Reproductive responses of planktivorous and piscivorous seabirds to climate variability in the northern Sea of Okhotsk

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Inter-annual oceanographic change

Seabird reproductive performance

Causal links between reproduction and climate variability on small and large geographic scales

Change in diet composition: over time and in relation to climate variability

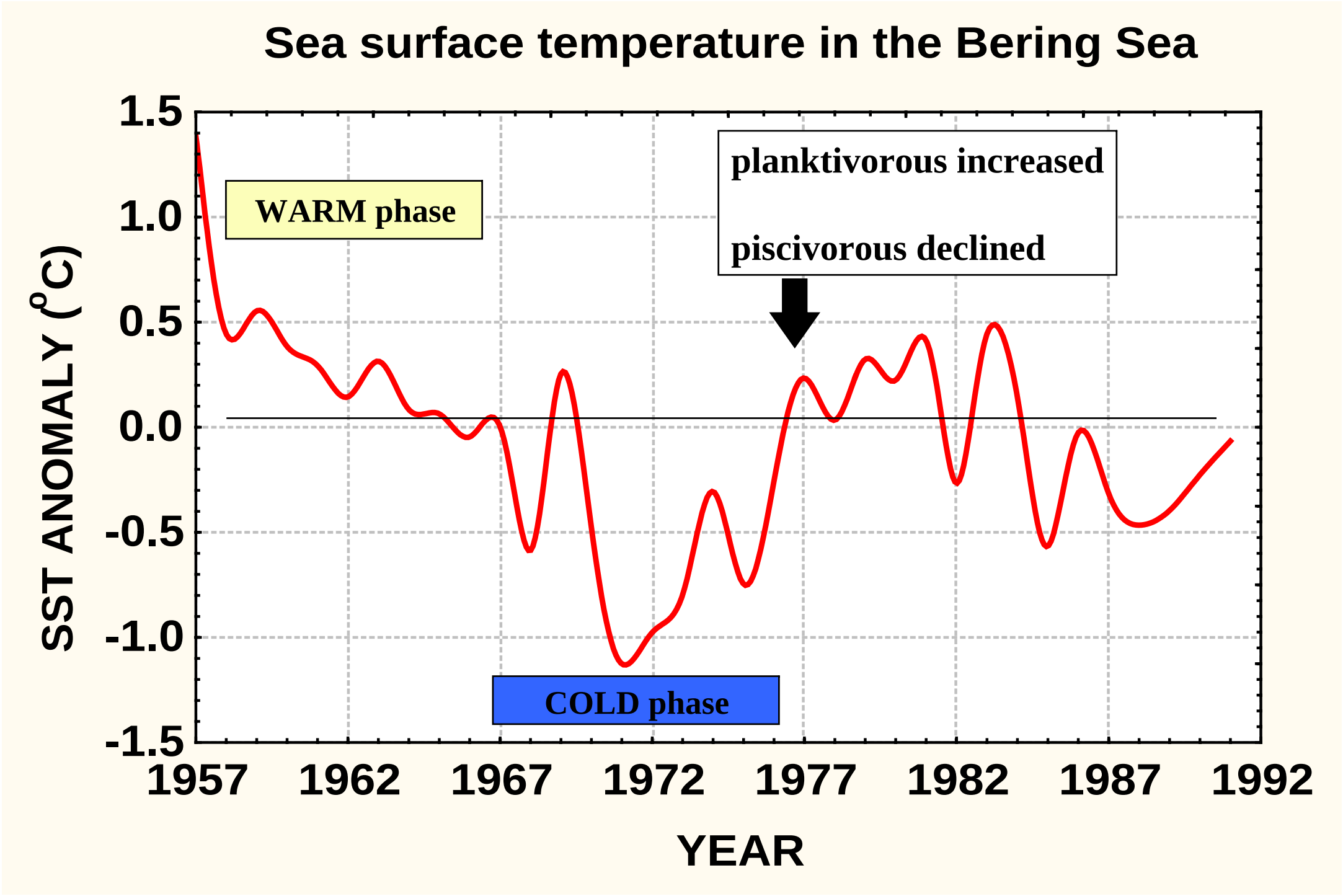
Bering Sea (1960s-1990s)

- **decline in populations of piscivorous seabirds**

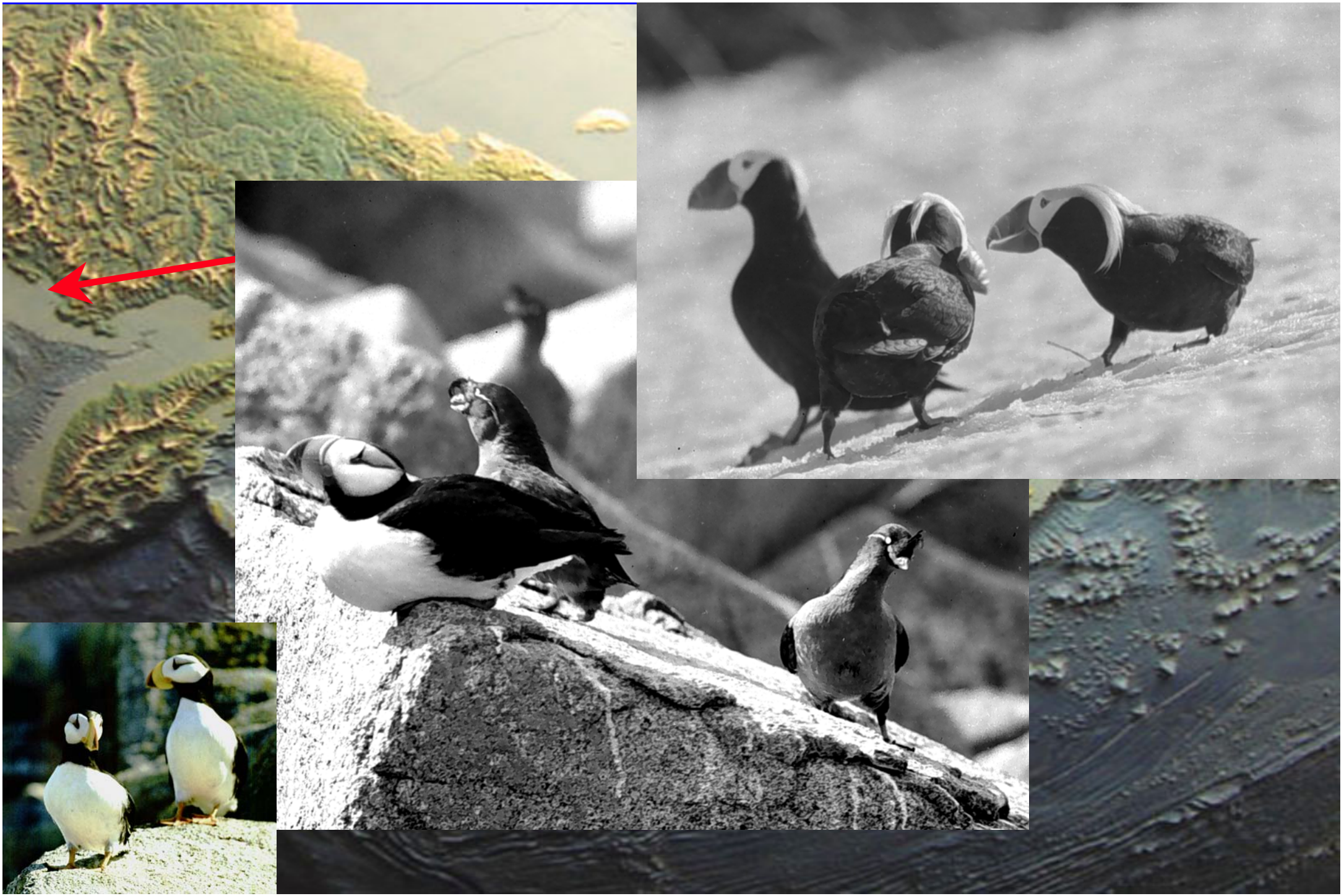
  Springer 1992
  Hunt & Byrd 2000

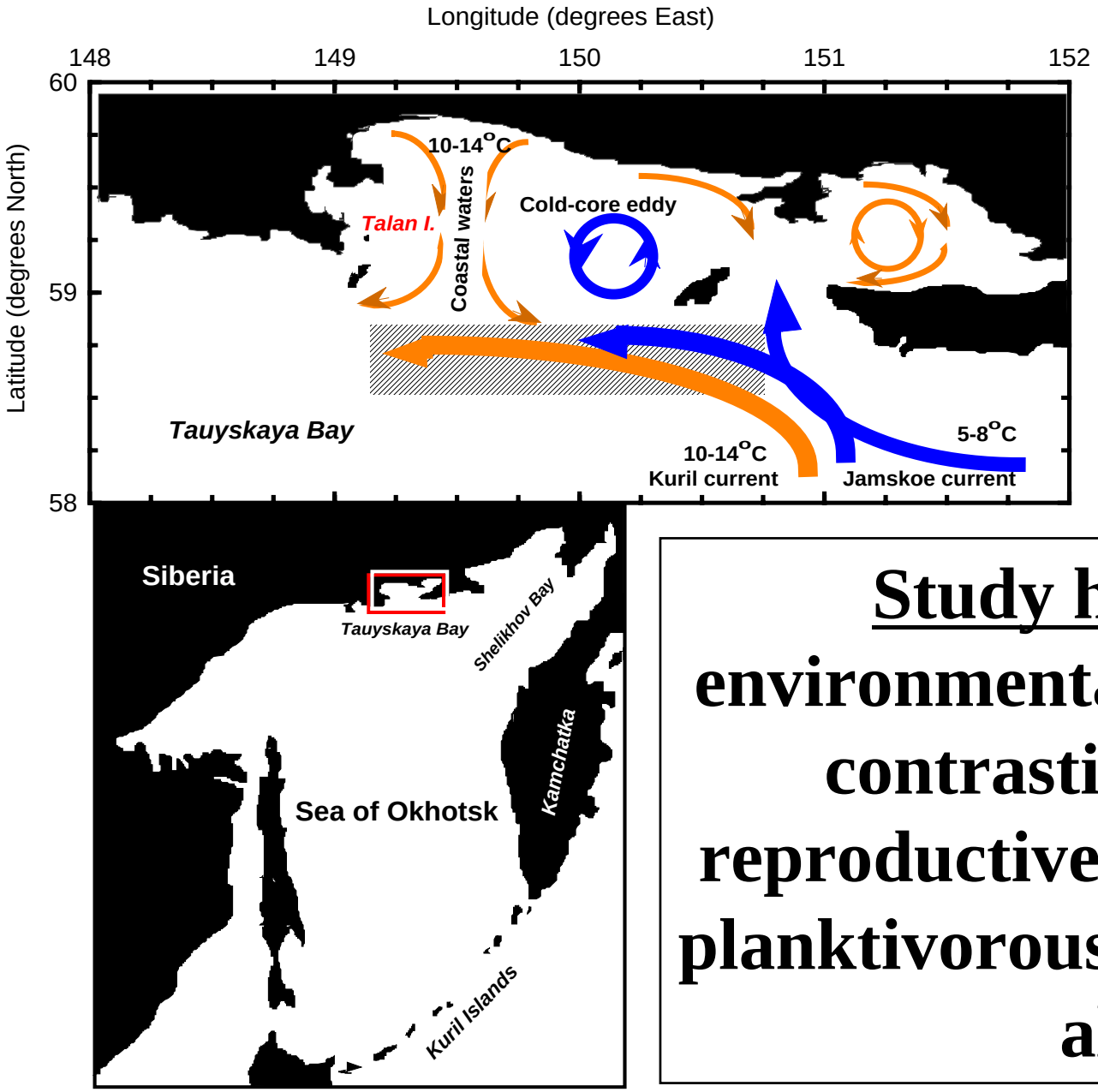
- **increase in populations of planktivorous seabirds**

