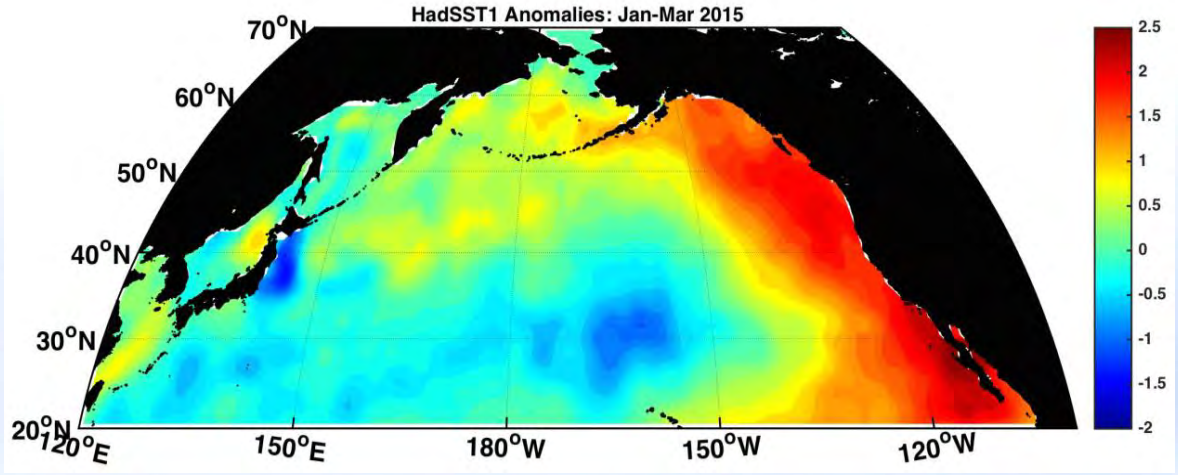
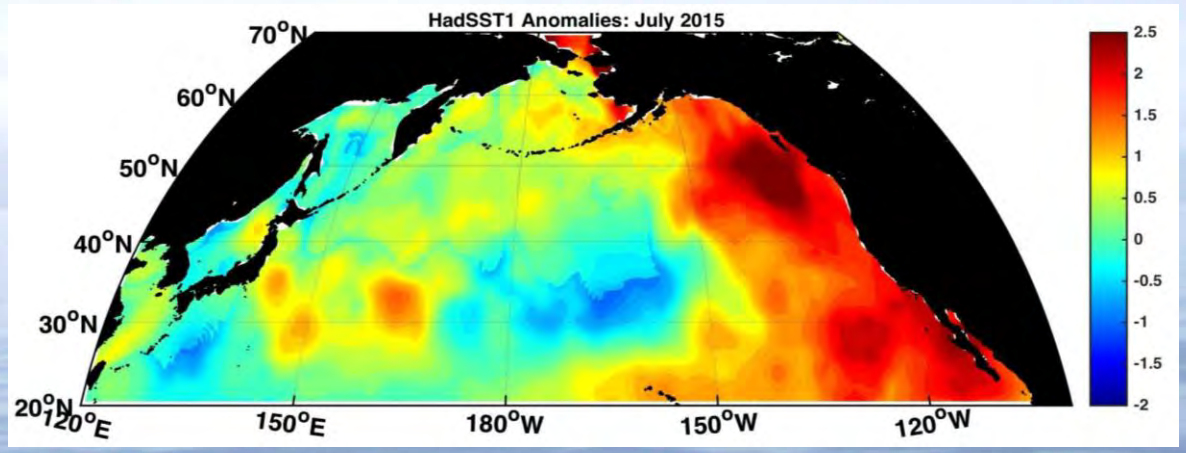
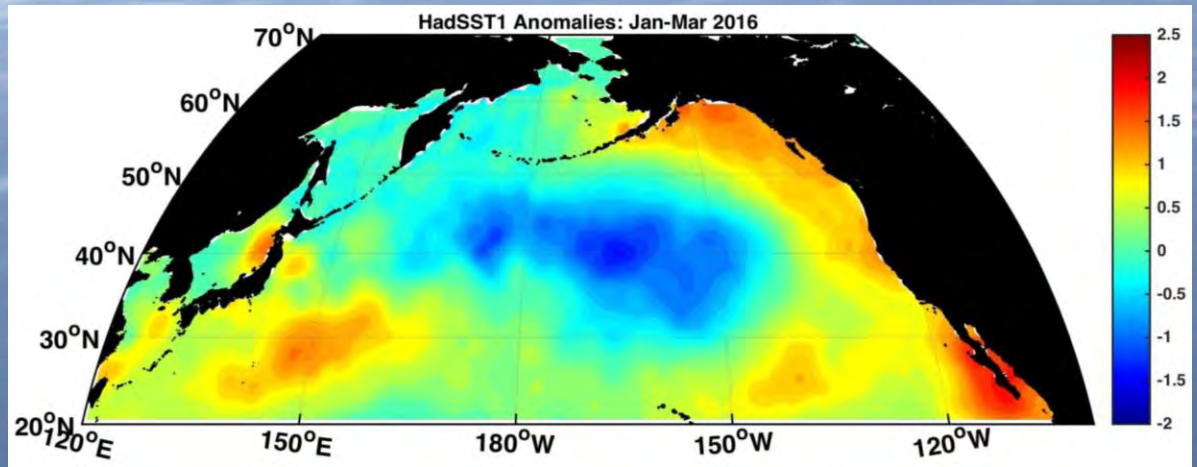
Extreme response of seabirds to extreme climate events in the NE Pacific

John Piatt, USGS Alaska Science Center

Timothy Jones, Kathy Kuletz, Heather Renner, Julia Parrish, Robin Corcoran, Sarah Schoen, Barbara Bodenstein, Robert Kaler, Marisol García-Reyes, Heather Coletti, Mayumi Arimitsu, Rebecca Duerr, Kirsten Lindquist, Jackie Lindsey, William Sydeman







