Welcome

ARCUS Arctic Research Seminar Series

"Forty Years of Change:
A Seabird Responds to a Melting Arctic"

26 October 2016

Presented by George Divoky
Friends of Cooper Island

#arcuswebinar

Forty Years of Change

A Seabird Responds to a Melting Arctic

George Divoky
Friends of Cooper Island
Seattle, WA and Barrow, AK

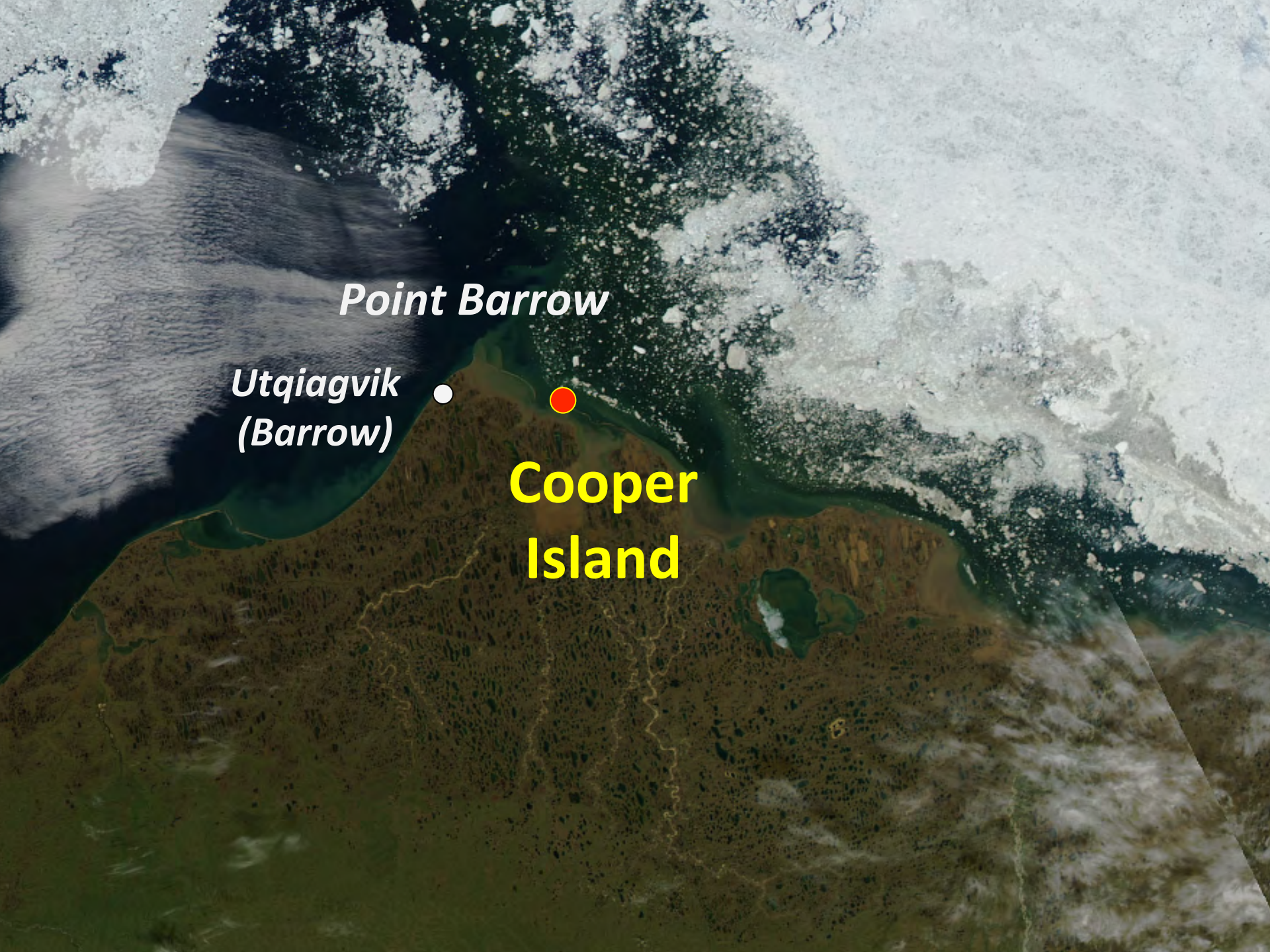
ARCUS, Washington, D.C. **October 2016**

Proposed tanker route
Early 1970s

Prudhoe Bay


Bering Strait
Beaufort Sea

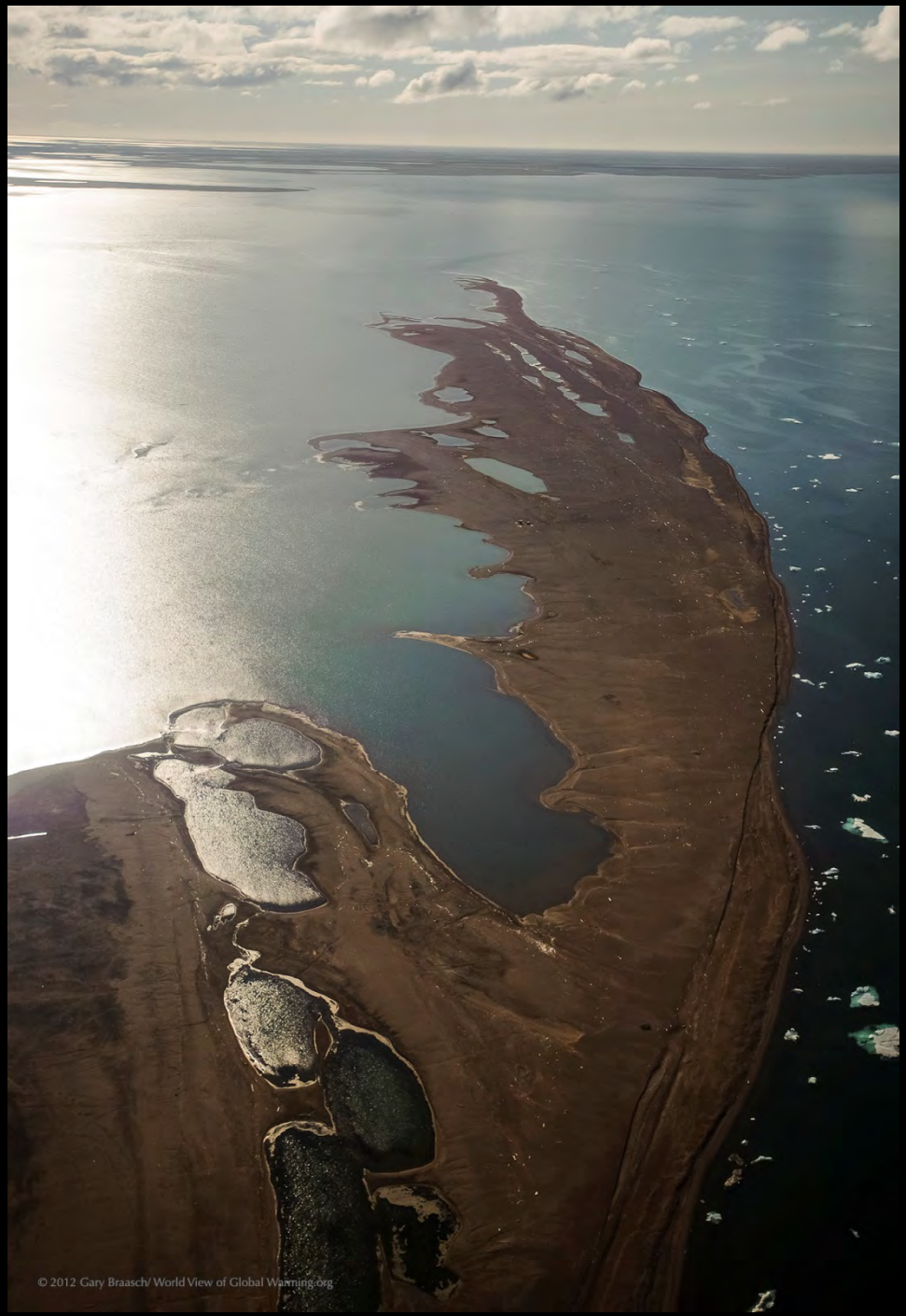

Point Barrow
Cooper Island

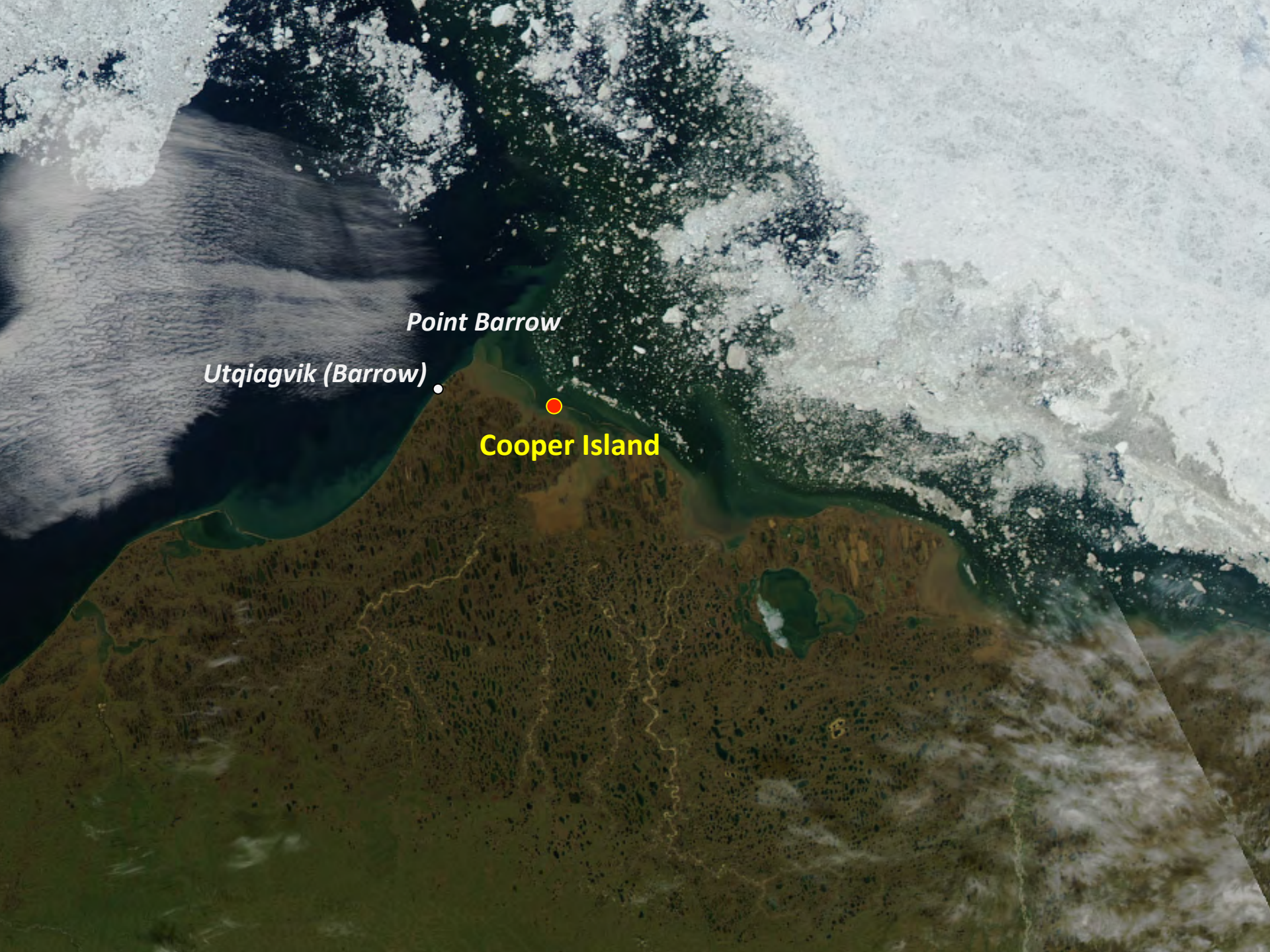

Point Barrow
Utqiagvik
(Barrow)
Cooper
Island

Cooper Island

Iglurak

Inupiaq


© 2012 Gary Braasch/ World View of Global Warming.org


Point Barrow
Utqiagvik (Barrow)
Cooper Island


August 1972


Mandt’s Black Guillemot

Scottish Black Guillemot colony

My Black Guillemot colony

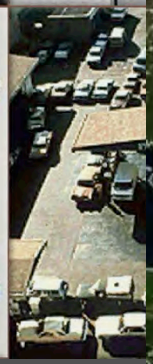
Cooper Island provided a researcher-friendly seabird colony

1974-1975


SAUDI ARABIA

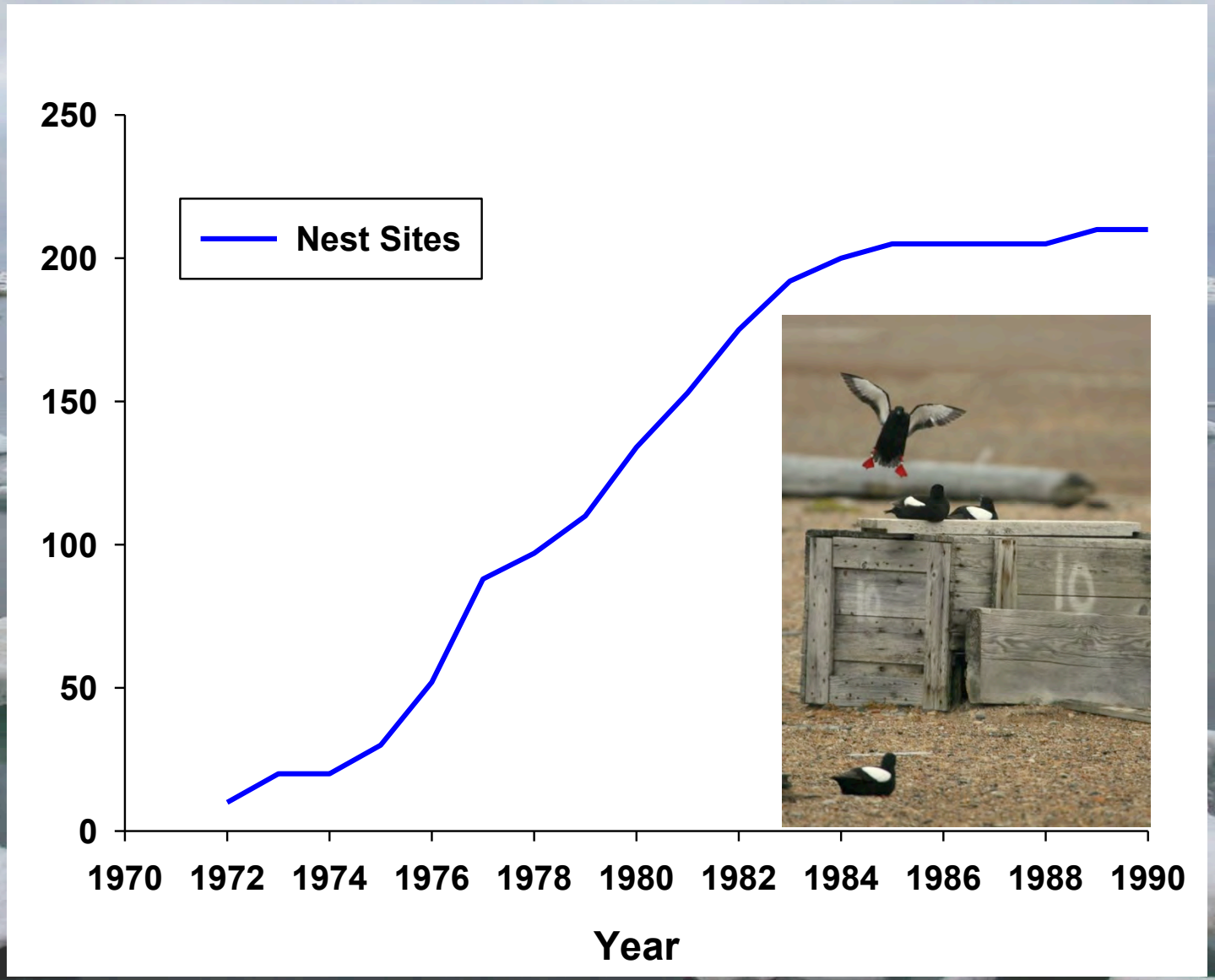

SPEE
LIMIT
70
55


GAS
SHORTAGE!
Sales Limited to
10 GALS. OF GAS.
PER CUSTOMER

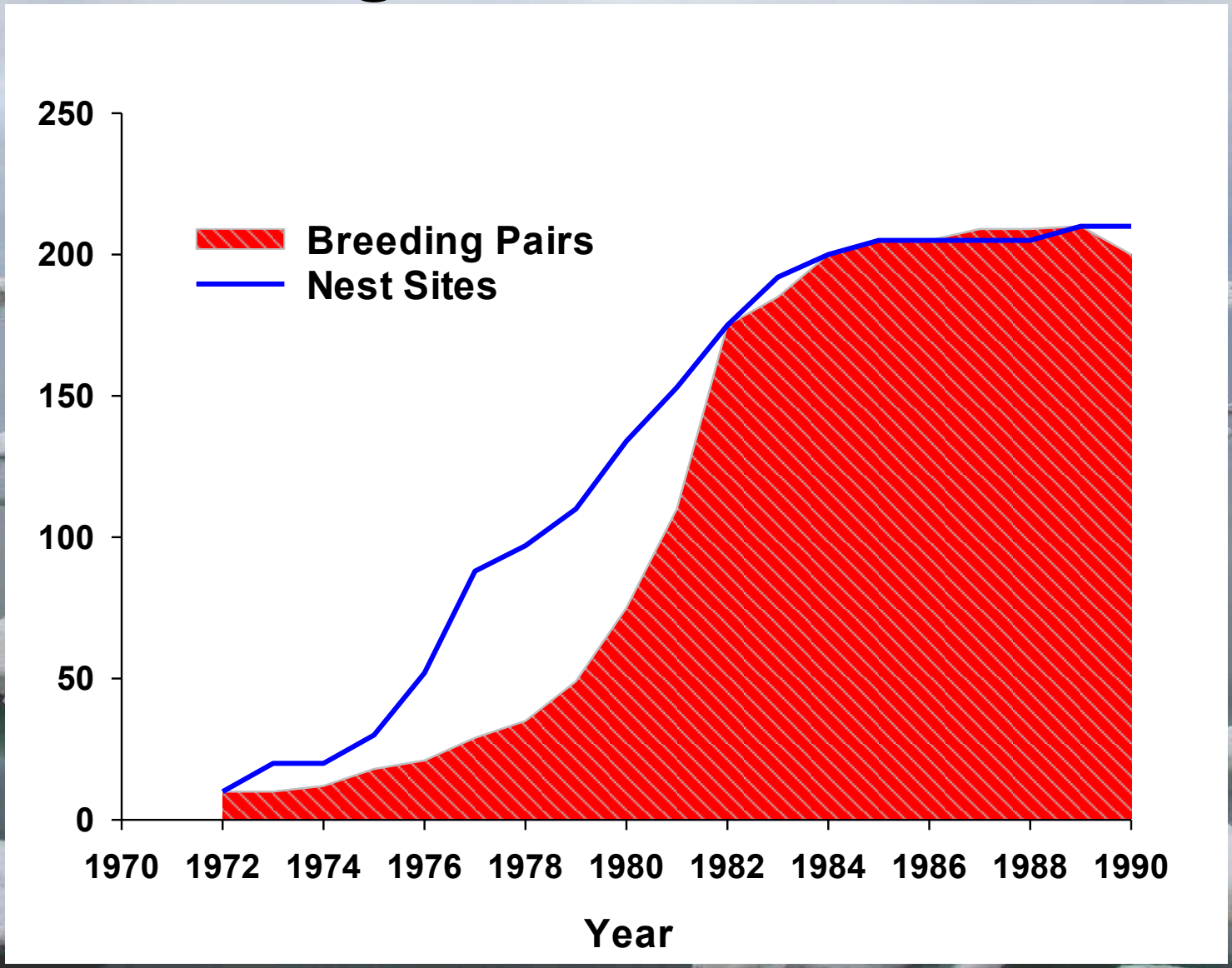



Cooper Island

Nest sites on Cooper Island



Breeding Pairs and Nest sites

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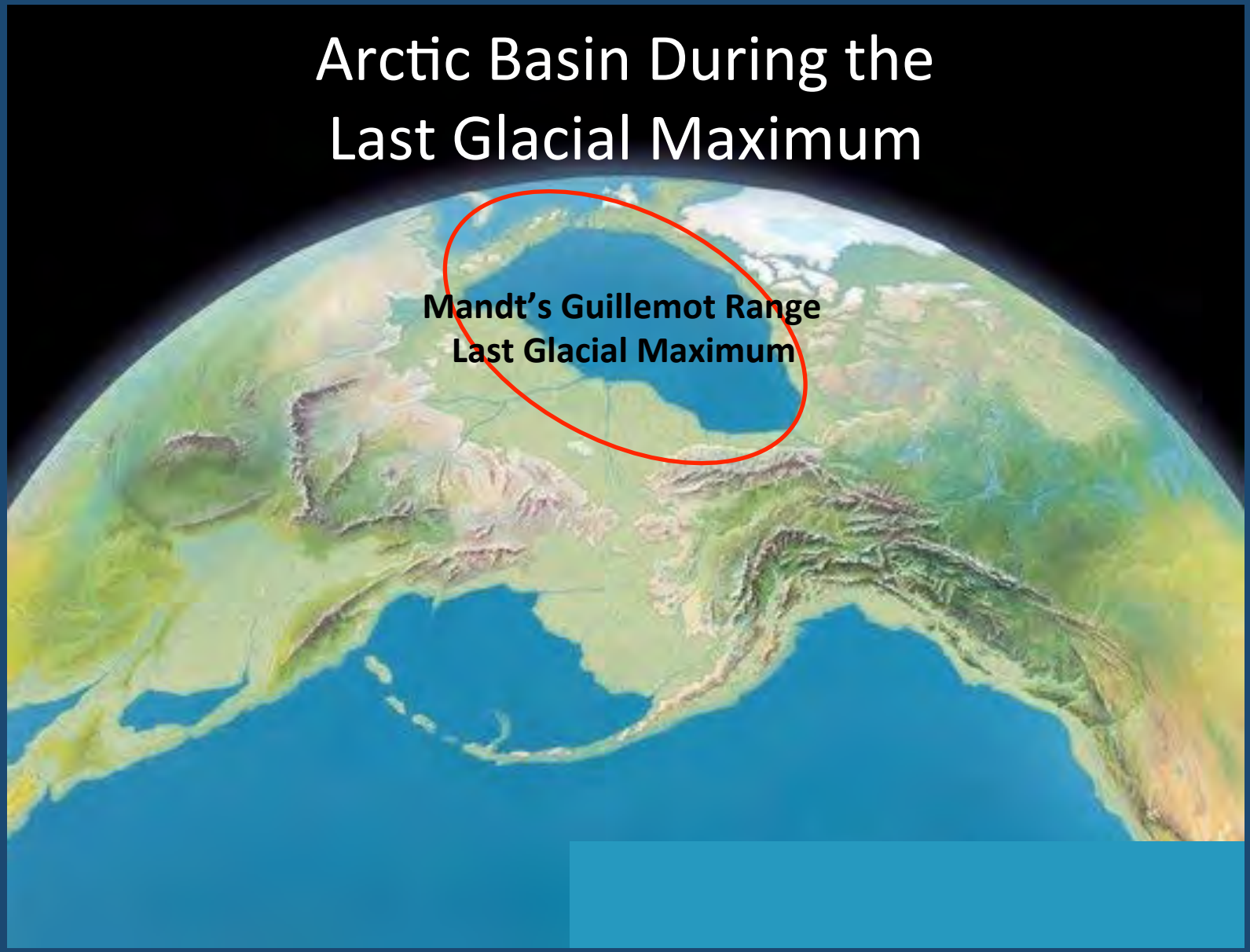
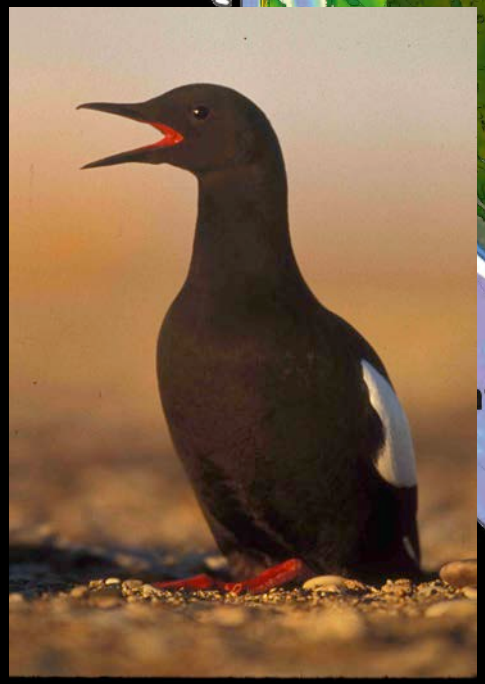
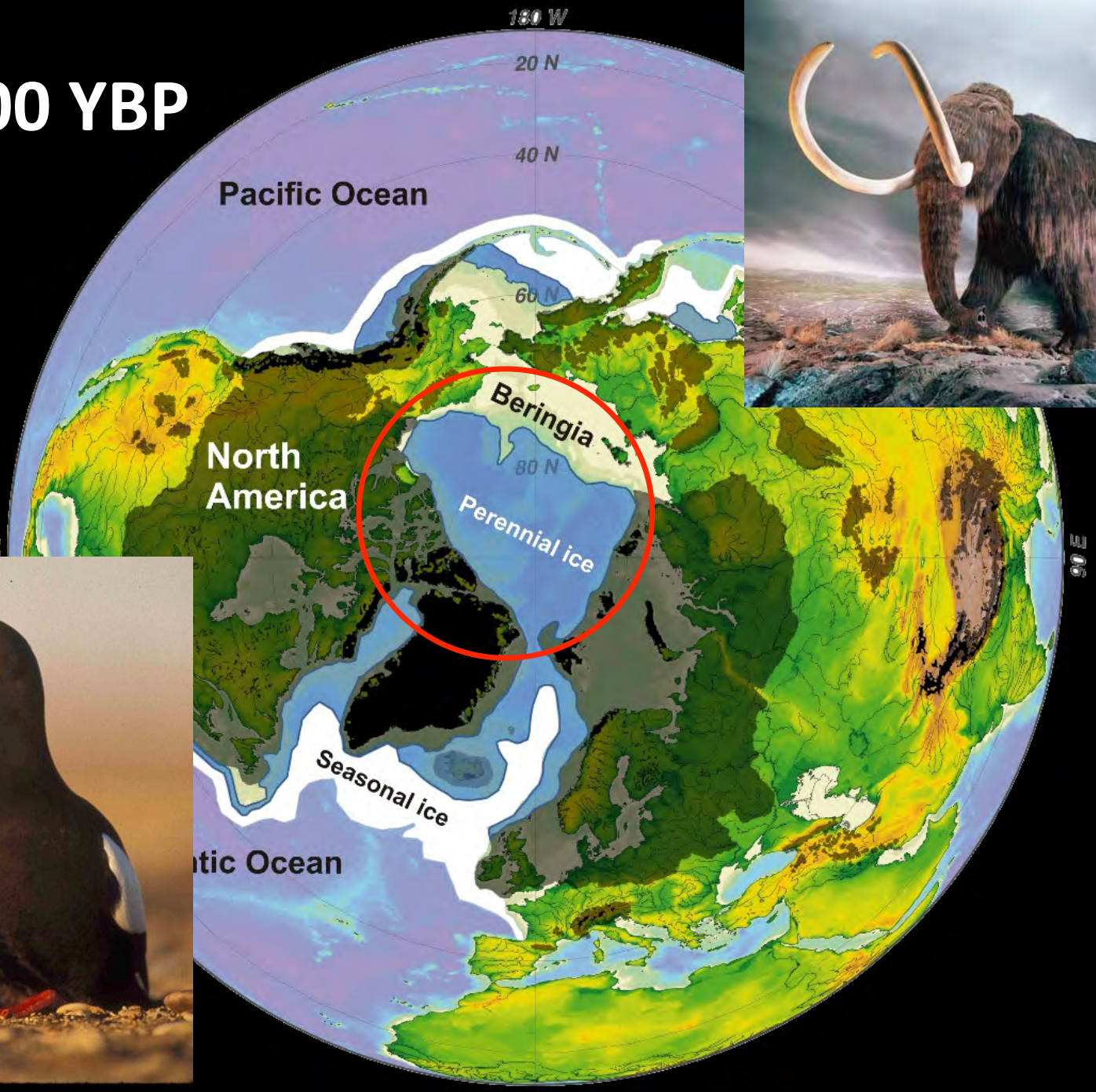
Arctic Basin During the Last Glacial Maximum

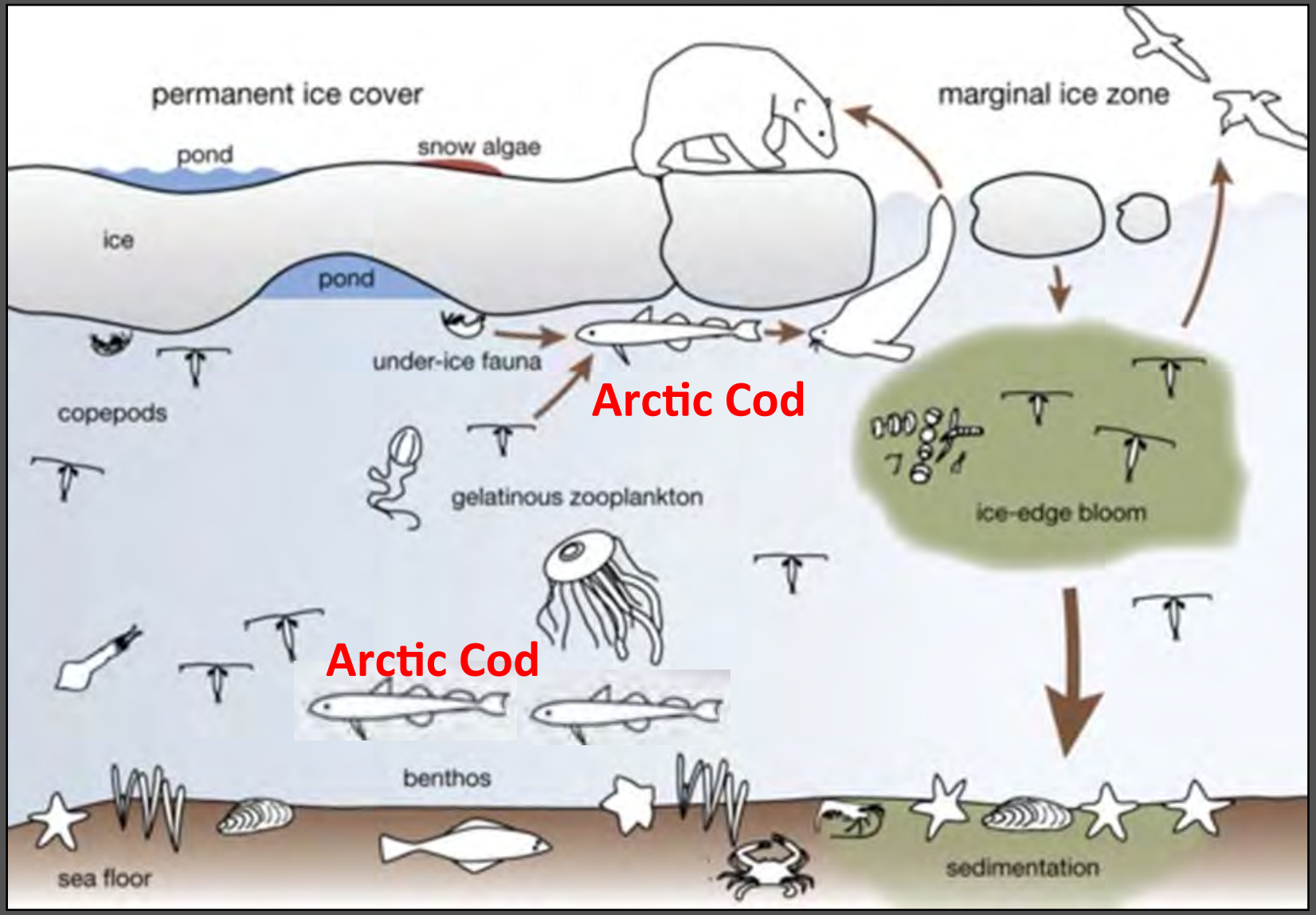


15000 YBP




180 W
20 N
40 N
Pacific Ocean
60 N
Beringia
80 N
North America
Perennial ice
Seasonal ice
tic Ocean
0

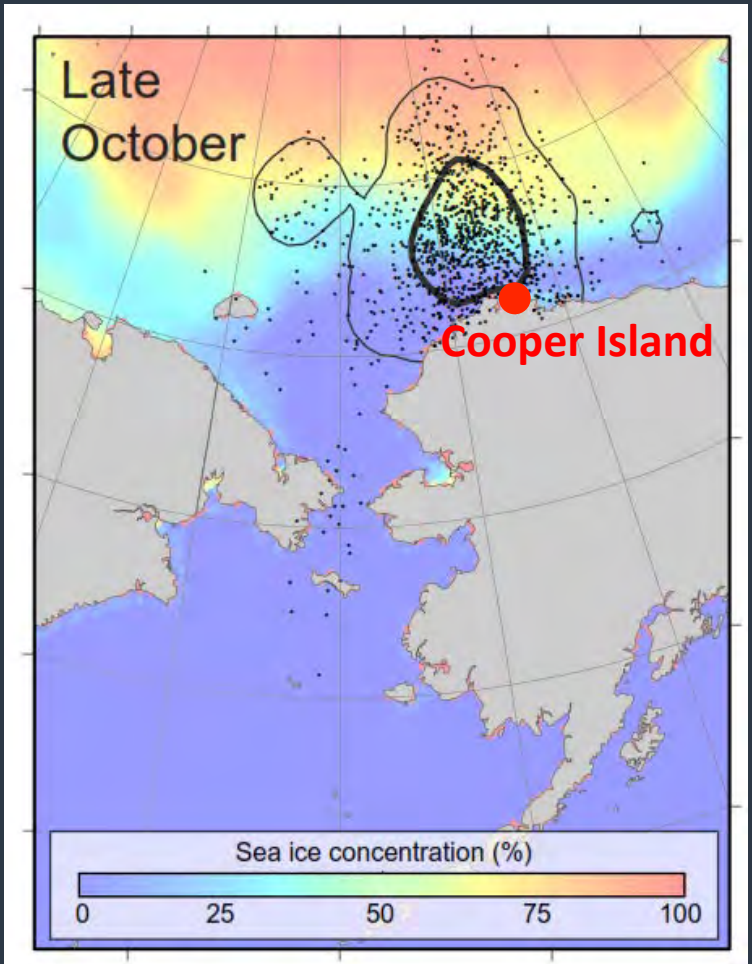
Cryopelagic ecosystem

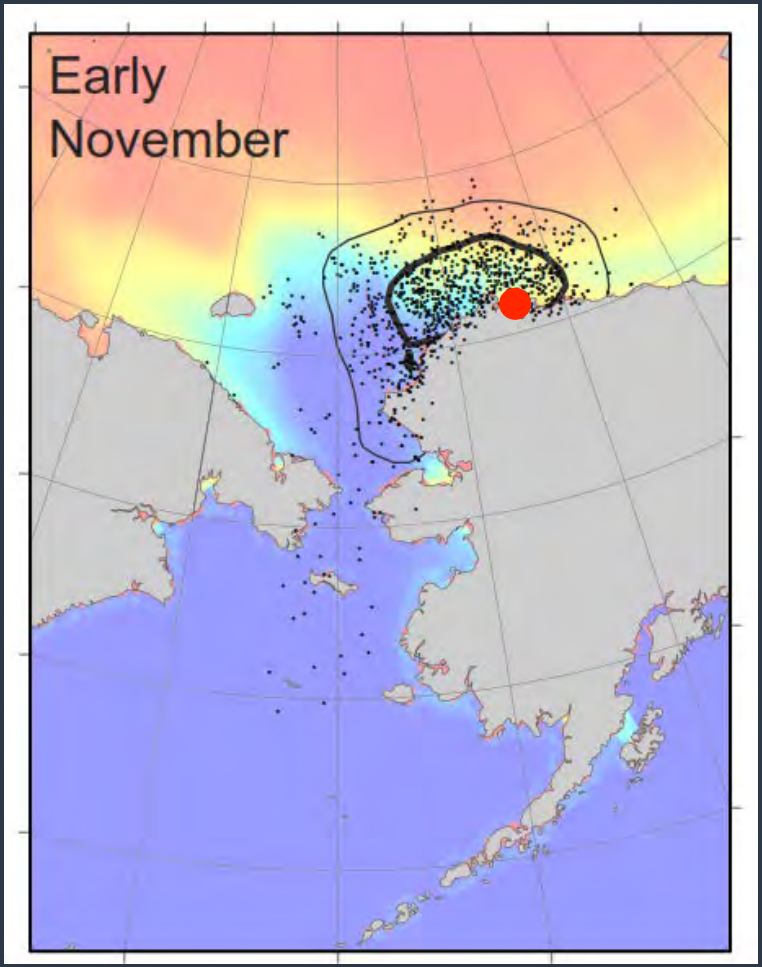


"Species that have critical life history stages either constrained by or dependent on snow and ice habitats will be among the first to be affected by increases in atmospheric temperature"

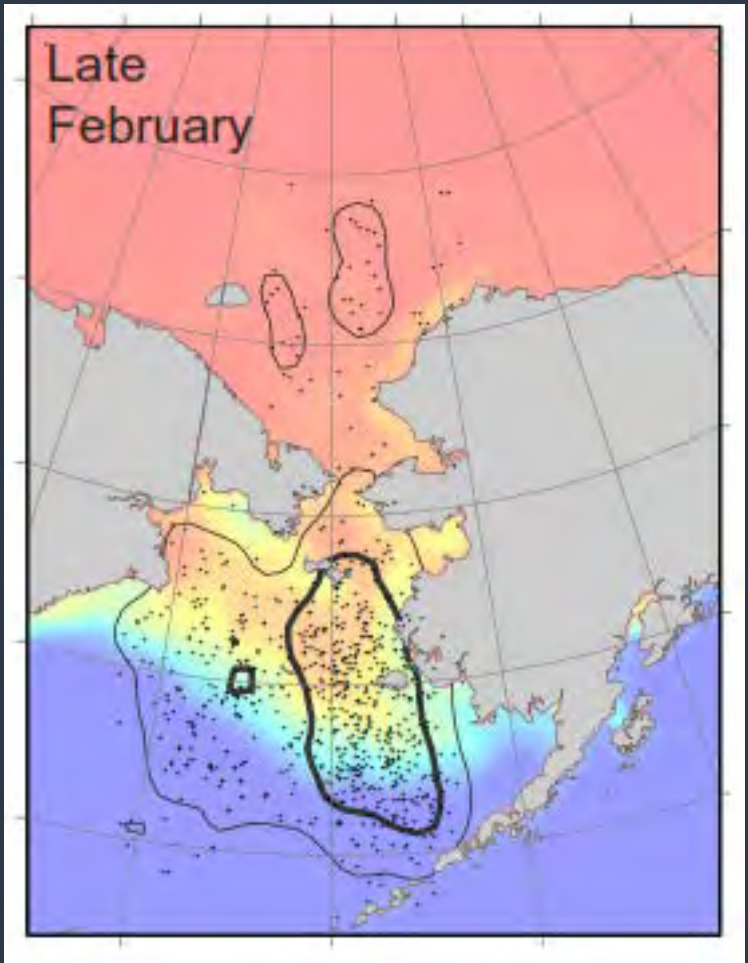

Black Guillemot Colonies

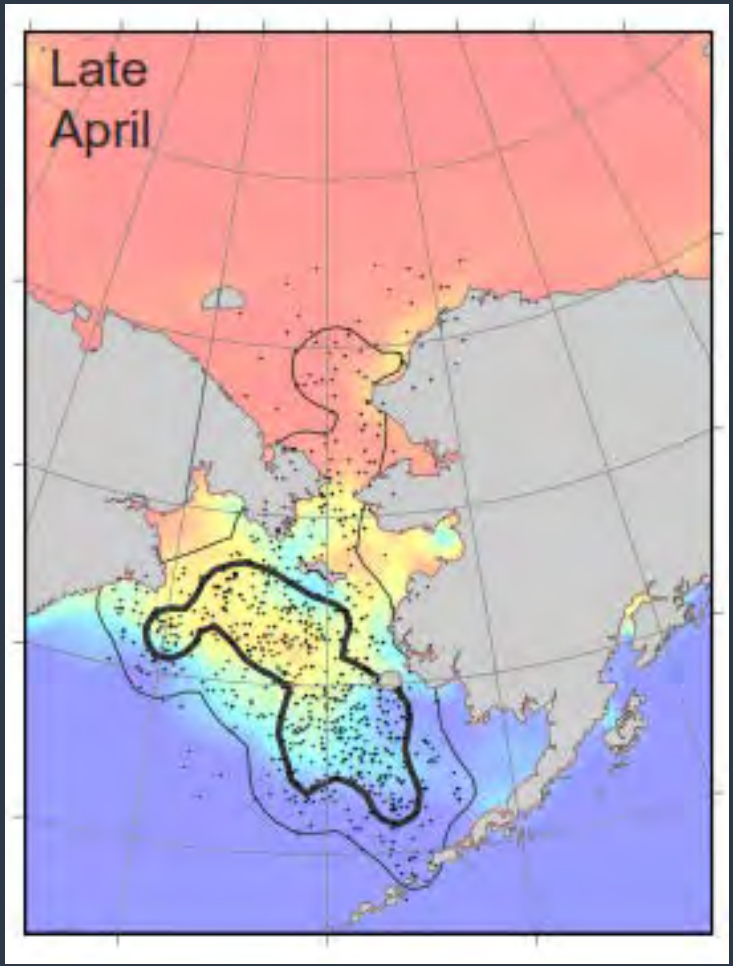
Early Fall Distribution





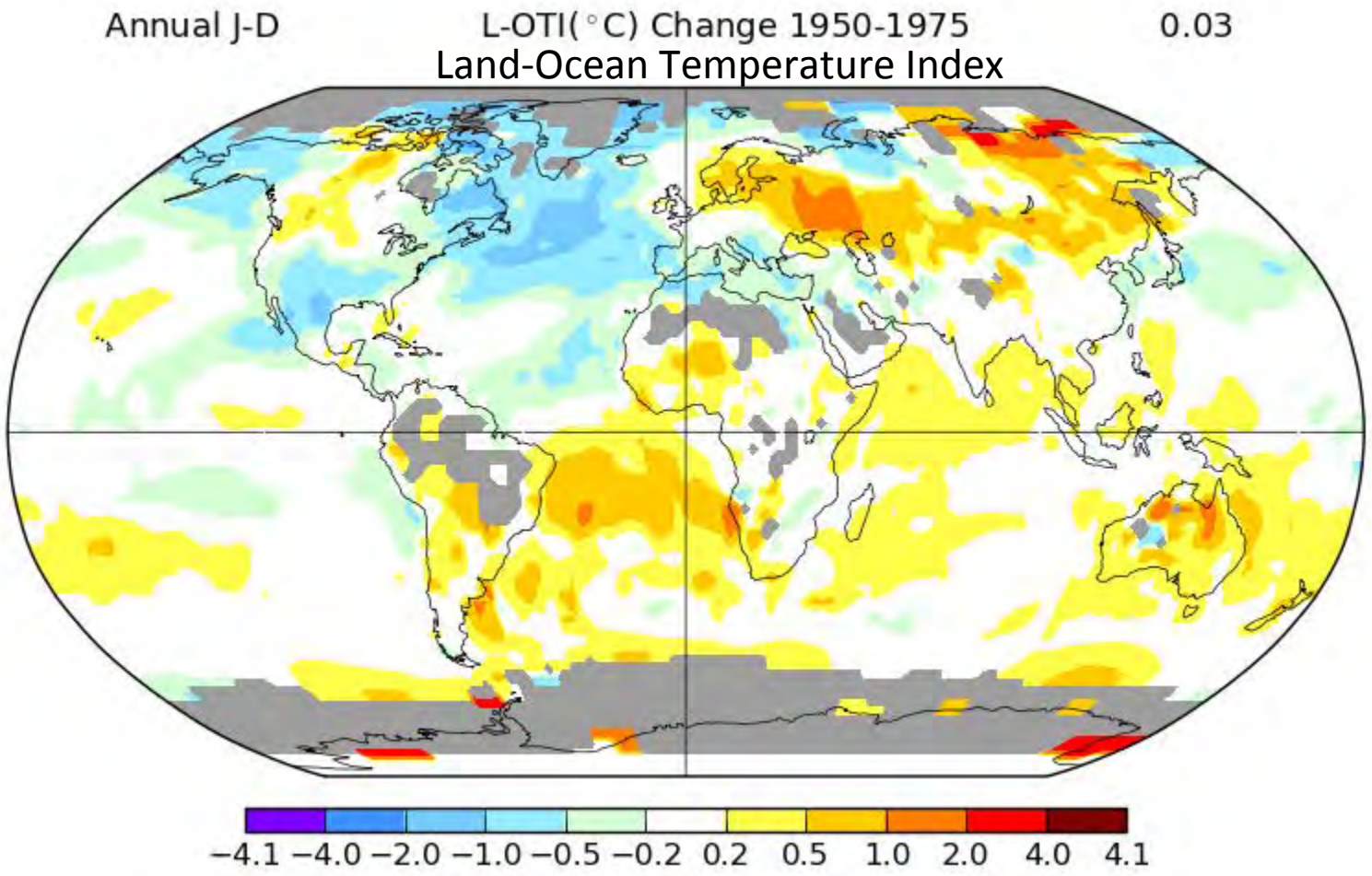
Late Winter and Early Spring Distribution



