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

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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

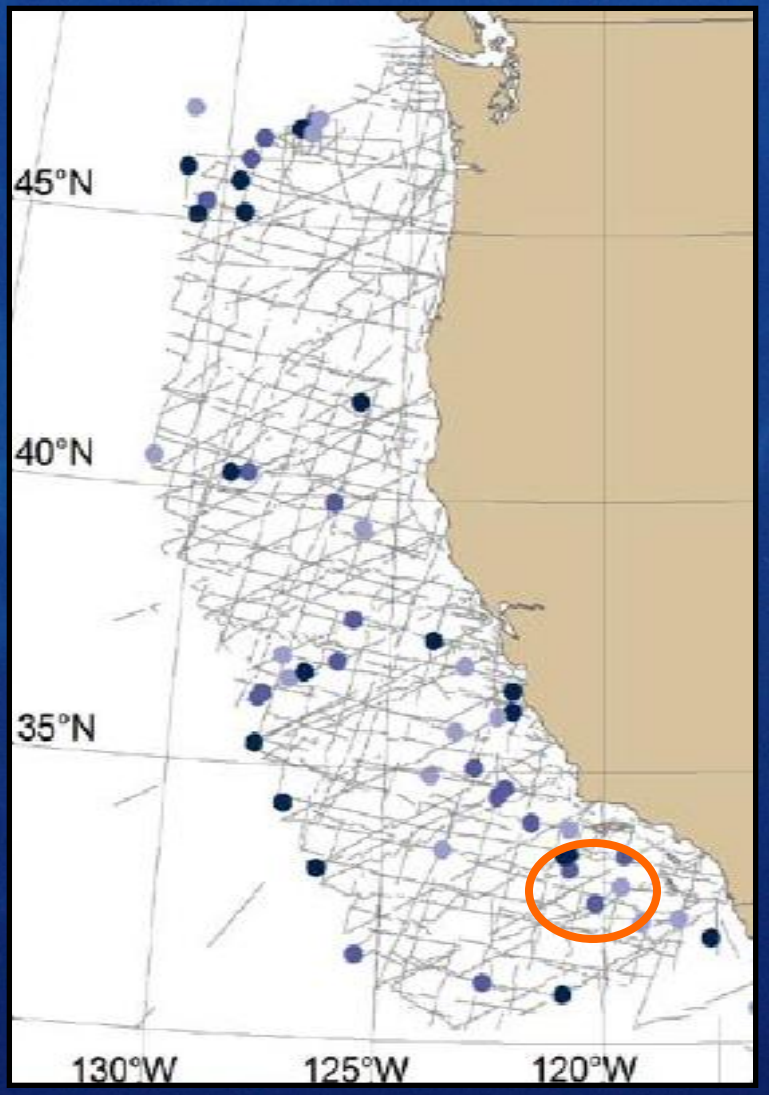
Users conduct environmental assessments regarding the impact of activities on protected species

Evaluated by NOAA Fisheries Office of Protected Resources and Regional Offices

Protected Species Issues:
How many individuals are impacted?

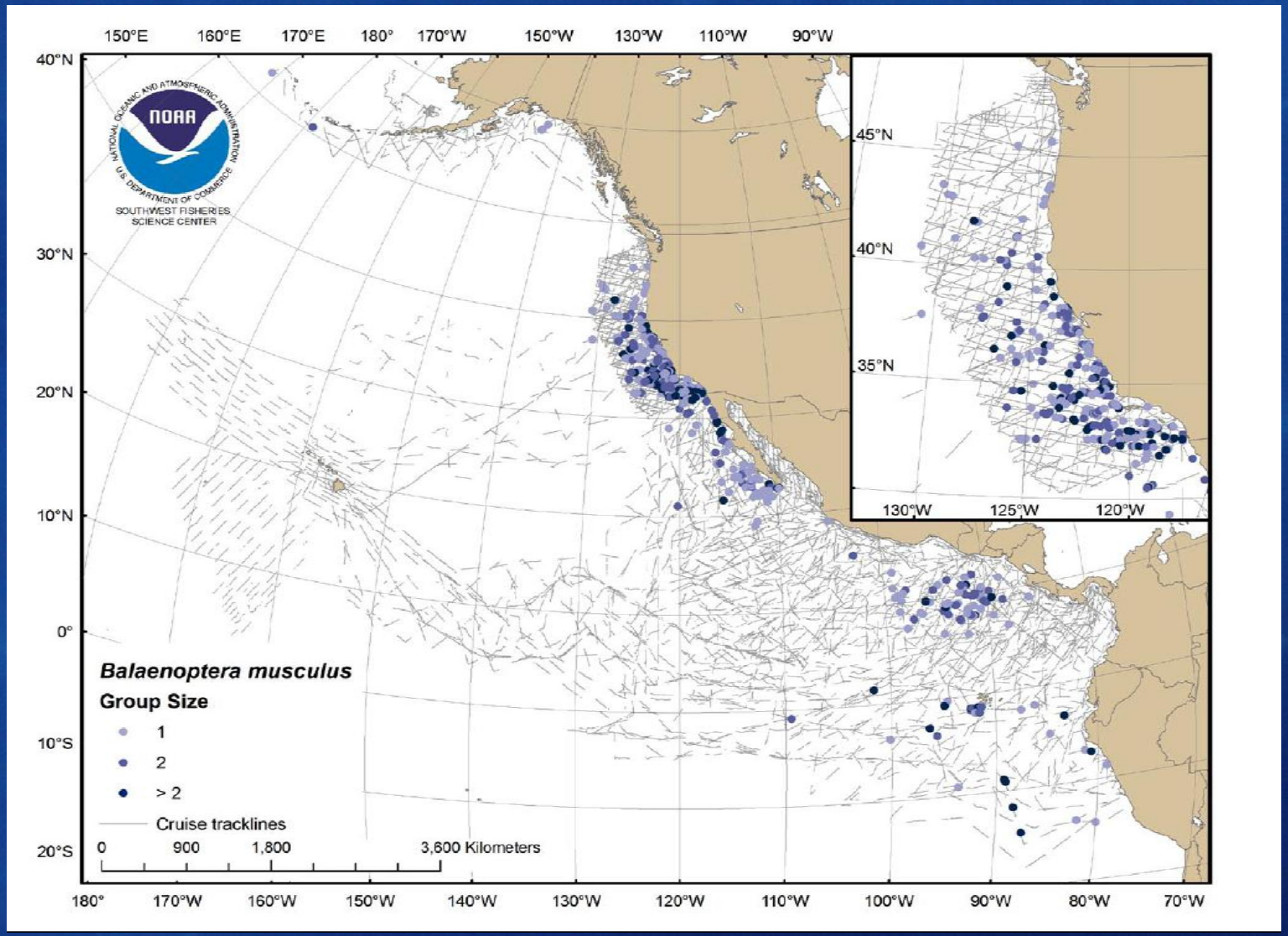
The Problem:

Numbers are either unavailable or based on different geographic areas.

