Characteristics Of Meso- and Submeso-scale Features Used by Highly Migratory Marine Predators

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Stephanie A. Loredo
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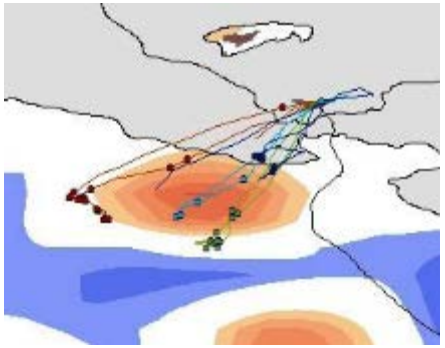
Zamon et al.



Paredes et al.

GEOPHYSICAL RESEARCH LETTERS, VOL. 28, NO. 8, PAGES 1583-1586, APRIL 15, 2001

Biological enhancement at cyclonic eddies tracked with GOES thermal imagery in Hawaiian waters

Michael P. Seki, Jeffrey J. Polovina, R
National Marine Fisheries Service, NOAA, SW Fish

Robert R. Bidigare, Carrie L. Leonard
Department of Oceanography, SOEST, University of

David G. Foley
Joint Institute for Marine and Atmospheric Research

Comparative foraging ecology of planktivorous auklets in relation to ocean physics and prey availability

George L. Hunt Jr[1,*], Robert W. Russell[1,**], Kenneth O. Coyle[2], Thomas Weingartner[2]

[1]Department of Ecology and Evolutionary Biology, University of California, Irvine, California 92697, USA
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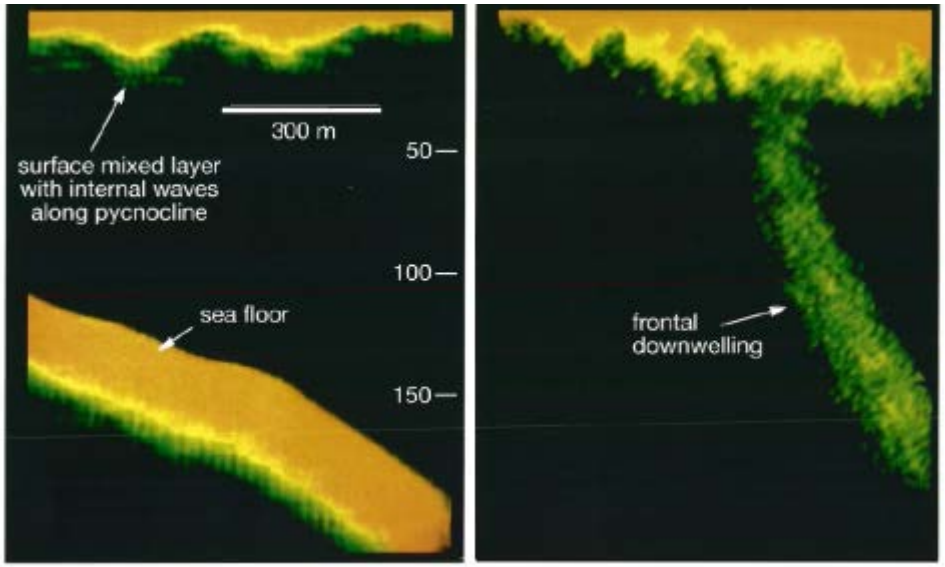
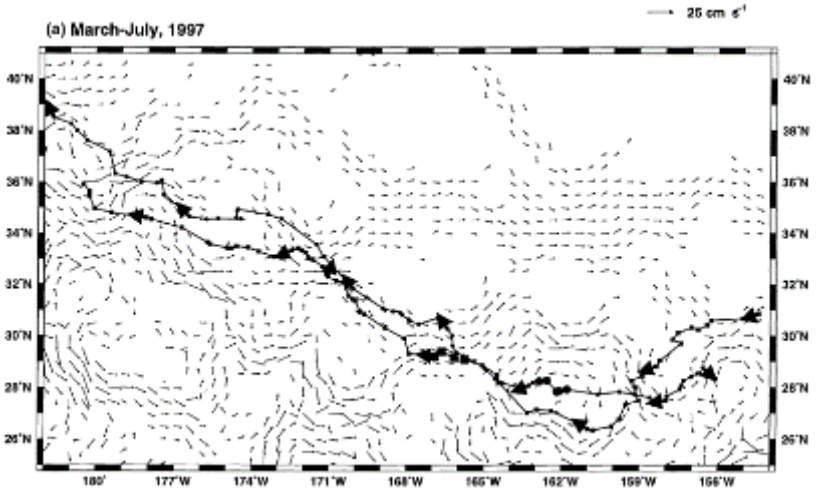
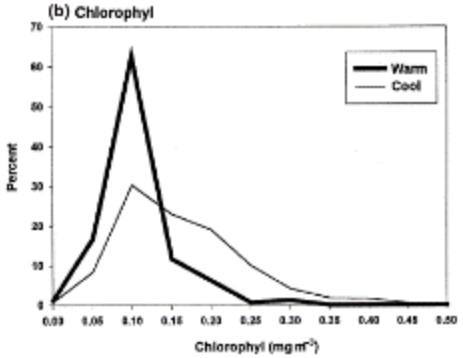


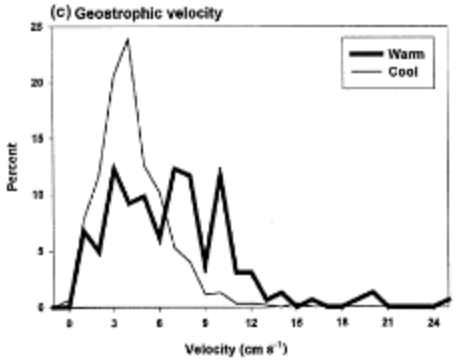
FISHERIES OCEANOGRAPHY Fish. Oceanogr. 9, 71–82, 2000

Turtles on the edge: movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts, spanning longline fishing grounds in the central North Pacific, 1997–1998

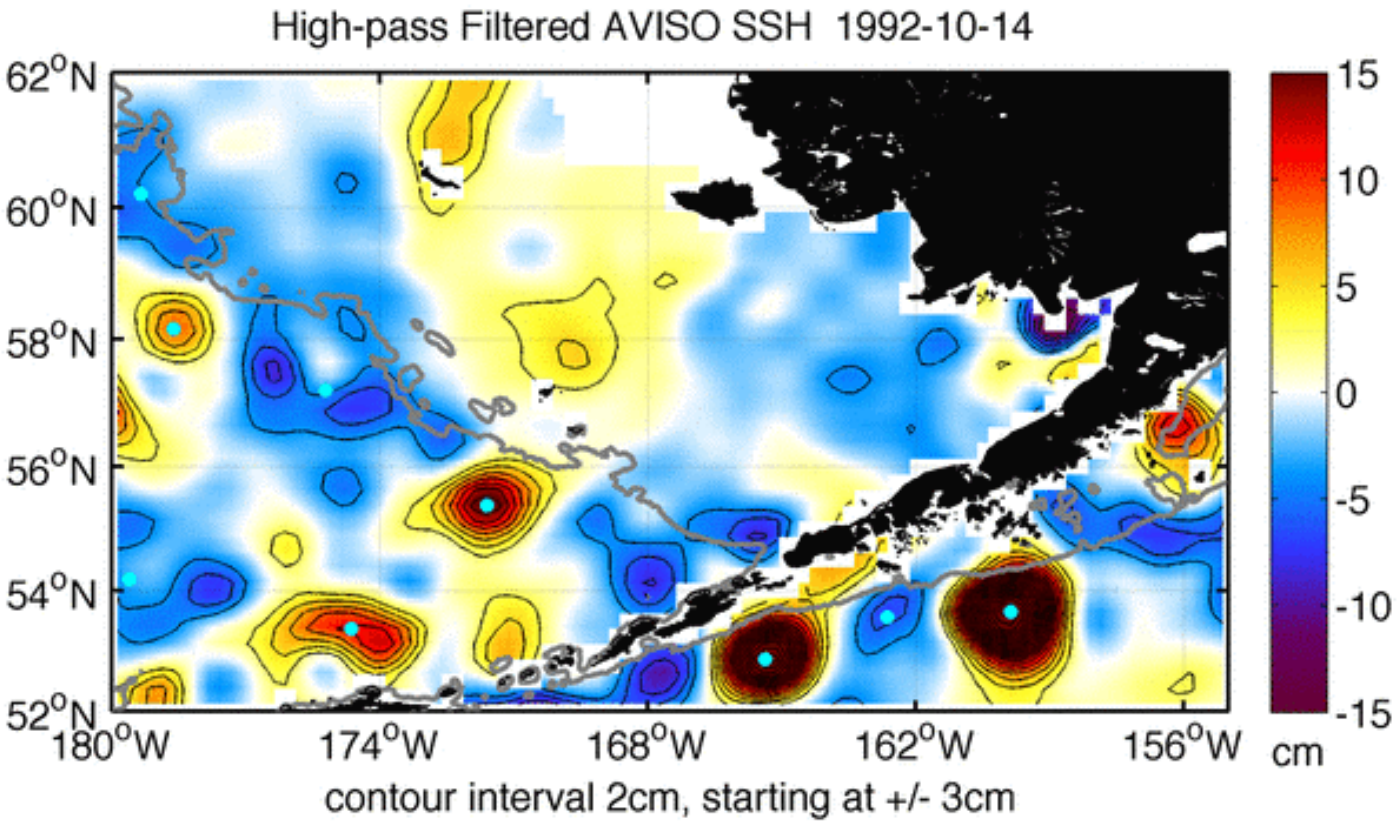
JEFFREY J. POLOVINA,[1,*]
DONALD R. KOBAYASHI,[1]
DENISE M. PARKER,[2]
MICHAEL P. SEKI[1] AND GEORGE H. BALAZS[1]







