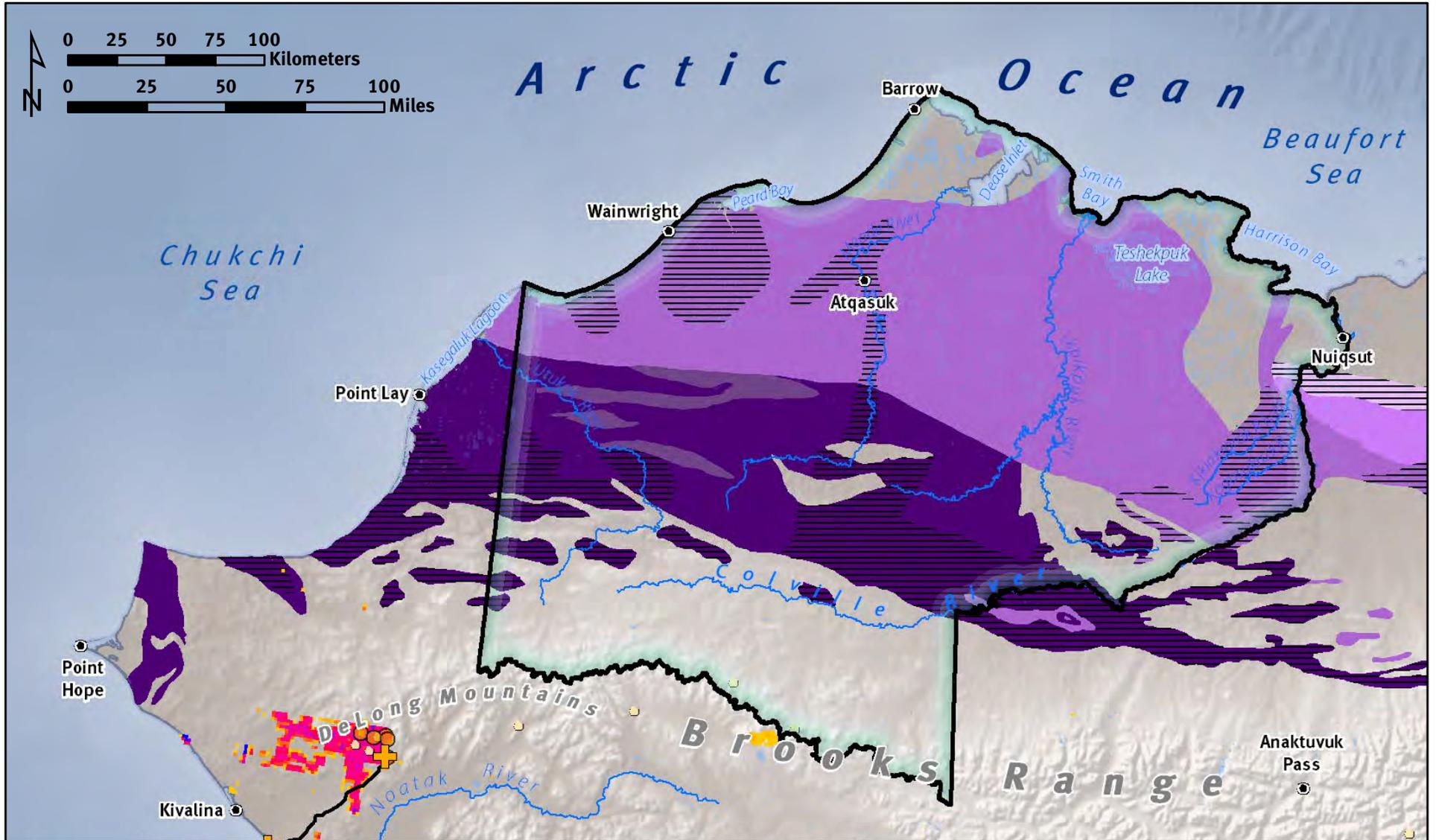
G A S R E S O U R C E S



<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<ul style="list-style-type: none"> ◆ CURRENTLY PRODUCING WELLS¹ ◆ PAST PRODUCING WELLS¹ 	<p>DRILLED WELLS¹</p> <ul style="list-style-type: none"> ▲ PRE 2000 ▲ 2000 - 2009 ▲ 2010 - 2015 	<p>NPRA ACTIVE LEASES²</p> <ul style="list-style-type: none"> ■ PRE 2000 ■ 2000 - 2009 ■ 2010 - 2015 	<p>ESTIMATED NPRA GAS DENSITY³ (MILLION CUBIC FEET OF GAS PER MI²)</p> <p>■ HIGH: 2,438 ■ LOW: 10</p>	
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Sources: 1) AOGCC 2016; 2) BLM 2015; 3) Houseknecht et al. 2010.