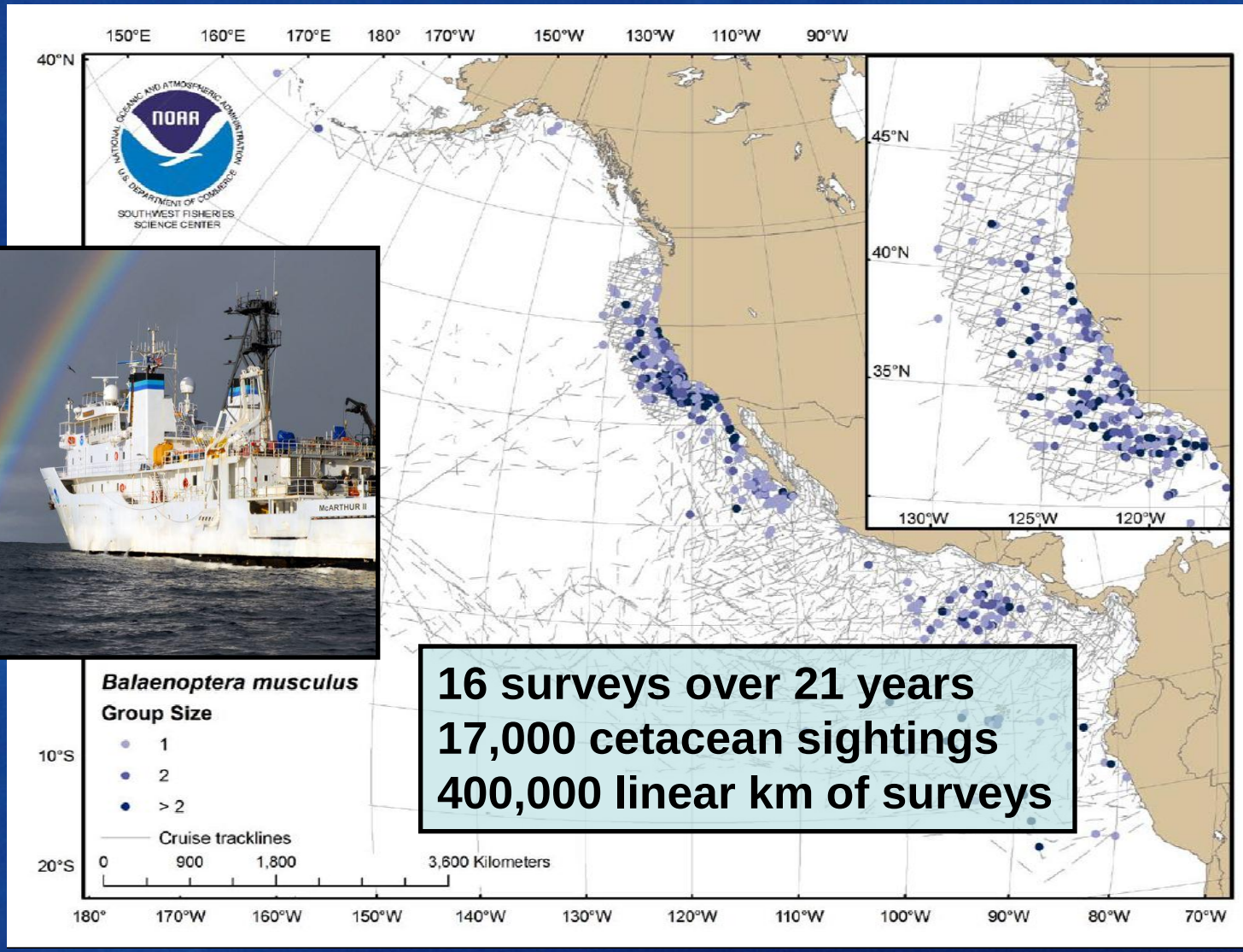


Cuvier's Beaked Whales

Southwest Fisheries Science Center Protected Species Data Sets



Southwest Fisheries Science Center Protected Species Data Sets



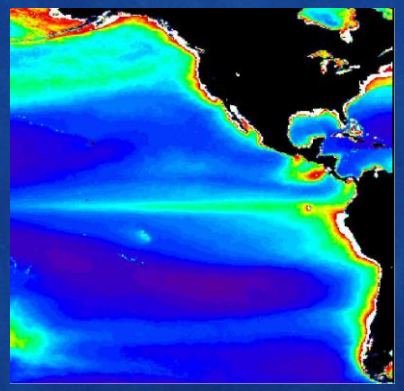
16 surveys over 21 years
17,000 cetacean sightings
400,000 linear km of surveys

Survey data → (Synthesis) → **Density**

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

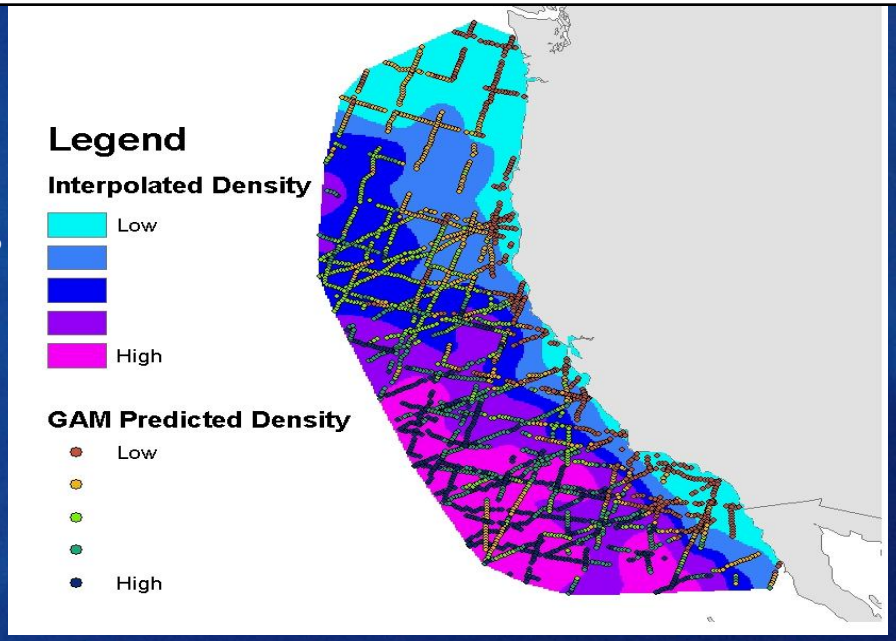
Survey data → Synthesis → Density

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*

Ecosystem Data 1986-2008:

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

Survey data → Density

Synthesis

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

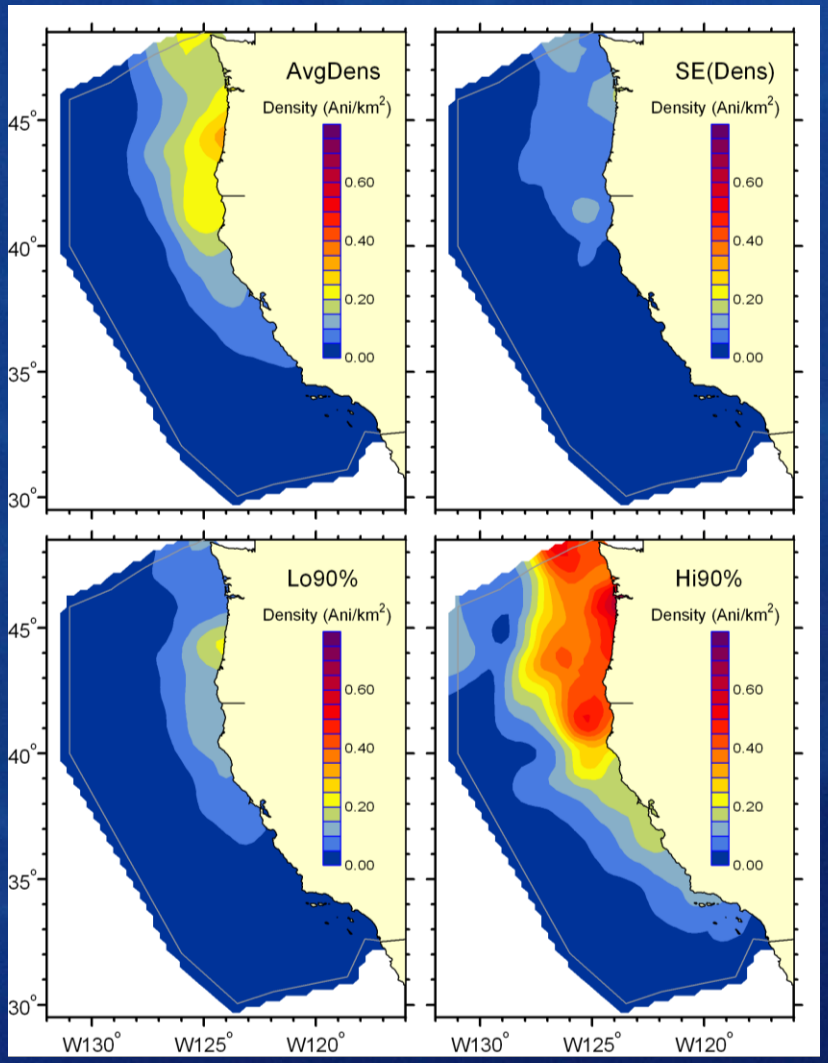
Published methods in peer-reviewed literature

Survey data → Density

Synthesis

Models were developed for:

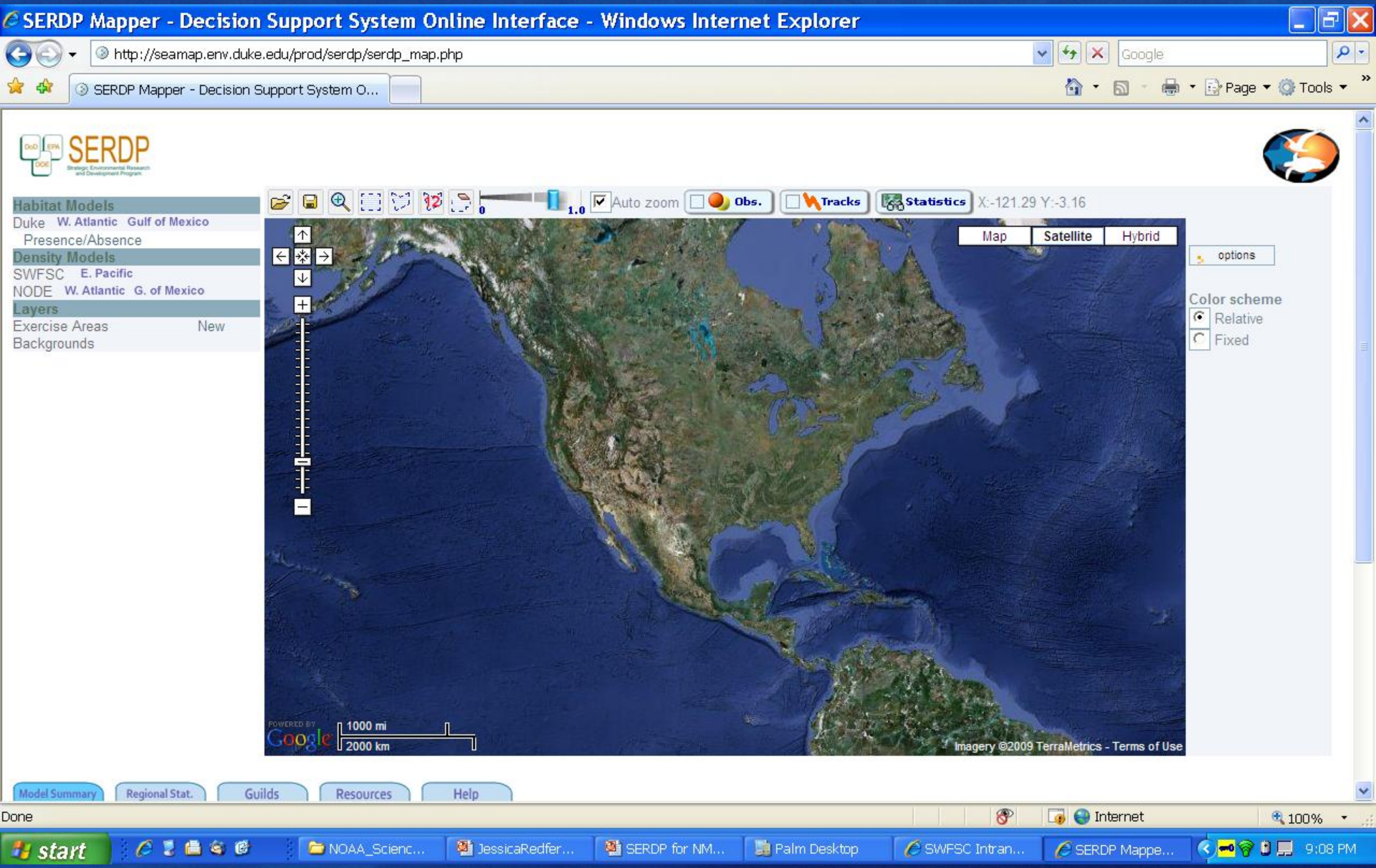
- **12 cetacean species in the California Current ecosystem**



