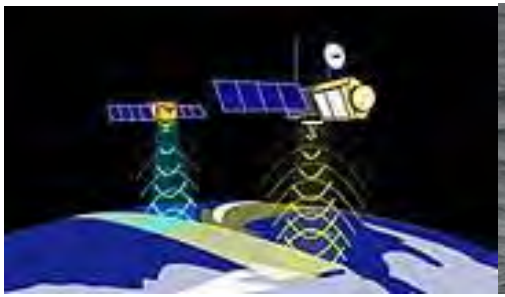
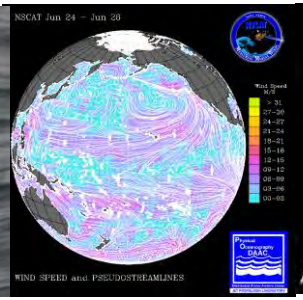
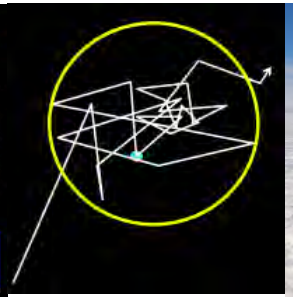
Making the Most of Satellite-Derived Oceanographic Data and Habitat Use Models to Understand Species Distributions

Rob Suryan





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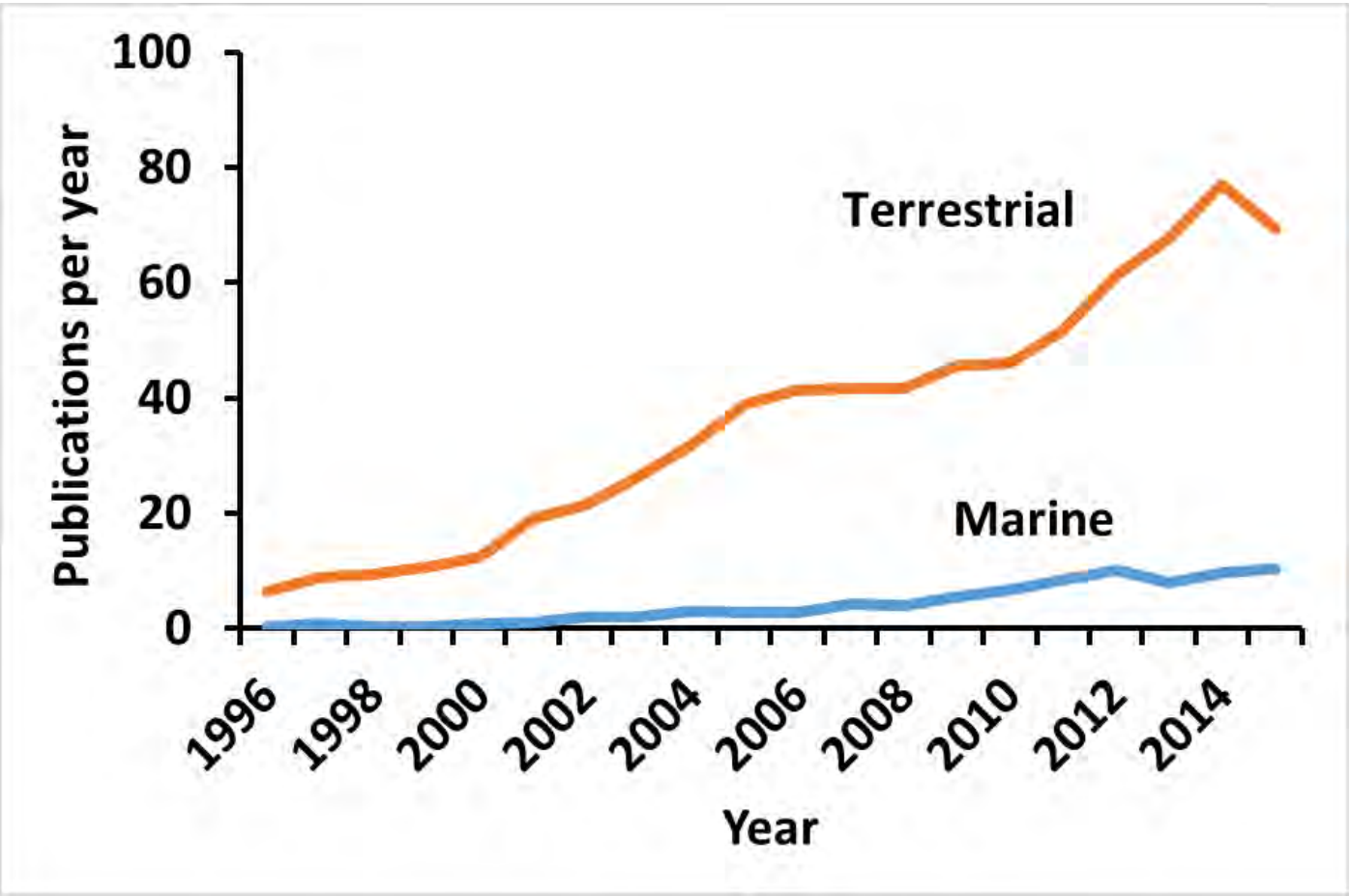
Increasing Publication Rate

Satellite Remote Sensing & Habitat Assessment



Database = Web of Science, terms = satellite & remote sensing & habitat

Words in Abstracts From 120 Bird and Mammal Satellite Habitat Use Papers 2006-2016

Determining Behavioral States

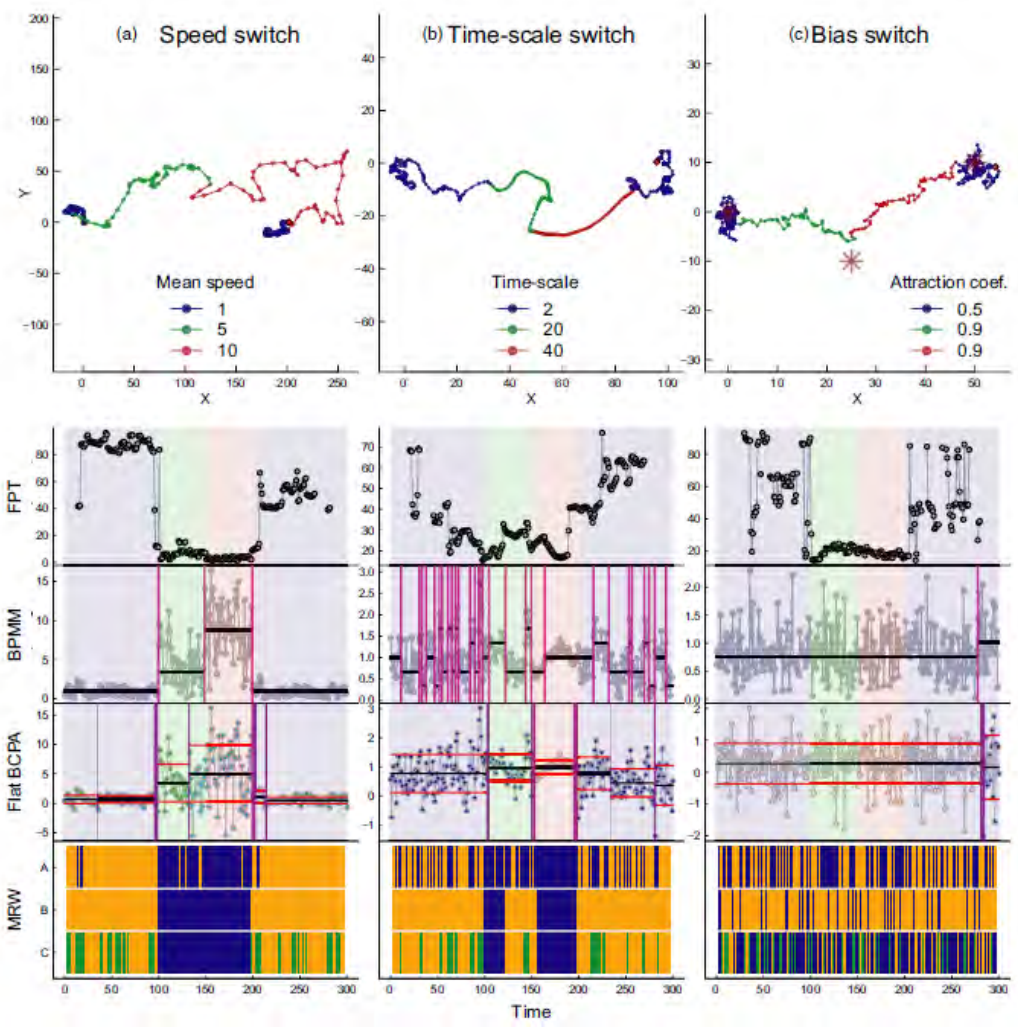
Journal of Animal Ecology

Journal of Animal Ecology 2016, **85**, 69–84 doi: 10.1111/1365-2656.12379

SPECIAL FEATURE: STUCK IN MOTION? RECONNECTING QUESTIONS AND TOOLS IN MOVEMENT ECOLOGY

What is the animal doing? Tools for exploring behavioural structure in animal movements

Eliezer Gurarie[1,2*], Chloe Bracis[3], Maria Delgado[4,5], Trevor D. Meckley[6], Ilpo Kojola[7] and C. Michael Wagner[6]



First Passage Time

Bayesian Partitioning of Markov Models

Flat Behavioral Change Point Analysis

Multi-State Random Walk

Determining Behavioral States

Journal of A

Journal of Animal Ecology 2016

SPECIAL FEATURE: S
MOVEMENT ECOLOGY

What is the ar
behavioural st

Eliezer Gurarie[1,2]*, Chl
C. Michael Wagner[6]

ch

traction coef.
0.5
0.9
0.9

40 50

0 250 300

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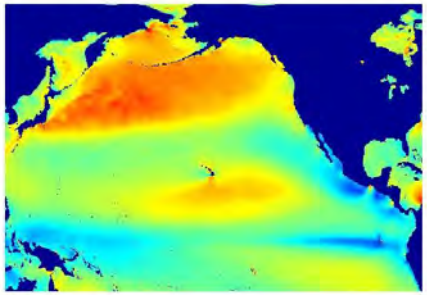
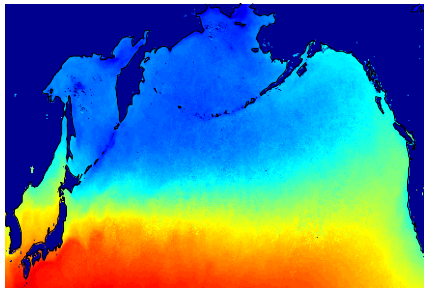
Commonly used Satellite-Derived "Habitat" Products