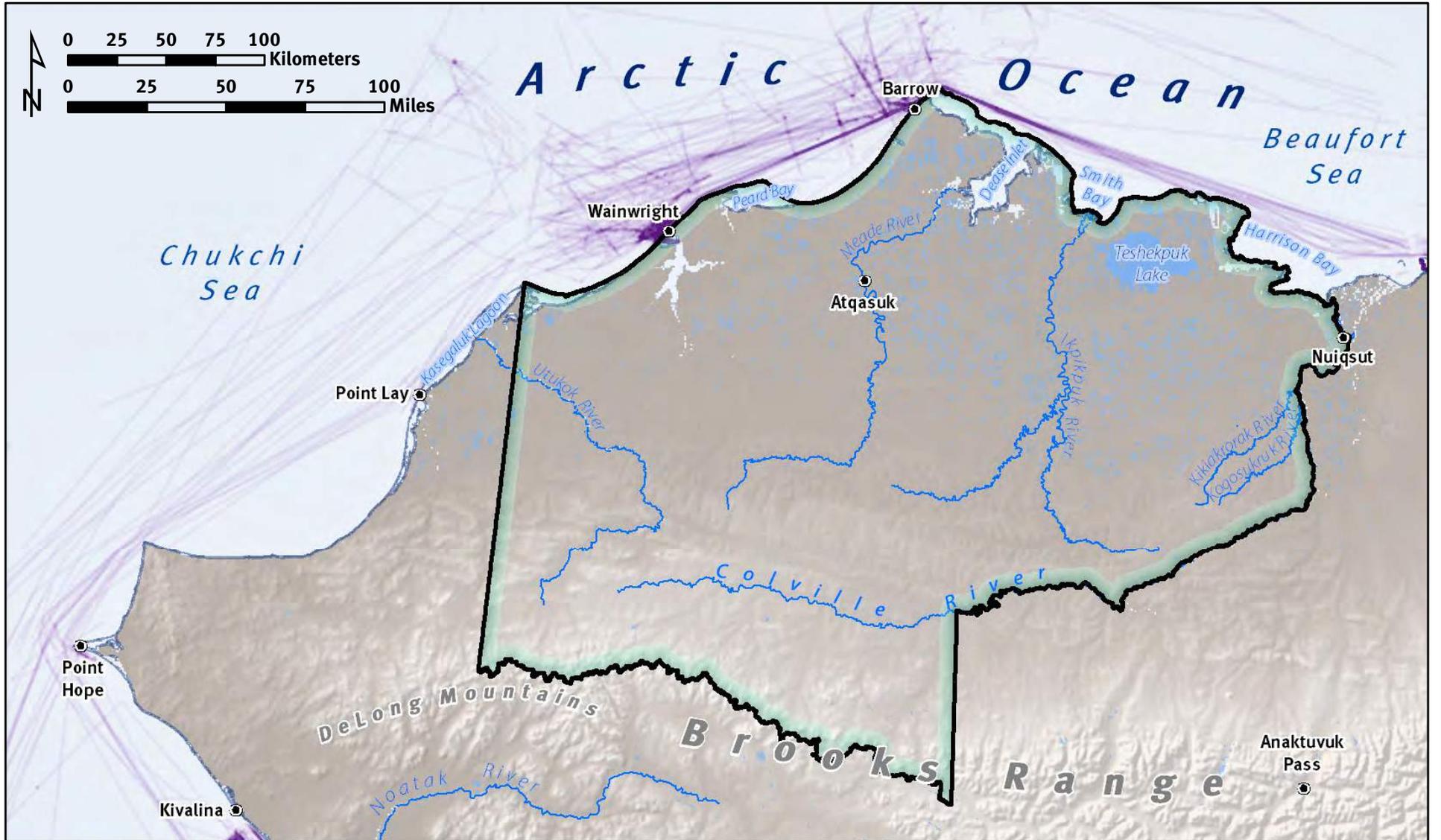
MINING AND MINERAL RESOURCES



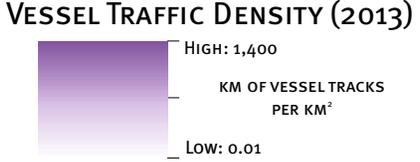
<ul style="list-style-type: none"> ● TOWNS ▭ NPRA BOUNDARY ~ MAJOR RIVERS 	<ul style="list-style-type: none"> ⊕ RED DOG MINE¹ — ROAD TO RED DOG MINE¹ ● ACTIVE MINING PROSPECTS² ○ INACTIVE MINING PROSPECTS² 	<p>MINING CLAIM DENSITY³ CLAIMS PER MI²</p>	<p>COAL OCCURRENCE⁴ HIGHEST TO LOWEST RANK</p> <p>RESOURCE MORE CERTAIN </p>	<ul style="list-style-type: none"> ■ BITUMINOUS ■ SUBBITUMINOUS ■ LIGNITE 	
--	--	--	--	--	--

Sources: 1) Audubon Alaska 2015; 2) USGS 2008; 3) Causey 2007; 4) Stricker et al. 2011.