Dall's Porpoise:

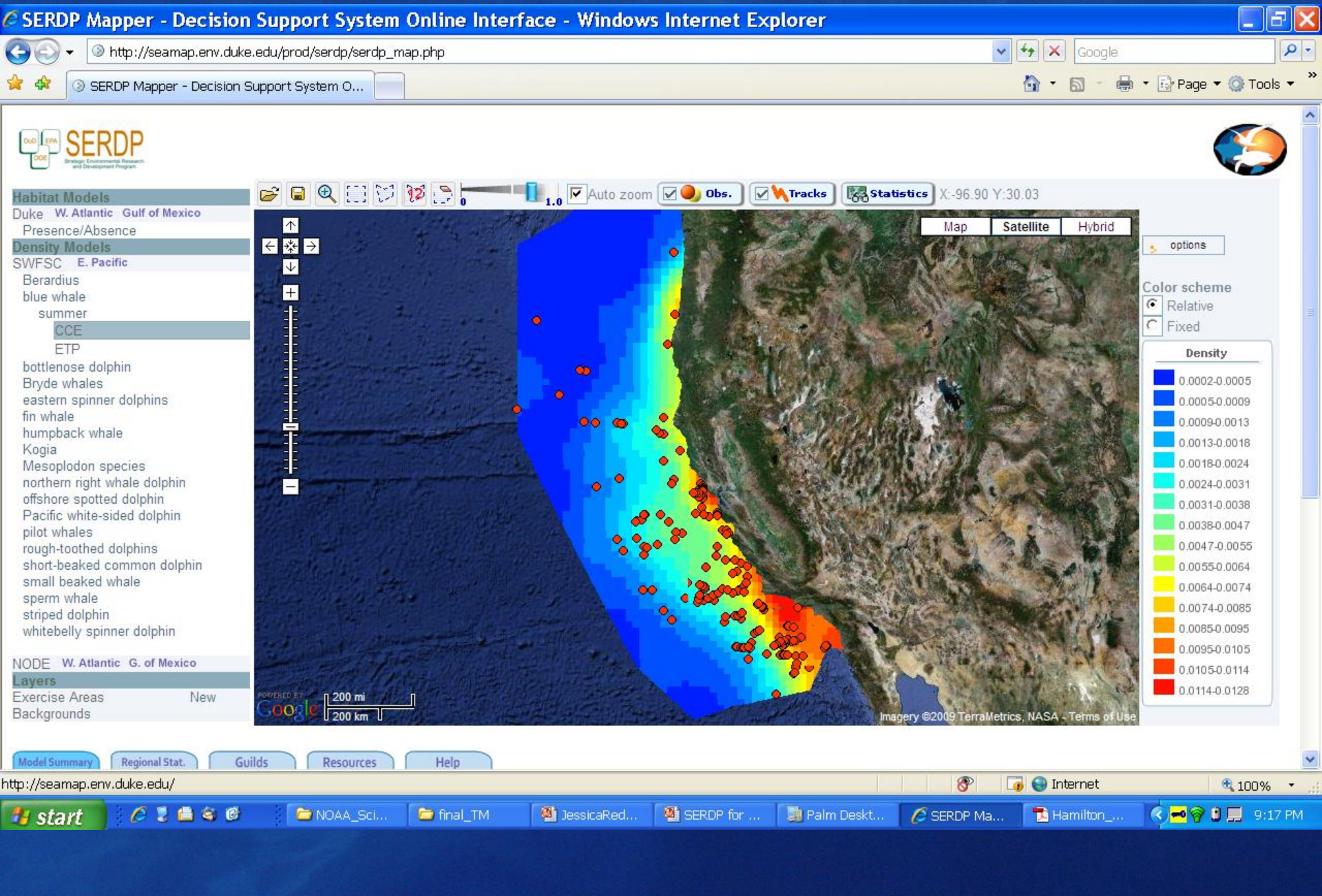
Mean, Standard Error, and Confidence Intervals

A Tool to Estimate Density In User-Defined Regions



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

A Tool to Estimate Density In User-Defined Regions



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

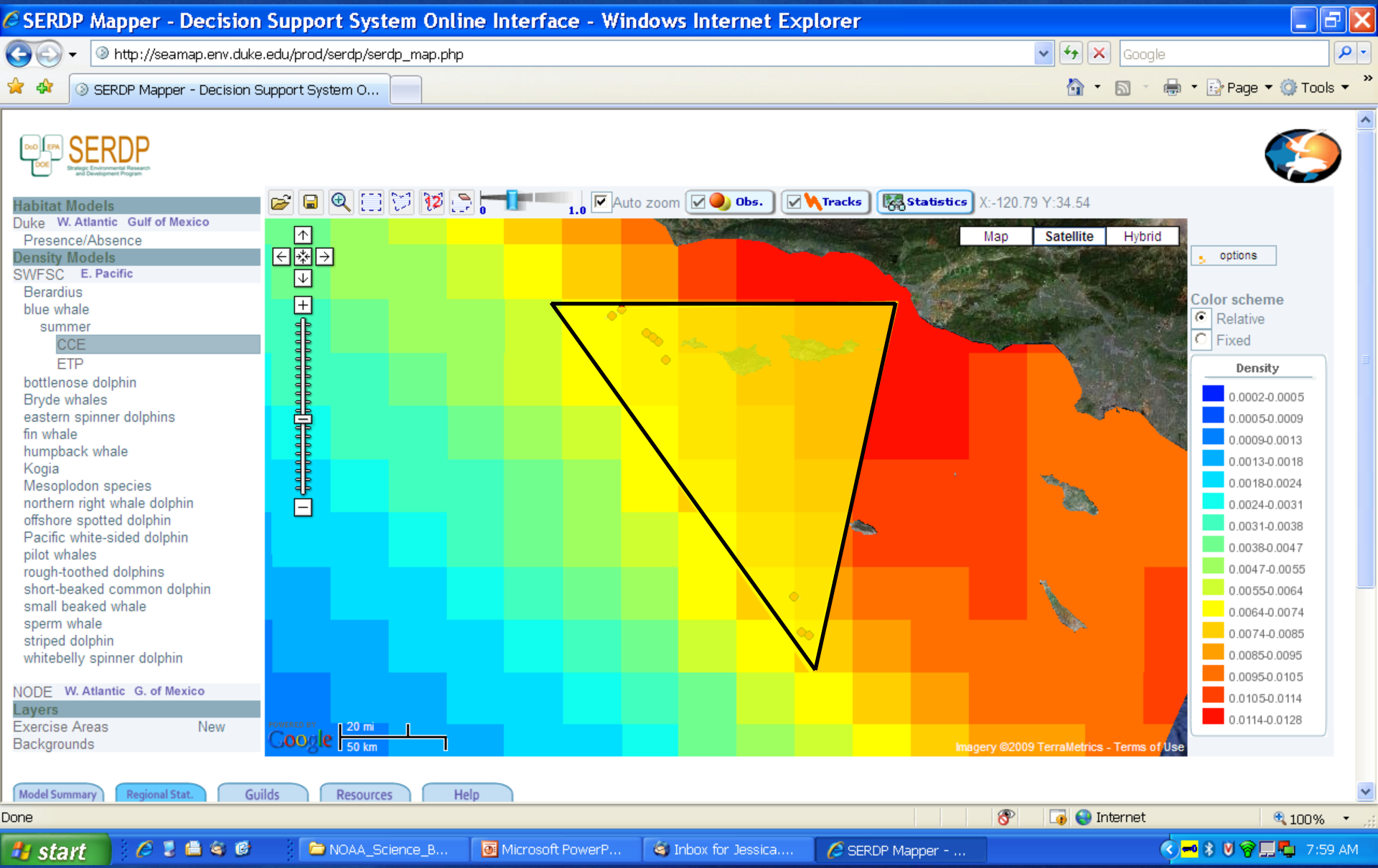
Summary statistics of the model output for the entire area

	Effort		Density (animals per km2) -			
#Obs.	hours	Length (km)	Min	Max	Mean	Std. dev
181	N/A	710.48	0.000193	0.012758	0.002318	0.002772