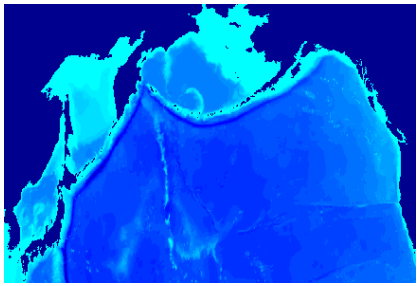
Wind Speed



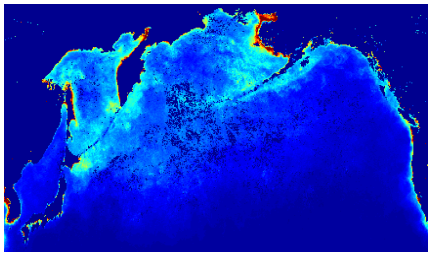
SST



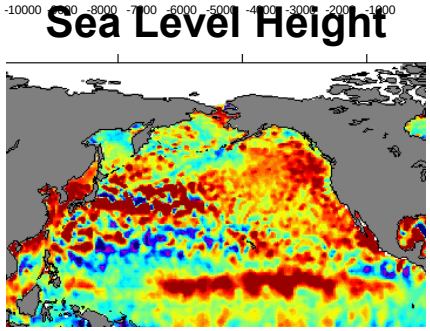
Depth



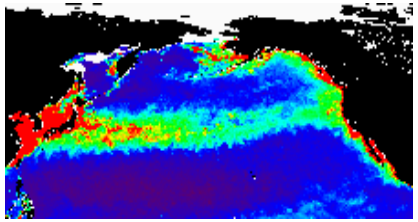
Chl *a*



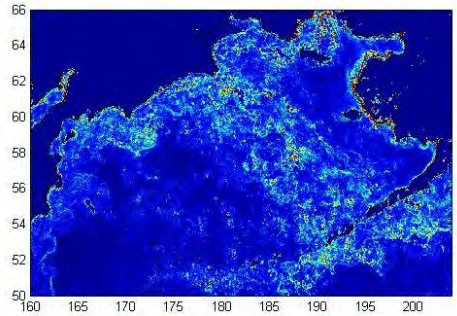
Sea Level Height



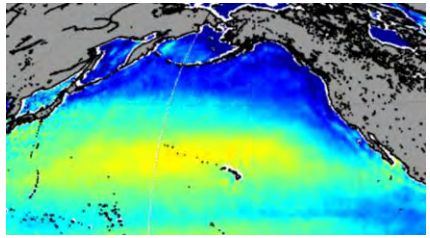
Primary Productivity



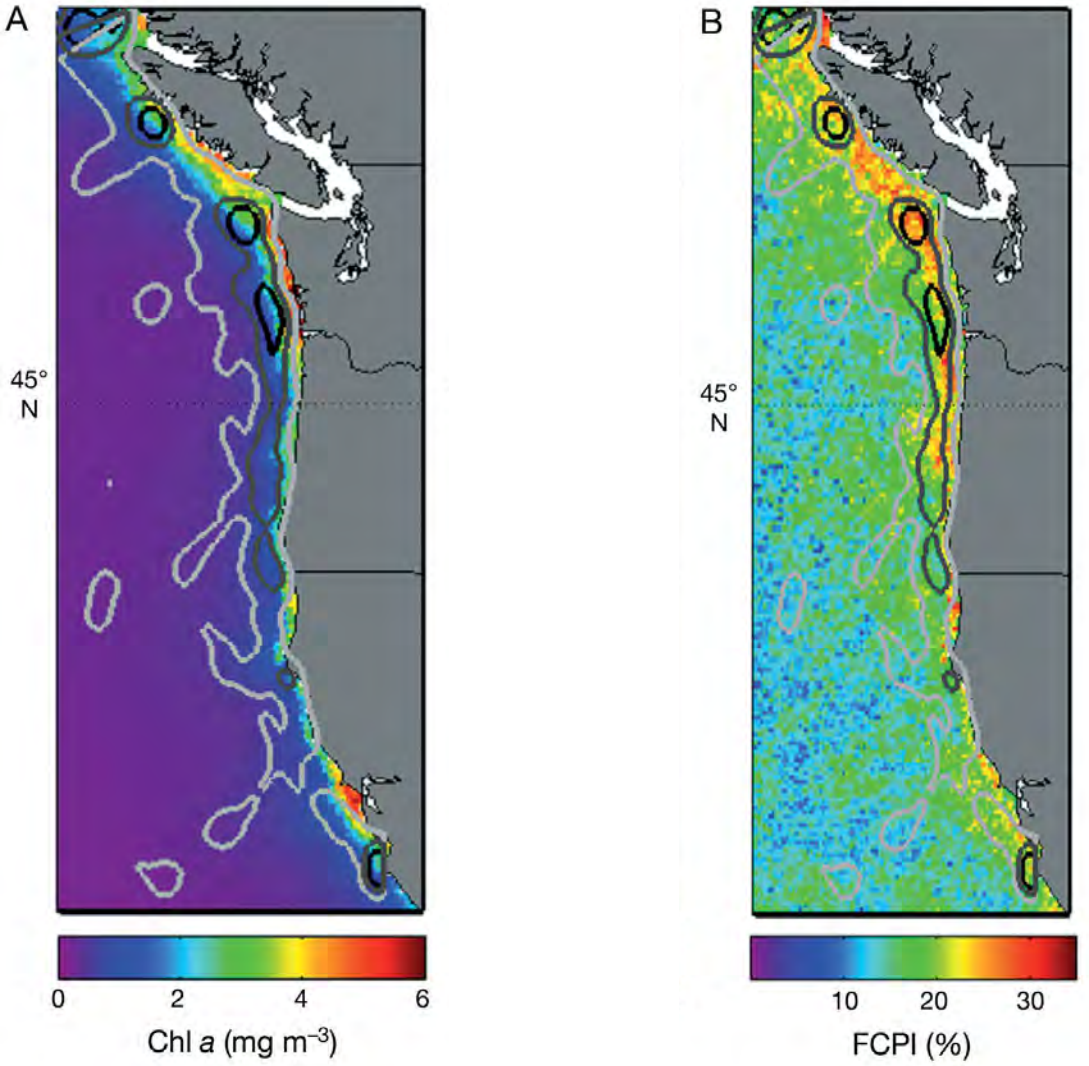
Gradients of Chl *a*, SST, Depth



Salinity

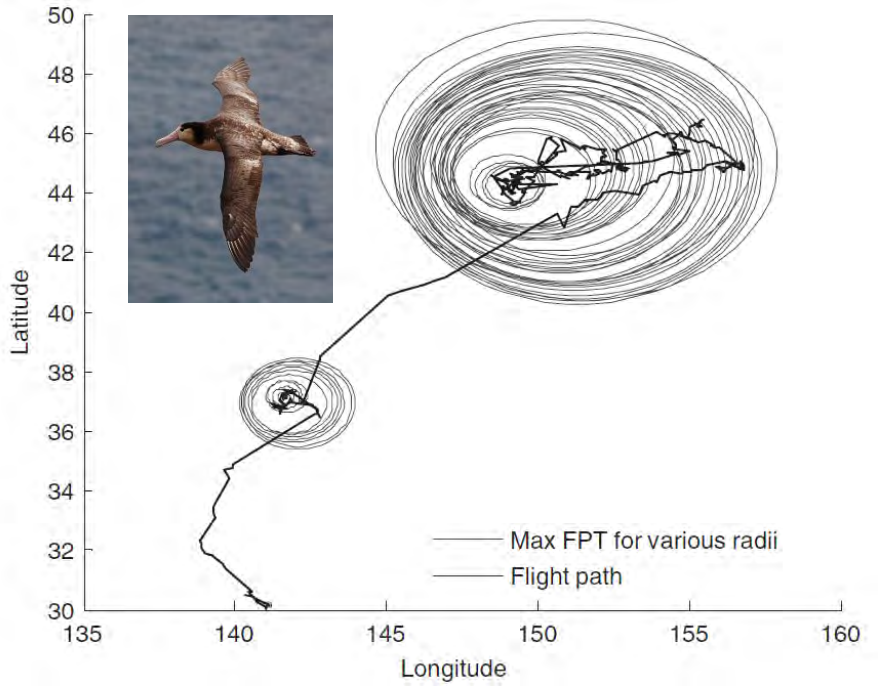


Static vs. Dynamic Features
& Albatross Core Use Areas

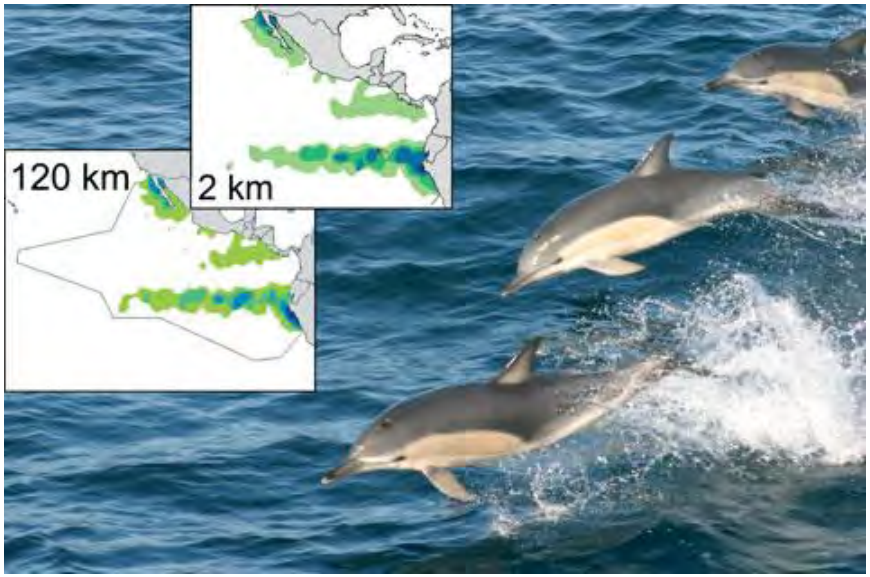


Suryan et al. 2012 Mar. Ecol. Progr. Ser.

Habitat Models: Scale and Variability

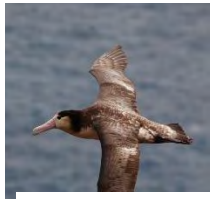


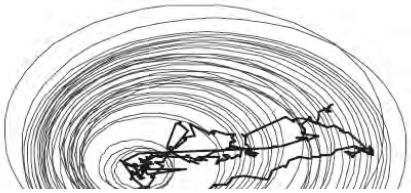
Suryan et al. 2006 Deep-Sea Res. II

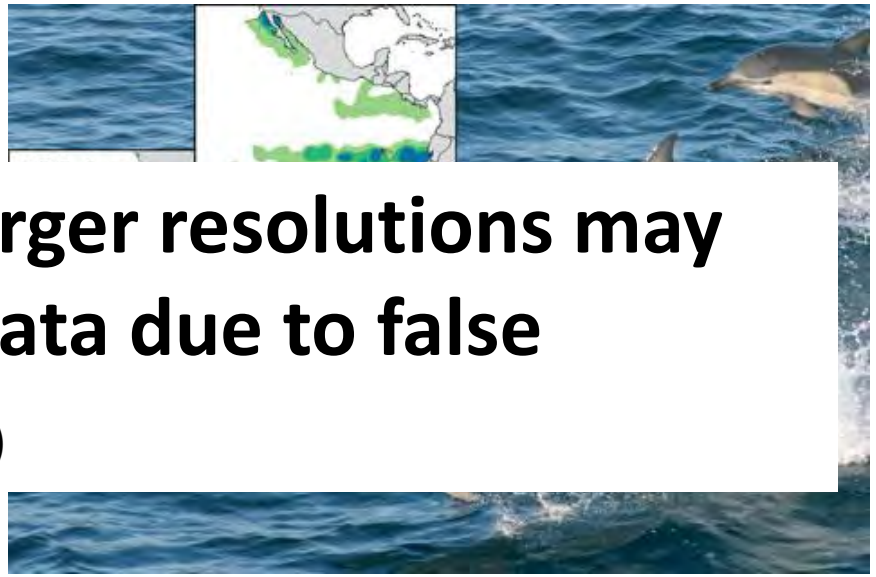


Redfern et al. 2008 Mar. Ecol. Progr. Ser.