  Piatt et al. 1990
  Konyoukhov 1991


Sea surface temperature in the Bering Sea
SST ANOMALY (°C)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1957
1962
1967
1972
1977
1982
1987
1992
YEAR
WARM phase
planktivorous increased
piscivorous declined
COLD phase


Study area:
Talan Island
1987-2001



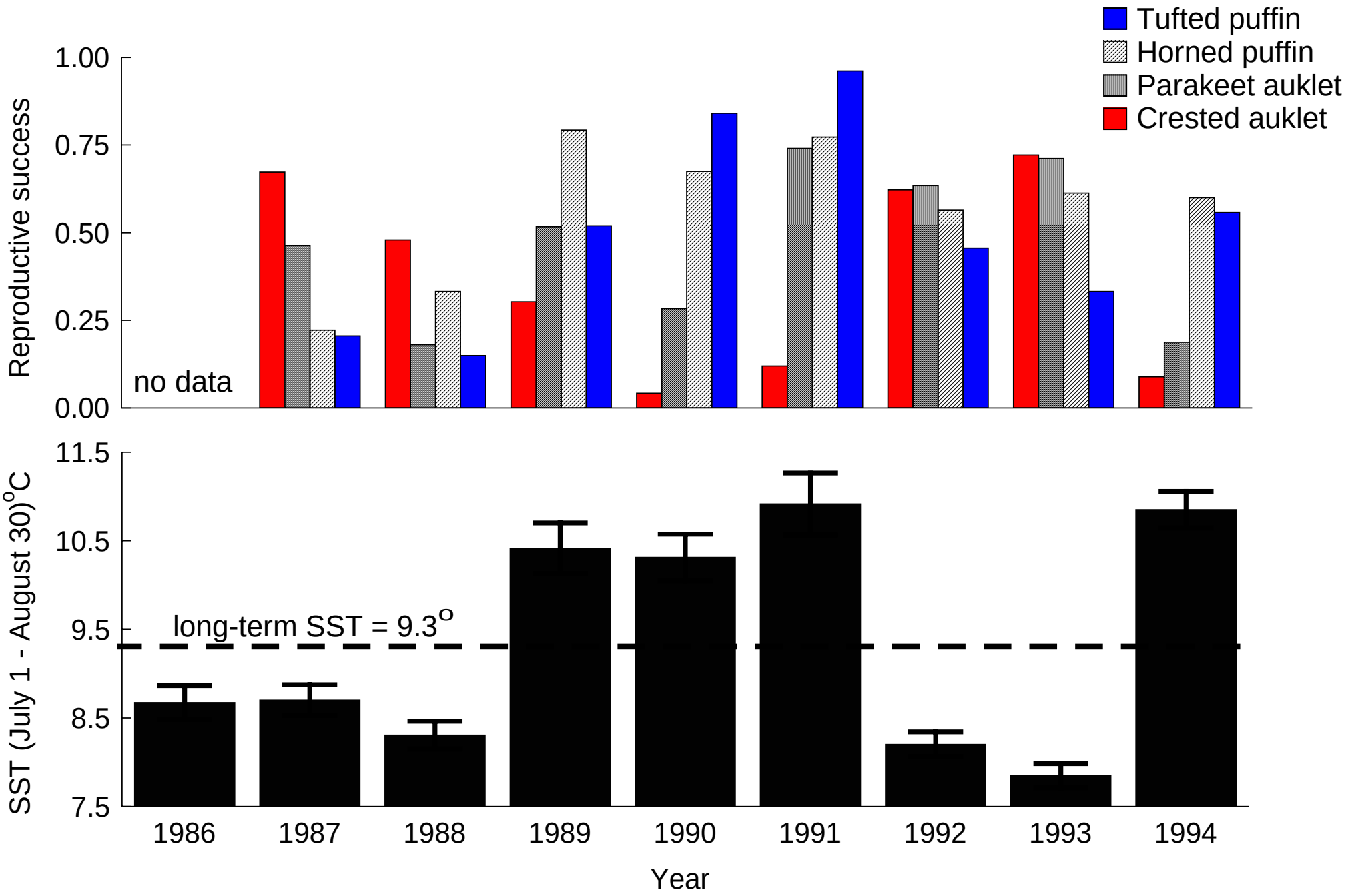


Kitaysky & Golubova 2000;
& in preparation

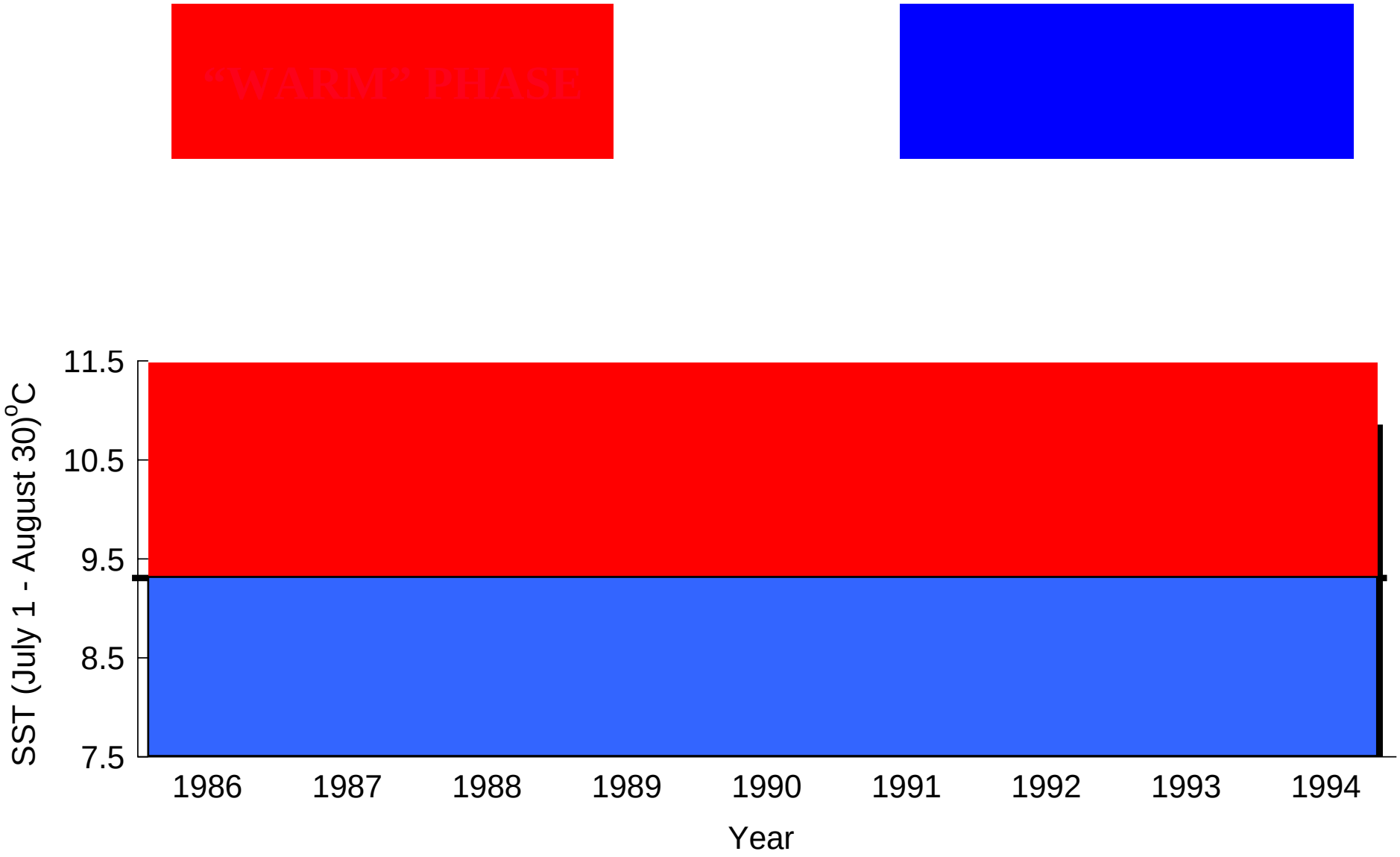
Talan I.