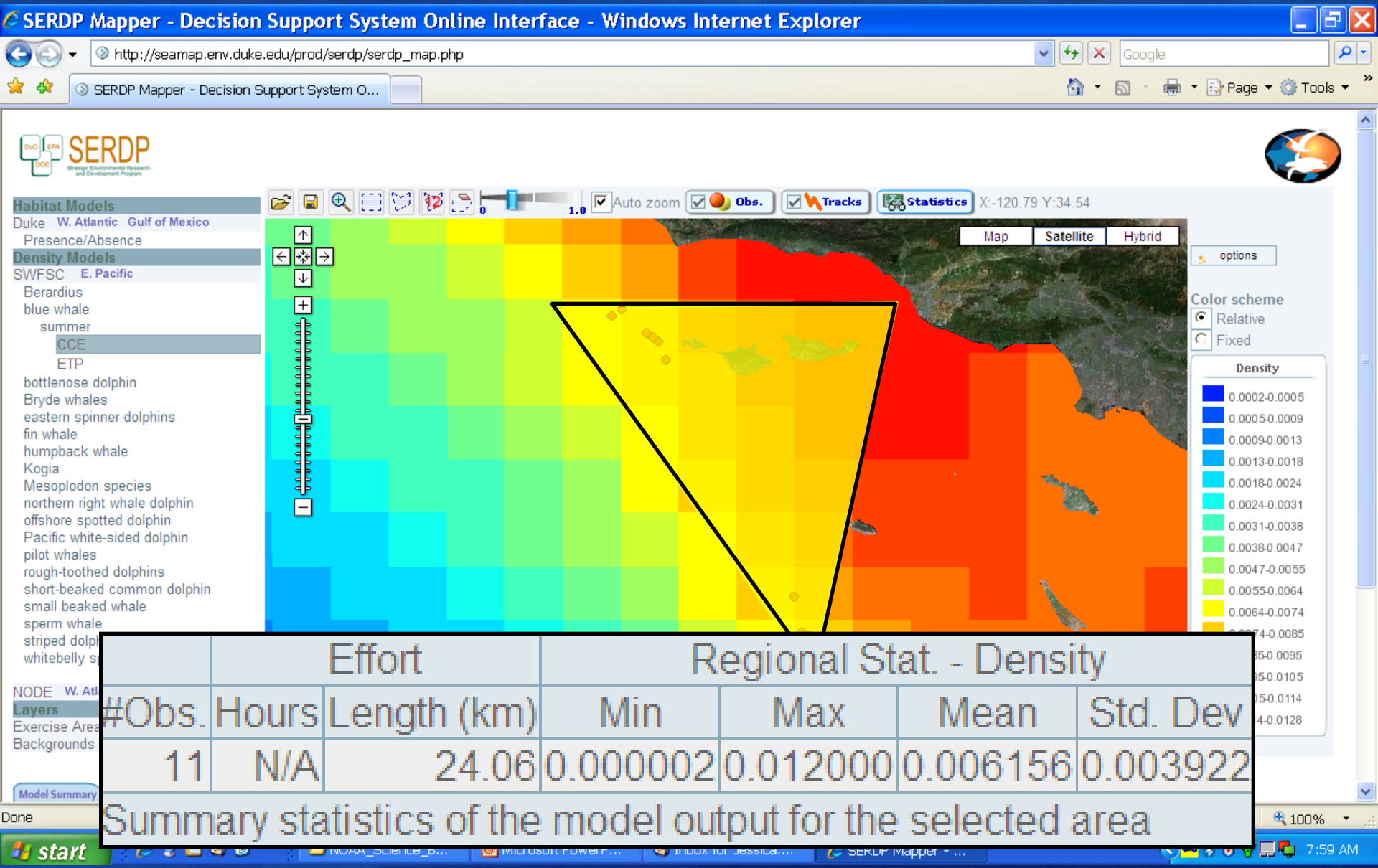
Species in Guild

	Scientific	Common		Status
●	Balaenoptera musculus	blue whale		Endangered

A Tool to Estimate Density In User-Defined Regions



A Tool to Estimate Density In User-Defined Regions

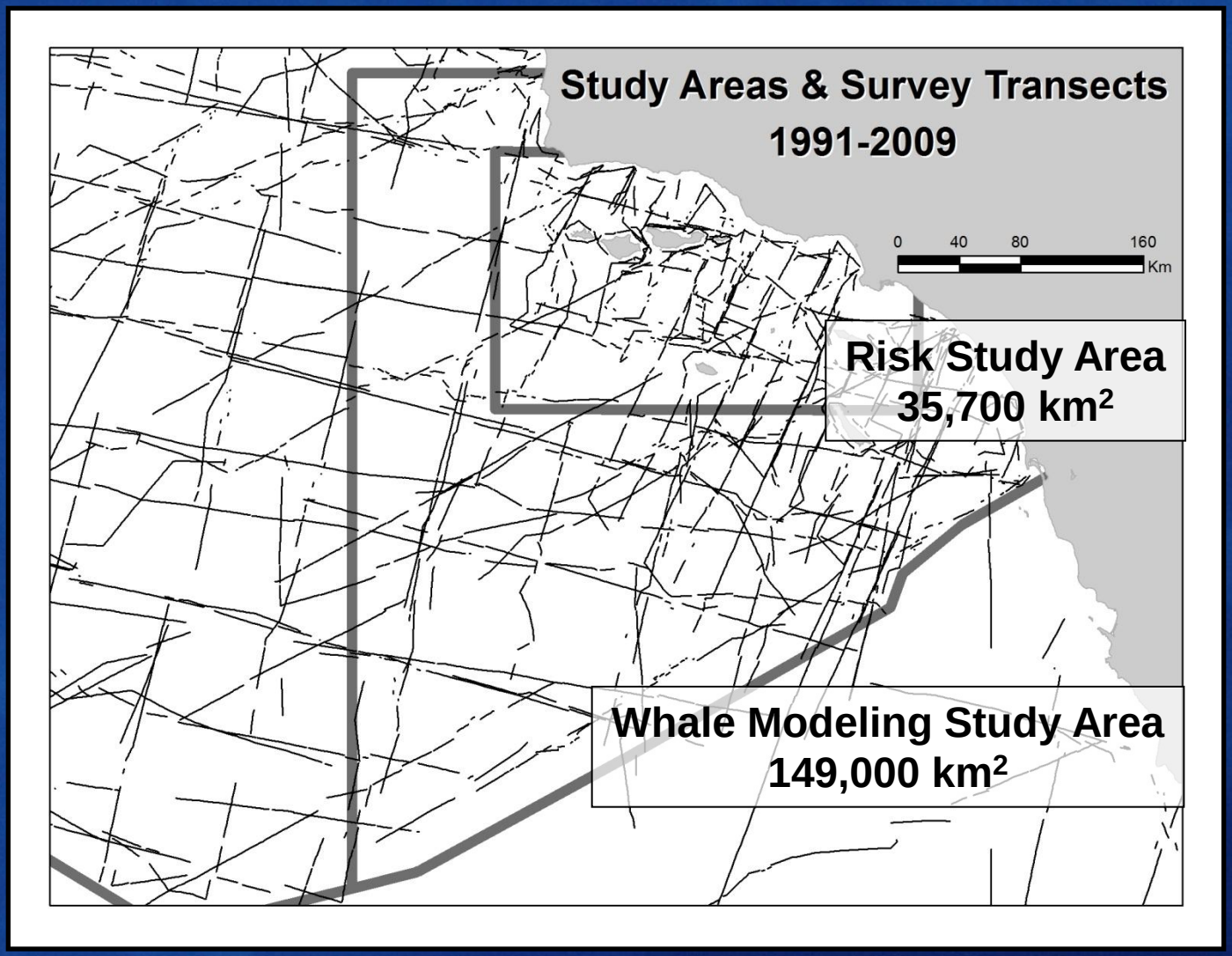


	Effort		Regional Stat. - Density			
#Obs.	Hours	Length (km)	Min	Max	Mean	Std. Dev
11	N/A	24.06	0.000002	0.012000	0.006156	0.003922

Summary statistics of the model output for the selected area

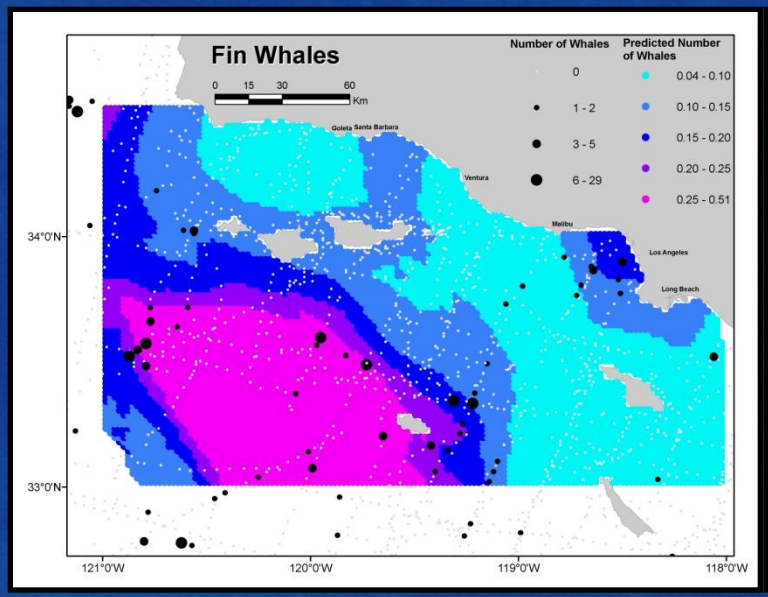
Whales and Ships in the Southern California Bight

