

Synthesizing Protected Species Data: Tools to Estimate Density and their application

Jessica V. Redfern

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Ballance, John Calambokidis, Monica DeAngelis, Paul
Fiedler, Susan Chivers, Robert Pitman, Jeff Seminoff**

**NOAA Fisheries
Southwest Fisheries Science Center**



Protected Species Issues: How many individuals are impacted?

Marine Mammal Protection Act

Endangered Species Act

National Environmental Policy Act



**Users conduct environmental
assessments regarding the impact
of activities on protected species**



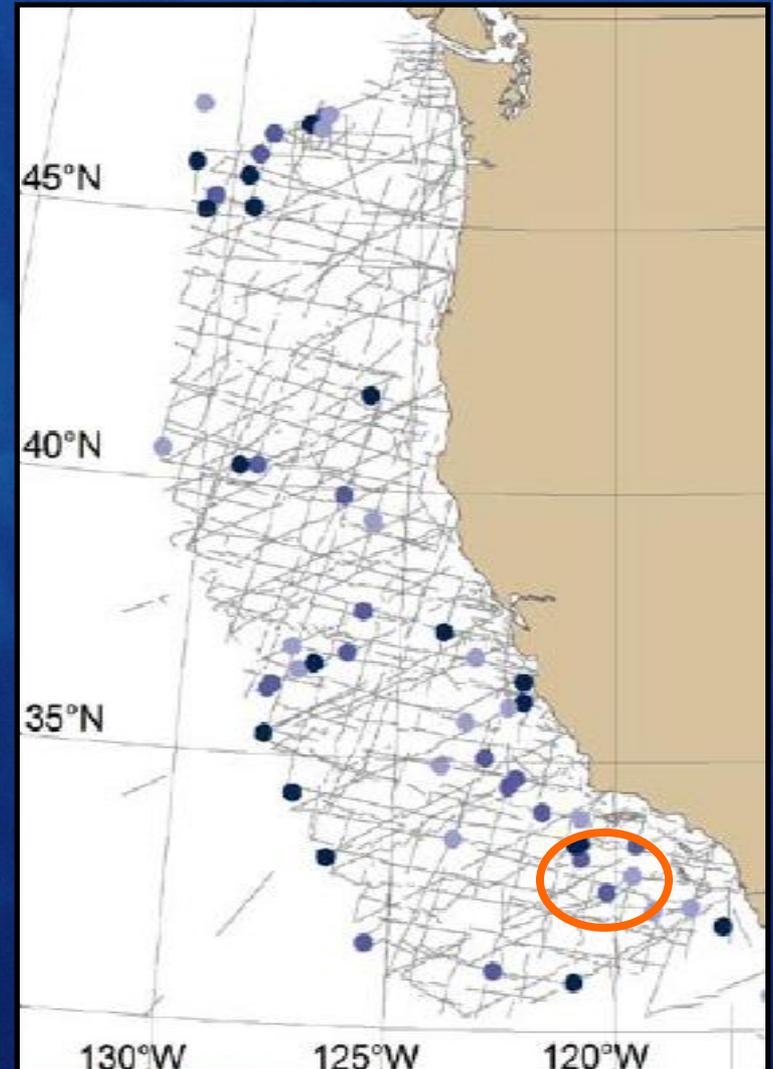
**Evaluated by NOAA Fisheries Office of
Protected Resources and Regional Offices**

Protected Species Issues: How many individuals are impacted?

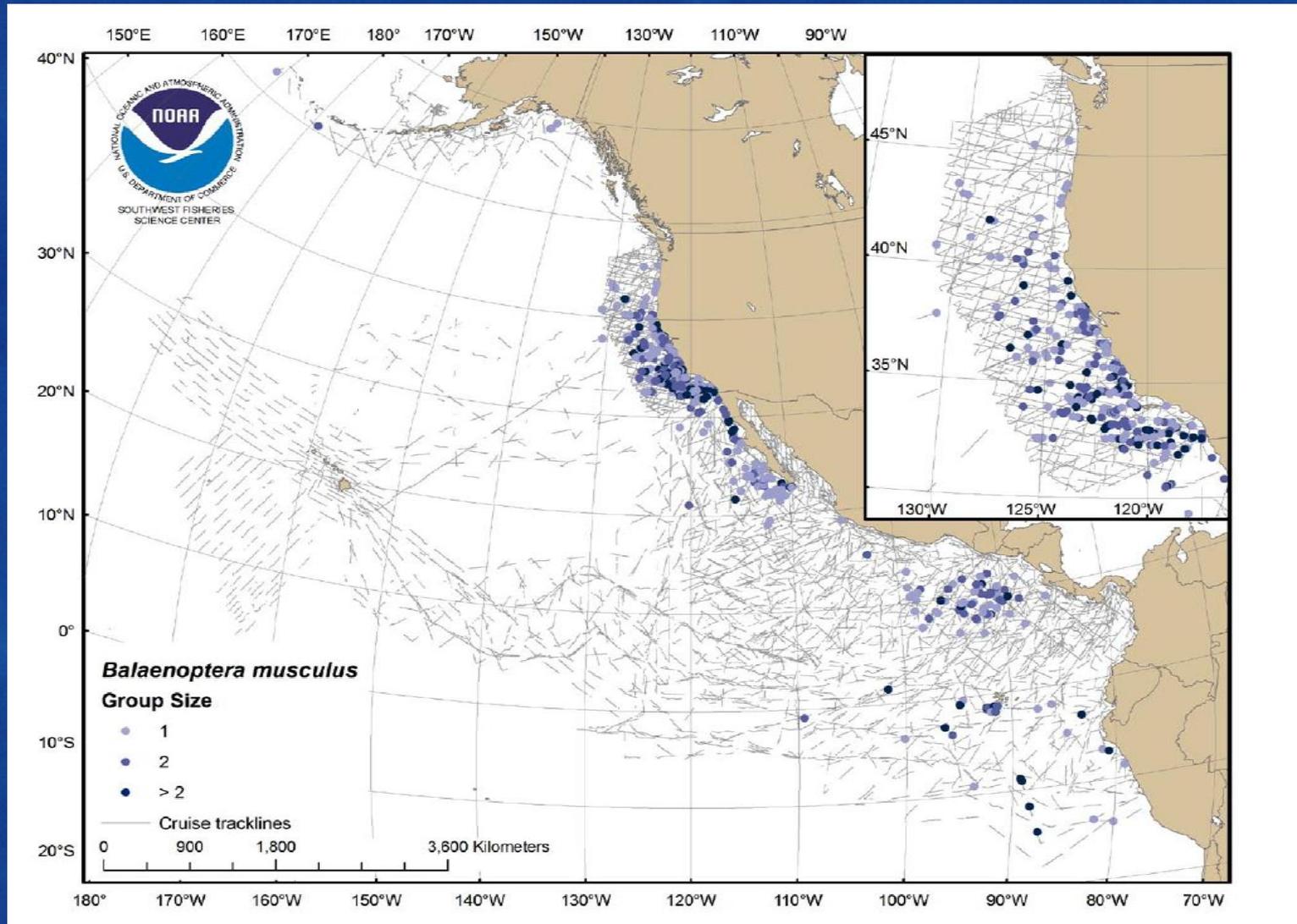
The Problem:

Numbers are either
unavailable or based
on different
geographic areas.