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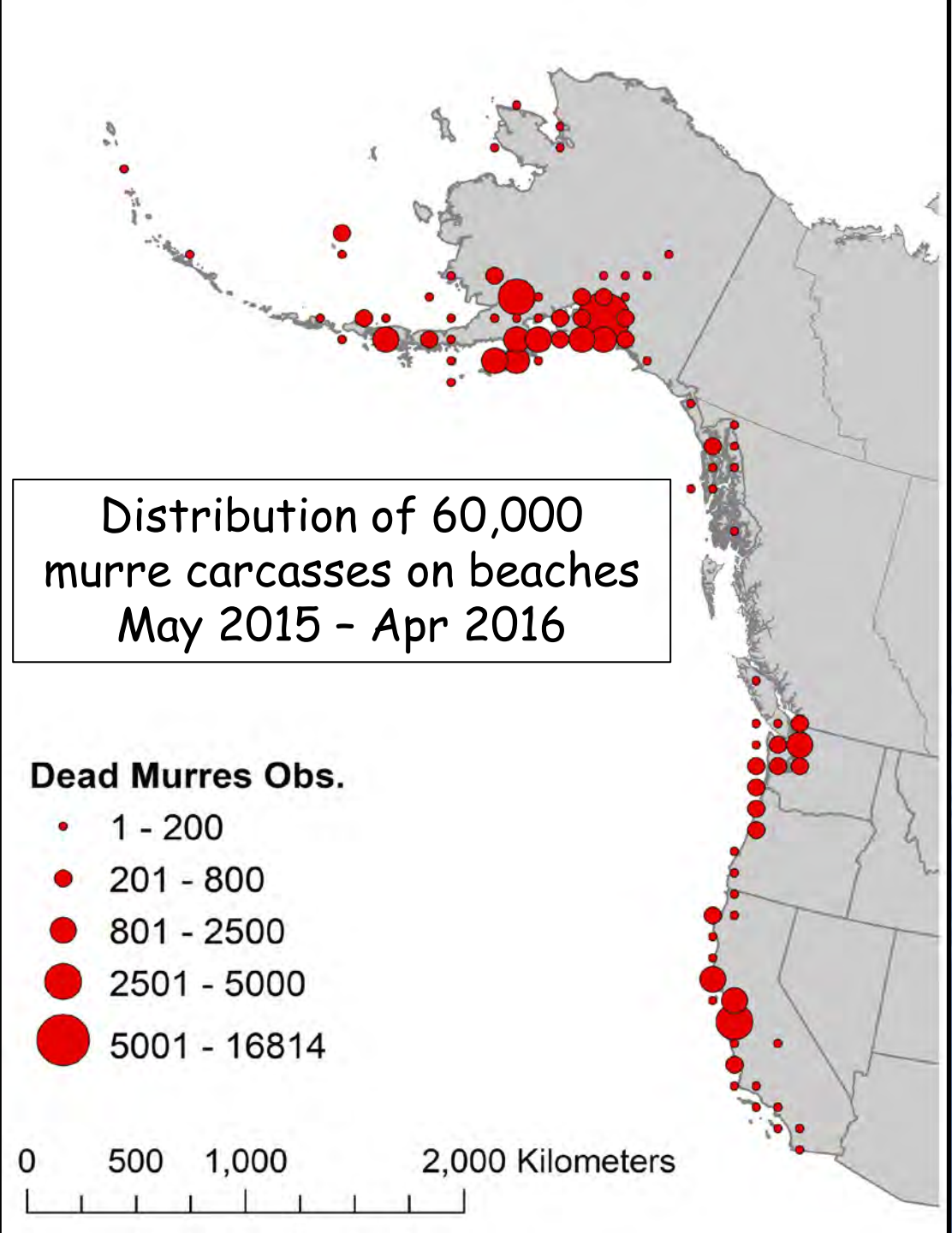
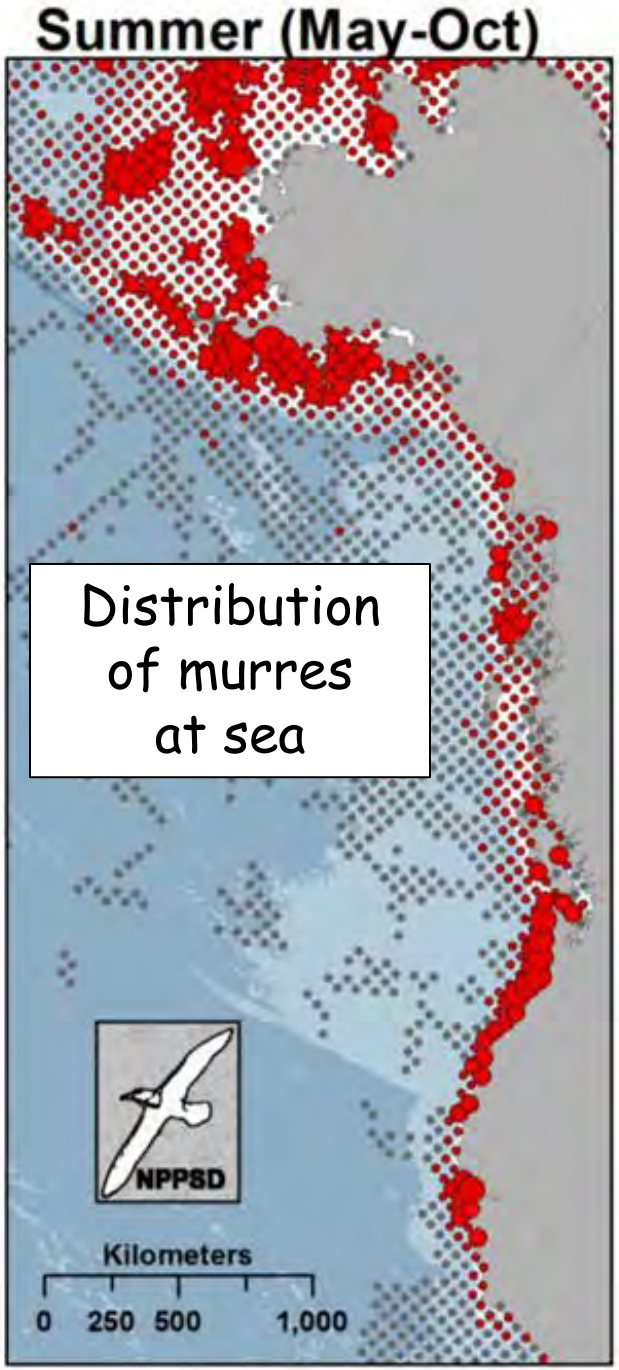
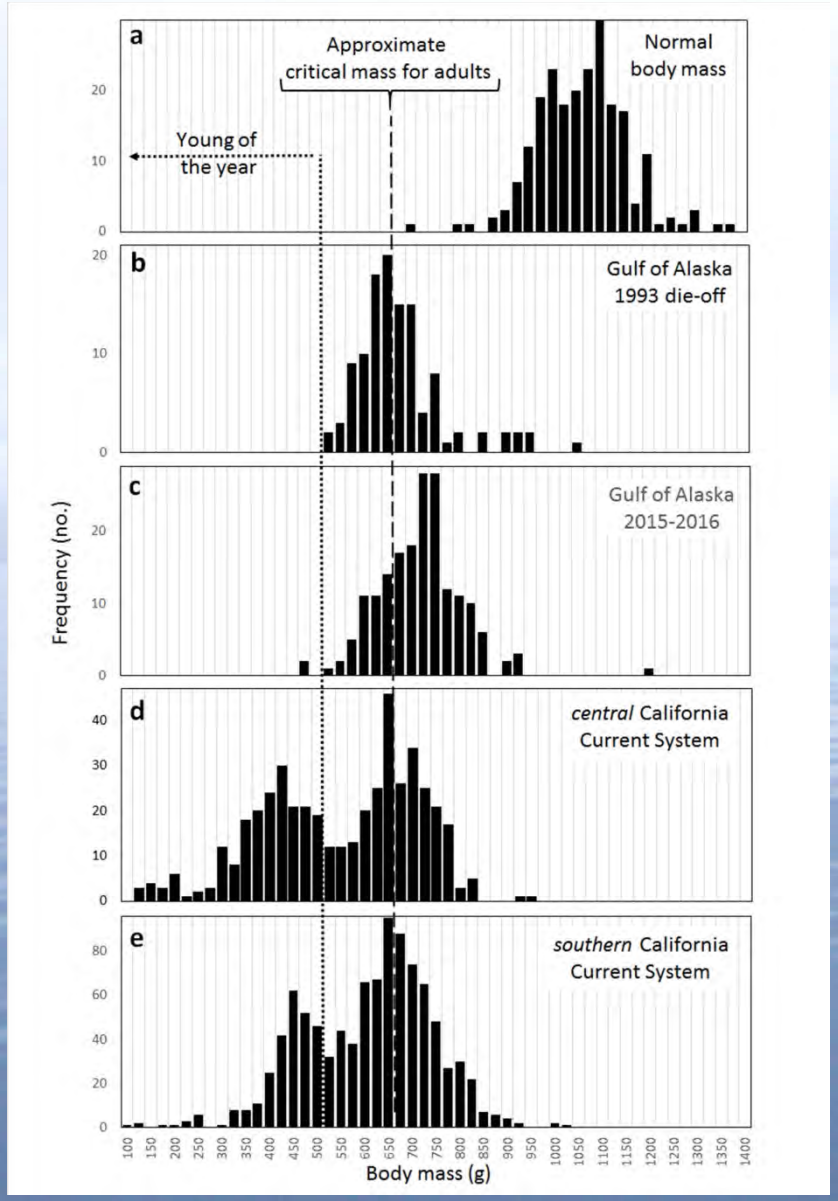
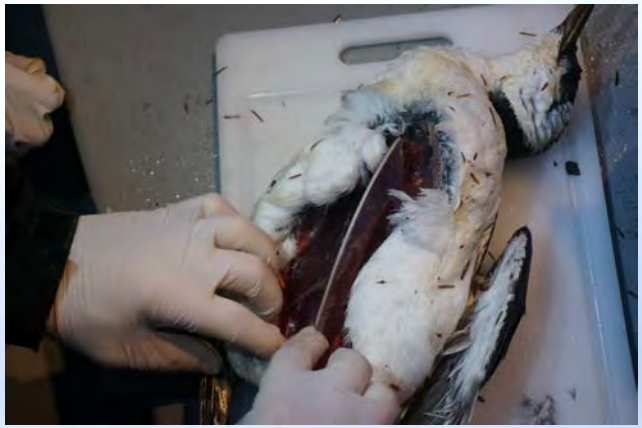