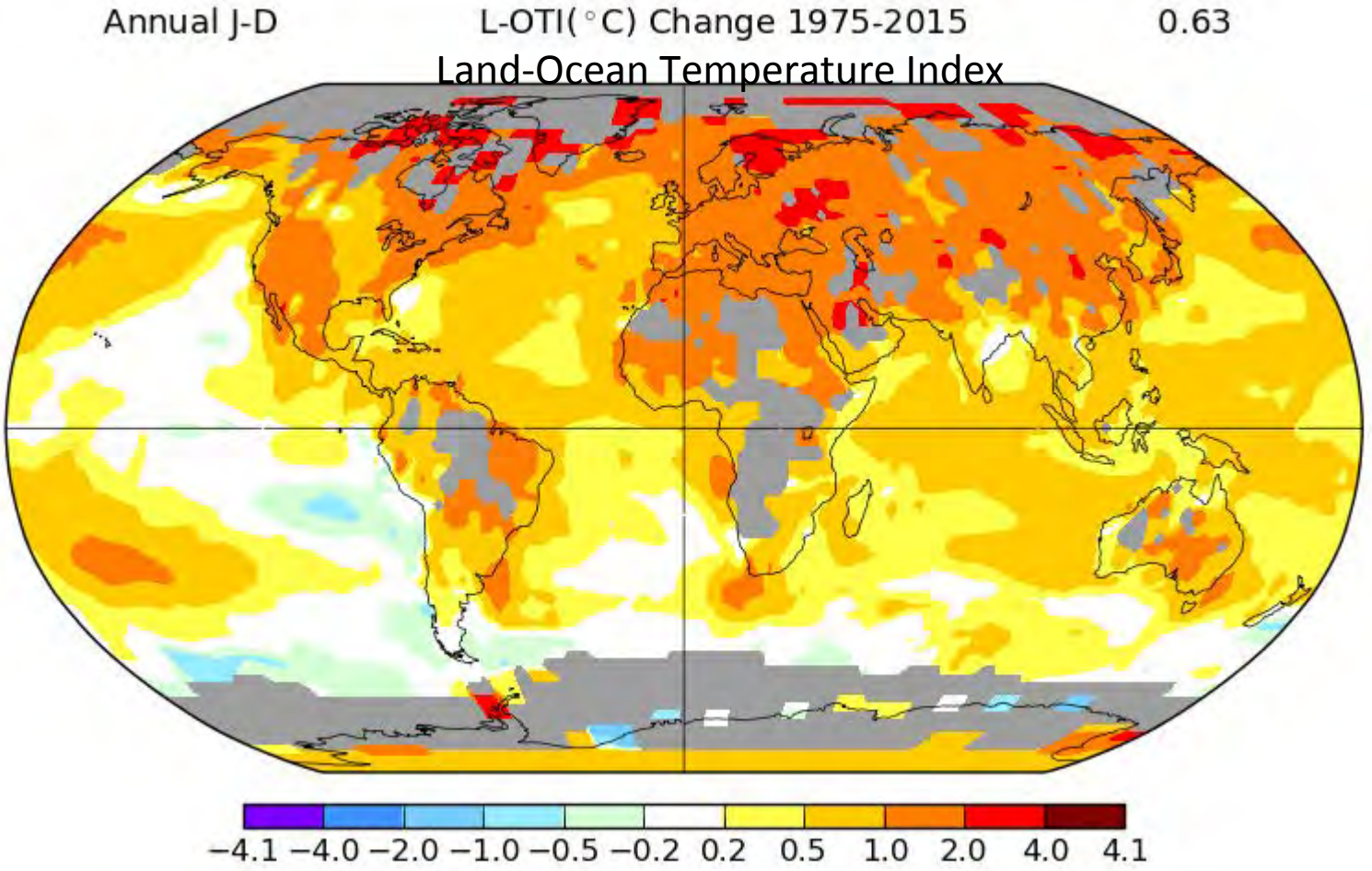


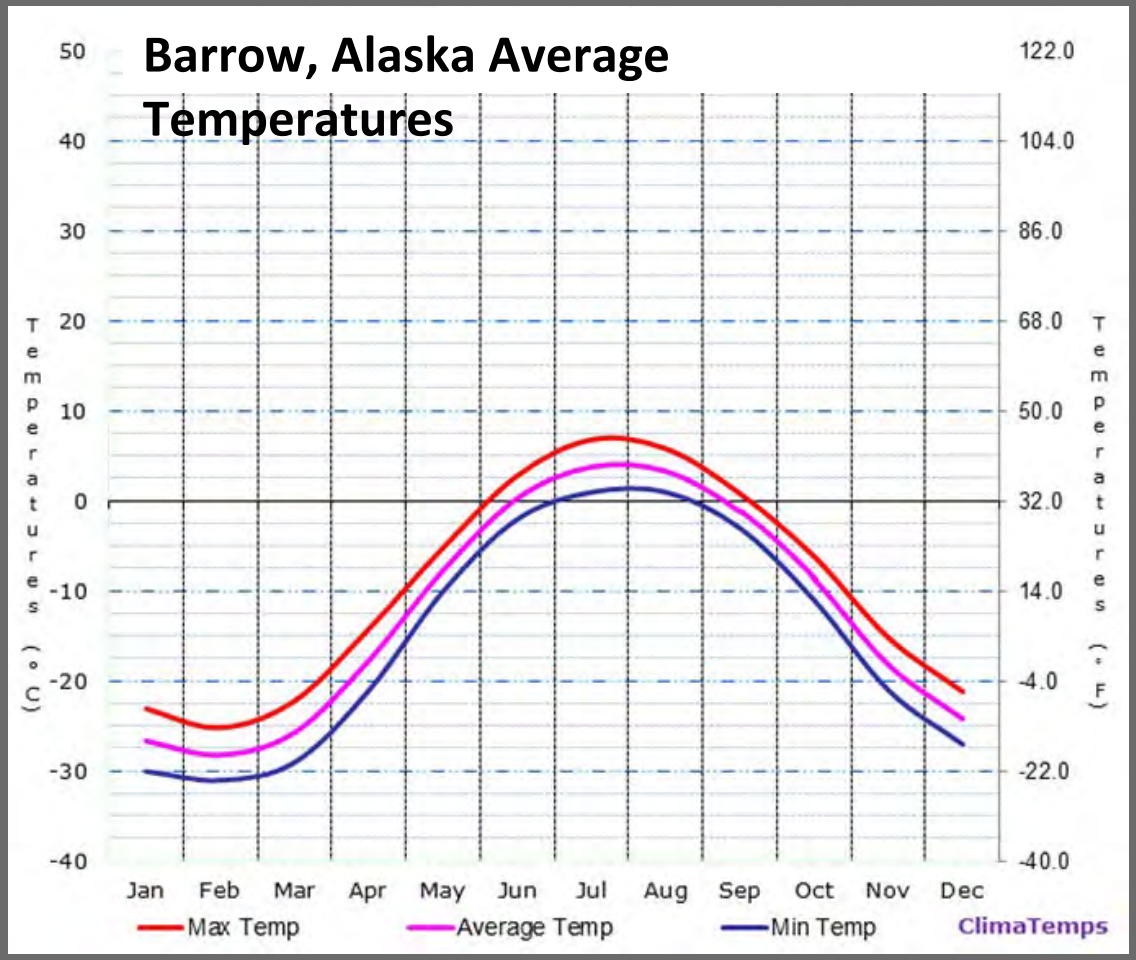

Sea Ice Habitat
in Winter

The world before my study began



The world during my study

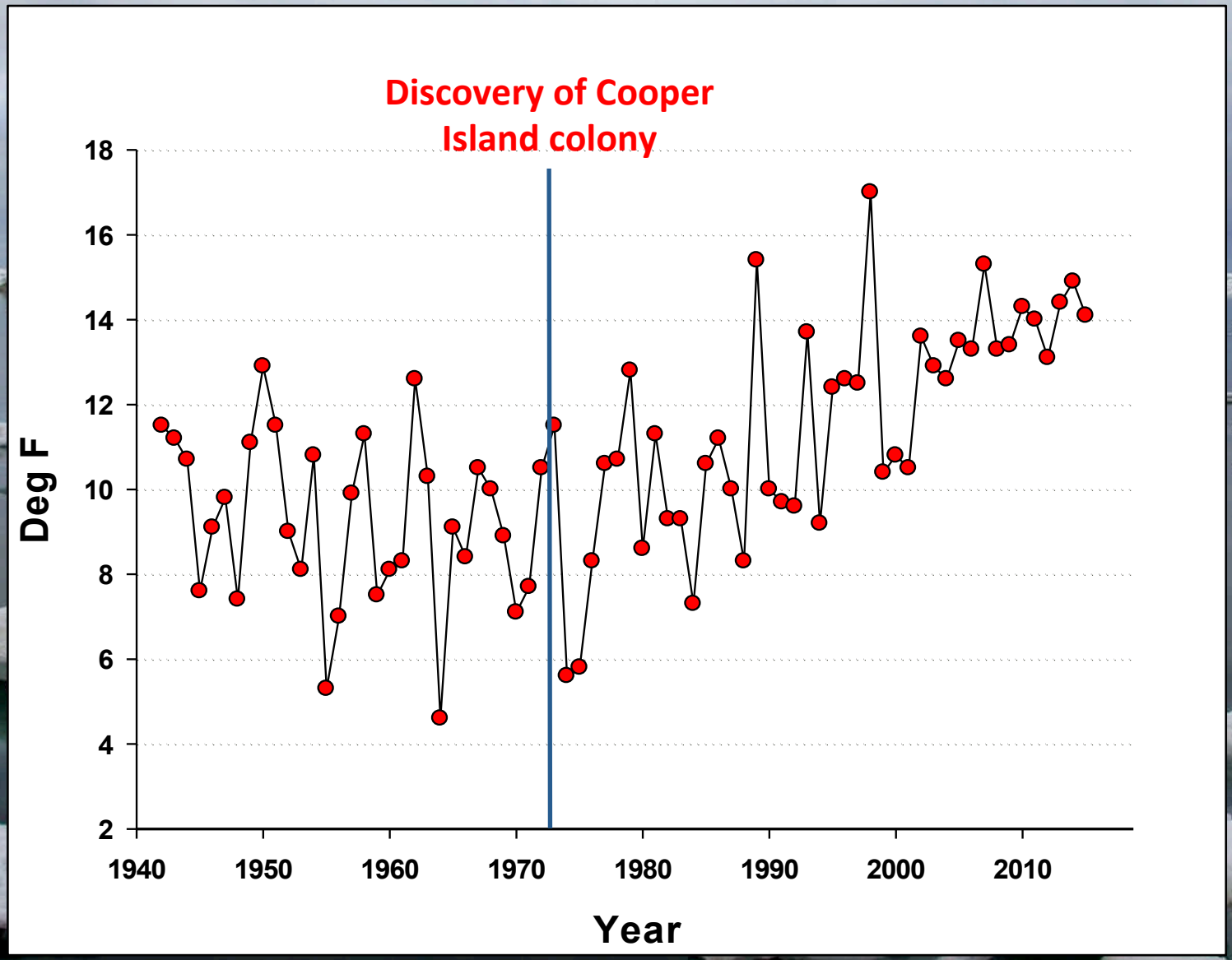




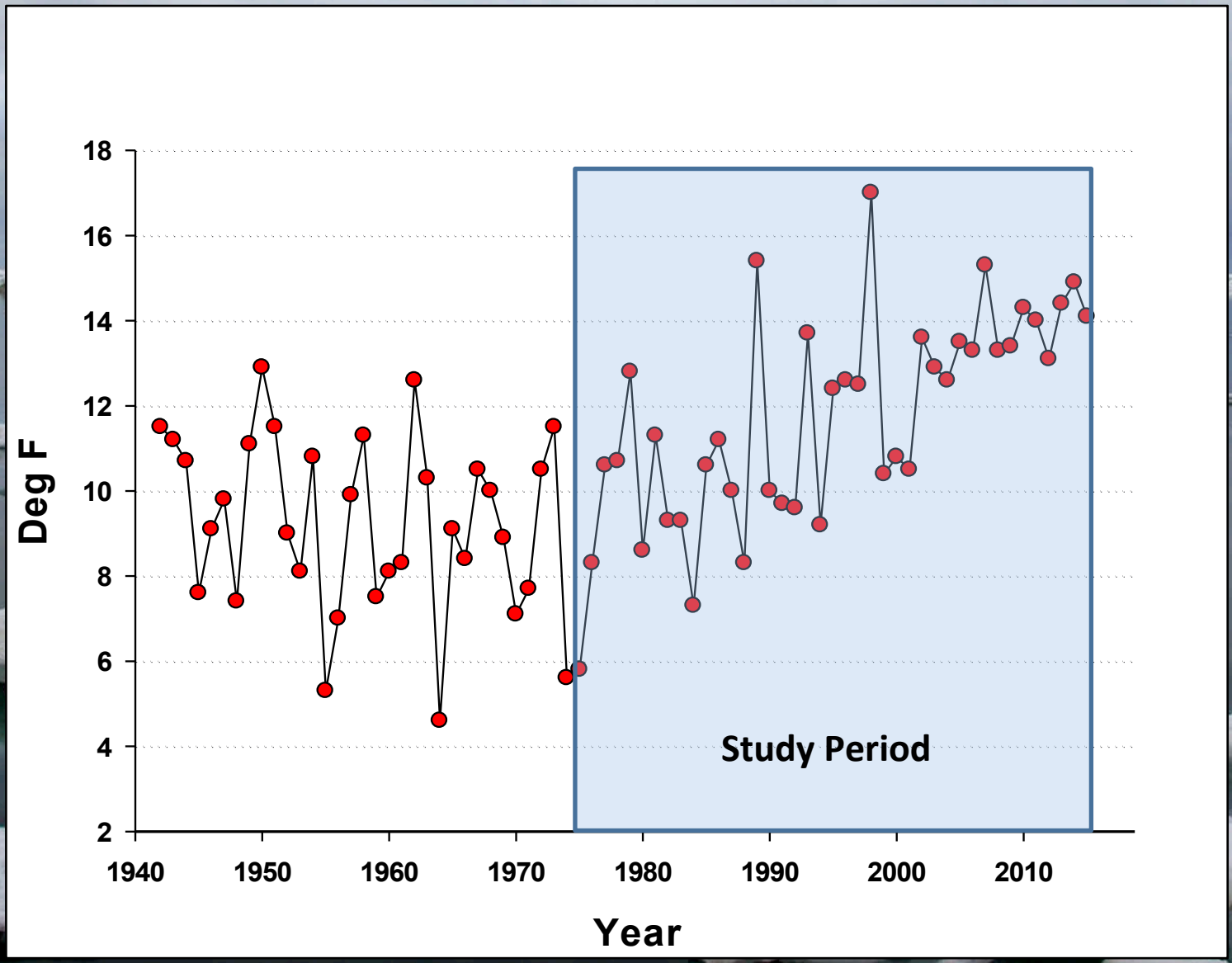
3.2°C increase

Total Change in Mean Temperature (°F) 1949-2015					
	Winter	Spring	Summer	Fall	Annual
1949-2015	7.6	5.6	3.6	6.3	5.8
1977-2015	3.4	5.3	2.5	9.8	5.1

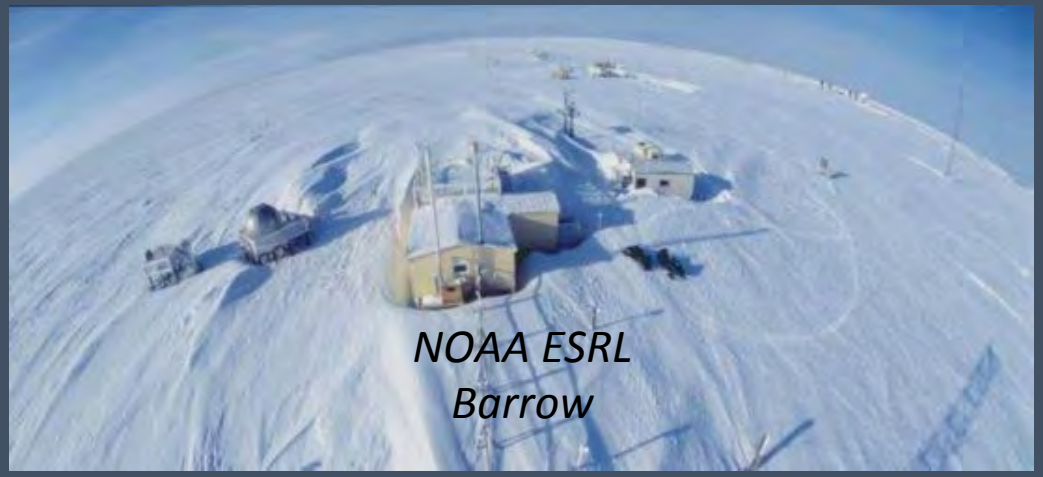
Average Monthly Temperature - Barrow



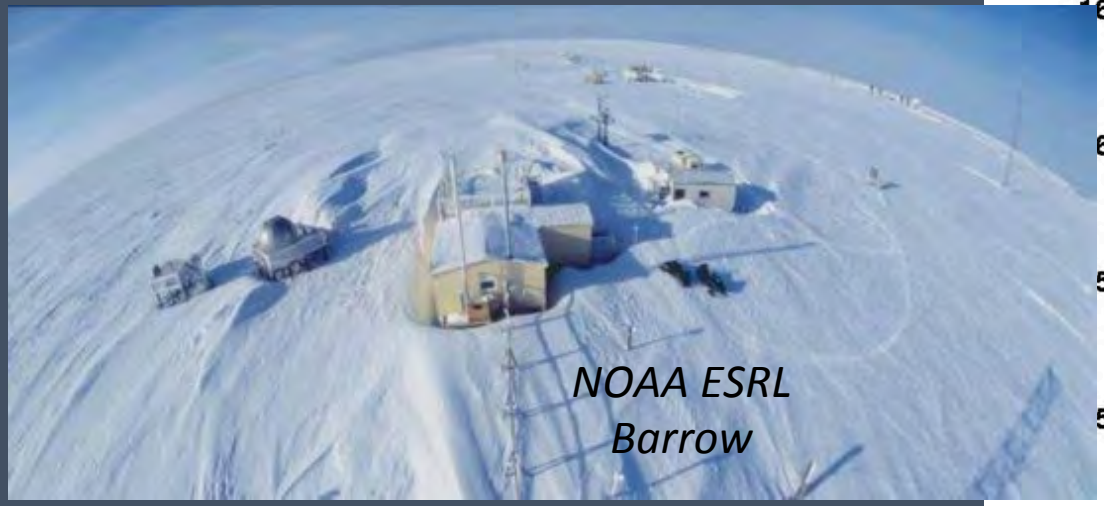
Average Monthly Temperature - Barrow

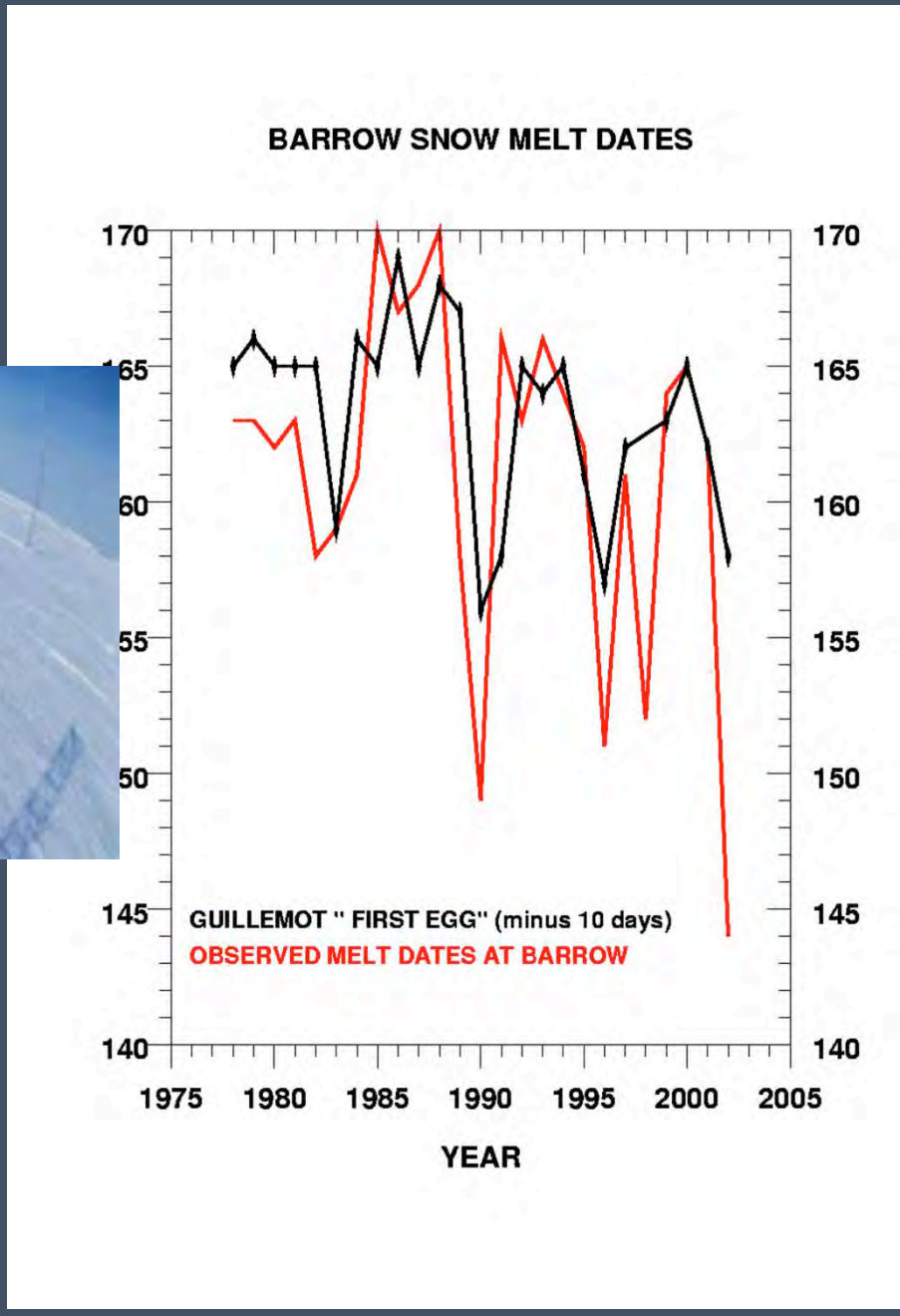


Excellent environmental data sets from 20 miles away in Barrow, Alaska

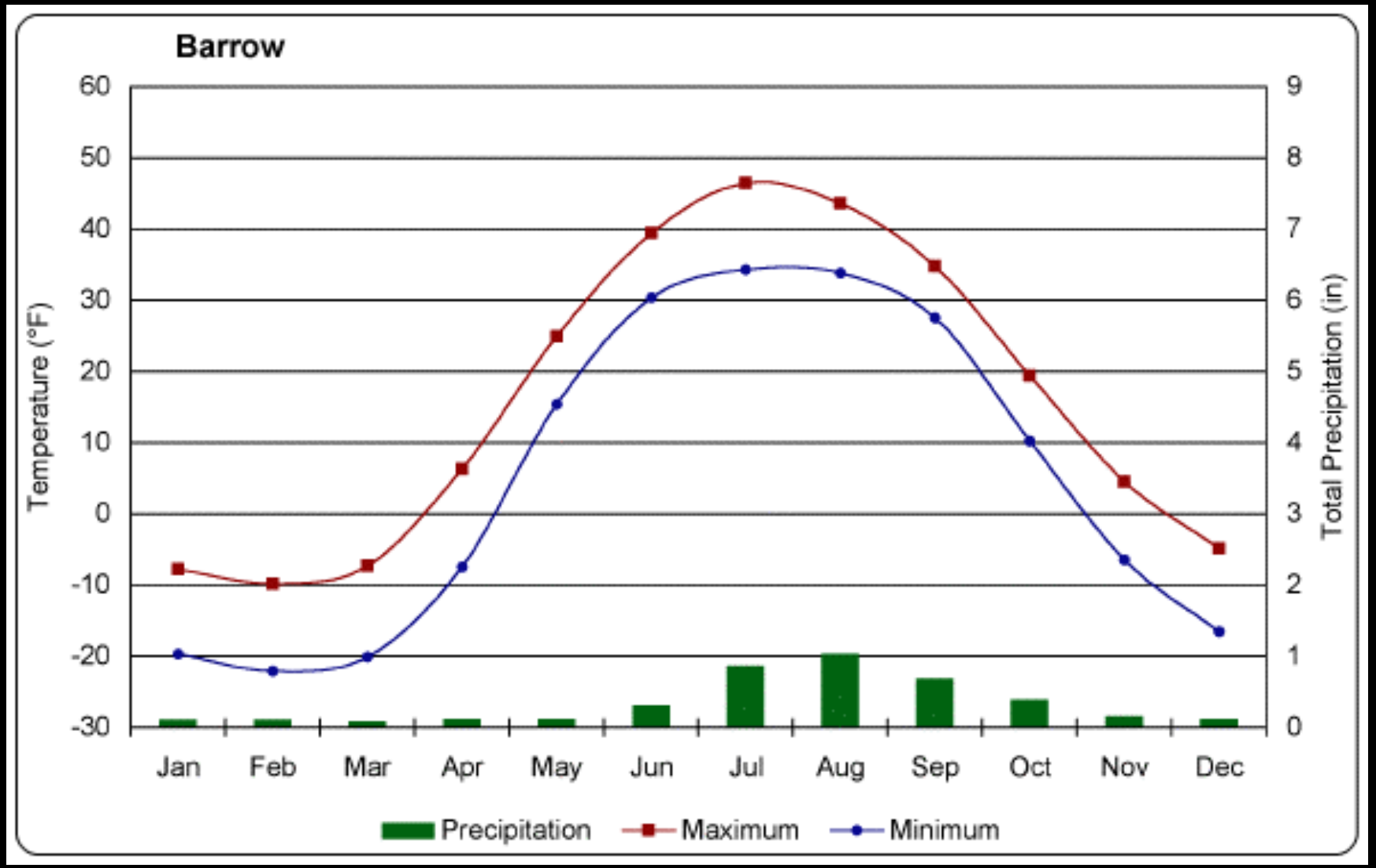


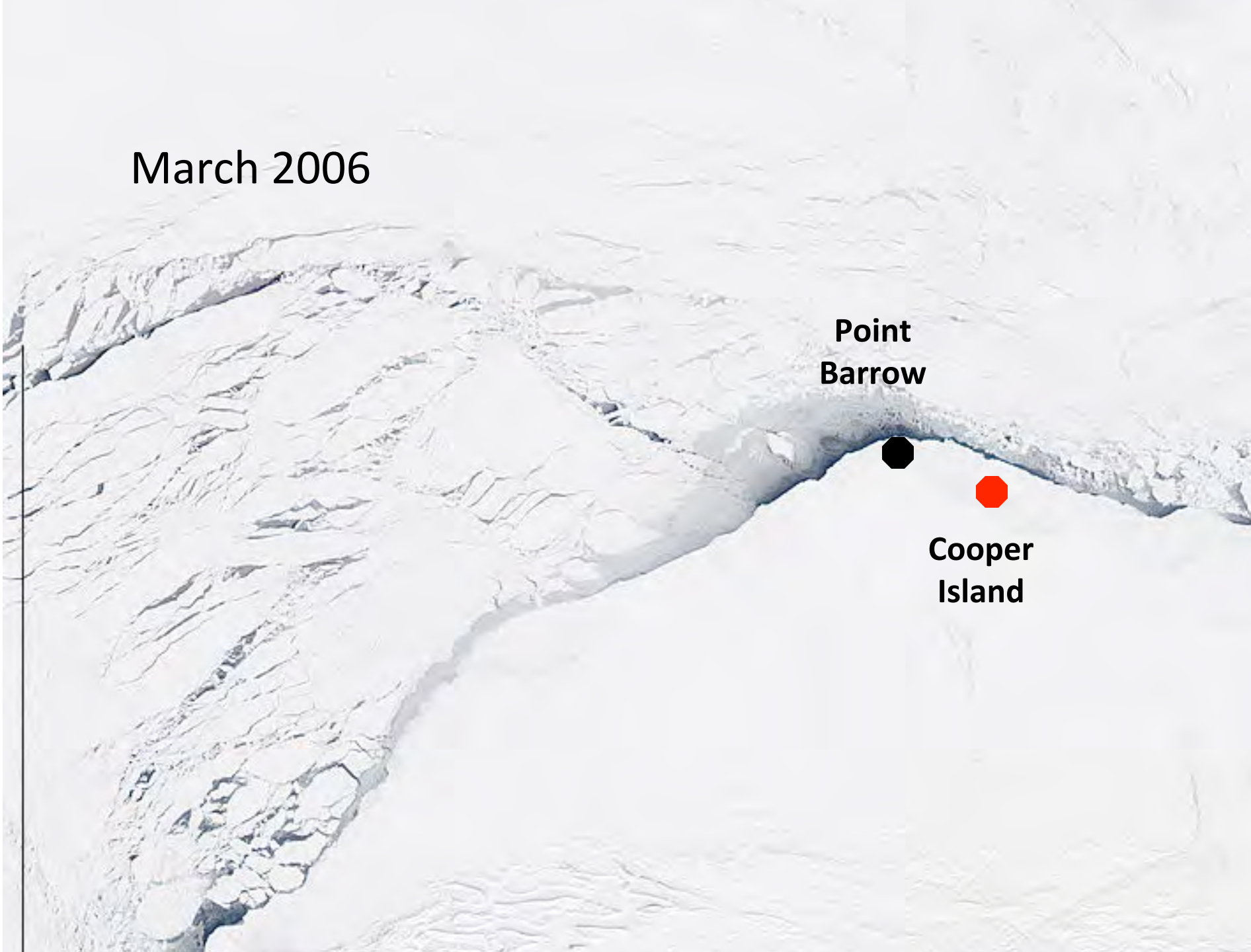
Correlation of annual snowmelt at Barrow and Cooper Island

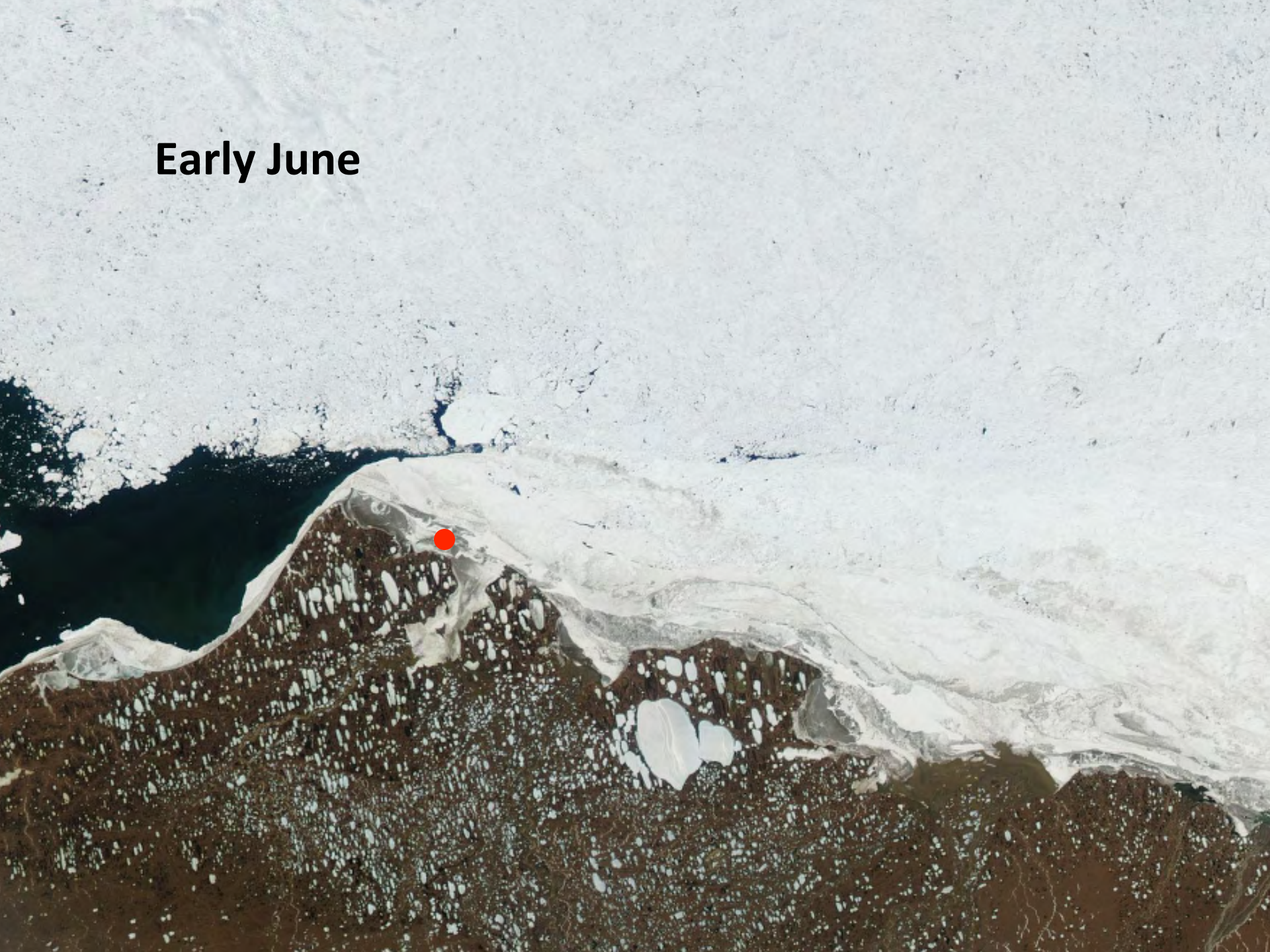




Range Expansion to Arctic Alaska


Barrow
Temperature (°F)
Total Precipitation (in)
60
50
40
30
20
10
0
-10
-20
-30
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Precipitation
Maximum
Minimum

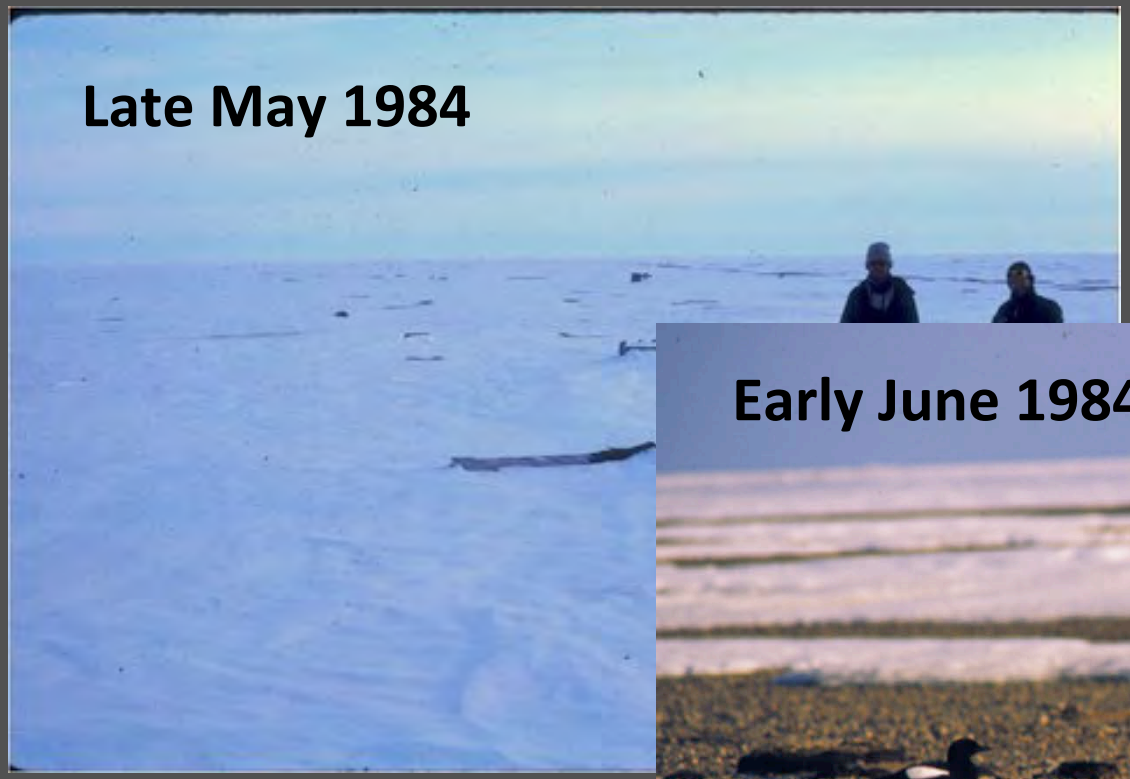

March 2006
Point
Barrow
Cooper
Island


Early June


May 1984

Initiation of guillemot breeding season constrained by timing of snowmelt

Guillemot breeding initiation constrained by timing of snowmelt



Guillemot breeding success reduced by snow accumulation preventing parents from feeding chicks

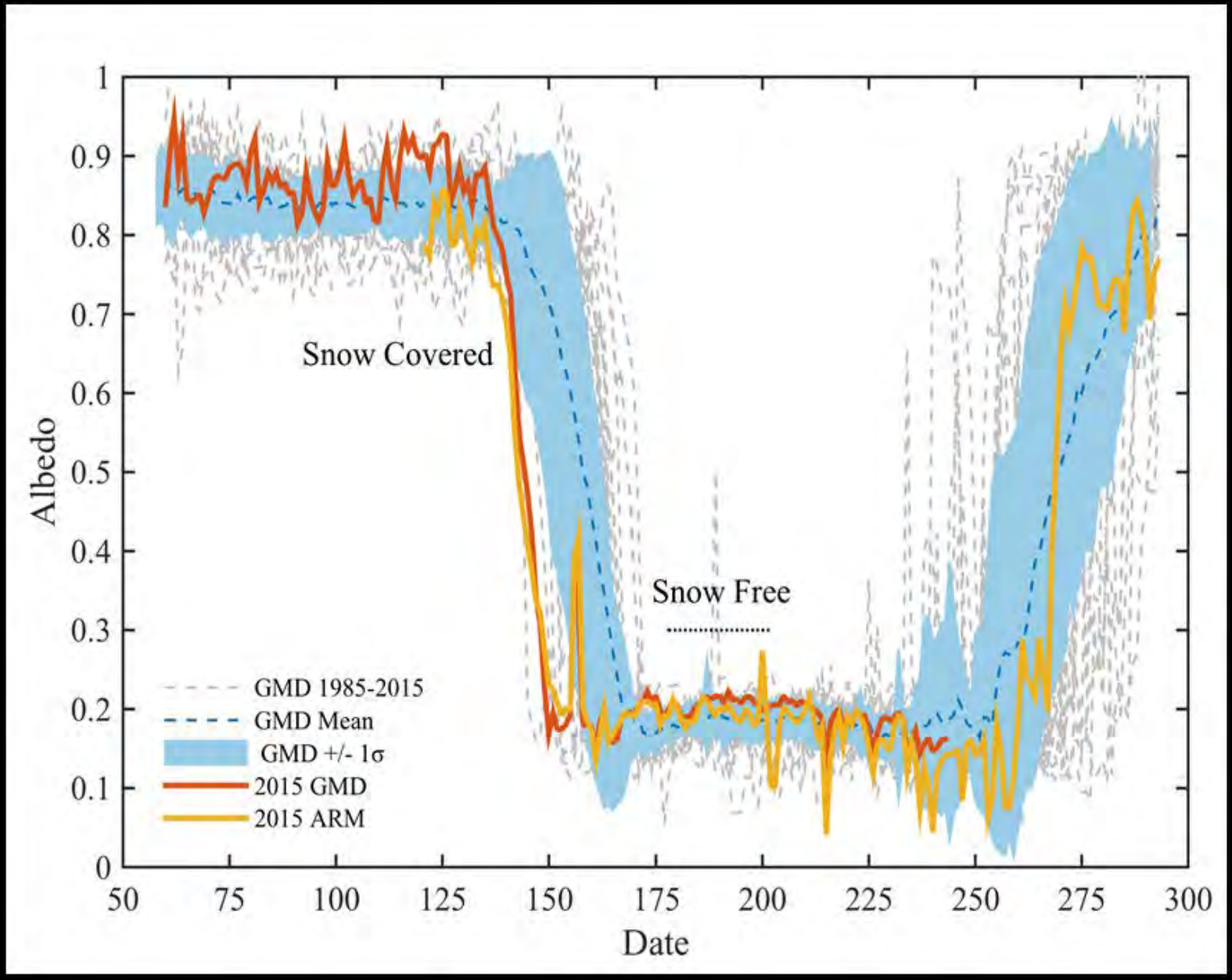
Black Guillemot Breeding Season

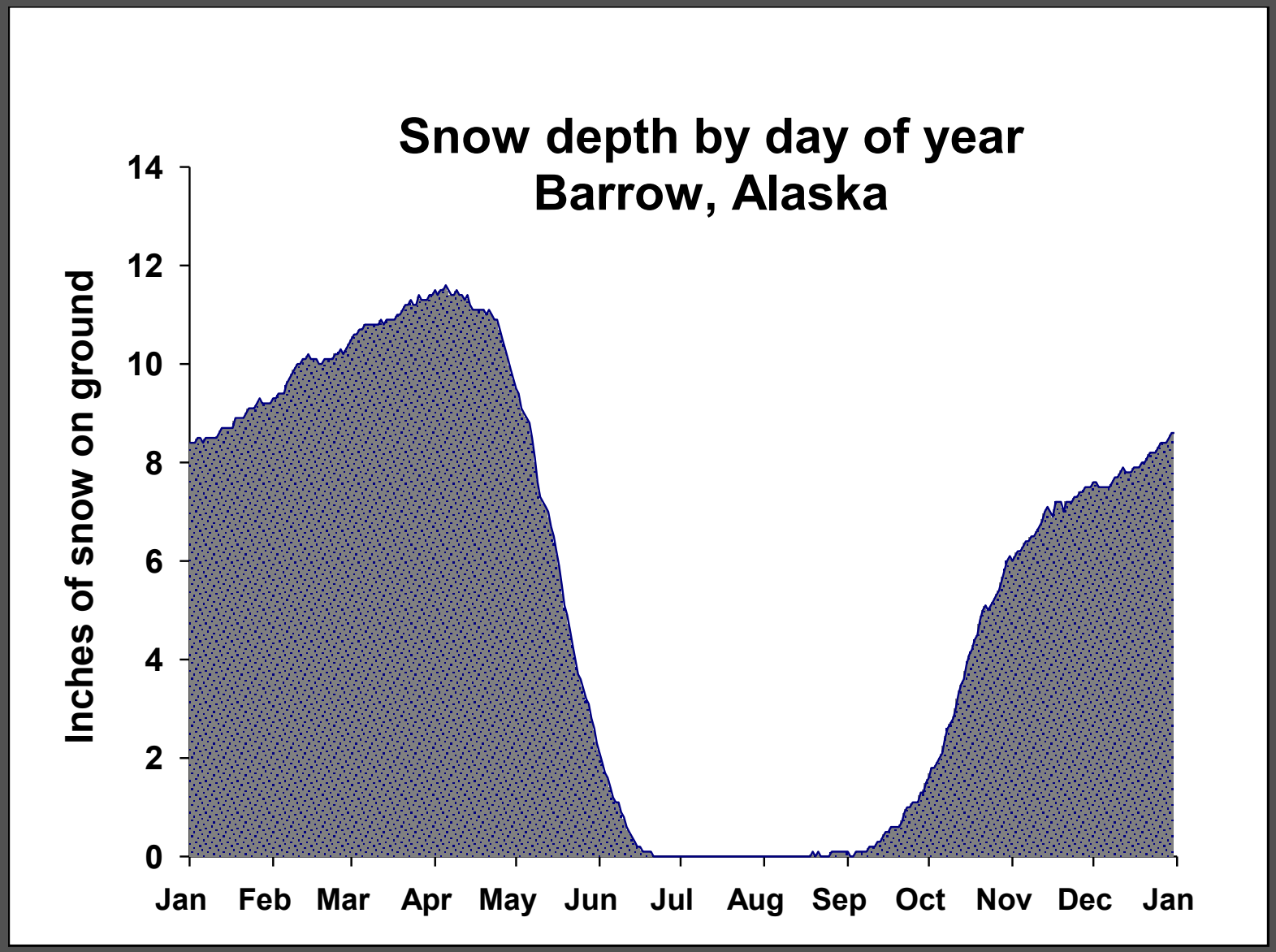
Egg Formation
14 days

Incubation
31 days

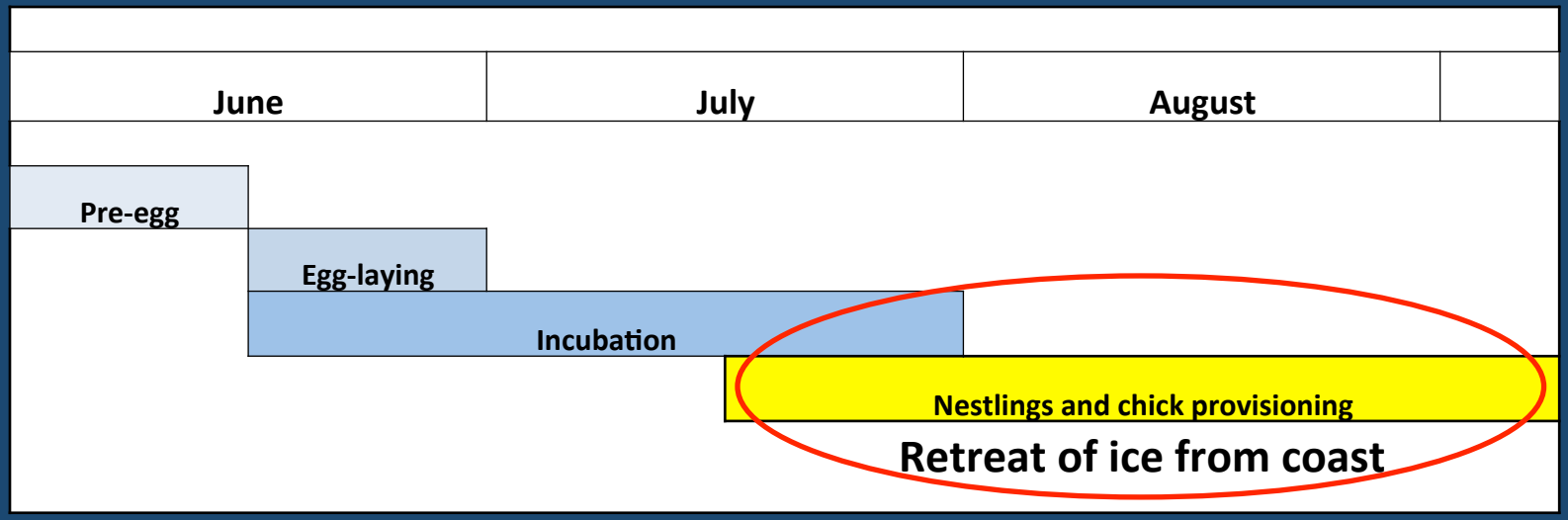
Need access to cavity for 80 days

Nestling Period 35 days

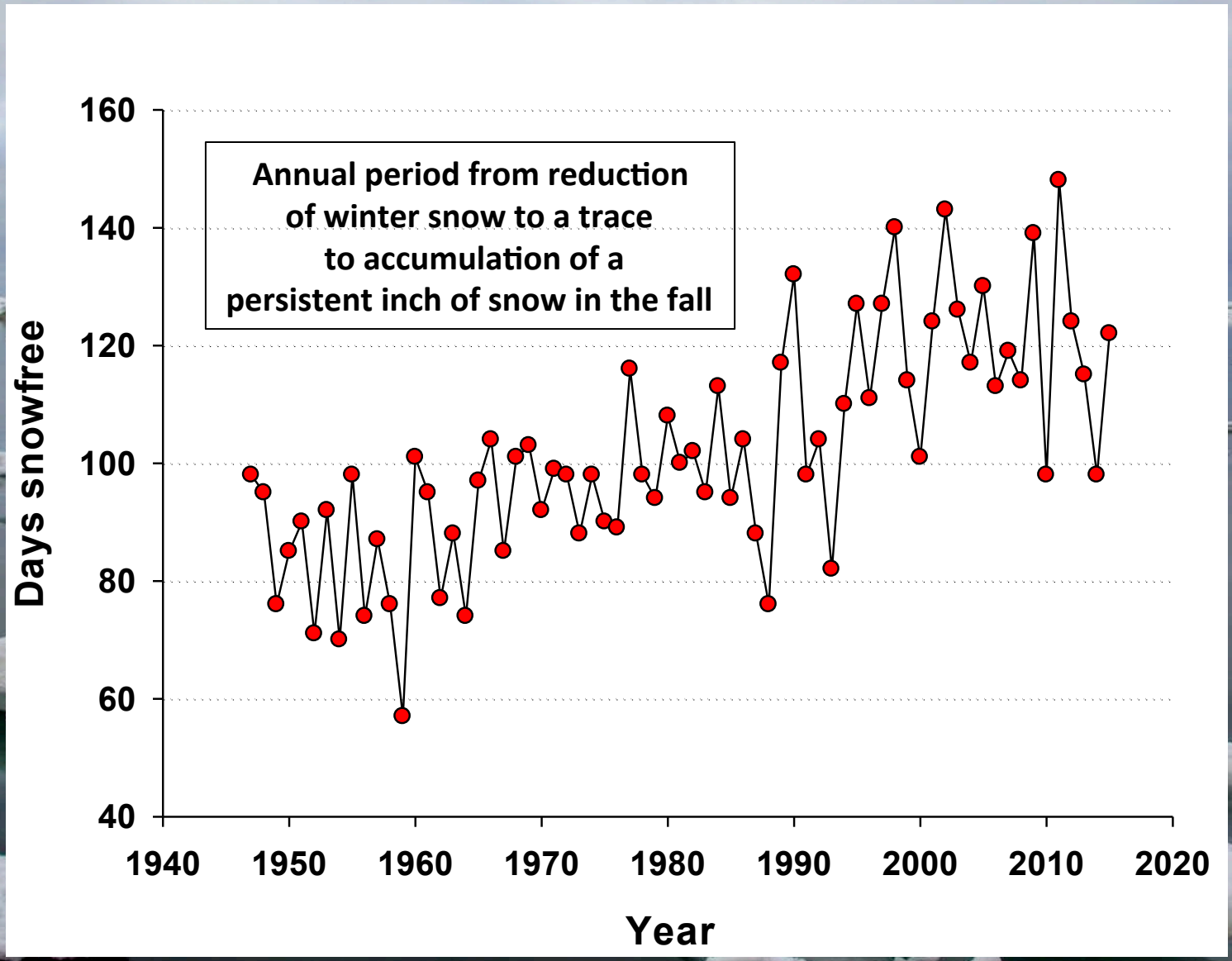

Albedo
Date
Snow Covered
Snow Free
GMD 1985-2015
GMD Mean
GMD +/- 1σ
2015 GMD
2015 ARM
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
50
75
100
125
150
175
200
225
250
275
300