Habitat Models: Scale and Variability





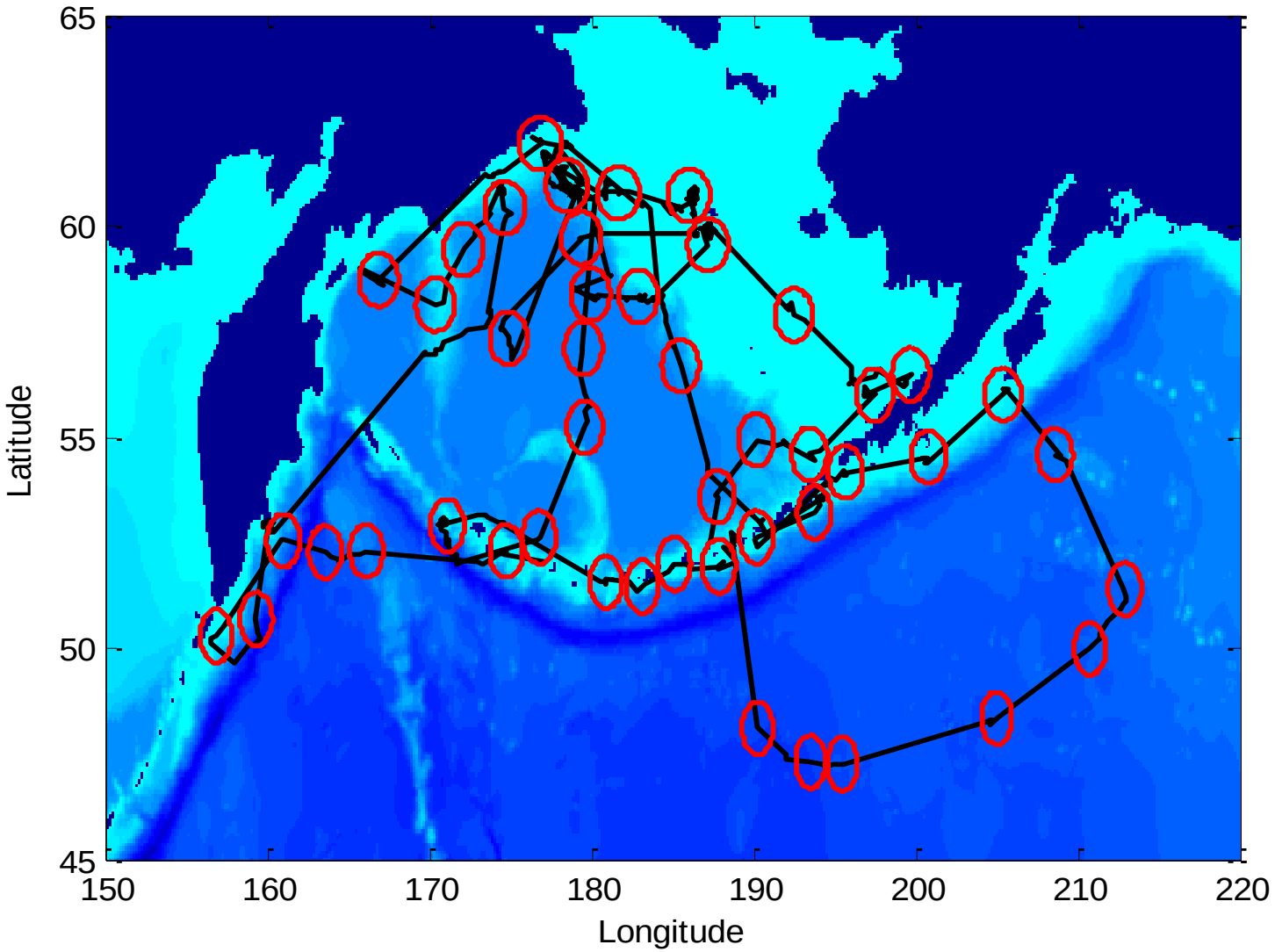


Building models at larger resolutions may reduce noise in the data due to false absences (Redfern et al. 2008)

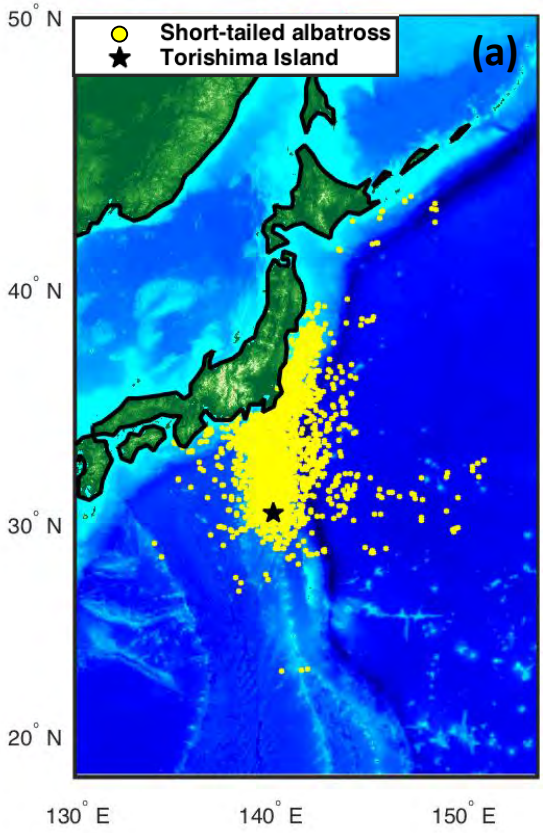
Suryan et al. 2006 Deep-Sea Res. II

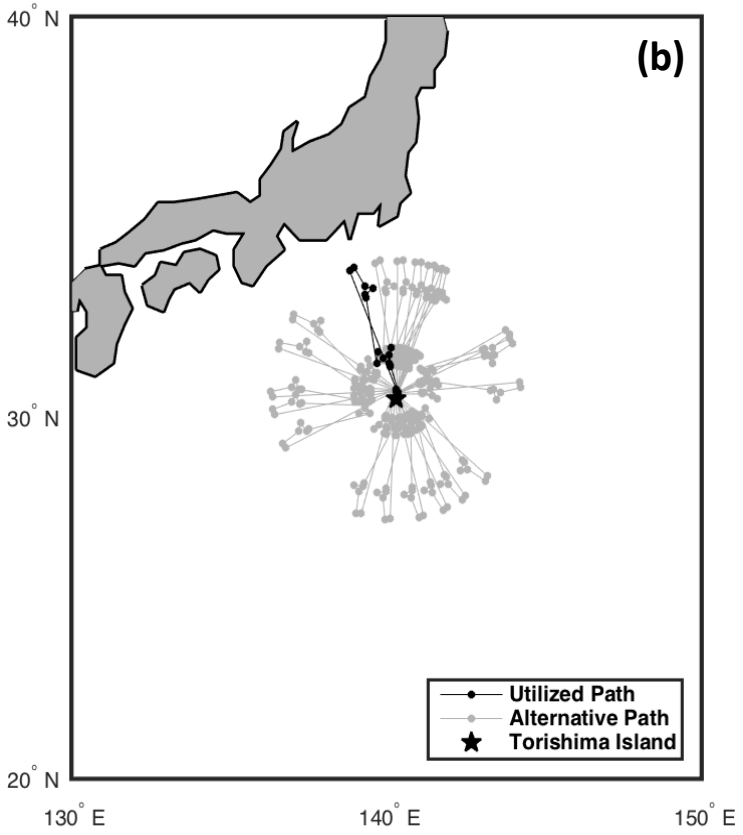
Redfern et al. 2008 Mar. Ecol. Progr. Ser.

Spatial Scale



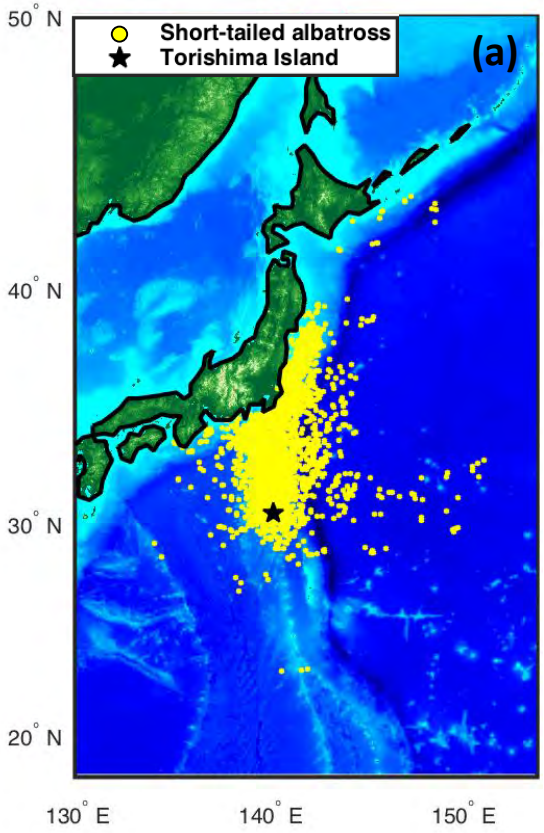
Presence Only vs. Presence & Absence





Antolos et al. in prep

Presence Only



Identifying what habitat is truly available to an animal is often equivocal

Johnson 1980, Porter and Church 1987, Millspaugh and Marzluff 2001

Focus analyses on resources used by animals & characterize animal behavior within particular habitats