V E S S E L T R A F F I C

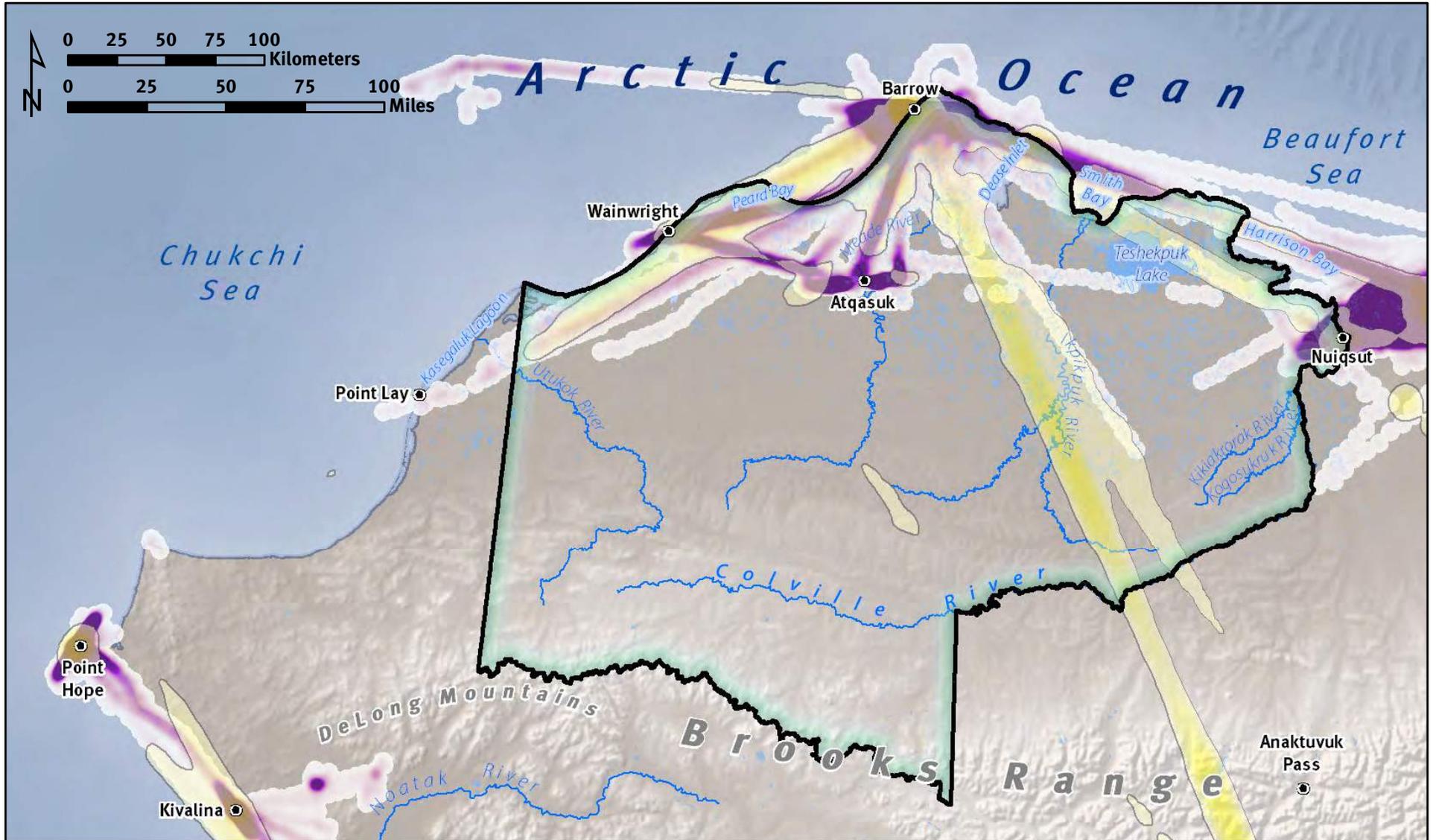


- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS



Source: Audubon Alaska 2015, based on BOEM & NOAA 2013.

LOW-ALTITUDE AIRCRAFT TRAFFIC



- TOWNS
- ▭ NPRA BOUNDARY
- ~ MAJOR RIVERS

LOW-ALTITUDE AIRCRAFT DENSITY
(<2,000 FEET; 2014-2015)

High: 288
Low: 0.1

MINUTES OF POTENTIAL OVERFLIGHT DISTURBANCE PER KM²

MAJOR MEDIUM-ALTITUDE FLIGHT PATHS
(<10,000 FEET; 2014-2015)

Most Traffic
Least Traffic



Source: Audubon Alaska 2016, based on Flight Aware 2015.

1:2,850,000

REFERENCES

LIST OF DATA SOURCES BY MAP

Chapter 1: Physical Setting

1. Context
2. Place Names and Geography
Bing Maps Imagery, courtesy of NASA Earthstar Geographics.
3. Topography
4. Terrestrial Climate Change – Active Layer Thickness
Smith and Walker 2014, based on Romanovsky and Marchenko 2014
5. Terrestrial Climate Change – Fraction of Precipitation Falling as Snow
Smith and Walker 2014, based on SNAP 2013
6. Terrestrial Climate Change – Length of Growing Season
Smith and Walker 2014, based on SNAP 2013
7. Terrestrial Climate Change – Precipitation
Smith and Walker 2014, based on SNAP 2013
8. Terrestrial Climate Change – Air Temperature at Ground Surface
Smith and Walker 2014, based on SNAP 2013
9. Terrestrial Climate Change – Cumulative Vulnerability
Smith and Walker 2014, based on SNAP 2013 and Romanovsky and Marchenko 2014
10. Coastal Erosion
 - 1) Gibbs et al. 2015
 - 2) Gutierrez et al. 2014