Snow depth by day of year
Barrow, Alaska
Inches of snow on ground
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan

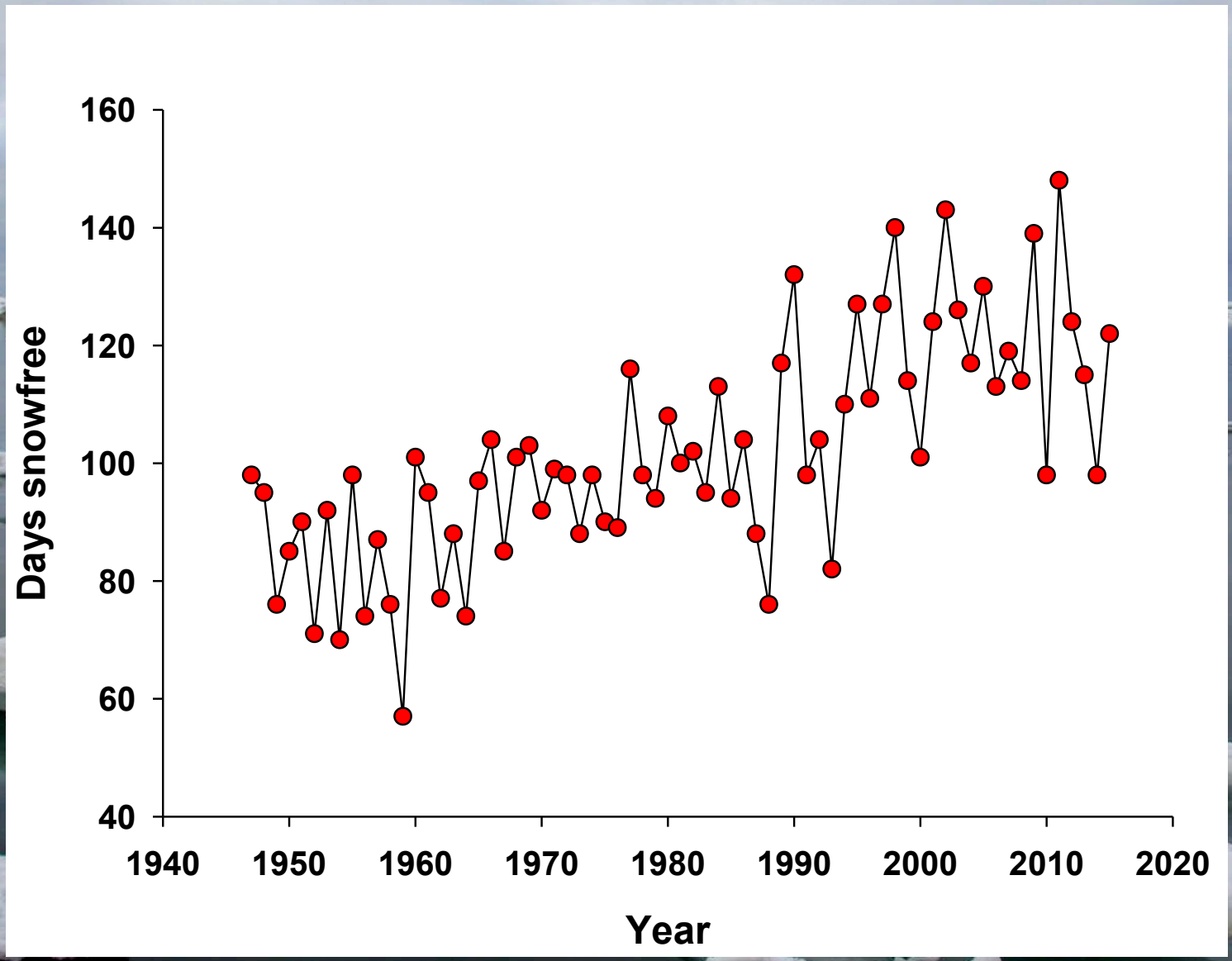
Black Guillemot Breeding Season in the Alaskan Arctic



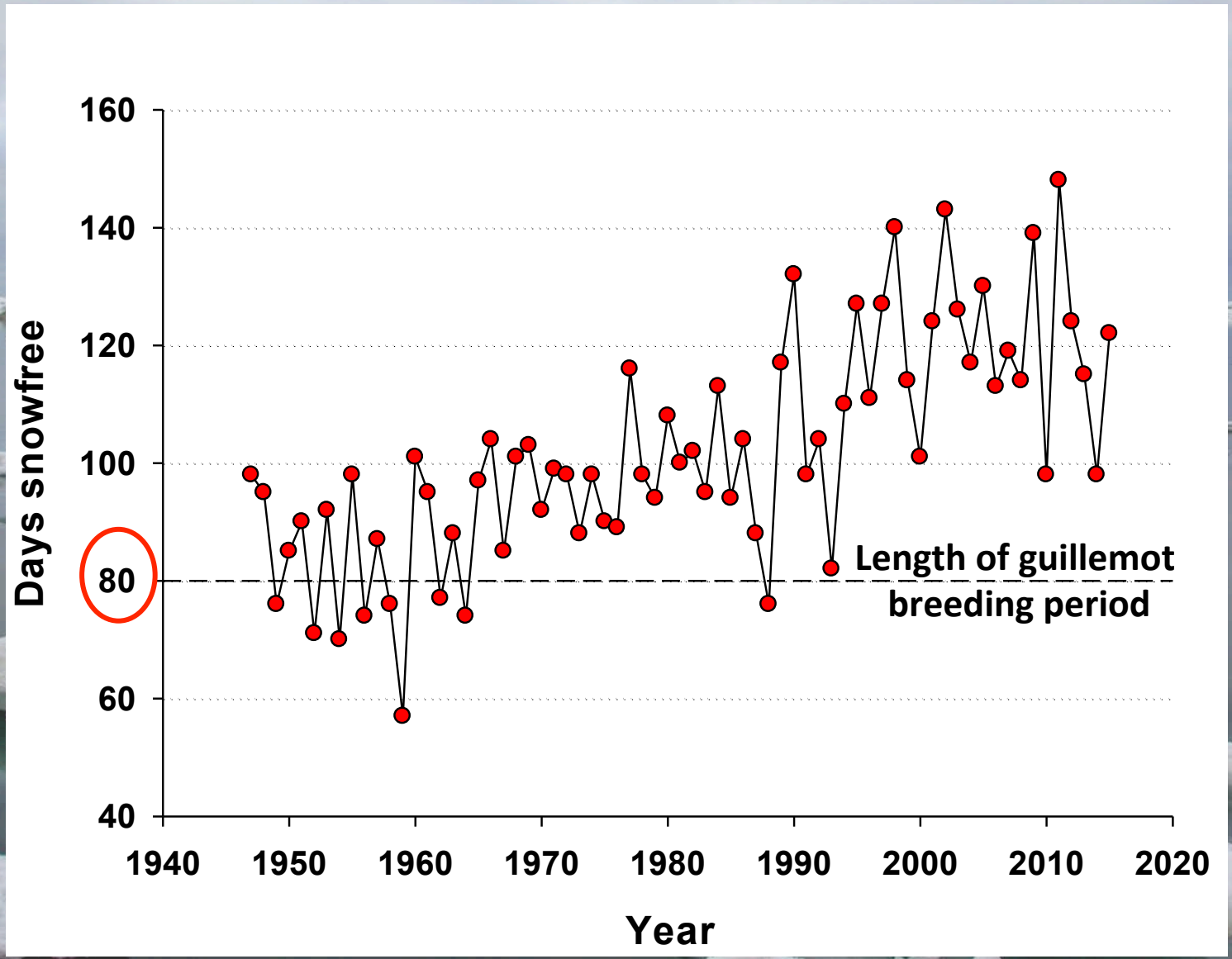
Duration of Snowfree Window



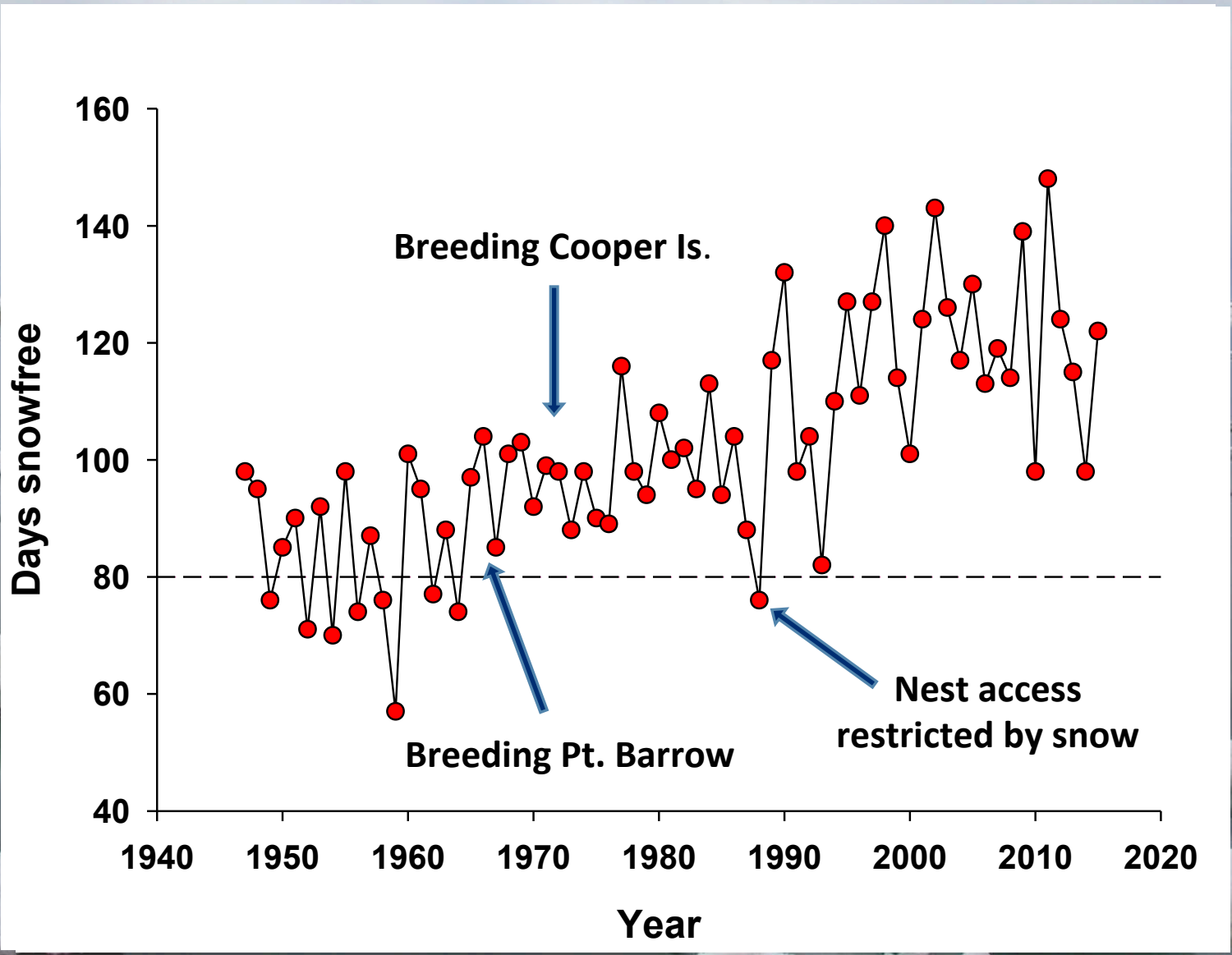
Duration of Snowfree Window



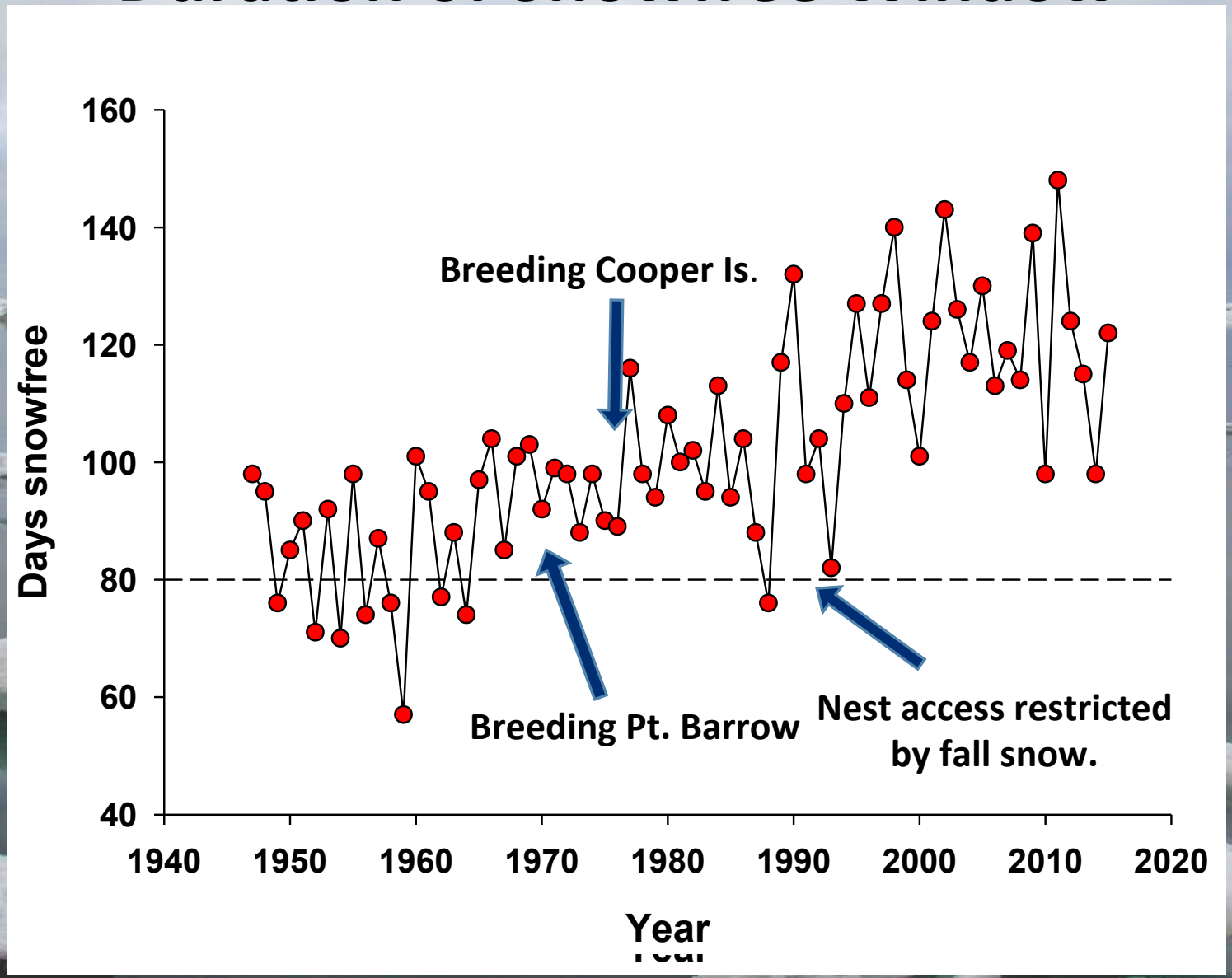
Duration of Snowfree Window



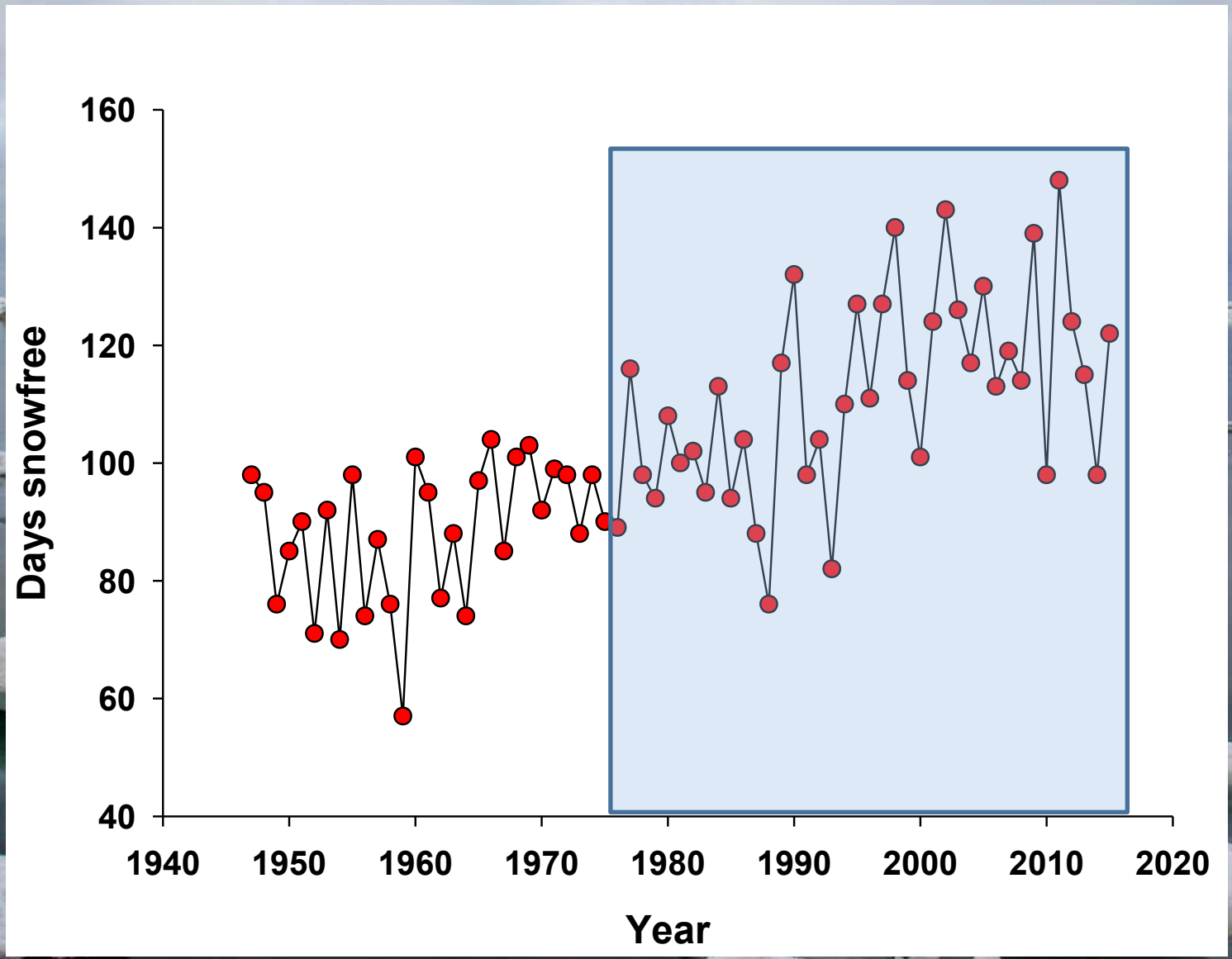
Duration of Snowfree Window



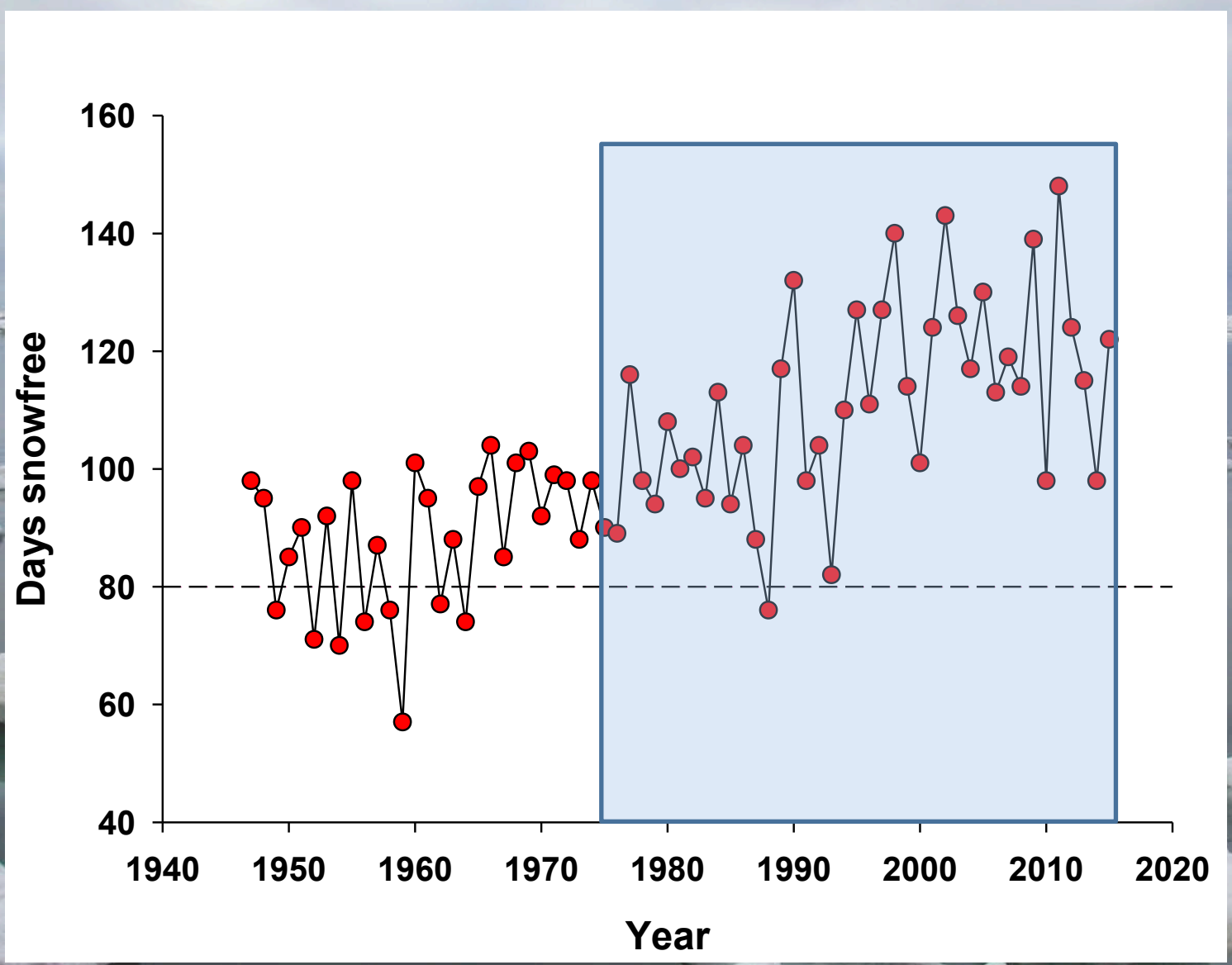
Duration of Snowfree Window



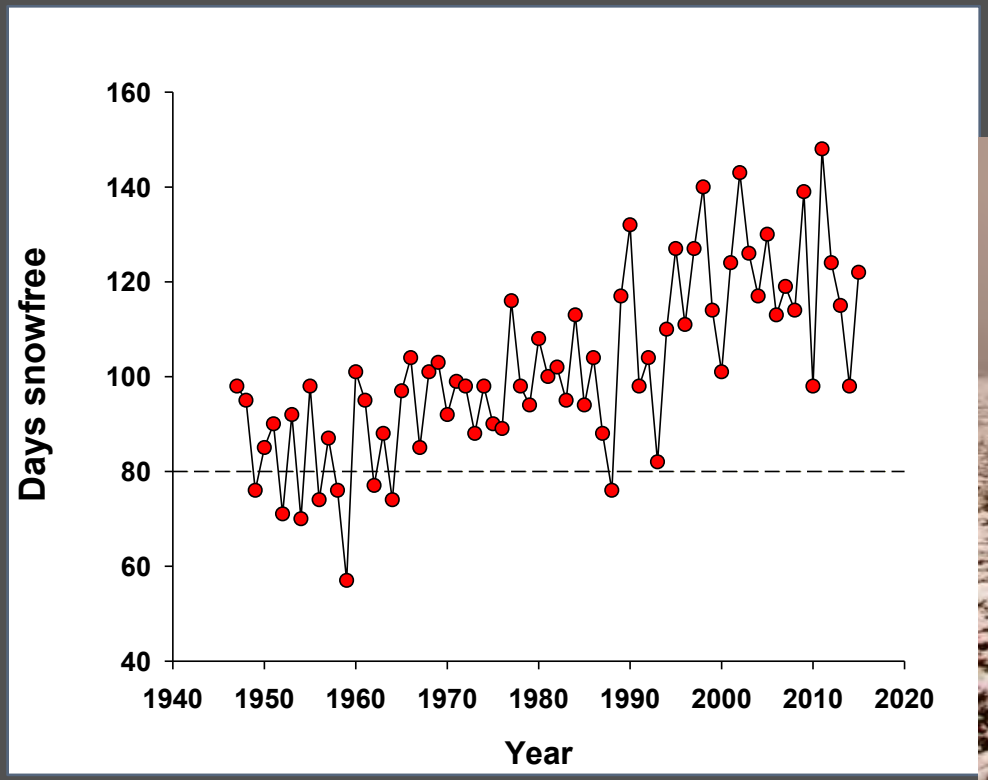
Duration of Snowfree Window



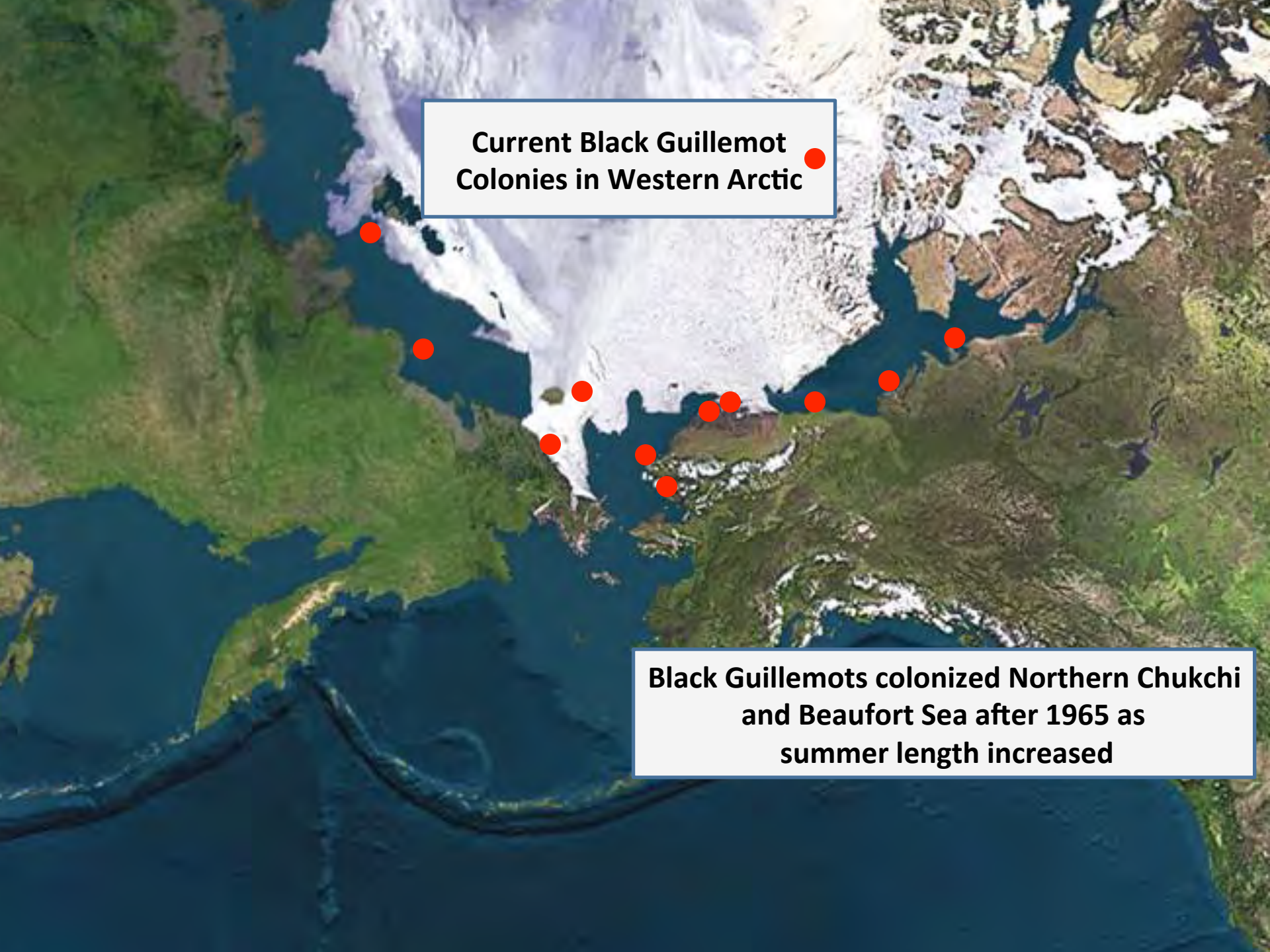
Duration of Snowfree Window



Duration of Snow




Black Guillemot Colonies in Western Arctic Before 1960s

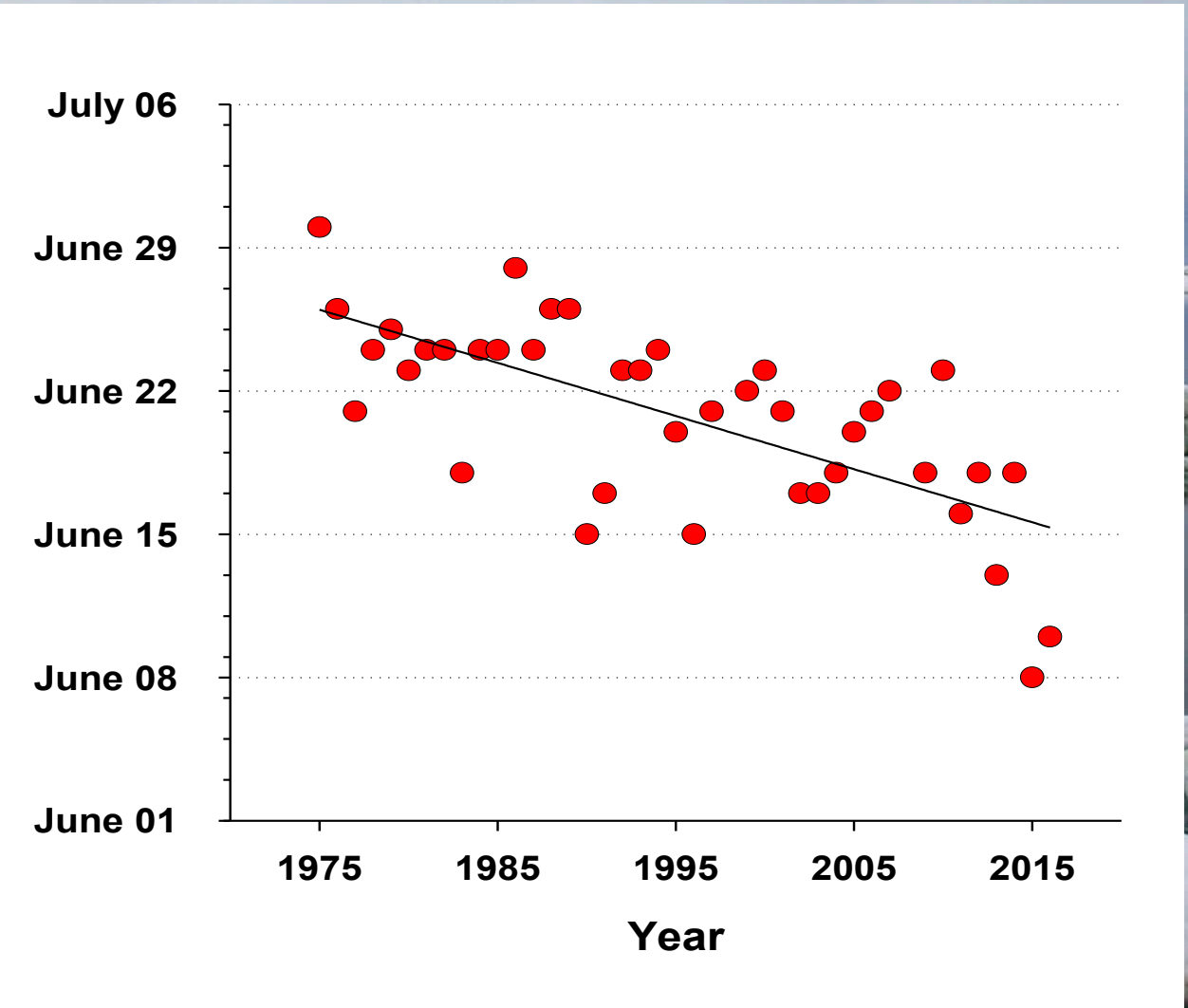

Current Black Guillemot Colonies in Western Arctic
Black Guillemots colonized Northern Chukchi and Beaufort Sea after 1965 as summer length increased