(Millspaugh and Marzluff 2001

Considerations For the Path Forward

Identify key questions & experimental design

- Habitat Use – What/Where

Survey

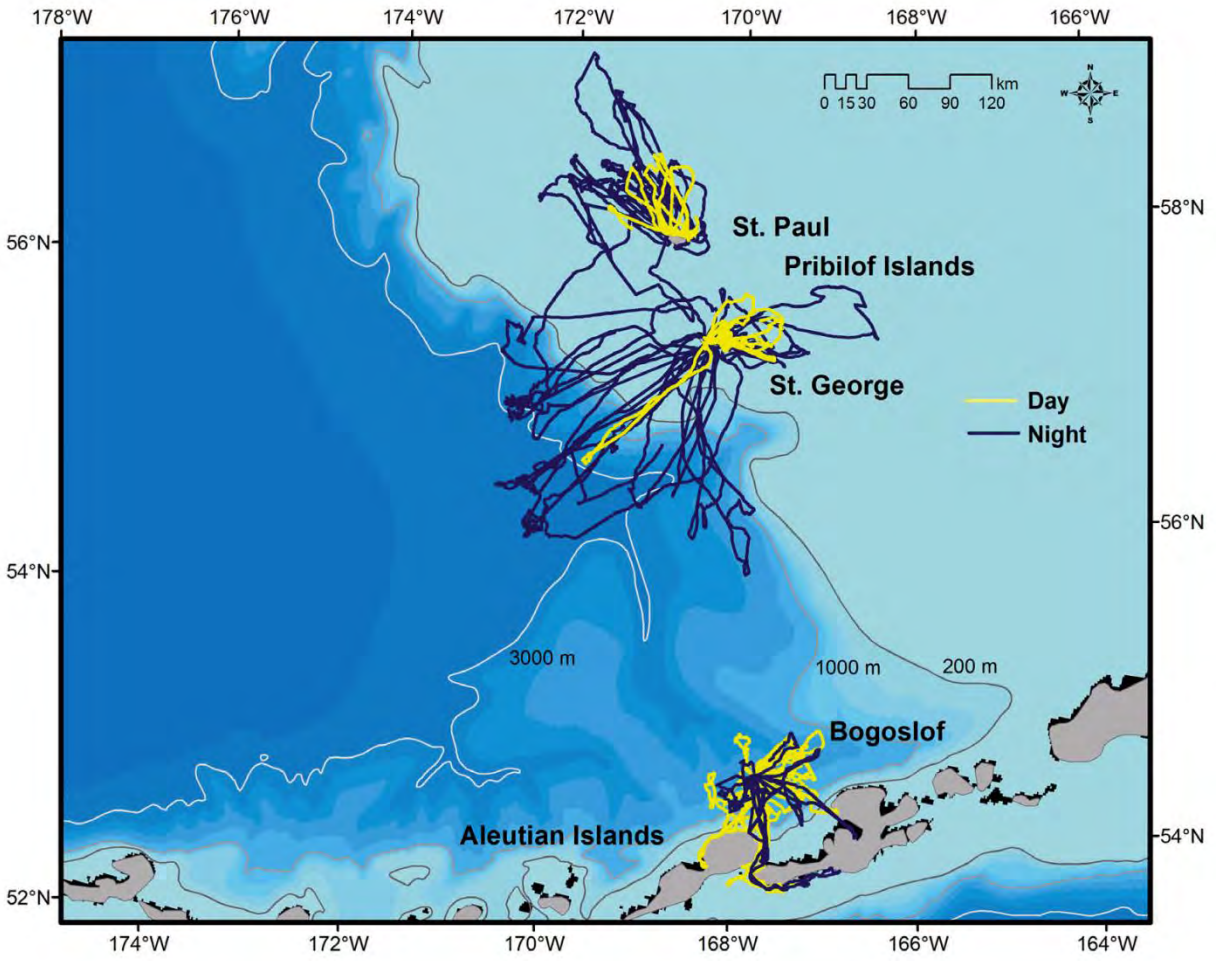
- Mechanisms of Use – How/Why

Process Study

Black-legged Kittiwake Foraging in the Bering Sea

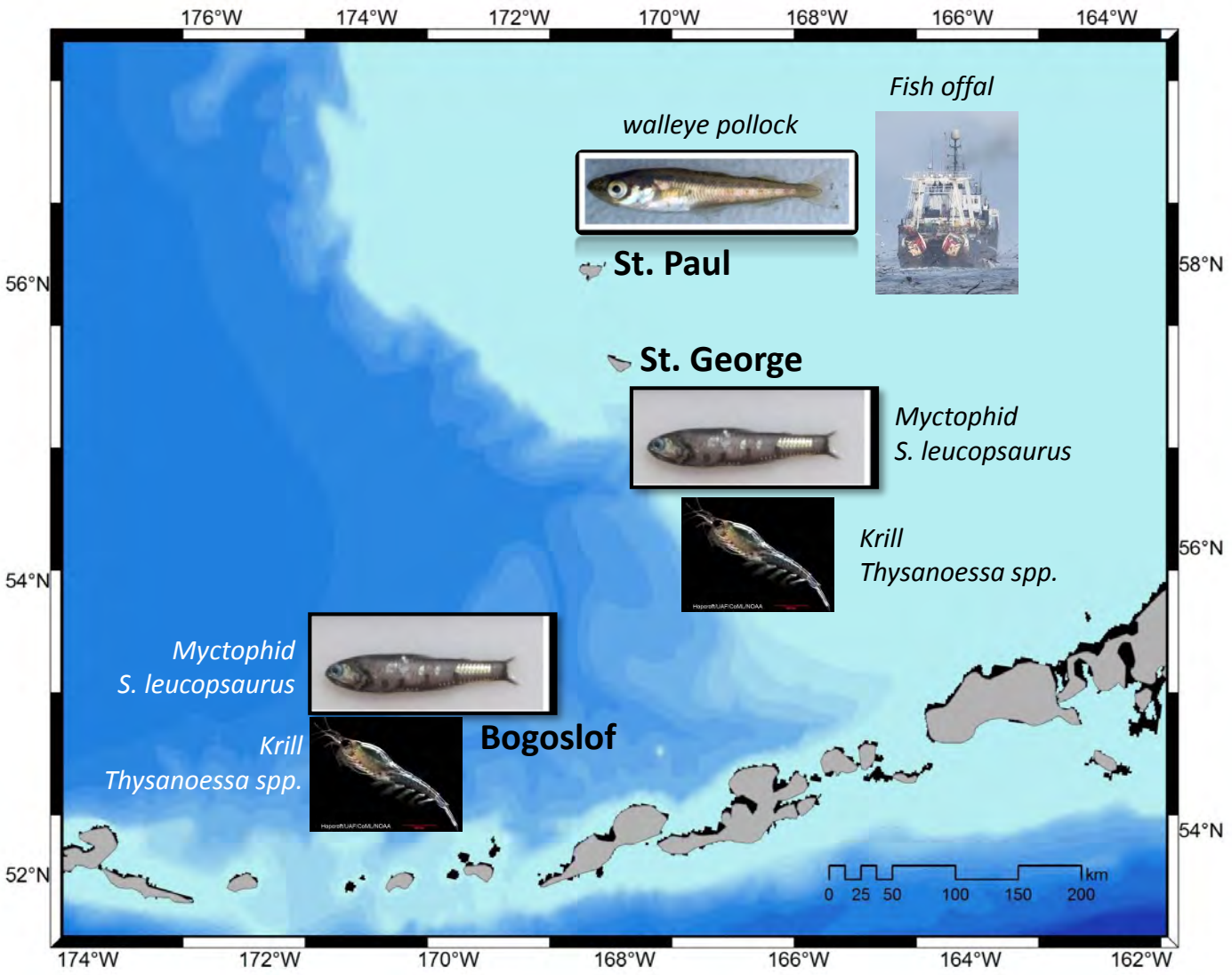
- Surface forager
- Sensitive to vertical changes in prey distribution

Kittiwake Foraging Trips



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

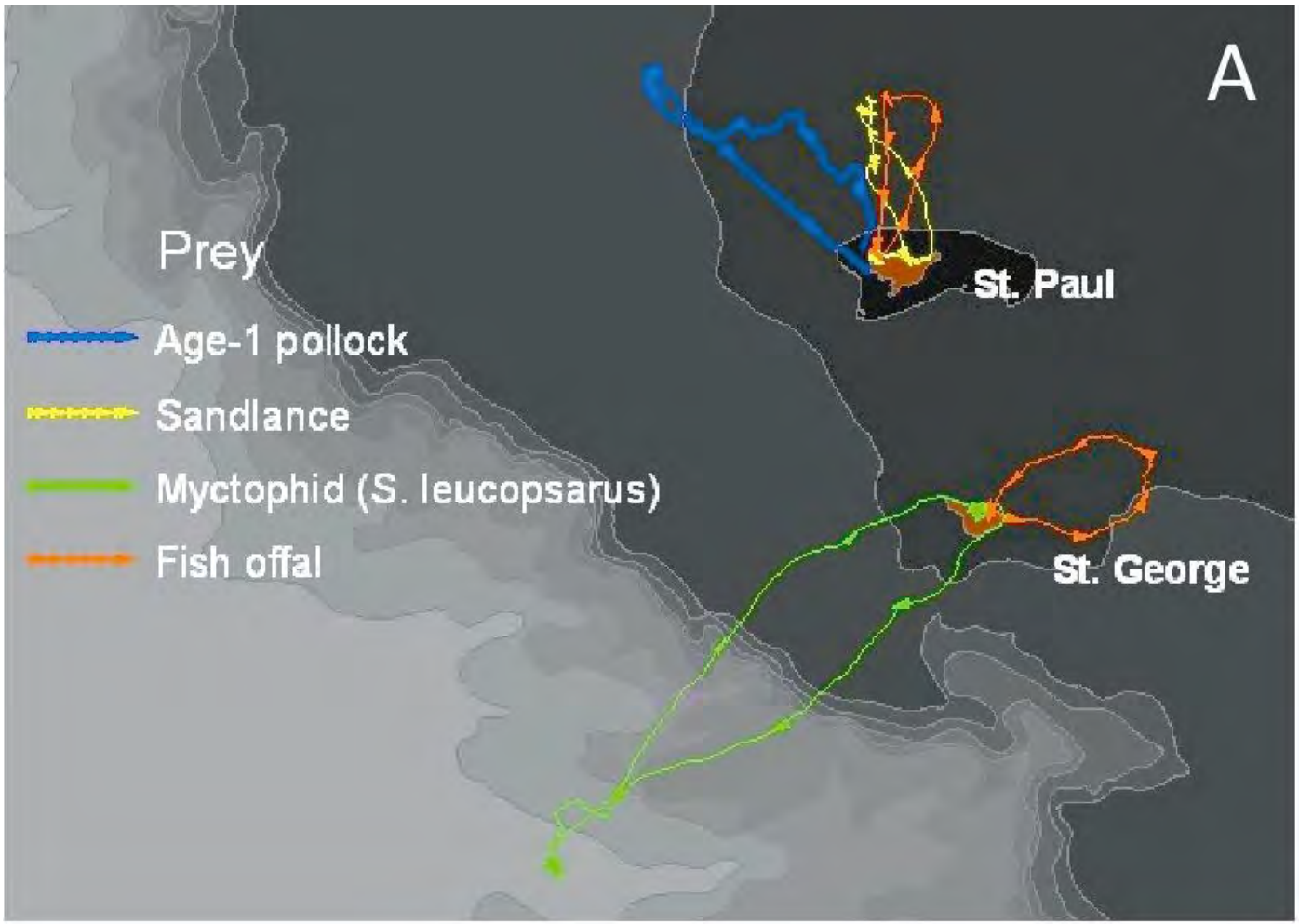
Diets



S5

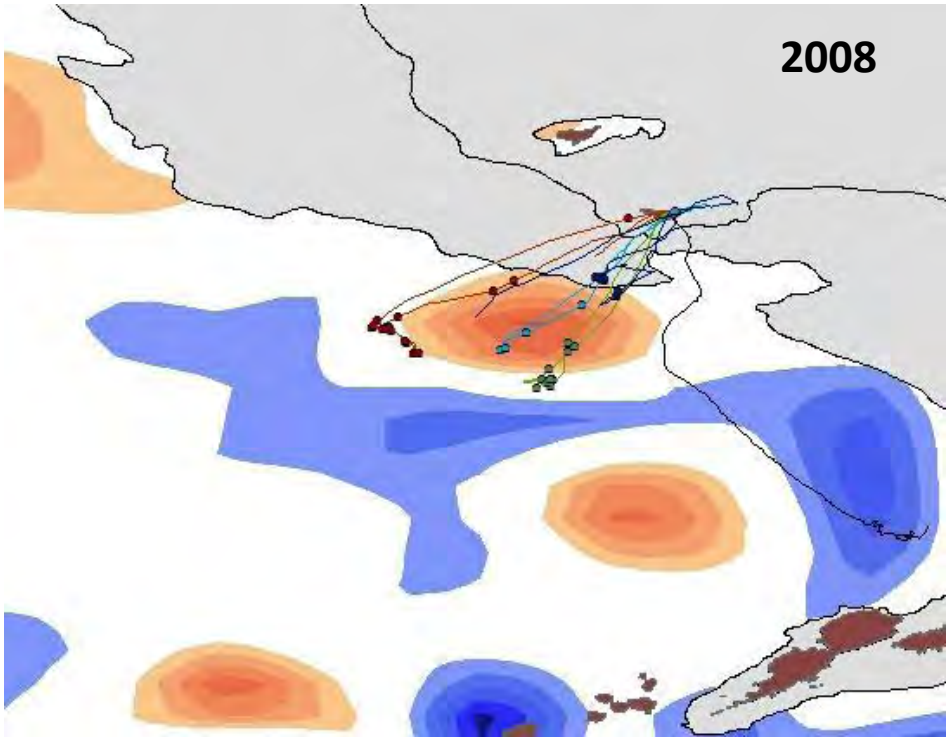
Paredes et al. 2012 Mar. Ecol. Prog. Ser.