Chapter 2: Biological Setting

11. Conservation Areas
 - 1) University of Montana 2015
 - 2) BOEM 2015
 - 3) BLM 2013
 - 4) Alaska DNR 2015
12. Conservation Priorities
 - 1) Audubon Alaska 2016
 - 2) Audubon Alaska 2011
 - 3) BLM 2013
 - 4) BOEM 2015
 - 5) Alaska DNR 2015
 - 6) University of Montana 2015

- 13. Ecoregions
Nowacki et al. 2001
- 14. Vegetation
NSSI 2013
- 15. Wetlands
USFWS 2016

Chapter 3: Fish

- 16. Fish Species Richness
ADF&G 2015
- 17. Pacific Salmon Distribution
ADF&G 2015
- 18. Fish Habitat
 - 1) North Pacific Fishery Management Council 2009
 - 2) USFWS 1977

Chapter 4: Birds

- 19. Important Bird Areas
Audubon Alaska 2014
- 20. Marine Bird Colonies and At-Sea Use Areas
 - 1) USFWS 2008
 - 2) Audubon Alaska 2016, based on Drew and Piatt 2013, Walker and Smith 2014, and USFWS 2016
- 21. Molting Goose Distribution
USFWS 2015
- 22. Raptor Nest Sites in the NPRA
Ritchie et al. 2003
- 23. Shorebirds
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
- 24. Watchlist Species
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
- 25. Arctic Tern
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010
- 26. Brant
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) Alaska Biological Research 2002

27. Common Eider
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2003
28. Greater White-fronted Goose
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2003
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010
29. King Eider
 - 1) Opper 2008
 - 2) Opper et al. 2009
 - 3) Audubon Alaska 2014
 - 4) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 5) USFWS 2010
30. Long-tailed Duck
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010
31. Northern Pintail
 - 1) Audubon Alaska, based on USFWS 2014 and NPPSD 2013
 - 2) USFWS 2010
32. Pacific Loon
 - 1) Audubon Alaska, based on USFWS 2014 and NPPSD 2013
 - 2) USFWS 2010
33. Red-throated Loon
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010
34. Sabine's Gull
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010
35. Spectacled Eider
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2001
 - 4) Sexson et al. 2012
 - 5) USFWS 2010
36. Steller's Eider
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
37. Yellow-billed Loon
 - 1) Audubon Alaska 2014, based on USFWS 2014 and NPPSD 2013
 - 2) Audubon Alaska 2014
 - 3) USFWS 2010

Chapter 5: Mammals

38. Seasonal Caribou Distribution
 - 1) Gotthardt et al. 2014
 - 2) Audubon Alaska 2014
39. Habitat Suitability by Season – Teshekpuk Caribou Herd
Wilson et al. 2012
40. Cetacean Biologically Important Areas
Clarke et al. 2015
41. Cetacean Distribution
Audubon Alaska and Oceana 2016, based on NOAA 2015.
42. Pinniped Distribution
 - 1) Audubon Alaska and Oceana 2016, based on NOAA 2015
 - 2) Robards et al. 2007
 - 3) NOAA 2014
 - 4) ADF&G 1997
 - 5) Huntington et al. 1999
 - 6) Lowry et al. 1998
 - 7) Rugh et al. 1997
43. Polar Bear Denning and Feeding Areas
 - 1) NOAA 1988
 - 2) USFWS 1995
 - 3) Durner et al. 2010
 - 4) USFWS 2010
 - 5) Kalxdorff 1997

Chapter 6: Human Uses

44. Subsistence Use
 - 1) ADF&G 2015.
 - 2) Table A (below).
45. Land Status and Ownership
DOI-BLM 2016.
46. Oil and Gas Development
 - 1) Alaska Center for the Environment 2009
 - 2) AK DNR 2006
 - 3) BOEM 2016
 - 4) BLM 2016
 - 5) Alaska DNR 2016
 - 6) Oceana 2016
 - 7) BLM 2015
 - 8) Alaska Oil and Gas Conservation Commission 2016

47. Oil and Gas Development Scenarios

- 1) Alaska Center for the Environment 2009
- 2) BOEM 2016
- 3) BLM 2016a
- 4) Alaska DNR 2016
- 5) Oceana 2016
- 6) Alaska Oil and Gas Conservation Commission 2016
- 7) NSSI 2015
- 8) BLM 2016b

48. Oil Resources

- 1) Alaska Oil and Gas Conservation Commission 2016
- 2) BLM 2015
- 3) Houseknecht et al. 2010

49. Gas Resources

- 1) Alaska Oil and Gas Conservation Commission 2016
- 2) BLM 2015
- 3) Houseknecht et al. 2010

50. Mining and Mineral Resources

- 1) Audubon Alaska 2015
- 2) USGS 2008
- 3) Causey 2007
- 4) Stricker et al. 2011