Distribution of 60,000 murre carcasses on beaches May 2015 – Apr 2016
Dead Murres Obs.
1 - 200
201 - 800
801 - 2500
2501 - 5000
5001 - 16814
0 500 1,000 2,000 Kilometers


Summer (May-Oct)
Distribution of murres at sea
NPPSD
Kilometers
0 250 500 1,000

Murres died of starvation





Factors contributing to starvation:

- Breeding stress
- Post-breeding molt
- Winter storms

Factors that were NOT a major cause of mortality, although some affected a small number of birds:

- Domoic acid
- Saxitoxin
- Salmonella
- Infectious disease
- Parasites
- Oil pollution

Data: USGS (Bodenstein, Piatt), Piatt et al. 1997

Piatt et al. *in prep*

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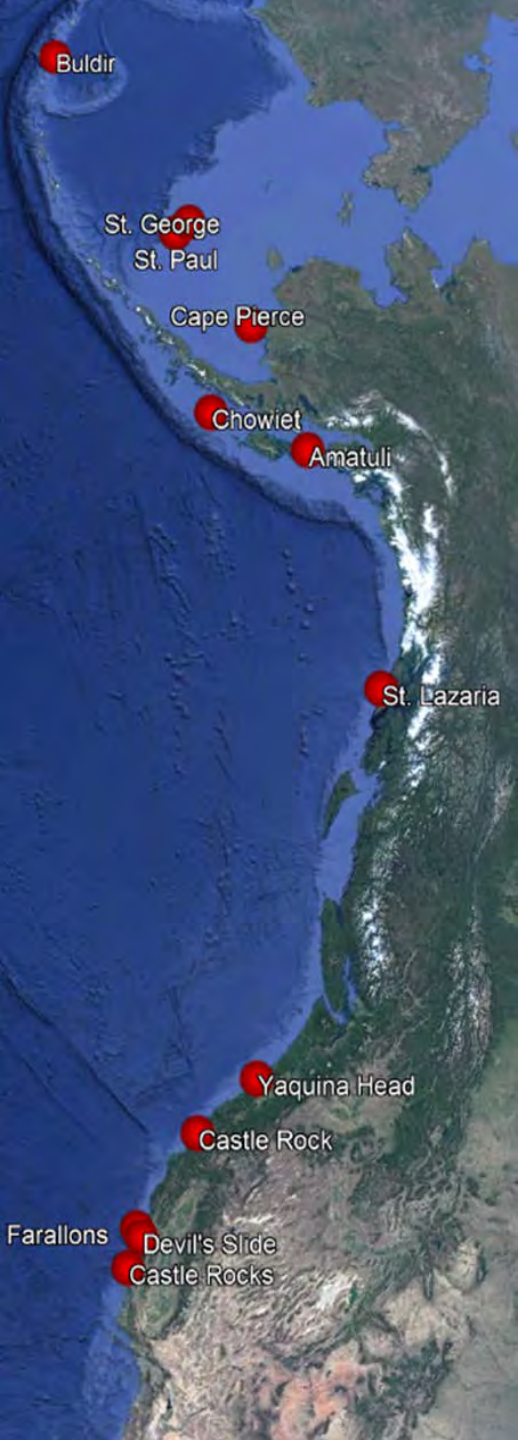