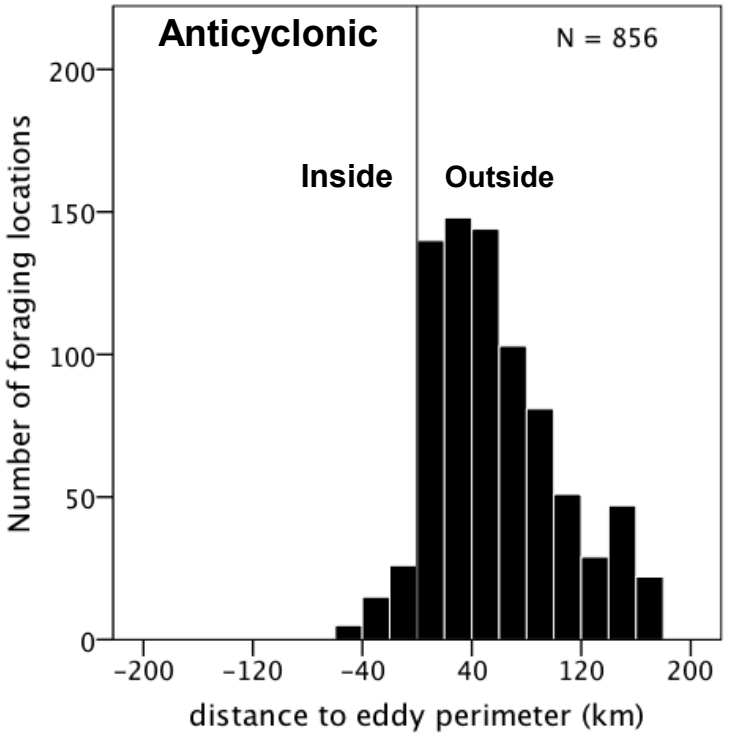
Prey-Specific Foraging Trips



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

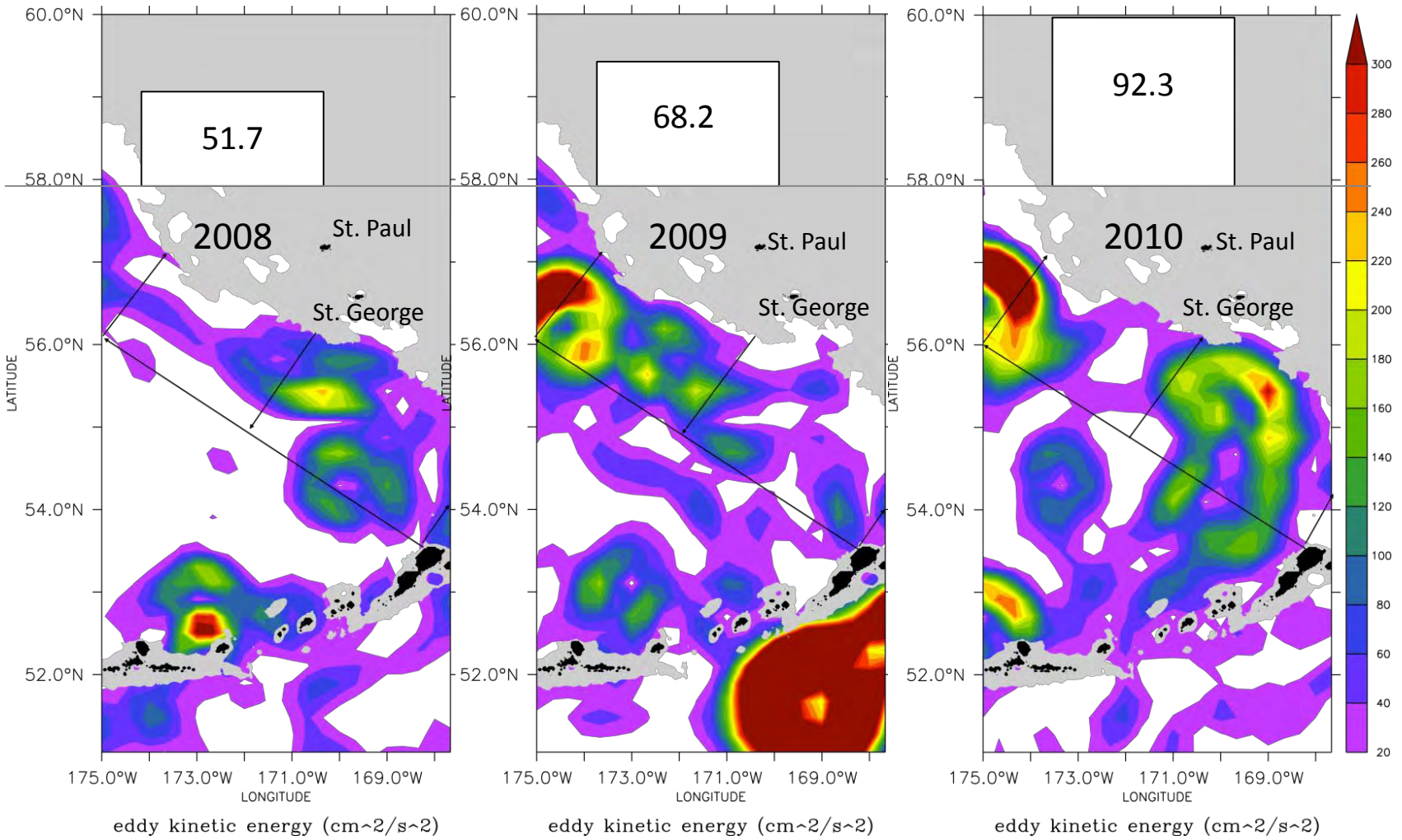
Foraging in Association With Eddies





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

Eddy Kinetic Energy Varies Among Years

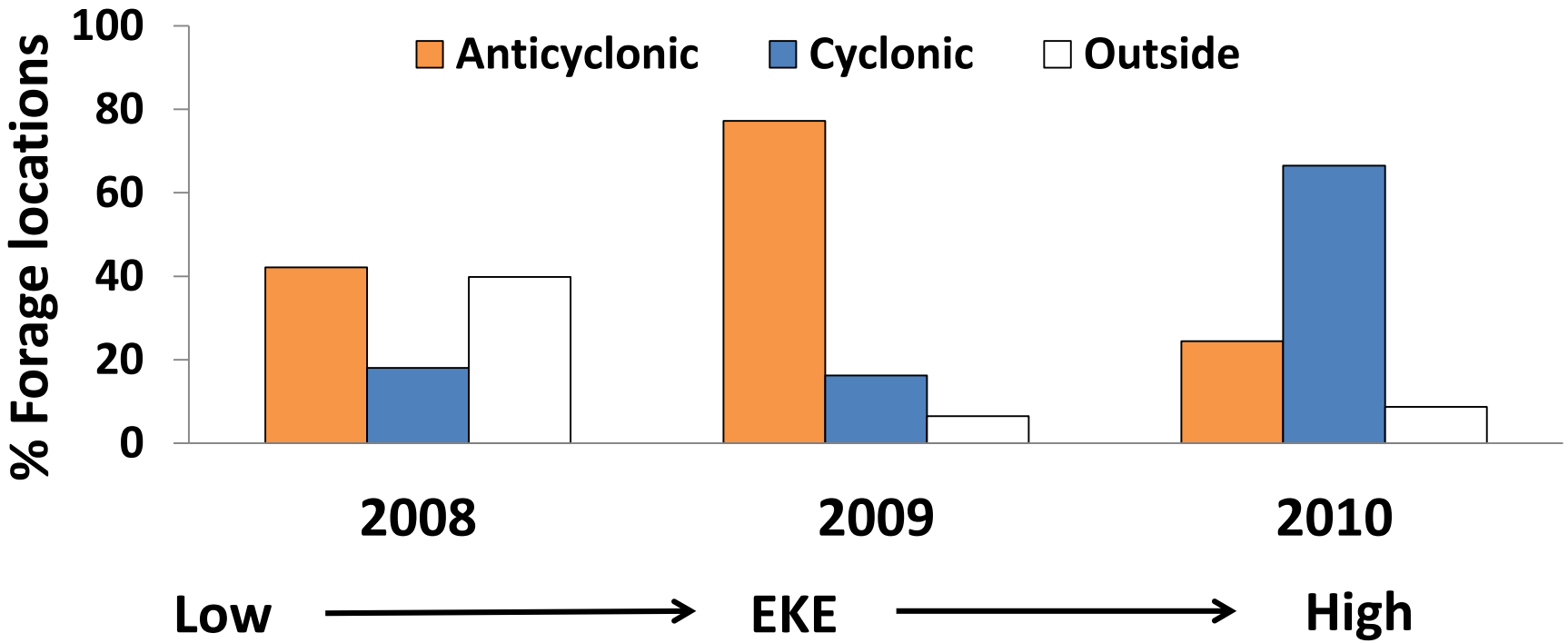


S5

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

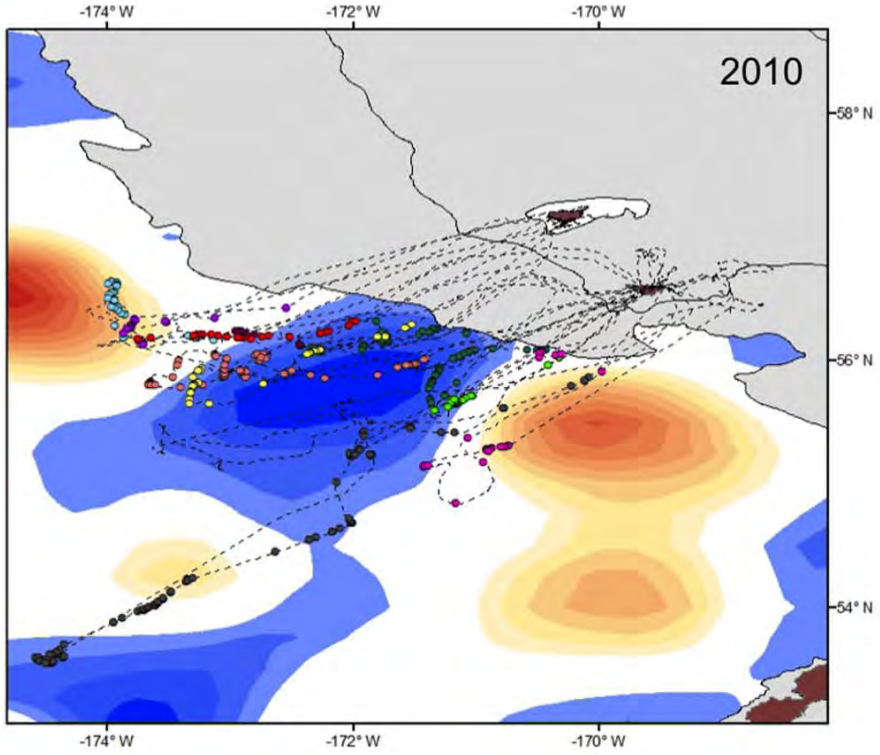
Foraging locations associated with eddies varies among years