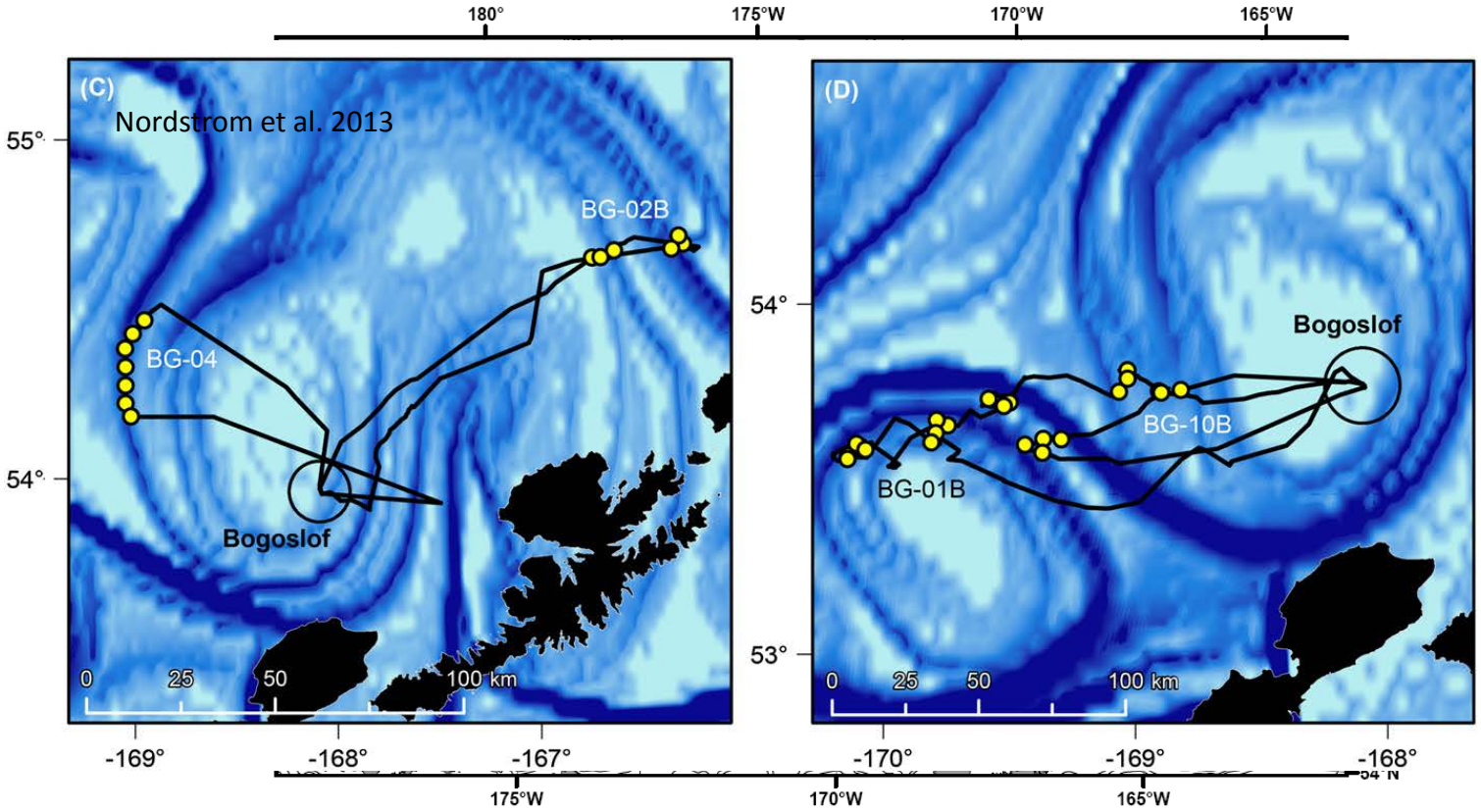
Dynamic Eddies of the SE Bering Sea and Alaska Peninsula



Gaube et al.

Northern Fur Seal

- Diving species
- Sensitive to horizontal changes in prey distribution

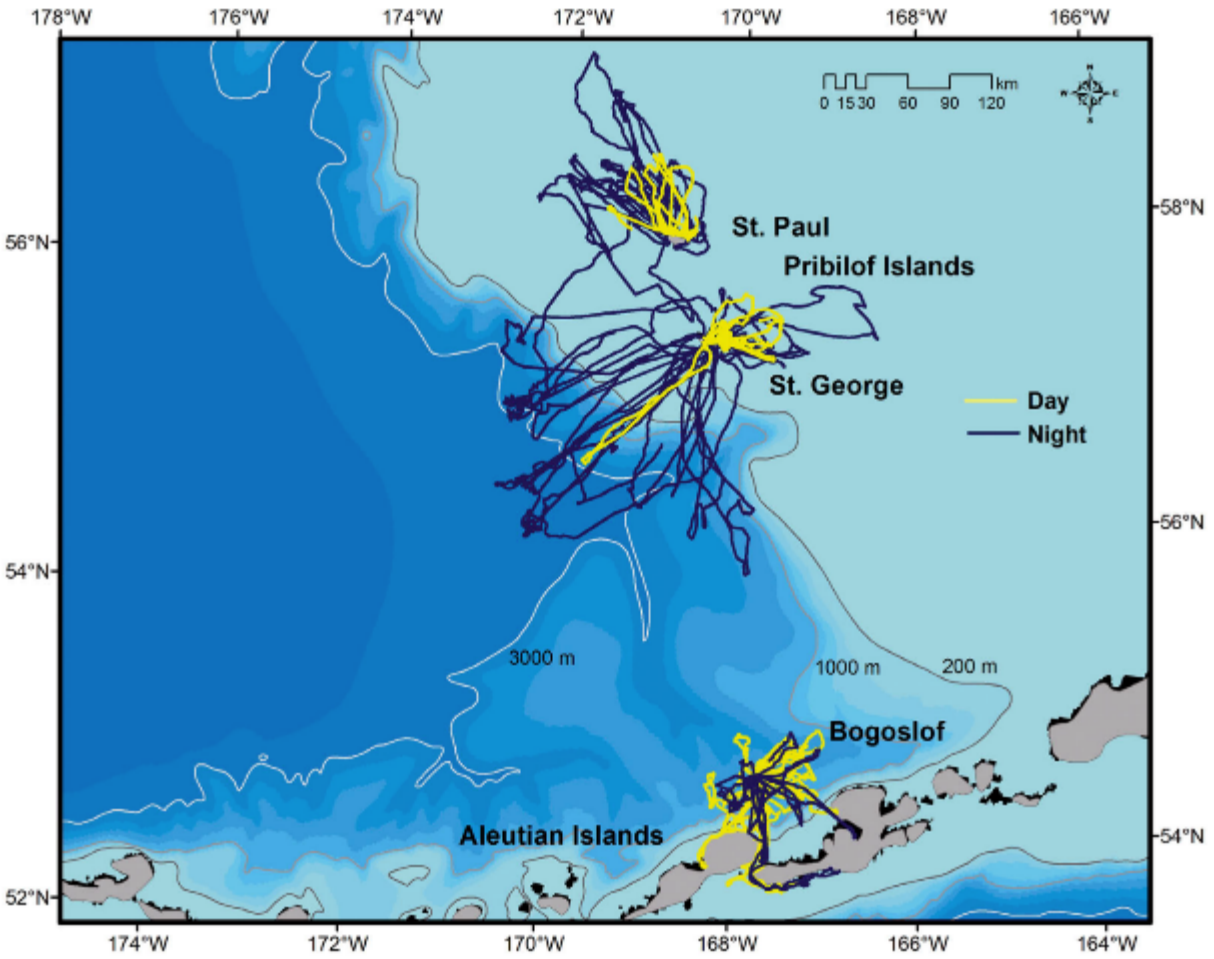


Sterling et al.

Black-legged Kittiwake Foraging in the Bering Sea

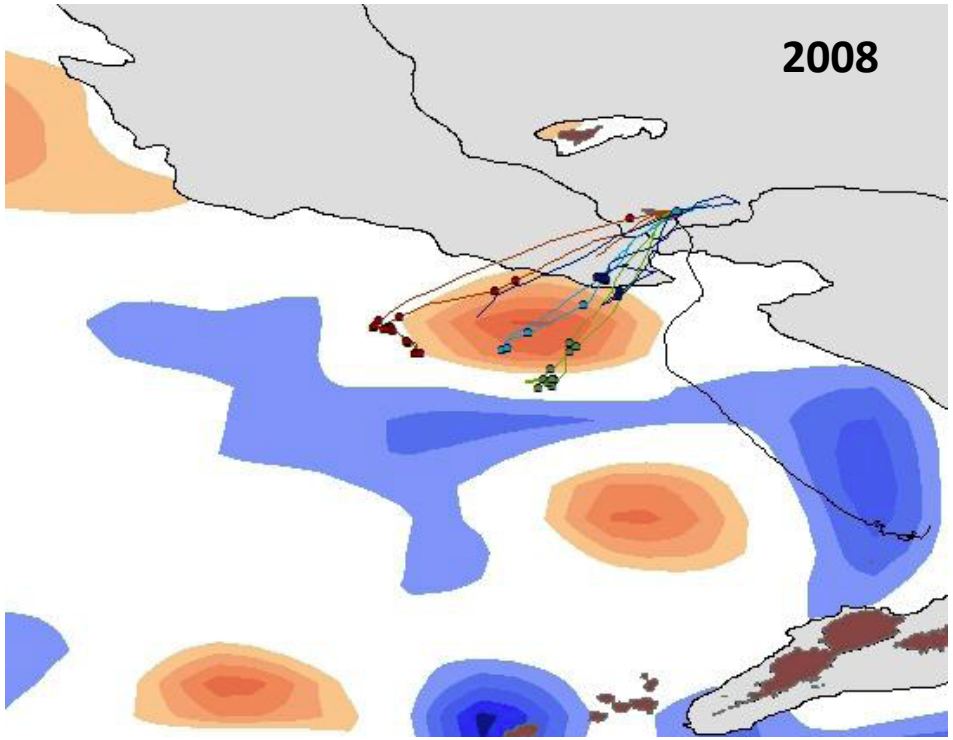
- Surface-feeding species
- Sensitive to vertical changes in prey distribution

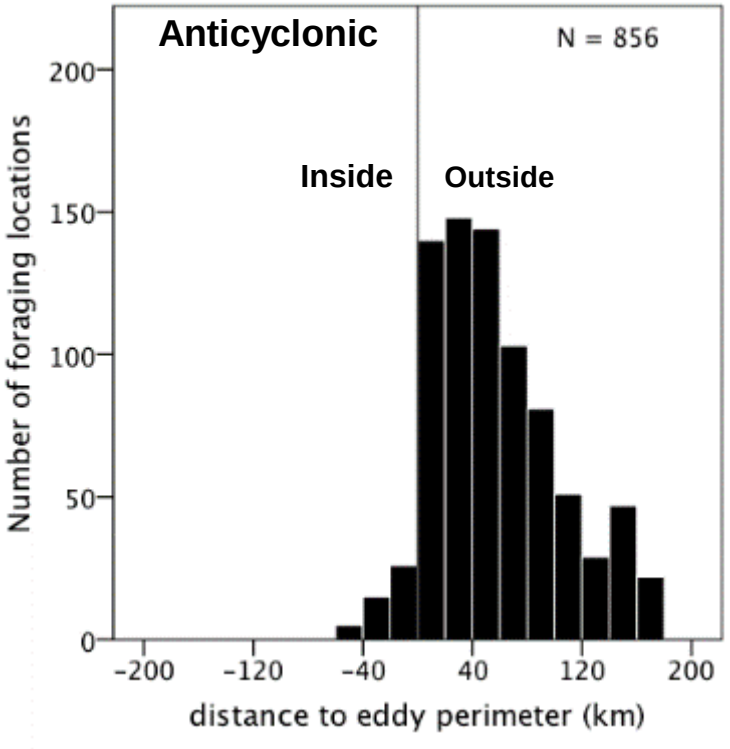
Kittiwake Foraging Trips



Paredes et al. 2012 Mar. Ecol. Prog. Ser.