Sea of Okhotsk
1987-2003

<u>Study hypothesis:</u>

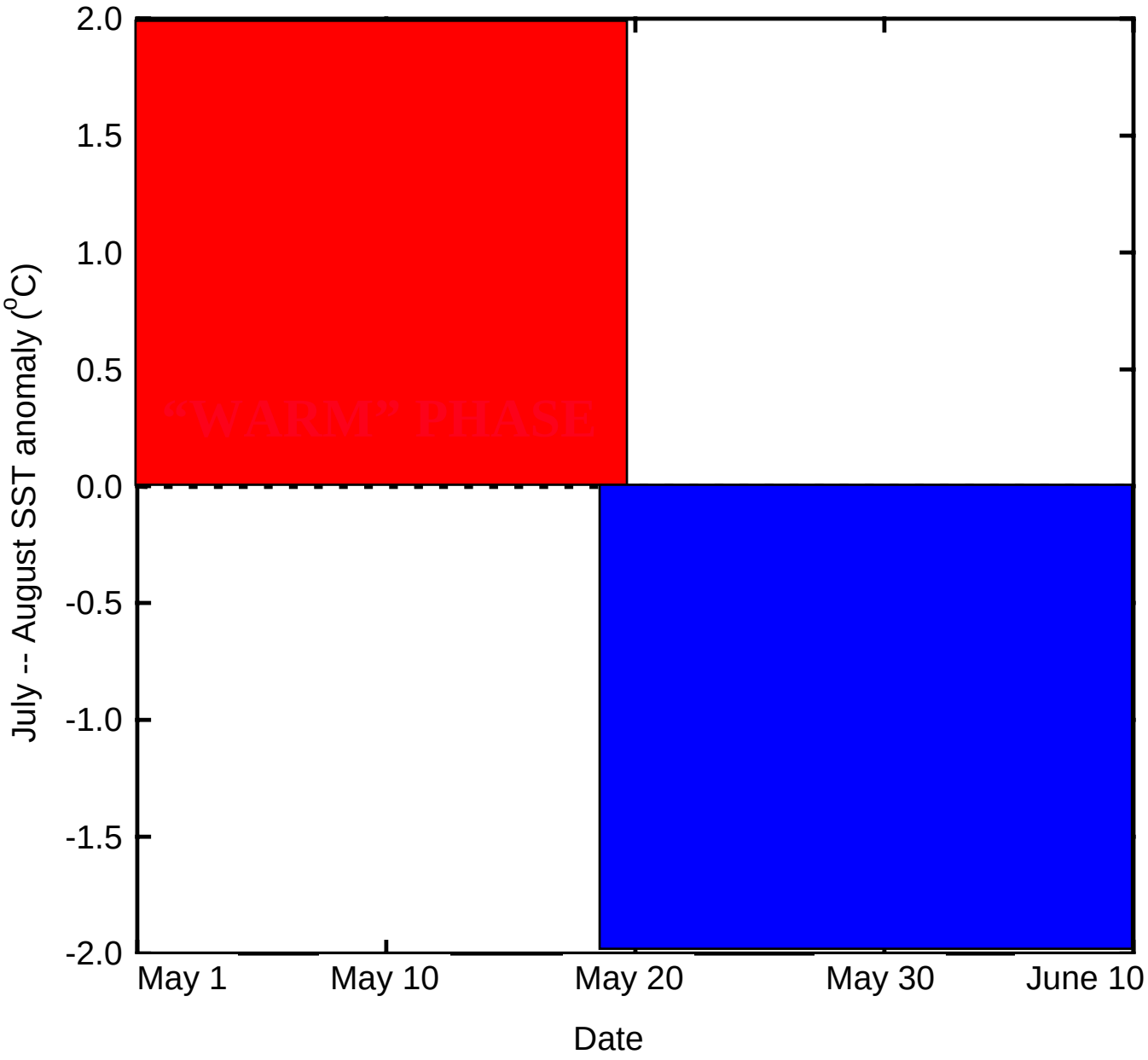
environmental change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids

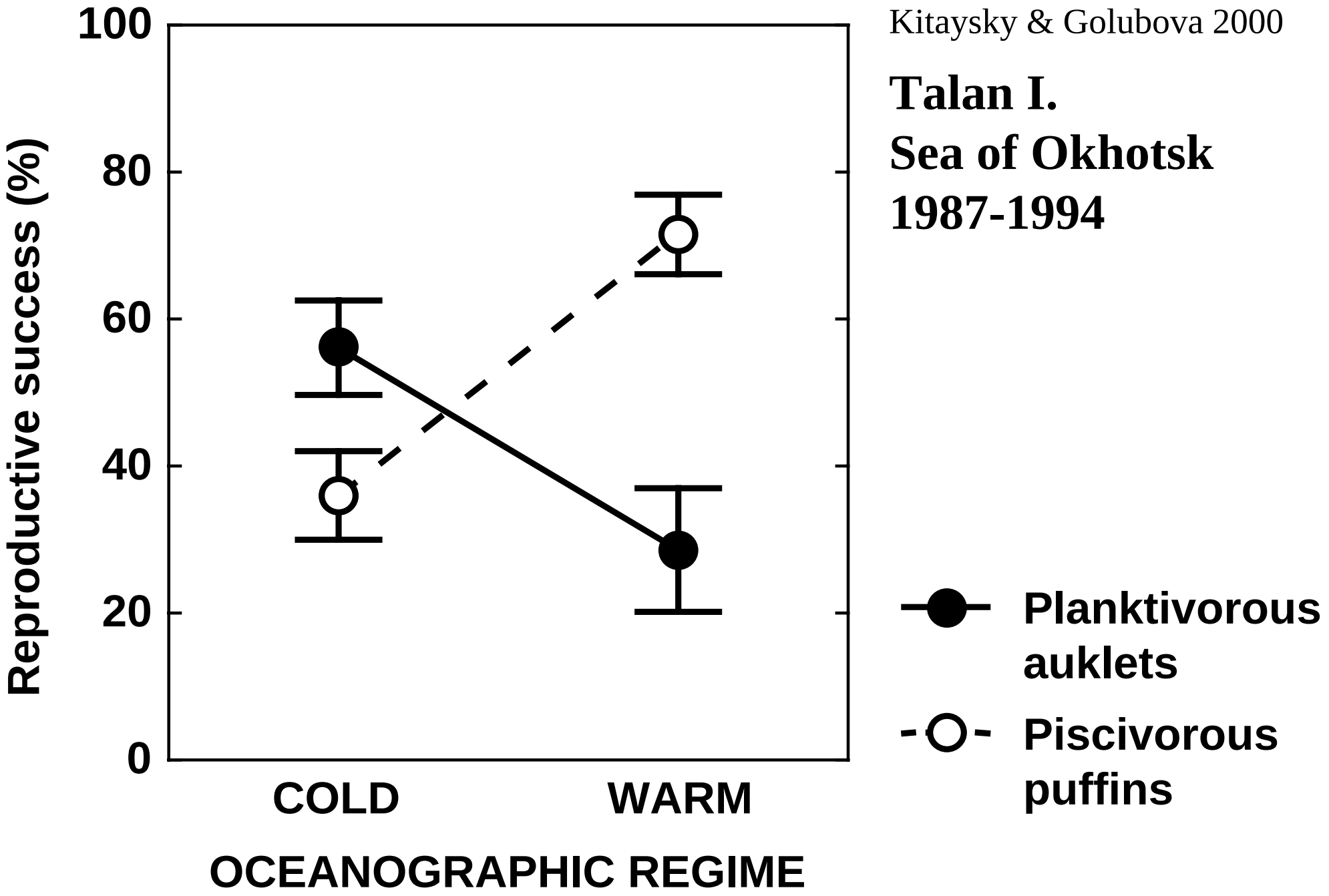

Tufted puffin
Horned puffin
Parakeet auklet
Crested auklet
Reproductive success
1.00
0.75
0.50
0.25
0.00
no data
SST (July 1 - August 30)°C
11.5
10.5
9.5
8.5
7.5
long-term SST = 9.3°
1986
1987
1988
1989
1990
1991
1992
1993
1994
Year