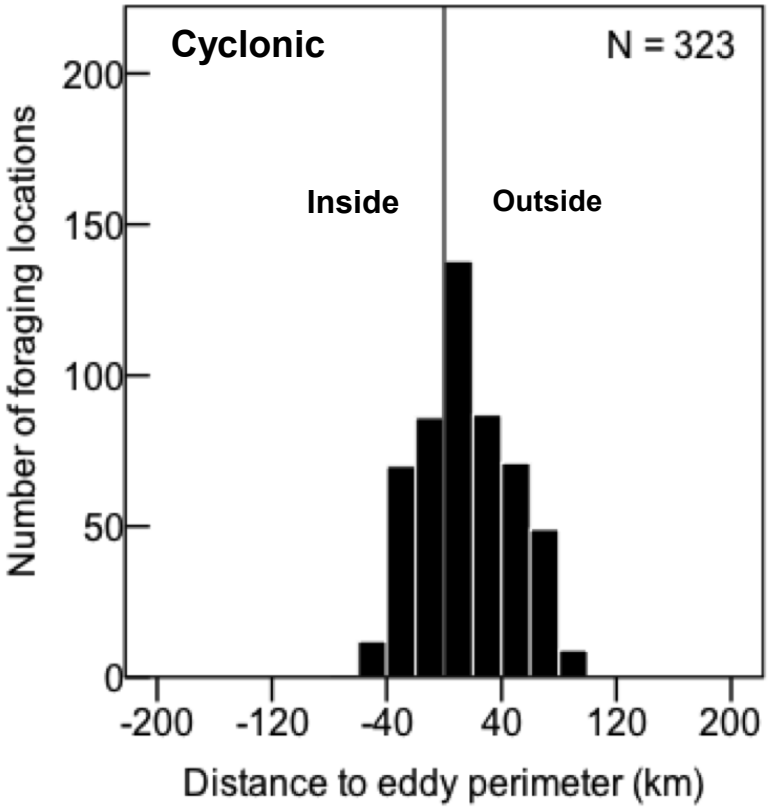
Foraging locations



Paredes et al. 2014 PLoS ONE

Foraging in Association With Eddies

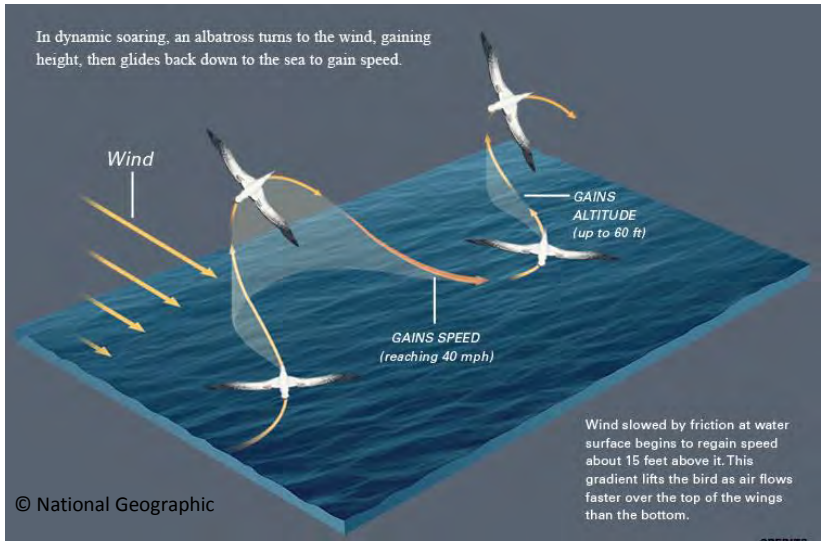




Paredes et al. 2014 PLoS ONE

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

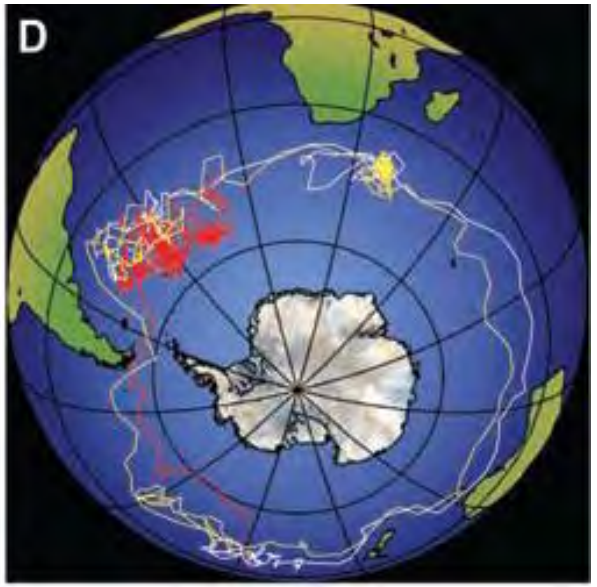
Dynamic Soaring



Flight speed > 100 km hr^{-1}

Global Circumnavigations: Tracking Year-Round Ranges of Nonbreeding Albatrosses

John P. Croxall,* Janet R. D. Silk, Richard A. Phillips, Vsevolod Afanasyev, Dirk R. Briggs



Croxall et al. 2005 Science

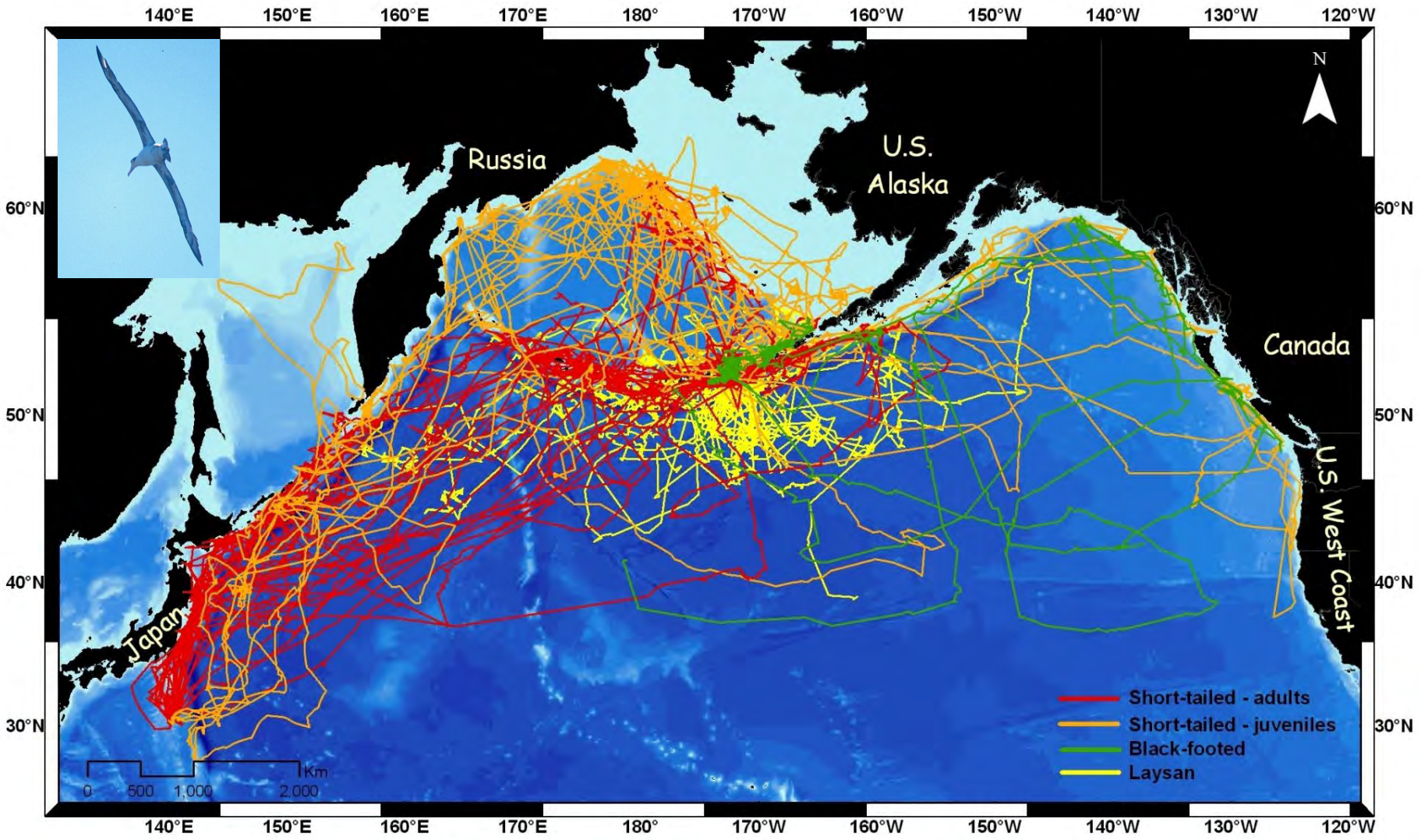
Albatrosses = High Speed, Long Distance, Ocean Wanderers

Albatross

?