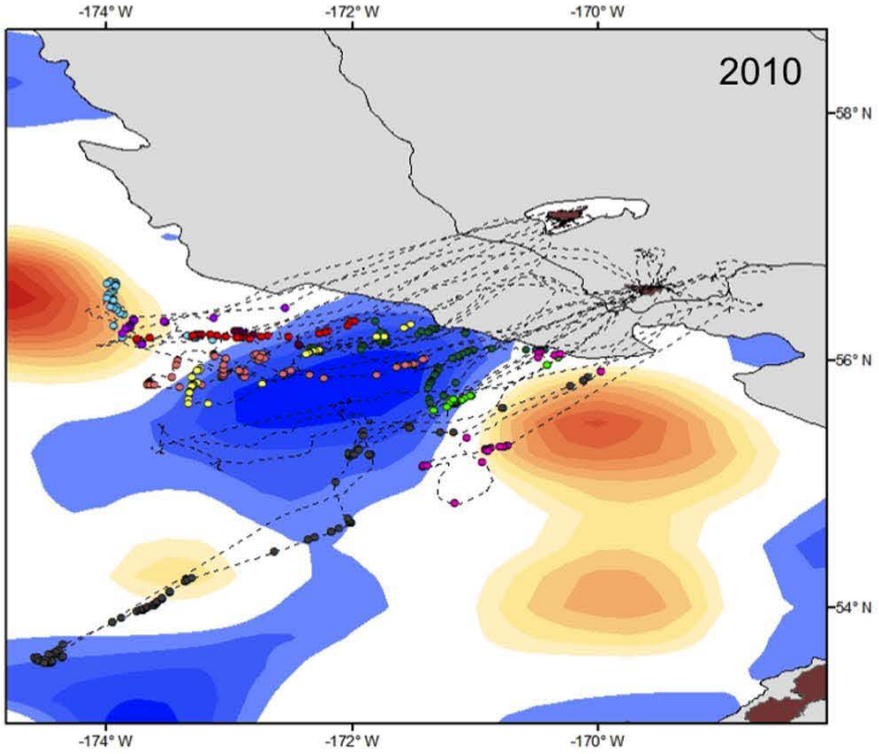
Foraging in Association With Eddies

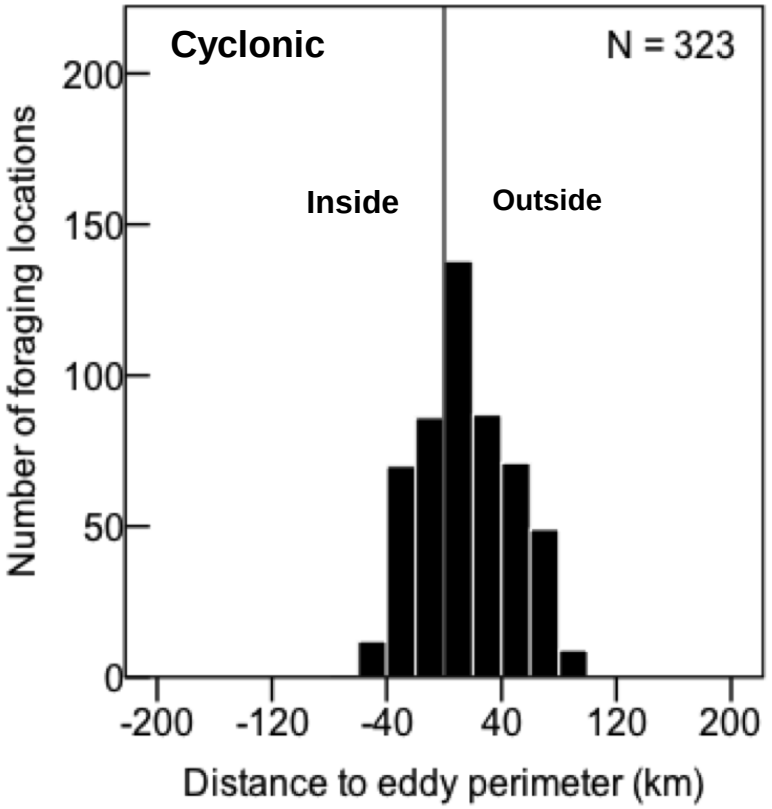




Paredes et al. 2014 PLoS ONE
Eddy data from Chelton, Schlax, and Gaube, OSU, CEOAS (Chelton et al. 2011 Prog. Ocn, 2011 Science)

Foraging in Association With Eddies



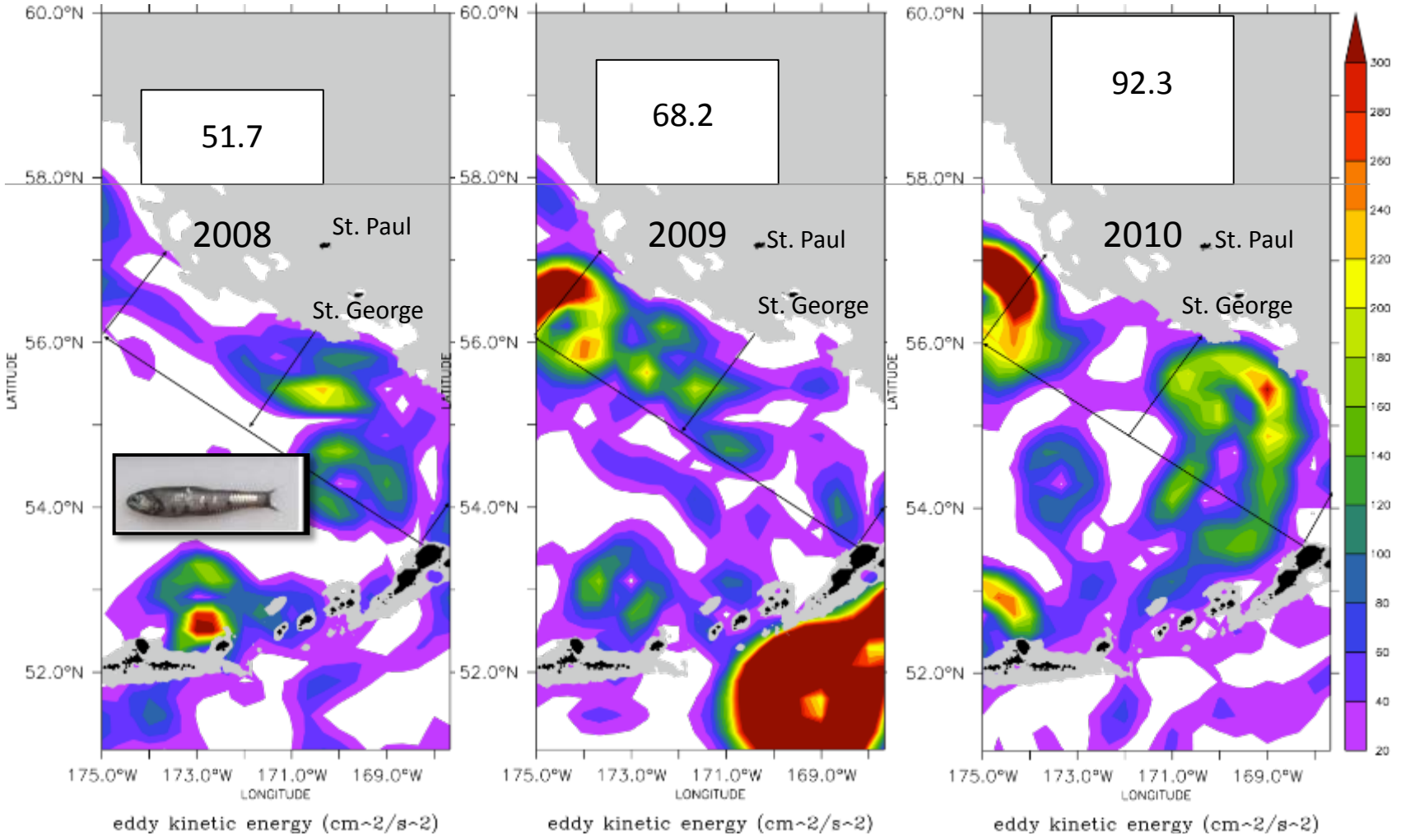


Paredes et al. 2014 PLoS ONE

Eddy data from Chelton, Schlax, and Gaube, OSU, CEOAS (Chelton et al. 2011 Prog. Ocn, 2011 Science)