Point
Barrow
Cooper
Island
March 2006

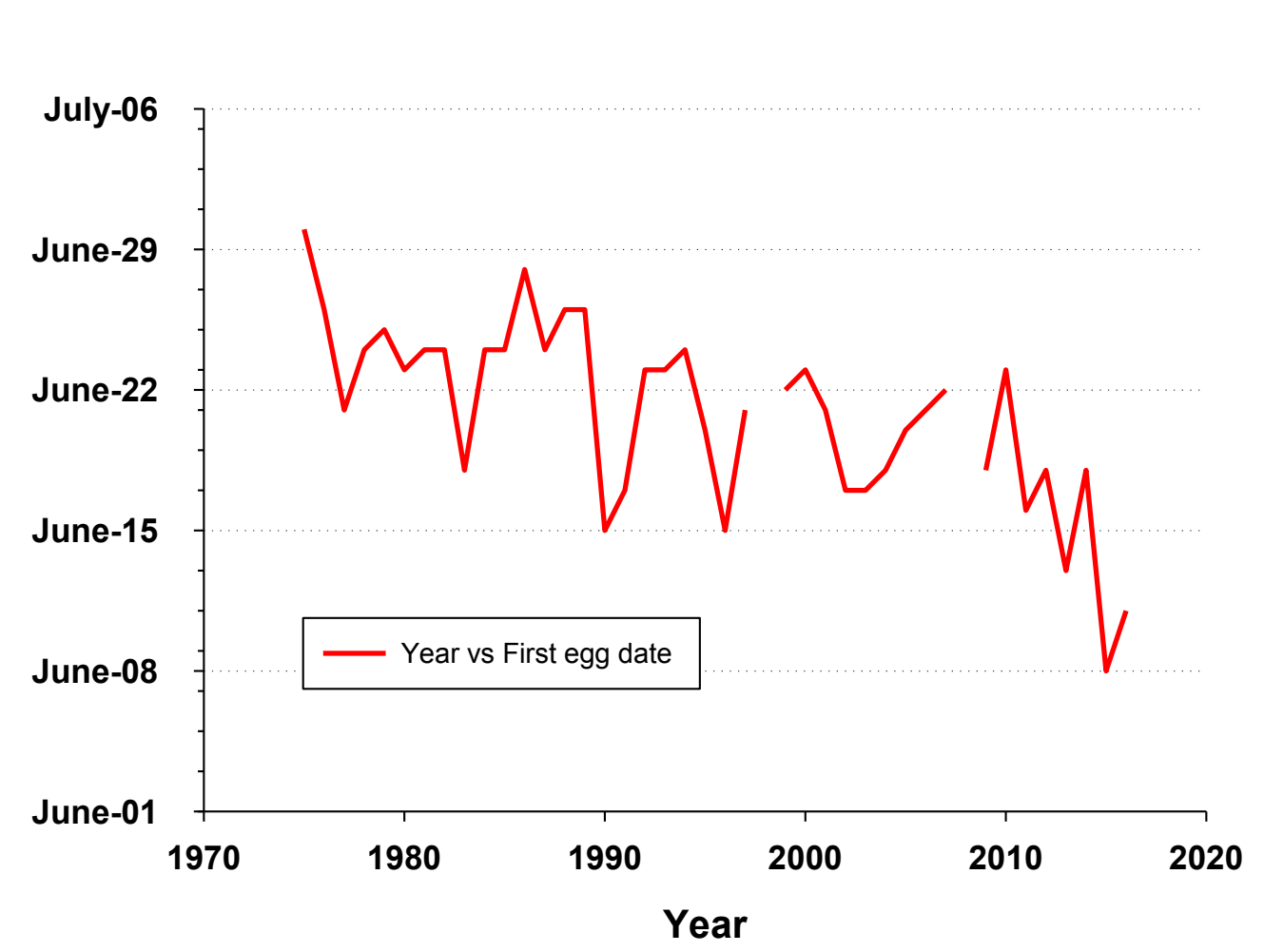
Advancement of Egg Laying

May 1984

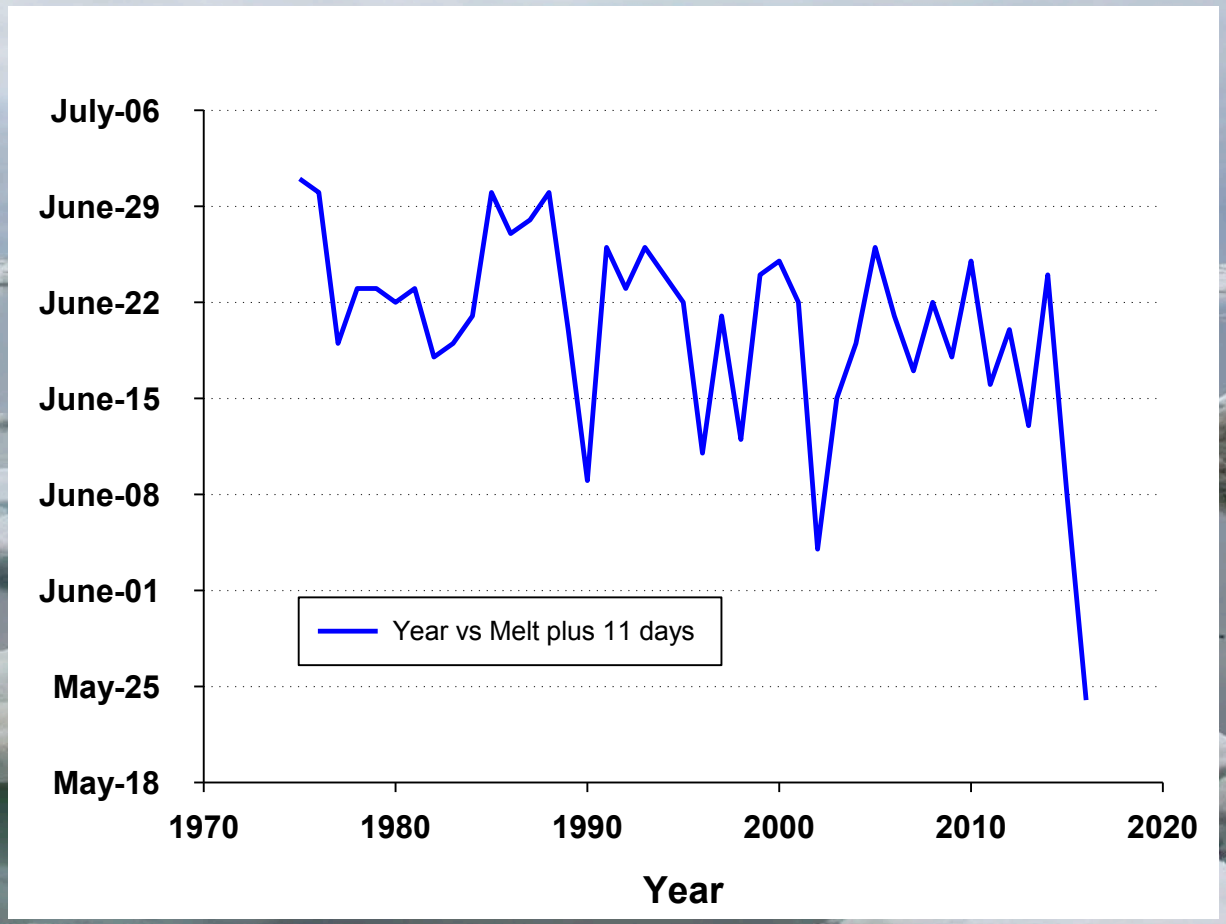
Date of First Egg in Colony



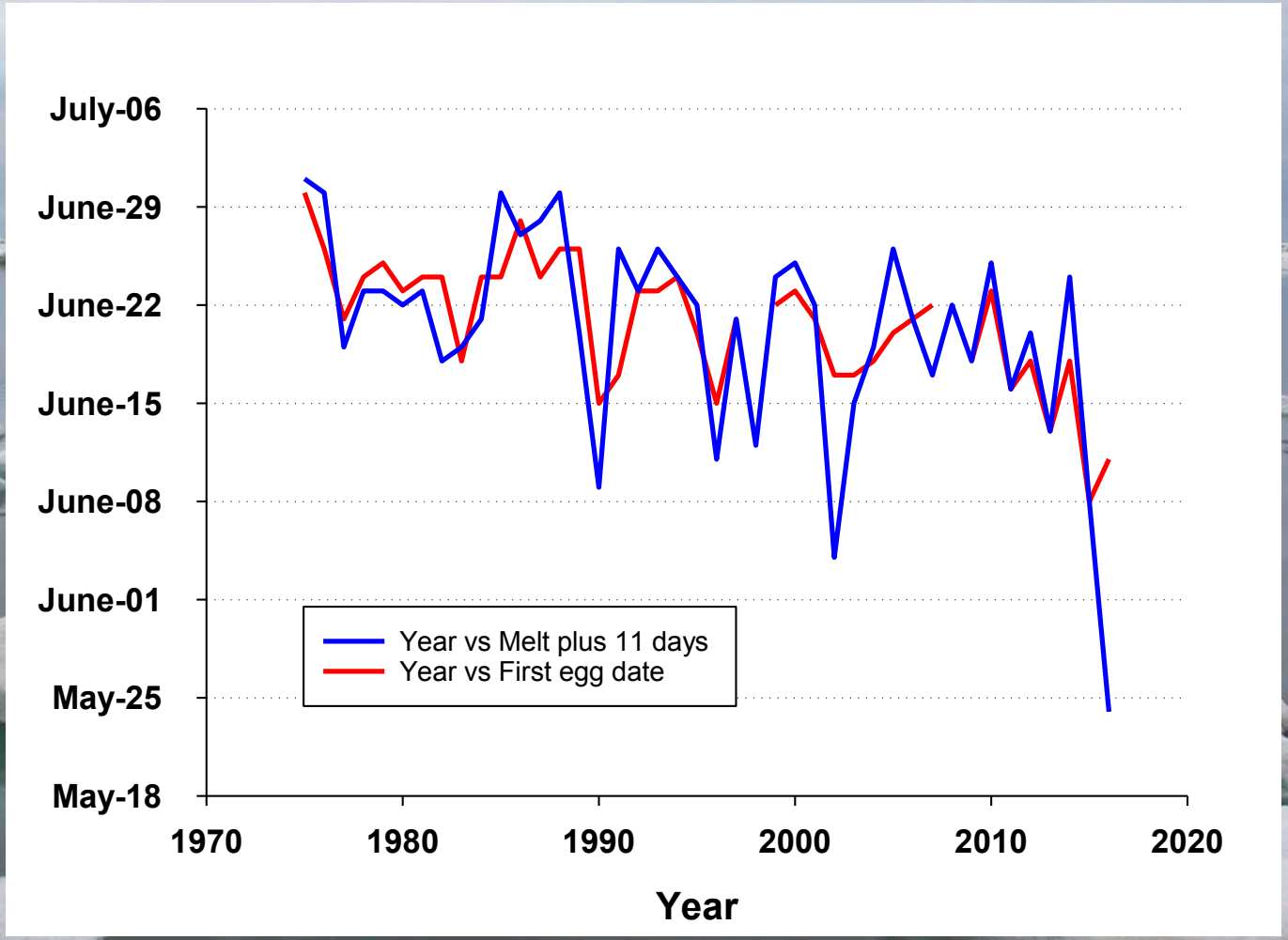
Date of First Egg in Colony

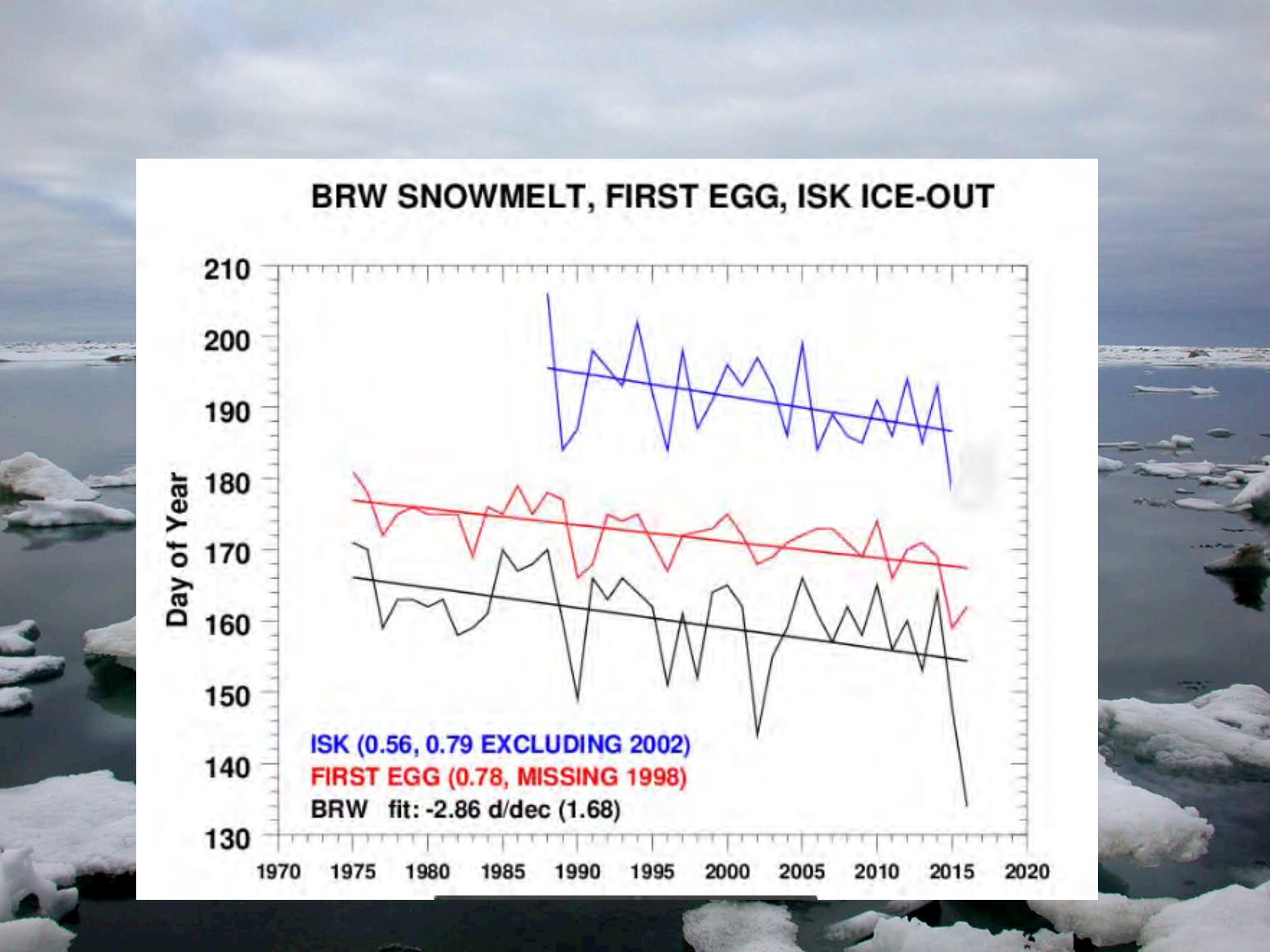


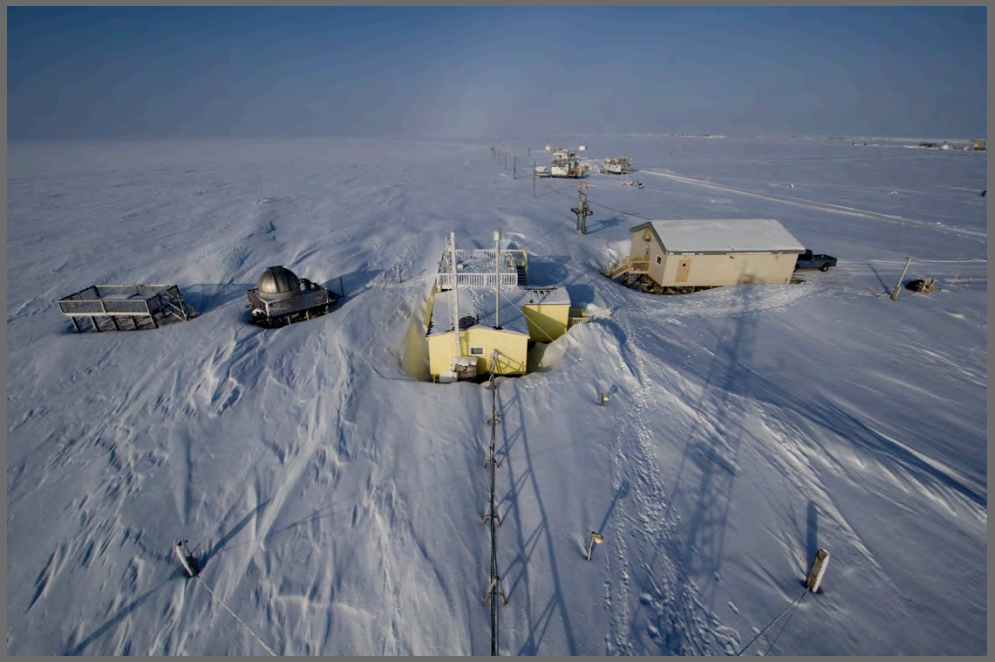
Barrow Snowmelt Date

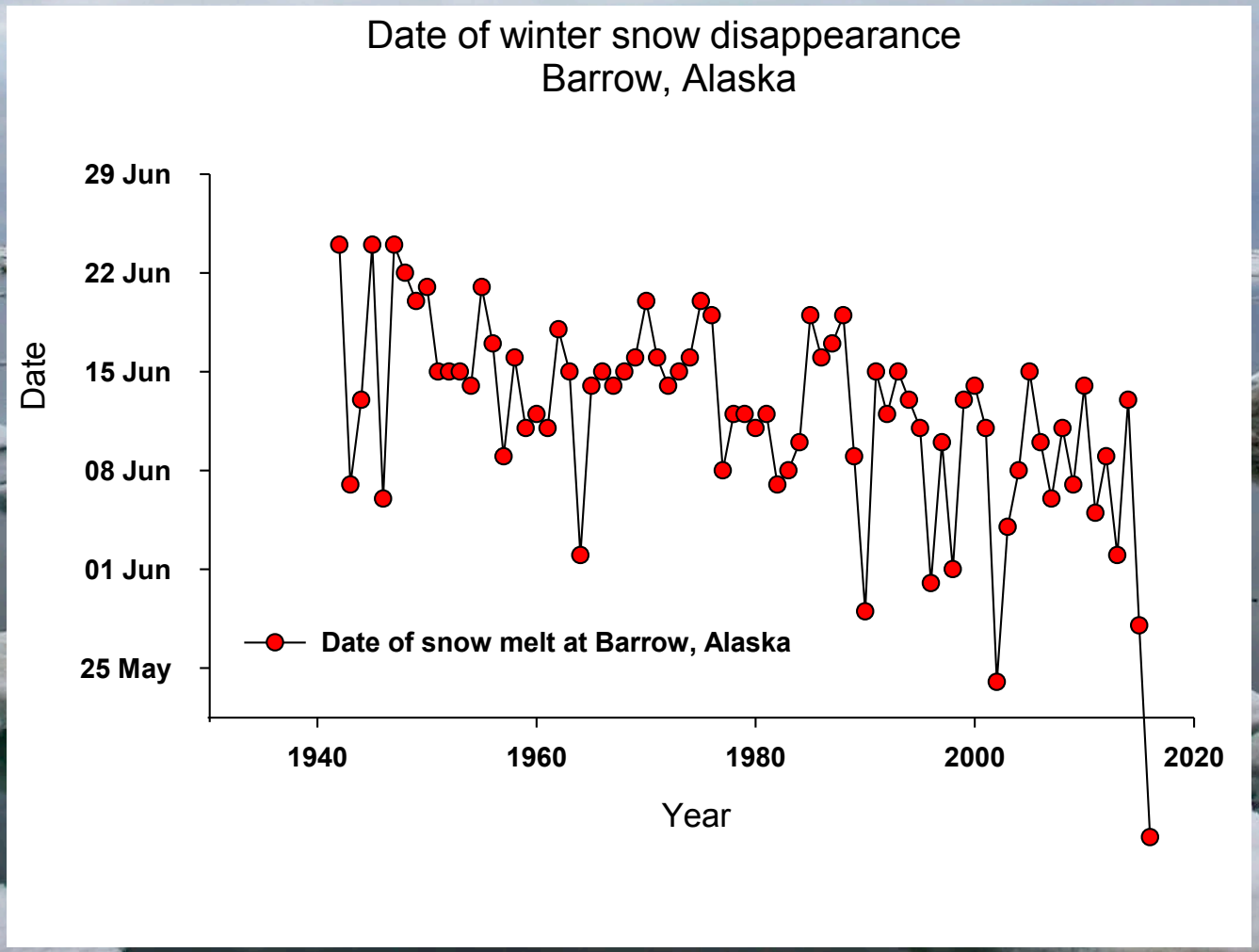


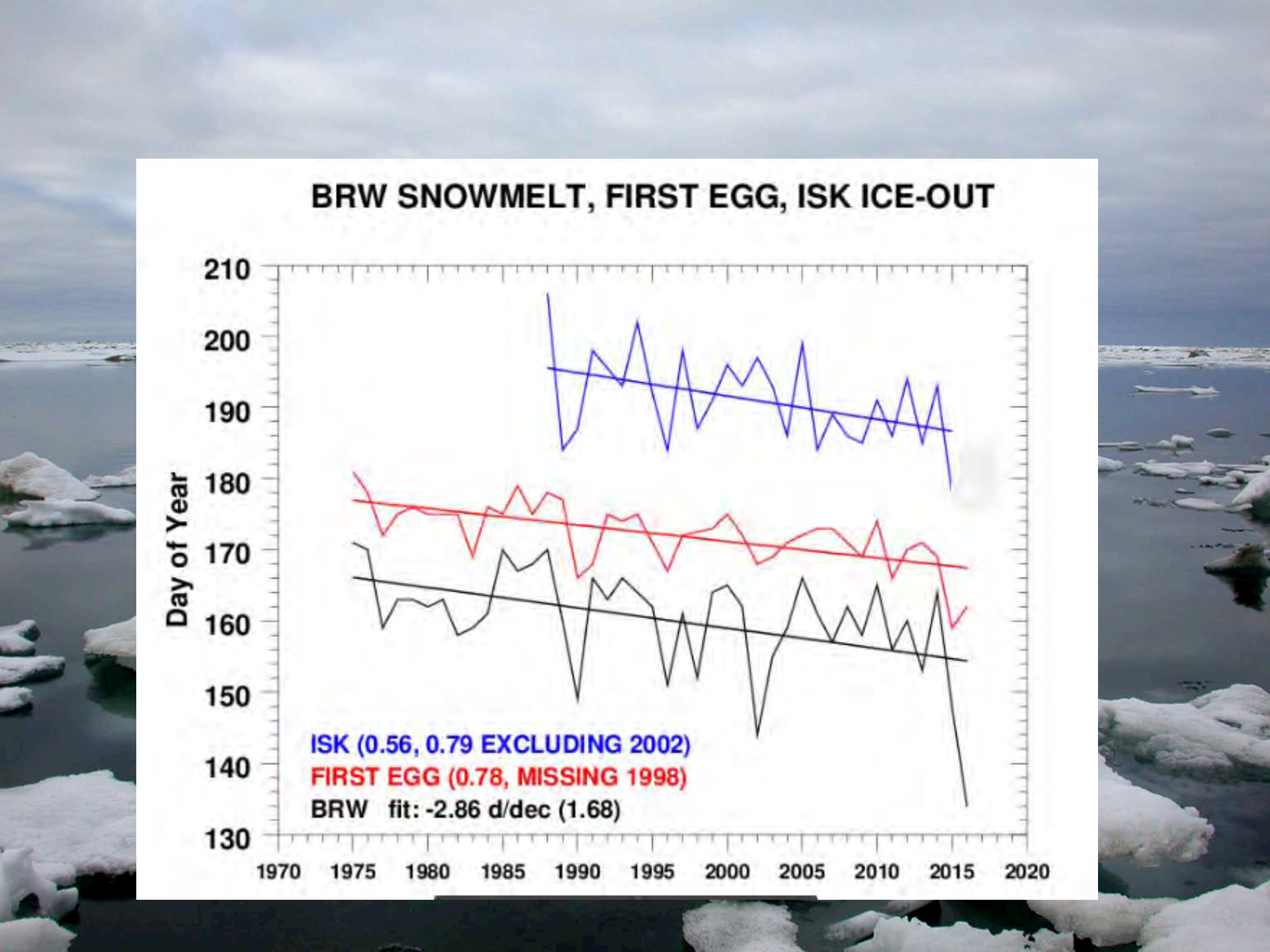
First Egg and Barrow Snowmelt Date



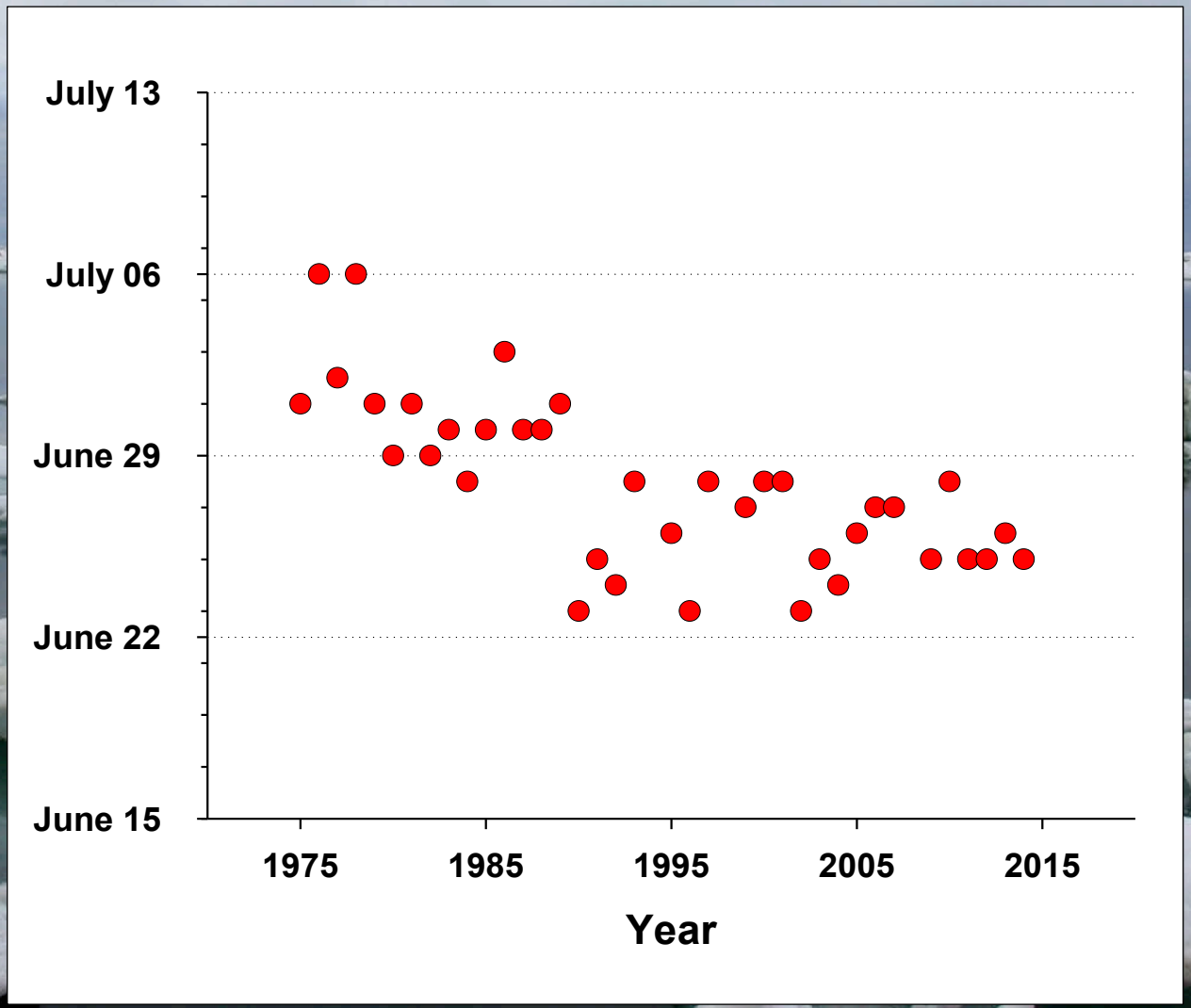

BRW SNOWMELT, FIRST EGG, ISK ICE-OUT
Day of Year
210
200
190
180
170
160
150
140
130
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
ISK (0.56, 0.79 EXCLUDING 2002)
FIRST EGG (0.78, MISSING 1998)
BRW fit: -2.86 d/dec (1.68)



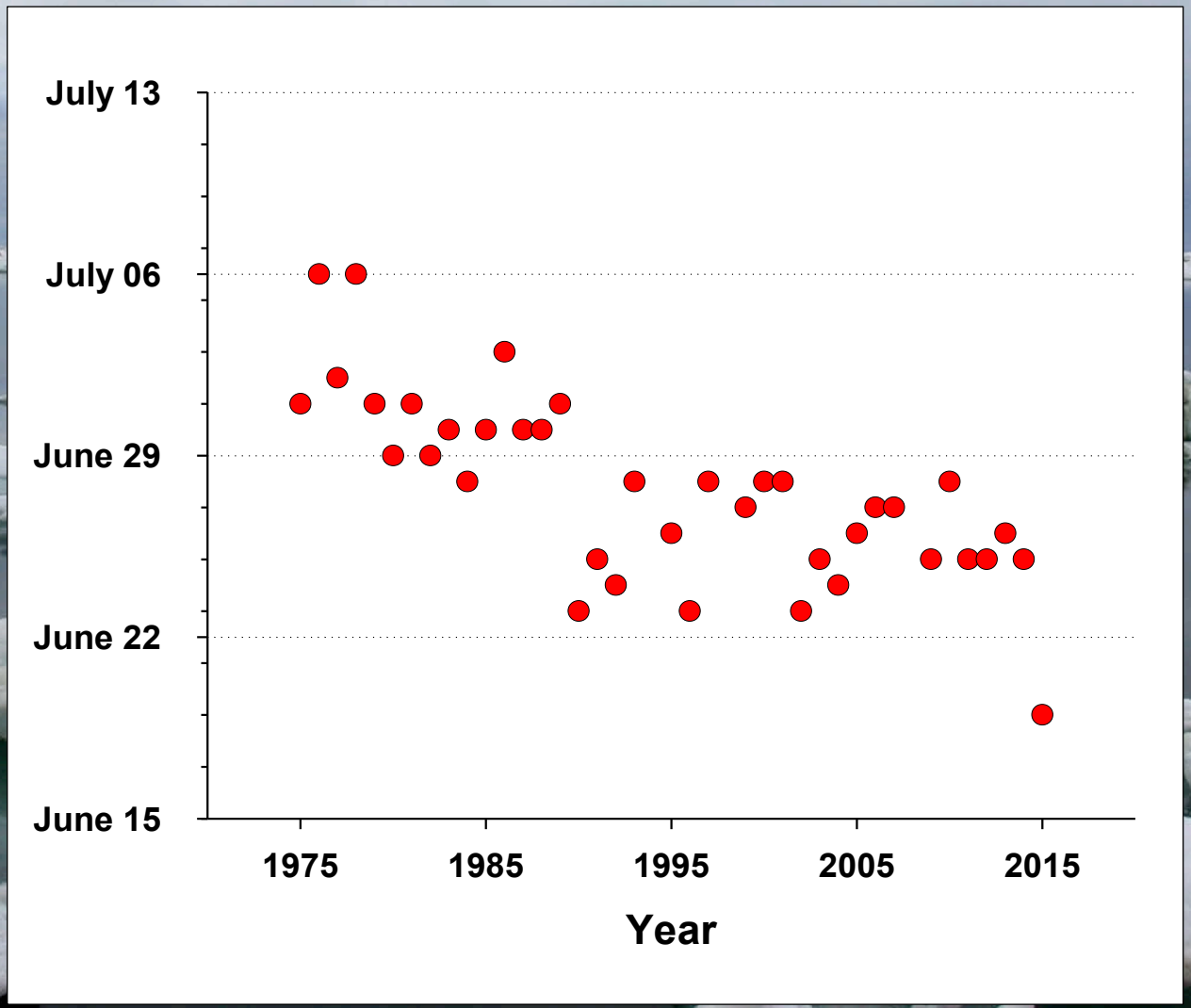

Date of winter snow disappearance
Barrow, Alaska
29 Jun
22 Jun
15 Jun
08 Jun
01 Jun
25 May
Date
Date of snow melt at Barrow, Alaska
1940
1960
1980
2000
2020
Year


BRW SNOWMELT, FIRST EGG, ISK ICE-OUT
Day of Year
210
200
190
180
170
160
150
140
130
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
ISK (0.56, 0.79 EXCLUDING 2002)
FIRST EGG (0.78, MISSING 1998)
BRW fit: -2.86 d/dec (1.68)

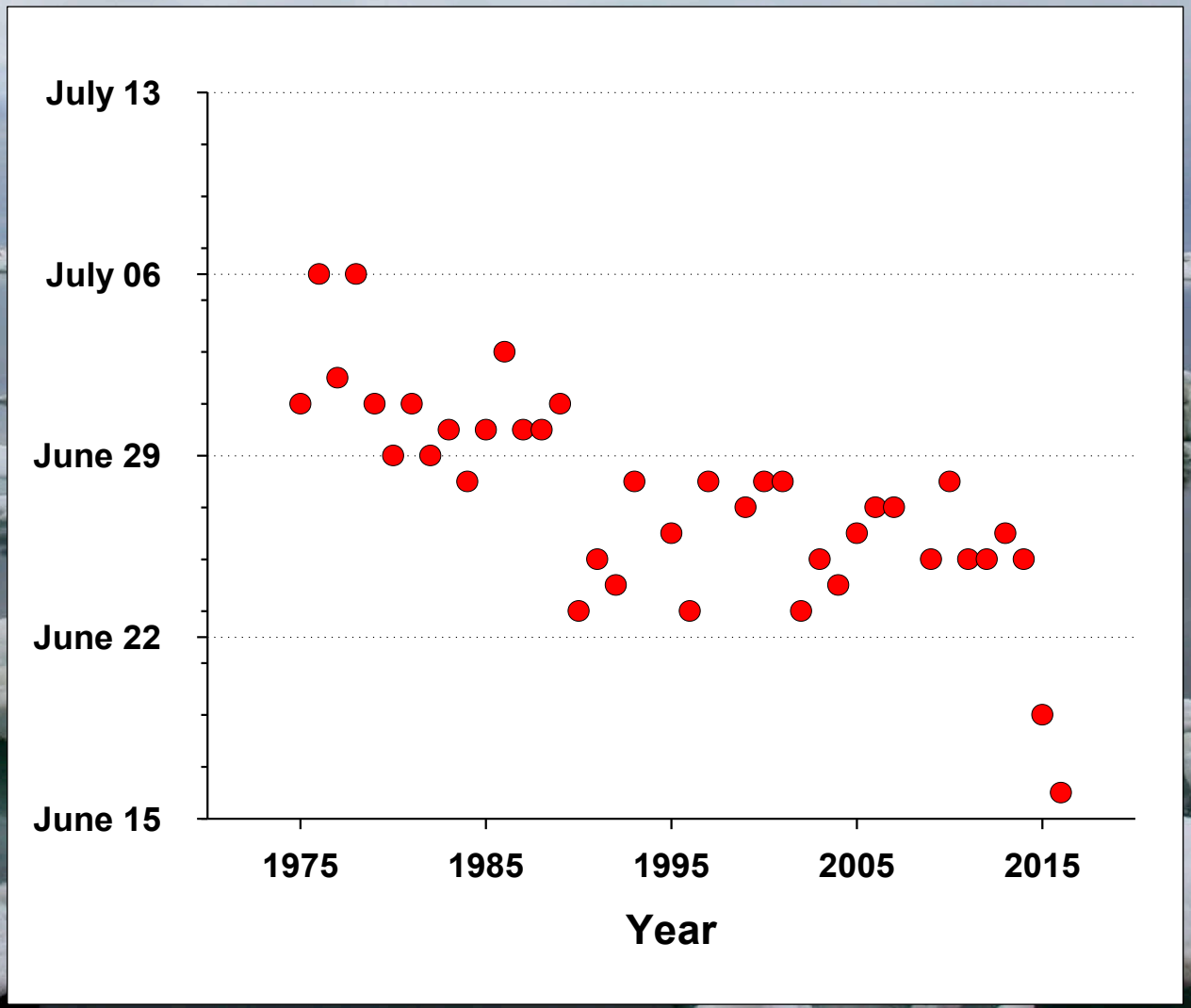
Median Date of Clutch Initiation



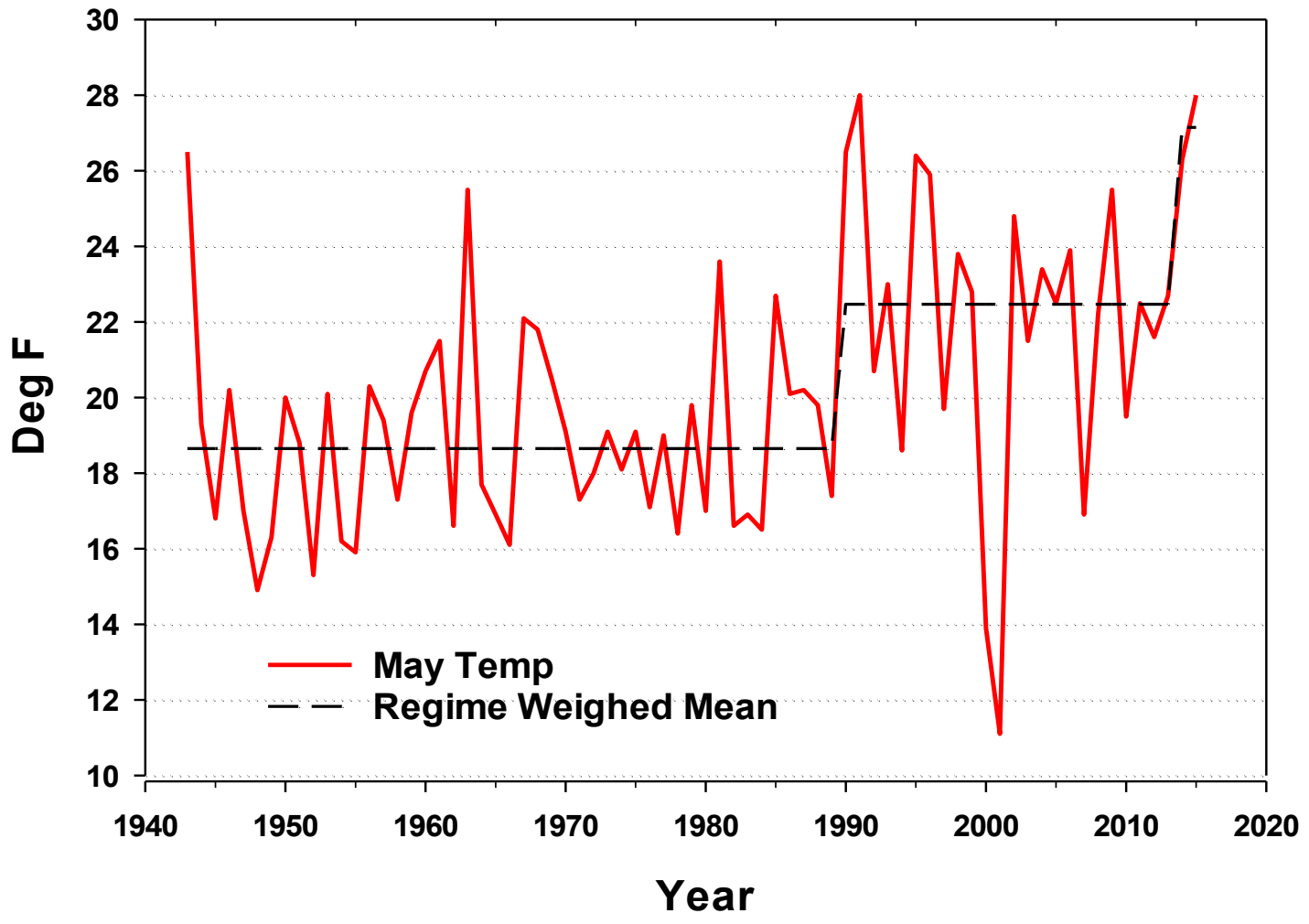
Median Date of Clutch Initiation



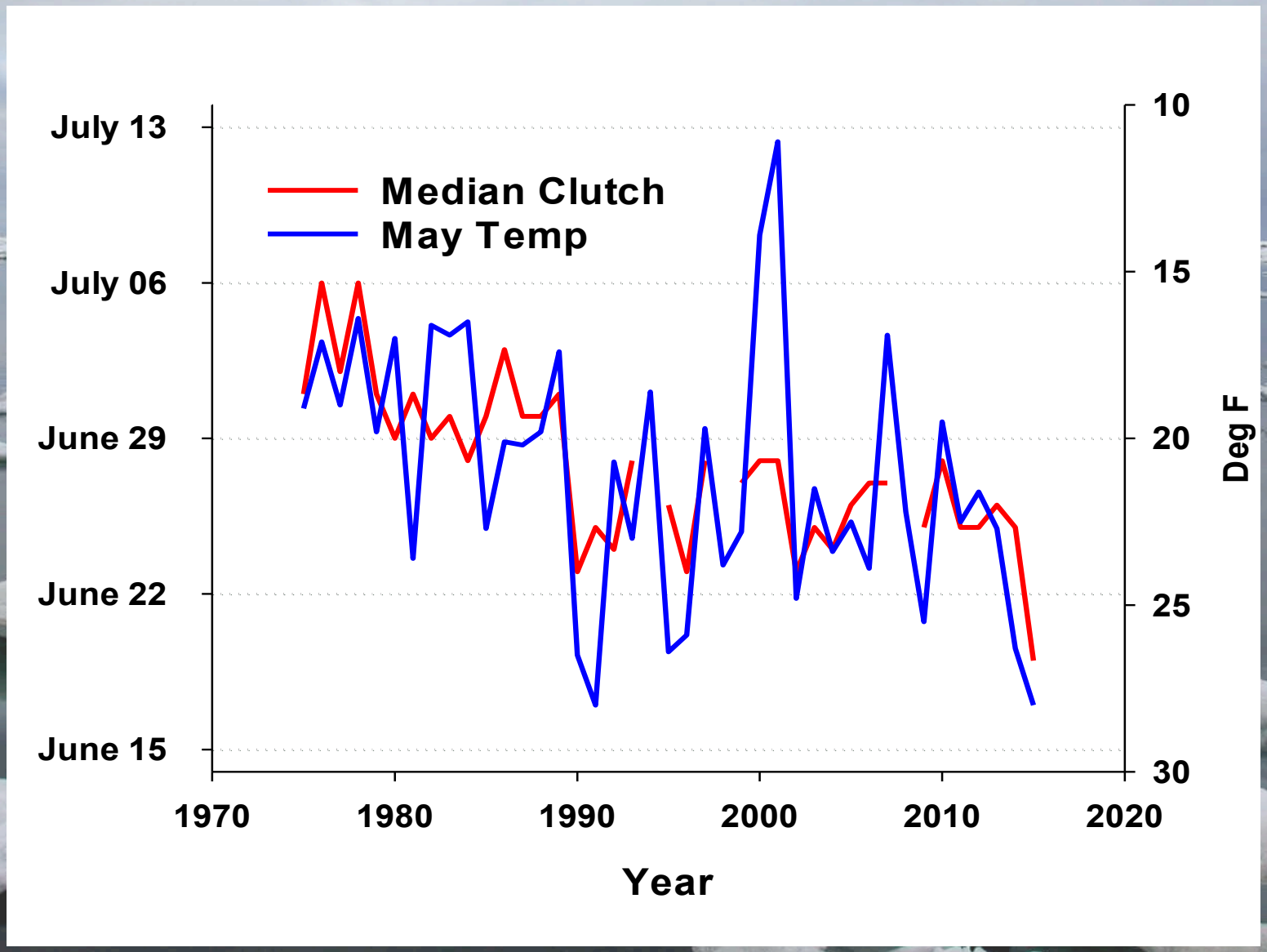
Median Date of Clutch Initiation



Barrow May Temperature



Median Clutch and May Temperature



Recording climate change from the top of the world

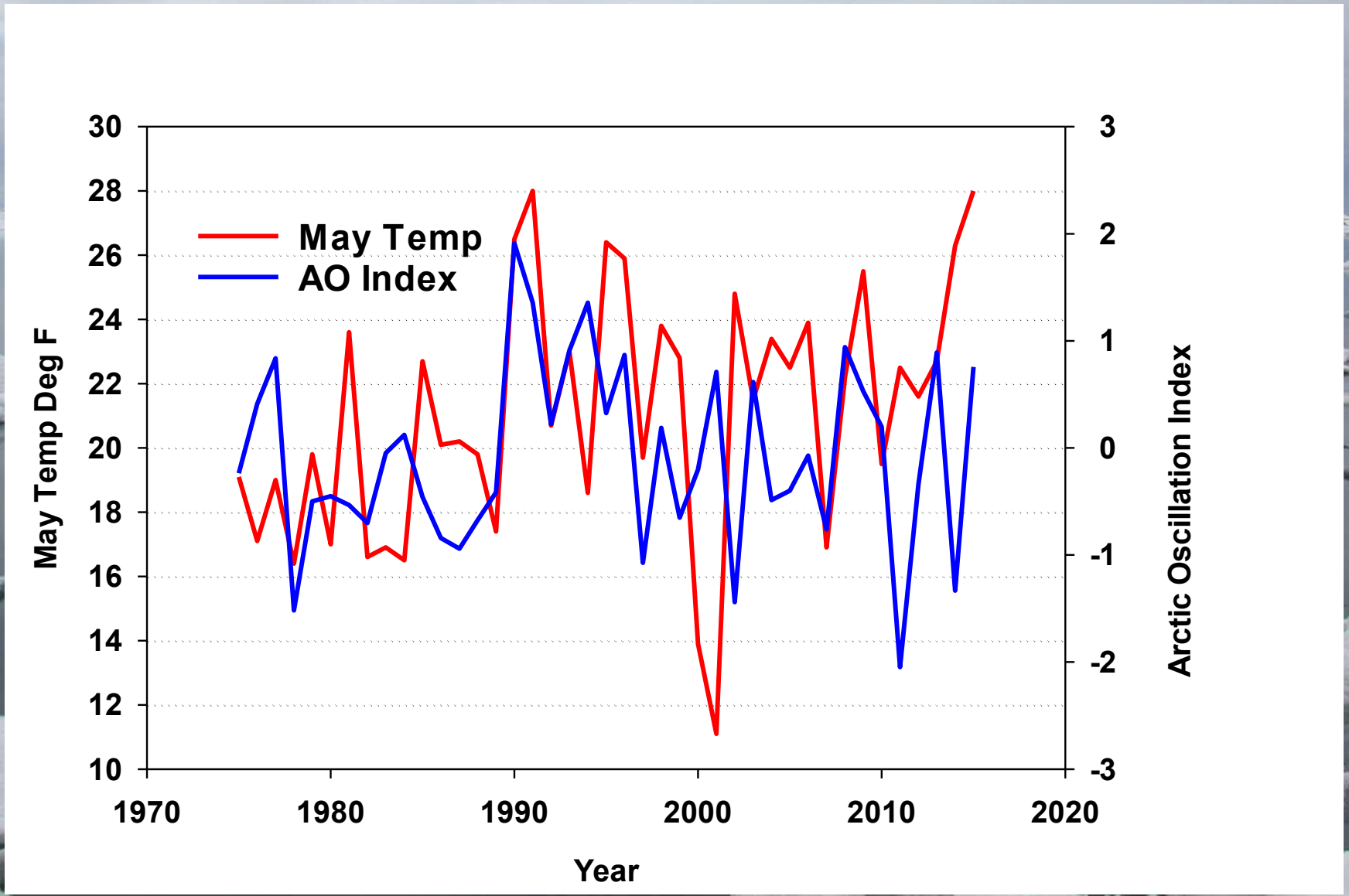
Barrow reports record-breaking 2015 Spring warming

News Categories

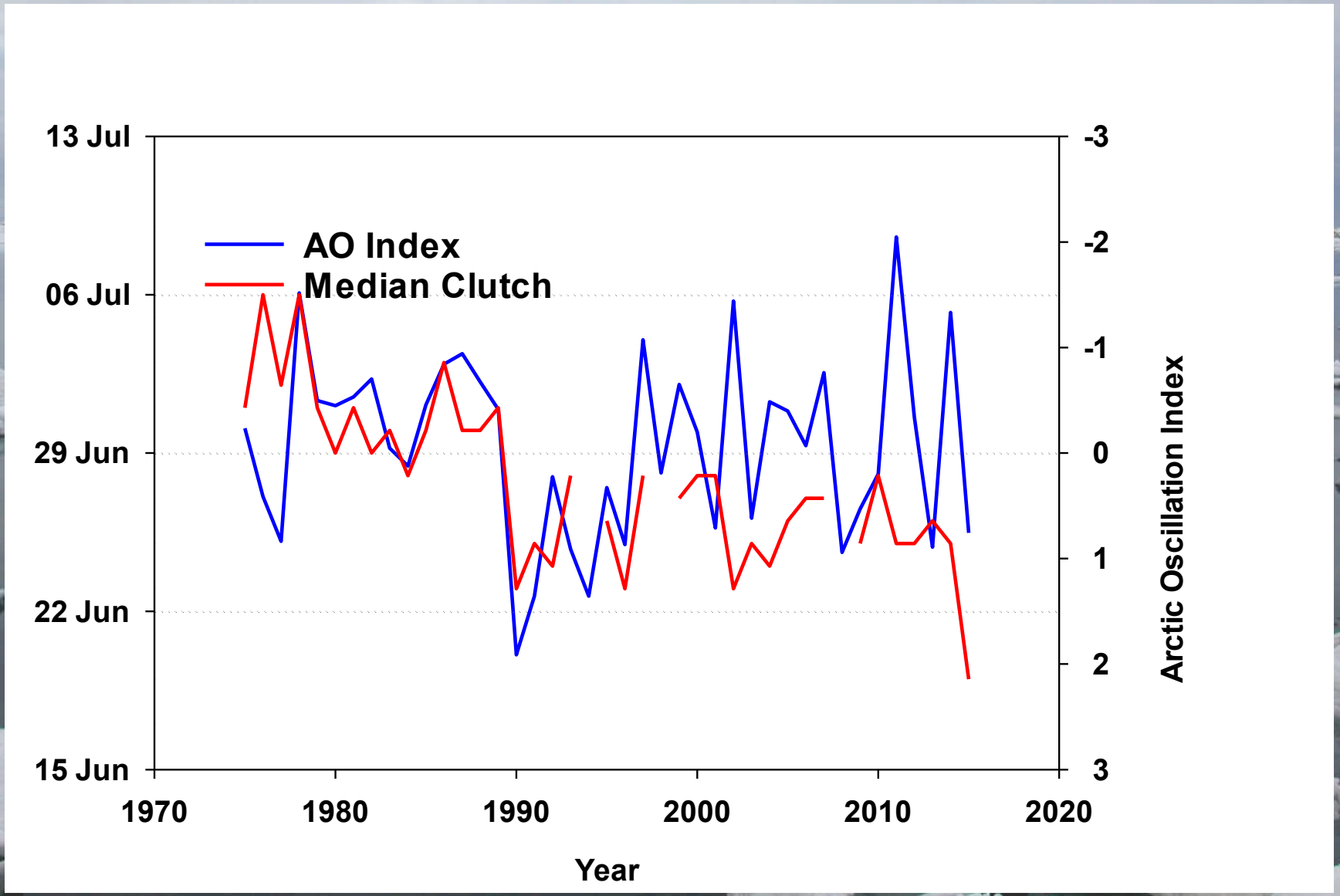
- Press Release (31)
- Air Quality (36)
- Arctic (25)
- Climate (115)
- Ecosystems (35)
- Fisheries & Seafood (24)
- Great Lakes (13)
- Marine Science (24)
- Ocean Exploration (18)
- Weather (63)