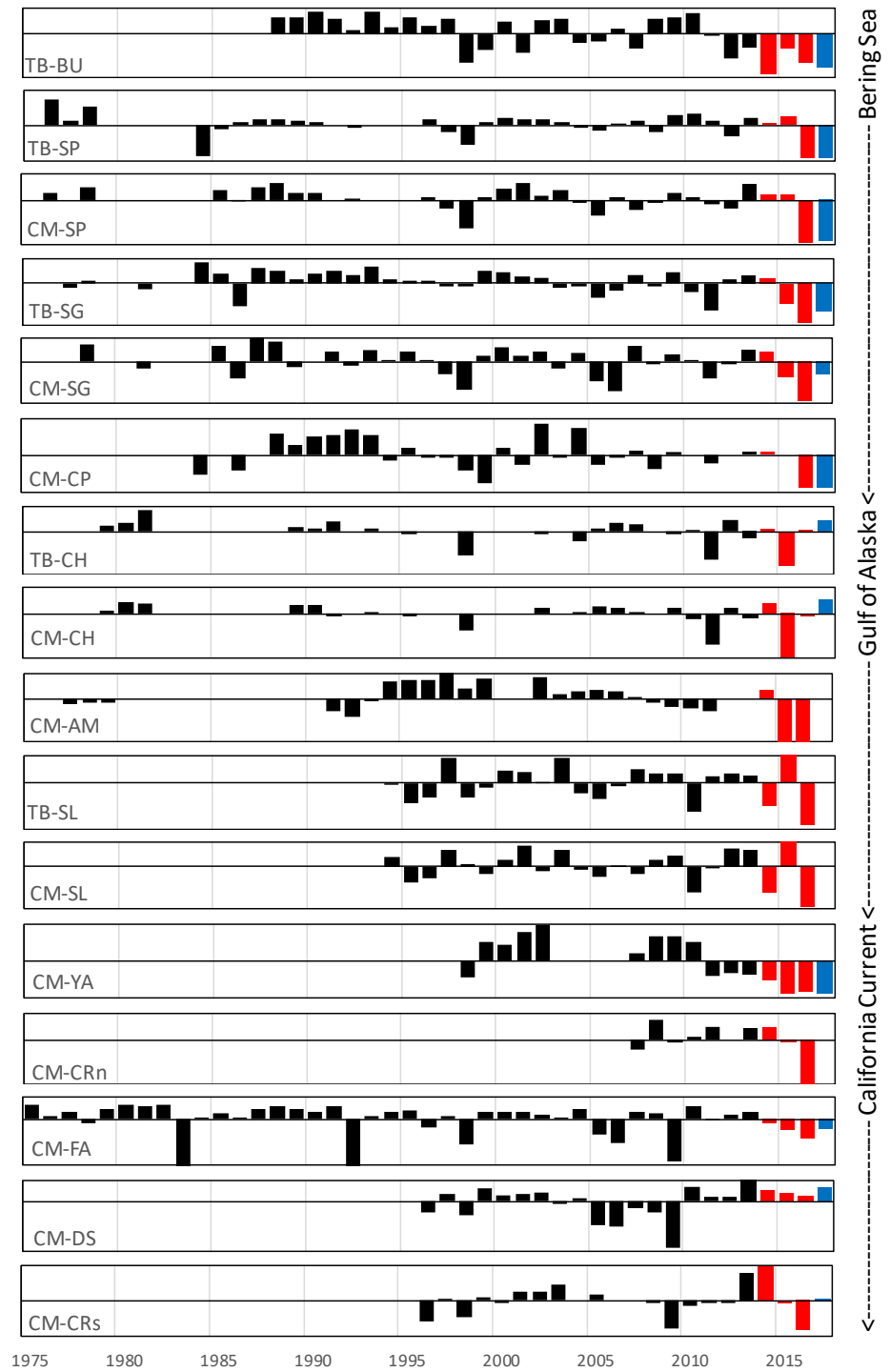

Supporting evidence of food scarcity: Unprecedented breeding failures at Common Murre colonies from California to Alaska

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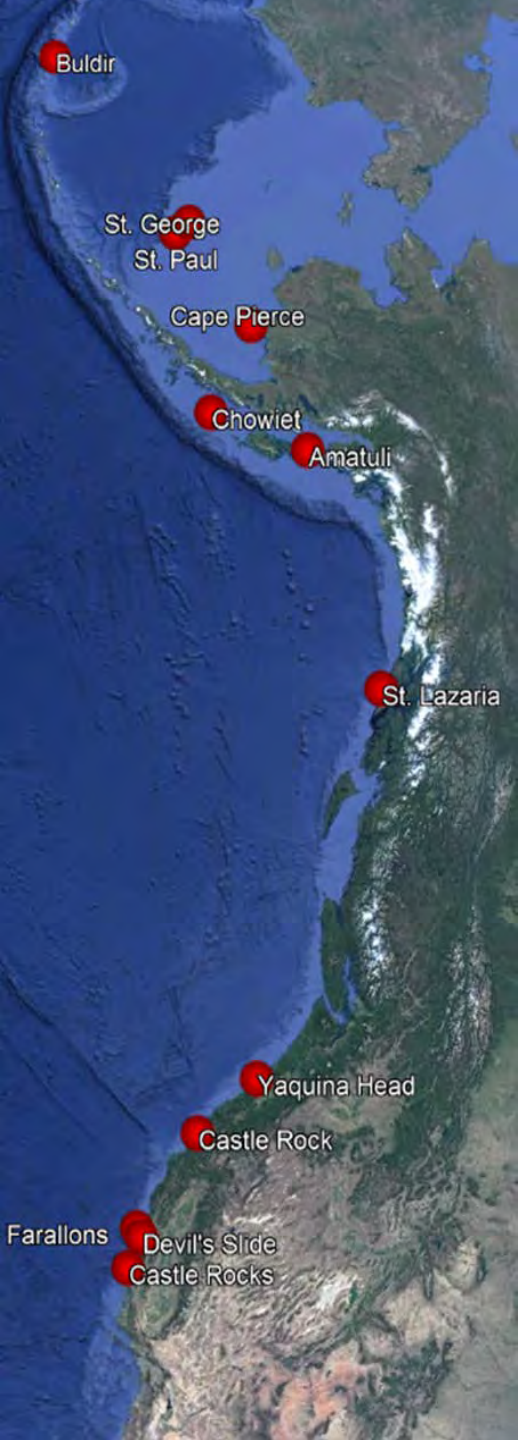

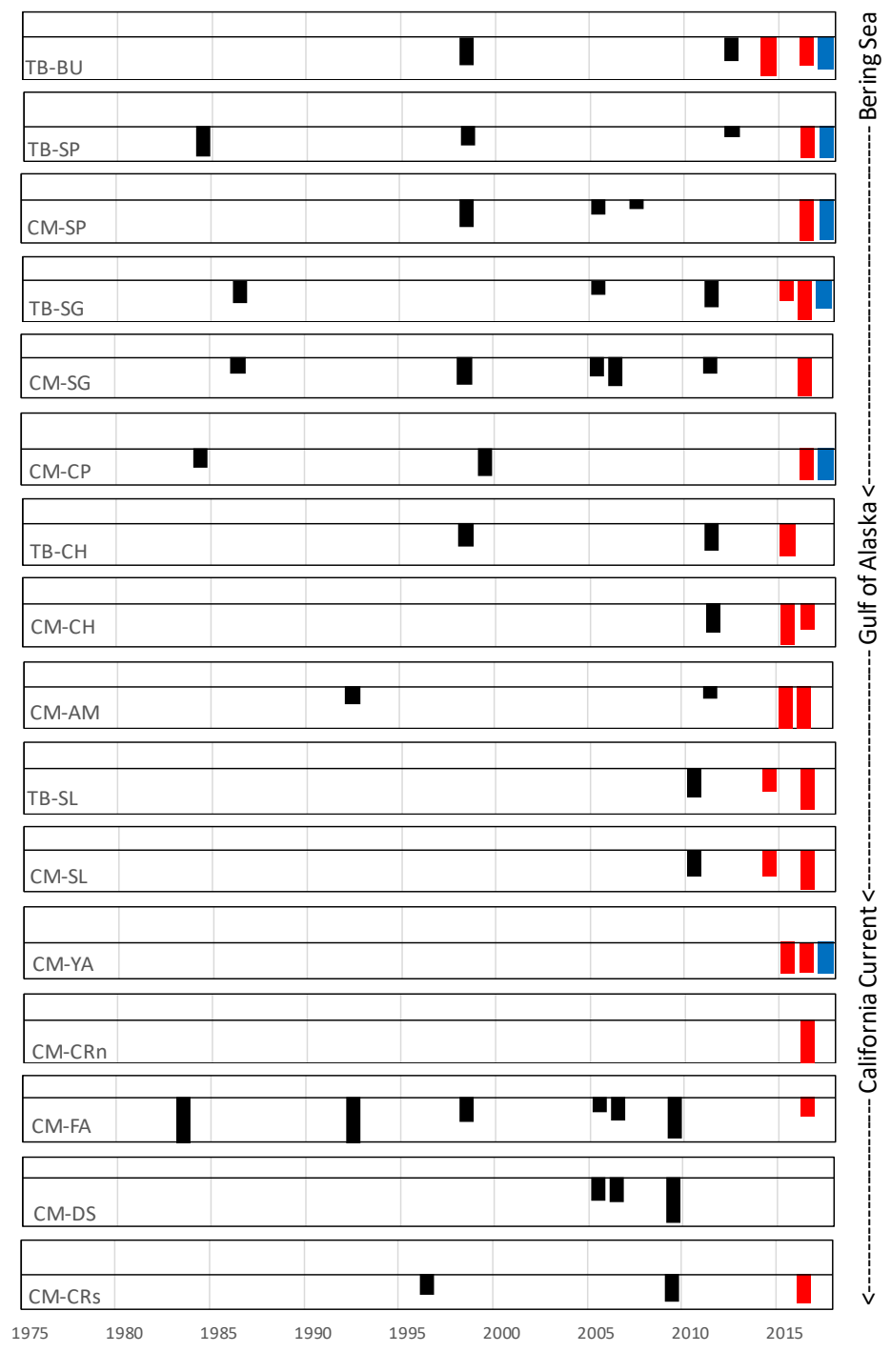

Worst Years: Lowest 15% of breeding success observations (N=423)