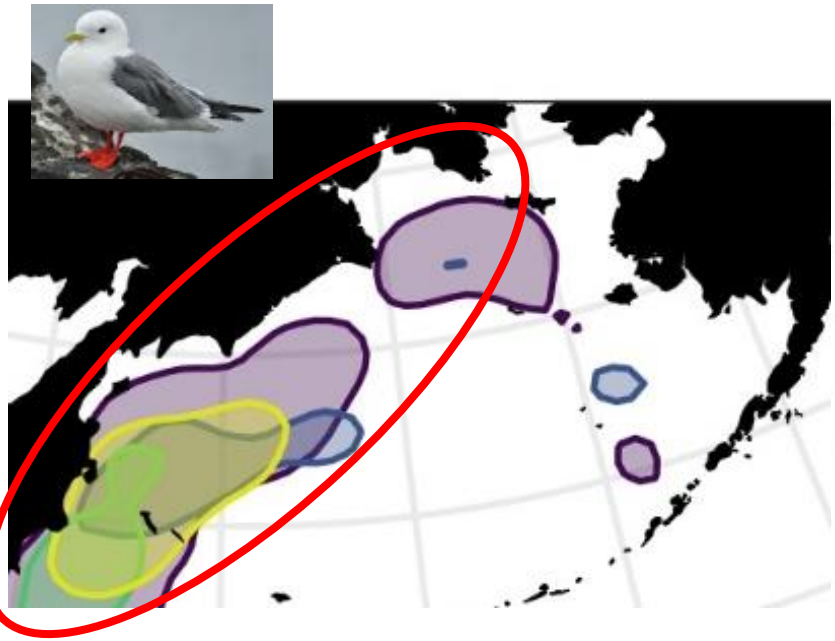
Eddy Kinetic Energy Varies Among Years

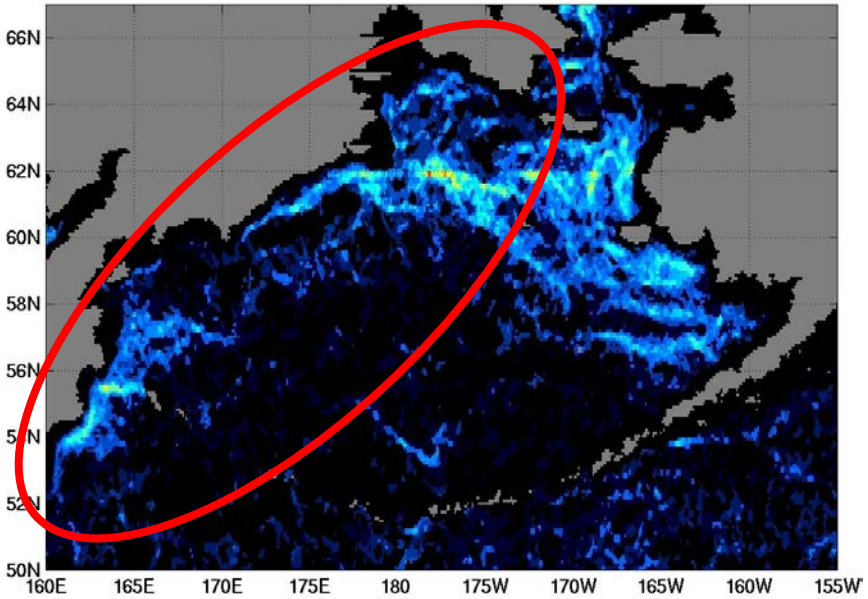
EKE = > use of basin



Paredes et al. 2014 PLoS ONE – Eddy data from Carol Ladd, NOAA, PMEL

Red–Legged Kittiwake Foraging and SST Fronts



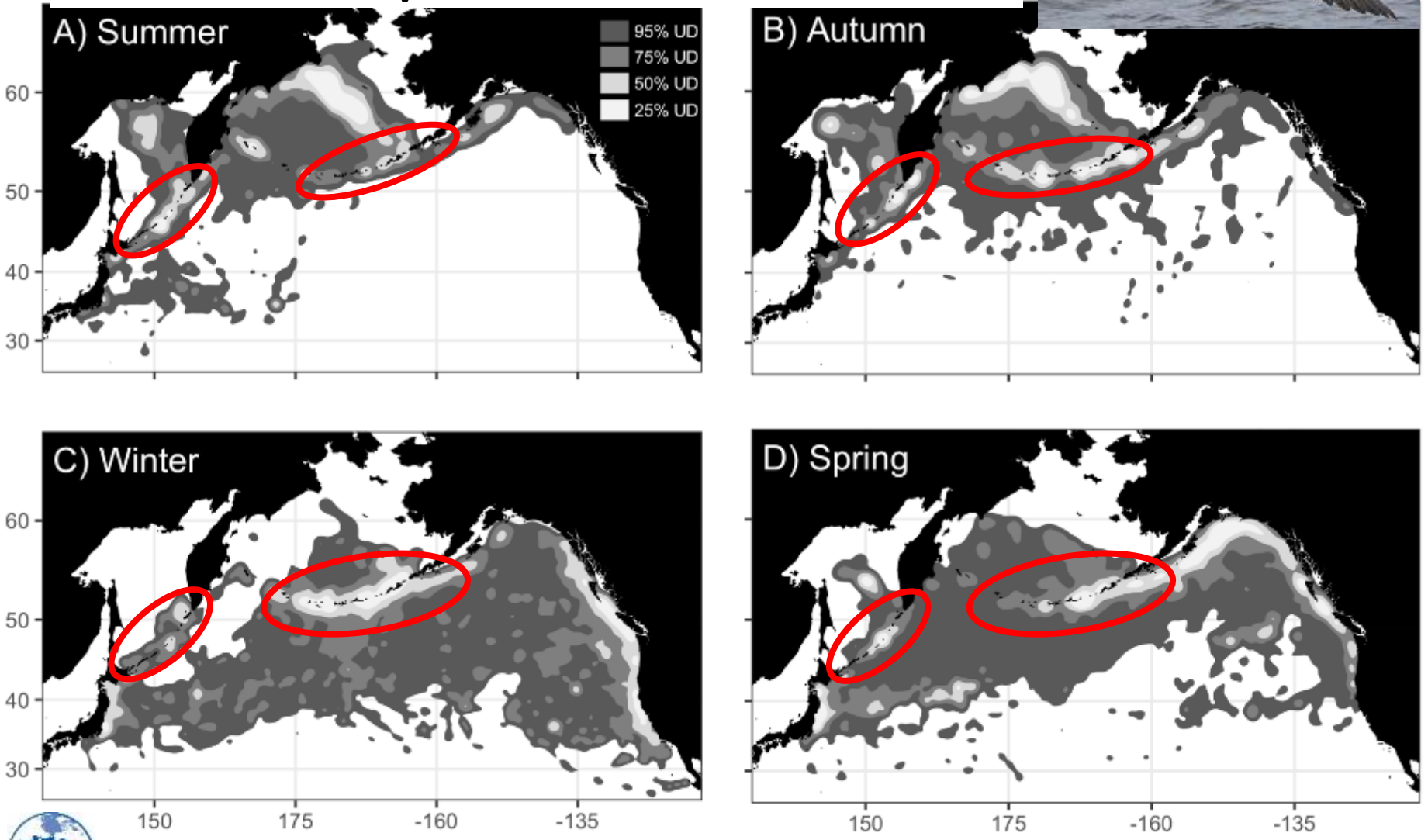


Core areas for individually-tracked Red-Legged Kittiwakes
(Orben et al 2015 J. Bio. Geogr., unpubl data)

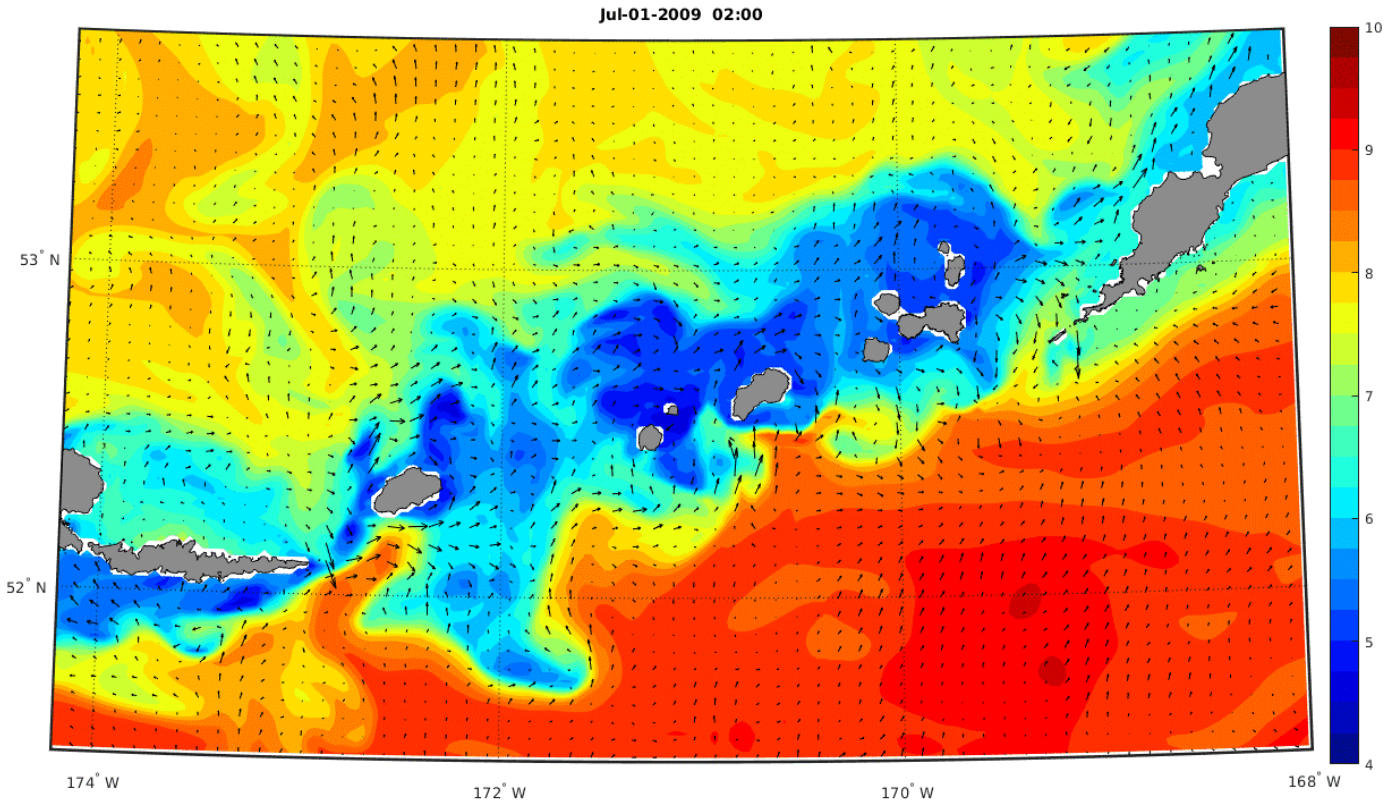
SST front frequency in the Bering Sea, November, 1985–1996.
(Belkin and Cornillon 2005 Pac. Ocn.)