51. Vessel Traffic

Audubon Alaska 2015, based on data from BOEM and NOAA 2013

52. Low-Altitude Aircraft Traffic

Audubon Alaska 2016, based on data from FlightAware 2015

Community		Source	Use Area (*=All Resources)	
North Slope Coastal Communities	Barrow	Braund and Burnham 1984	1979-1983	
		Pedersen 1979	Lifetime to 1979*	
		SRB&A 2010a	1997-2006*	
		SRB&A and ISER 1993	1987-1989*	
		SRB&A and ISER Unpublished	1987-1989*	
	Kaktovik	SRB&A 2010a	1996-2006*	
	Nuiqsut	Brown 1979	Pre-1979*	
		Pedersen 1979	Lifetime to 1979*	
		Pedersen 1986	1973-1986*	
		SRB&A 2003	1994-2003*	
		SRB&A 2010a	1995-2006*	
		SRB&A 2010b	2008	
		SRB&A 2011	2009	
		SRB&A 2012	2010	
	Point Lay	SRB&A 2013a	2011	
		SRB&A 2014	1997-2006	
		Braund and Burnham 1984	1979-1983	
	Wainwright	Pedersen 1979	Lifetime to 1979*	
Braund and Burnham 1984		1979-1983		
North Slope Inland Communities	Anaktuvuk Pass	Pedersen 1979	Lifetime to 1979*	
		SRB&A 2003	1994-2003*	
		SRB&A 2013b	2001-2010*	
	Atqasuk	SRB&A 2003	1994-2003*	
		Pedersen 1979	Lifetime to 1979*	
Northwest Alaska Communities	Shungnak	Braund and Burnham 1984	1979-1983	
		Kiana	Schroeder et al. 1987	Lifetime to 1986*
		Kobuk	Schroeder et al. 1987	Lifetime to 1985*
		Ambler	Schroeder et al. 1987	Lifetime to 1985*
		Noorvik	Schroeder et al. 1987	Lifetime to 1986*
		Noatak	Schroeder et al. 1987	Lifetime to 1986*

Notes: The term "Lifetime" refers to use areas documented for the respondent's lifetime prior to the year of data collection. For example, "Lifetime to 1979" refers to the use areas utilized during the respondent's lifetime prior to 1979.

Table A (for Map 44: Subsistence Use). Data and table compiled by Stephen R. Braund & Associates, 2016.

M A P R E F E R E N C E S

- Alaska Biological Research. 2002. Monitoring of Black Brant and Lesser Snow Geese. Barrow, AK.
- Alaska Center for the Environment (ACE). 2009. Oil Development, 2003–2008. Alaska Center for the Environment, Anchorage, AK.
- Alaska Department of Fish and Game (ADF&G). 1997. Most Environmentally Sensitive Area (MESA) Data. Habitat and Restoration Division, Alaska Department of Fish and Game, Anchorage, AK.
- Alaska Department of Fish and Game (ADF&G). 2015. Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes. Alaska Department of Fish and Game, Juneau, AK.
- Alaska Department of Fish and Game (ADF&G). 2015. Community Subsistence Information System: Harvest Information. Alaska Department of Fish and Game, Anchorage, AK. Accessed online at: <http://www.adfg.alaska.gov/sb/CSIS/>.
- Alaska Department of Natural Resources (AK DNR). 2006. Alaska Roads 1:63,360. Information Resource Management, Alaska Department of Natural Resources, Anchorage, AK.
- Alaska Department of Natural Resources (AK DNR). 2015. Competitive Oil and Gas Lease Sale Regional Tract Map. Division of Oil and Gas, State of Alaska Department of Natural Resources, Anchorage, AK. Accessed online at: http://dog.dnr.alaska.gov/leasing/Documents/SaleDocuments/BeaufortSea/LatestSale/BeaufortSea_LeaseSaleTractMap_201510.pdf.
- Alaska Oil and Gas Conservation Commission. 2016. Oil and Gas Information System. Alaska Oil and Gas Conservation Commission, Alaska Department of Administration, Anchorage, AK. Accessed online at: <http://doa.alaska.gov/ogc/publicdb.html>
- Audubon Alaska. 2011. Alaska's Western Arctic: A Resource Synthesis and Conservation Strategy. Audubon Alaska, Anchorage, AK.
- Audubon Alaska. 2014. Caribou Herd Insect Relief Core Area Analysis. Anchorage, AK.
- Audubon Alaska. 2014. Important Bird Areas of Alaska, v3. Audubon Alaska, Anchorage, AK. Accessed online at: <http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9>.
- Audubon Alaska. 2014. Marine Bird Species Core Area Analysis. Anchorage, AK.
- Audubon Alaska. 2015. Analysis of Vessel Traffic in the Arctic. Audubon Alaska, Anchorage, AK.
- Audubon Alaska. 2015. Red Dog Mine Location. Audubon Alaska, Anchorage, AK.
- Audubon Alaska. 2016. Analysis of Flight Traffic in the Arctic. Audubon Alaska, Anchorage, AK.

Audubon Alaska. 2016. A Synthesis of Important Areas in the U.S. Chukchi and Beaufort Seas: Best Available Data to Inform Management Decisions. Audubon Alaska, Anchorage, AK.
Accessed online at:
https://ak.audubon.org/sites/g/files/amh551/f/synthesis_of_important_areas_us_chukchi_beaufort_seas_28apr2016.pdf.

Audubon Alaska. 2016. Marine Bird Species Core Area Analysis. Anchorage, AK.