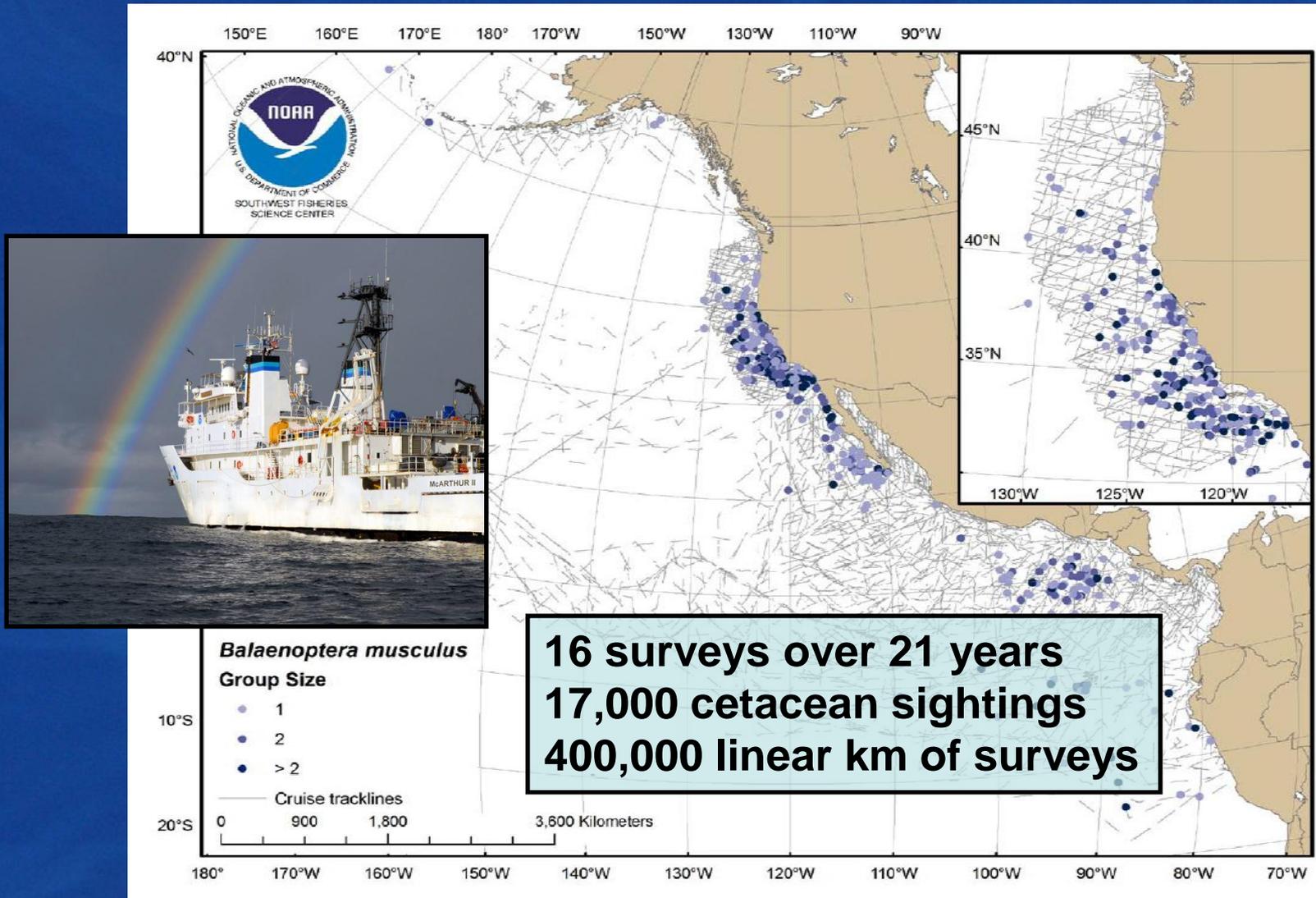
Cuvier's Beaked Whales



Southwest Fisheries Science Center Protected Species Data Sets



Southwest Fisheries Science Center Protected Species Data Sets





- Provide density estimates in any user-defined region
- Estimate density using the best available science
- Provide confidence intervals for density estimates
- Validate density estimates

Survey data

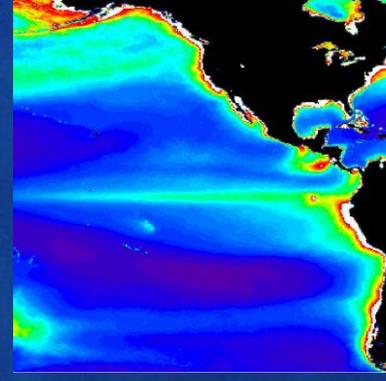
Synthesis



Density



Marine Mammal Survey Data



Ecosystem Data

Habitat Models to Estimate Marine Mammal Density

Marine Mammal Data 1986-2008:

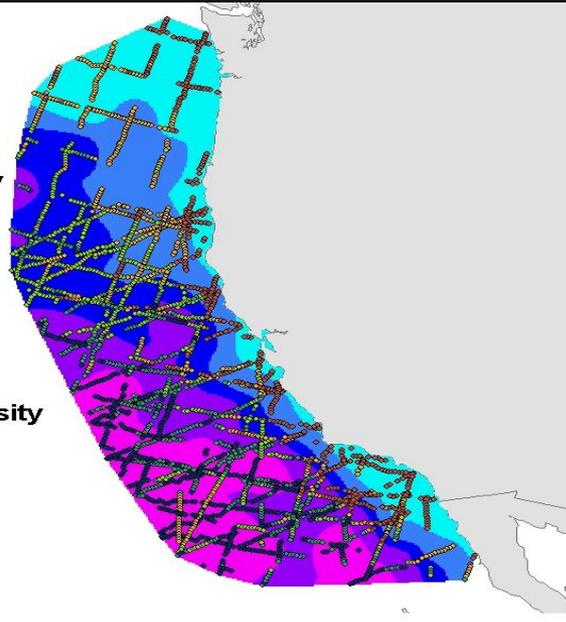
- Ship and aerial surveys
Southwest Fisheries Science Center

Legend

Interpolated Density



GAM Predicted Density



Ecosystem Data 1986-2008:

- In situ oceanographic and prey data
Southwest Fisheries Science Center
- Remotely sensed data



MODELING FRAMEWORK

- Generalized linear models
- Generalized additive models
- Tree-based models

DATA SOURCES

- In situ*
- Remotely sensed
- Mid-trophic indices

ERROR STRUCTURE

- Poisson
- Quasi-likelihood
- Negative Binomial

MODEL SELECTION

- AIC
- Cross-validation

MODEL VALIDATION

- Novel data sets

Statistical habitat models

**Published methods in
peer-reviewed literature**

Survey data

Synthesis

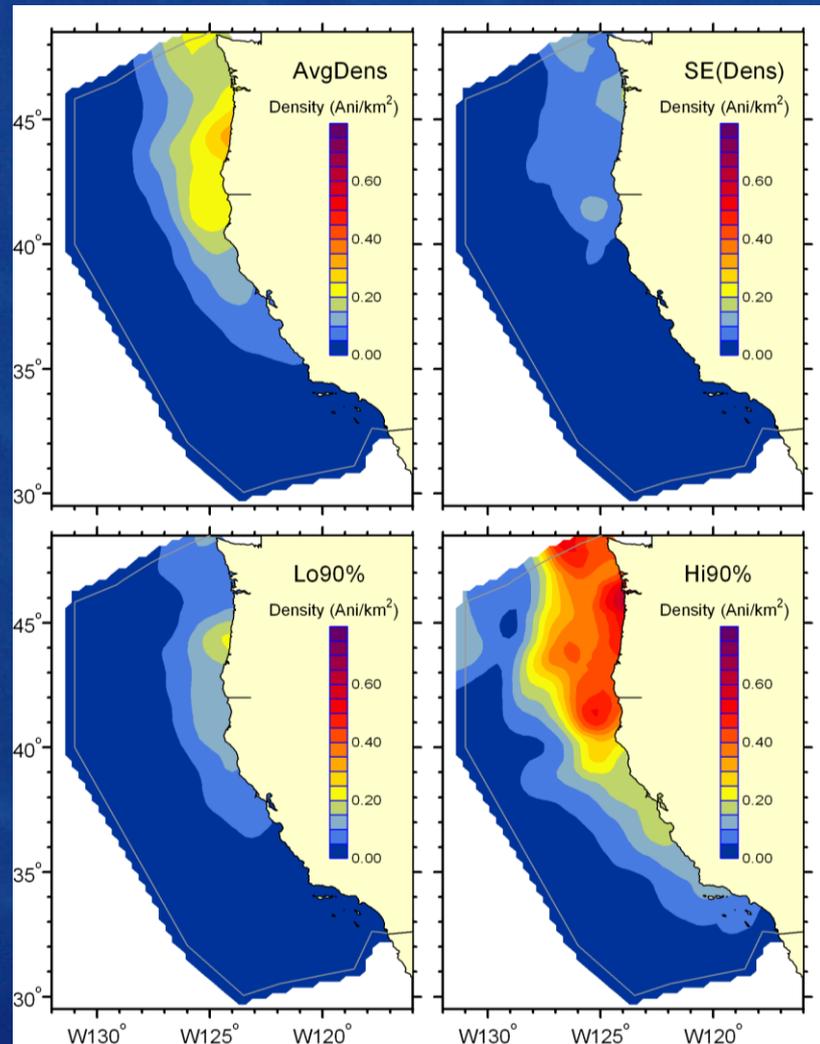


Density

Models were developed for:

- 12 cetacean species in the California Current ecosystem

Dall's Porpoise:
Mean, Standard Error, and
Confidence Intervals



A Tool to Estimate Density In User-Defined Regions

SERDP Mapper - Decision Support System Online Interface - Windows Internet Explorer

http://seamap.env.duke.edu/prod/serdp/serdp_map.php

SERDP
Strategic Environmental Research and Development Program

Habitat Models
Duke W. Atlantic Gulf of Mexico
Presence/Absence

Density Models
SWFSC E. Pacific
NODE W. Atlantic G. of Mexico

Layers
Exercise Areas New
Backgrounds

Map Satellite Hybrid

options

Color scheme
 Relative
 Fixed

1000 mi
2000 km

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Model Summary Regional Stat. Guilds Resources Help

start
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Habitat Models
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Density Models
SWFSC E. Pacific
Berardius
blue whale
summer
CCE
ETP
bottlenose dolphin
Bryde whales
eastern spinner dolphins
fin whale
humpback whale
Kogia
Mesoplodon species
northern right whale dolphin
offshore spotted dolphin
Pacific white-sided dolphin
pilot whales
rough-toothed dolphins
short-beaked common dolphin
small beaked whale
sperm whale
striped dolphin
whitebelly spinner dolphin

NODE W. Atlantic G. of Mexico
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Color scheme
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Fixed

Density

0.0002-0.0005
0.0005-0.0009
0.0009-0.0013
0.0013-0.0018
0.0018-0.0024
0.0024-0.0031
0.0031-0.0038
0.0038-0.0047
0.0047-0.0055
0.0055-0.0064
0.0064-0.0074
0.0074-0.0085
0.0085-0.0095
0.0095-0.0105
0.0105-0.0114
0.0114-0.0128

Model Summary Regional Stat. Guilds Resources Help

http://seamap.env.duke.edu/

start NOAA_Sci... final_TM JessicaRed... SERDP for ... Palm Desk... SERDP Ma... Hamilton... 9:17 PM

A Tool to Estimate Density In User-Defined Regions

Model Summary

Regional Stat.

Guilds

Resources

Help

Model Description

Model Statistics

Species in Guild

Model Description

Model Type	SWFSC - Density Model
Model Version	1
Guild	blue whale
Season (*)	summer
Region	CCE

* For definition of seasons, see [Resources].

Model Statistics

Summary statistics of the model output for the entire area

	Effort		Density (animals per km ²) -			
#Obs.	hours	Length (km)	Min	Max	Mean	Std. dev
181	N/A	710.48	0.000193	0.012758	0.002318	0.002772

Species in Guild

	Scientific	Common		Status
●	Balaenoptera musculus	blue whale		Endangered

A Tool to Estimate Density In User-Defined Regions

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0.0024-0.0031
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0.0038-0.0047
0.0047-0.0055
0.0055-0.0064
0.0064-0.0074
0.0074-0.0085
0.0085-0.0095
0.0095-0.0105
0.0105-0.0114
0.0114-0.0128

20 mi
50 km

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Model Summary Regional Stat. Guilds Resources Help

start NOAA_Science_B... Microsoft PowerP... Inbox for Jessica... SERDP Mapper - ... 7:59 AM

A Tool to Estimate Density In User-Defined Regions

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SERDP Strategic Environmental Research and Development Program

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0.0038-0.0047
0.0047-0.0055
0.0055-0.0064
0.0064-0.0074
0.0074-0.0085
0.0085-0.0095
0.0095-0.0105
0.0105-0.0114
0.0114-0.0128

	Effort	Regional Stat. - Density				
#Obs.	Hours	Length (km)	Min	Max	Mean	Std. Dev
11	N/A	24.06	0.000002	0.012000	0.006156	0.003922

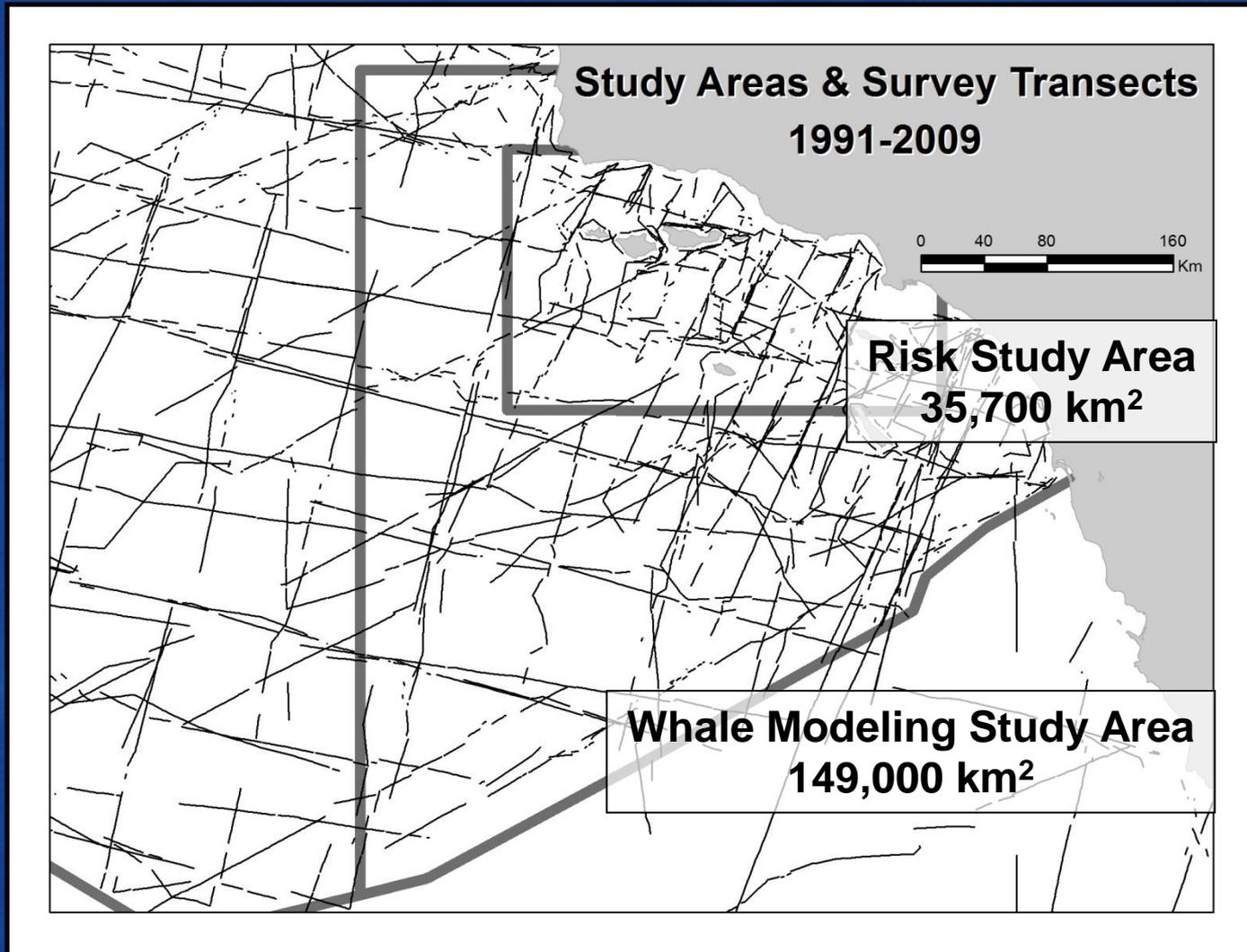
Summary statistics of the model output for the selected area