Tidally & Topographically Driven Meso-Scale Features

Used by Short-tailed Albatross



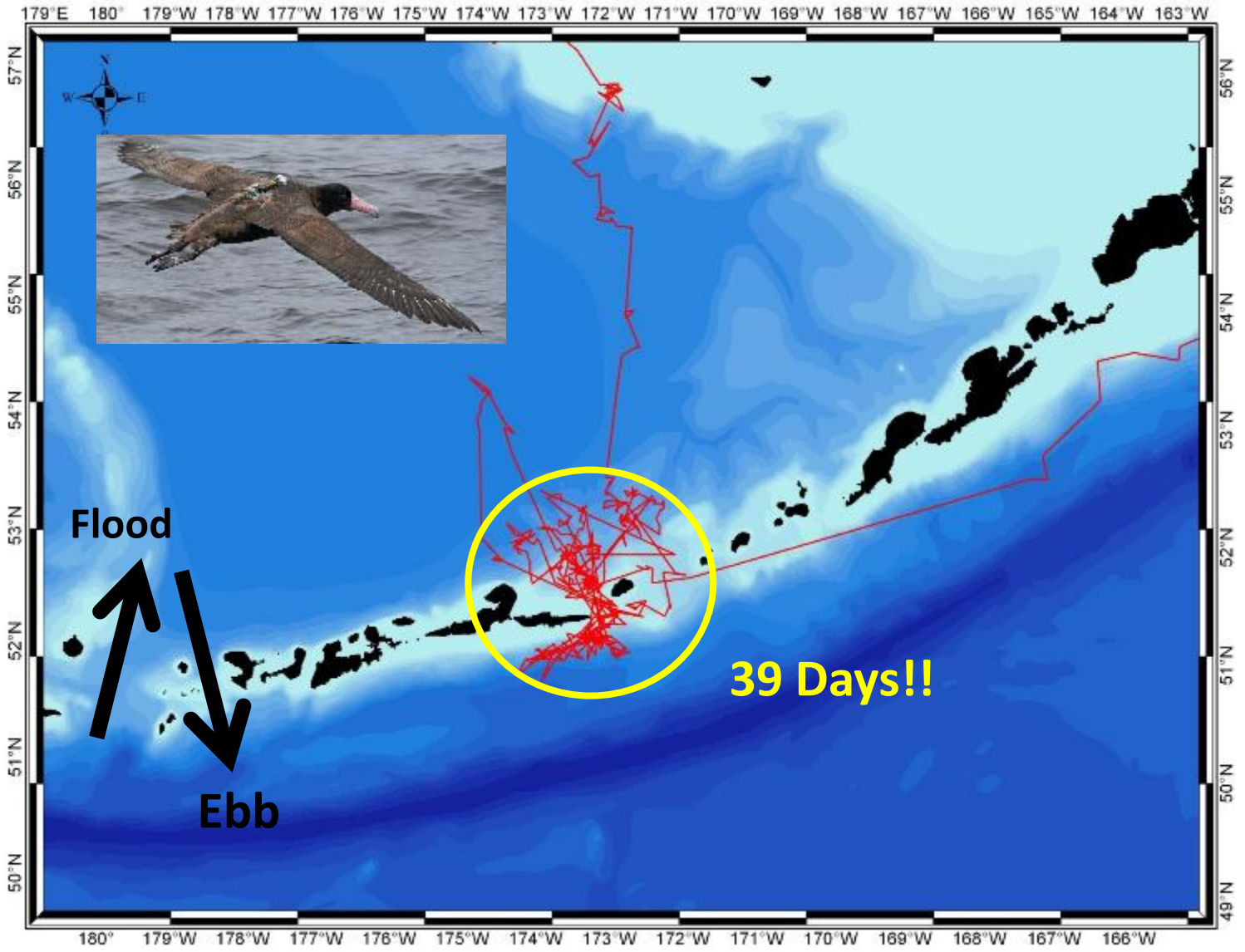
Oregon State University OSU Hatfield Marine Science Center



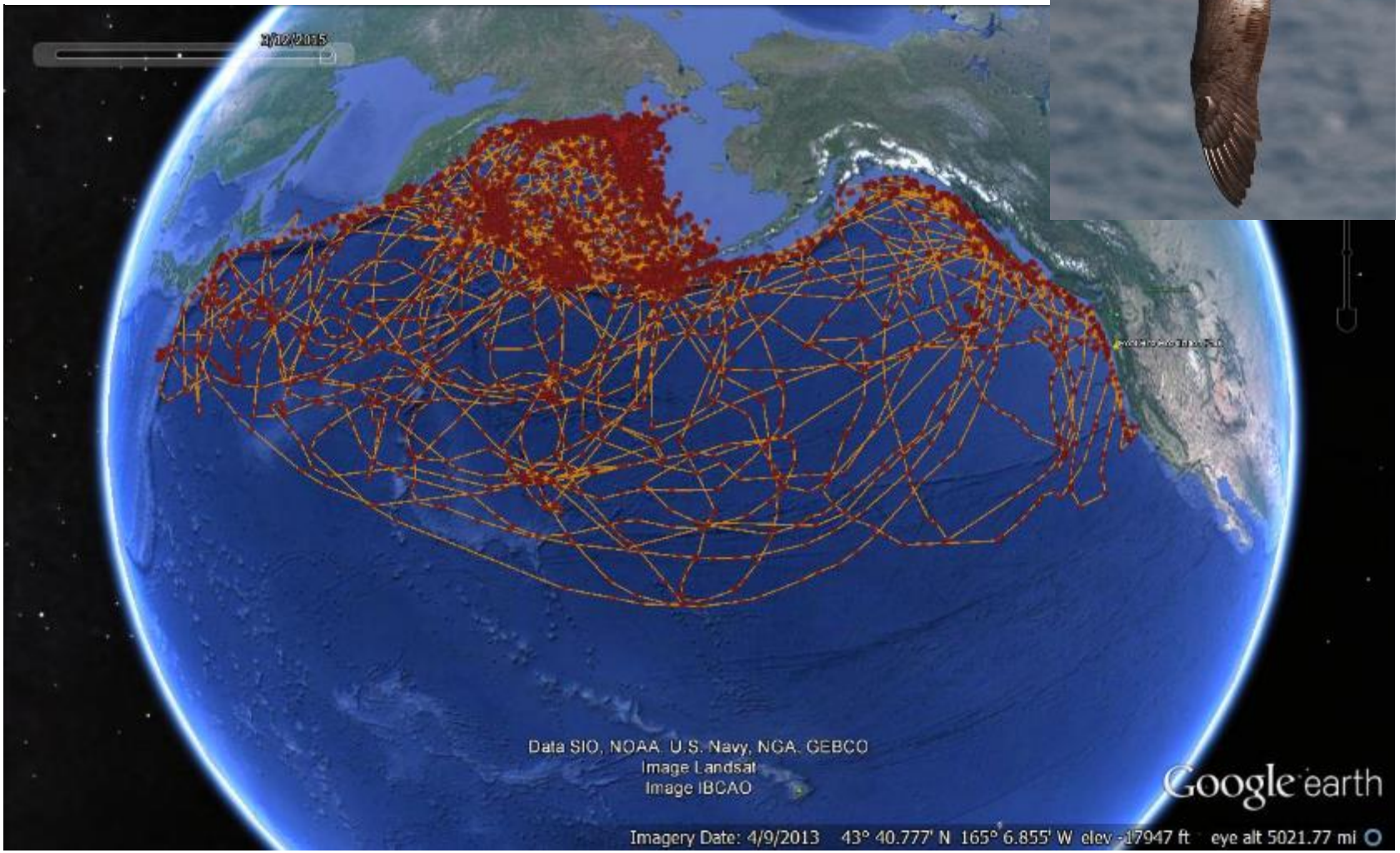
ROMS Simulation 2km Resolution
Temperature & surface currents - tides included

http://ingria.coas.oregonstate.edu/news/Amukta_pass.html

Scott Durski, Coastal Ocean Modeling, Oregon State University

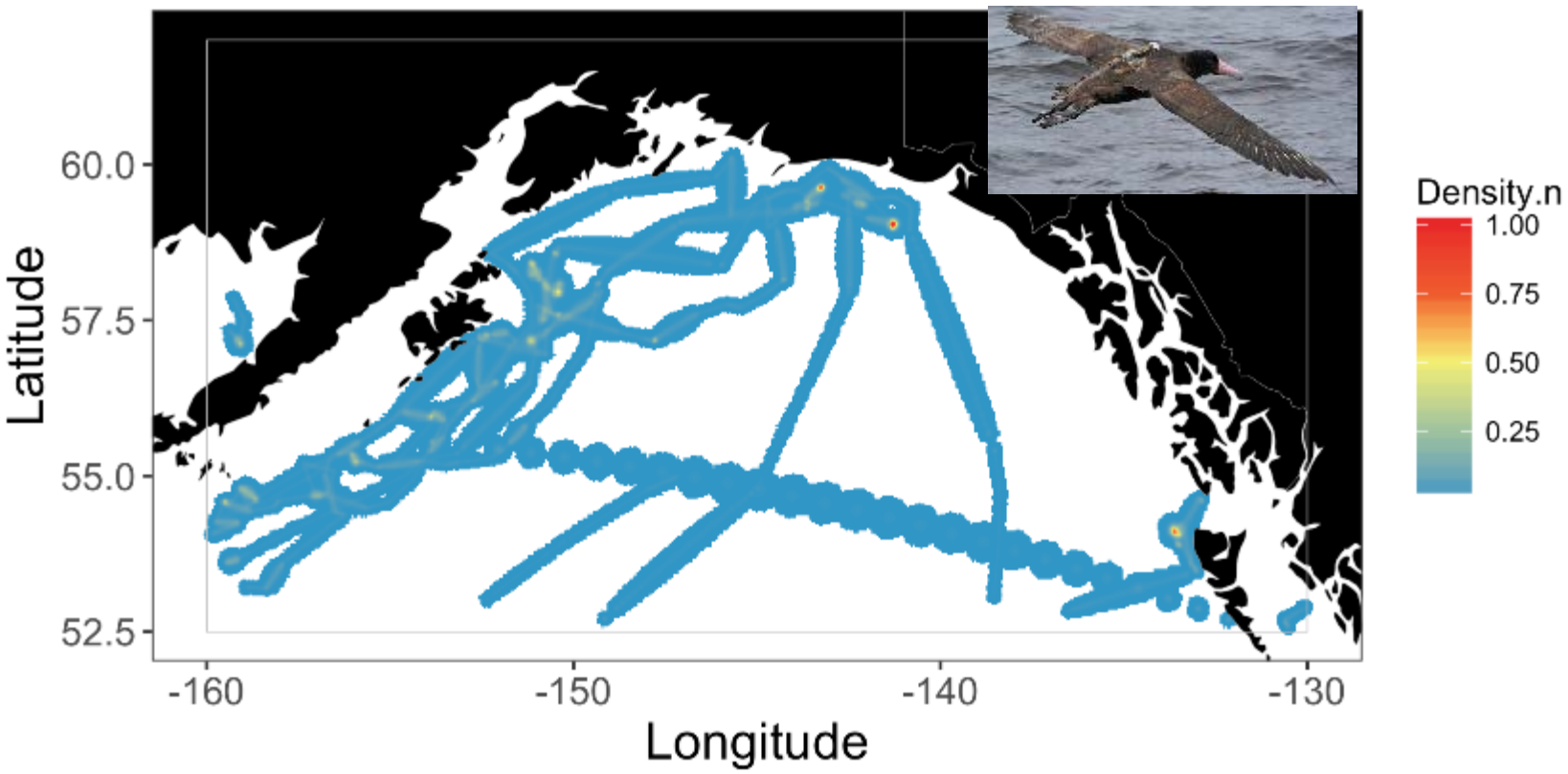

179°E 180° 179°W 178°W 177°W 176°W 175°W 174°W 173°W 172°W 171°W 170°W 169°W 168°W 167°W 166°W 165°W 164°W 163°W
57°N
56°N
55°N
54°N
53°N
52°N
51°N
50°N
49°N
Flood
Ebb
39 Days!!
180° 179°W 178°W 177°W 176°W 175°W 174°W 173°W 172°W 171°W 170°W 169°W 168°W 167°W 166°W