Sea-Surface Temperature

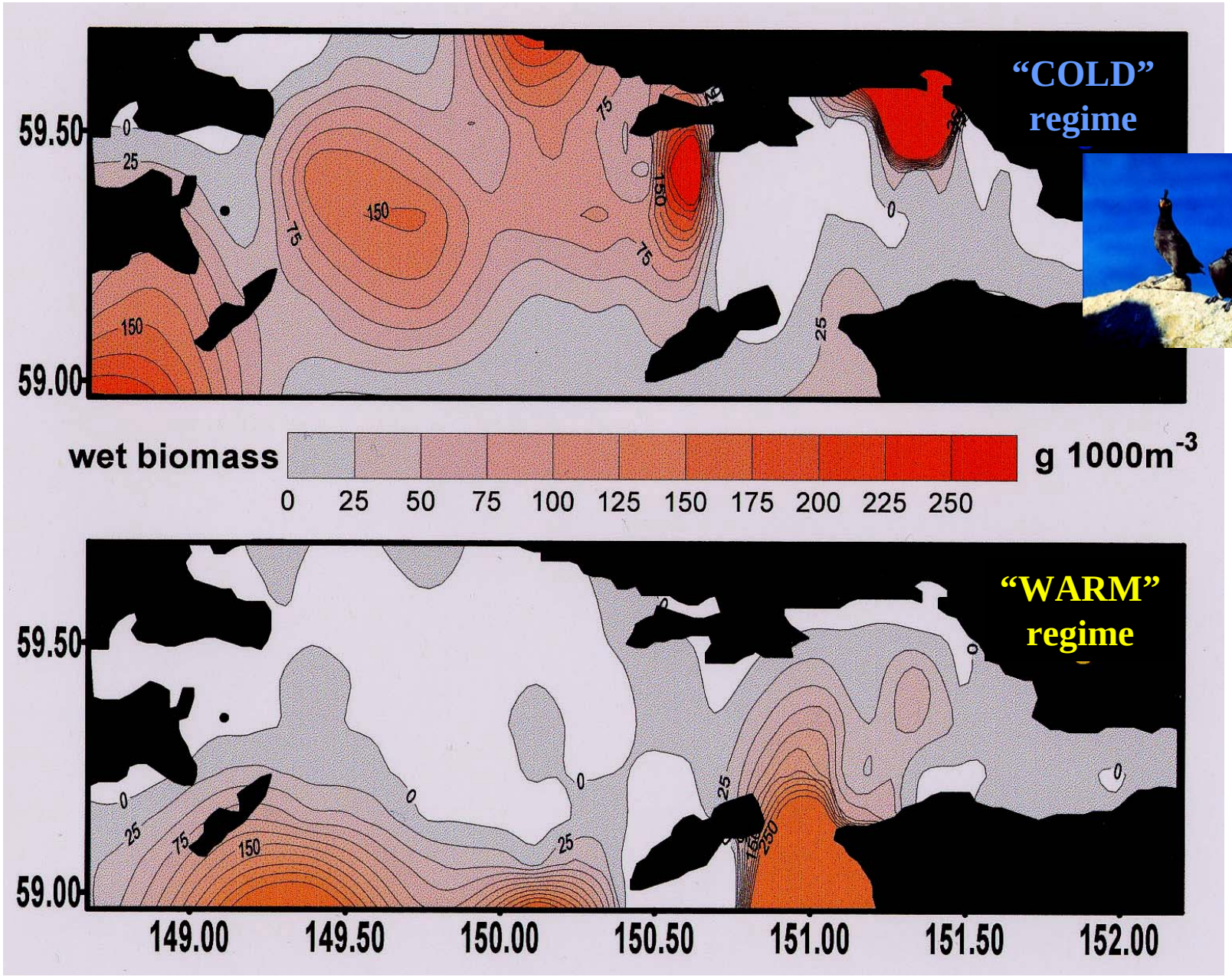


Dates of permanent ice disappearance

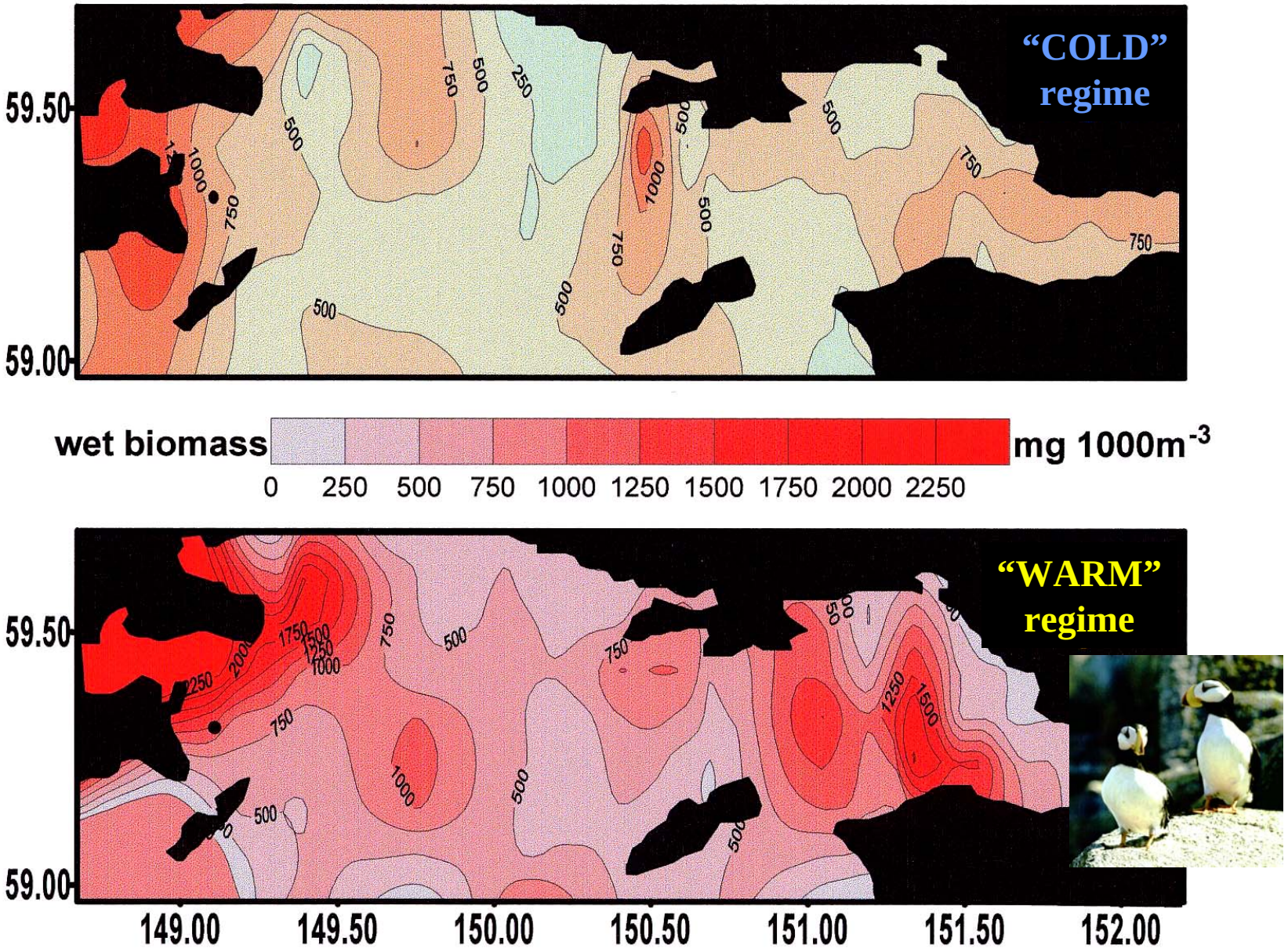



Kitaysky & Golubova 2000
Talan I.
Sea of Okhotsk
1987-1994
Reproductive success (%)
100
80
60
40
20
0
COLD
WARM
OCEANOGRAPHIC REGIME
Planktivorous auklets
Piscivorous puffins

Distribution of adult euphausiids *Thysanoessa rashii* (major prey of planktivorous auklets)



Distribution of *Acartia* and calanoid copepods (major prey of small "forage" fish)



Talan I.
1987-2001

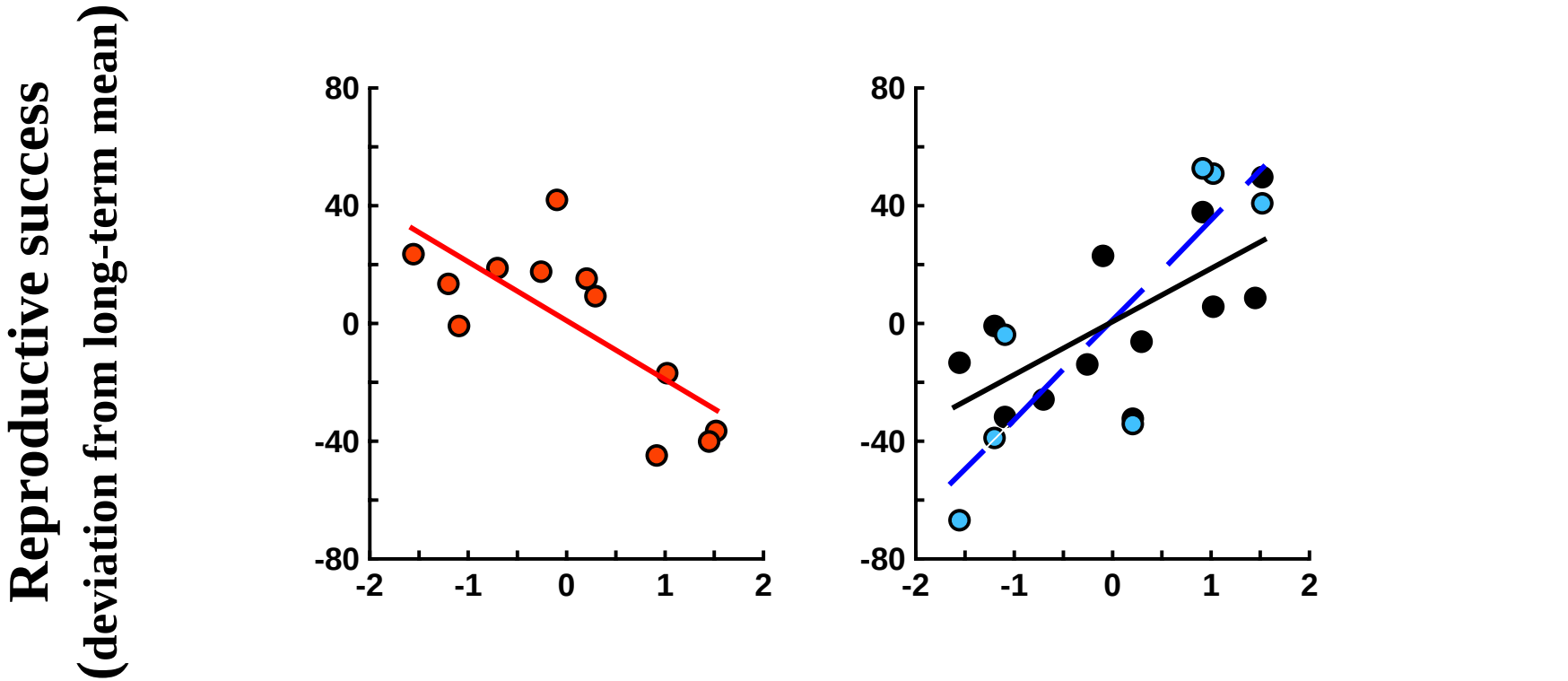
planktivorous:

piscivorous:

Tufted puffins ●

● Crested auklets

Black-legged kittiwakes ●

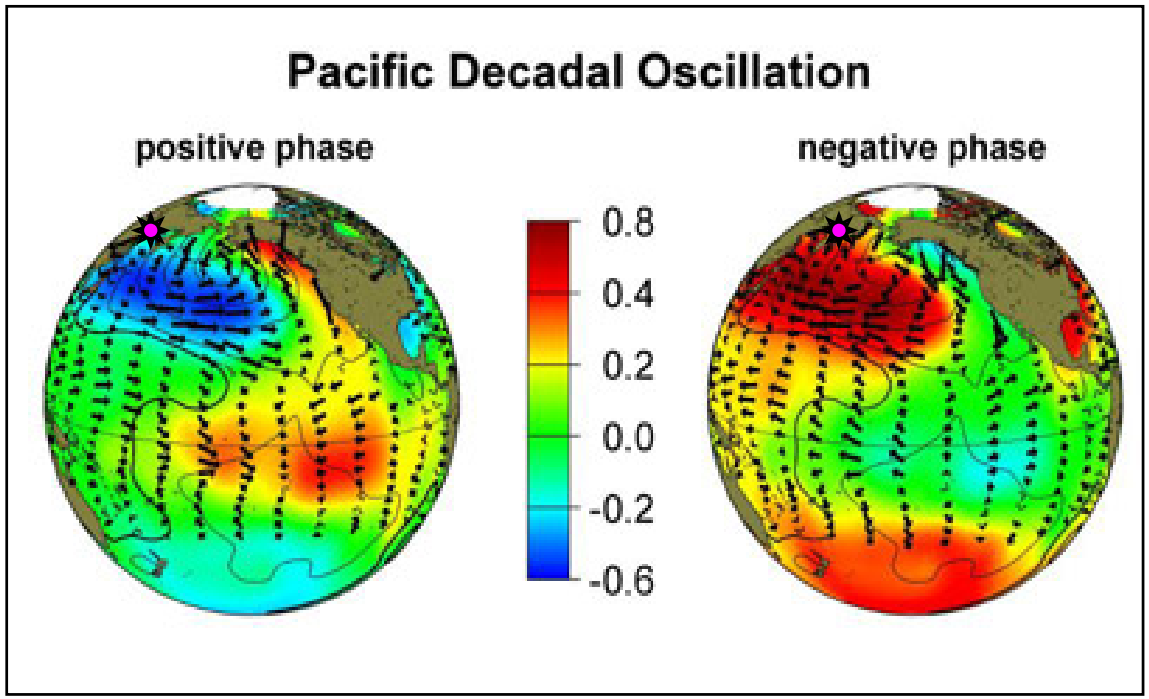


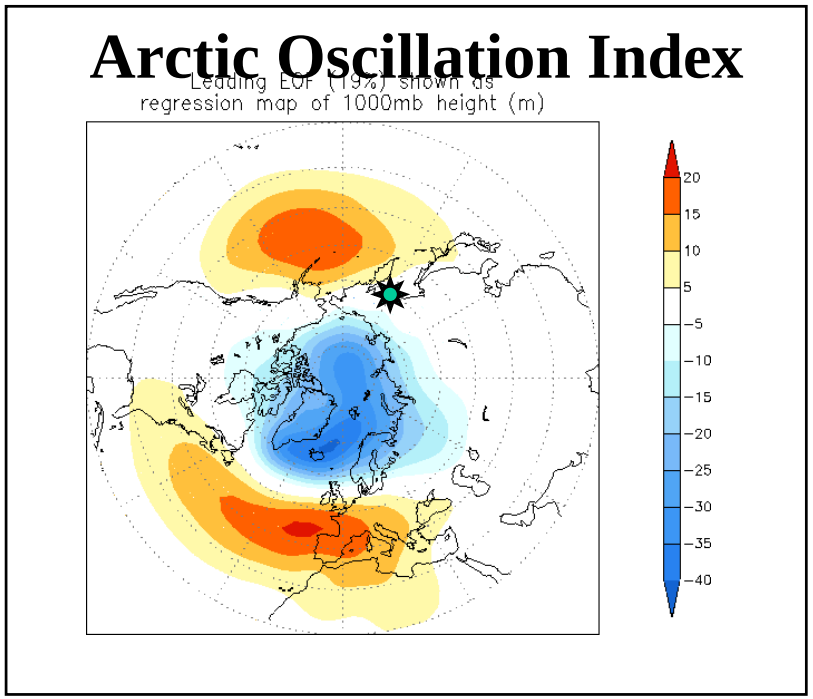
Conclusion:

Environmental change affects trophic level linkages in marine ecosystems

- **Alternations in distribution of zooplankton are driven by local inter-annual oceanographic change**

- **Reproductive performance of planktivorous and piscivorous seabirds reflects these changes**



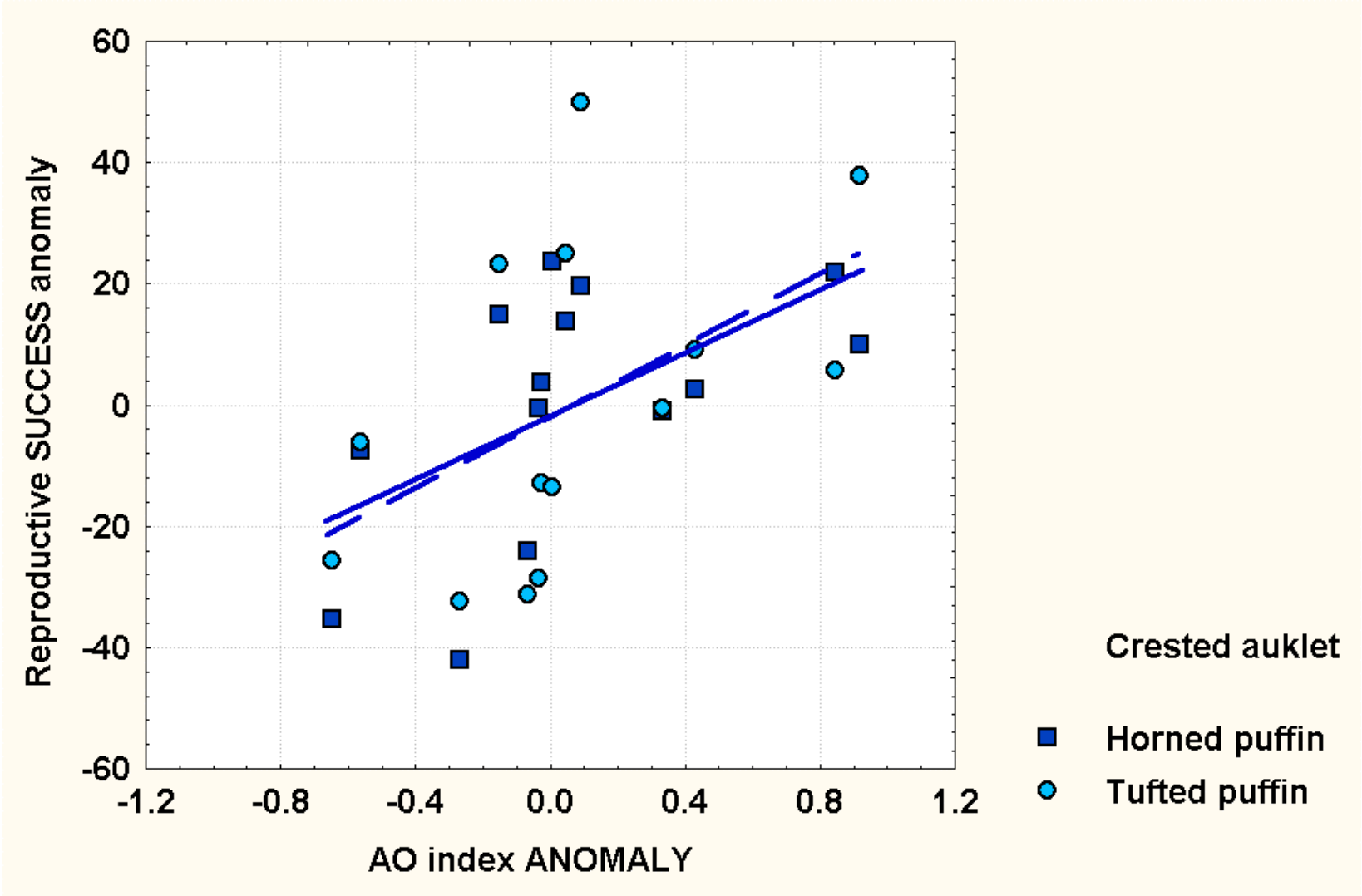


Is reproduction of birds in the northern Sea of Okhotsk related to climate variability on a large geographic scale?

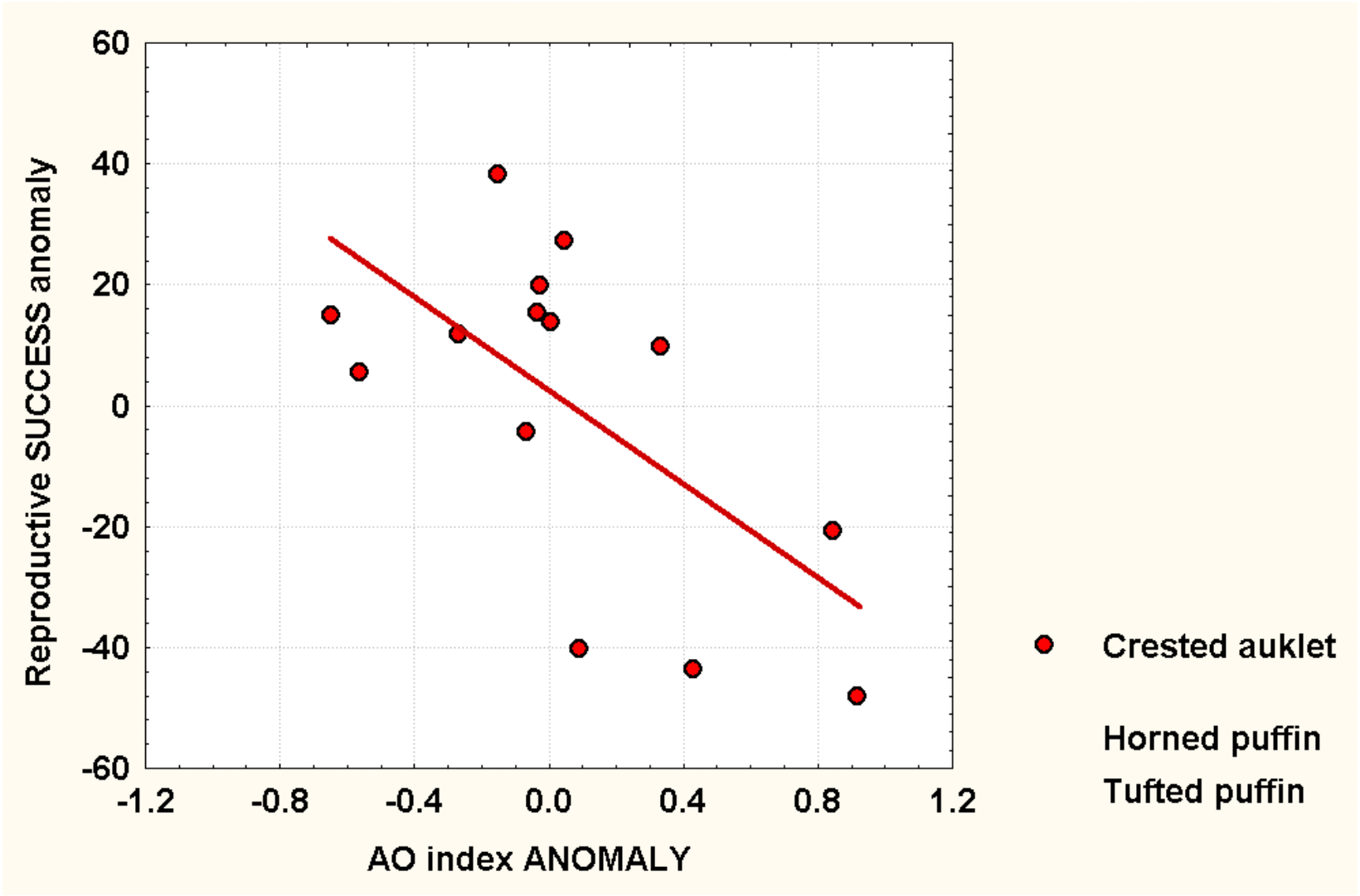
Talan SST vs composite indices of climate in the North Pacific 1986-2003