start

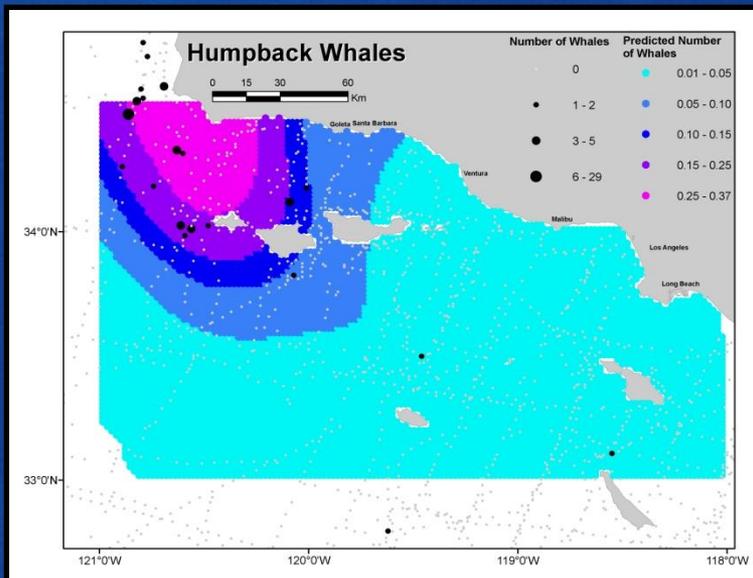
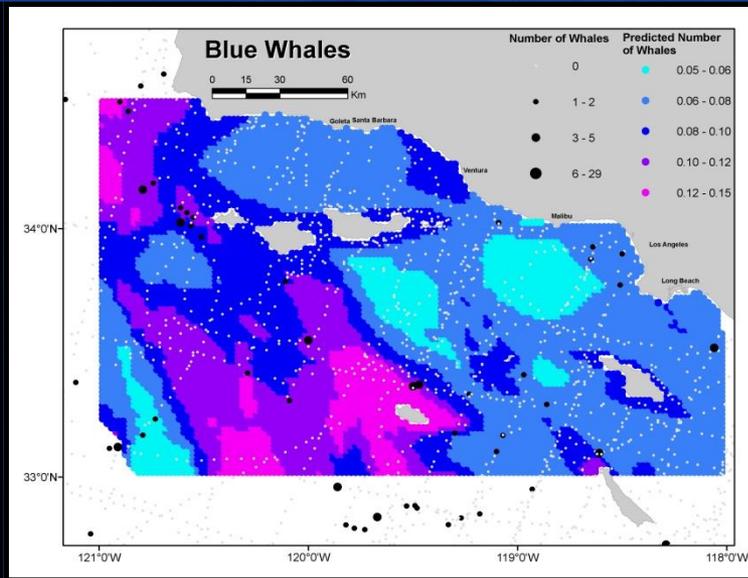
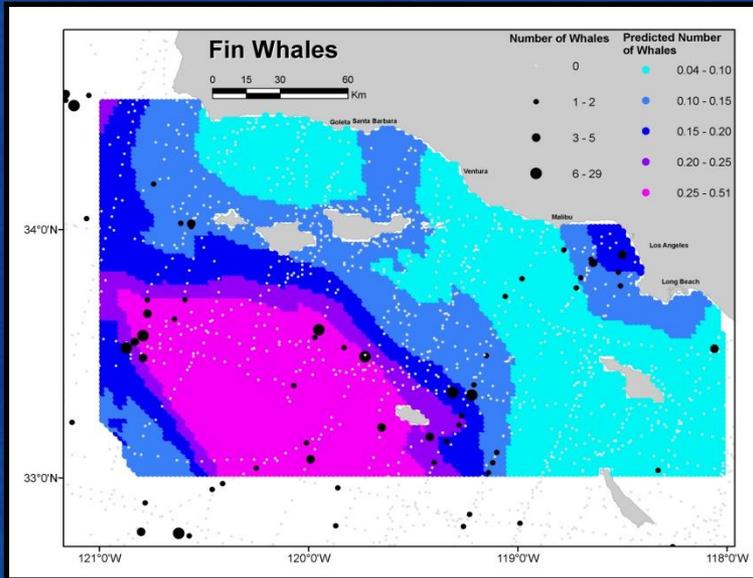
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Whales and Ships in the Southern California Bight

Study Areas



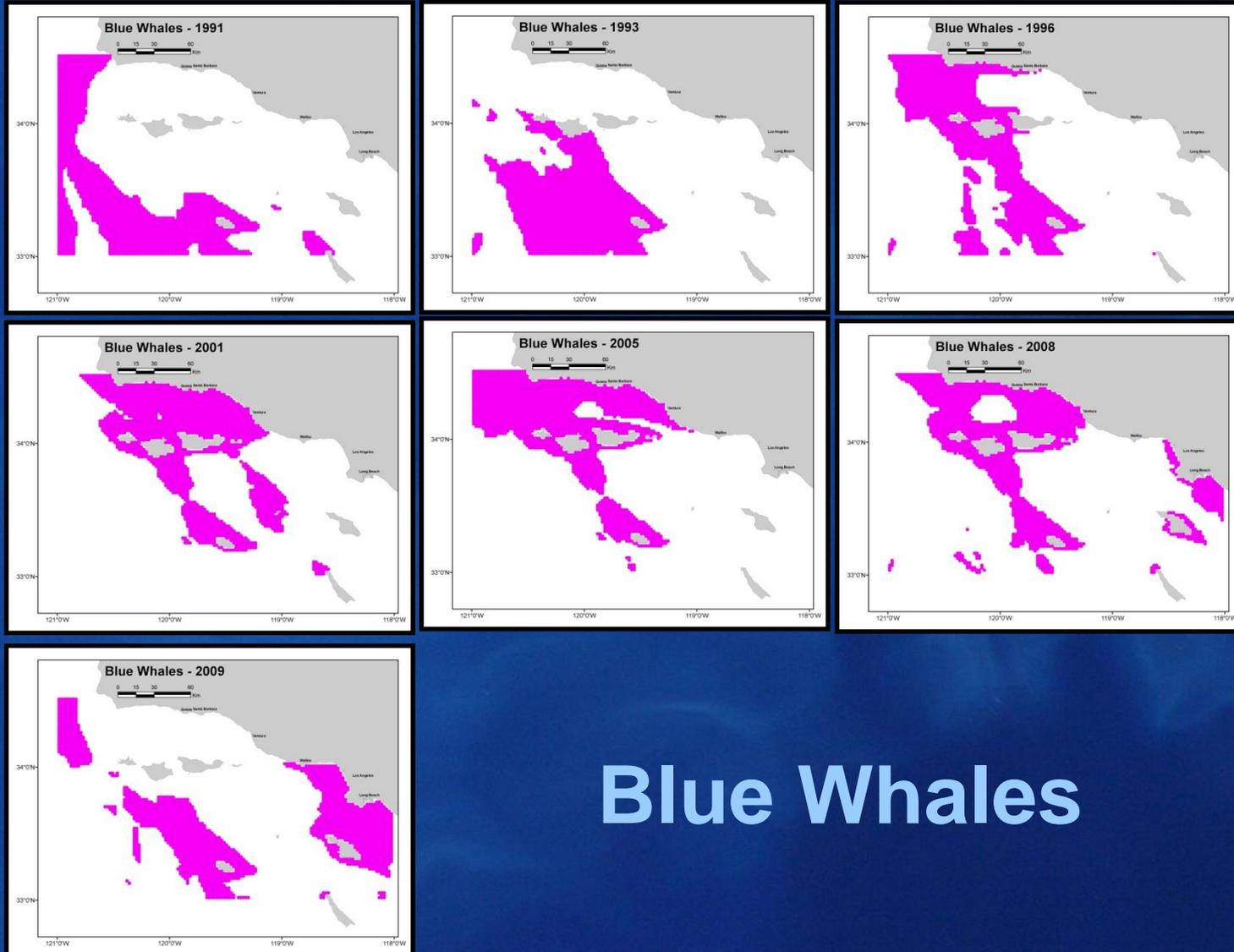
Whale Predictions – 1991 to 2009



- Fin and humpback whales have opposing hot spots
- Blue whales are spread more evenly through the area