1 Individual Short-tailed Albatross tracked for 5 years



Brownian Bridge distribution of Short-tailed Albatrosses – Gulf of Alaska

2009



Brownian Bridge distribution of Short-tailed Albatrosses – Gulf of Alaska

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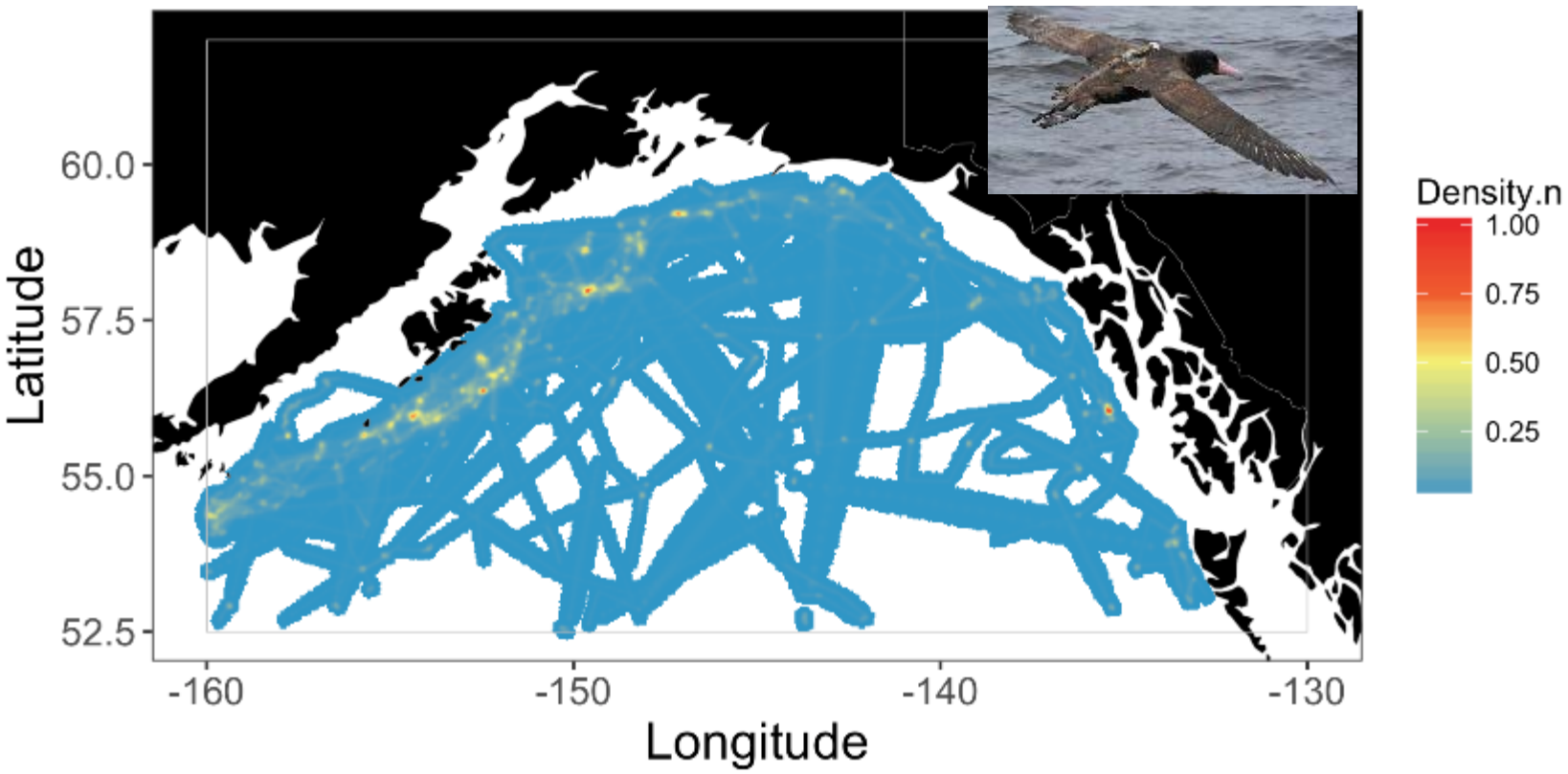
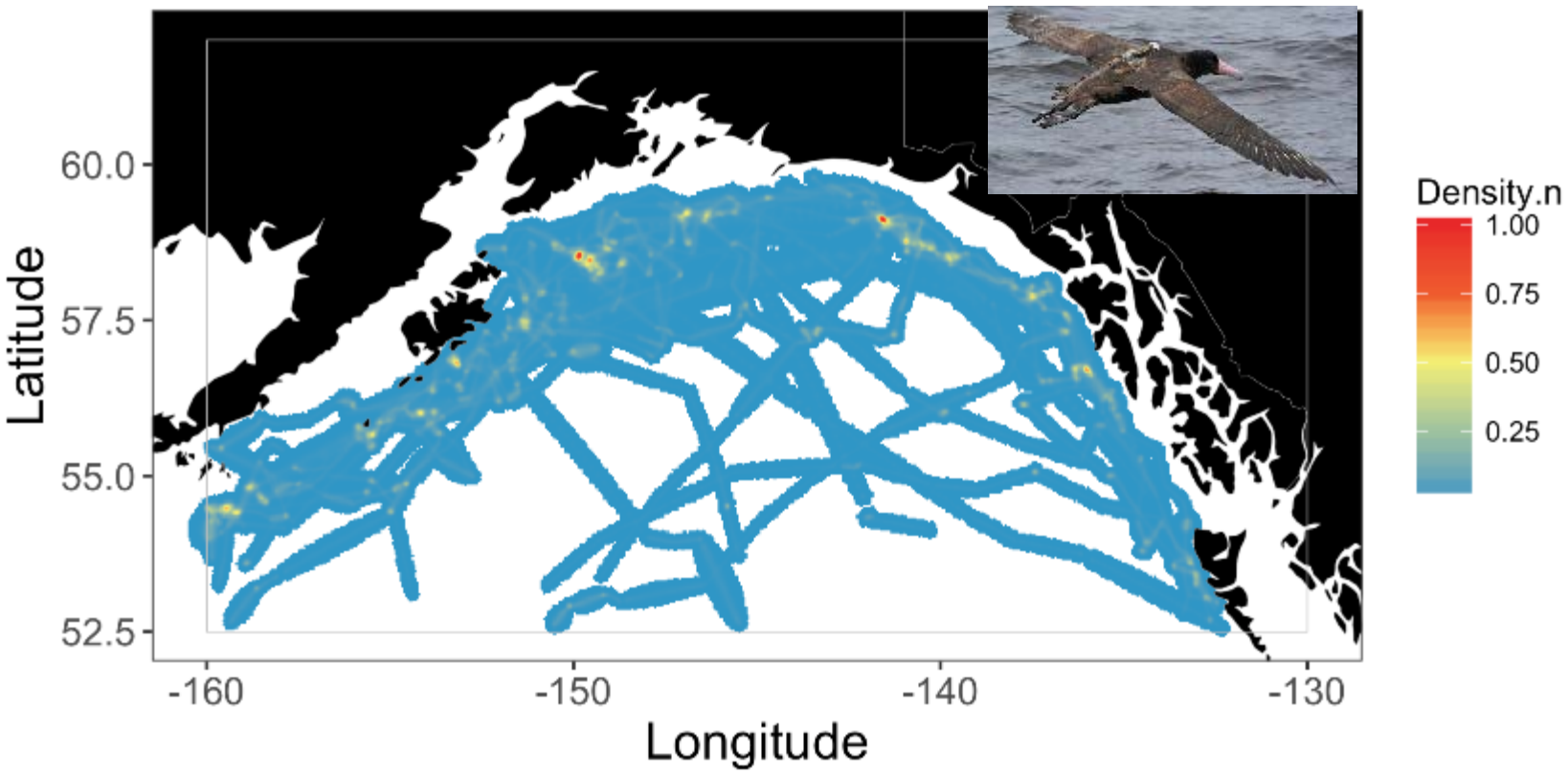


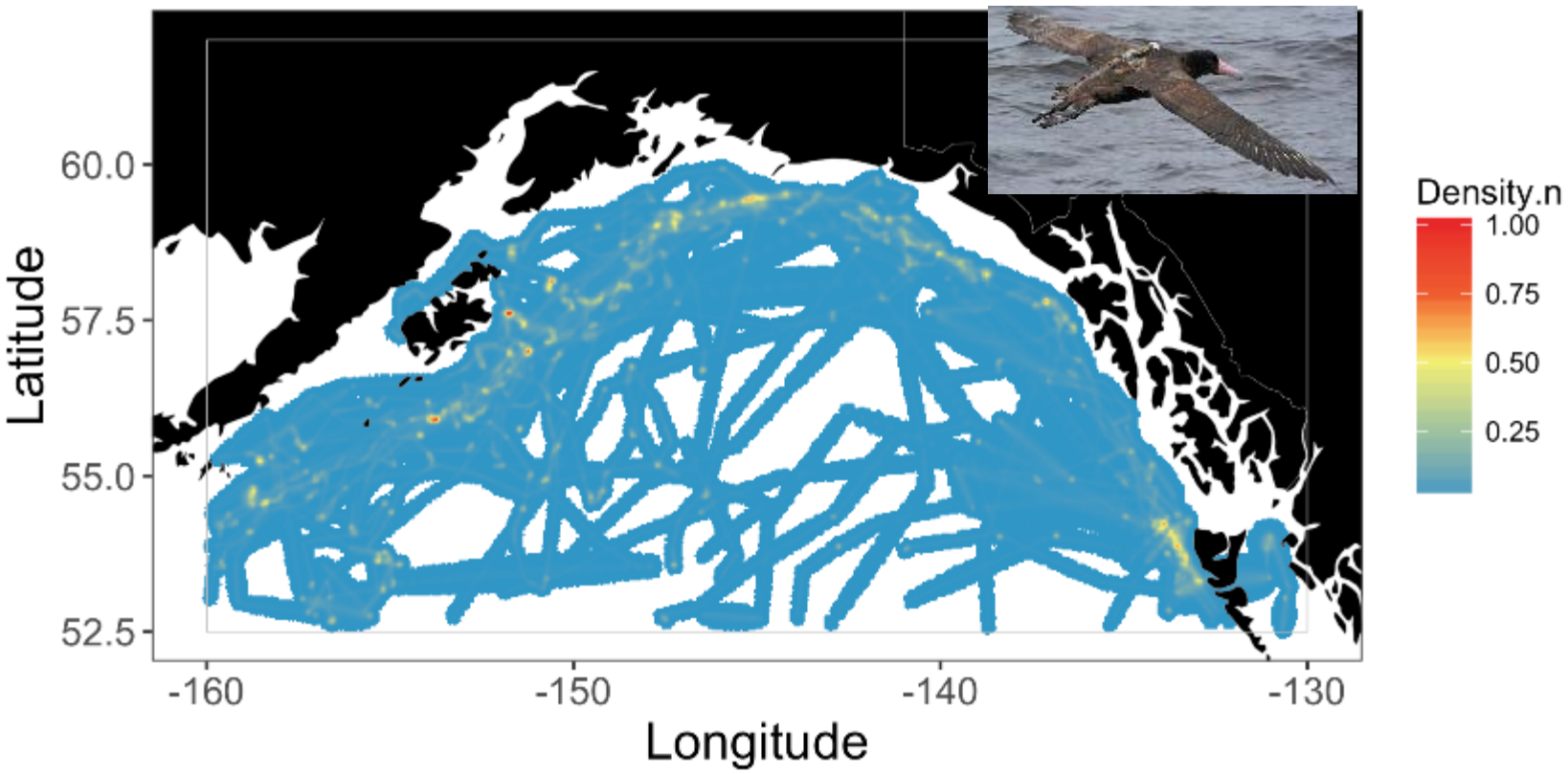
Brownian Bridge distribution of Short-tailed Albatrosses – Gulf of Alaska