Research Headlines

May Temperature and the Arctic Oscillation Index



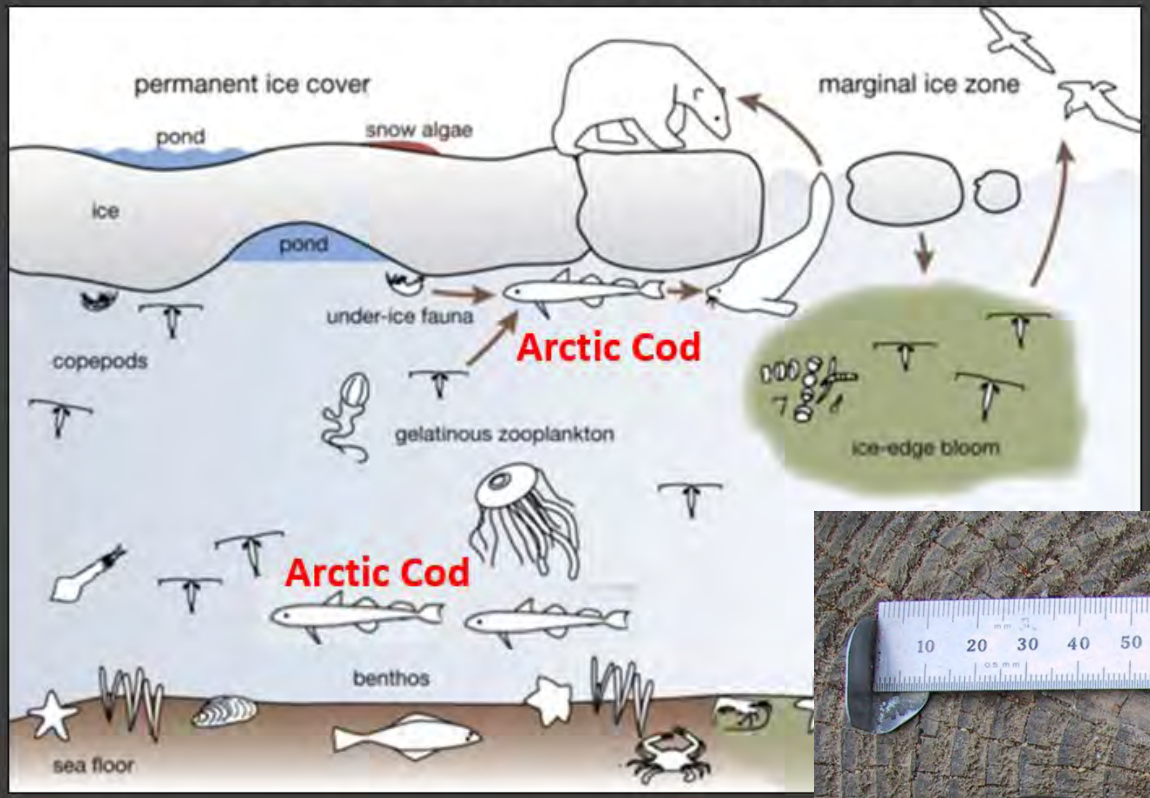
Median Clutch Date and the Arctic Oscillation Index



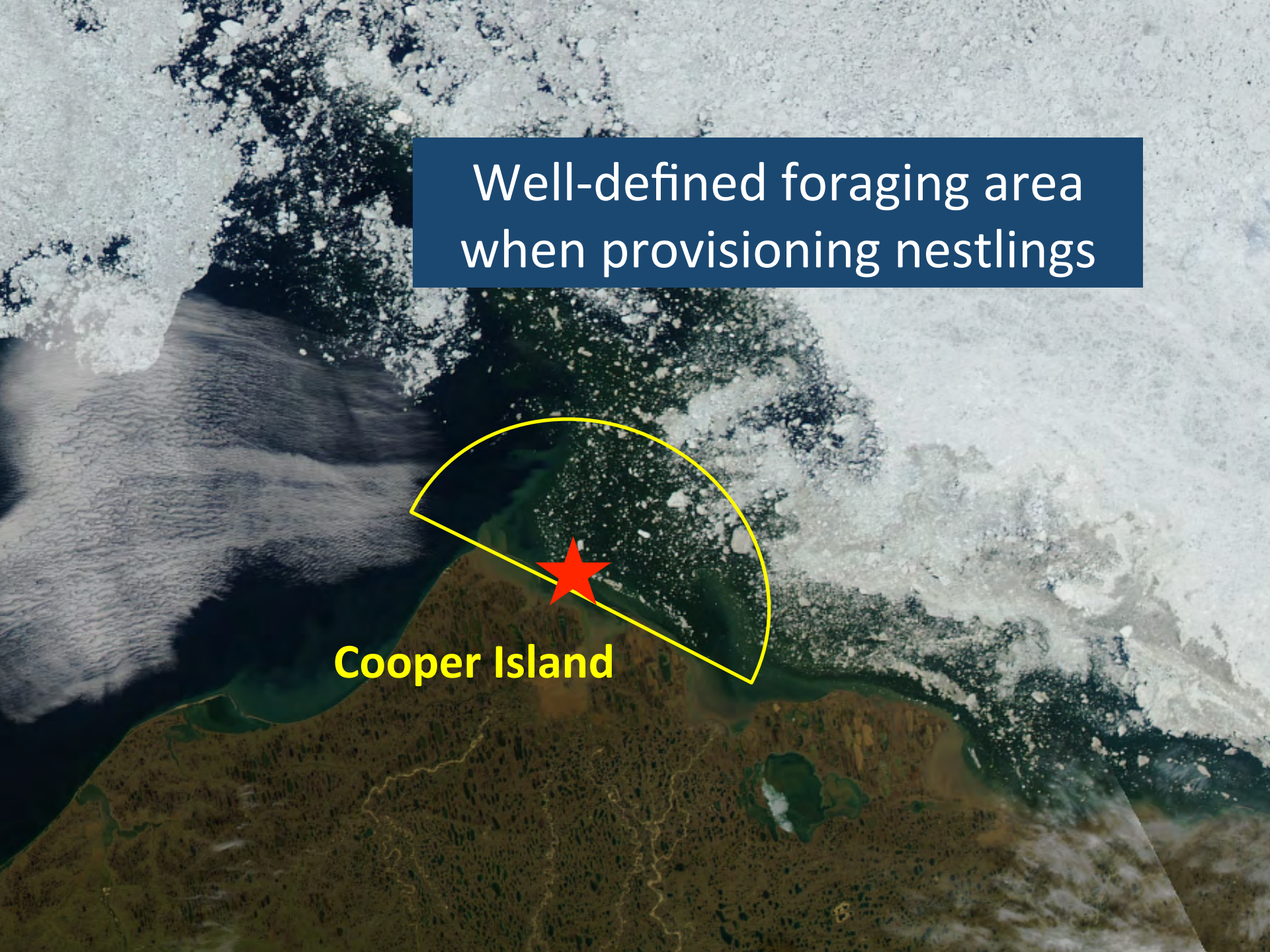
Date of Median Clutch Initiation

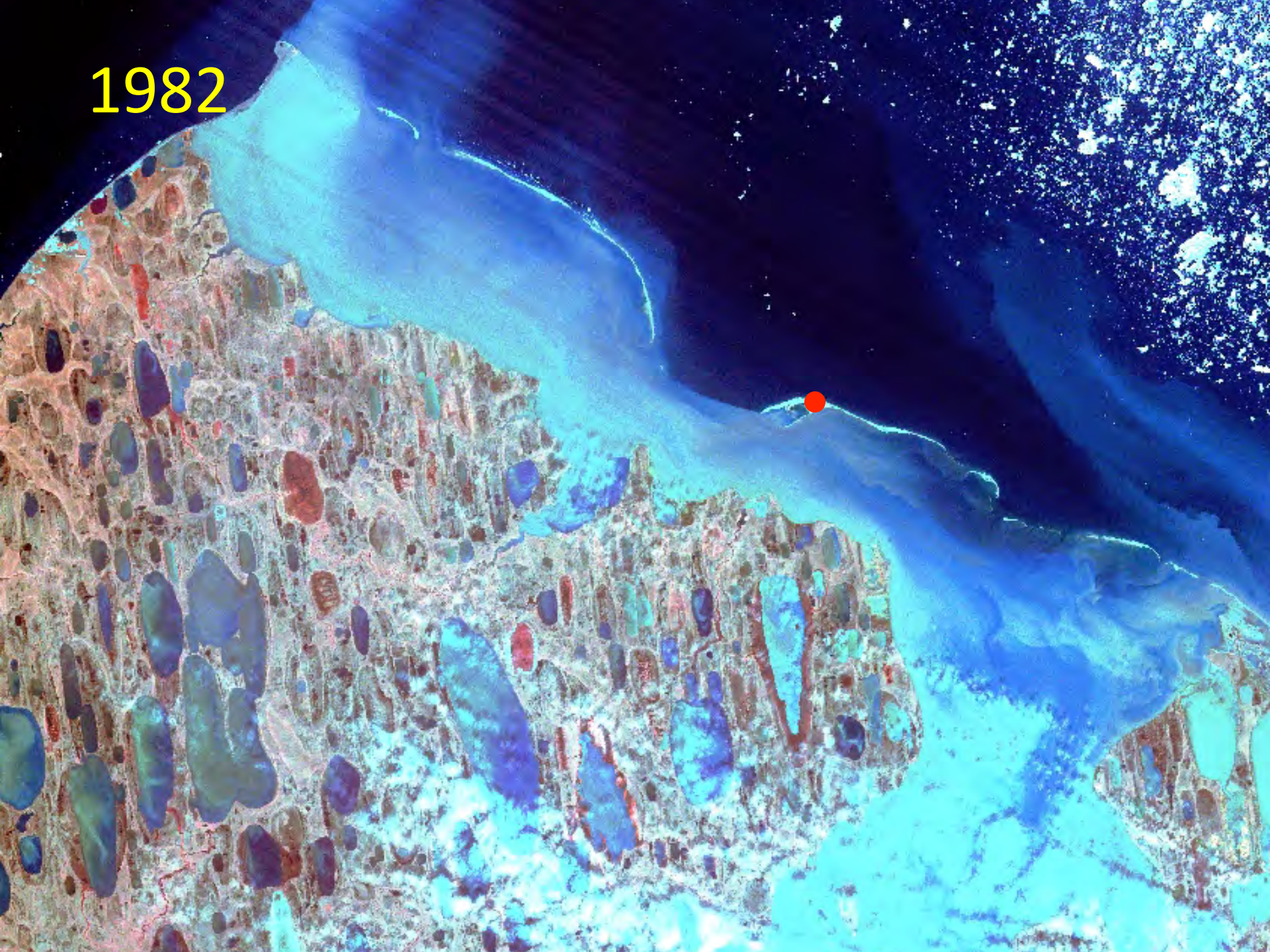
Changes in Sea Ice and Sea Surface Temperature

Cryopelagic ecosystem



Guillemots feed chicks approximately once per hour

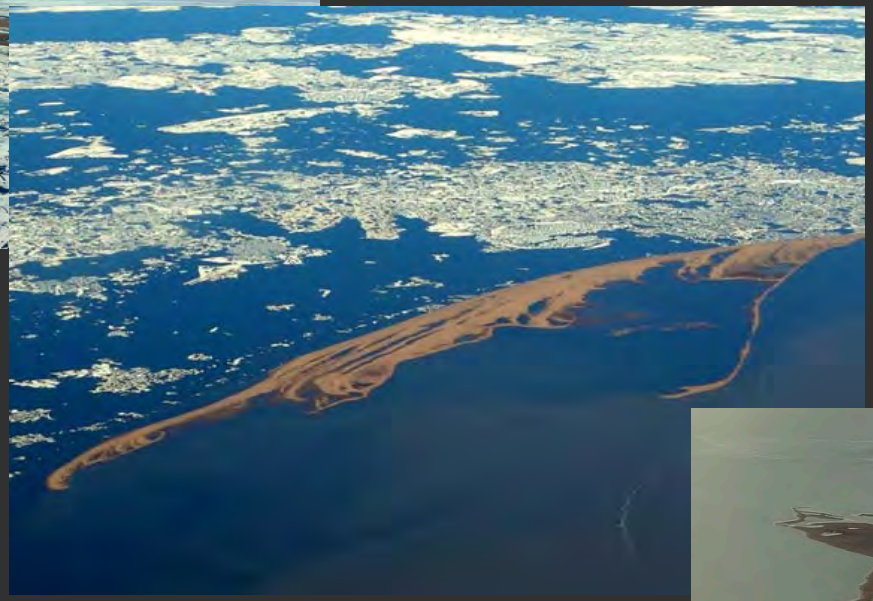

Well-defined foraging area when provisioning nestlings
Cooper Island


1982

Island surrounded by ice in early June and ice-free in early September

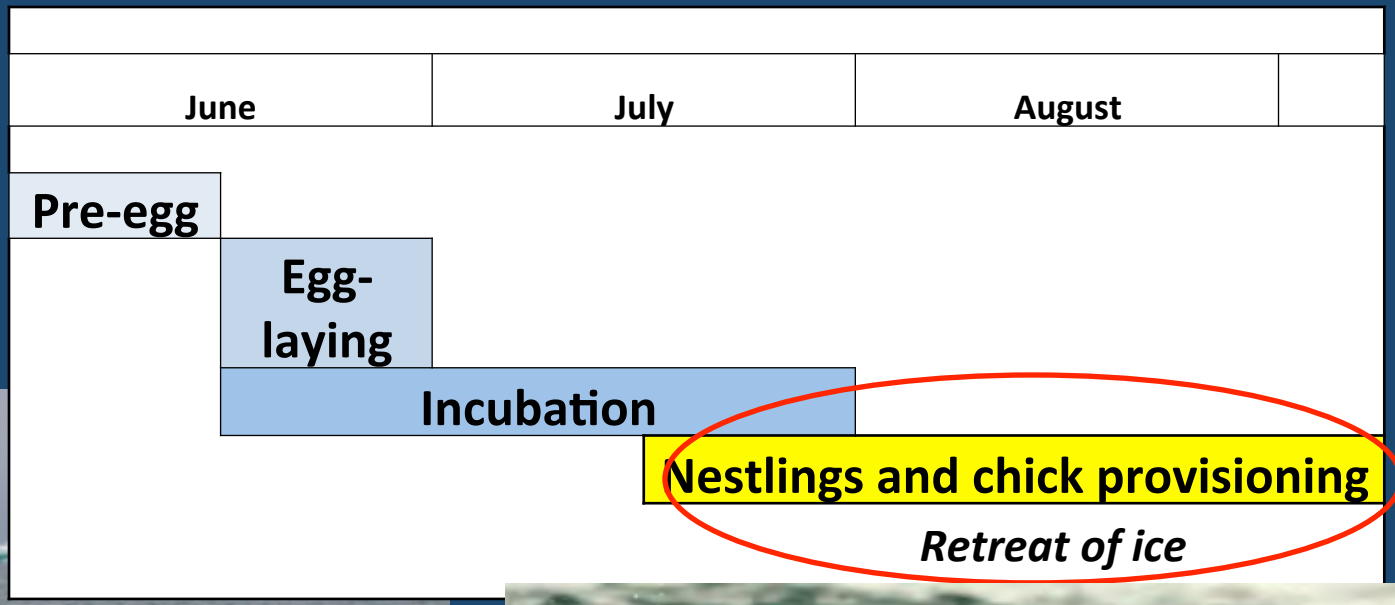
Early June

Mid-July

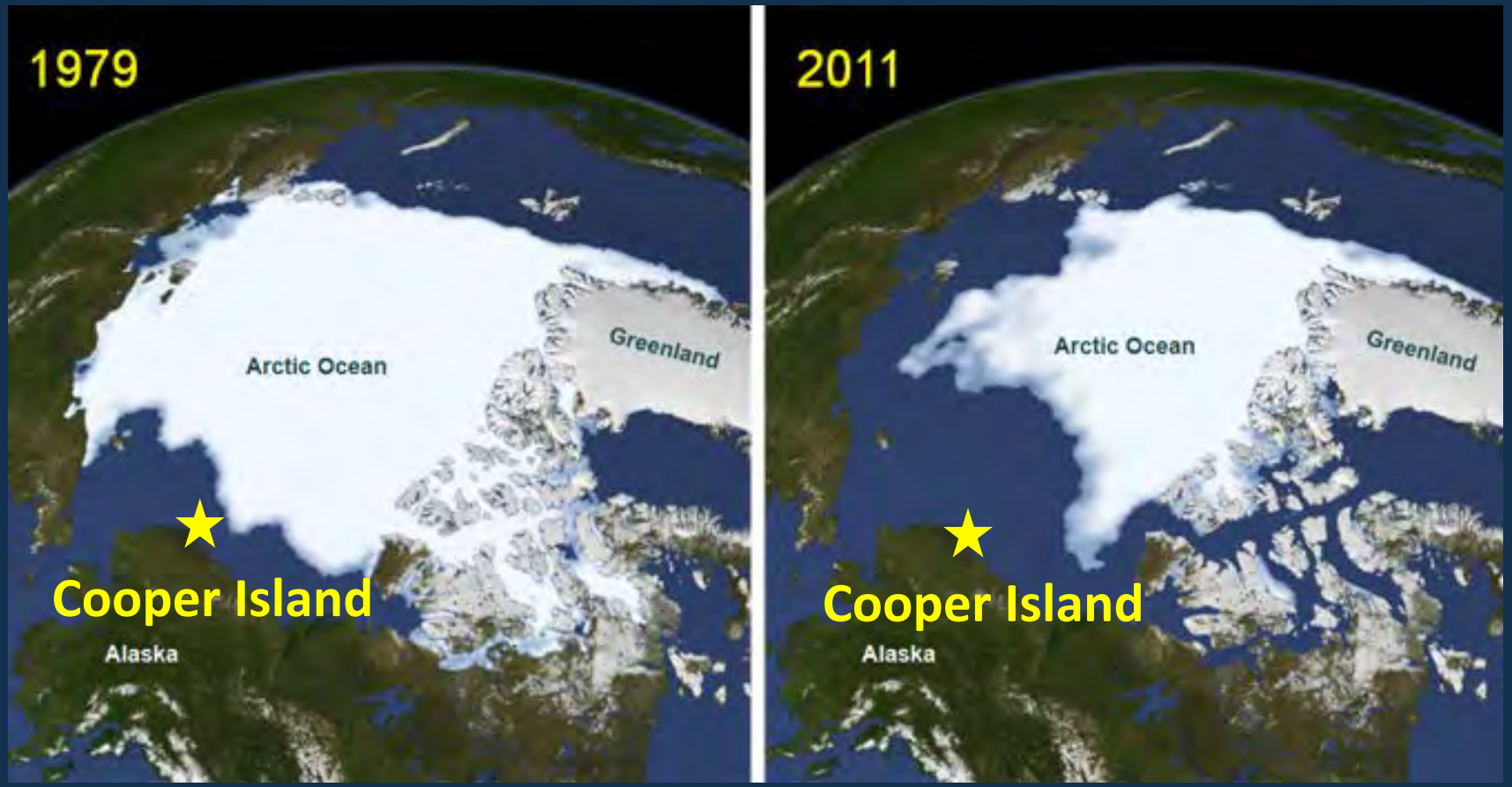


Late August

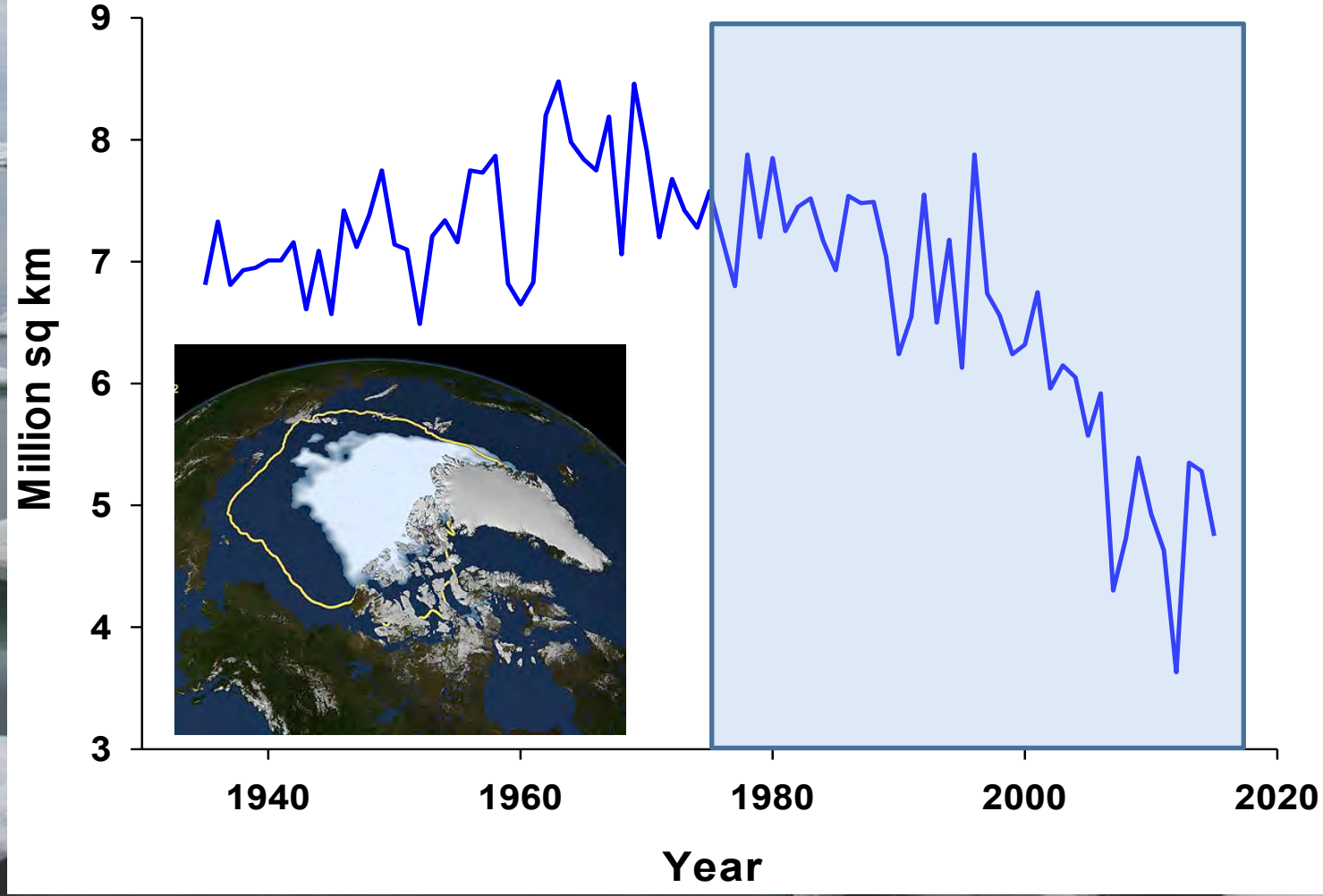
Black Guillemot Breeding Chronology in the Alaskan Arctic



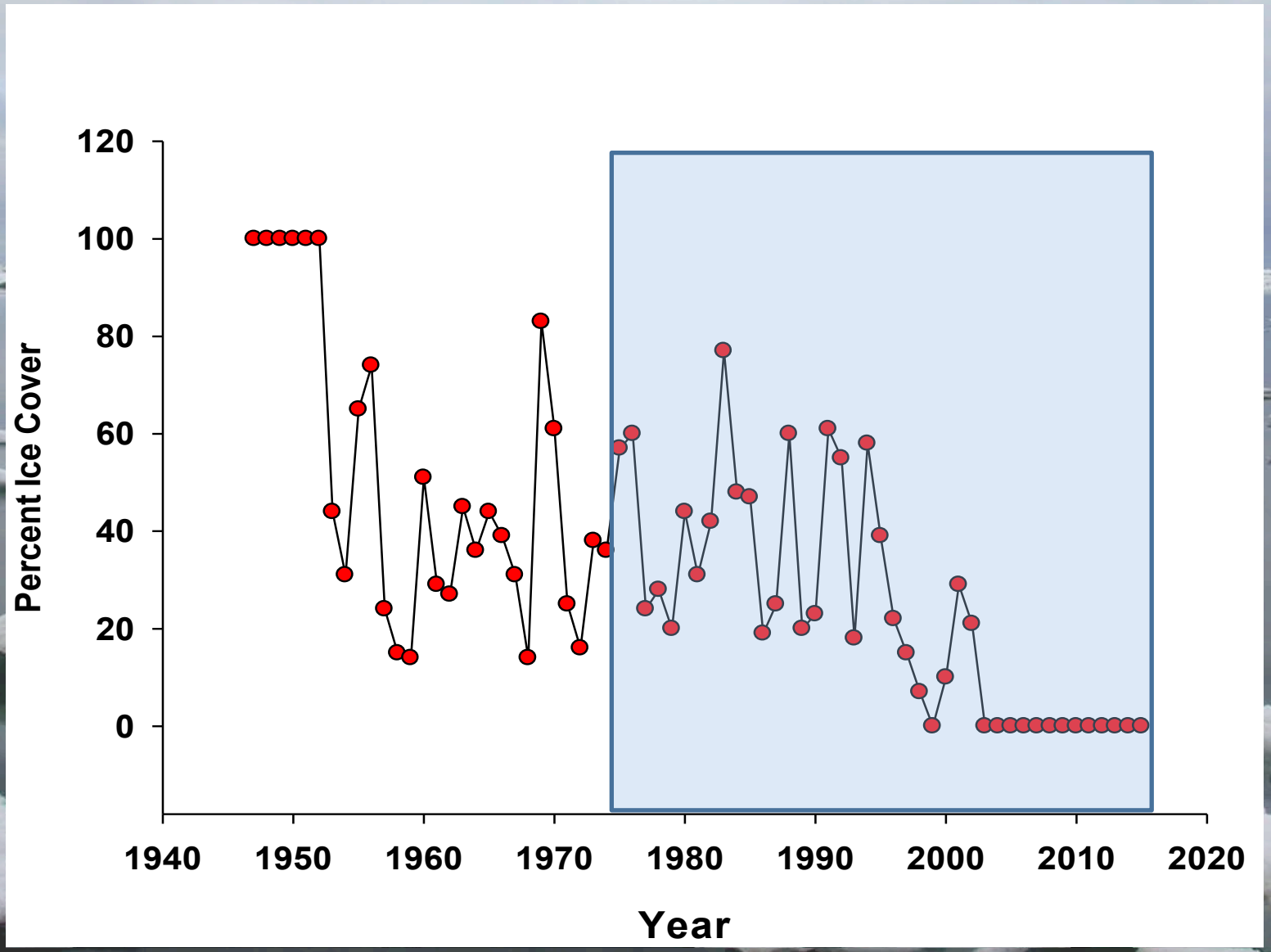
September Sea Ice Extent



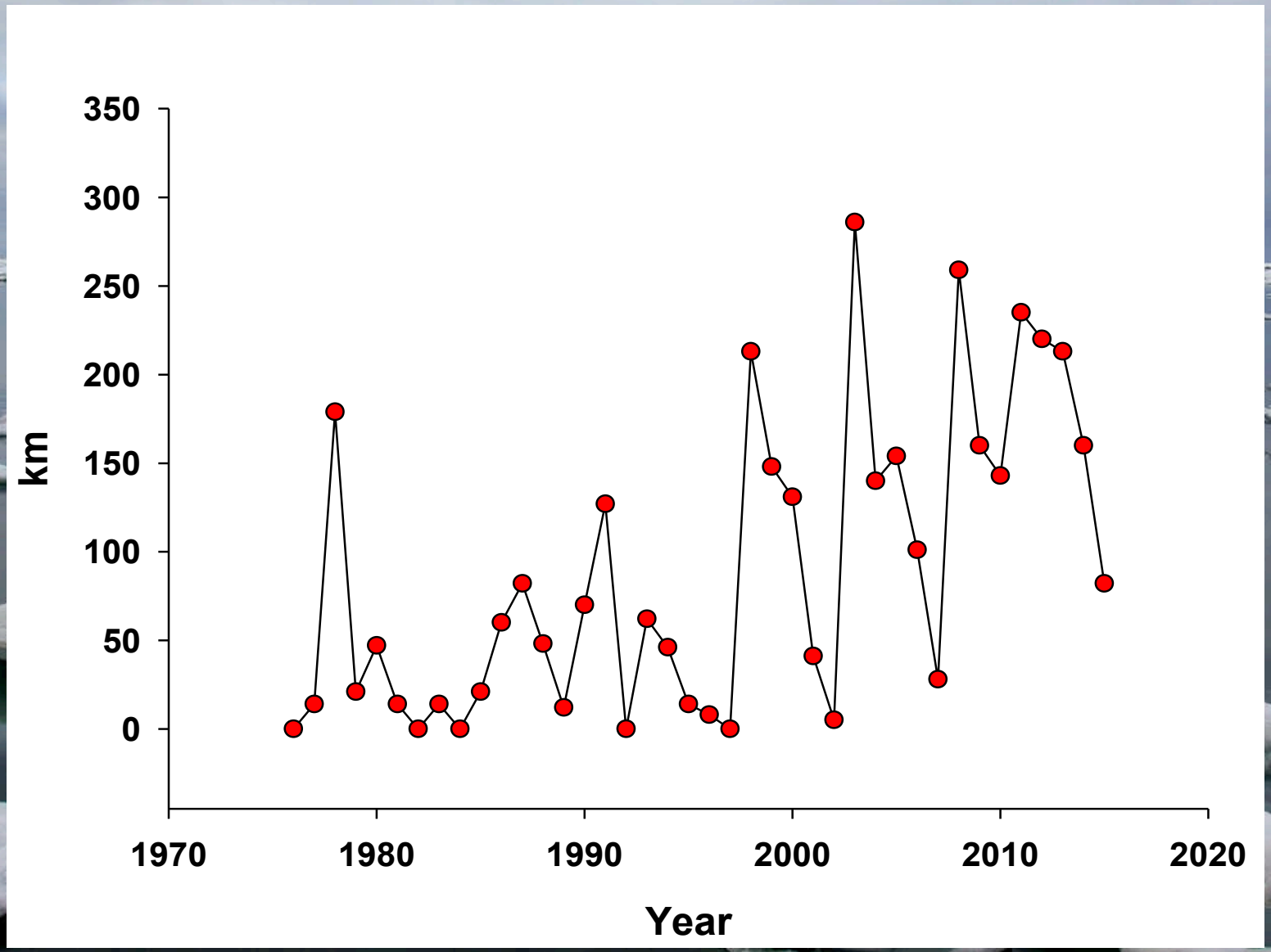
September Ice Extent



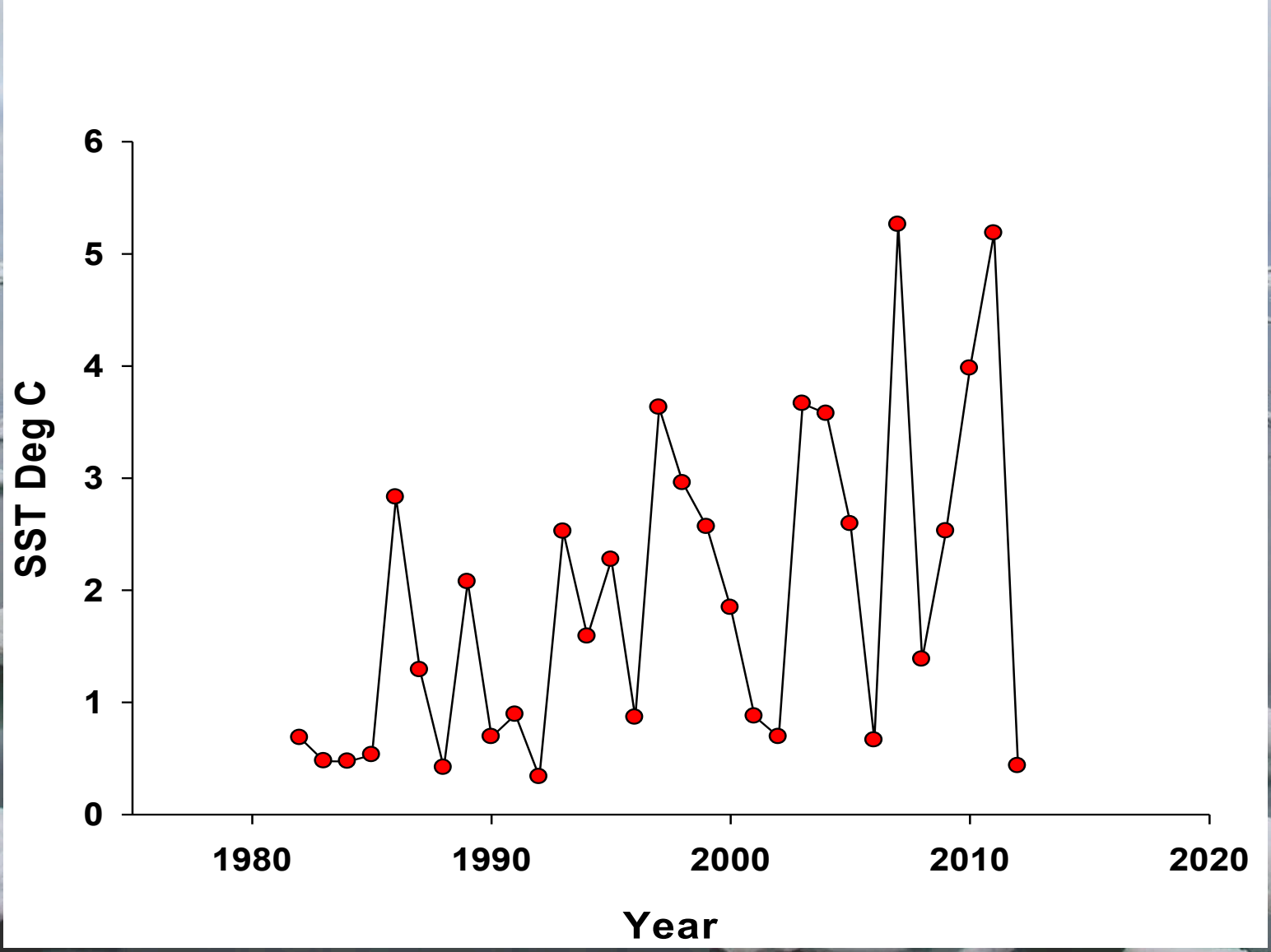
August Ice Concentration - Cooper Island



Distance to 30 percent ice – 1 Sept

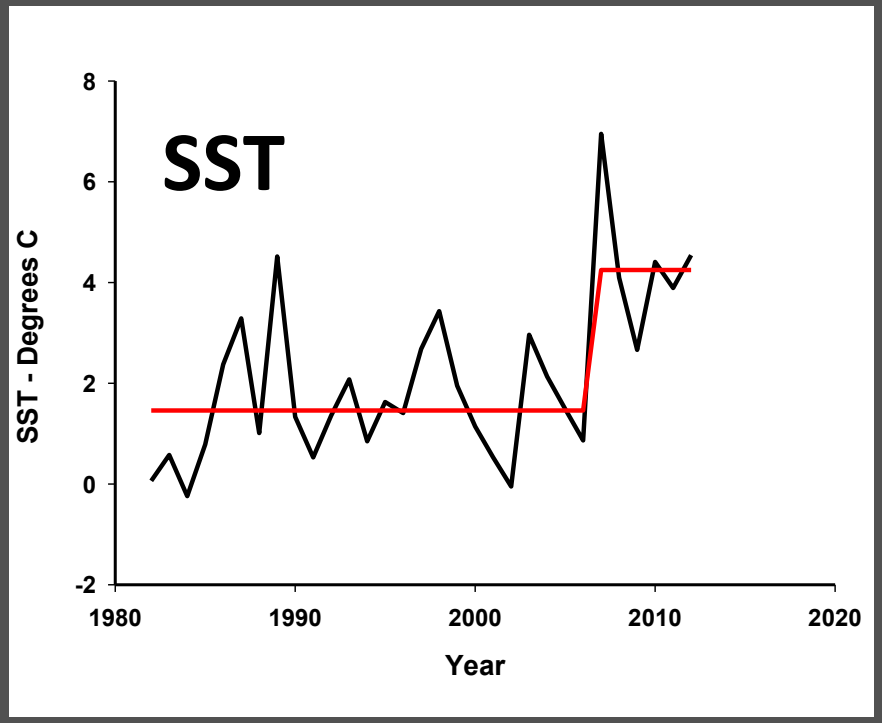


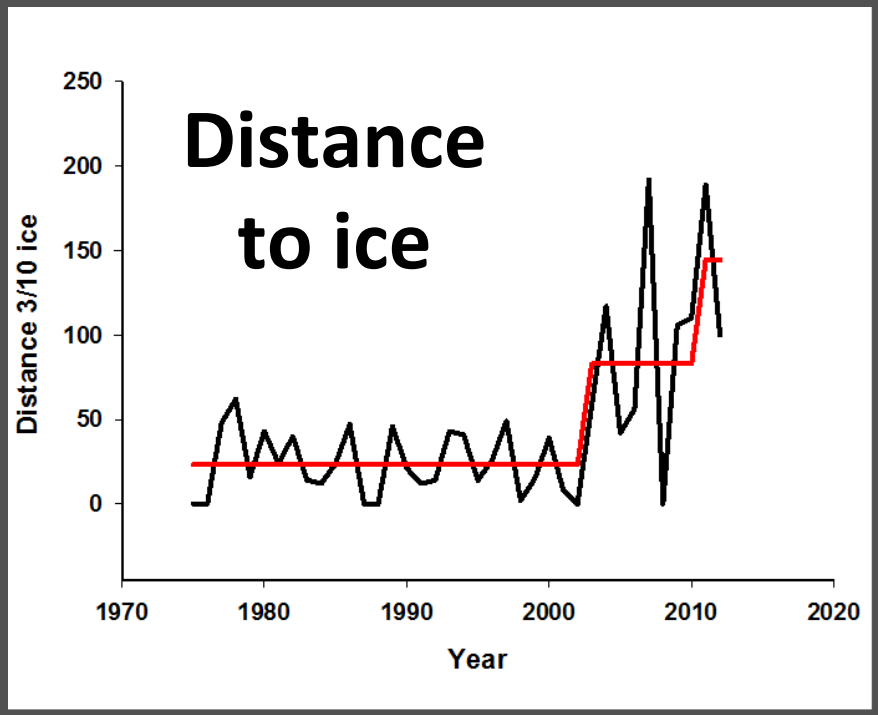
SST North of Cooper Island – 1 Sept



Late August

Sea Surface Temperature and Distance to Ice



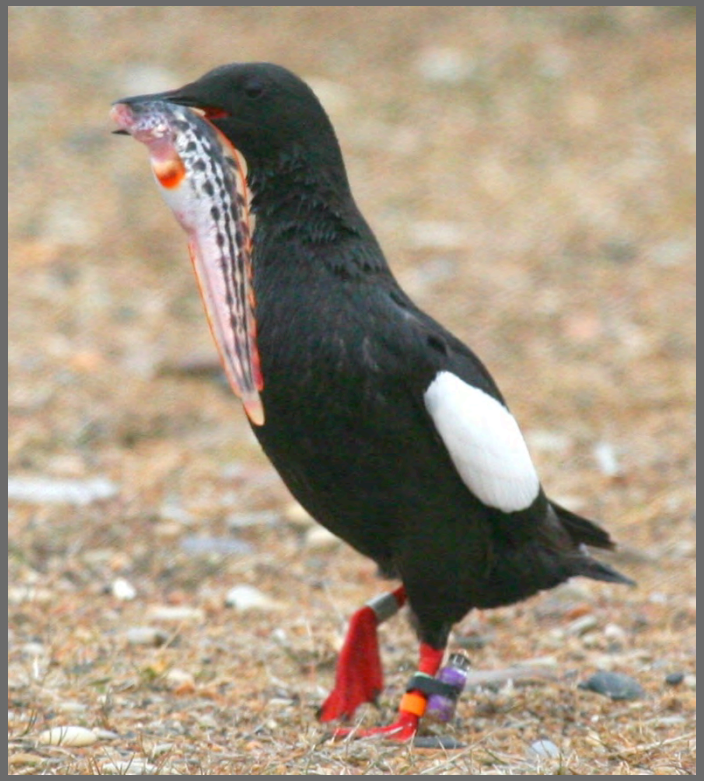


The Alternate Prey
Four-horned Sculpin

Switch to sculpin in 2003

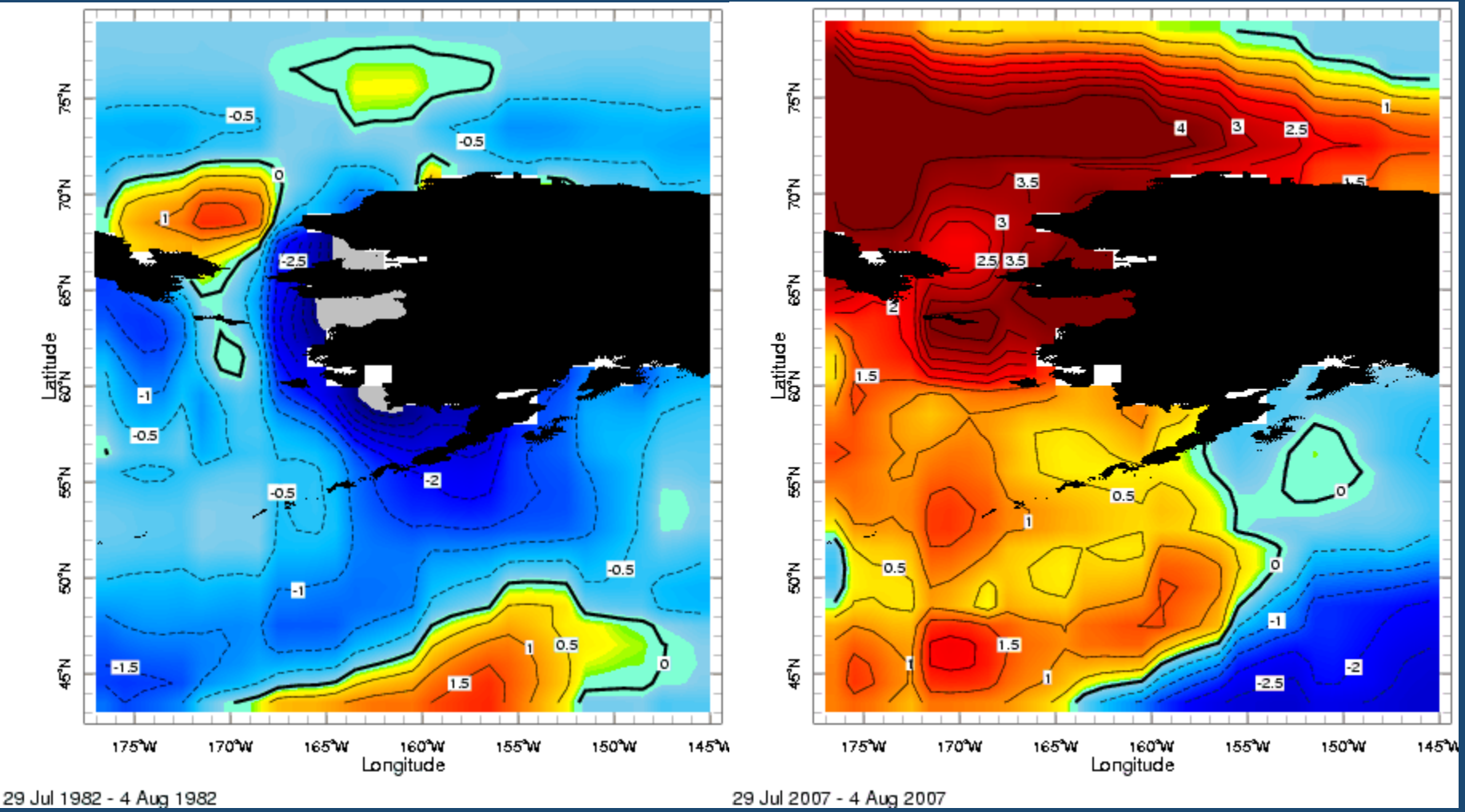
Sculpin are less preferred by both adult and nestling guillemots