Audubon Alaska and Oceana. 2016. Marine Mammal Species Core Area Analysis. Audubon Alaska, Anchorage, AK; and Oceana, Juneau, AK.

Bing Maps Imagery, courtesy of NASA Earthstar Geographics.

Braund, Stephen R. & Associates (SRB&A). Unpublished. North Slope Borough Key Informant Subsistence Mapping Project, Barrow and Wainwright. Barrow use area data depict 1987–1989 use areas reported during 59 interviews. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2003. Field Interviews Conducted for U.S. Department of the Interior, Bureau of Land Management 2004 Alpine Satellite Development Plan Final Environmental Impact Statement. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2010a. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Prepared for United States Department of the Interior, Minerals Management Service, Alaska OCS Region, Environmental Studies Program. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2010b. Nuiqsut Subsistence Monitoring Project: Results of 2009 Hunter Interviews. Prepared for ConocoPhillips Alaska, Inc. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2011. Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 2 Hunter Interviews. Prepared for ConocoPhillips Alaska, Inc. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2012. Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 3 Hunter Interviews. Prepared for ConocoPhillips Alaska, Inc. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2013a. Nuiqsut Caribou Subsistence Monitoring Project: Results of Year 4 Hunter Interviews. Prepared for ConocoPhillips Alaska, Inc. Stephen R. Braund & Associates, Anchorage, AK.

Braund, Stephen R. & Associates (SRB&A). 2013b. Subsistence Use Area and Traditional Knowledge Studies: Anaktuvuk Pass, Barrow, and Nuiqsut. Foothills West Transportation Access Environmental Studies. Prepared for Three Parameters Plus, Inc., and the Alaska Department of Transportation and Public Facilities. Stephen R. Braund & Associates, Anchorage, AK.

- Braund, Stephen R. & Associates (SRB&A). 2014. Subsistence Use Areas and Traditional Knowledge Study for Point Lay, Alaska: 1997-2006. Prepared for the North Slope Borough Department of Wildlife Management, Barrow, Alaska. Stephen R. Braund & Associates, Anchorage, AK.
- Braund, S. and D. Burnham. 1984. Subsistence Economics and Marine Resource Use Patterns. In Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development. Prepared by LGL Ecological Research Associates, Inc. Prepared for U.S. Department of Interior, Minerals Management Service and Department of Commerce, NOAA. Stephen R. Braund & Associates, Anchorage, AK.
- Braund, Stephen R. & Associates (SRB&A) and Institute of Social and Economic Research (ISER). 1993. North Slope Subsistence Study: Barrow, 1987, 1988, and 1989. Prepared by: S. Braund, K. Brewster, L. Moorehead, T. Holmes, J. Kruse, S. Stoker, M. Glen, E. Witten, D. Burnham, and W. Simeone. Prepared for the U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region Social and Economic Studies, Technical Report No. 149, OCS Study MMS 91-0086. Stephen R. Braund & Associates, Anchorage, AK.
- Brown, W. 1979. Nuiqsut Paisanich: Nuiqsut Heritage, a Cultural Plan. Prepared for the Village of Nuiqsut and the North Slope Borough Planning Commission on History and Culture. Anchorage, AK.
- Bureau of Land Management (BLM). 2013. National Petroleum Reserve–Alaska Integrated Activity Plan Record of Decision. Bureau of Land Management, US Department of the Interior, Anchorage, AK. Accessed online at: https://eplanning.blm.gov/epl-front-office/projects/nepa/5251/42462/45213/NPR-A_FINAL_ROD_2-21-13.pdf.
- Bureau of Land Management (BLM). 2015. National Petroleum Reserve–Alaska Units. Alaska State Office, Bureau of Land Management, Department of the Interior, Anchorage, AK. Accessed online at: http://www.blm.gov/ak/st/en/prog/energy/oil_gas/npra/npra_units.html.
- Bureau of Land Management (BLM). 2016a. NPR–A Oil & Gas Leases. Alaska State Office, Bureau of Land Management, Department of the Interior, Anchorage, AK. Accessed online at: http://www.blm.gov/ak/st/en/prog/energy/oil_gas/npra/npra_leasing.html.
- Bureau of Land Management (BLM). 2016b. Description of Anticipated Future Oil and Gas Development in the Northeast National Petroleum Reserve–Alaska. Working draft. Alaska State Office, Bureau of Land Management, Department of the Interior, Anchorage, AK. Accessed online at: http://www.blm.gov/style/medialib/blm/ak/aktest/planning/NPR-A_RMS.Par.22085.File.dat/20160225_RMS_Future_Development_Projection.pdf
- Bureau of Ocean Energy Management (BOEM). 2015. 2017–2022 Draft Proposed Program and January 27, 2015, Presidential Withdrawals GIS Files. Bureau of Ocean Energy Management, Sterling, VA. Accessed online at: <http://www.boem.gov/2017-2022-Map-Layer-Files/>.
- Bureau of Ocean Energy Management (BOEM). 2016. OCS Alaska Current Oil and Gas Leases. Department of the Interior, Bureau of Ocean Energy Management, Anchorage, AK.

- Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Administration (NOAA). 2013. Marine Cadastre Vessel Traffic Data. Accessed online at: <http://marinecadastre.gov/data/>.
- Causey, J. D. 2007 (revised 2011). Mining claim activity on federal land in the United States: U.S. Geological Survey Data Series 290, v. 4.0. U.S. Geological Survey, Anchorage, AK. Accessed online at: <http://pubs.usgs.gov/ds/2007/290/>.
- Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. *Aquatic Mammals* 94-103.
- Department of the Interior – Bureau of Land Management (DOI-BLM). 2016. Generalized Land Status of Alaska. Alaska State Office, Bureau of Land Management, Department of the Interior, Anchorage, Alaska. Accessed online at: <http://sdms.ak.blm.gov/download/landstatus/genstat.zip>.
- Drew, G. F. and J. Piatt. 2013. North Pacific Pelagic Seabird Database (NPPSD) v2. US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK.
- Durner, G. M., A. S. Fischbach, S. C. Amstrup, and D. C. Douglas. 2010. Catalogue of Polar Bear (*Ursus maritimus*) Maternal Den Locations in the Beaufort Sea and Neighboring Regions, Alaska, 1910–2010.
- FlightAware. 2015. FlightAware Alaska North Slope Traffic (GIS Dataset). FlightAware, Houston, TX.
- Gibbs, A. E., K. A. Ohman, and B. M. Richmond. 2015. National assessment of shoreline change—A GIS compilation of vector shorelines and associated shoreline change data for the north coast of Alaska, U.S.-Canadian border to Icy Cape. U.S. Geological Survey Open-File Report 2015-1030. U.S. Geological Survey, U.S. Department of the Interior, Reston, VA.
- Gotthardt, T., T. Nawrocki, and N. Fresco. 2014. Terrestrial fine-filter conservation elements. North Slope Rapid Ecoregional Assessment. Alaska Natural Heritage Program, University of Alaska Anchorage, Anchorage, AK.
- Gutierrez, B. T., N. G. Plant, E. A. Pendleton, and E. R. Thieler. 2014. Using a Bayesian Network to predict shore-line change vulnerability to sea-level rise for the coasts of the United States. U.S. Geological Survey Open-File Report 2014-1083. U.S. Geological Survey, U.S. Department of the Interior, Reston, VA.
- Houseknecht, D. W., K. J. Bird, J. H. Schuenemeyer, E. D. Attanasi, C. P. Garrity, C. J. Schenk, R. R. Charpentier, R. M. Pollastro, T. A. Cook, and T. R. Klett. 2010. 2010 updated assessment of undiscovered oil and gas resources of the National Petroleum Reserve–Alaska (NPR–A): U.S. Geological Survey Fact Sheet 2010–3102, 4 p. U.S. Geological Survey, Anchorage, AK. Accessed online at: <http://pubs.usgs.gov/fs/2010/3102/>.
- Huntington, H. P., The Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the eastern Chukchi and northern Bering Seas, Alaska. *Arctic* 52:49-61.

- Kalxdorff, S. 1997. Collection of local knowledge regarding polar bear habitat use in Alaska. Technical Report MMM 97-2. USFWS, Marine Mammal Management, Anchorage, Alaska.
- Lowry, L. F., K. J. Frost, R. Davis, D. P. DeMaster, and R. S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi seas. *Polar Biology* 19:221-230.
- National Oceanic and Atmospheric Administration (NOAA). 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.
- National Oceanic and Atmospheric Administration (NOAA). 2014. ASAMM-Chukchi – Flight 240, 27 September 2014. 2014 Aerial Survey Reports. Accessed online at: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/2014/ASAMM-Chukchi_Flight240_27September2014.pdf.
- National Oceanic and Atmospheric Administration (NOAA). 2015. Aerial Survey of Arctic Marine Mammals, 1979-2014 (ASAMM; including the Historical BWASP and COMIDA Databases). NOAA Fisheries, Alaska Fisheries Science Center, National Marine Mammal Laboratory, Anchorage, AK. Accessed online at: <http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php>.
- North Pacific Fishery Management Council. 2009. Essential fish habitat. North Pacific Fishery Management Council, Anchorage, AK.
- North Slope Science Initiative (NSSI). 2013. NSSI Landcover for North Slope of Alaska. Accessed online at: <http://catalog.northslope.org/catalogs/6979-2013-nssi-landcover-for-north-slope-of-alaska>.
- North Slope Science Initiative (NSSI). 2015. Scenarios for Energy and Resource Development on the North Slope and Adjacent Areas. Research and Monitoring Workshop. University of Alaska-Fairbanks, Fairbanks, AK.
- Nowacki, G. J., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson. 2001. Unified ecoregions of Alaska. USGS Open-File Report 02-297. U.S. Geological Survey, Reston, VA.
- Oceana. 2016. Beaufort and Chukchi Oil and Gas Leases. Oceana, Juneau, AK.
- Oppel, S. 2008. King Eider migration and seasonal interactions at the individual level. Ph. D. thesis. University of Alaska-Fairbanks, Fairbanks, AK.
- Oppel, S., D. L. Dickson, and A. N. Powell. 2009. International importance of the eastern Chukchi Sea as a staging area for migrating king eiders. *Polar Biology* 32:775-783.
- Pedersen, S. 1979. Regional Subsistence Land Use, North Slope Borough, Alaska. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska, Fairbanks, Alaska and Conservation and Environmental Protection, North Slope Borough, Barrow, AK, Occasional Paper No. 21.