2011



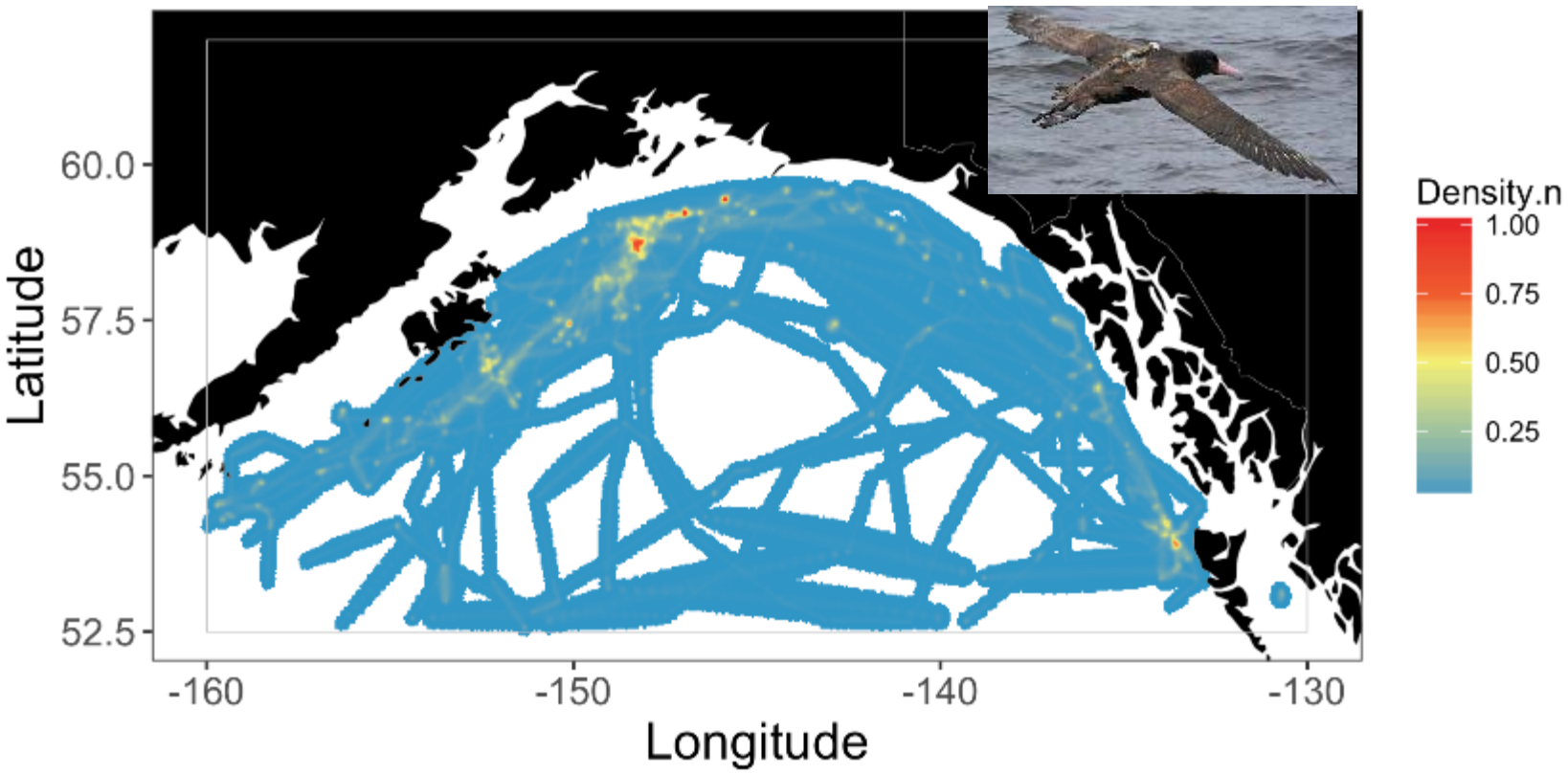
Brownian Bridge distribution of
Short-tailed Albatrosses – Gulf of Alaska

2012



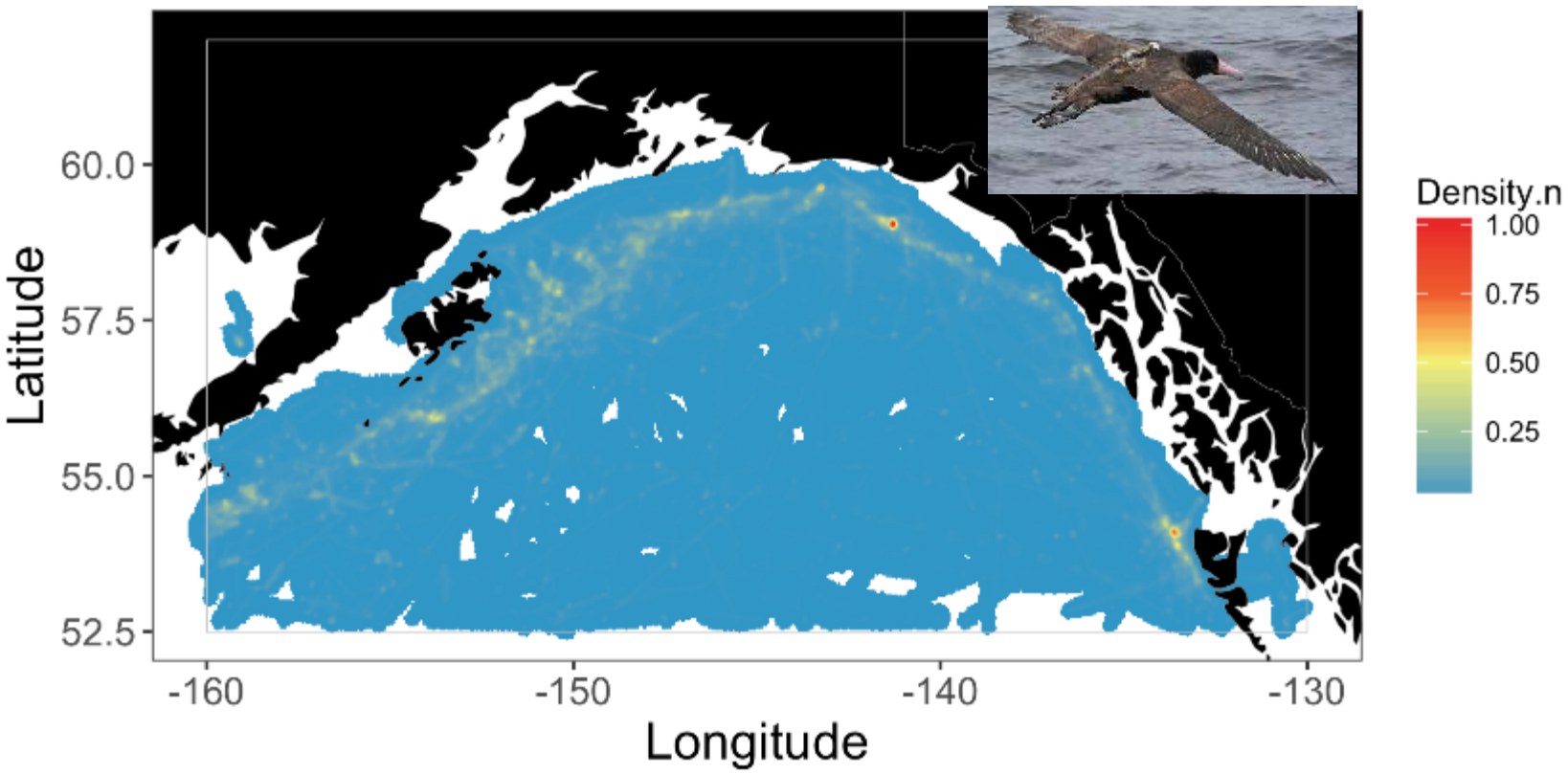
Brownian Bridge distribution of Short-tailed Albatrosses – Gulf of Alaska