	PDO *annual mean*	**NPI** *Jan-April mean*	**AO** *annual mean*
Talan I. **SST** *August*	r=**−0.54** P<0.04	r=**+0.78** P<0.001	r=**+0.53** P<0.04

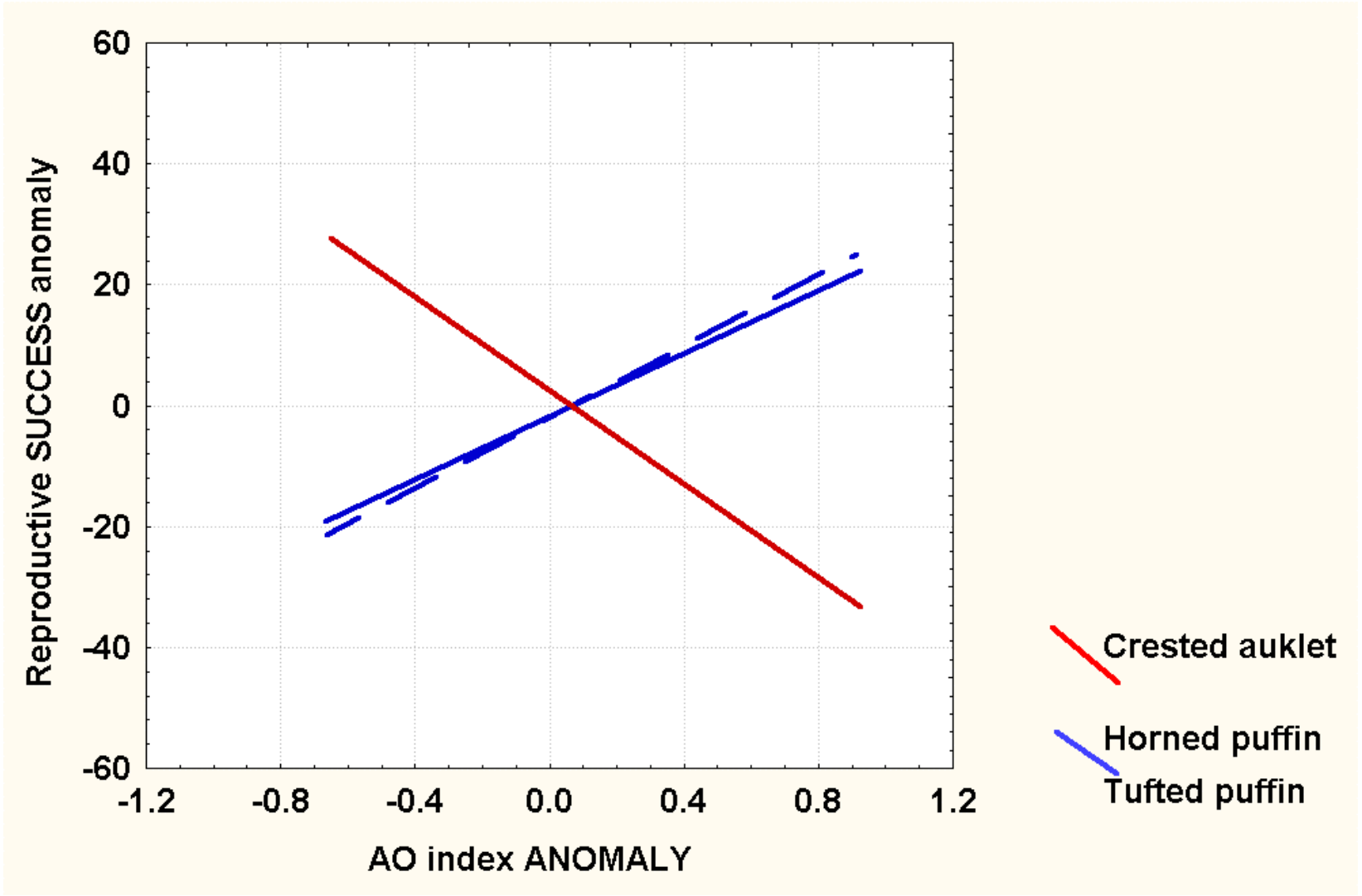
Talan I.
1987-2003



Talan I.
1987-2003



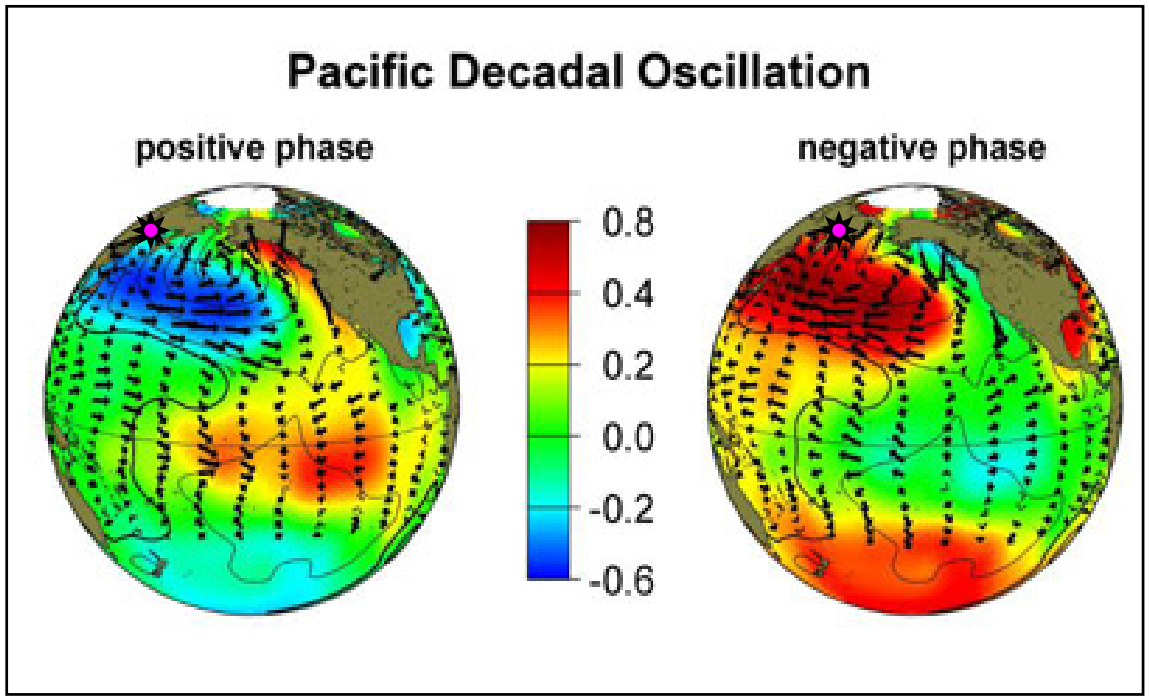
Talan I.
1987-2003

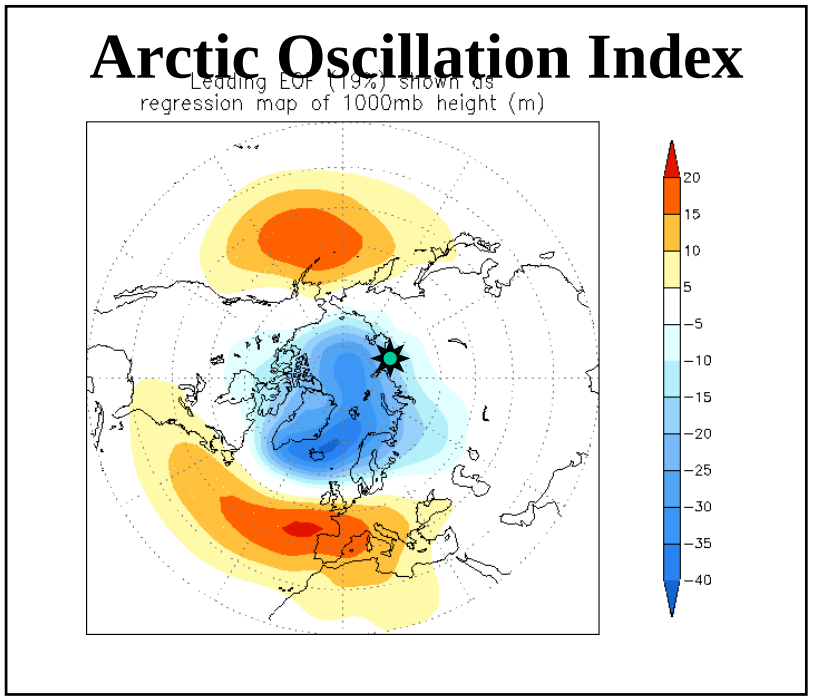


Conclusion:

Environmental change affects trophic level linkages in marine ecosystems

- **Alternations in reproduction of piscivorous and planktivorous seabirds in the northern Sea of Okhotsk are driven by inter-annual oceanographic change on large geographic scale**