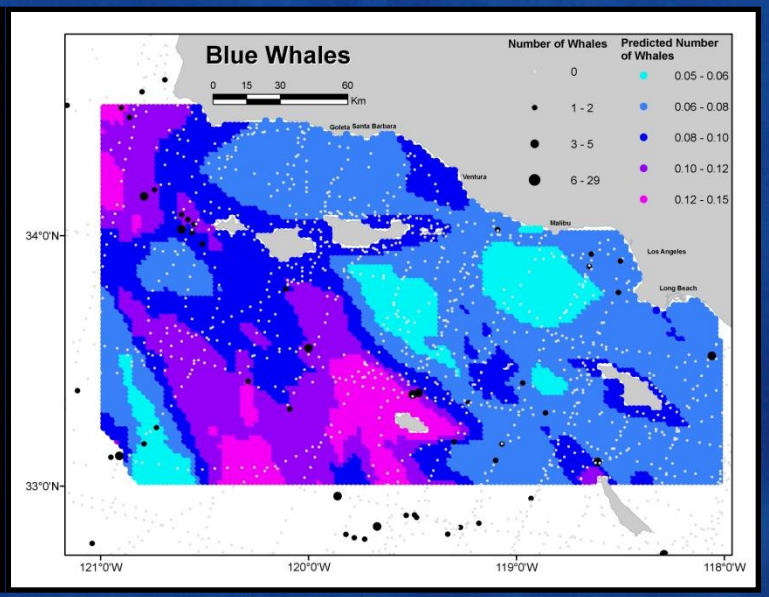
Study Areas

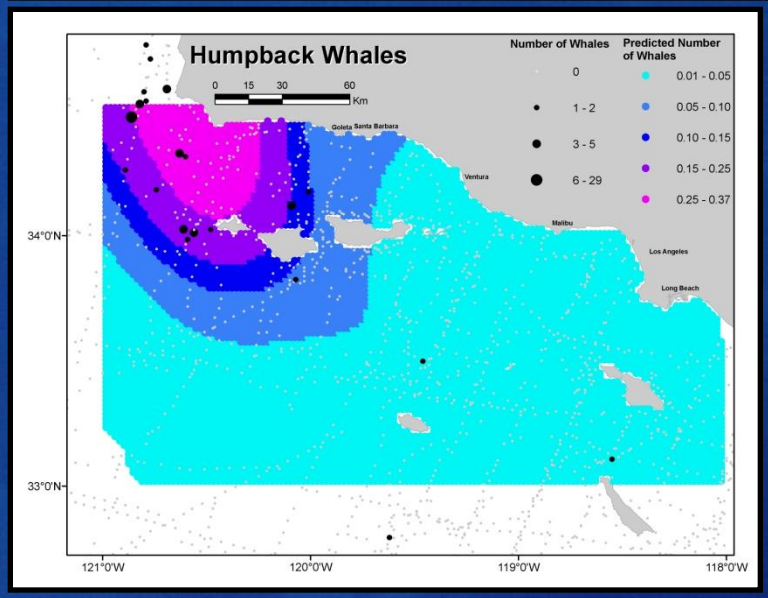

Study Areas & Survey Transects
1991-2009
0
40
80
160
Km
Risk Study Area
35,700 km²
Whale Modeling Study Area
149,000 km²

Preliminary Results

Whale Predictions – 1991 to 2009



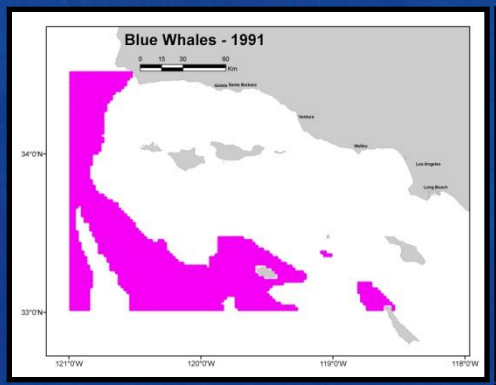


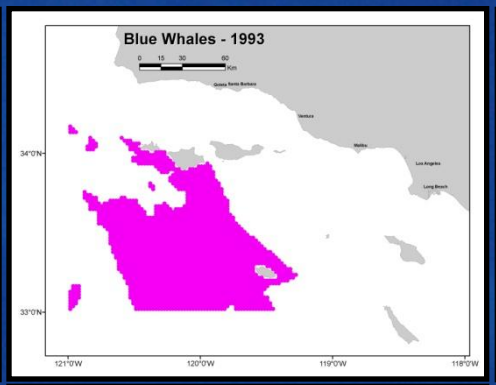


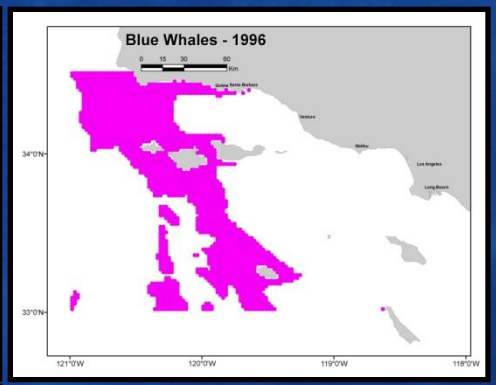
- Fin and humpback whales have opposing hot spots
- Blue whales are spread more evenly through the area

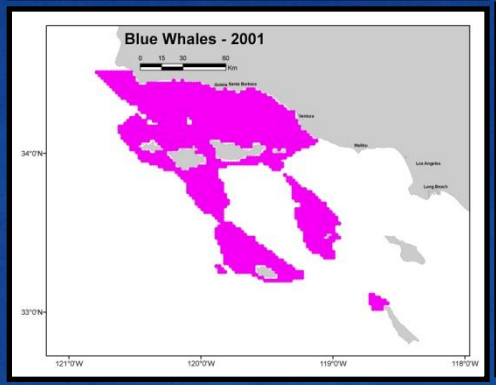
Whale Predictions
Preliminary Results

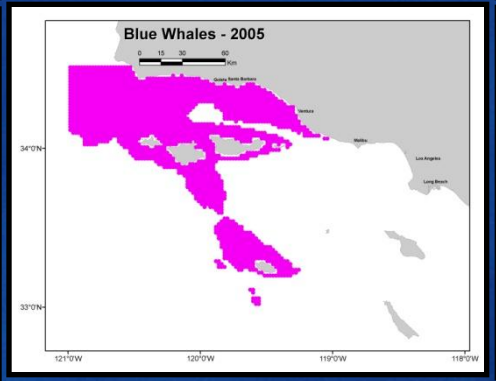
Interannual Variability

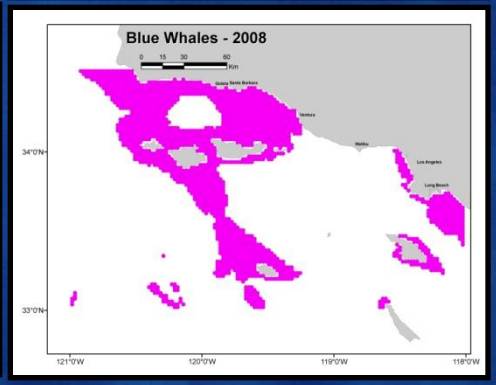


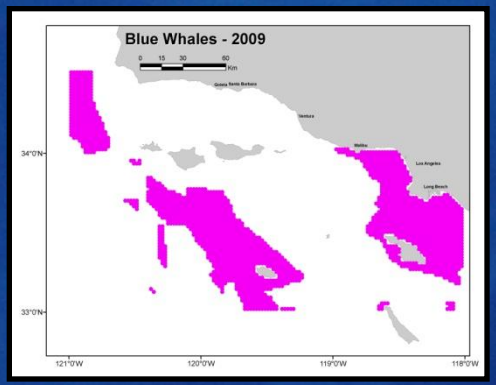












Blue Whales

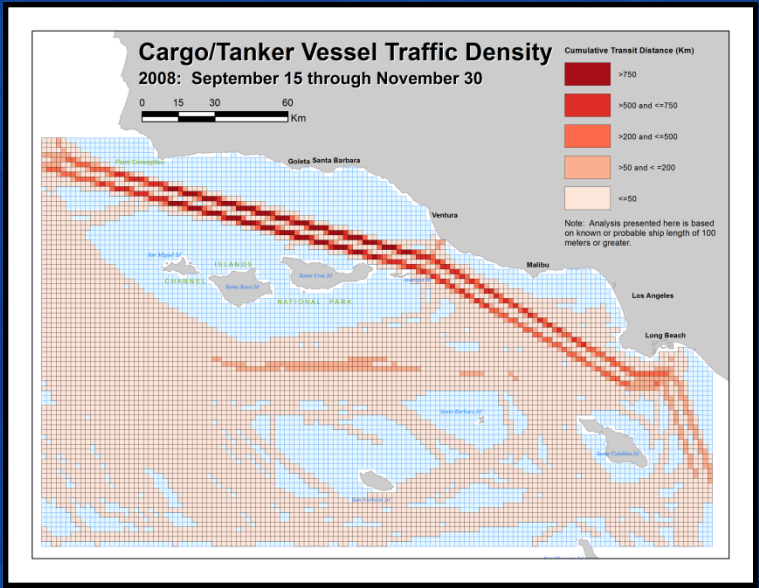
Assessing Risk

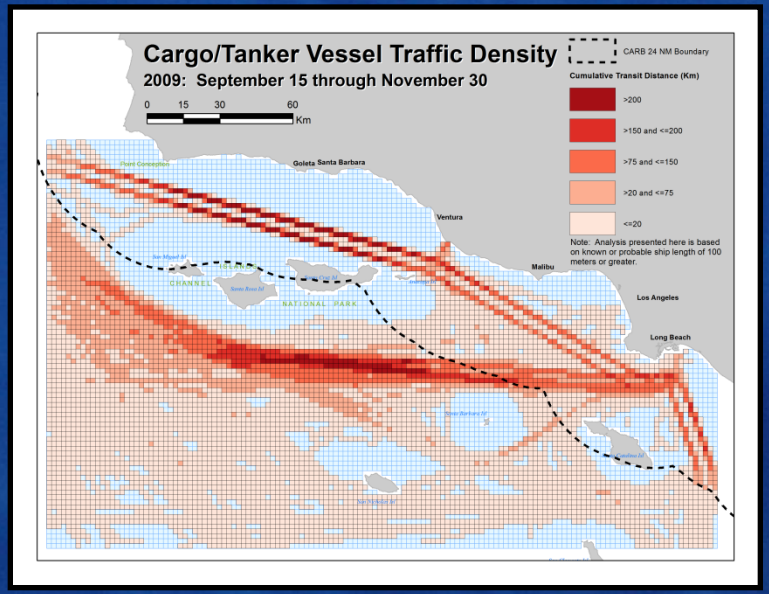
In 2009, the California Air Resources Board (CARB) ruled that ships had to use cleaner fuels when traveling within 24 nmi of the coast.