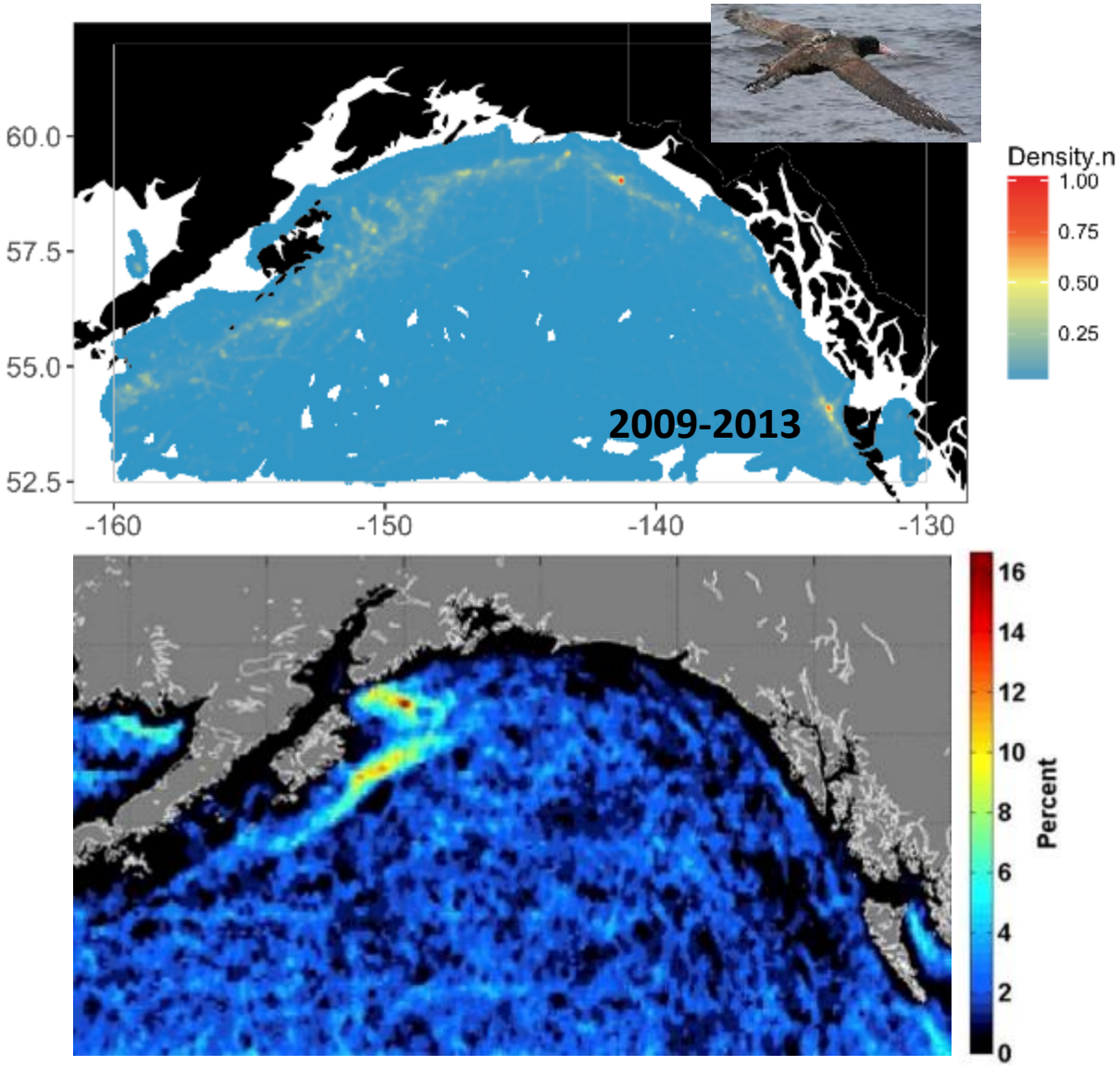
2013



Brownian Bridge distribution of
Short-tailed Albatrosses – Gulf of Alaska

2009-2013

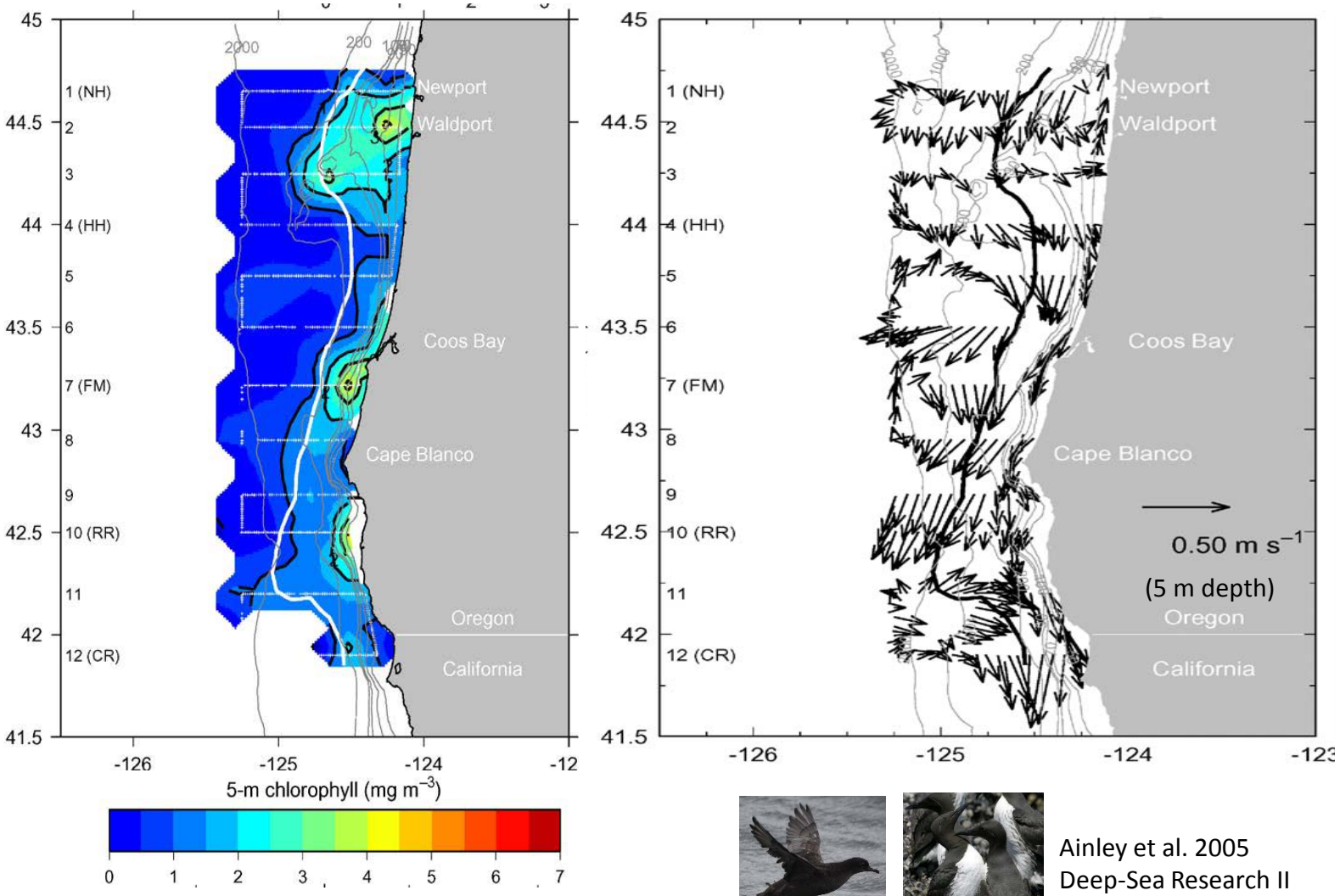




SST front frequency in the Gulf of Alaska, August, 1985–1996.
(Belkin and Cornillon 2003 Phys. Ocn.)

Vessel-based Observations

Heceta Bank – Marine Important Bird Area



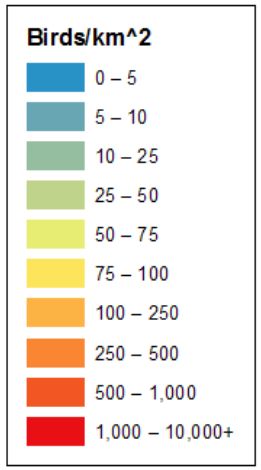
Ainley et al. 2005
Deep-Sea Research II

Barth et al. 2005 Deep-Sea Research II

Seabird Abundance and Distribution at Prominent Meso-scale Features Offshore of Oregon

Columbia River Plume

Heceta Bank



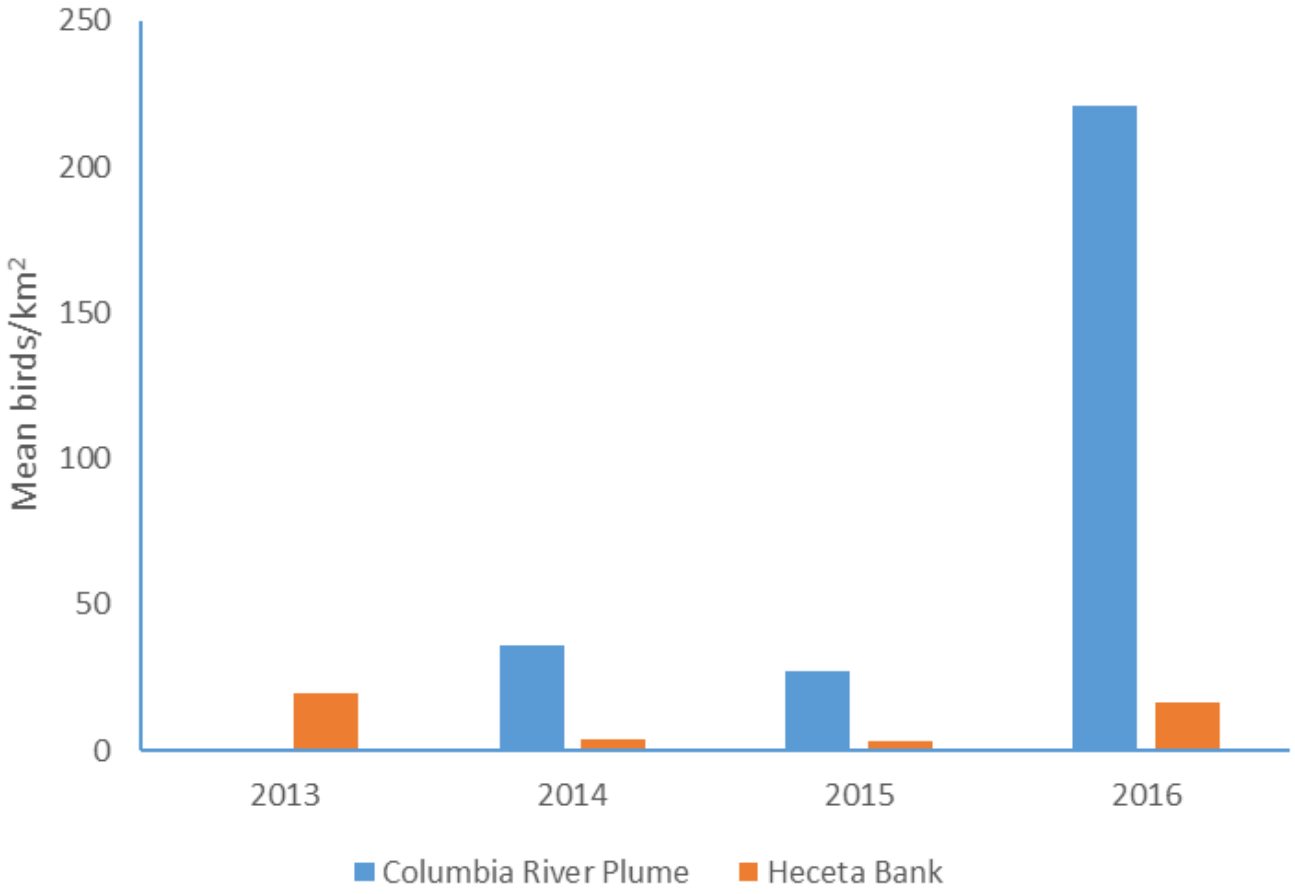
2013 2014 2015 2016

Oregon State University OSU Hatfield Marine Science Center

Columbia River Plume Front

Zamon et al. 2014 Deep-Sea Research II

Inter-annual Variability in Abundance at Prominent Features



Conclusions

- Predators extensively use both persistent and ephemeral meso- and sub-meso scale features throughout the Pacific
- Species we studied primarily targeted features in neritic zones along continental shelf margins, but….
- Considerable annual variability in use of prominent features. Topographically and tidally influenced = least variable

Looking Forward

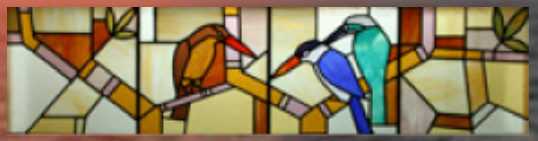
- Focal studies of specific features to quantify time-varying patterns of use by predators during formation through deterioration

- Energy transfer with/without features

- Approaches include:
    1) Use of extensive animal tracking datasets
    2) *In situ* and remotely sensed observations
    3) ROMS models

Process Studies

Acknowledgements


Yamashina Institute for Ornithology

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