Passive Drifter

Tracks of North Pacific Albatrosses



72 birds tracked: 47 Short-tailed, 7 Black-footed, 18 Laysan

2002 - 2008

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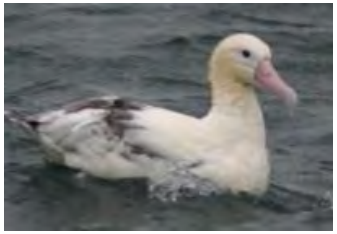

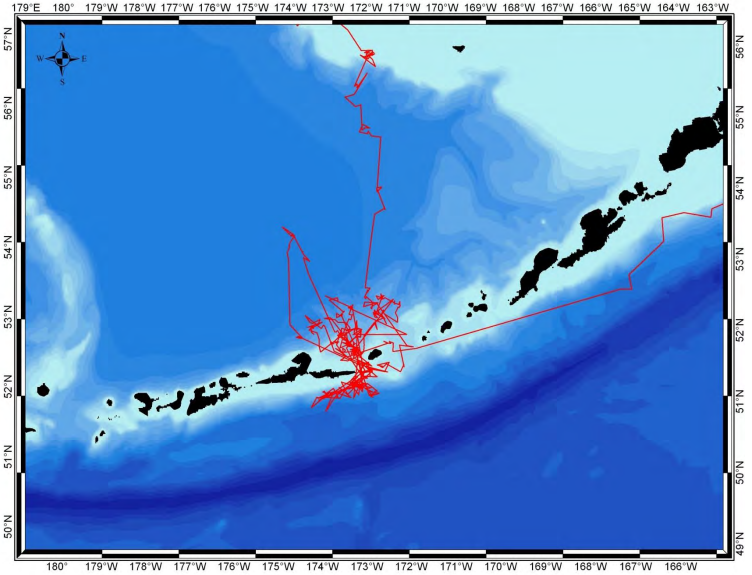

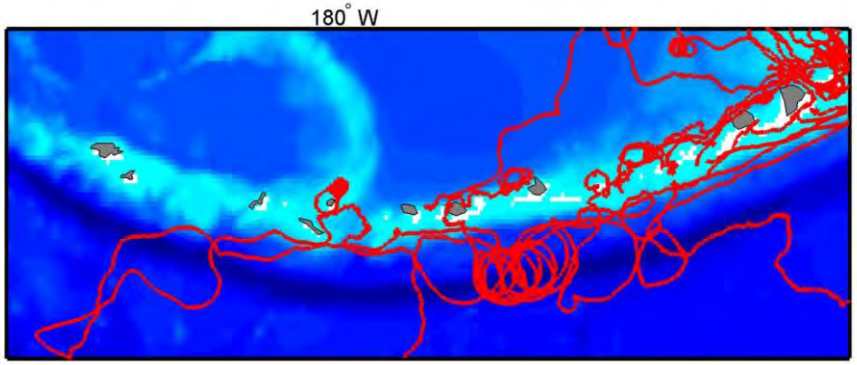

National Oceanic and Atmospheric Administration

Pacific Marine Environmental Laboratory

A leader in developing ocean observational systems to address NOAA's mission

P. Stabeno, C. Ladd, et al.

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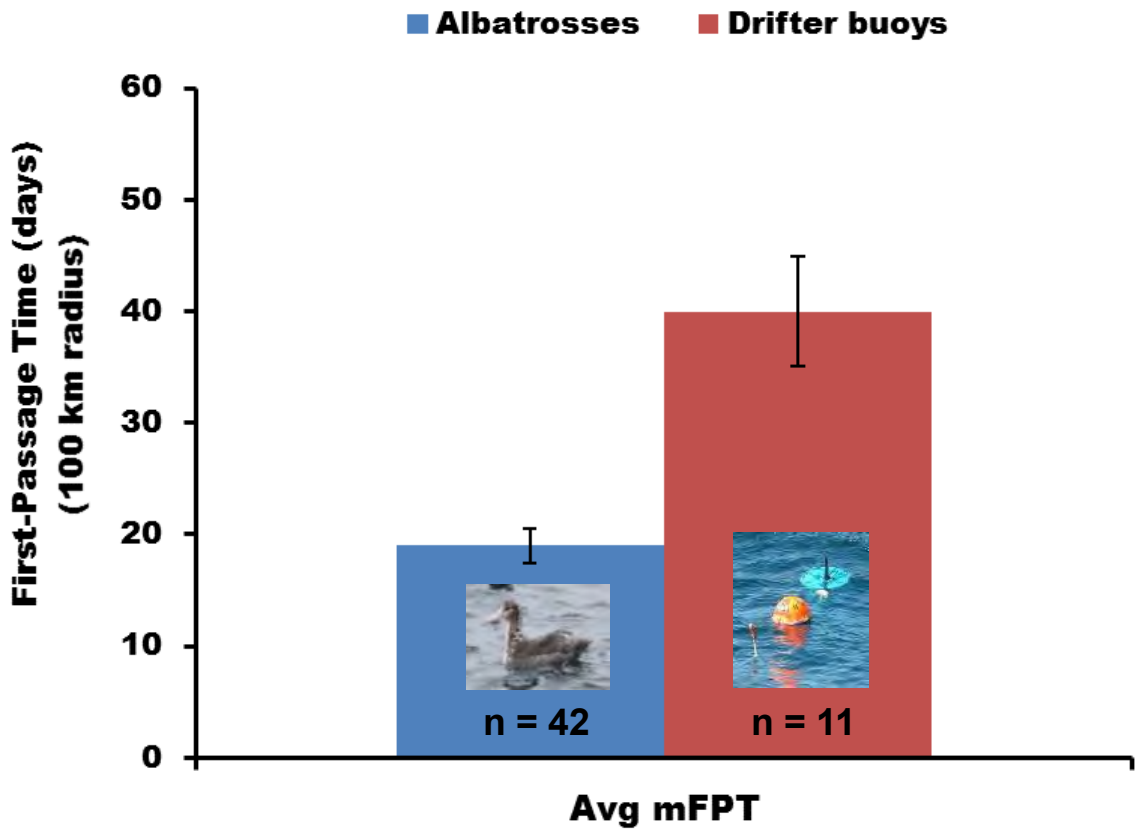
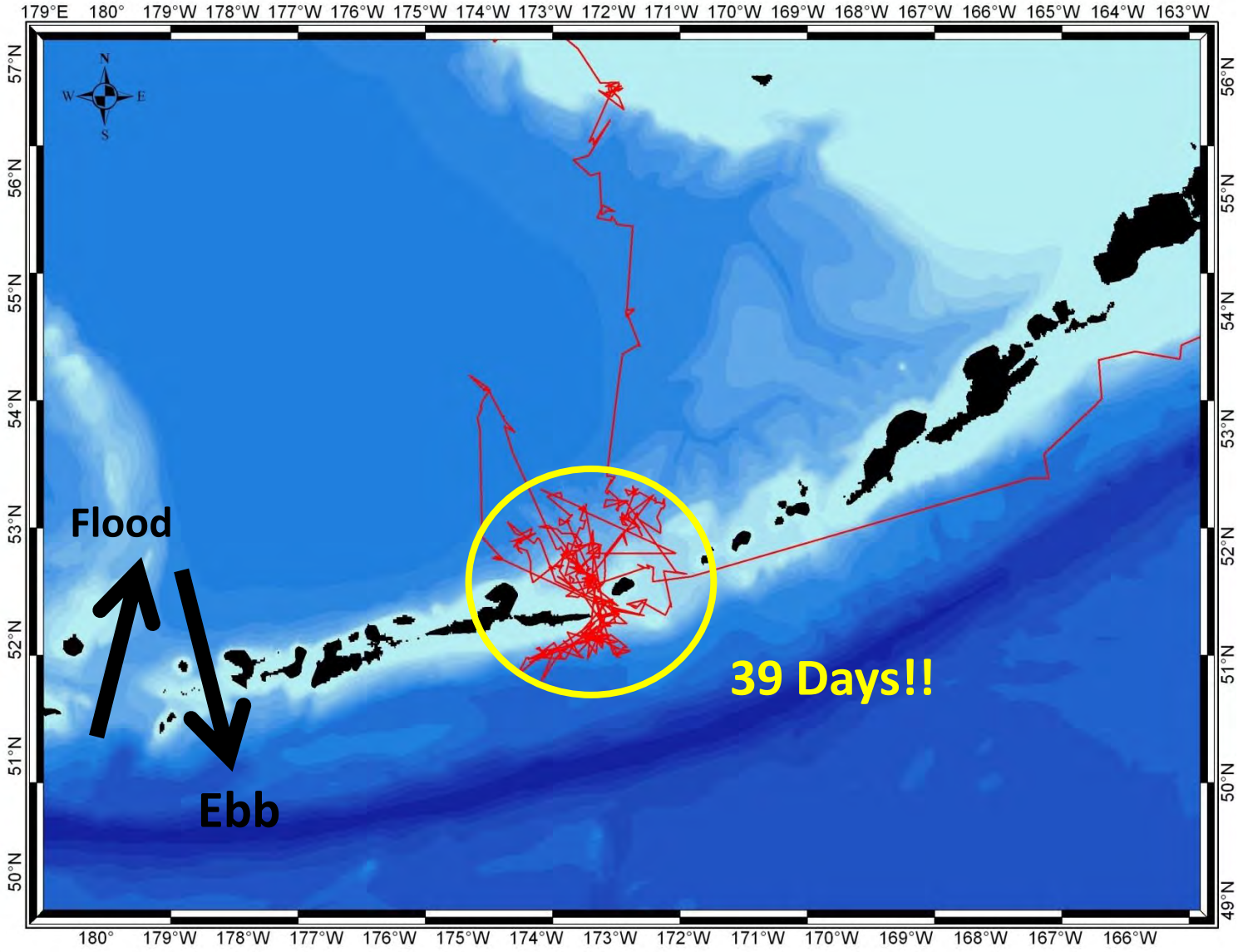
Albatrosses vs. Drifters – Aleutian Islands



Drifter residence time in Aleutian Islands is only 2X as long as albatrosses even though drifters travel < 1/10 the speed


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
N
W
E
S
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


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
56°N 55°N 54°N 53°N 52°N 51°N 50°N 49°N
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
N
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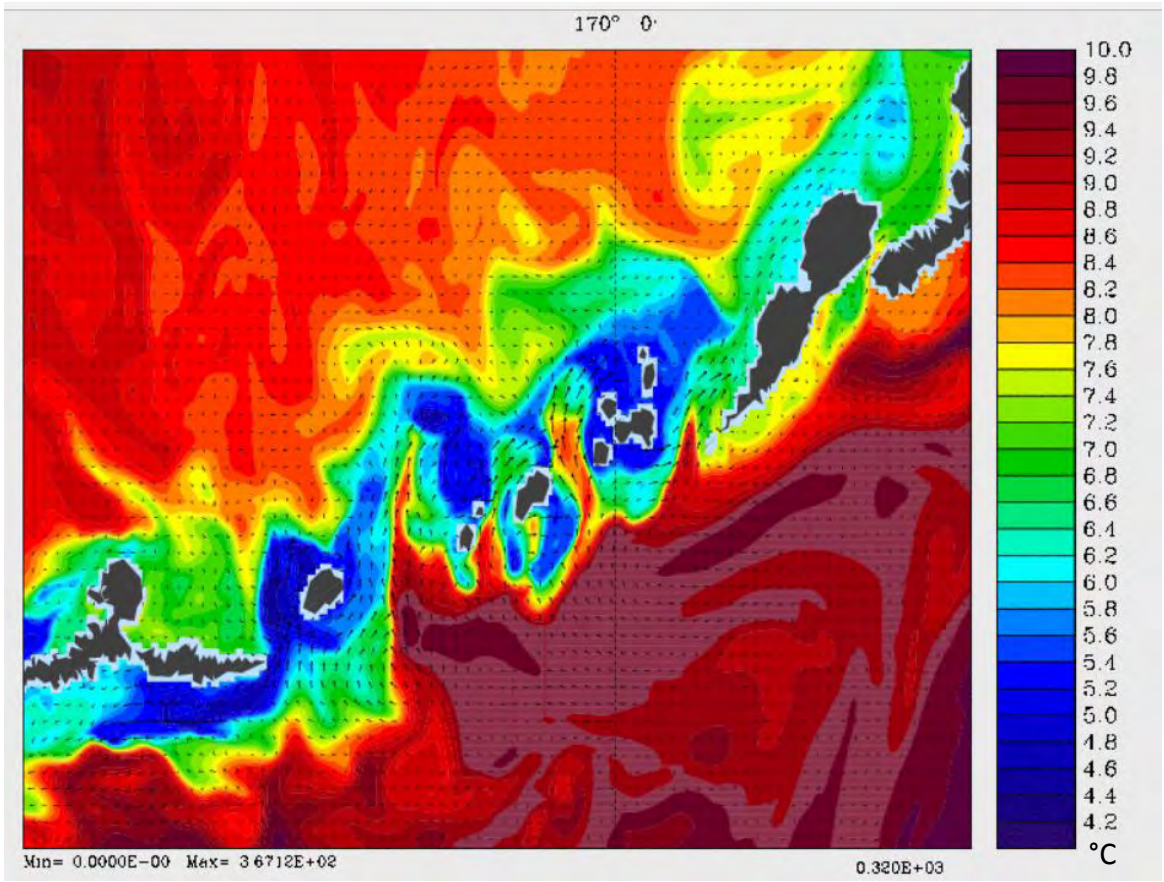
E
S
Flood
Ebb