Snail Fish



Wolf Fish

Sea Surface Temp. Anomaly

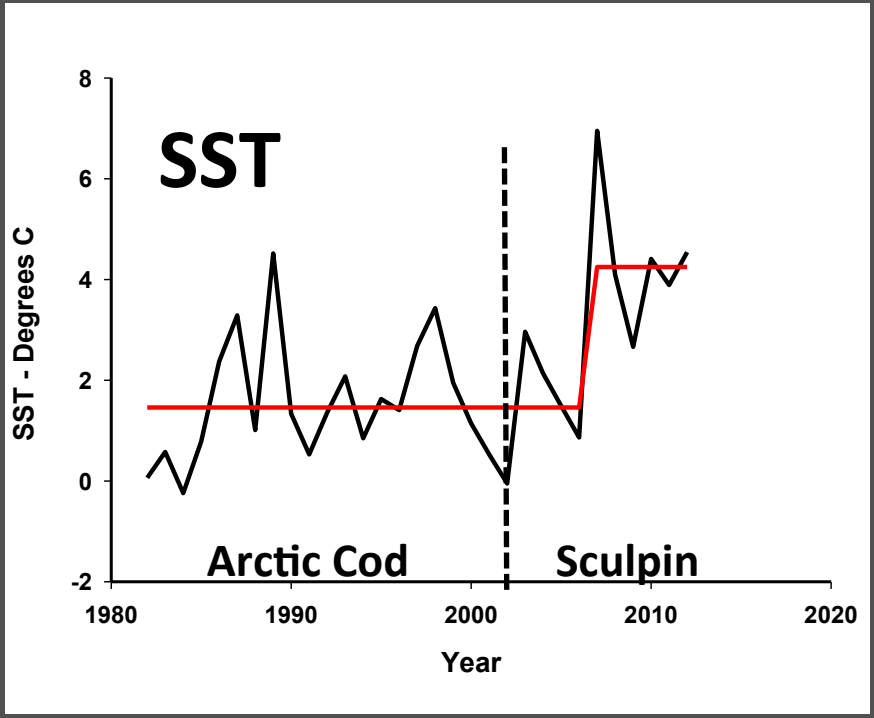


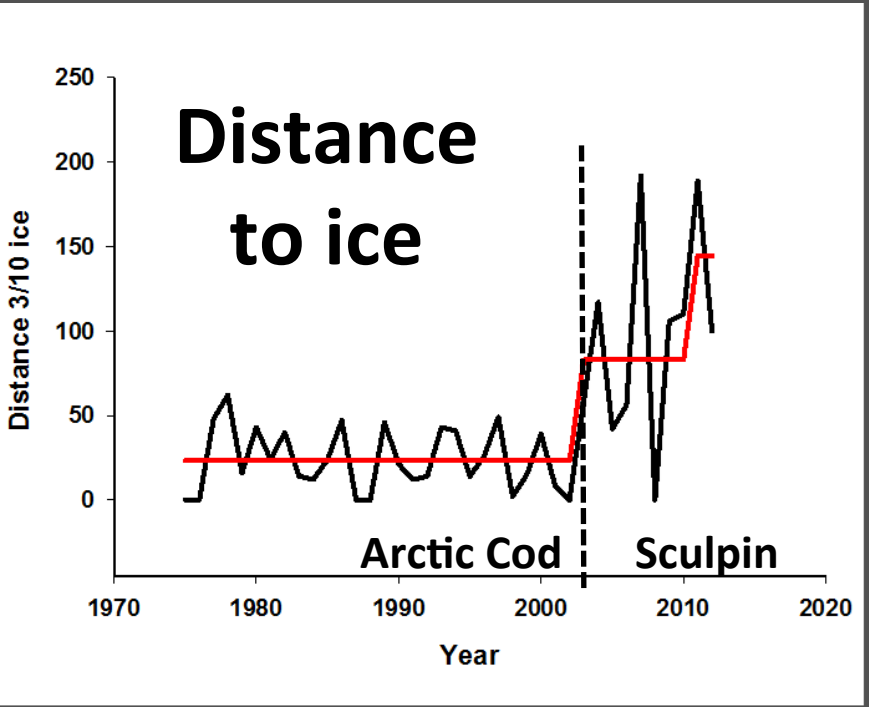
1982

2007

Late August

Sea Surface Temperature and Distance to Ice

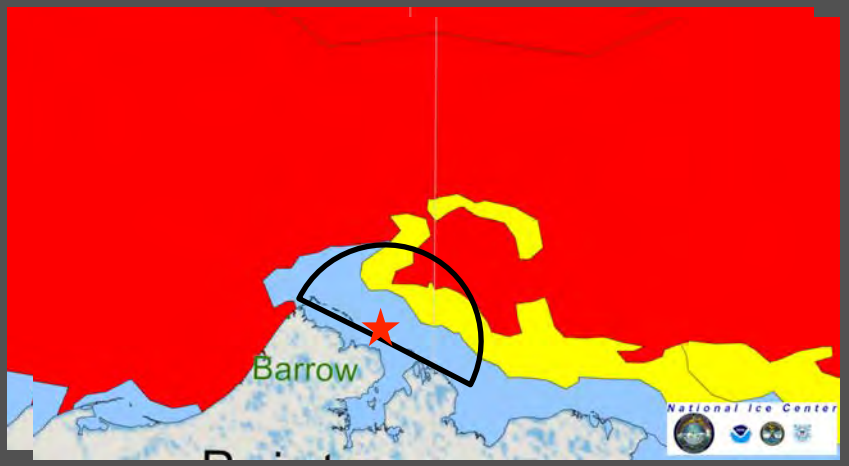




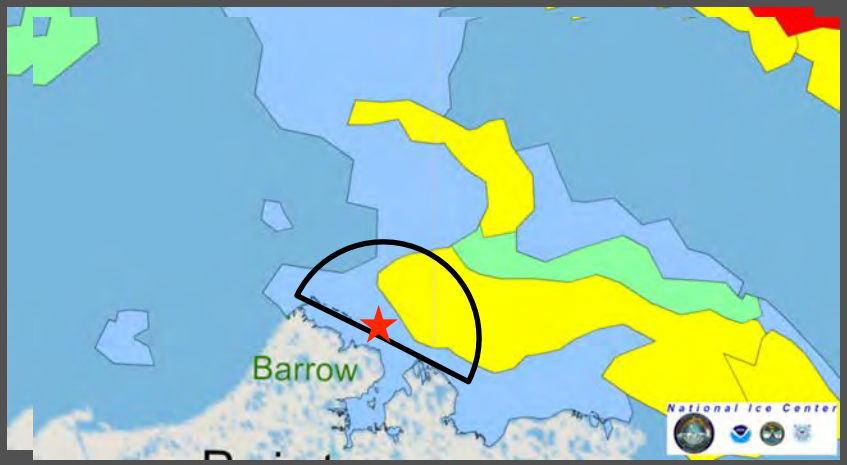
1 AUGUST

Early growth with some hatching

2006



2007

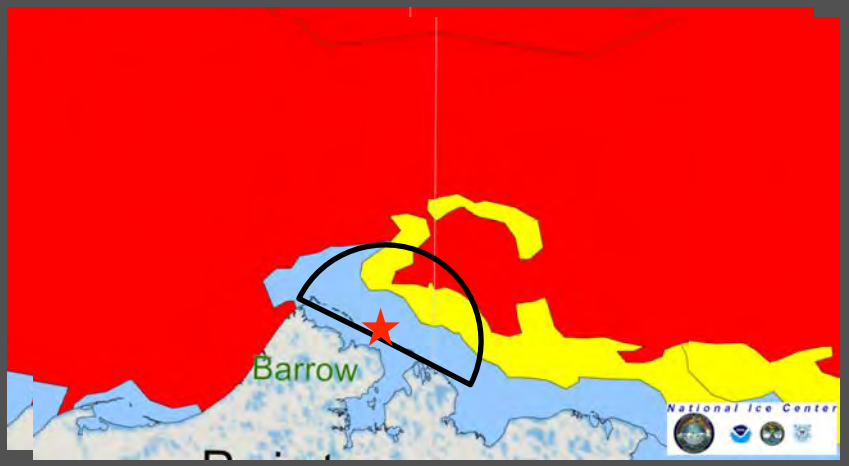


2011

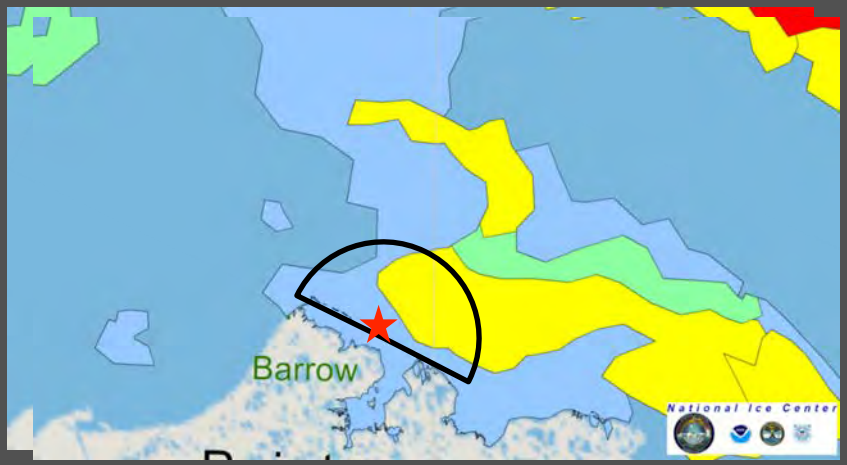
1 AUGUST

Early growth with some hatching

2006

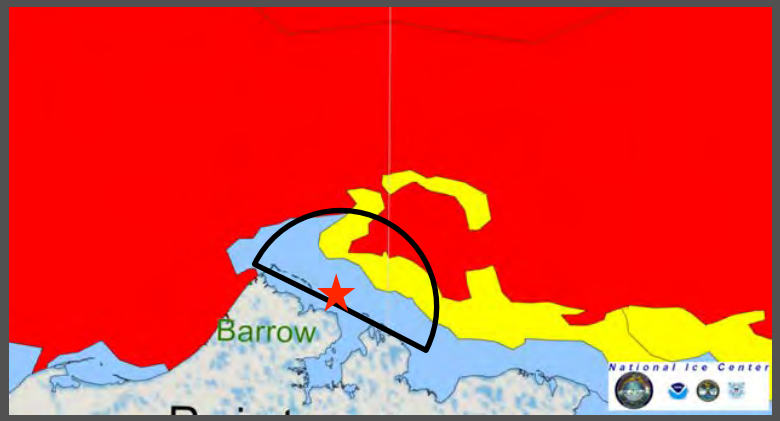


2007

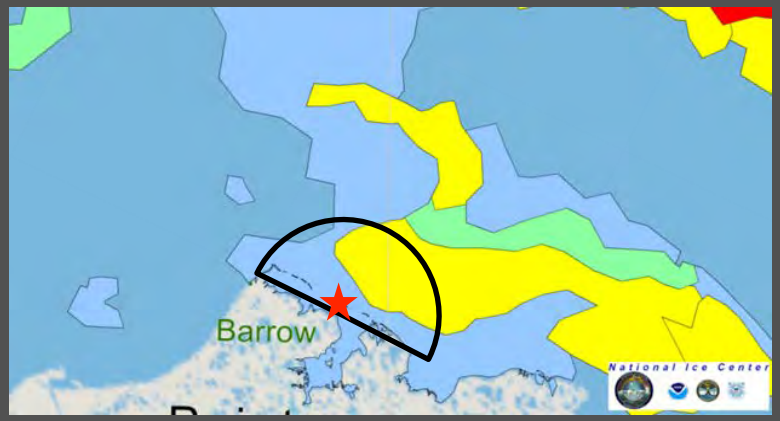


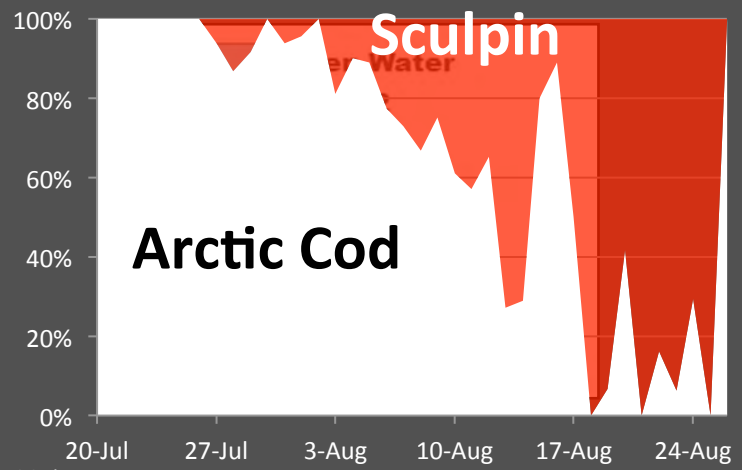
2011

2006

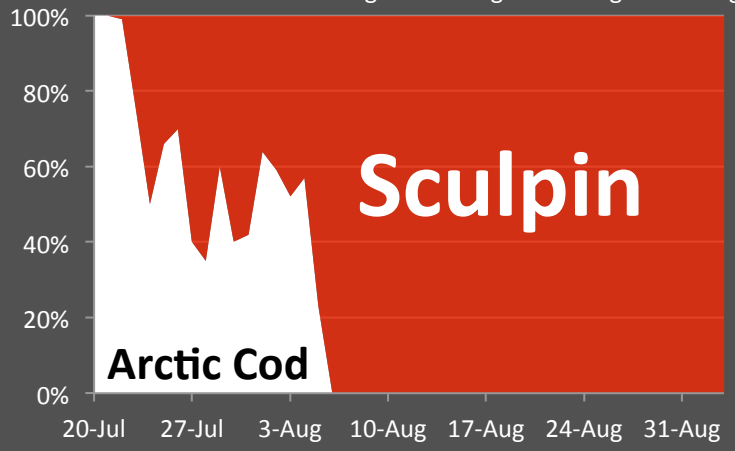


2007

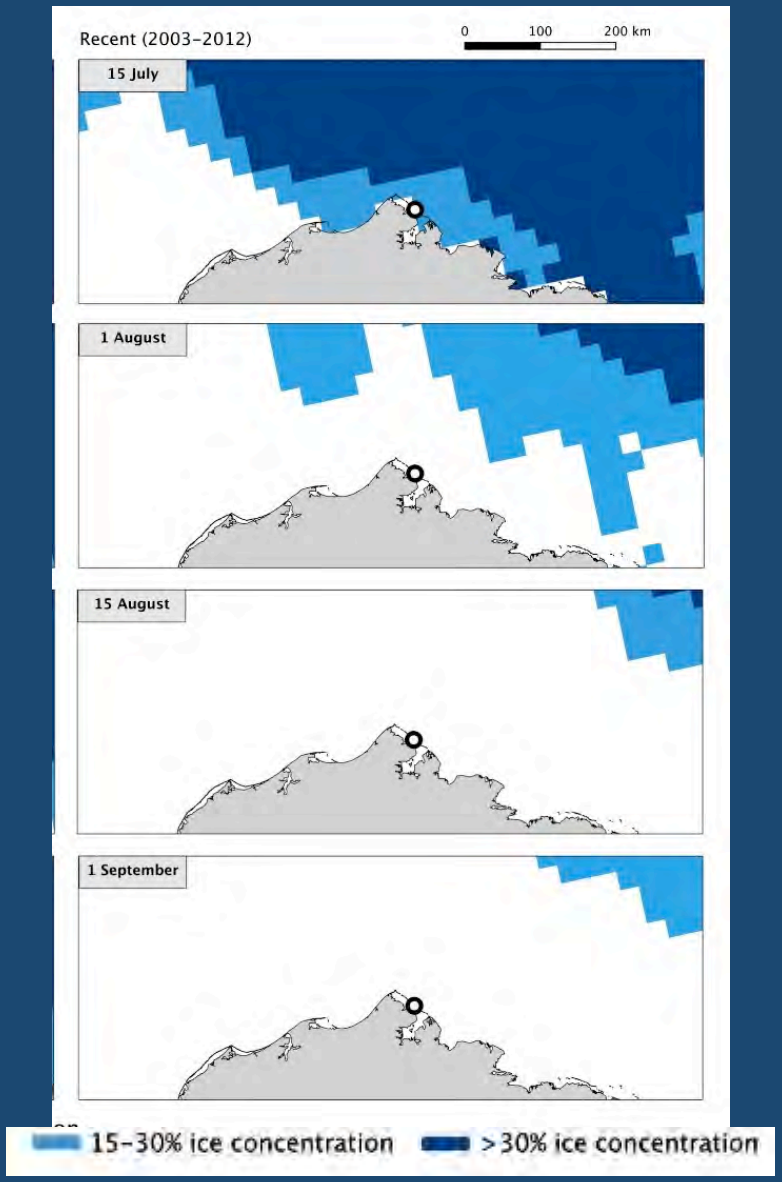




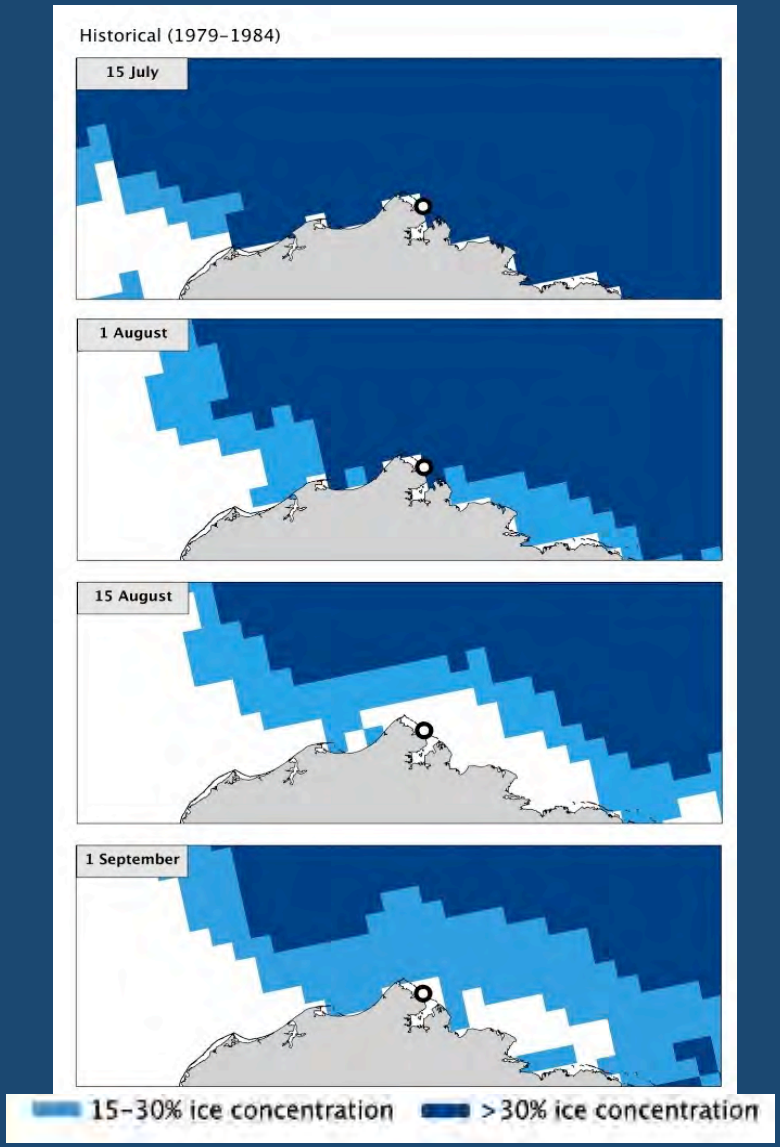
2011

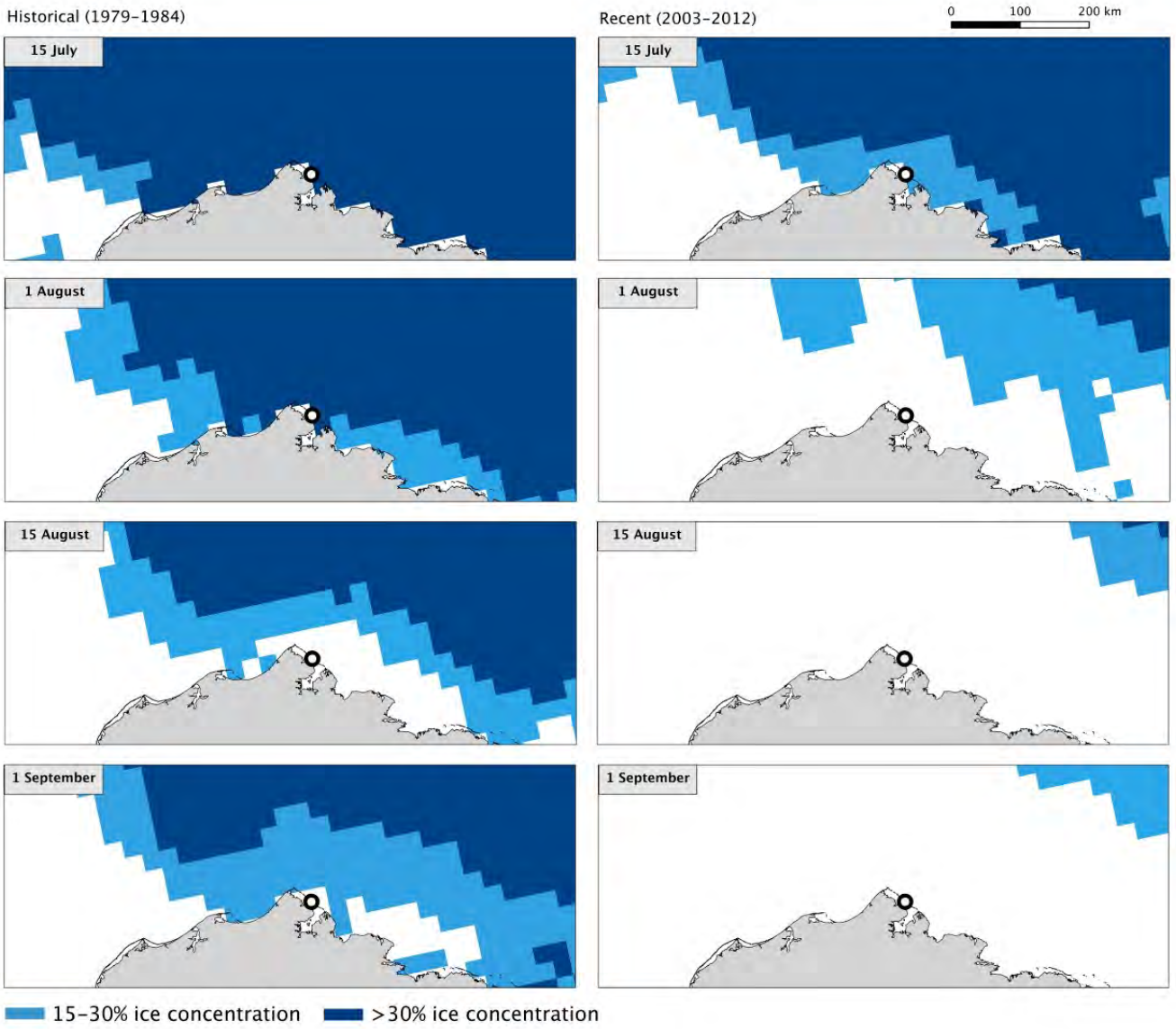


Sea ice during guillemot nestling period in recent decade (2003-2012)

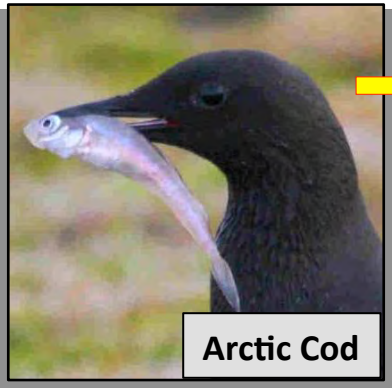


Sea ice during guillemot nestling period in historic decade (1979-1984)




Historical (1979–1984)
Recent (2003–2012)
0
100
200 km
15 July
15 July
1 August
1 August
15 August
15 August
1 September
1 September
15–30% ice concentration
>30% ice concentration

1979-1984



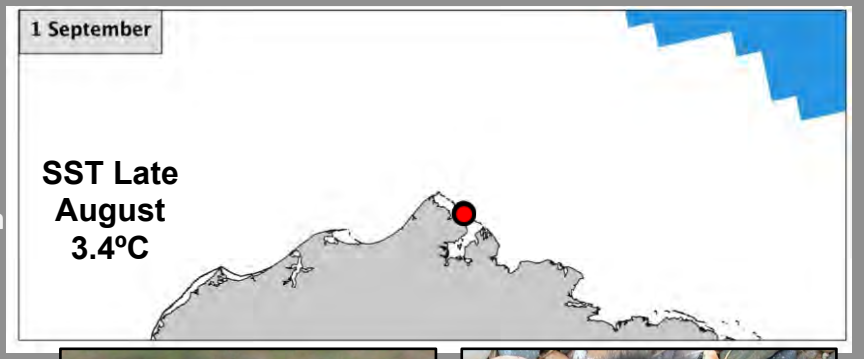
Cooper Island

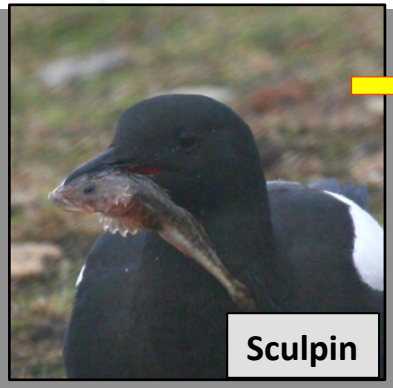
Ice concentration

15-30%

>30%

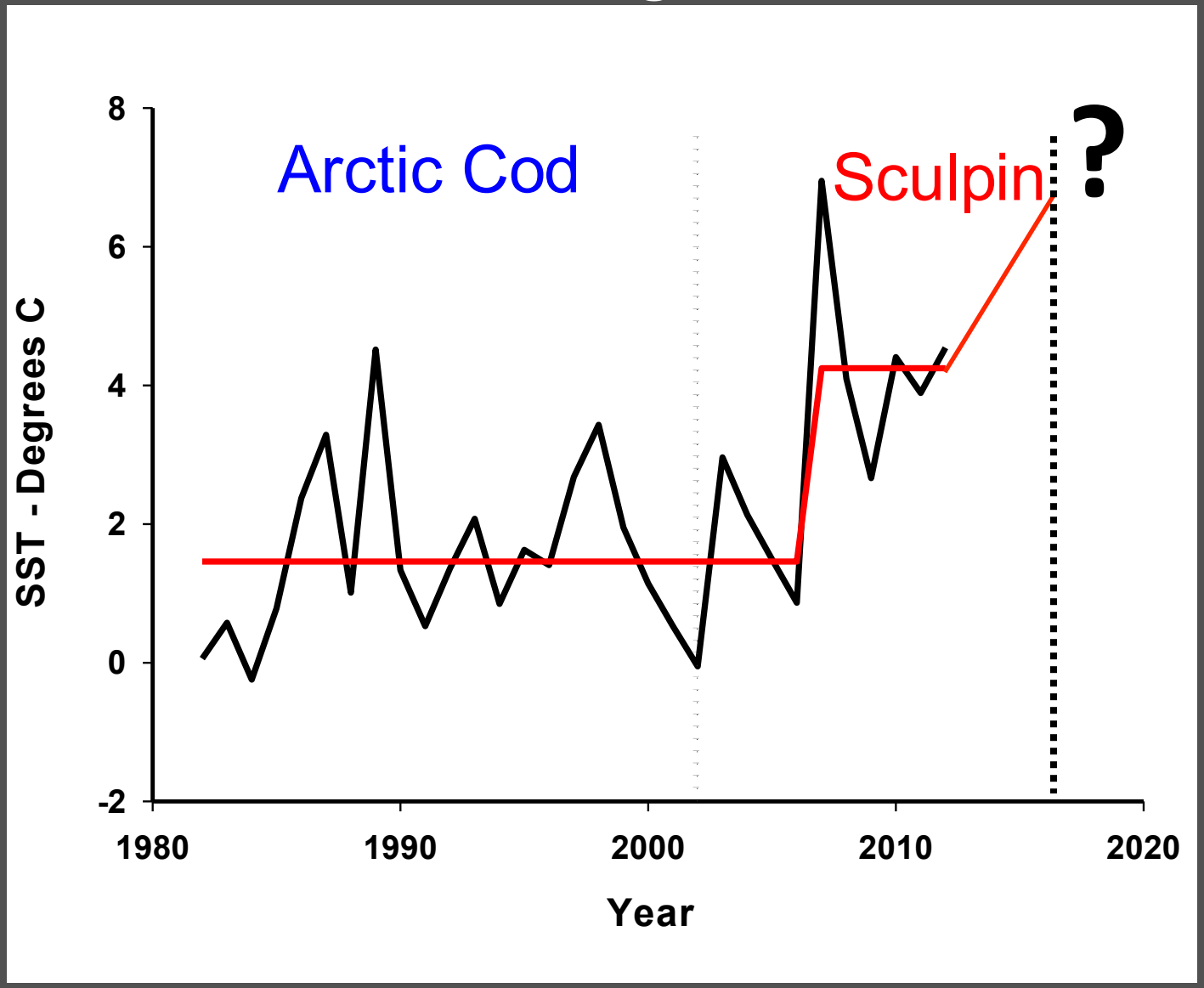
2003-2012





Divoky, G.J, M.L. Druckenmiller, and P.M. Lukacs. 2015. Effects of recent decreases in arctic sea ice on an ice-associated marine bird. Progress in Oceanography136:151-161

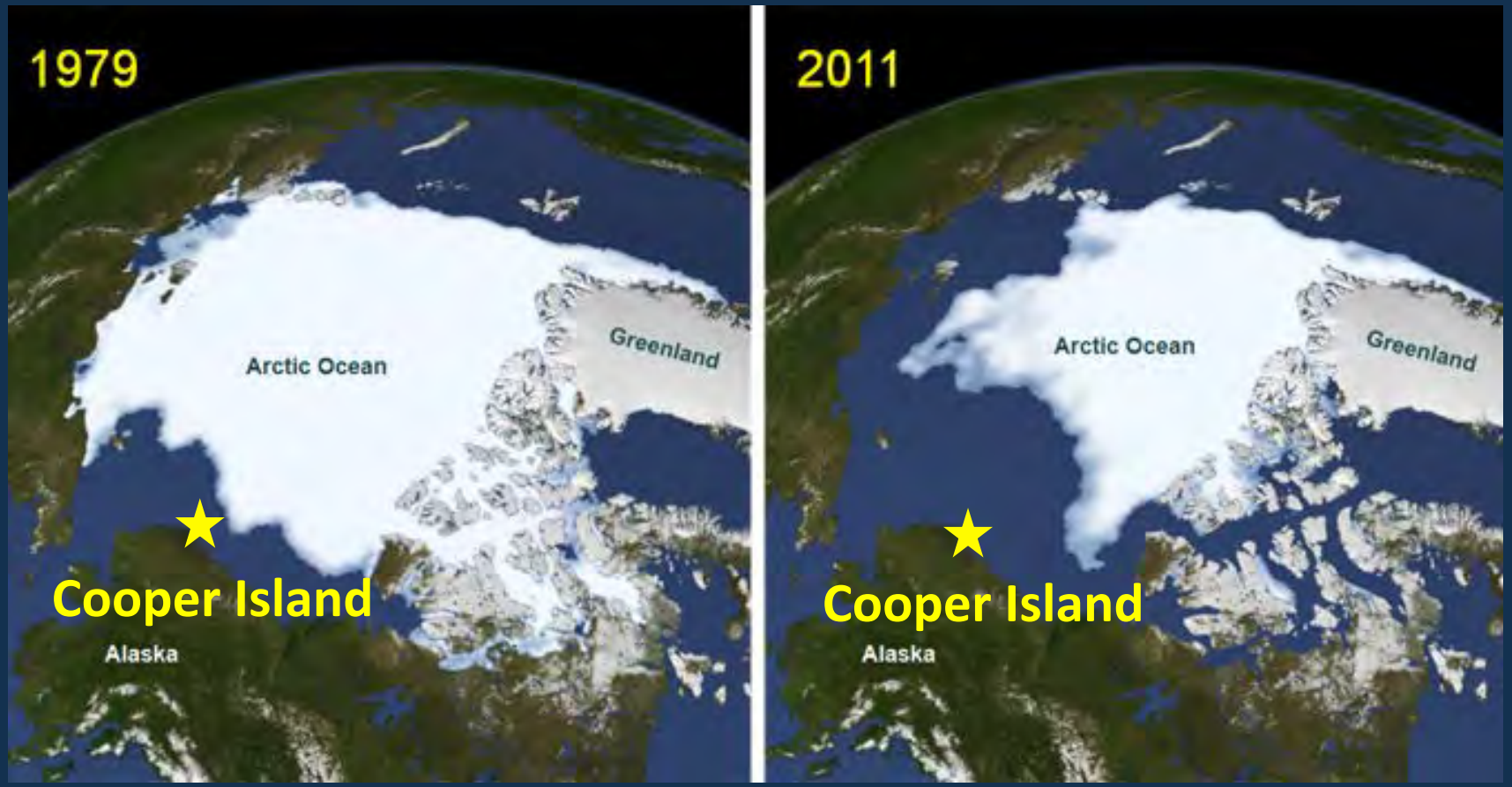
Another prey shift is likely – probably to a subarctic fish moving into the Arctic



Nest Competitors and Nest Predators

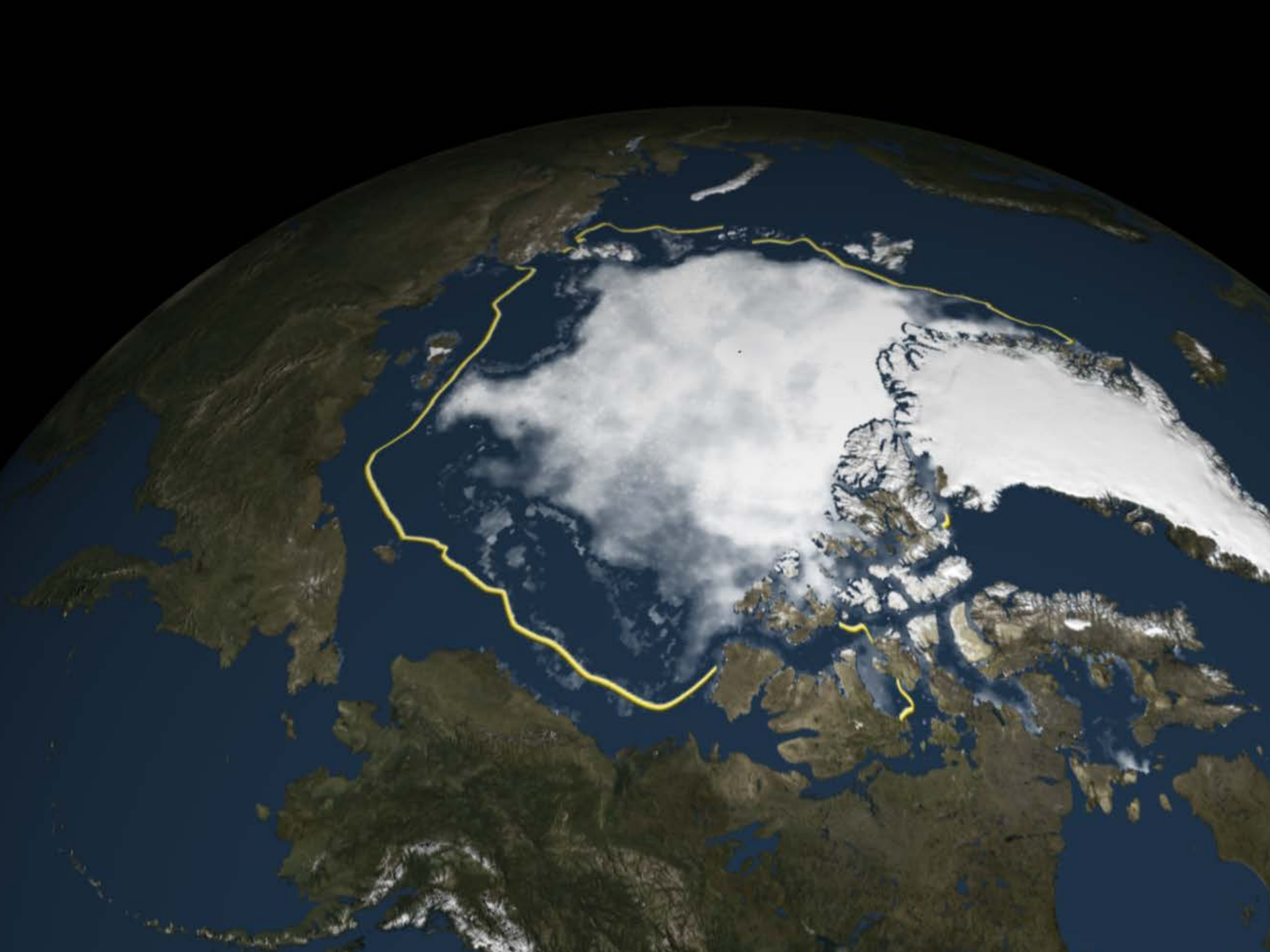

Horned Puffins, a subarctic species, colonized northern Alaska in 1986
1986
Historical extent of breeding
One million Horned Puffins

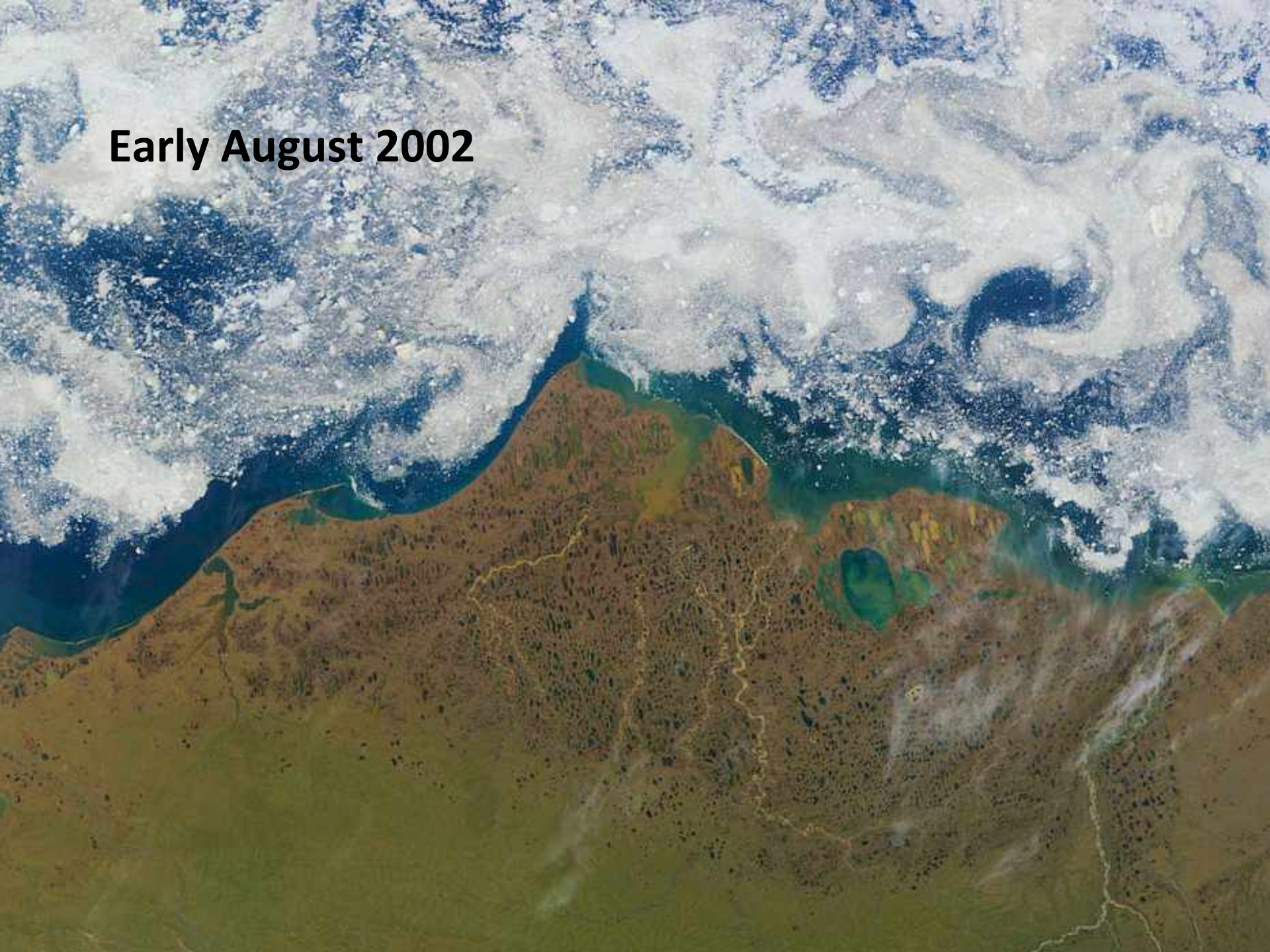
September Sea Ice Extent



Horned Puffin nest competitor with Black Guillemots
First bred on Cooper Island in 1986
Increased prospecting of guillemot nest sites since 2000

Polar bear predation on puffin nestlings high and number of Horned Puffins at colony has decreased in recent years.