Whale Predictions **Preliminary Results**

Interannual Variability



Blue Whales

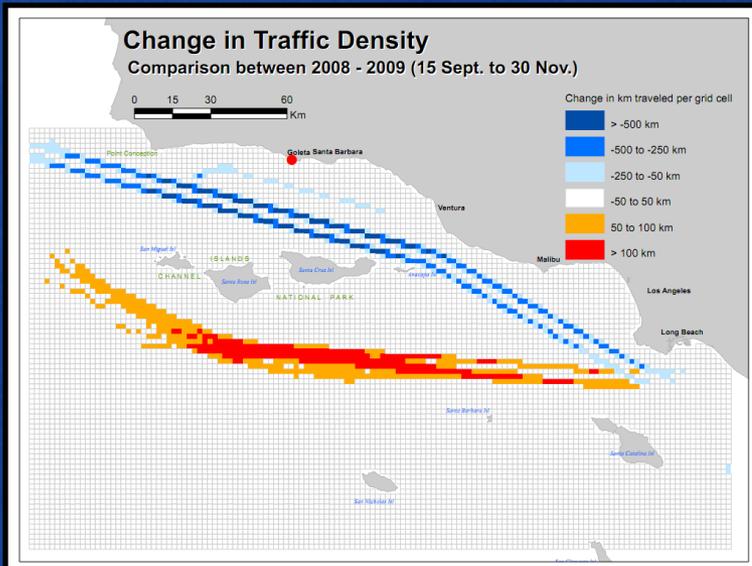
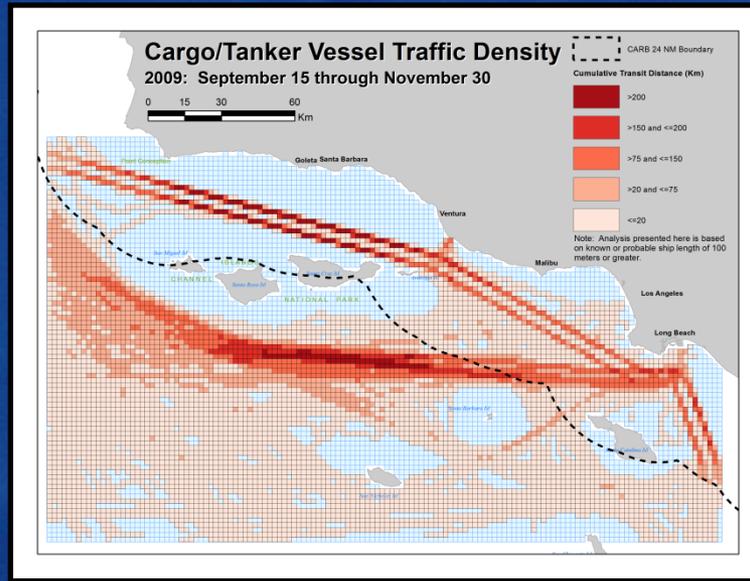
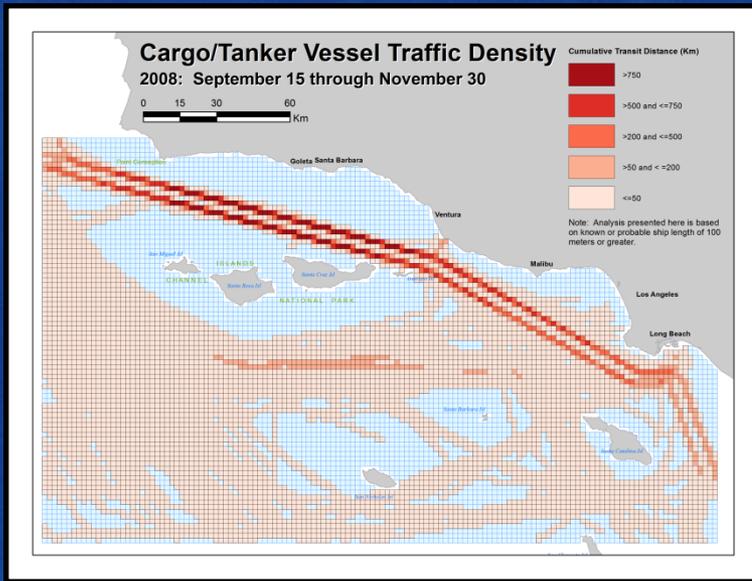
Assessing Risk

In 2009, the California Air Resources Board (CARB) ruled that ships had to use cleaner fuels when traveling within 24 nmi of the coast.

What was the change in risk associated with the change in ship traffic caused by the CARB rule?



Did the change in traffic affect risk?



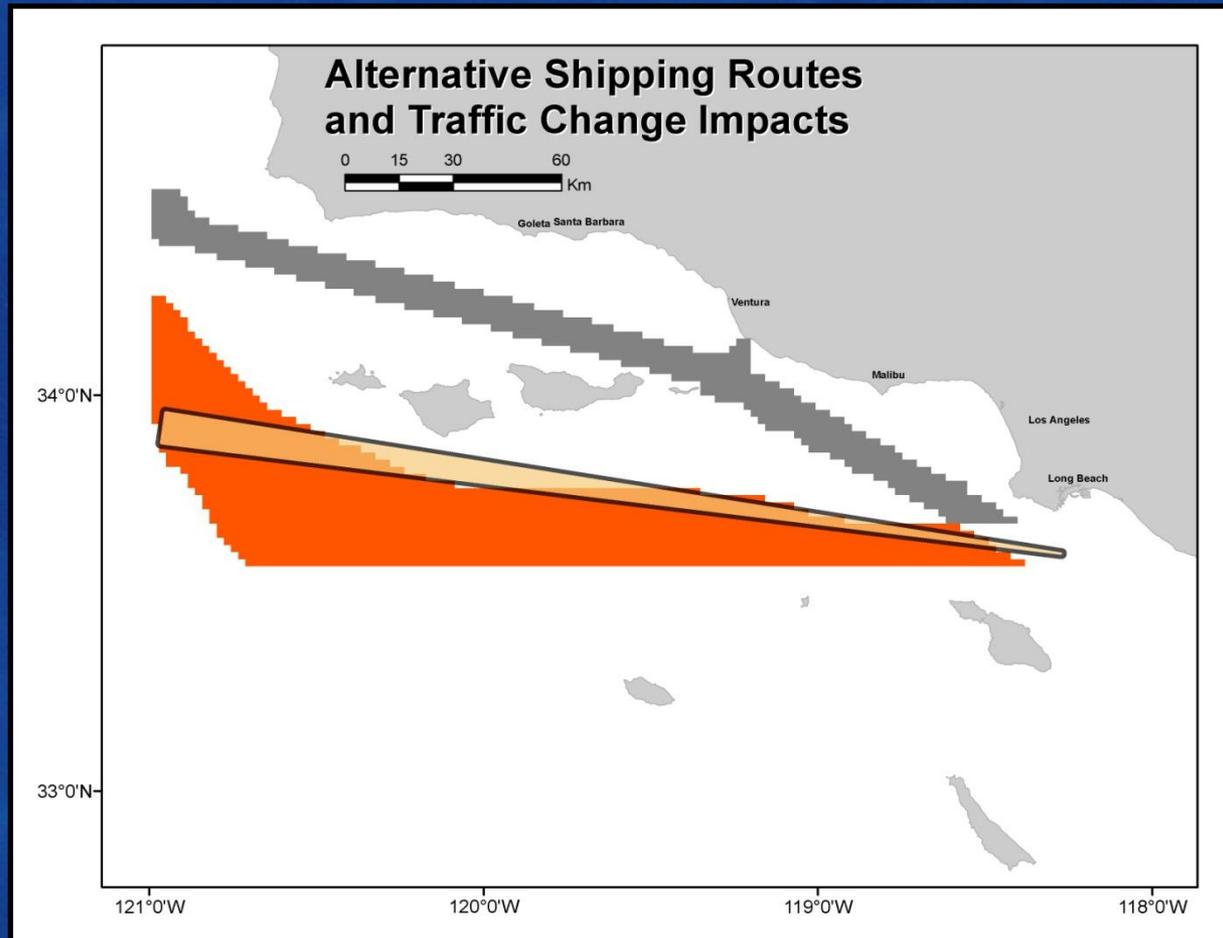
- Traffic was primarily in the Santa Barbara Channel in 2008
- Traffic shifted primarily south of the Channel Islands in 2009

Did the change in traffic affect risk?