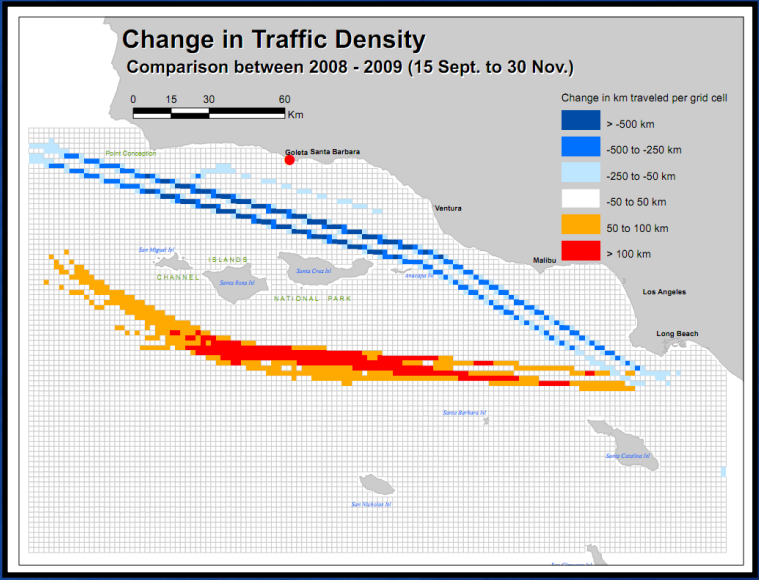
What was the change in risk associated with the change in ship traffic caused by the CARB rule?

Preliminary Results

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

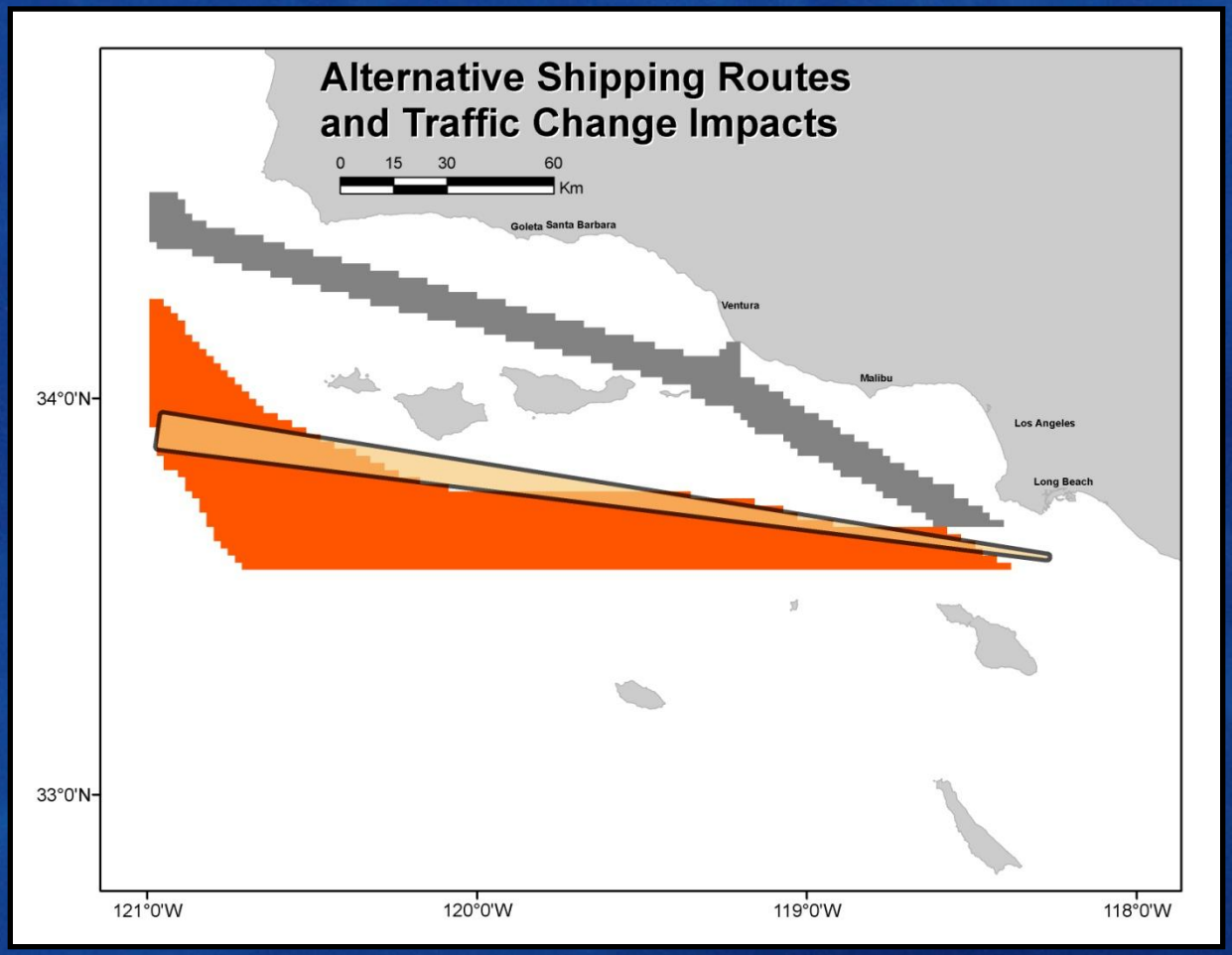
Preliminary Results

Did the change in traffic affect risk?

Channel

Narrow South

Broad South



- Assume traffic is uniformly distributed

Risk = sum(whale density * ship density)

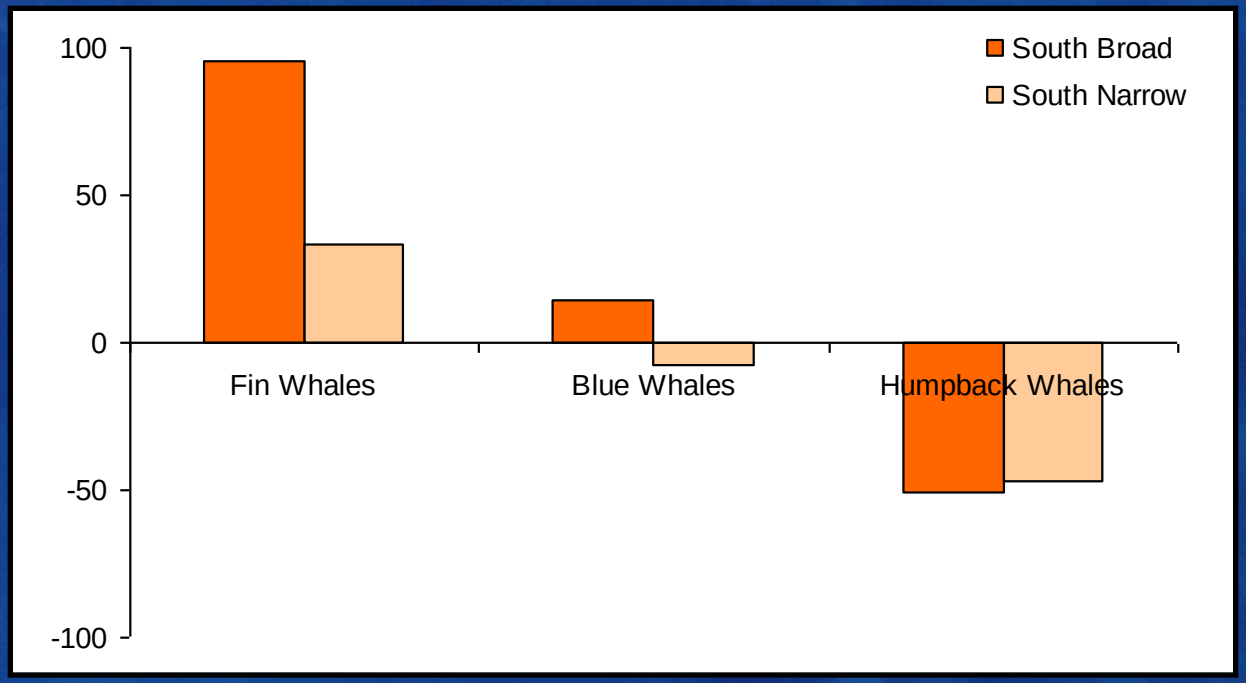
Preliminary Results

Did the change in traffic affect risk?