Almost half (44%) of all worst years occurred in association with 2014-2016 heatwave

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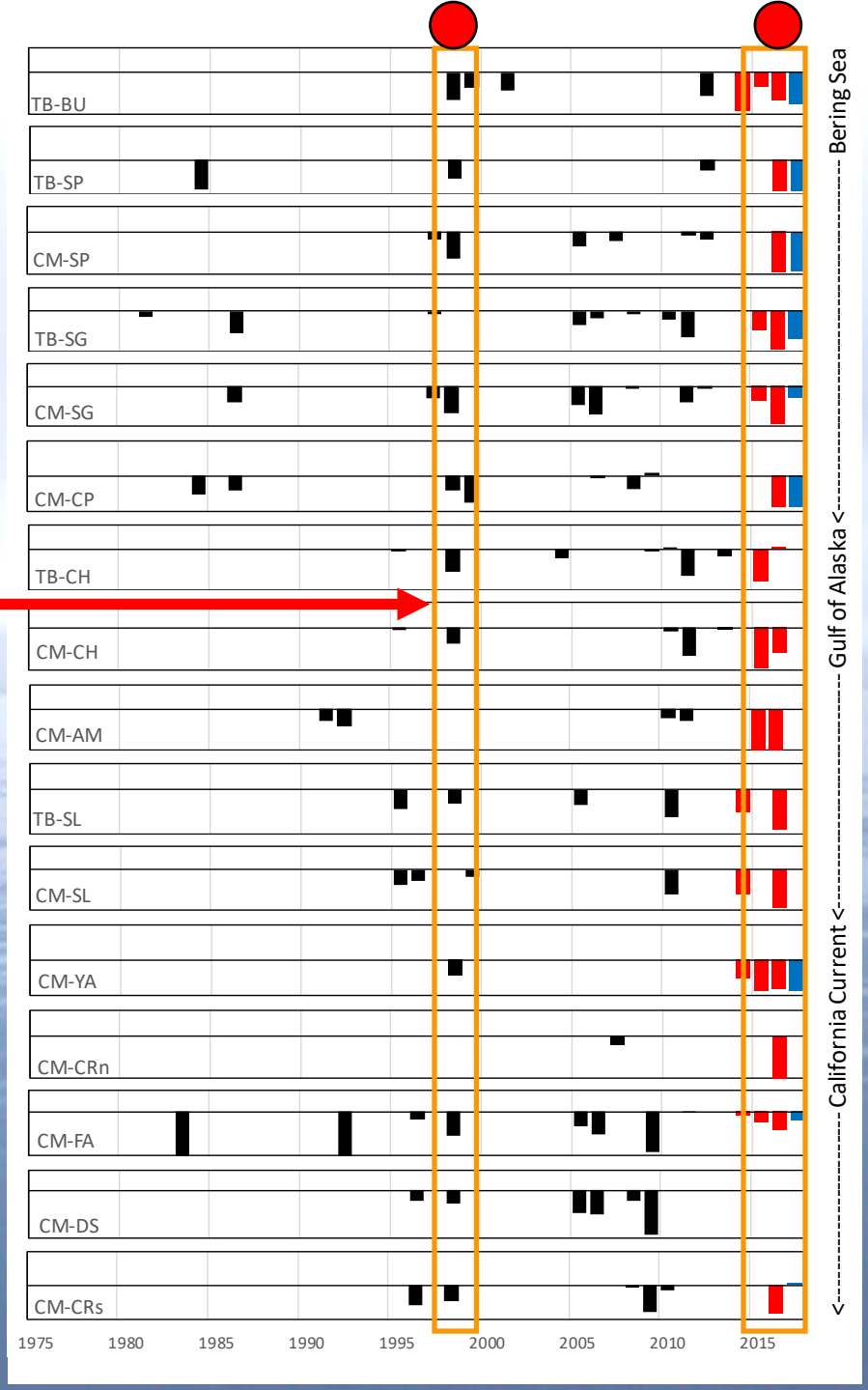
1997-1998 ENSO



Lowest 25% of breeding success observations

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Other mortality events of marine bird and mammal species in the GOA and CCS during the 2014-2016 heatwave

Cassins Auklet 2014-2015 (100K)

Common Murre 2015-2016

Rhinoceros Auklet 2016

Tufted Puffin 2016

Guadalupe Fur Seal 2014-2015

California Sea Lion 2014-2016

Humpback and Fin whales 2015-2016

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Common Murres: Masters of their domain

So why did this die-off happen?

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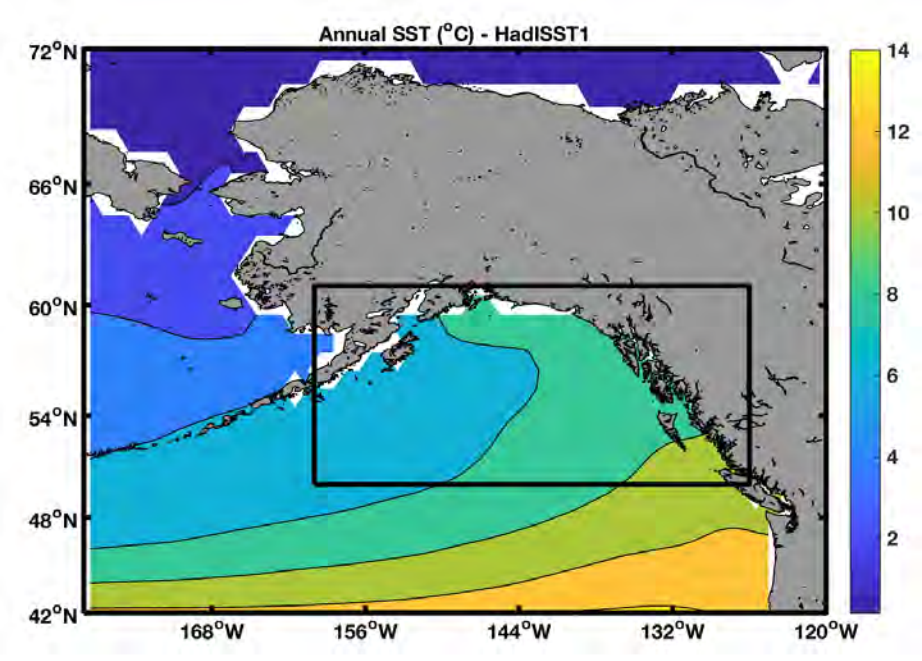
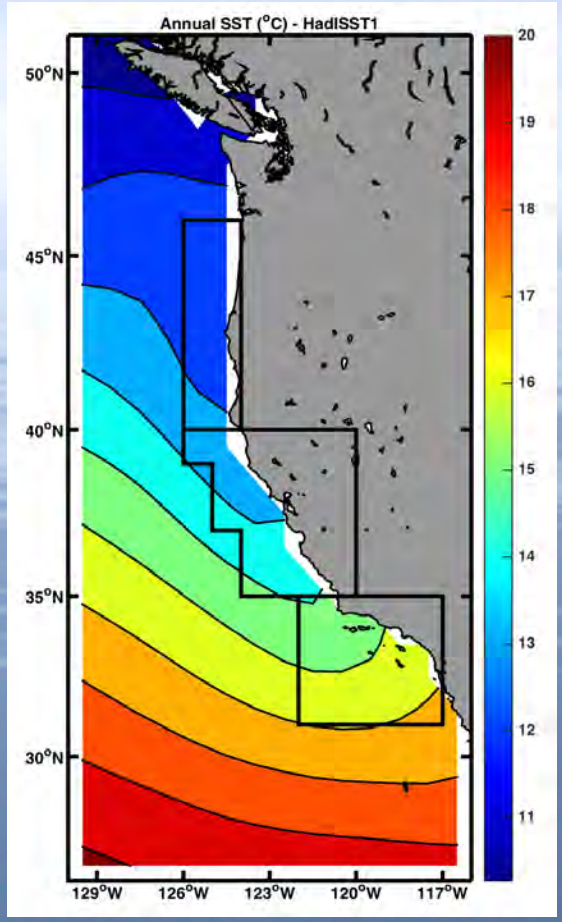
Event Attribution: Decomposition of SST signal for the Gulf of Alaska and the California Current System