Channel

Narrow South

Broad South



- Assume traffic is uniformly distributed

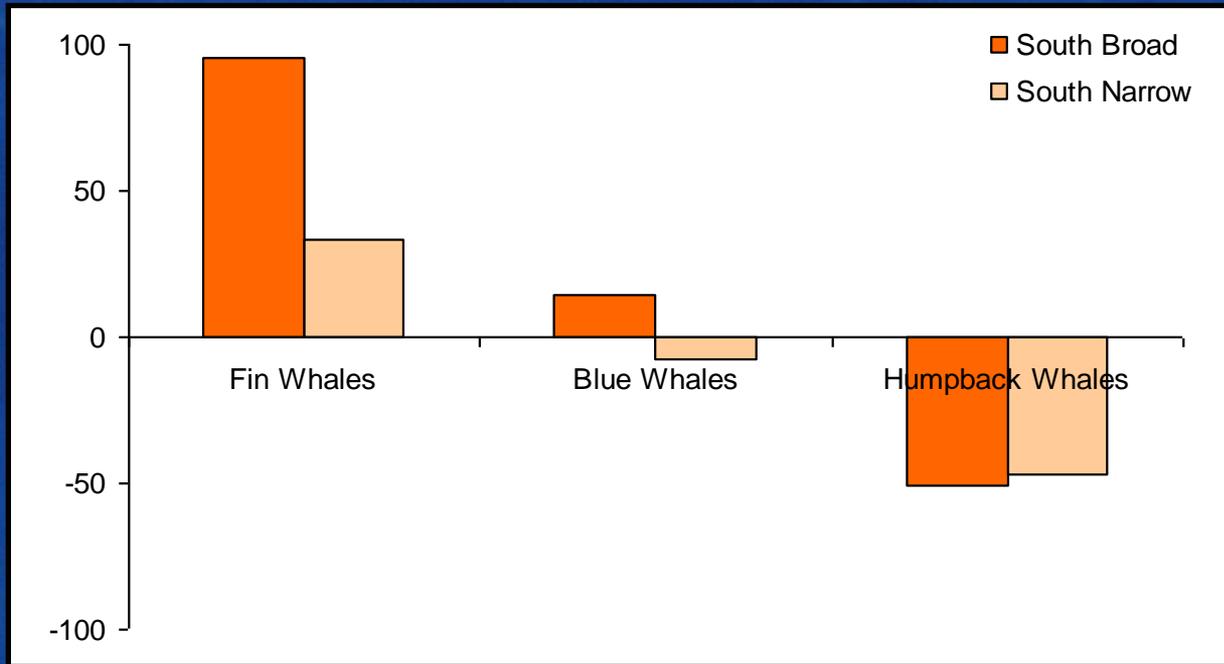
$$\text{Risk} = \text{sum}(\text{whale density} * \text{ship density})$$

Did the change in traffic affect risk?

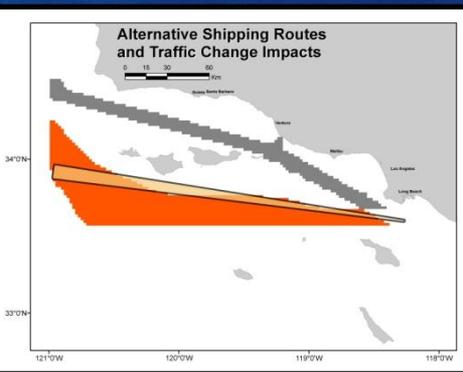
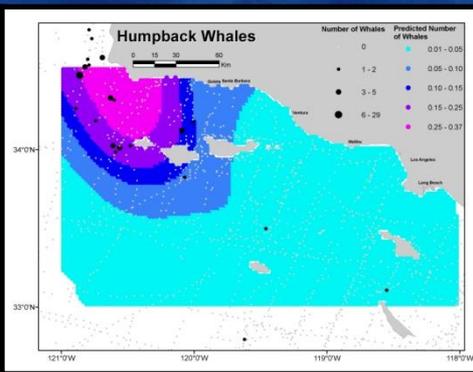
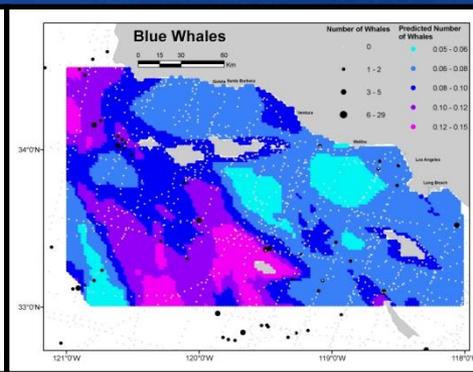
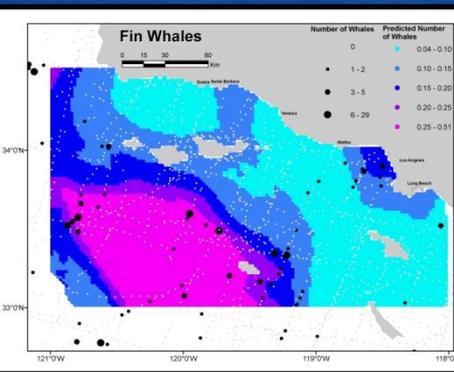
Percent change in risk between traffic patterns in Channel and South