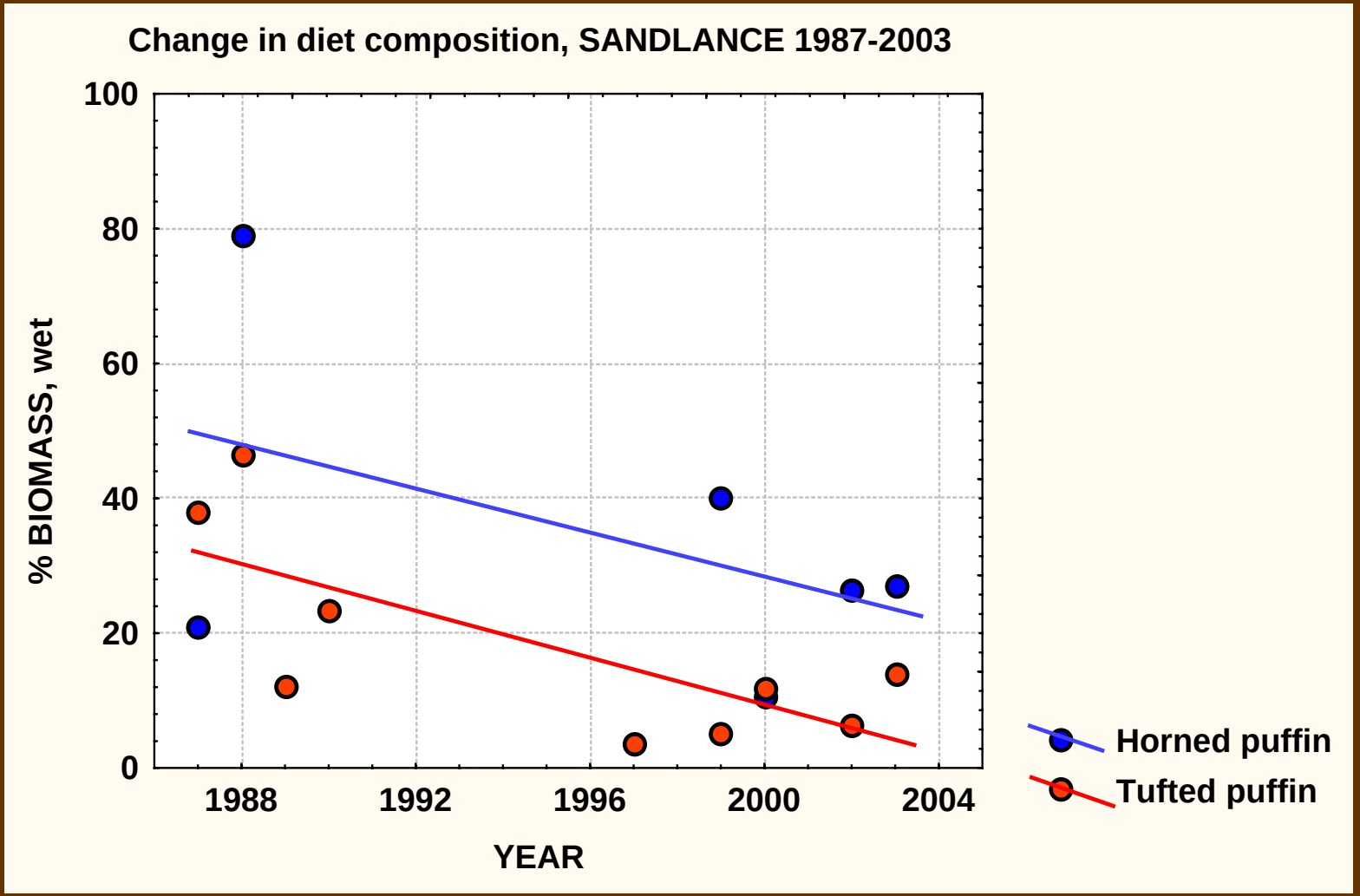


Are DIETs of birds in the northern Sea of Okhotsk related to changes in climate phenomena on a large geographic scale?

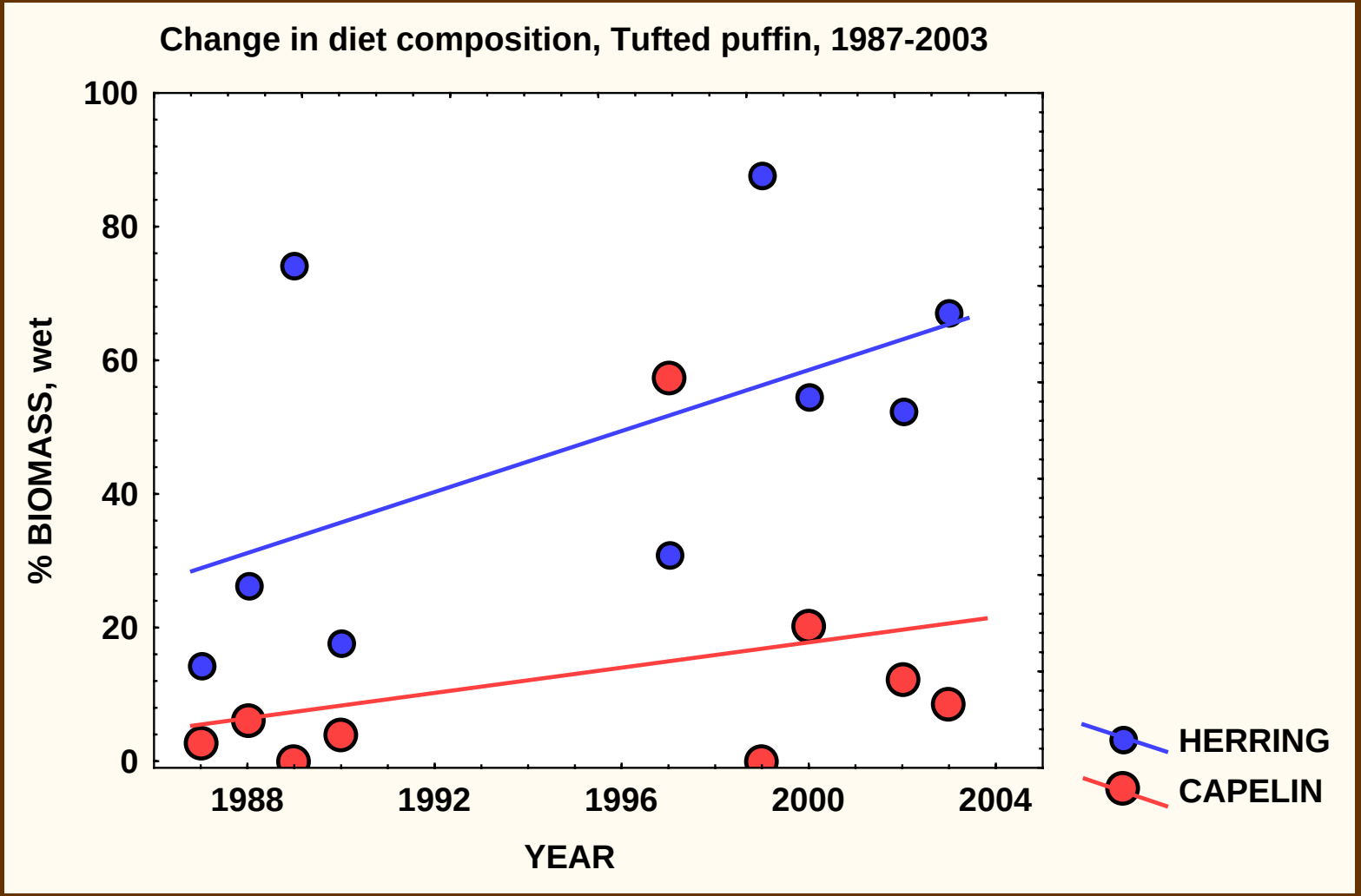
Diet composition of puffin chicks on Talan I.
1987-2003

	Fish	**Invertebrates**
Horned Puffin N=6 years	29 spp 99% biomass	6 spp 1% biomass
Tufted Puffin N=9 years	37 spp 98% biomass	7 spp 2% biomass