Sea Surface Temperature (SST) record from January 1870 to May 2017
from the reanalysis dataset HadISST1





Analysis: García-Reyes, Sydeman, Piatt, *in prep.*

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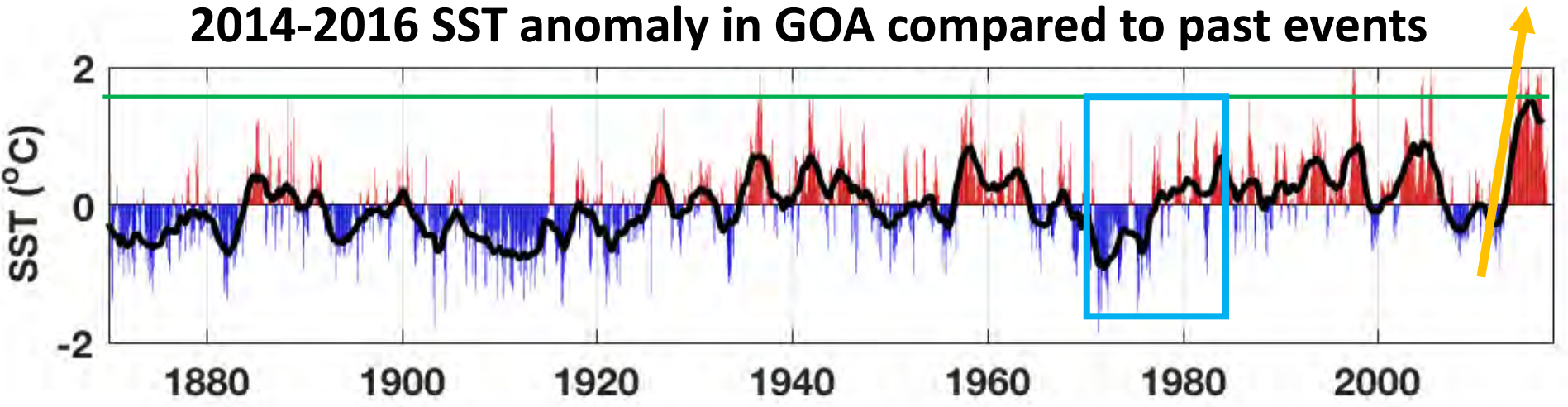
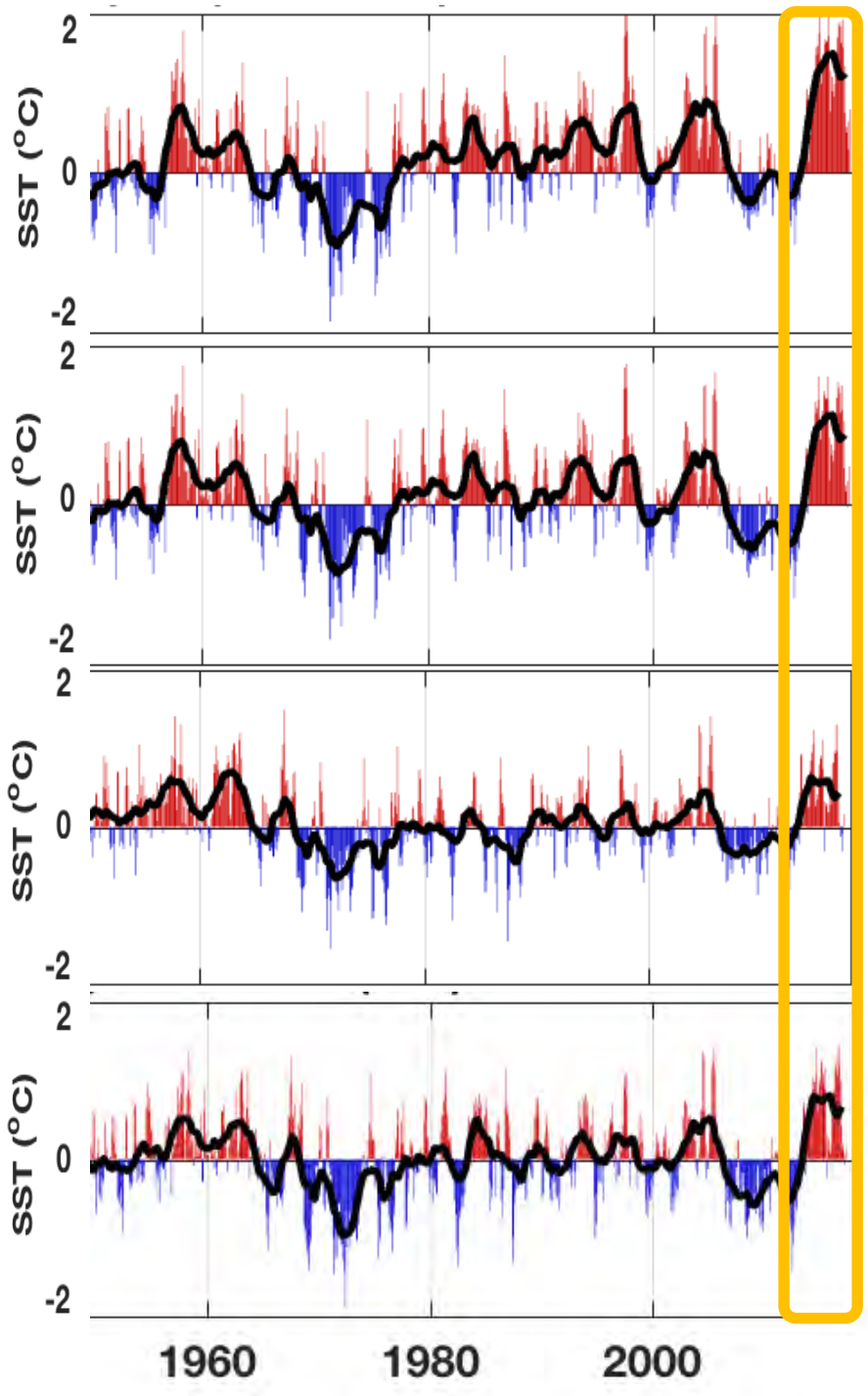
2014-2016 SST anomaly in GOA compared to past events