Increase risk from shift south

Decrease risk from shift south

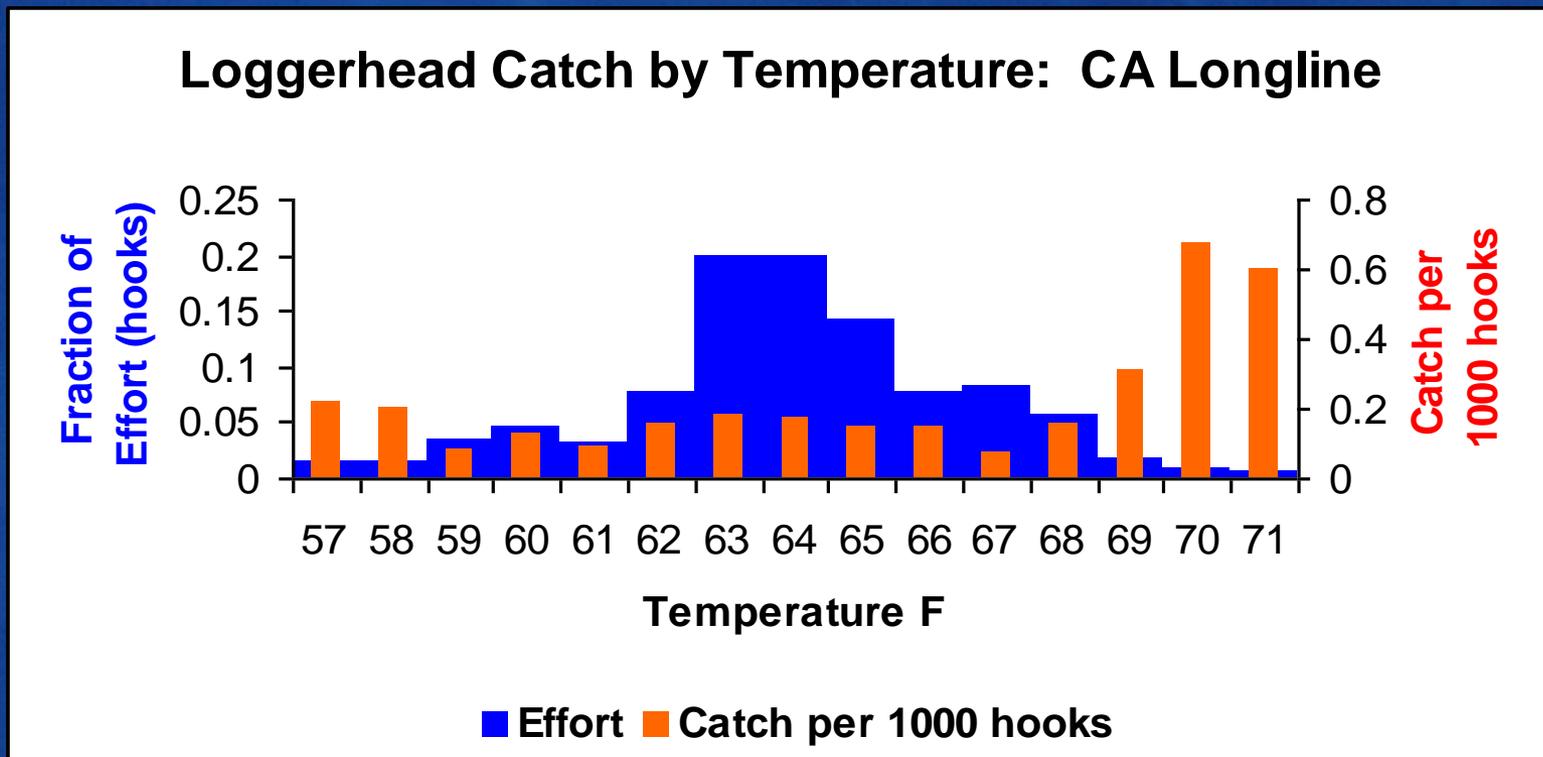


Risk



Sea Turtles

Fishing effort in the CA longline fishery is concentrated in SSTs between 63-65F. Loggerhead catch rates are much higher in SSTs > 68F.



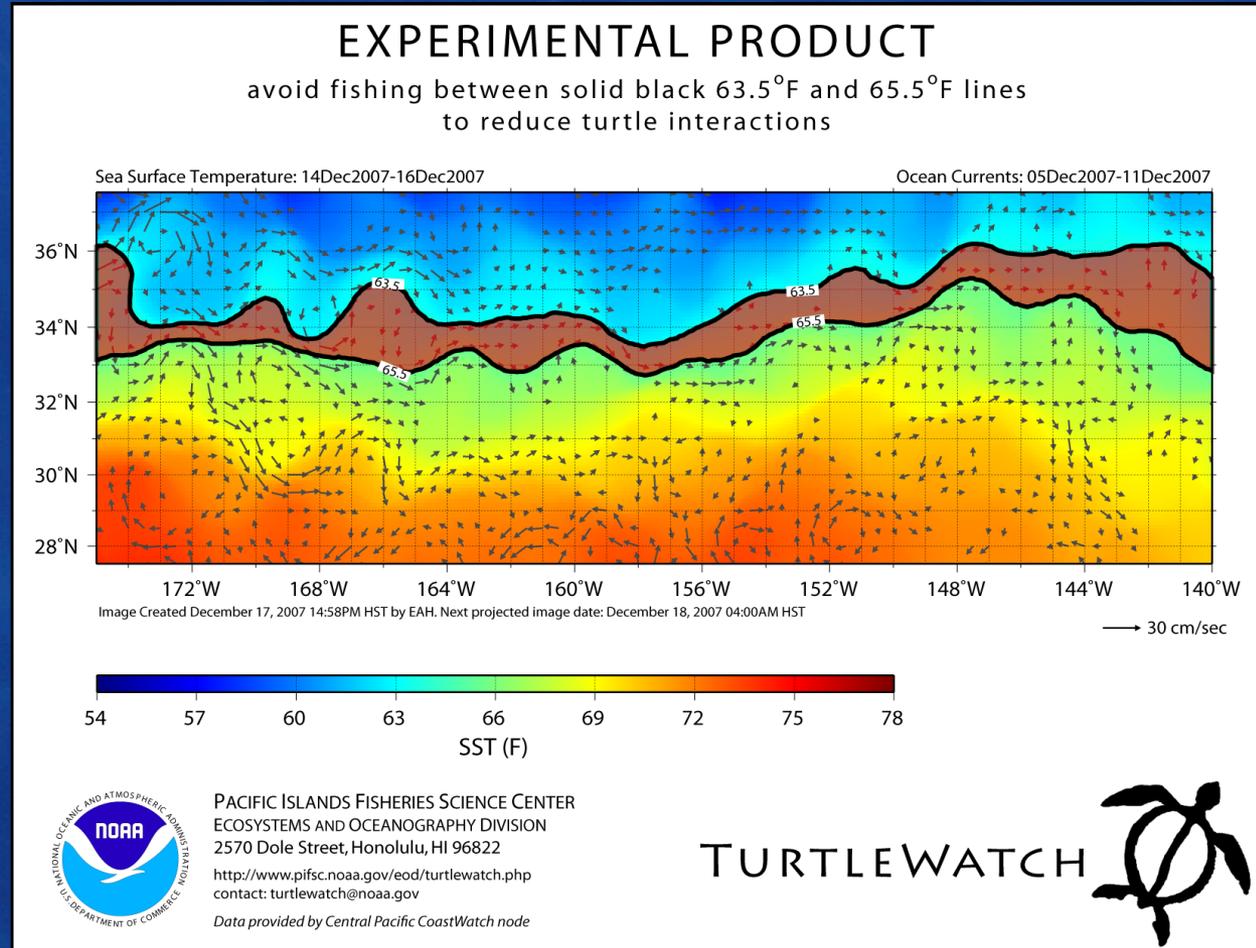
TurtleWatch product

Based on NESDIS SST
(GAC 4 km 3 day average)
and JPL Geostrophic
Currents (9 km 7 day)

Provided daily by email to
industry/managers and
hand carried to fishers

Distributed in both English
and Vietnamese

Also distributed by
GeoEye to fishers



Moving Forward

PIFSC-SWFSC collaborations

- Reviewing loggerhead interaction data
- Examining the efficacy of using a tool similar to TurtleWatch for leatherbacks
 - Other drivers may determine distributions (e.g., productivity, jelly abundance, etc.)