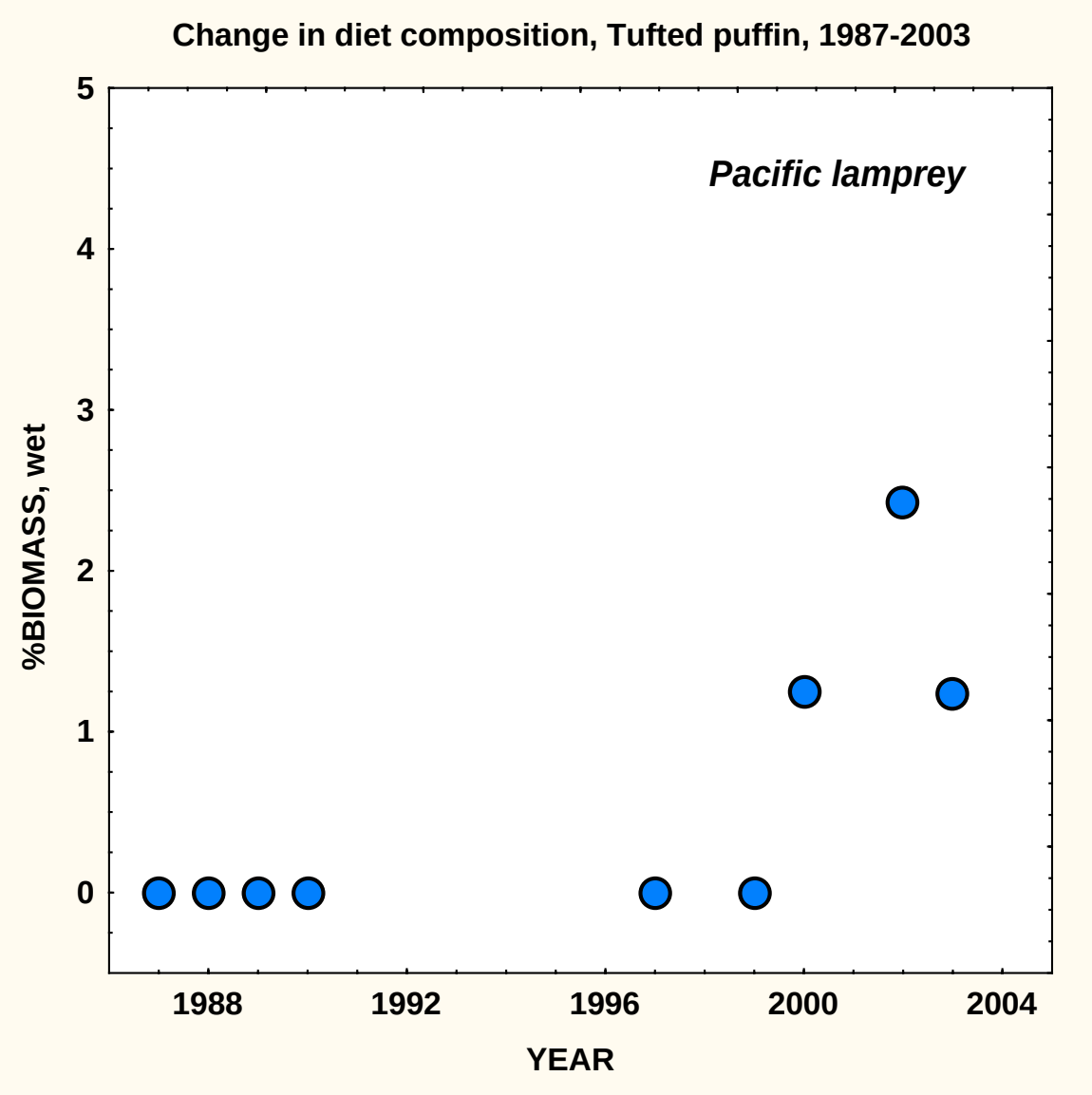
Talan I.
1987-2003



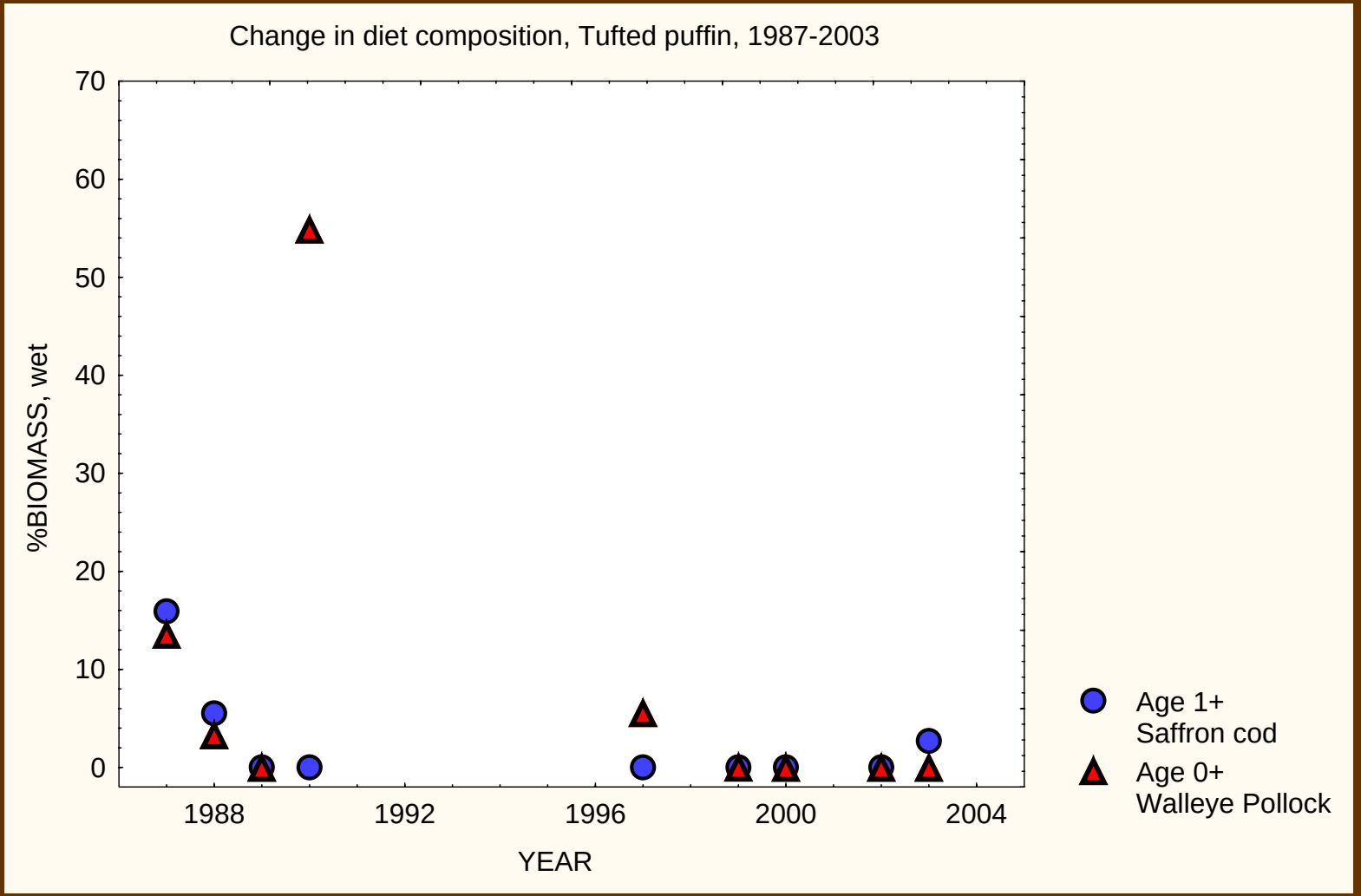
Talan I.
1987-2003

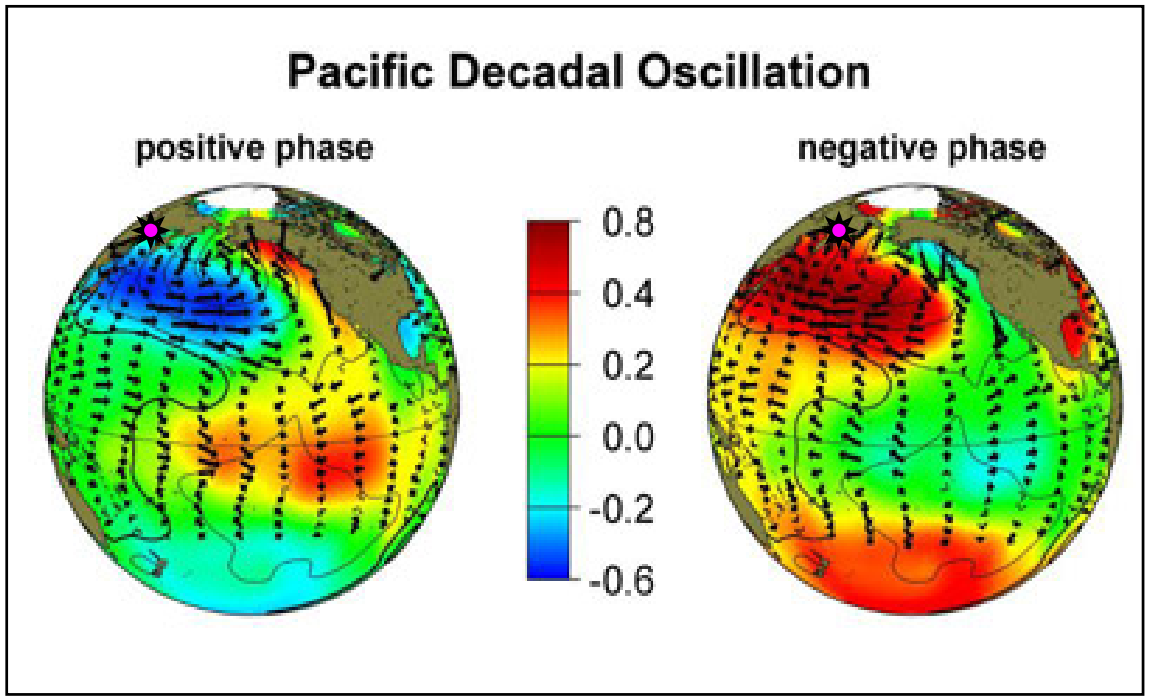


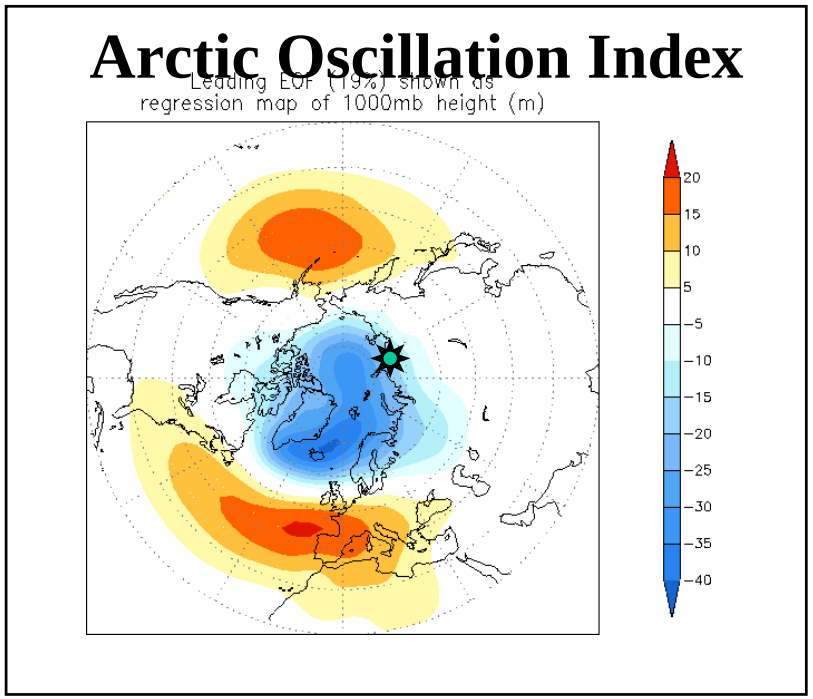
Talan I.
1987-2003



Talan I.
1987-2003







Are DIETs of birds in the northern Sea of Okhotsk related to climate variability on a large geographic scale?

Diet (% biomass) vs composite indices of climate in the North Pacific 1986-2003

	PDO *annual mean*	**NPI** *Jan-April mean*	**AO** *annual mean*
Horned Puffin N=6	r=**+0.91** P<0.011 gadids	r=**-0.74** P=0.090 gadids	r=**-0.95** P<0.01 pollock
Tufted Puffin N=9	r=**+0.66** P=0.055 Saffron cod		r=**-0.60** P=0.088 Saffron cod

Diet (% biomass) vs reproductive performance of puffins on Talan I. 1986-2003

	Pollock	Flatfish	Poachers	Squid
Repr. success *Horned Puffin* *N=6 years*	r=**-0.80** P=0.057	r=**-0.89** P<0.02	r=**-0.97** P<0.01	r=**-0.94** P<0.01

Summary

1. Local oceanographic conditions in the northern Sea of Okhotsk are driven by large-scale oceanographic patterns
2. Availability of forage fish and consequently seabird reproduction are determined by these patterns
3. The same oceanographic event has opposite consequences for planktivorous and piscivorous birds
4. Whether these relationships are specific to the Sea of Okhotsk or apply to other arctic regions remains to be seen

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