1) Largest sustained SST anomaly during past 147 years

2) Most rapid and extreme rise from low to high SST

3) Exceeds 1976 regime shift for magnitude and rate of change (but not duration)



GOA SST anomalies

Drivers of SST Variability in Phase

Remove Global SST

% contribution to anomalies

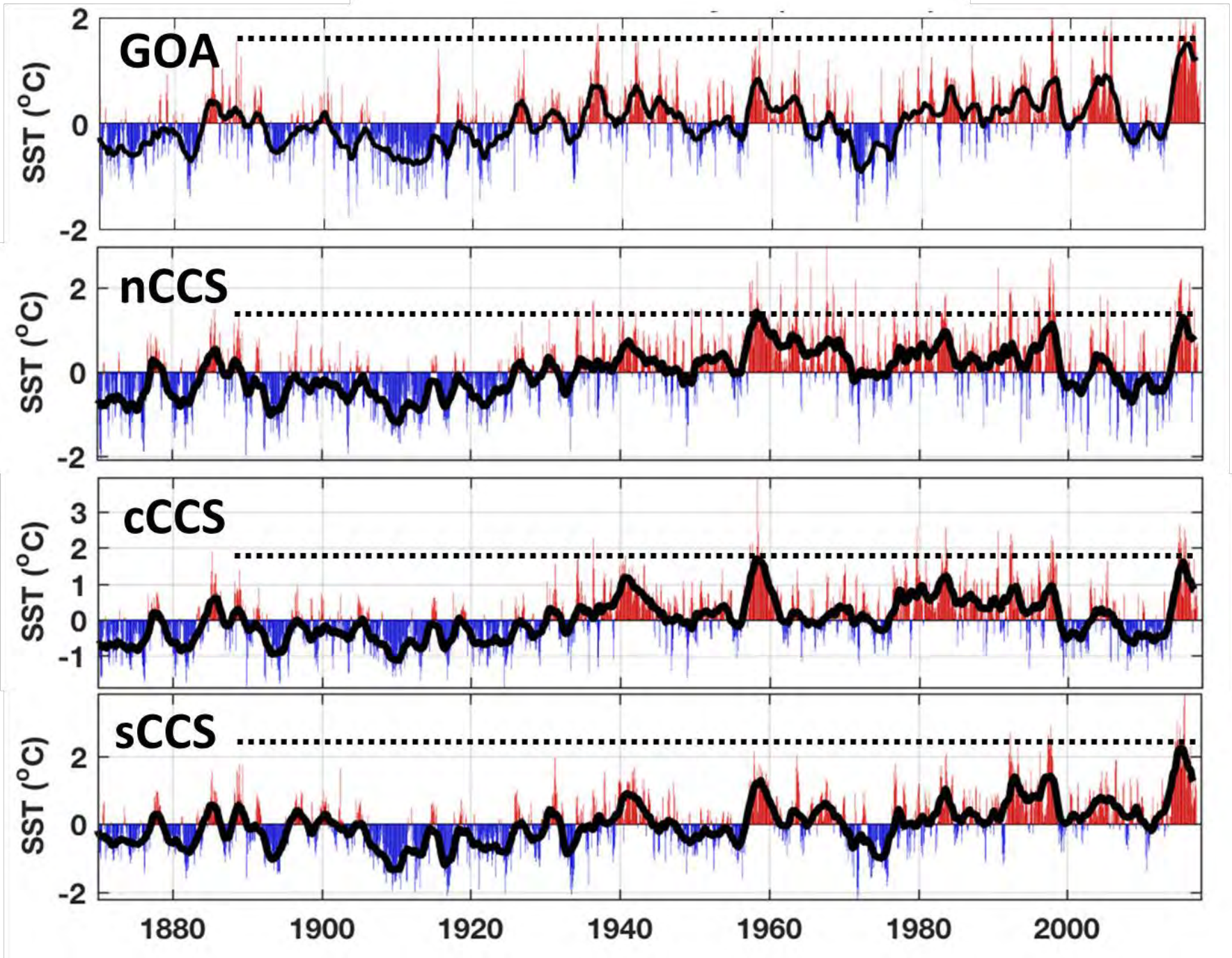
27% 1870-2017
25% 2014-2016

Remove PDO

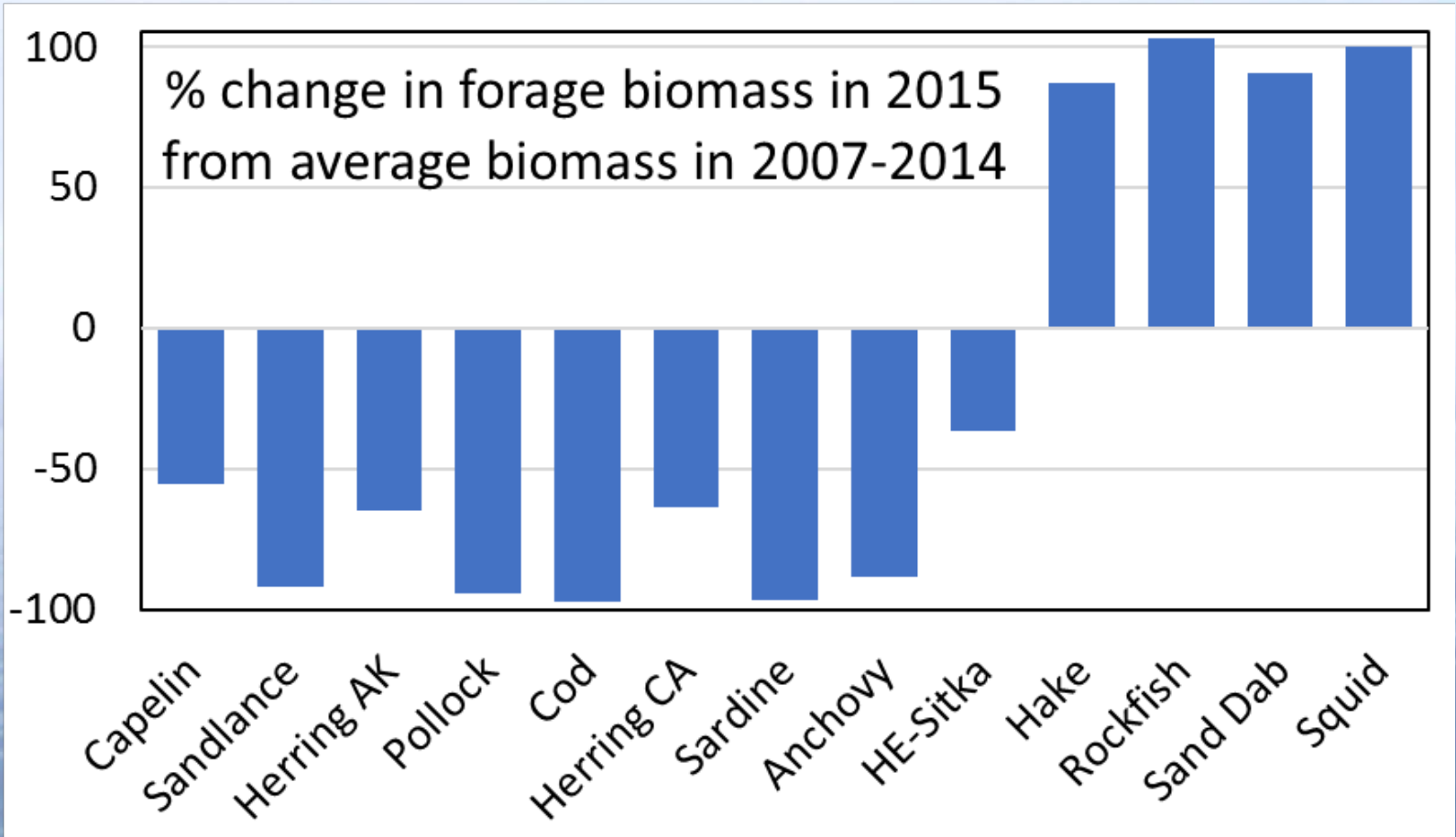
28% / 35%

Remove ENSO

12% / 22%


GOA
nCCS
cCCS
sCCS
SST (°C)
2
0
-2
3
1
-1
1880
1900
1920
1940
1960
1980
2000

Effect of the heatwave on forage fish typically consumed by murres



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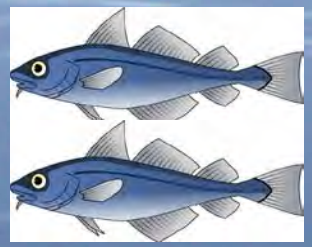
What could cause wide-spread loss of access to forage fish?

1) Commercial fishing (not likely)
2) Redistribution of fish out of reach of birds (possibly, but murres can go everywhere)
3) Reduced recruitment (likely some species, some areas)
4) Increased metabolic rate of predatory fish (affects all species, all areas-)

x6=



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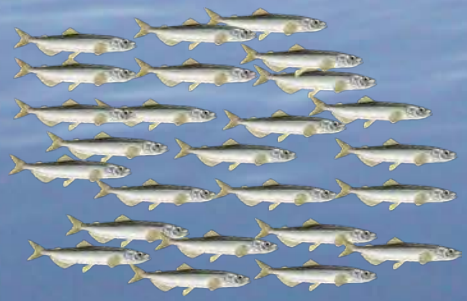
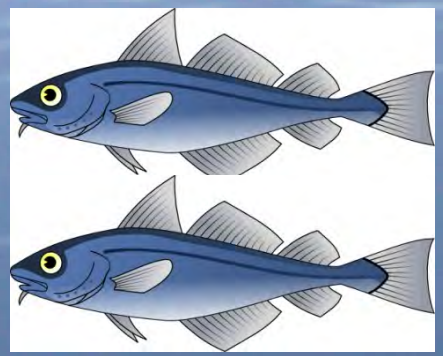
4) Increased metabolic rate of predatory fish (affects all species, all areas- increased prey competition)



x10=



+2 deg C

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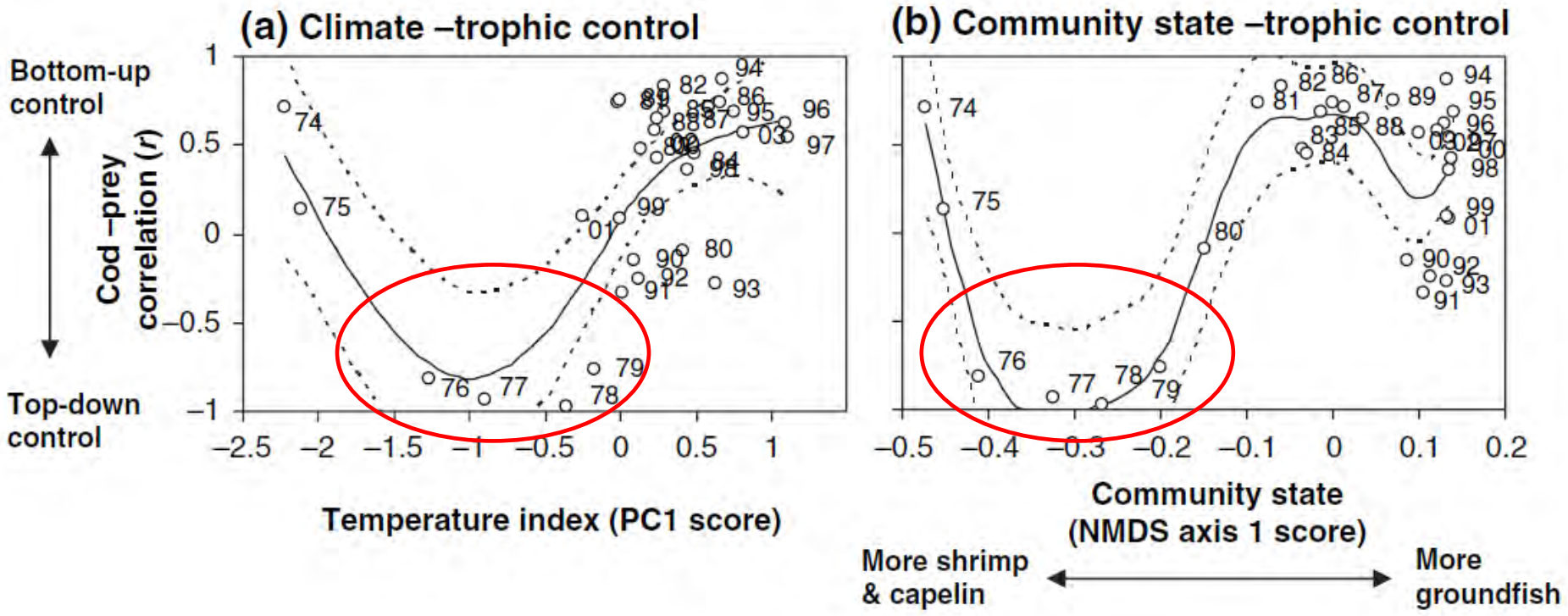
Litzow and Ciannelli. 2007. Oscillating trophic control induces community reorganization in a marine ecosystem. *Ecology Letters*.

Ectotherm Effect?



What did it mean when half a million of the dominant fish-eating seabirds of the North Pacific died *en masse* from starvation?

D. Irons

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Extreme ocean warming precipitated "Ectotherm Effect" resulting in a major perturbation to food webs across several contiguous Large Marine Ecosystems