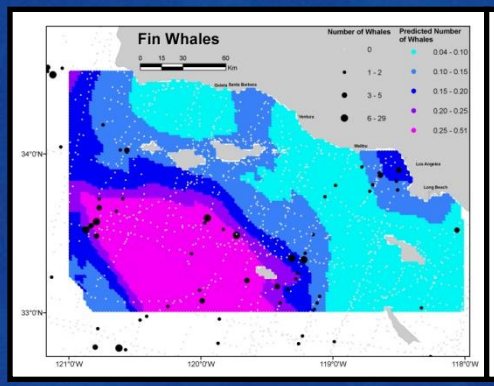
Percent change in risk between traffic patterns in Channel and South

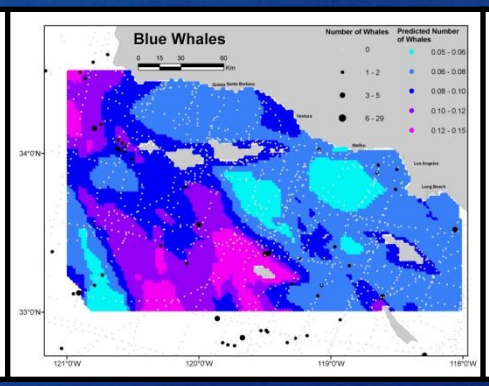
Increase risk from shift south

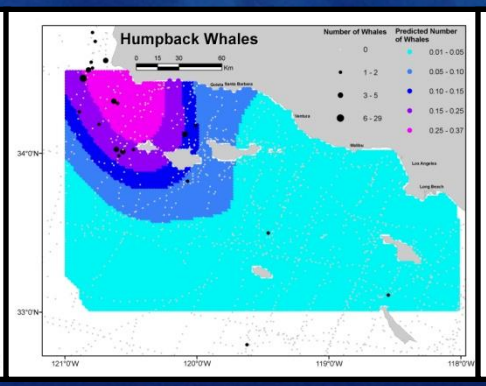
Decrease risk from shift south

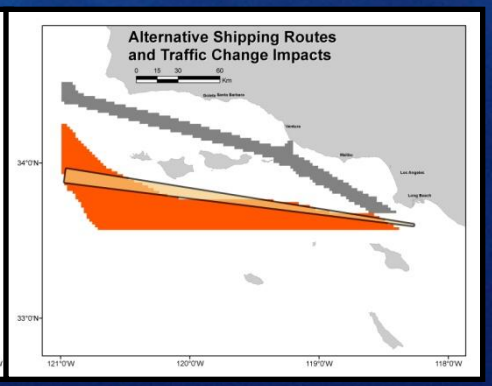


Risk



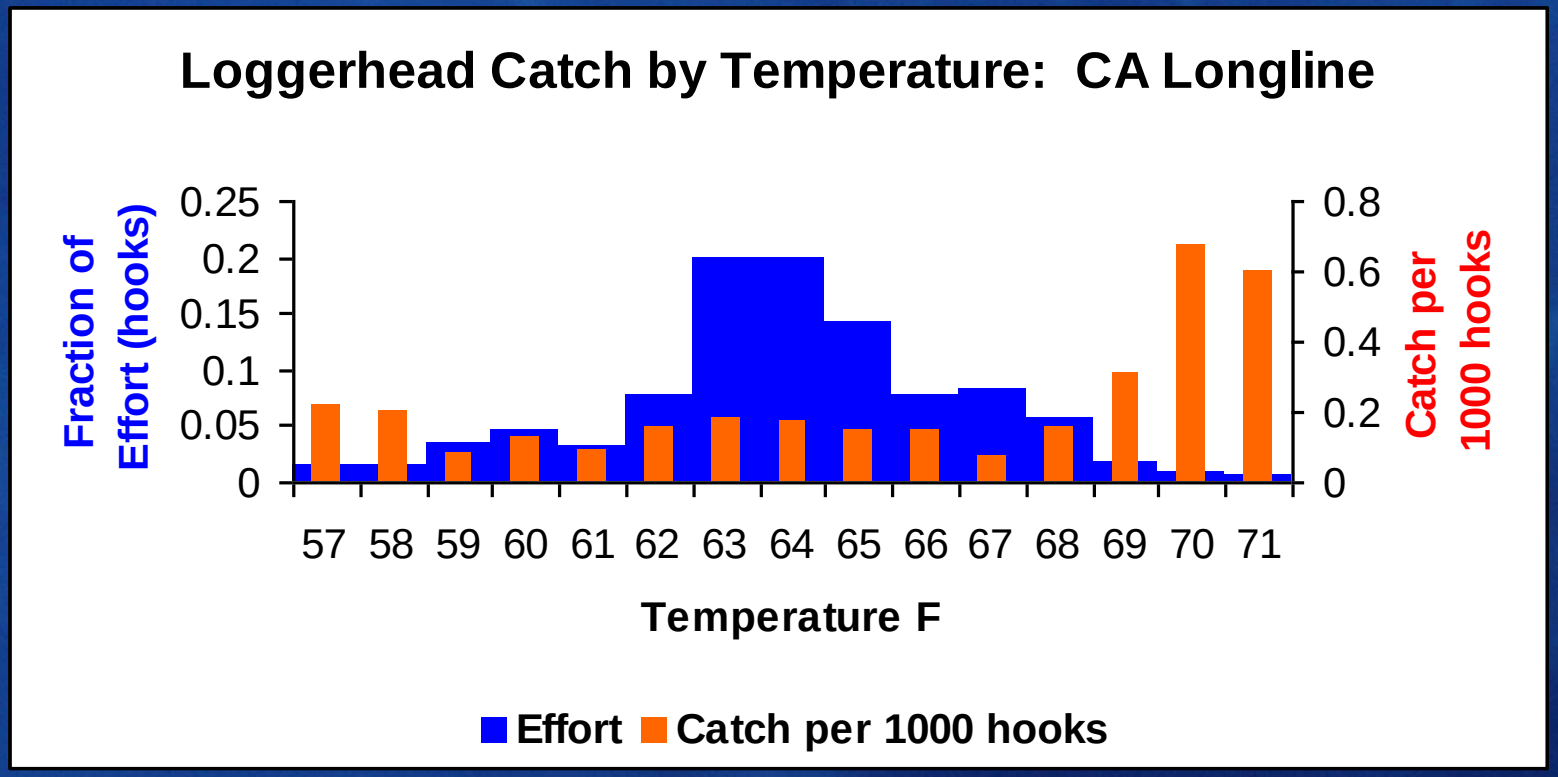






Sea Turtles

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



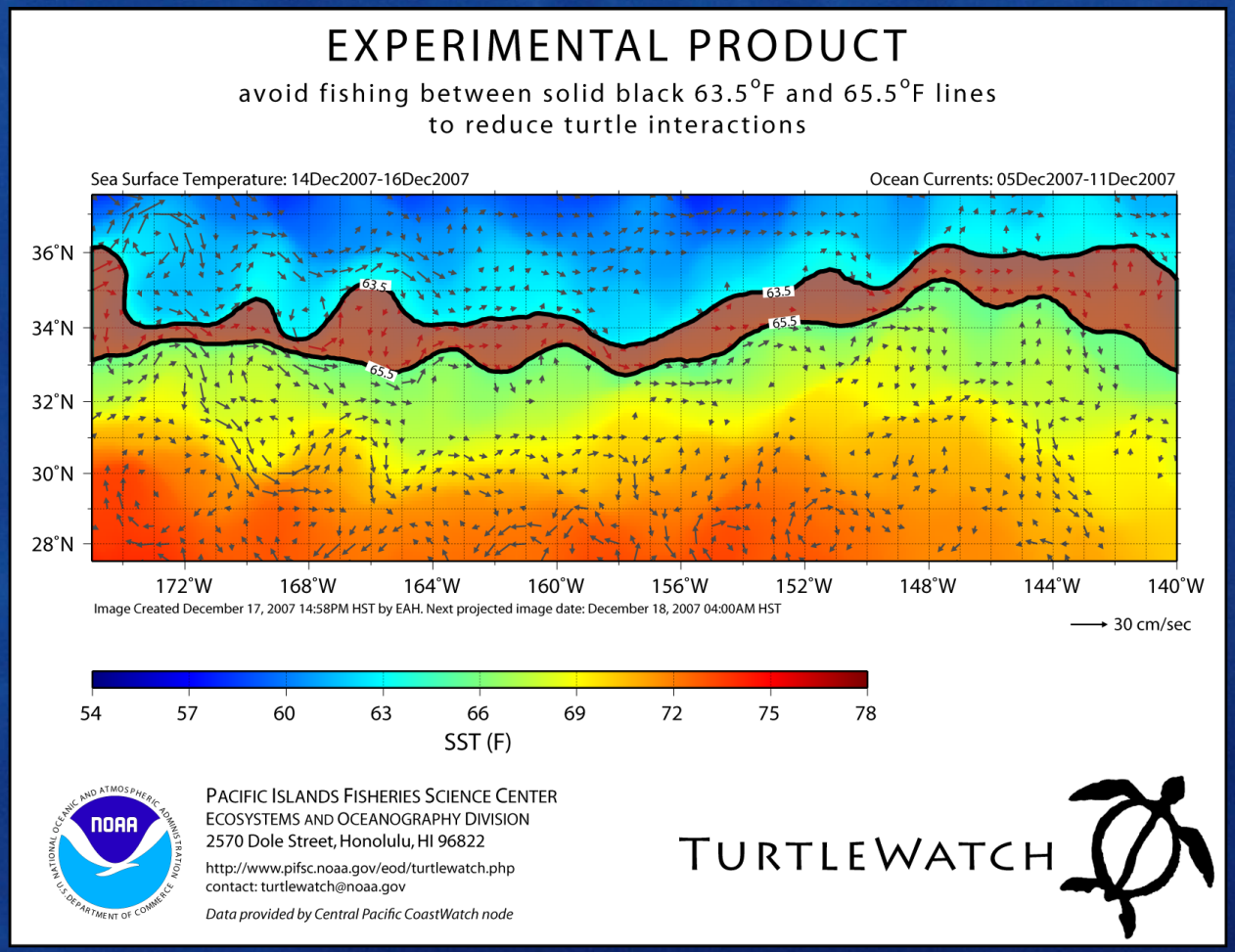
TurtleWatch product

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

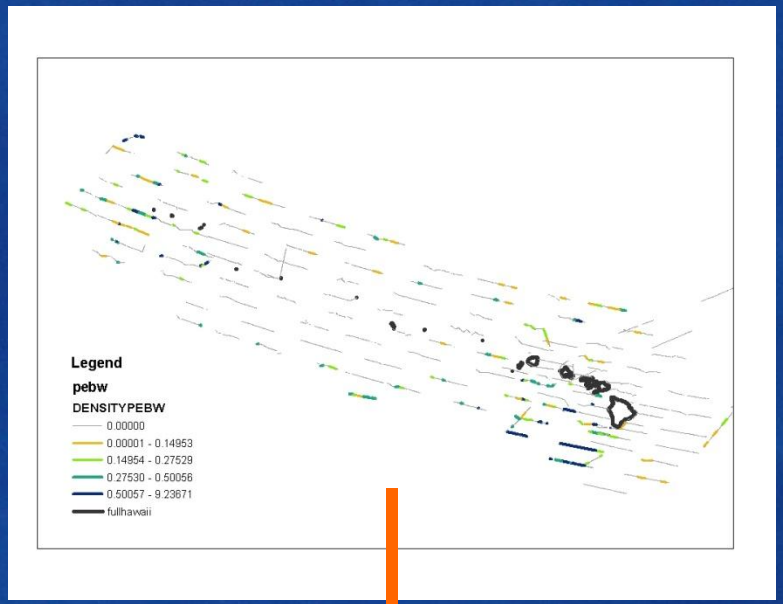
- Reviewing loggerhead interaction data
- Examining the efficacy of using a tool similar to TurtleWatch for leatherbacks
  - Other drivers may determine distributions (e.g., productivity, jelly abundance, etc.)