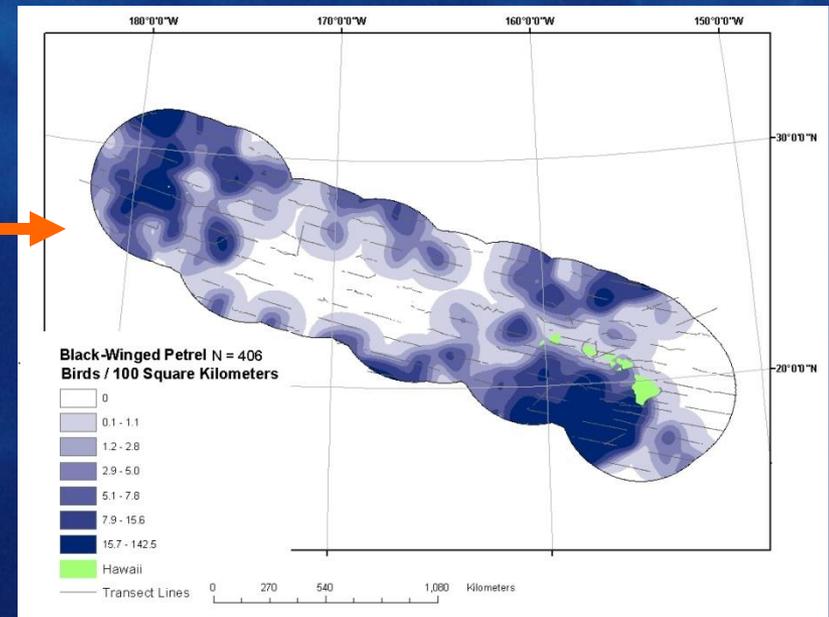
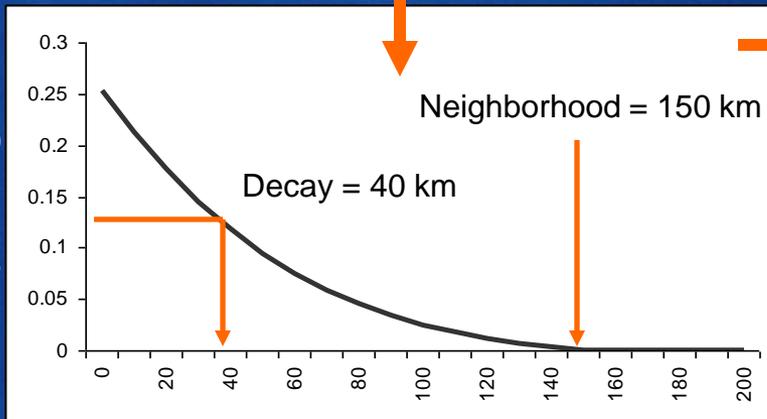
Distribution and Abundance of Seabirds in Hawaiian Waters

- 1) Who's here
- 2) Where are they?
- 3) How many?
- 4) Hot spots?



To plot distributions:

- Calculate density along tracklines
- Interpolate density
 - Negative exponential distance weighting



Distance from Trackline (km)

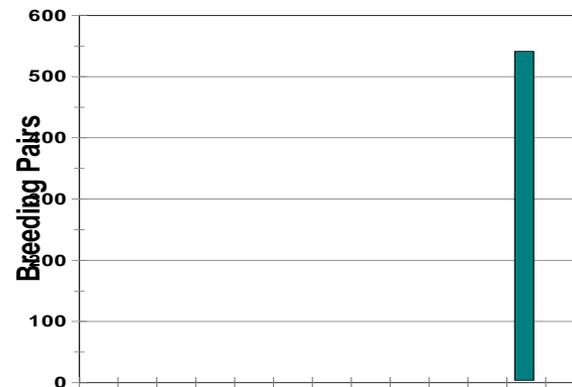
180°0'0"W

170°0'0"W

160°0'0"W

150°0'0"W

Breeds Spring - Fall



30°0'0"N

Low Islands

High Islands

Hawaiian Petrel N = 183
Birds / 100 Square Kilometers

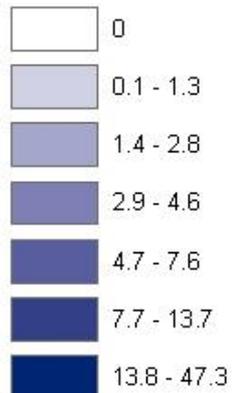


Photo copyright of Hadoram Shirihai

20°0'0"N

— Transect Lines

0 340 680 1,360 Kilometers

180°0'0"W

170°0'0"W

160°0'0"W

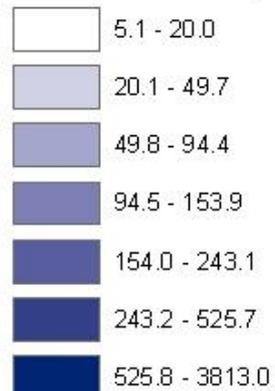
150°0'0"W

➤ Density hot spots:
• Leewards (Laysan - Kure)
• Oahu and vicinity

30°0'0"N

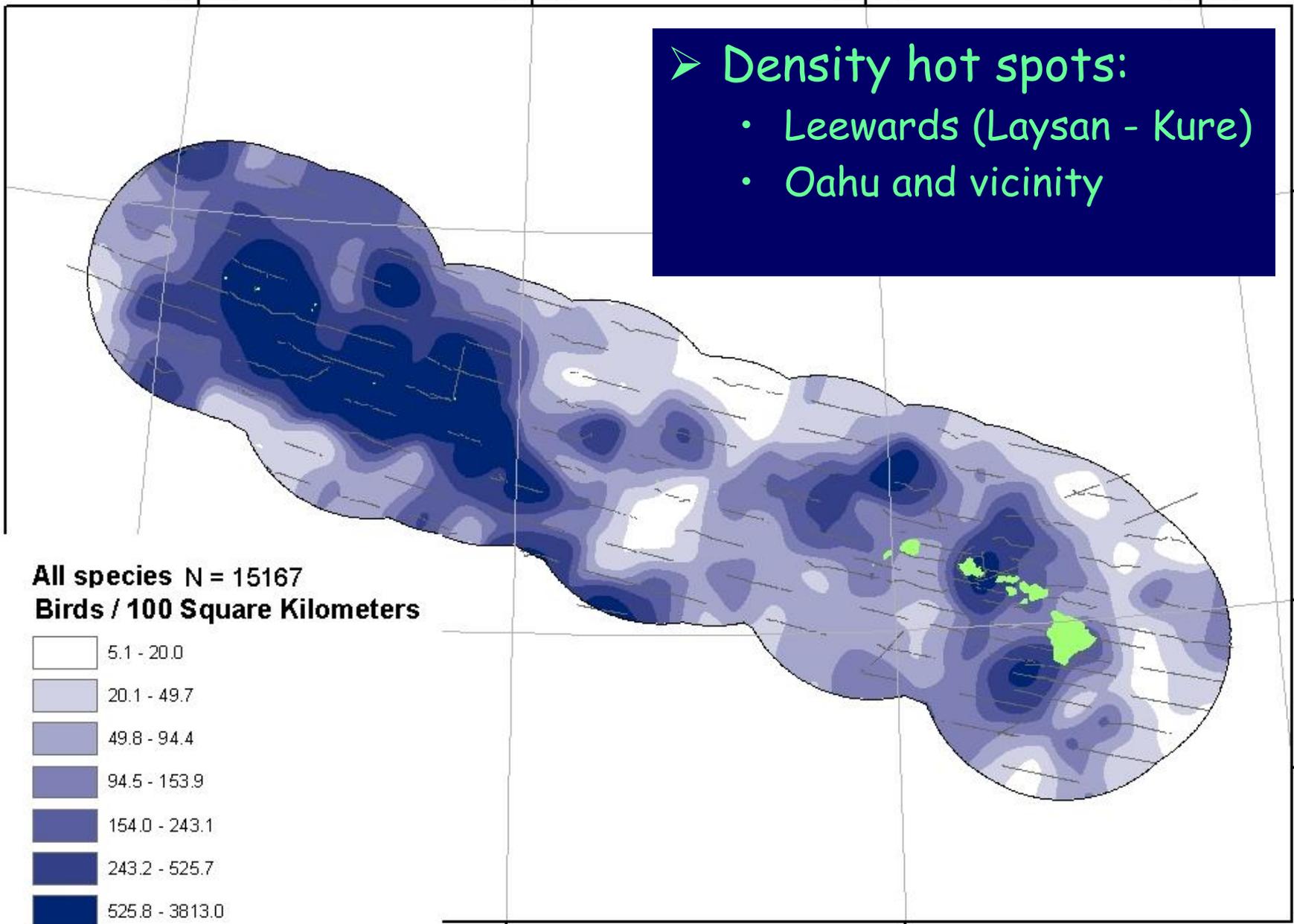
20°0'0"N

All species N = 15167
Birds / 100 Square Kilometers



Hawaii

Transect Lines



Acknowledgements

- Strategic Environmental Research and Development Program
- Navy N-45 (Frank Stone & Ernie Young)
- NOAA Southwest Fisheries Science Center (mammal observers, cruise leaders, survey coordinators, oceanographers, plankton sorters, officers, crews)
- Duke SERDP Team (esp. Pat Halpin, Andy Read, Ben Best, & Ei Fujioka).