Early August 2002

18 August 2002

Nest site used from 1975-2011

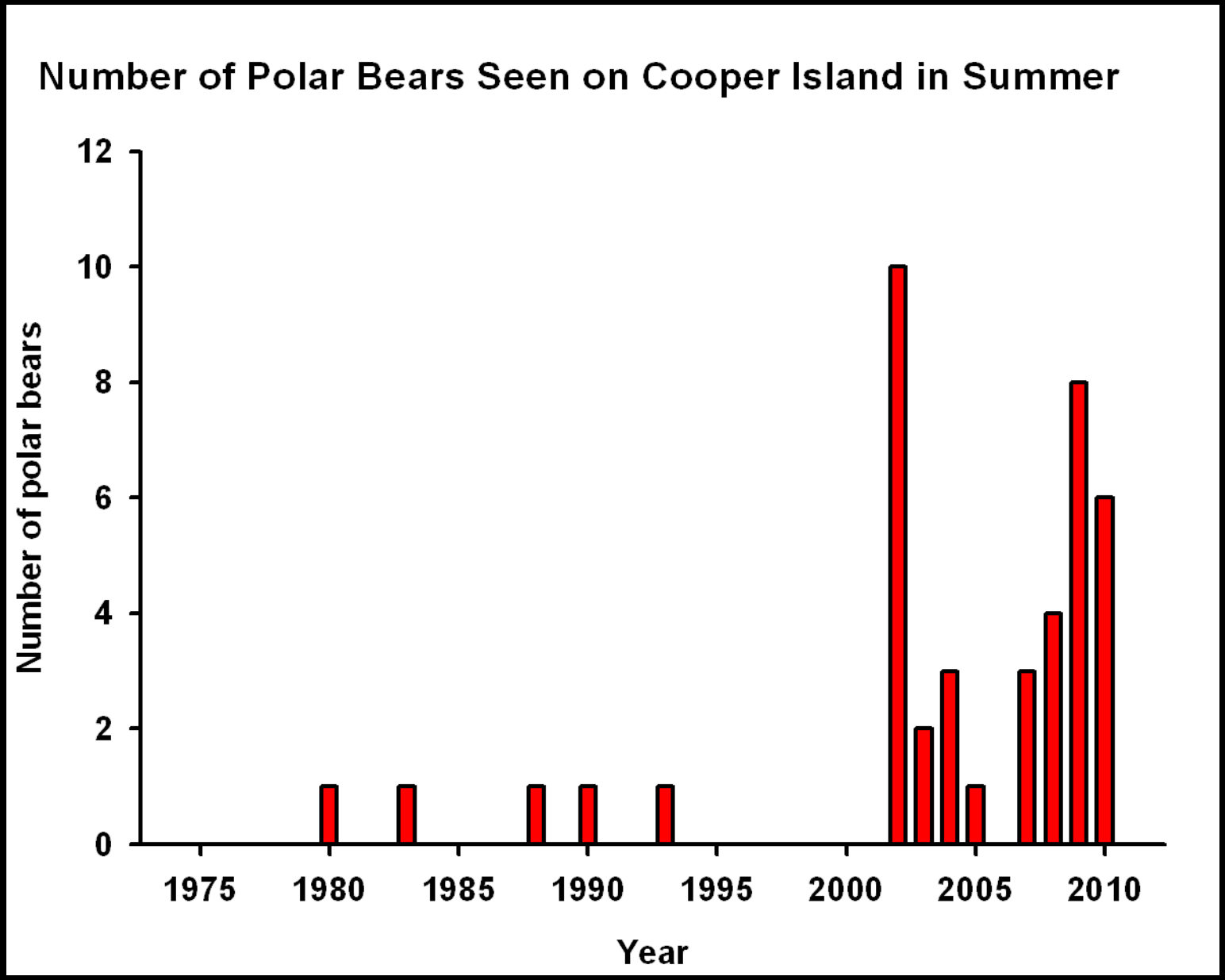

2008-08-17 06:55:59 M 1/20 38°F
RECON 1
WWW.RECONYX.COM

Polar Bear eating vegetation

Summer 2009

- Black Guillemot chicks hatched 184
- Eaten or killed by polar bear 90
- Killed by horned puffin 81
- Die of other causes 12
- Fledge 1

Plastic cases tested in 2010 as possible bear deterrent


Number of Polar Bears Seen on Cooper Island in Summer
Number of polar bears
0
2
4
6
8
10
12
1975
1980
1985
1990
1995
2000
2005
2010
Year

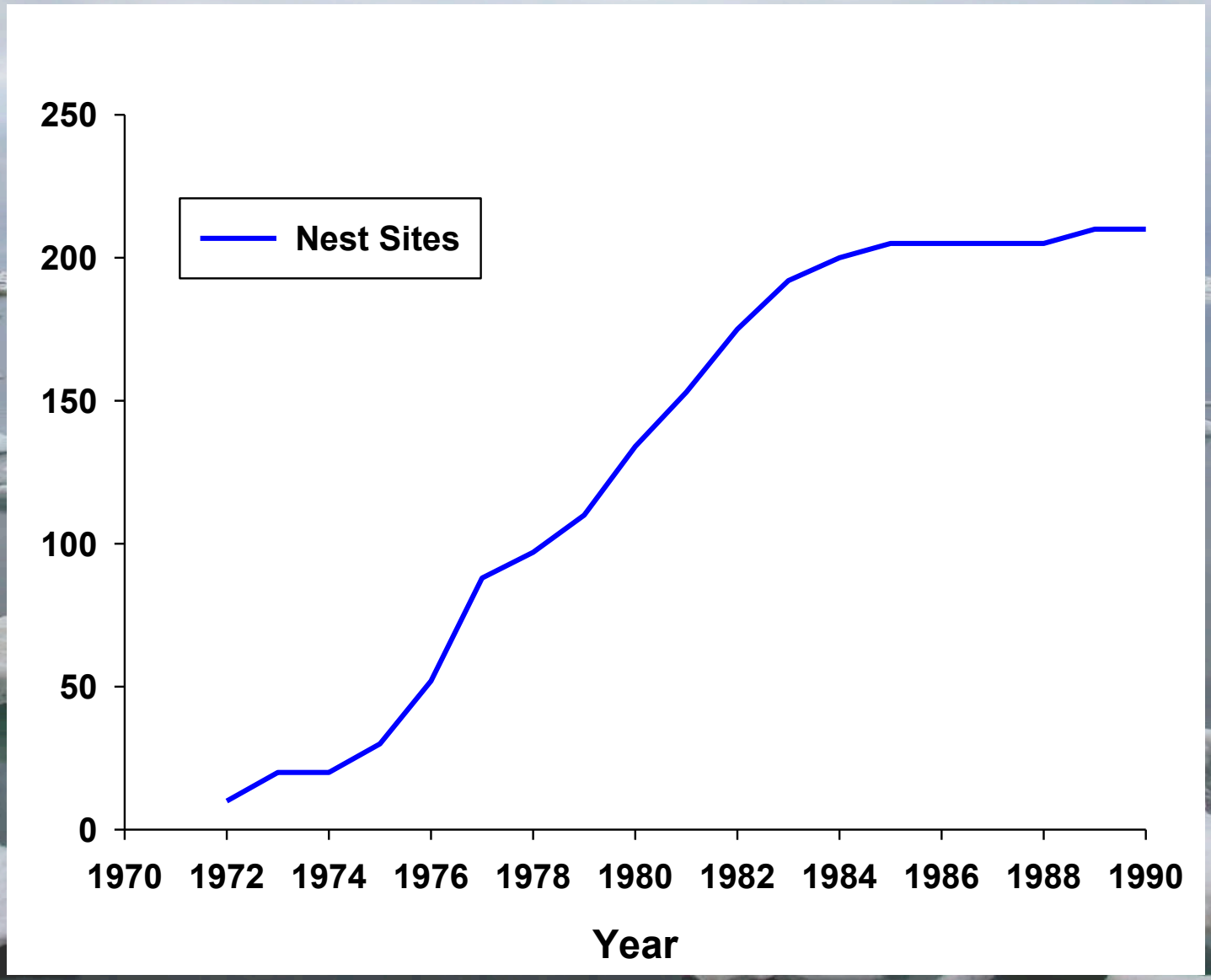

2008-08-17 06:56:01 M 4/20 38°F
RECON 1
WWW.RECONYX.COM


G. Divoky cooperisland.org

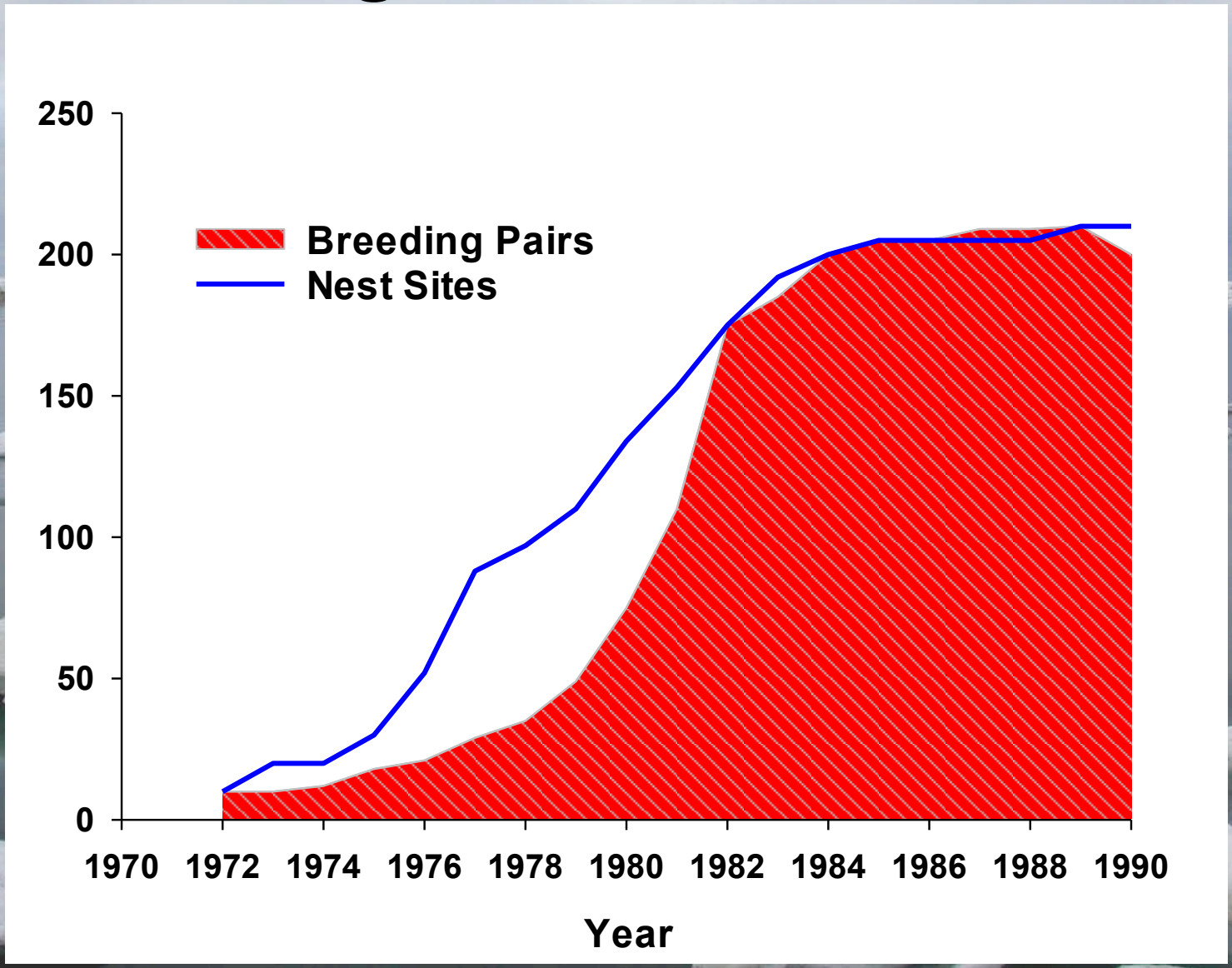

2016-08-19 21:11:49 39°F M 5/5
COOPER ISLAND
RECONYX

Population Trends

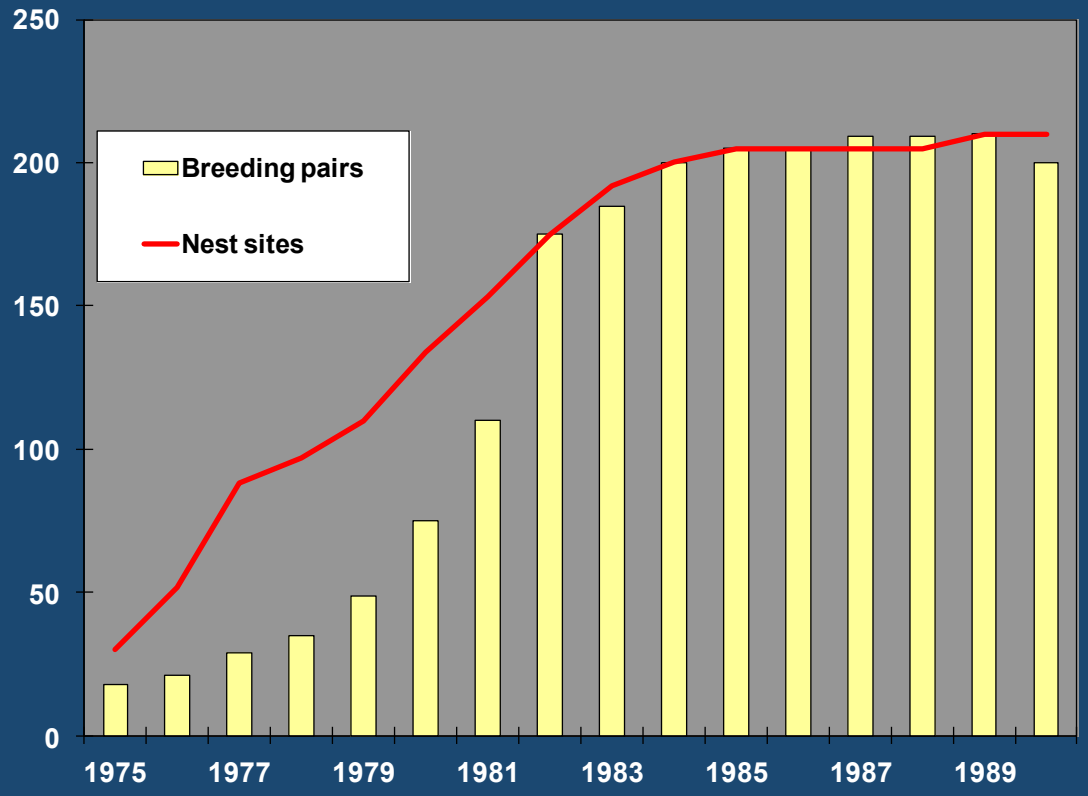
Nest sites on Cooper Island

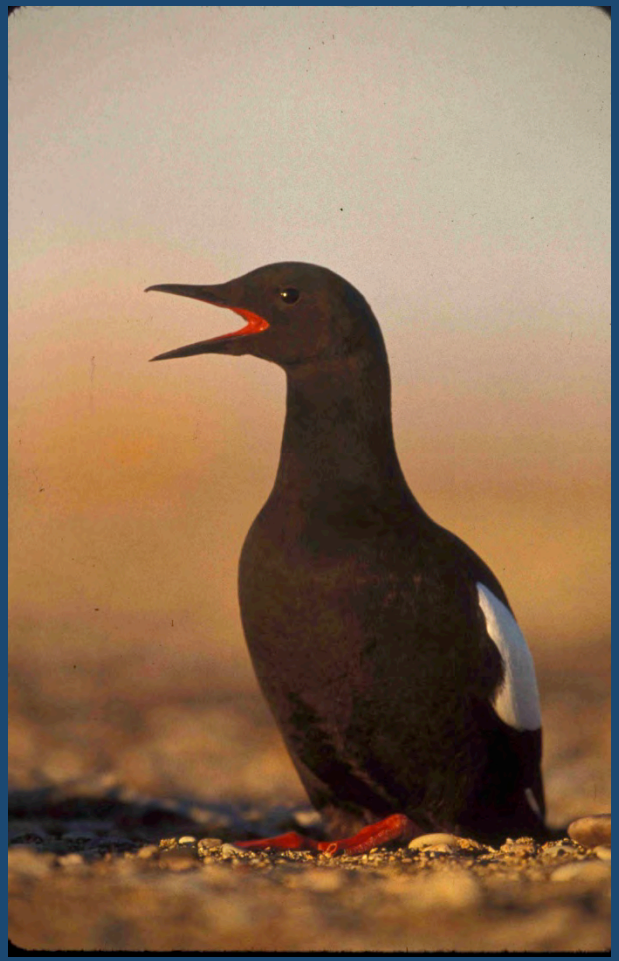


Breeding Pairs and Nest sites

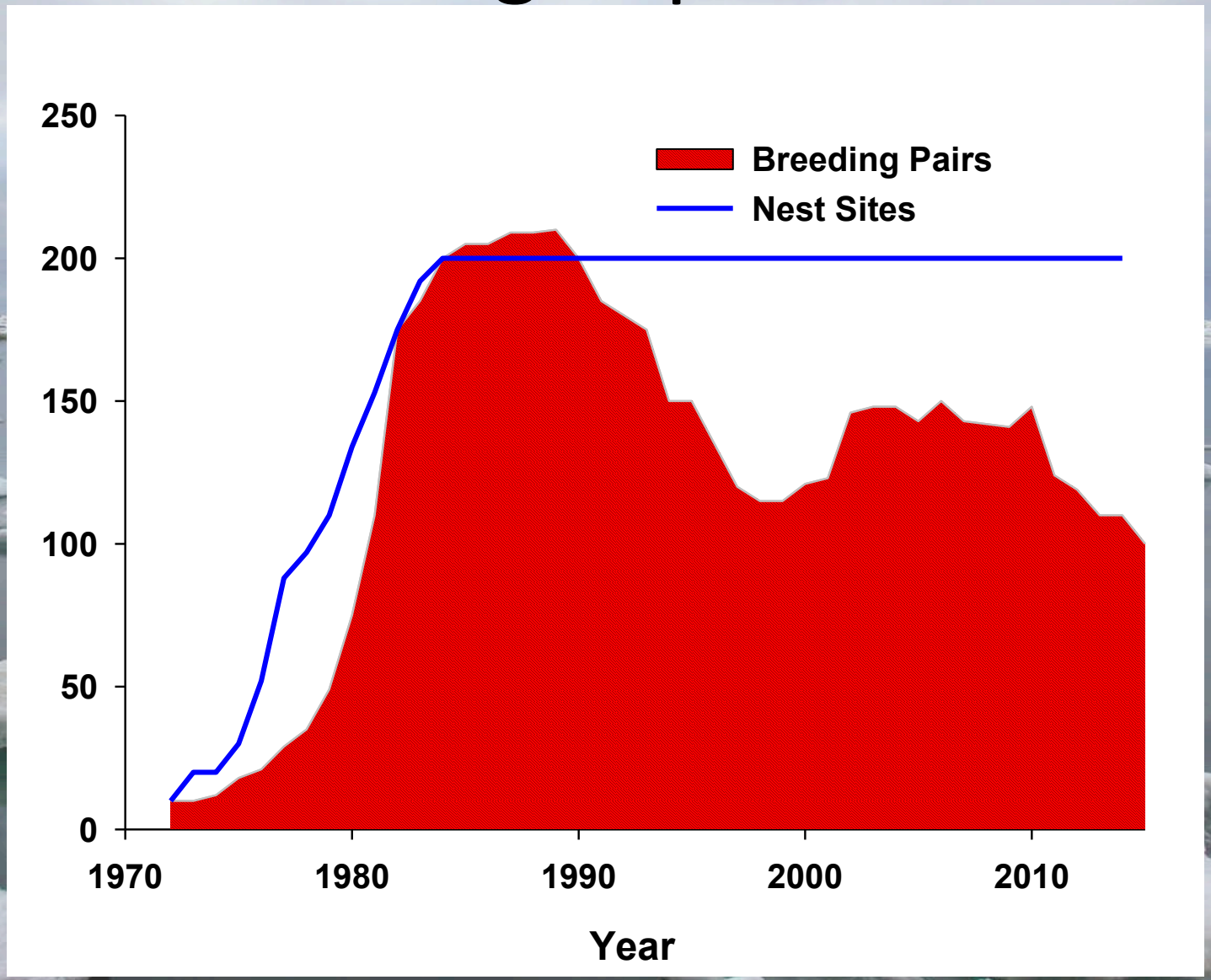


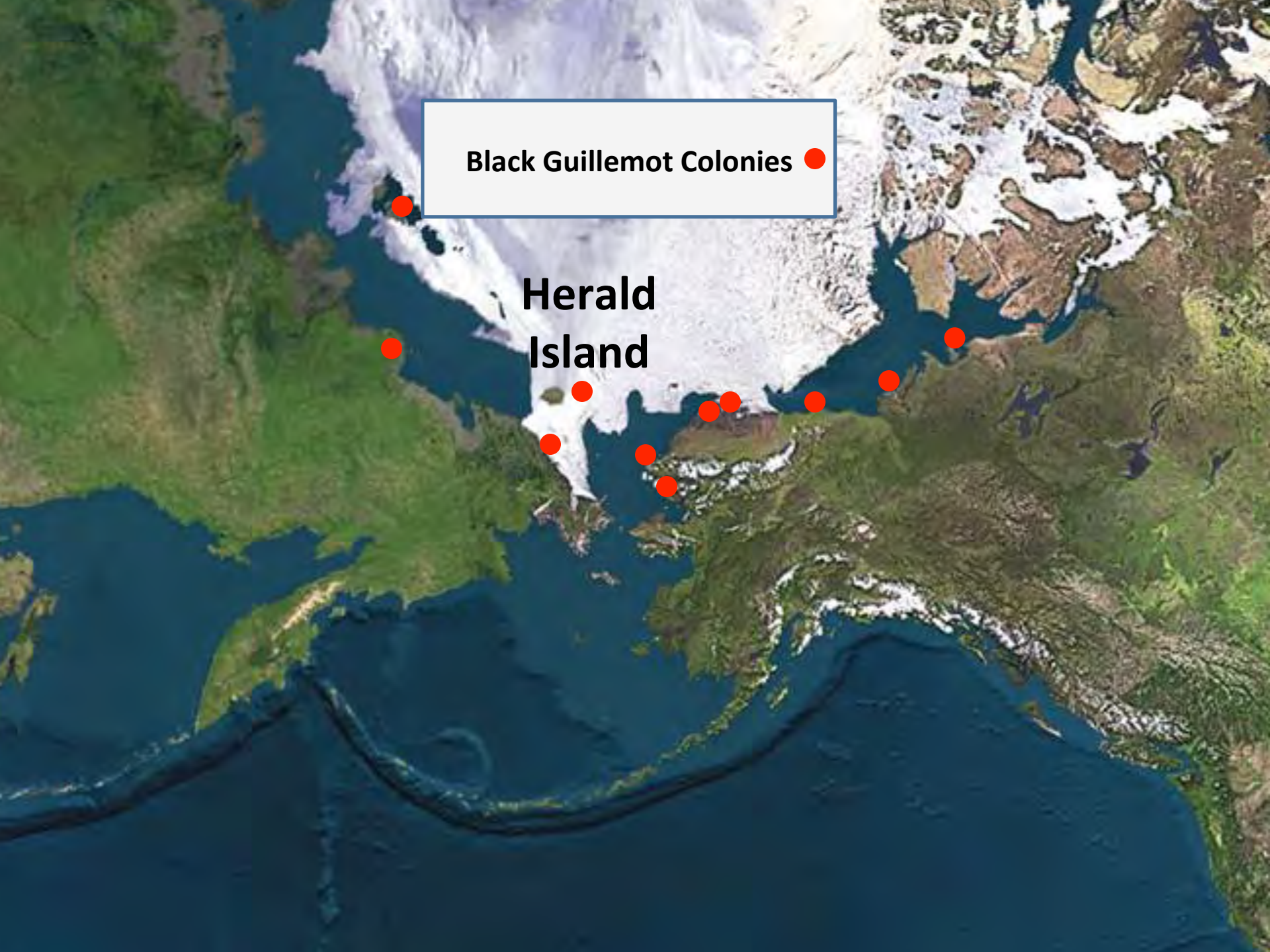
Colony Growth 1975-1990





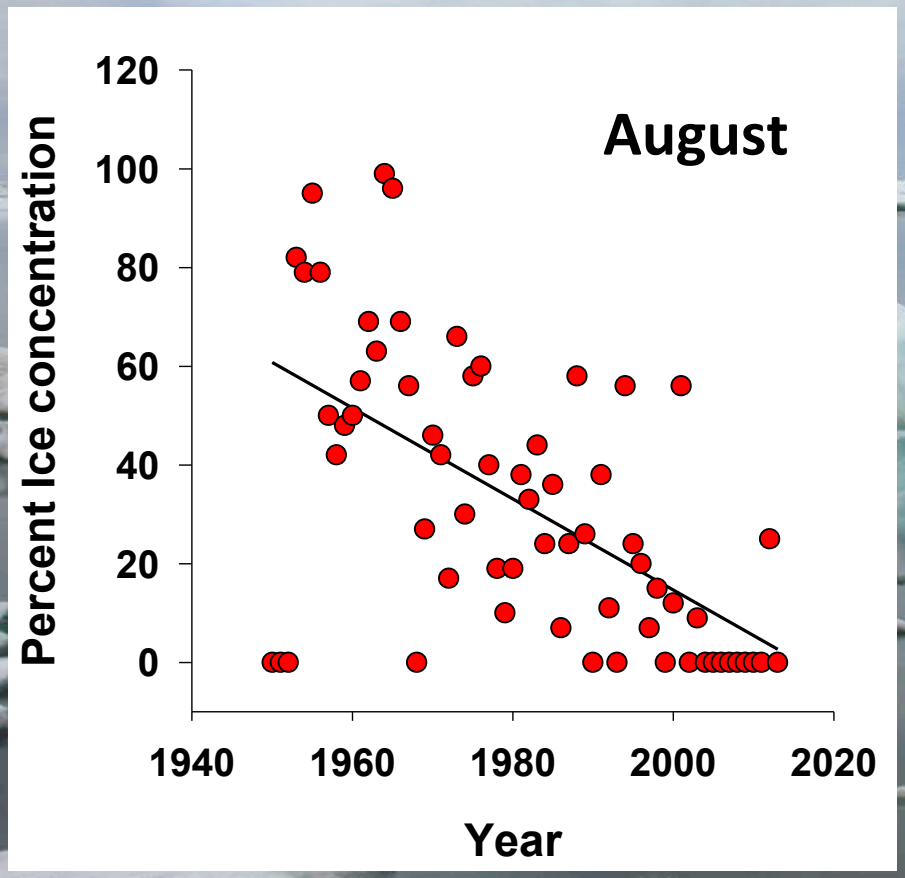
Breeding Population

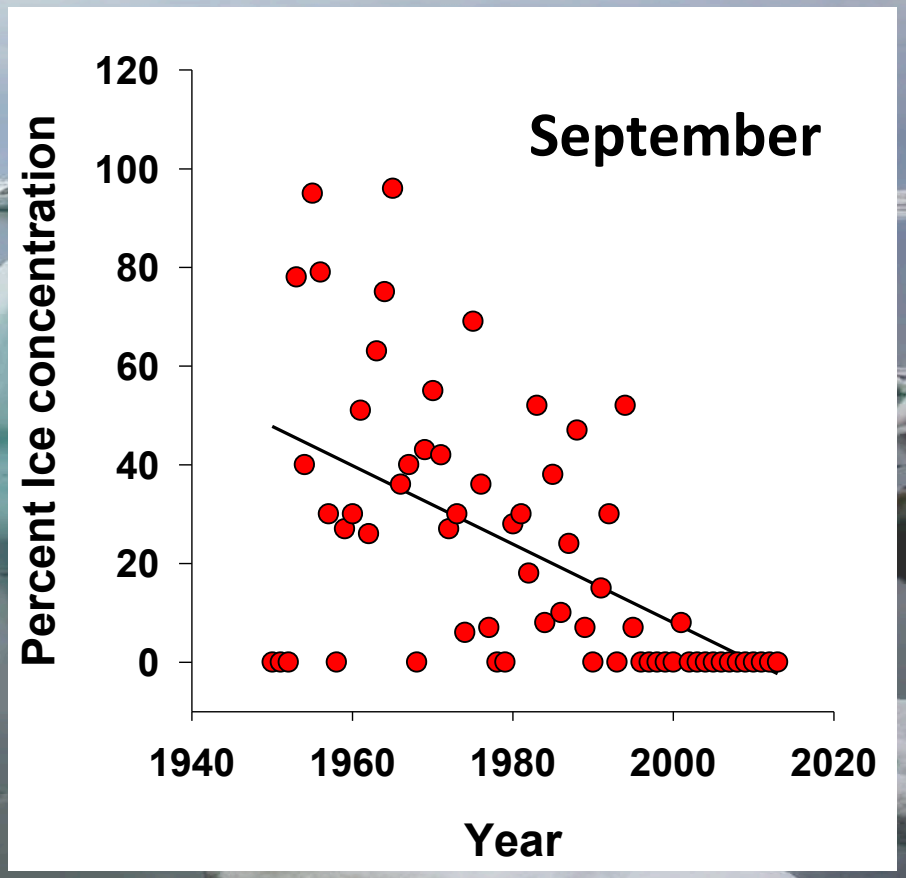



Black Guillemot Colonies
Herald Island

Herald Island

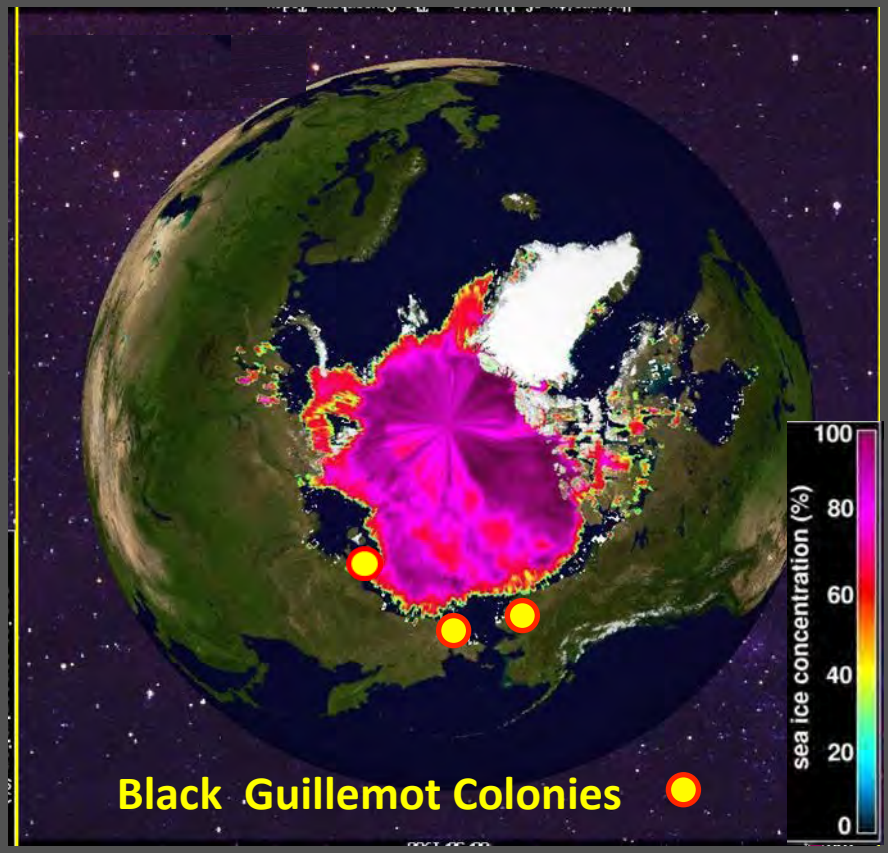
Sea Ice Concentration
Herald Island, Russia



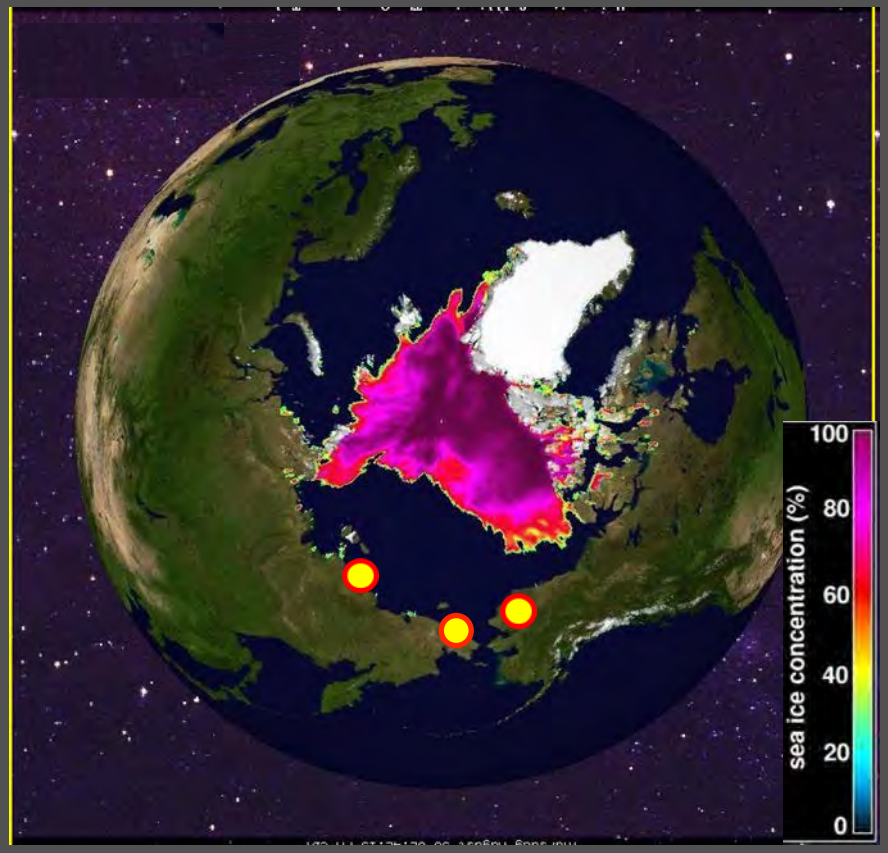


August 30 Sea Ice

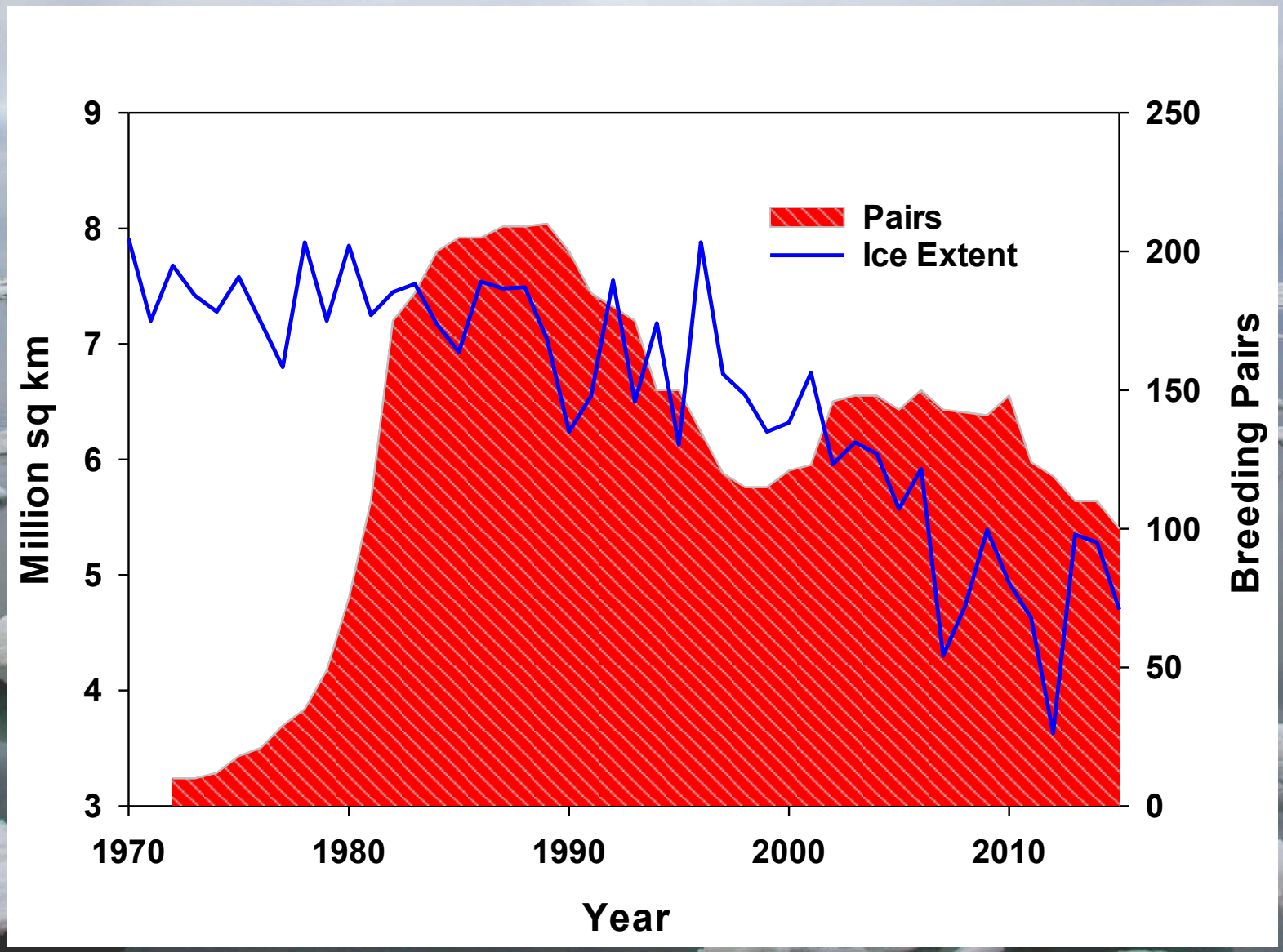
1981



2007



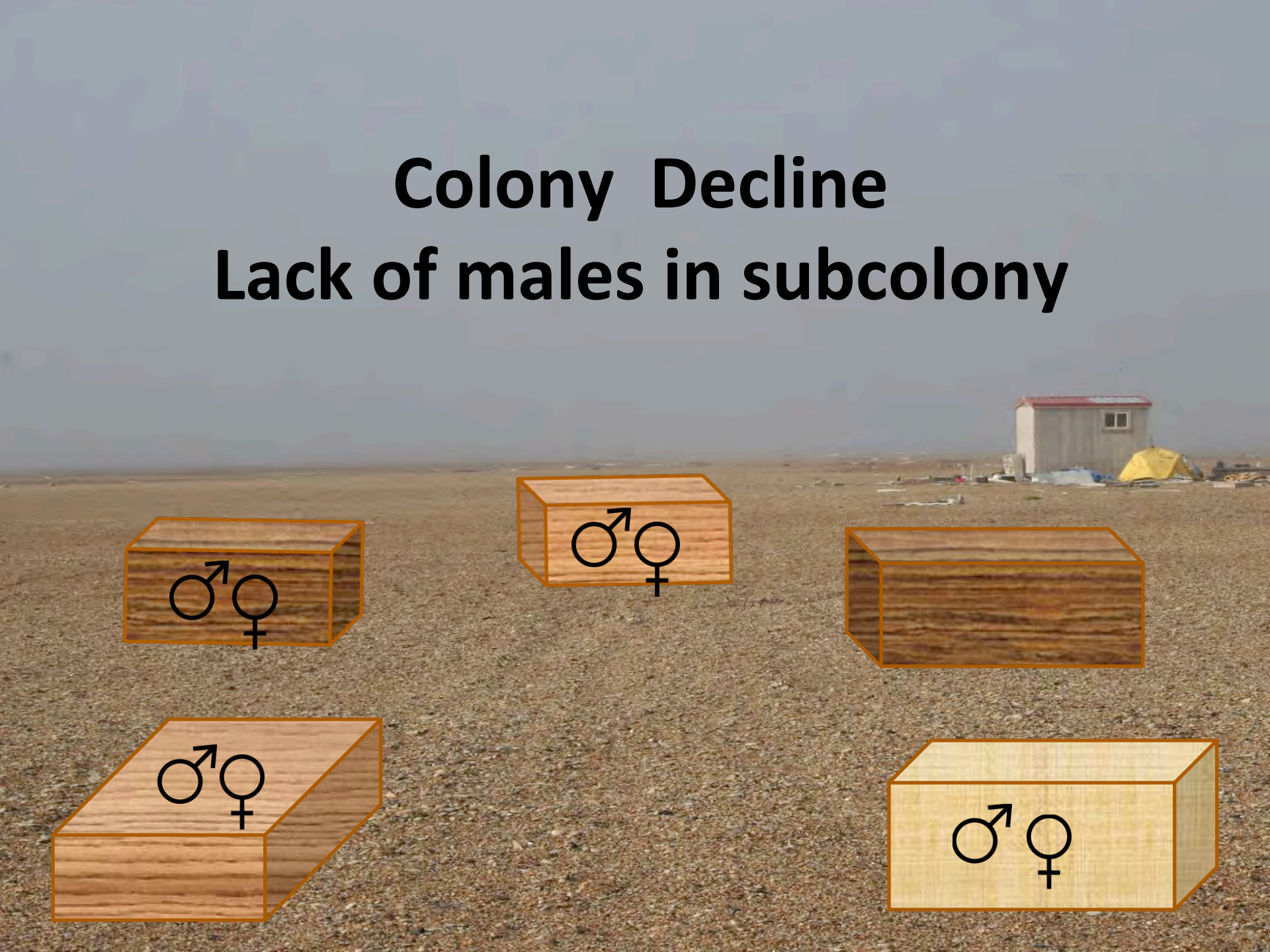
Population Response to Warming



All 200 nest sites replaced with plastic Nanuk cases in 2011

Full occupation with queues

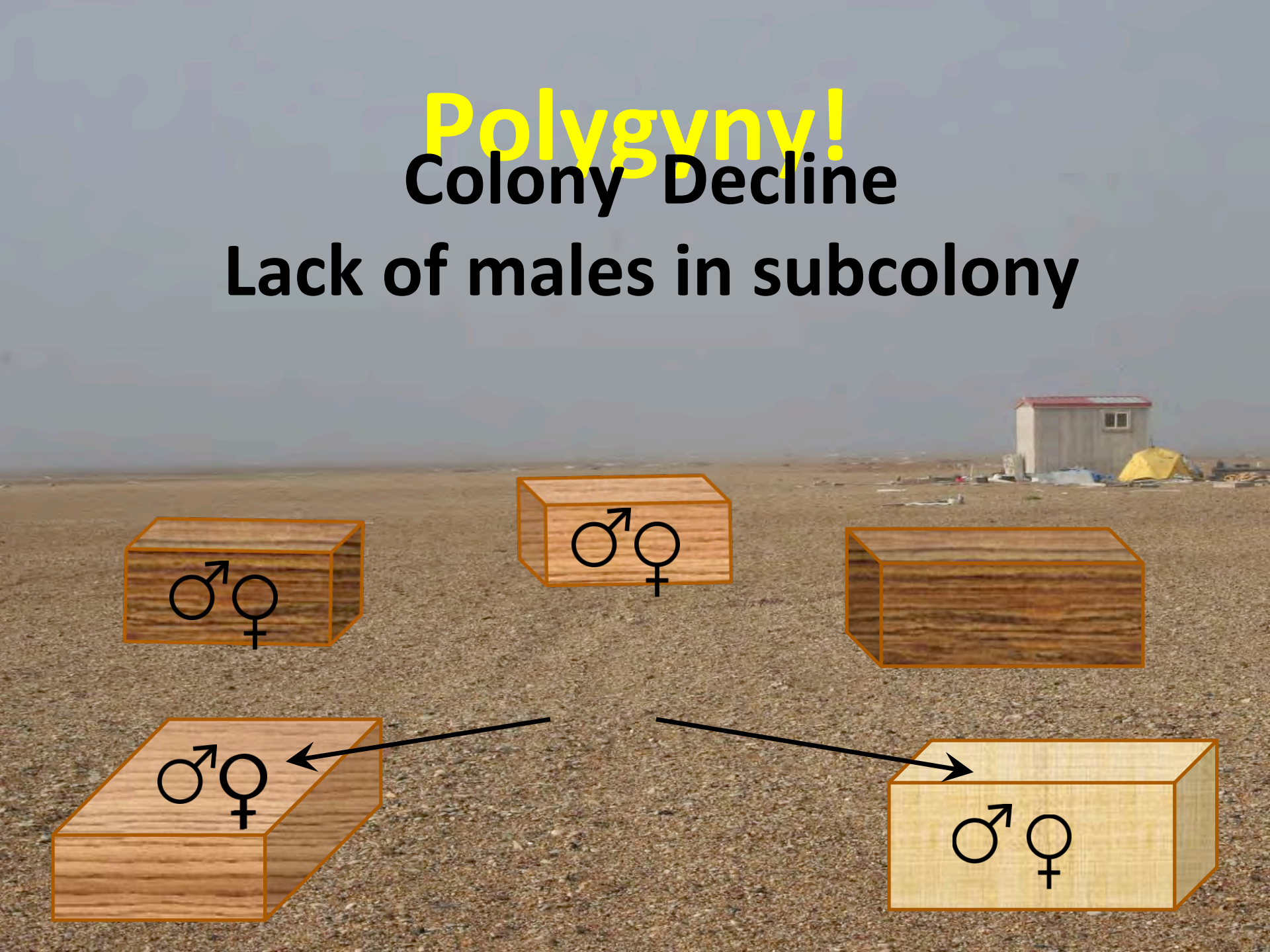
Colony Decline
Lack of males in subcolony



Polygyny!

Colony Decline

Lack of males in subcolony



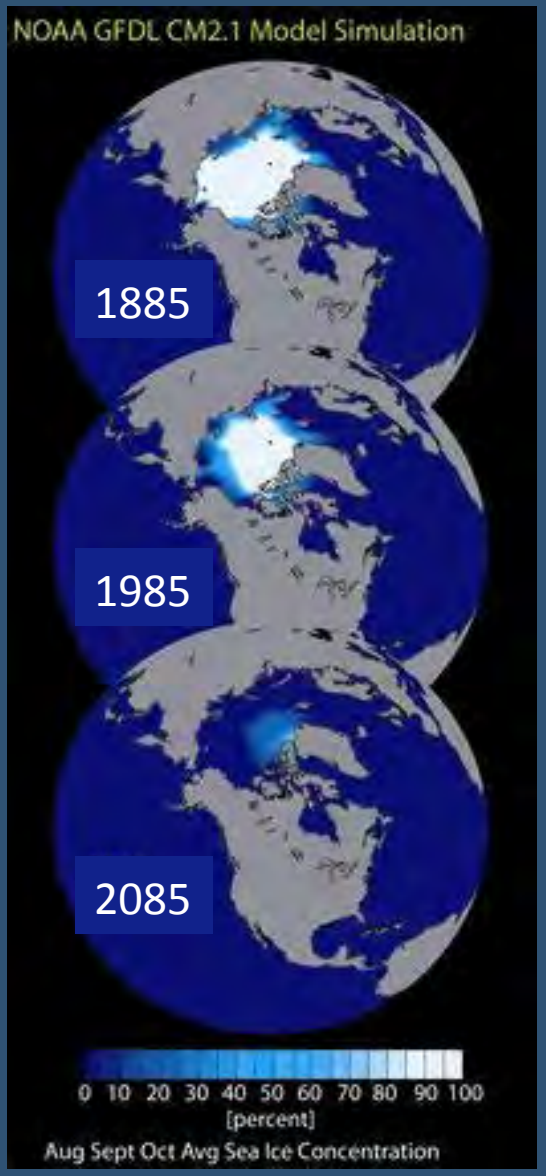

2015-08-11 07:36:25 M 4/10 38°F
M-6
COOPER ISLAND- CAM 8
RECONYX


2015-08-09 07:39:29 M 10/10 41°F
M-7
COOPER ISLAND-CAM 10
RECONYX


2015-08-20 17:38:11 M 1/10 43°F
M-6
COOPER ISLAND- CAM 8
RECONYX


2015-08-20 19:31:17 M 3/10 41°F
M-7
COOPER ISLAND- CAM 7
RECONYX

Who would care who is dating who during a disaster?