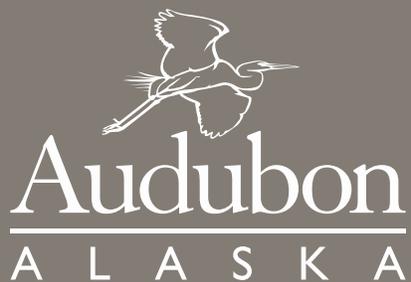
- Pedersen, S. 1986. Nuiqsut Subsistence Land Use Atlas, 1986 Update. ADF&G, Division of Subsistence, Fairbanks, Alaska, File Report 1986-01.
- Ritchie, R. J., A. M. Wildman, and D. A. Yokel. 2003. Aerial surveys of cliff-nesting raptors in the National Petroleum Reserve–Alaska, 1999, with comparisons to 1977. Technical Note 413. Bureau of Land Management, Denver, Colorado. BLM/AK/ST-03/016+6501+023. 66 pp.
- Robards, M., A. Kochnev, and S. Deming. 2007. Sharing Knowledge about Pacific Walrus (published map). University of Alaska-Fairbanks, Fairbanks, AK.
- Romanovsky, V. E. and S. Marchenko. 2014. The GIPL permafrost dynamics model. University of Alaska-Fairbanks, Fairbanks, AK.
- Rugh, D. J., K. E. Sheldon, and D. E. Withrow. 1997. Spotted Seals, *Phoca largha*, in Alaska. Marine Fisheries Review 59:1-18.
- Scenarios Network for Alaska + Arctic Planning (SNAP). 2013. Alaska climate change adaptation series, regional climate projections. University of Alaska-Fairbanks, Fairbanks, AK.
- Schroeder, R., D. B. Andersen, and G. Hildreth. 1987. Subsistence Use Area Map Atlas for Ten Kotzebue Sound Communities. Juneau. Division of Subsistence, Department of Fish and Game, State of Alaska, and Maniilaq Association.
- Sexson, M. G., M. R. Petersen, and A. N. Powell. 2012. Spatiotemporal distribution of spectacled eiders throughout the annual cycle, In 15th Alaska Bird Conference. Anchorage, AK.
- Smith, M. A. and N. J. Walker. 2014. Using spatial climate change data to assess vulnerability across Alaska. Audubon Alaska, Anchorage, AK.
- Stricker, G. D., B. D. Spear, J. M. Sprowl, J. D. Dietrich, M. I. McCauley, and S. A. Kinney. 2011. Coal database for Cook Inlet and North Slope, Alaska: U.S. Geological Survey Digital Data Series 599, 11 p. U.S. Geological Survey, Anchorage, AK. Accessed online at: <https://pubs.usgs.gov/ds/599/downloads/DS599.pdf>.
- U.S. Fish and Wildlife Service (USFWS). 1977. Winter Water Availability and Use Conflicts as Related to Fish and Wildlife in Arctic Alaska. US Fish and Wildlife Service, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 1995. Habitat conservation strategy for polar bears in Alaska. US Fish and Wildlife Service, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 2001. FWS Critical Habitat for Threatened and Endangered Species. US Fish and Wildlife Service, Anchorage, AK. Accessed online at: <http://ecos.fws.gov/crithab/>.
- U.S. Fish and Wildlife Service (USFWS). 2003. Arctic Nearshore Survey. US Fish and Wildlife Service, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 2008. Beringian seabird colony catalog (Microsoft Excel spreadsheet). Anchorage, AK.

- U.S. Fish and Wildlife Service (USFWS). 2010. Arctic Coastal Plain Aerial Waterbird Surveys 2007–2010. USFWS, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 2010. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Federal Register 75 FR 76085:76085–76137.
- U.S. Fish and Wildlife Service (USFWS). 2014. At-Sea Surveys of Seabirds from Ships of Opportunity. USFWS, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 2015. Teshekpuk Lake Molting Goose Survey. US Fish and Wildlife Service, Anchorage, AK.
- U.S. Fish and Wildlife Service (USFWS). 2016. At-Sea Surveys of Seabirds from Ships of Opportunity. USFWS, Anchorage, AK.
- U.S. Geological Survey (USGS). 2008. Alaska Resource Data File. U.S. Geological Survey Open-File Report 2008–1225. U.S. Geological Survey, Anchorage, AK. Accessed online at: <http://mrdata.usgs.gov/ardf/>.
- University of Montana. 2015. National Wilderness Preservation System. Wilderness Institute, University of Montana, Missoula, MT.
- Walker, N. J. and M. A. Smith. 2014. Alaska Waterbird Database v1. Audubon Alaska, Anchorage, AK.
- Wilson, R. R., A. K. Prichard, L. S. Parrett, B. T. Person, G. M. Carroll, M. A. Smith, C. L. Rea, and D. A. Yokel. 2012. Summer resource selection and identification of important habitat prior to industrial development for the Teshekpuk Caribou Herd in northern Alaska. PLoS ONE 7(11)e48697.

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