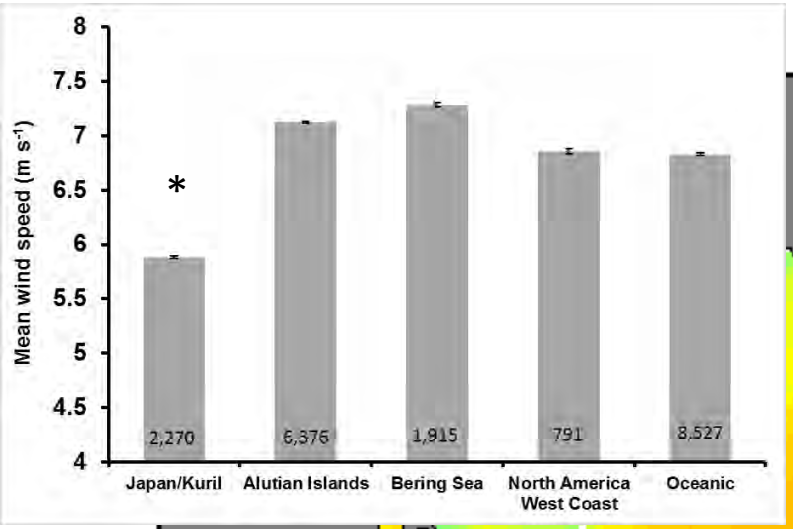


ROMS Simulation 2km Resolution
Temperature & surface currents - tides included

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

Scott Durski, Coastal Ocean Modeling, Oregon State University

Wind Speed During Summer Non-breeding Season June-August, 1999-2008



S5

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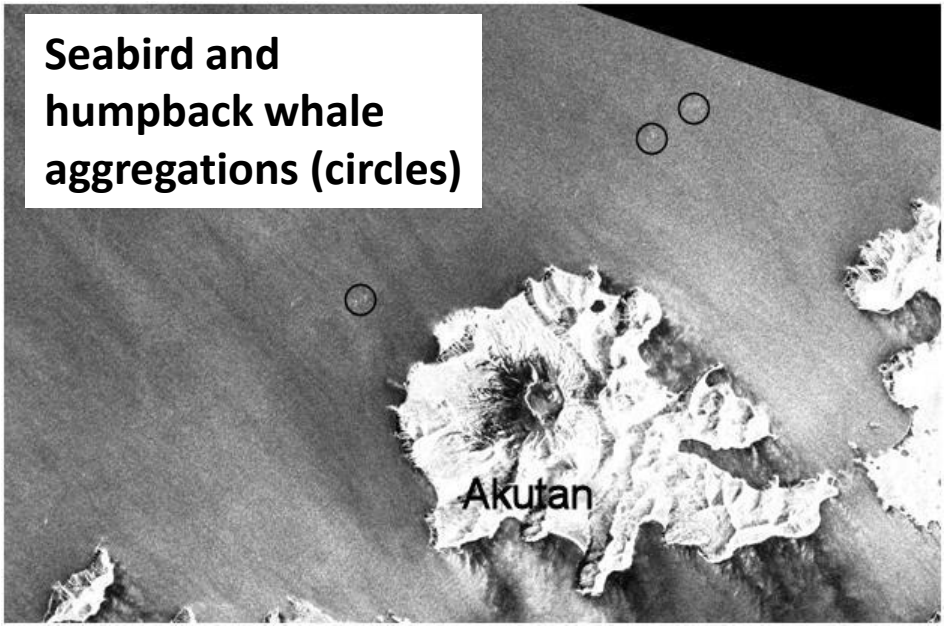
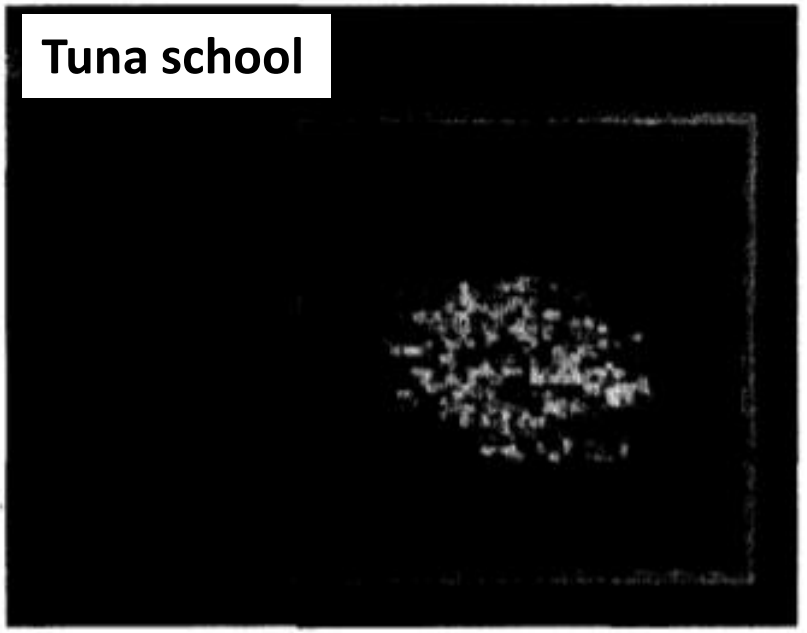
Visual Satellite Imagery

SAR data from the RADARSAT-1 swath width = 100 km



Churnside et al. 2011 Rem. Sens.



Petit et al. 1992 IEEE Trans. Geo. Rem. Sens.

True-Color Satellite Imagery

MODIS, resolution = 250 m

Oceanic nonlinear waves from the Lombok Strait
Mitnik et al. 2001

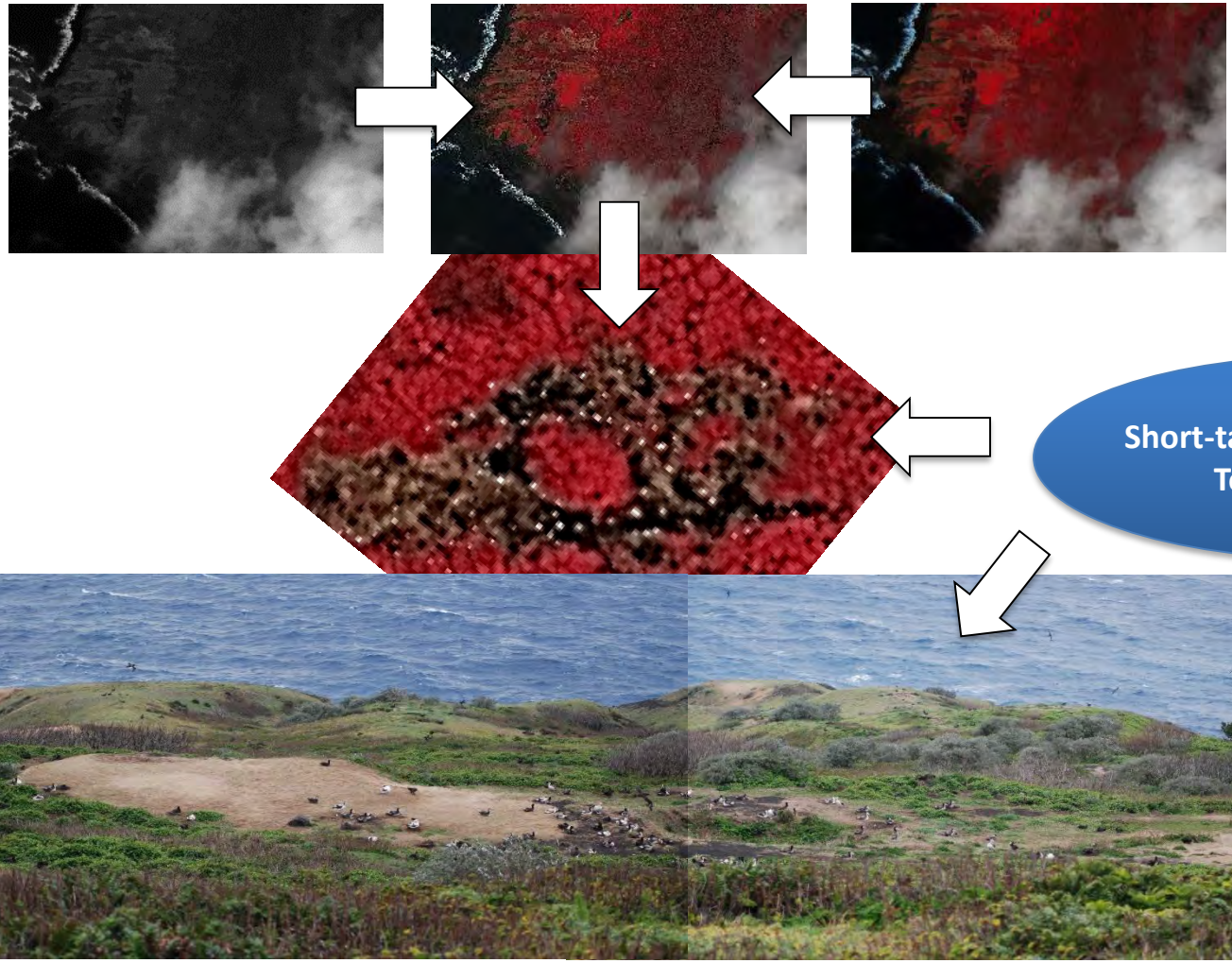
WorldView 3 Satellite Imagery

- One panchromatic band - 0.31m resolution
- Eight multispectral bands - blue through near infrared - 1.24m
- Swath width - 13.1km
- Geolocation accuracy – < 3.5m
- 1-3 day revisit interval

WorldView 3 Satellite Imagery

Count Nesting Short-tailed Albatrosses

Example of Panchromatic and Multispectral Fusion



Dolliver et al. unpubl. data

Conclusions

- Continued advancement in this field will come from **innovative study design** in addition to advanced sensors and novel quantitative approaches

- Habitat use is highly dynamic & models are **prone to failure** when projecting under future climate conditions

Important to Understand Mechanisms of Use

Acknowledgements