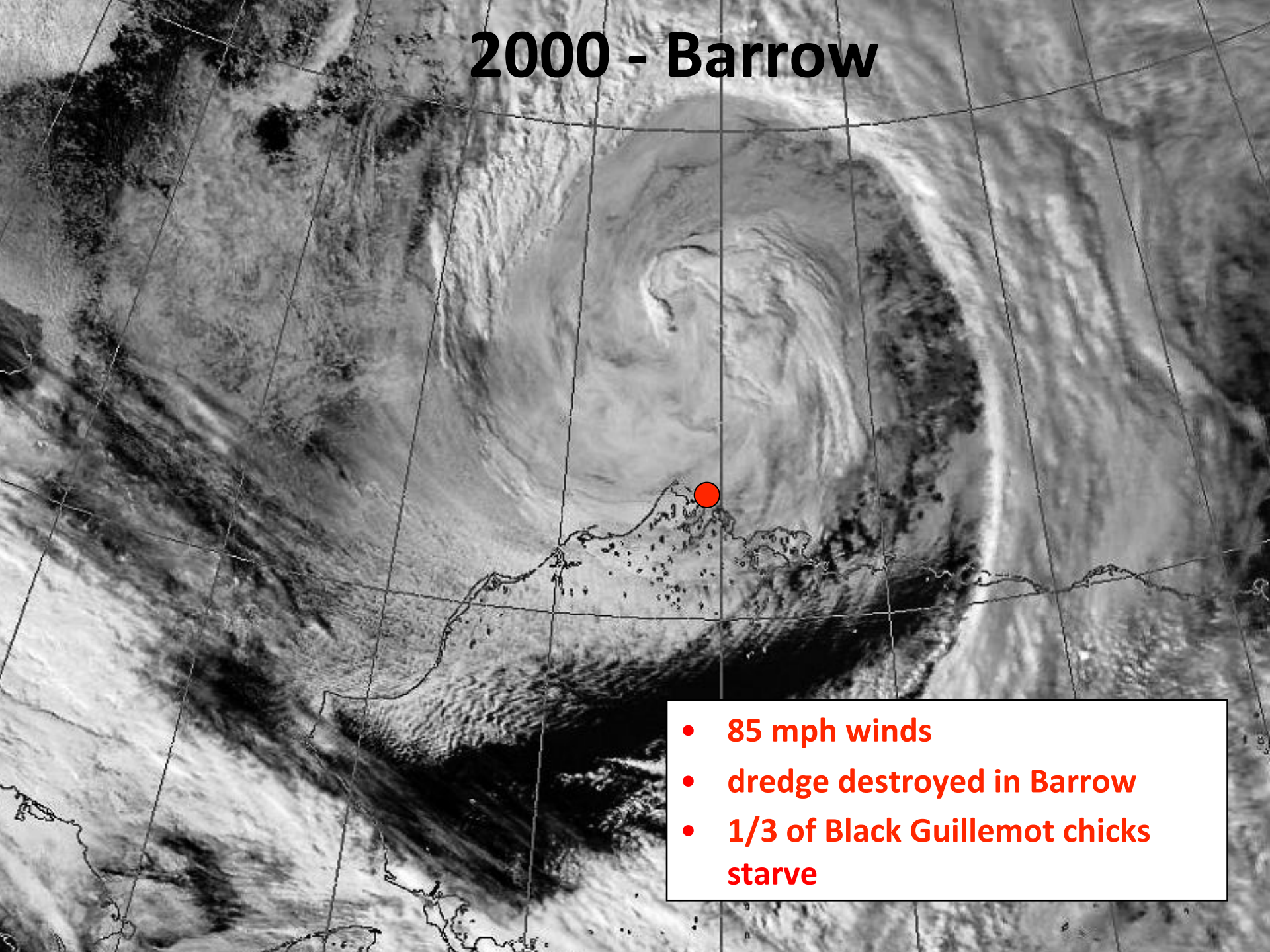



TITANIC

I’m the
King of the World!!

Other Warming Effects

2000 - Barrow

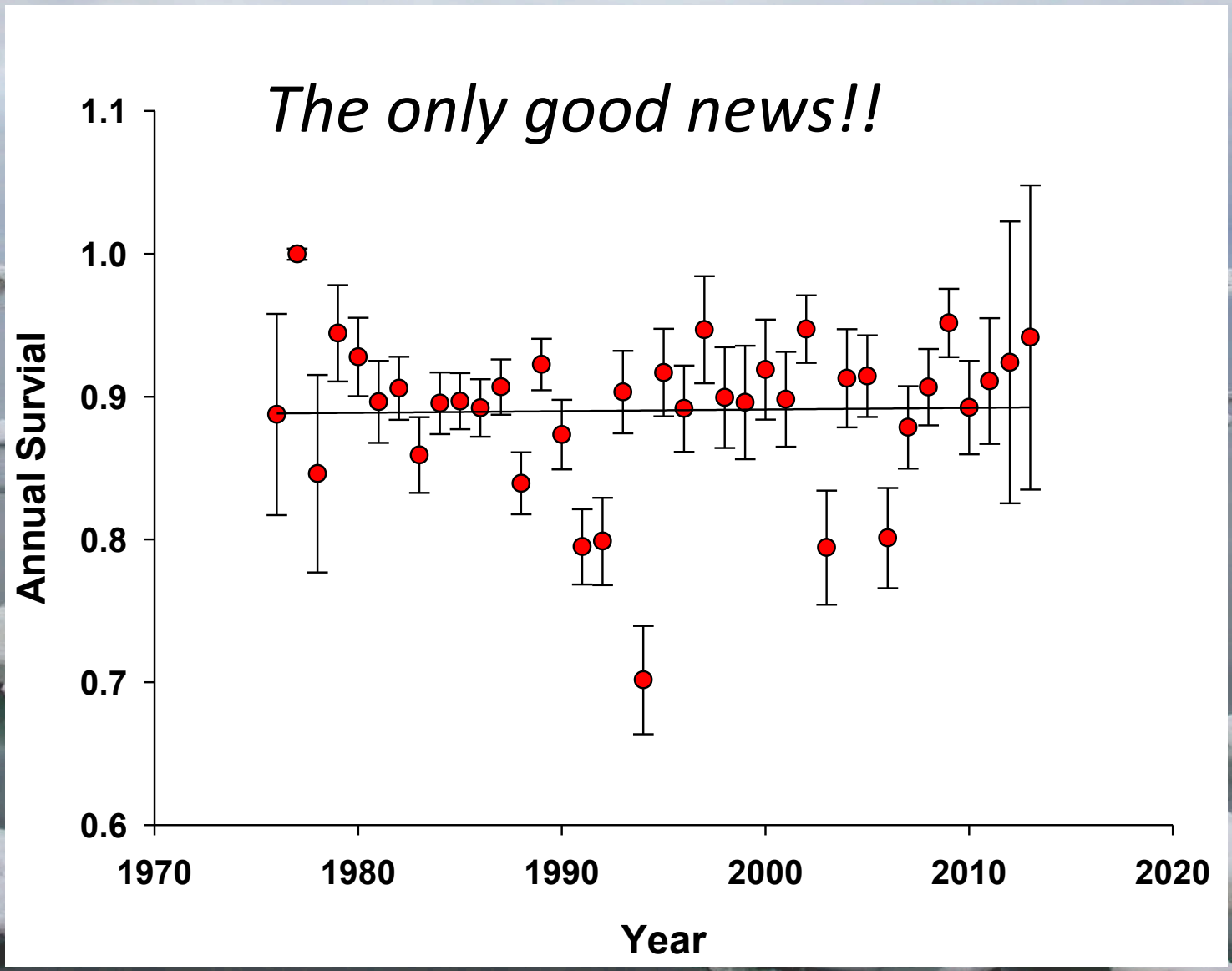


- 85 mph winds
- dredge destroyed in Barrow
- 1/3 of Black Guillemot chicks starve

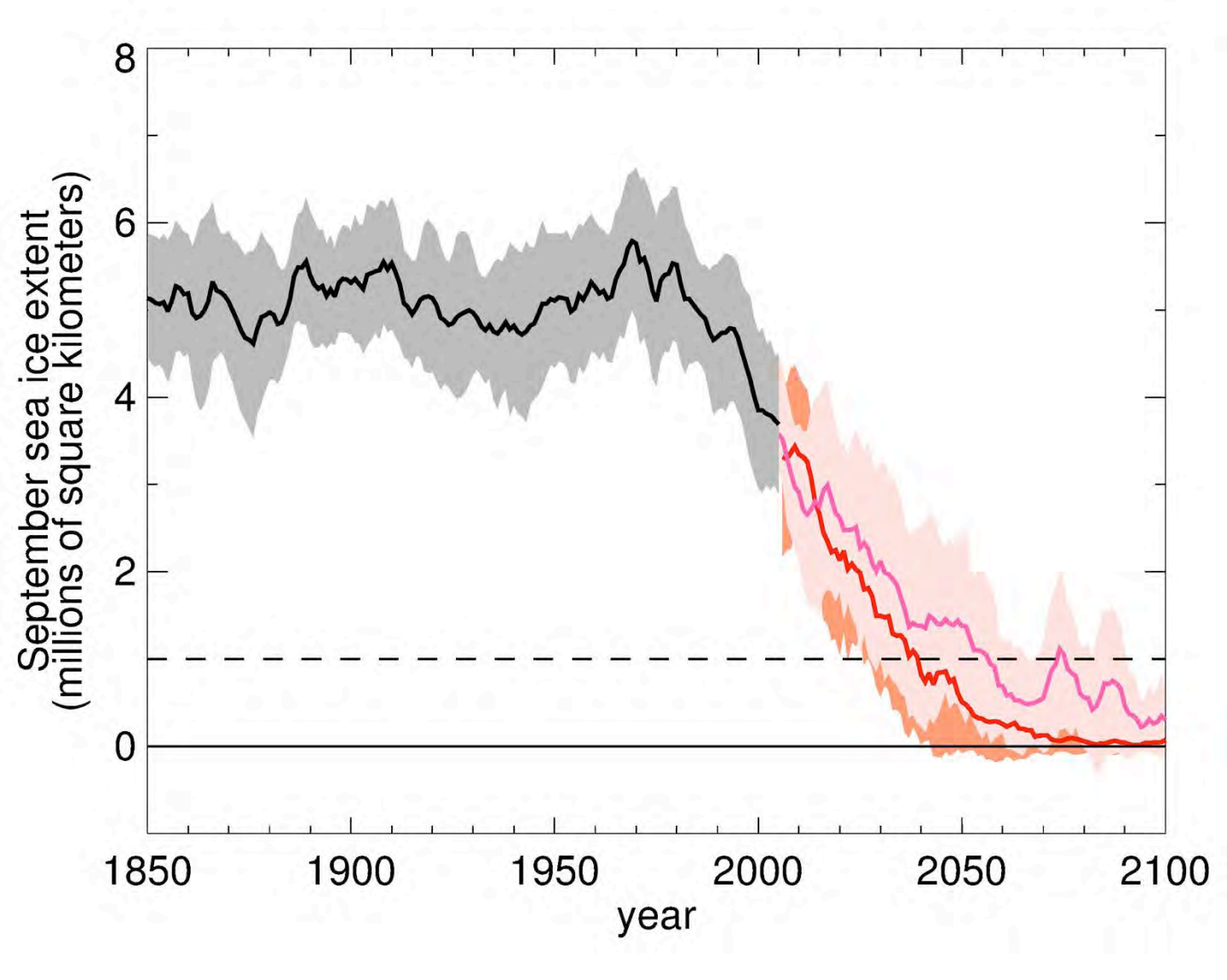
Response of Black Guillemot to Warming in Arctic Alaska

1. Warming allowed range expansion (1960- early 1970s)
2. Short period when the species thrived (early 1970s -1989)
3. Earlier breeding as warming occurred in 1990 with Arctic Oscillation shift but also a population decline
4. Early 2000s shifts in SST and sea ice reduced availability of Arctic Cod while increasing presence of a nest competitor and predator resulting in a decreased breeding success
5. Continuing population declines in 2010s as loss of sea ice continues

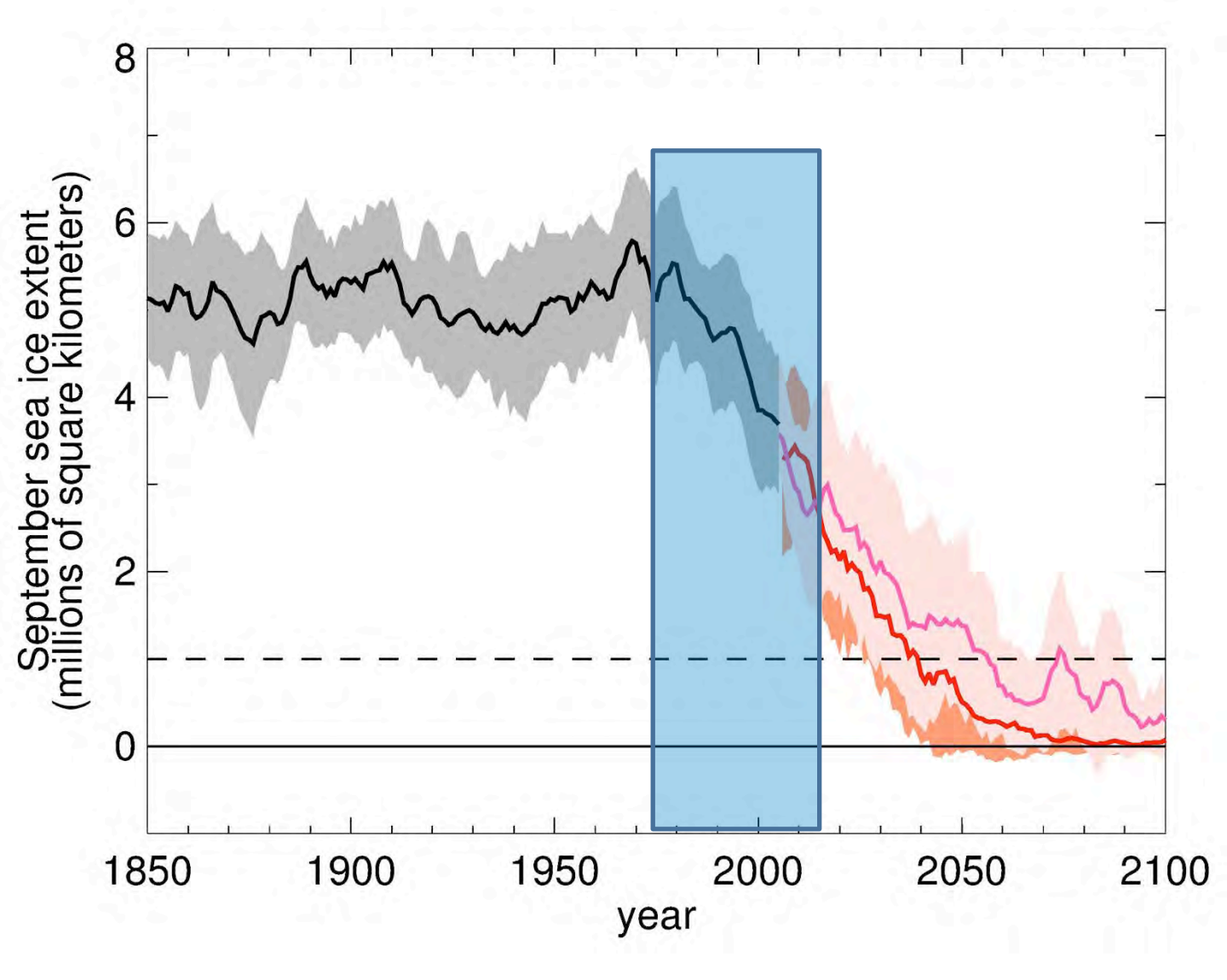
Adult Survival



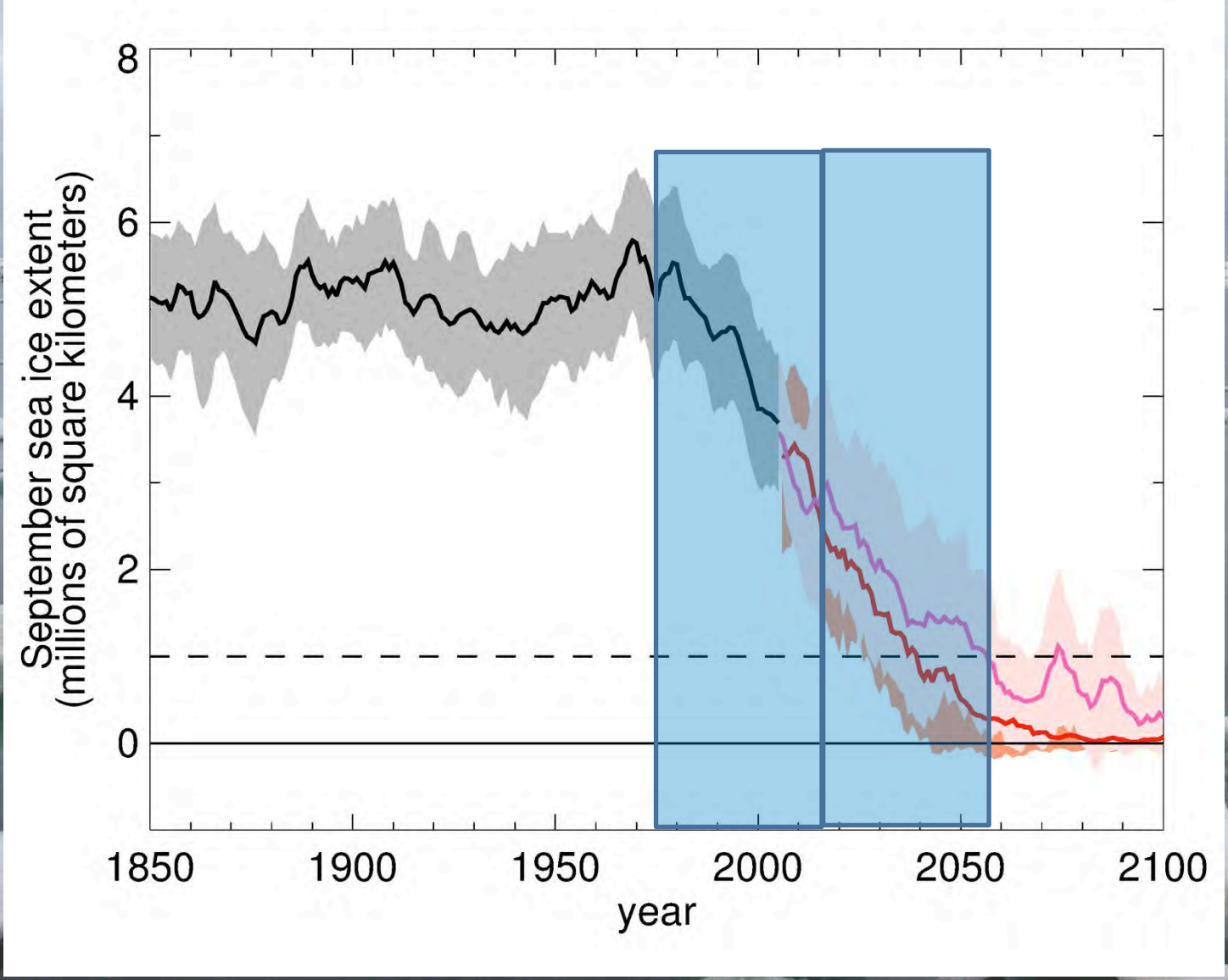
Observed and predicted September sea ice extent

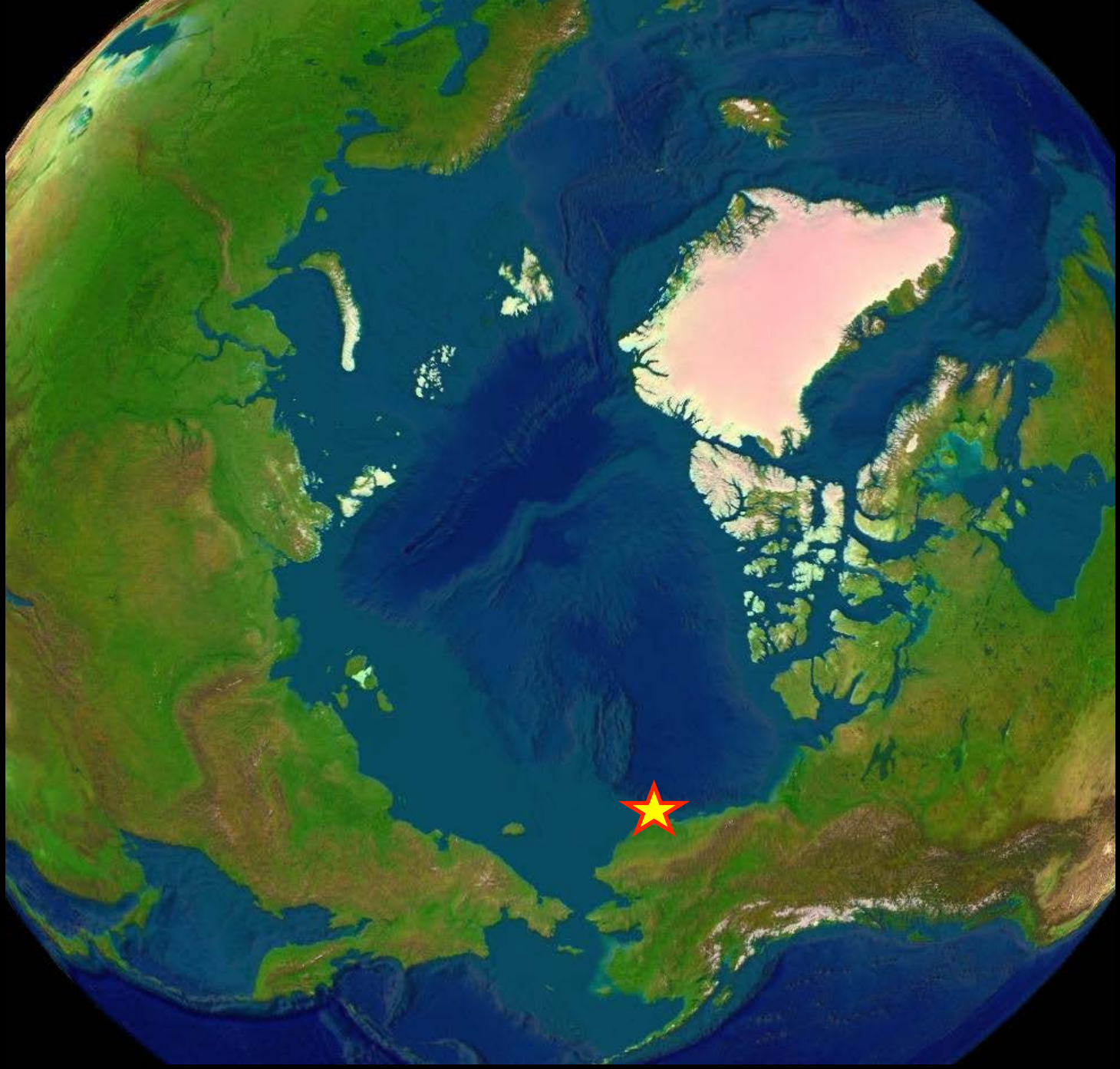


Observed and predicted September sea ice extent

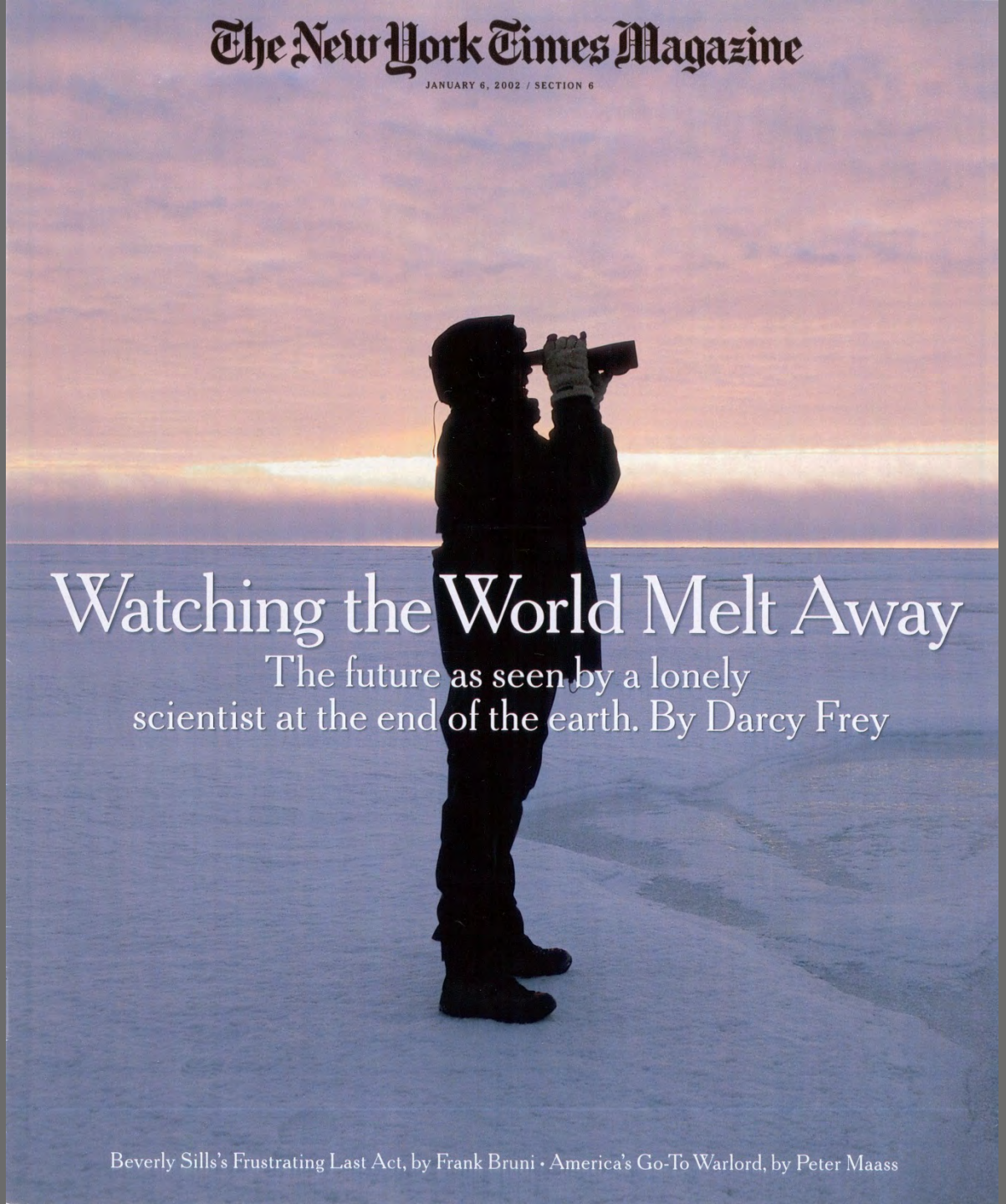


Observed and predicted September sea ice extent





The New York Times Magazine
JANUARY 6, 2002 / SECTION 6



Watching the World Melt Away

The future as seen by a lonely scientist at the end of the earth. By Darcy Frey

Beverly Sills's Frustrating Last Act, by Frank Bruni • America's Go-To Warlord, by Peter Maass


Ed Sullivan Theater
LATE SHOW
with David Letterman
ANGELO'S
ITALIAN RESTAURANT


on ice that may not be here in a hundred years
George Divoky, Ph.D., Researcher, Institute of Arctic Biology, University of Alaska
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Shouting warming in a crowded theatre

Cooper Island research featured in the UK Royal National Theatre Production of Greenland, a play written to inform the public of the realities of climate change

Foraging for Fish in a Melting Arctic: the Black Guillemots' Quest to Feed Their Young

ARCUS

Friends of Cooper Island

Monitoring a Changing Arctic since 1975

AN INDICATOR OF ARCTIC CHANGE, BLACK GUILLEMOT

THE BLACK GUILLEMOT

NESTING

BLACK GUILLEMOT EGGS

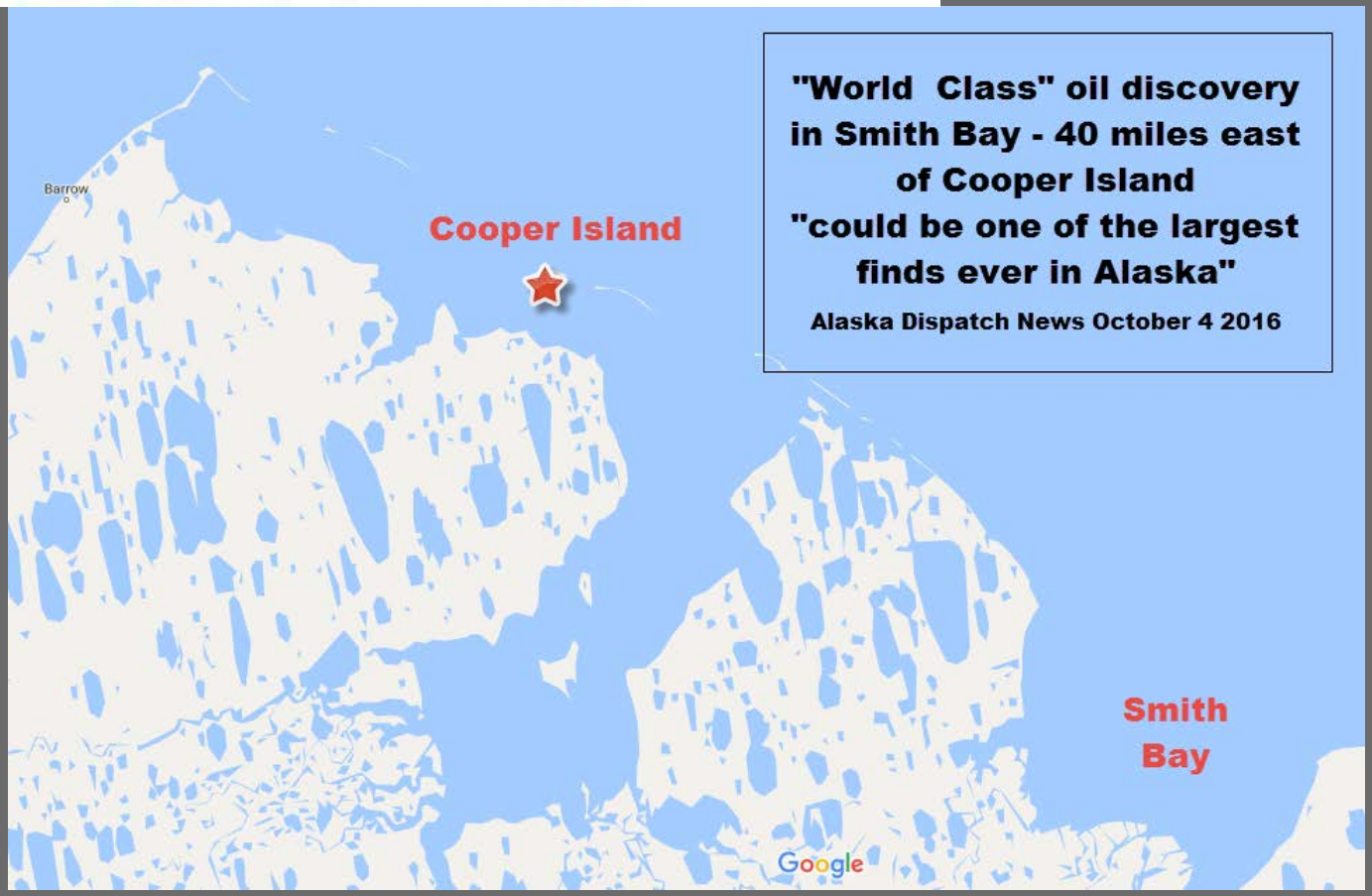
AN INDICATOR OF ARCTIC CHANGE, SEA ICE

SEA ICE NORTH OF COOPER ISLAND

Energy

Caelus claims Arctic oil discovery that could rank among Alaska's biggest ever

Author: Alex DeMarban Updated: October 5 Published October 4



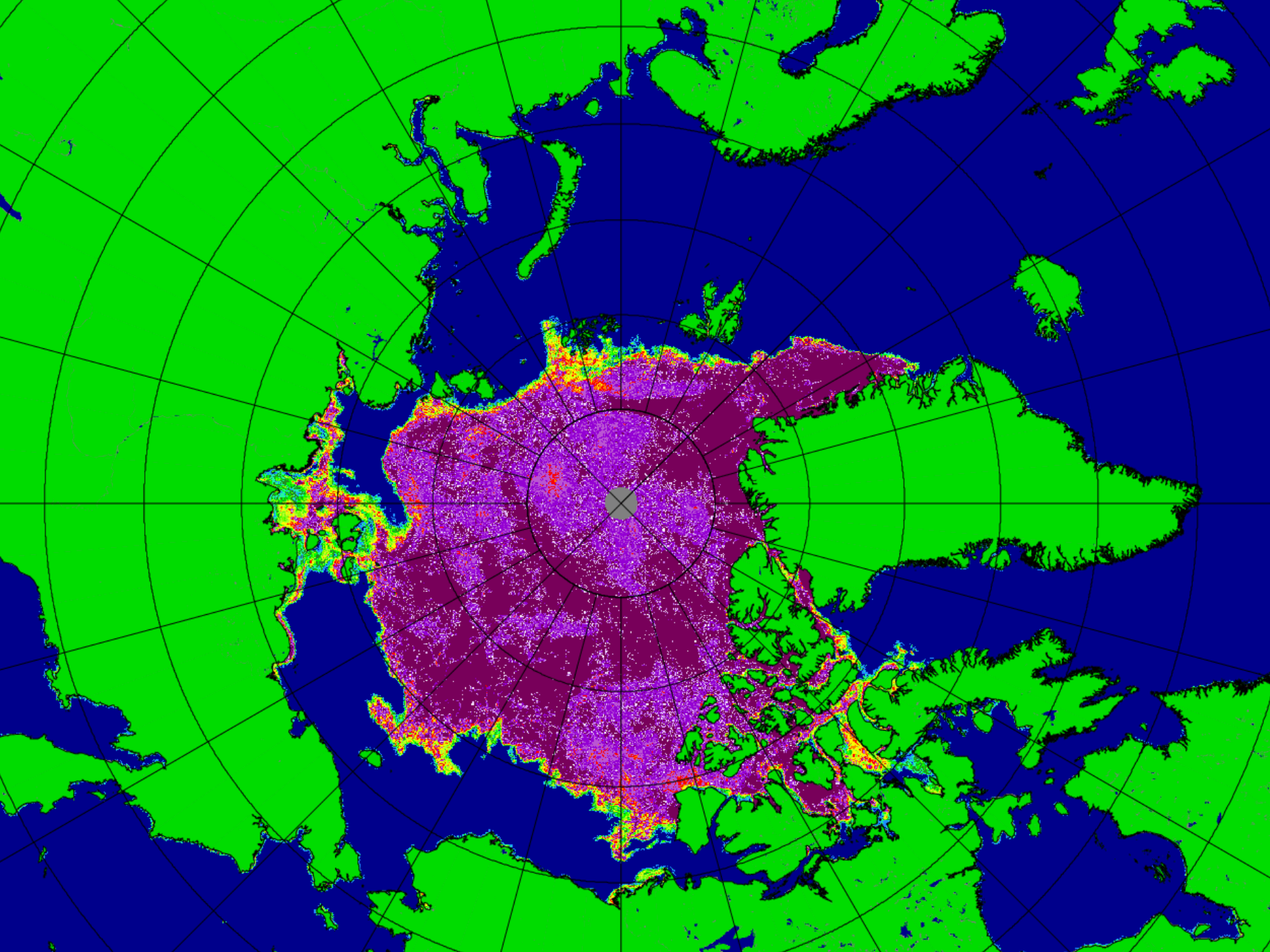
Take Home Message

The Western Arctic went from too cold to too warm to support ground-nesting

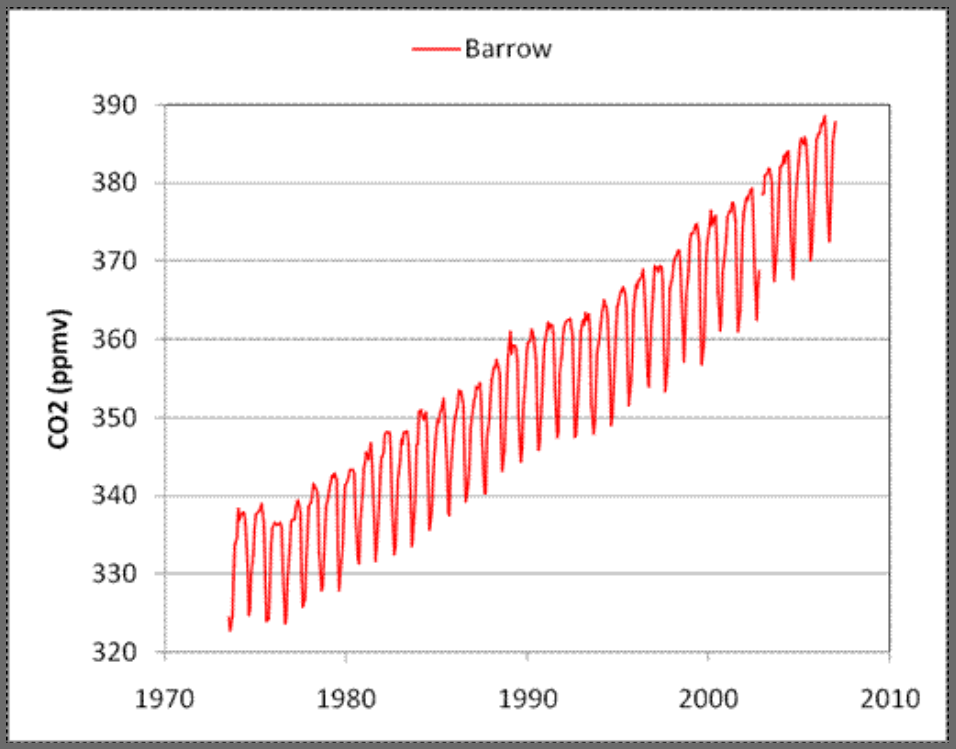
Black Guillemots in 50 years

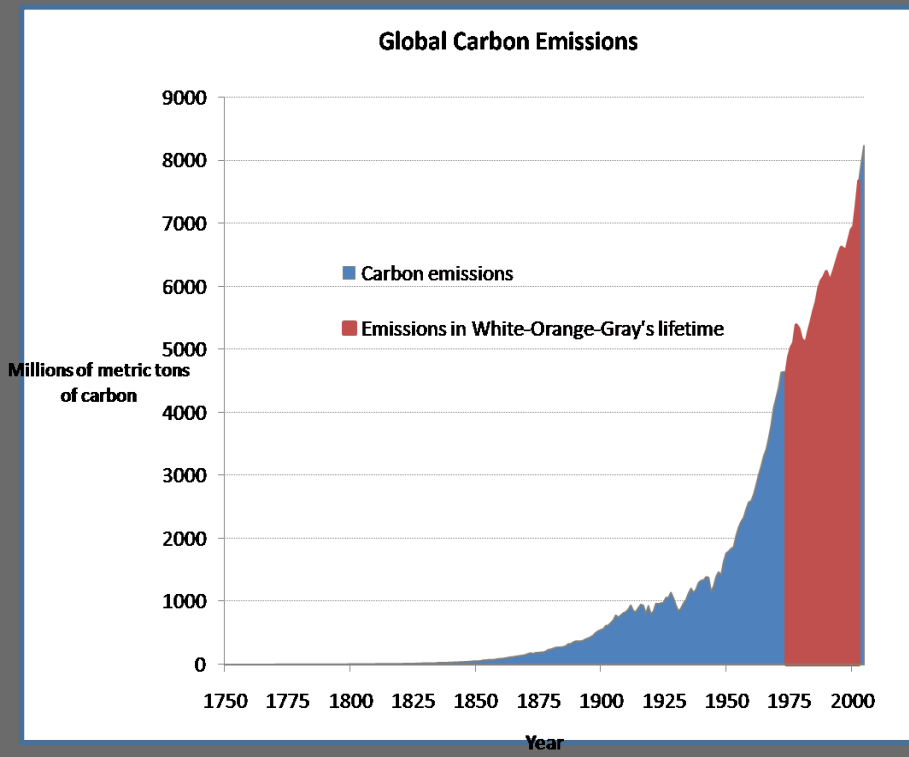

1972

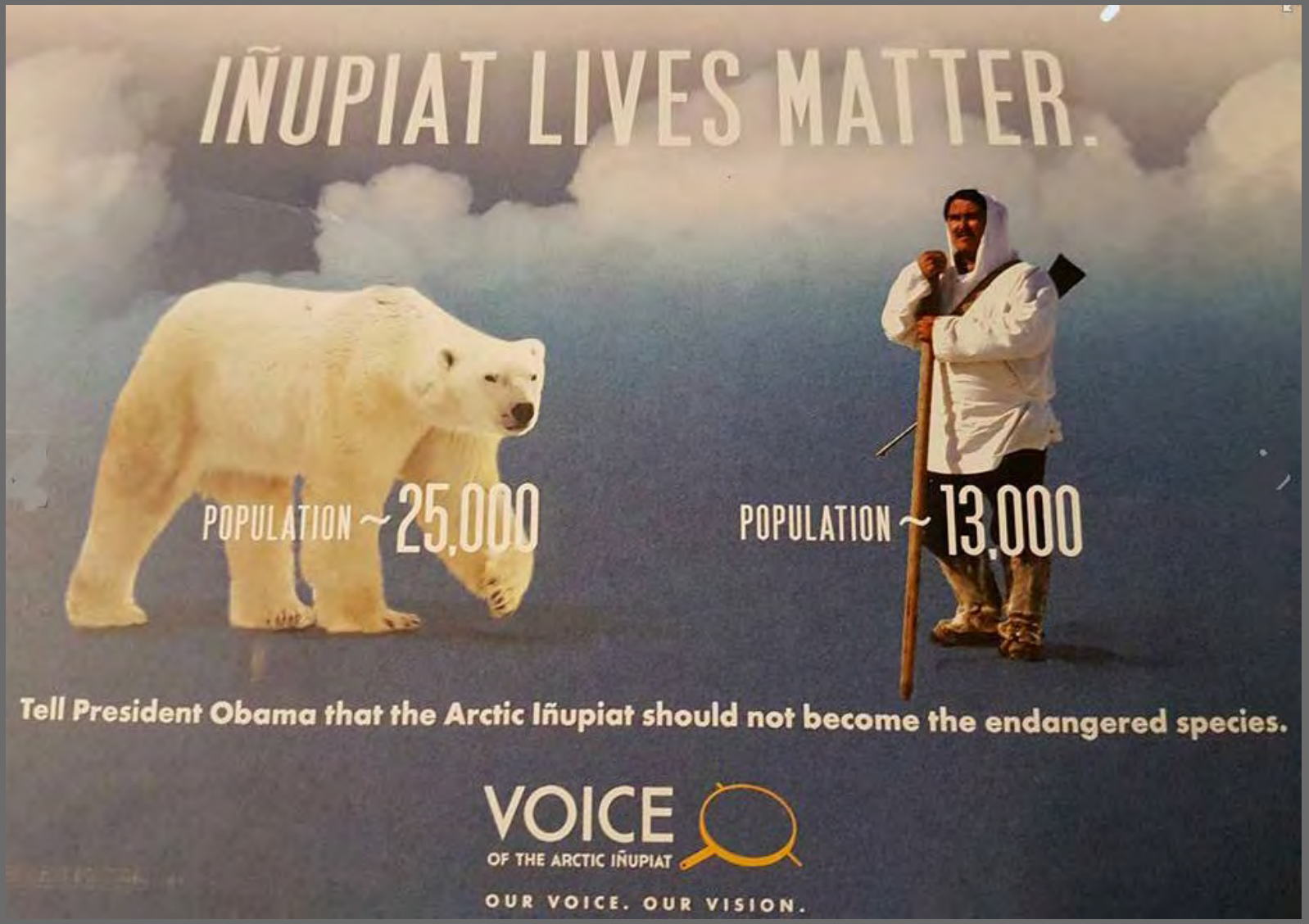

2013
I-12
©2013 Gary Braasch - WorldView of Global Warming.org



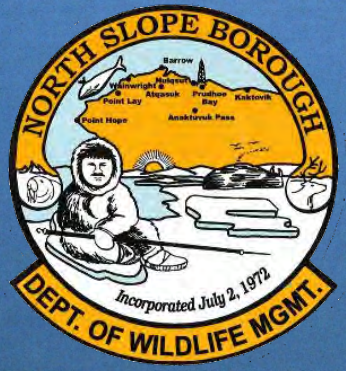
Global carbon emissions in one guillemot's lifetime






IÑUPIAT LIVES MATTER.
POPULATION ~ 25,000
POPULATION ~ 13,000
Tell President Obama that the Arctic Iñupiat should not become the endangered species.
VOICE
OF THE ARCTIC IÑUPIAT
OUR VOICE. OUR VISION.

Acknowledgements



The Residents of Barrow Alaska

Thank You!

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- ARCUS 2016 Annual Meeting and Arctic Community Reception will be 14 December 6-7pm at the AGU Meeting in San Francisco More info: http://bit.ly/2e8aetV
- Arctic Community Meeting Rooms at the AGU Fall Meeting More info: http://bit.ly/2e8aUQa
- The Fulbright Arctic Symposium at the National Academies of Sciences is Thursday, 27 October 9-4:30pm

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