Prediction: ripple and hangover effects of this perturbation on less visible members* of these LMEs in following years…

* e.g., Pacific Cod – see Steven Barbeaux

Thanks for hanging out with me!

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Stay on the deck of the Ripley by my side this clear and cold morning. See how swiftly scuds our gallant bark, as she cuts her way through the foaming billows, now inclining to the right and again to the left. Far in the east, dark banks of low clouds indicate foul weather to the wary mariner, who watches the approach of a northern storm with anxiety. Suddenly the wind changes ; but for this he has prepared ; the topsails are snugged to their yards, and the rest are securely reefed. A thick fog obscures all around us. The waters, suddenly checked in their former course, furiously war against those which now strike them in front. The uproar increases, the bark is tossed on every side ; now a sweeping wave rushes against the bows, the vessel quivers, while down along her deck violently pour the waters, rolling from side to side, seeking for a place by which they may escape. At this moment all about you are in dismay save the Guillemots. The sea is covered with these intrepid navigators of the deep. Over each tumultuous billow they swim unconcerned on the very spray at the bow of the vessel, and plunging as if with pleasure, up they come next moment at the rudder. Others fly around in large circles, while thousands contend with the breeze, moving directly against it in long lines, towards regions unknown to all, save themselves and some other species of sea birds.

THE END

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