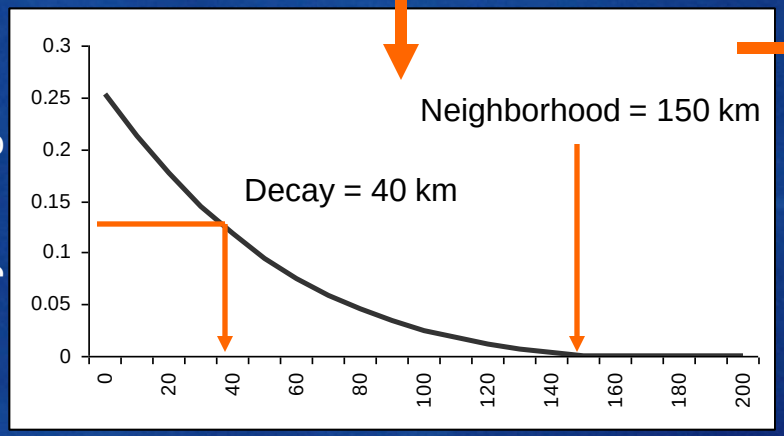
Distribution and Abundance of Seabirds in Hawaiian Waters

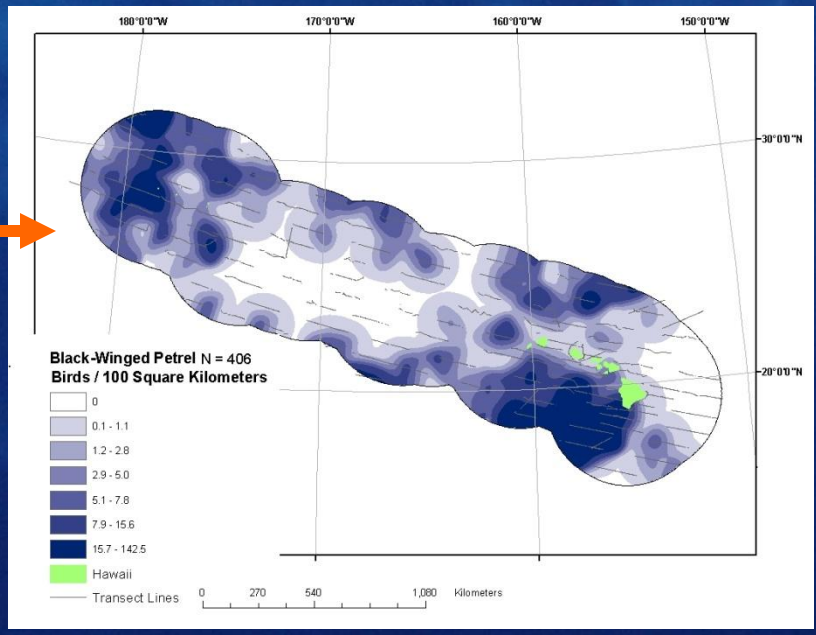
1) Who’s here
2) Where are they?
3) How many?
4) Hot spots?

To plot distributions:

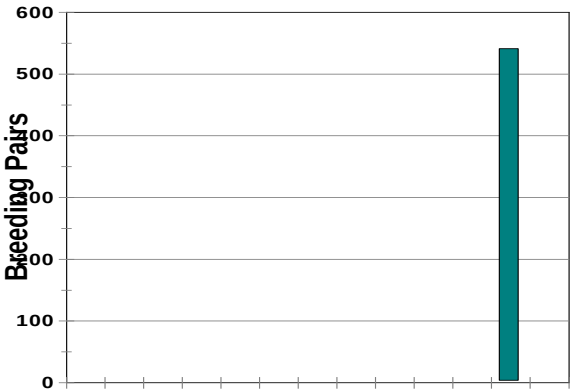
- Calculate density along tracklines
- Interpolate density
  - Negative exponential distance weighting







Breeds Spring - Fall



180°0'0"W 170°0'0"W 160°0'0"W 150°0'0"W

30°0'0"N

20°0'0"N

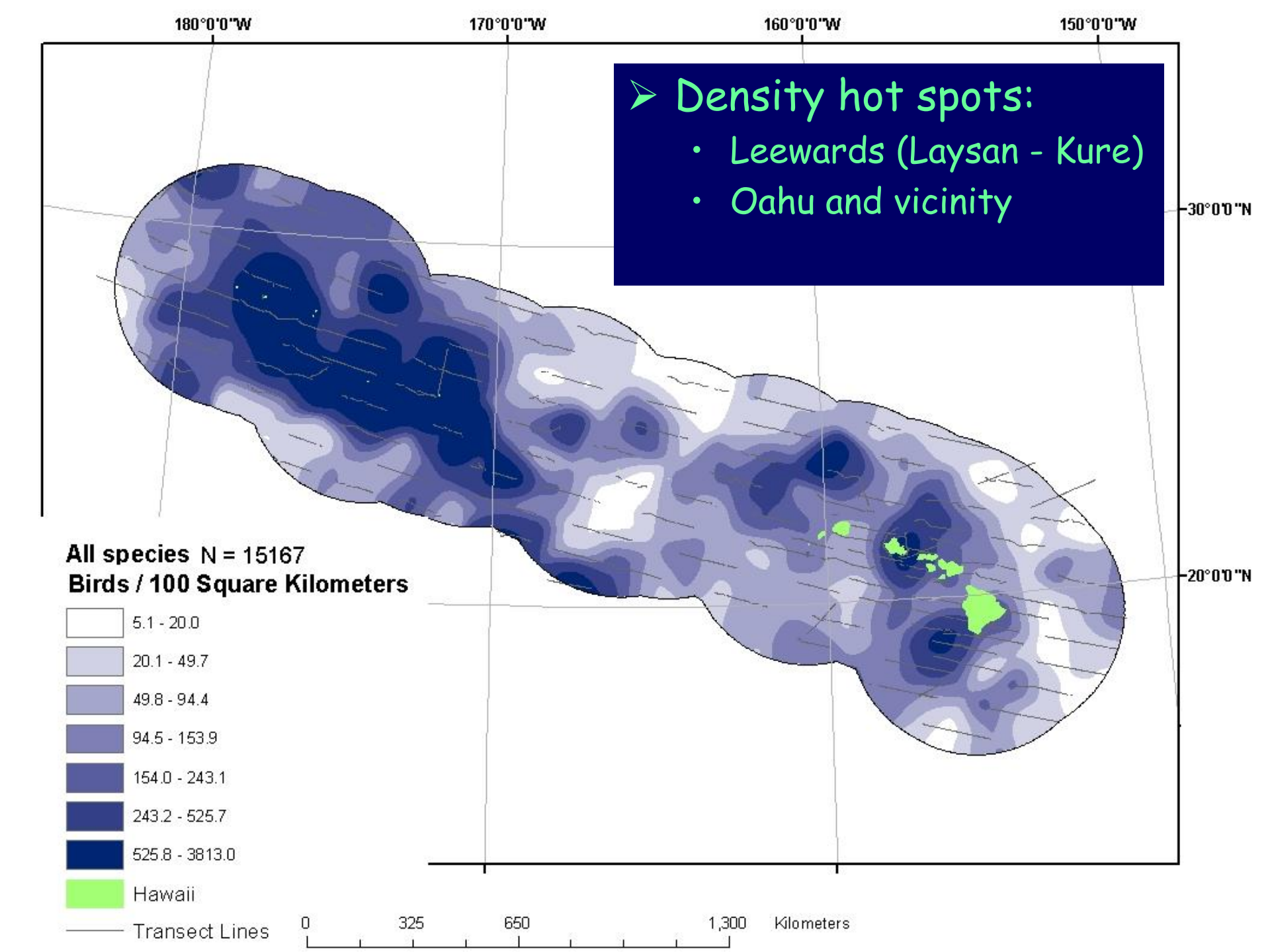
Low Islands

High Islands

Hawaiian Petrel N = 183
Birds / 100 Square Kilometers

- 0
- 0.1 - 1.3
- 1.4 - 2.8
- 2.9 - 4.6
- 4.7 - 7.6
- 7.7 - 13.7
- 13.8 - 47.3
- Hawaii
- Transect Lines

0 340 680 1,360 Kilometers


180°0'0"W
170°0'0"W
160°0'0"W
150°0'0"W
30°0'0"N
20°0'0"N
Density hot spots:
Leewards (Laysan - Kure)
Oahu and vicinity
All species N = 15167
Birds / 100 Square Kilometers
5.1 - 20.0
20.1 - 49.7
49.8 - 94.4
94.5 - 153.9
154.0 - 243.1
243.2 - 525.7
525.8 - 3813.0
Hawaii
Transect Lines
0
325
650
1,300
Kilometers

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)
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