OBIS-SEAMAP:
Developing a biogeographic research data commons for the conservation of marine mammals, sea birds and sea turtles

P.N. Halpin, A. Read, L. Crowder, B. Best, M. Coyne, D. Hyrenbach, S. Freeman, and Ei Fujioka

Nicholas School of the Environment & Earth sciences

Duke University Marine Laboratory

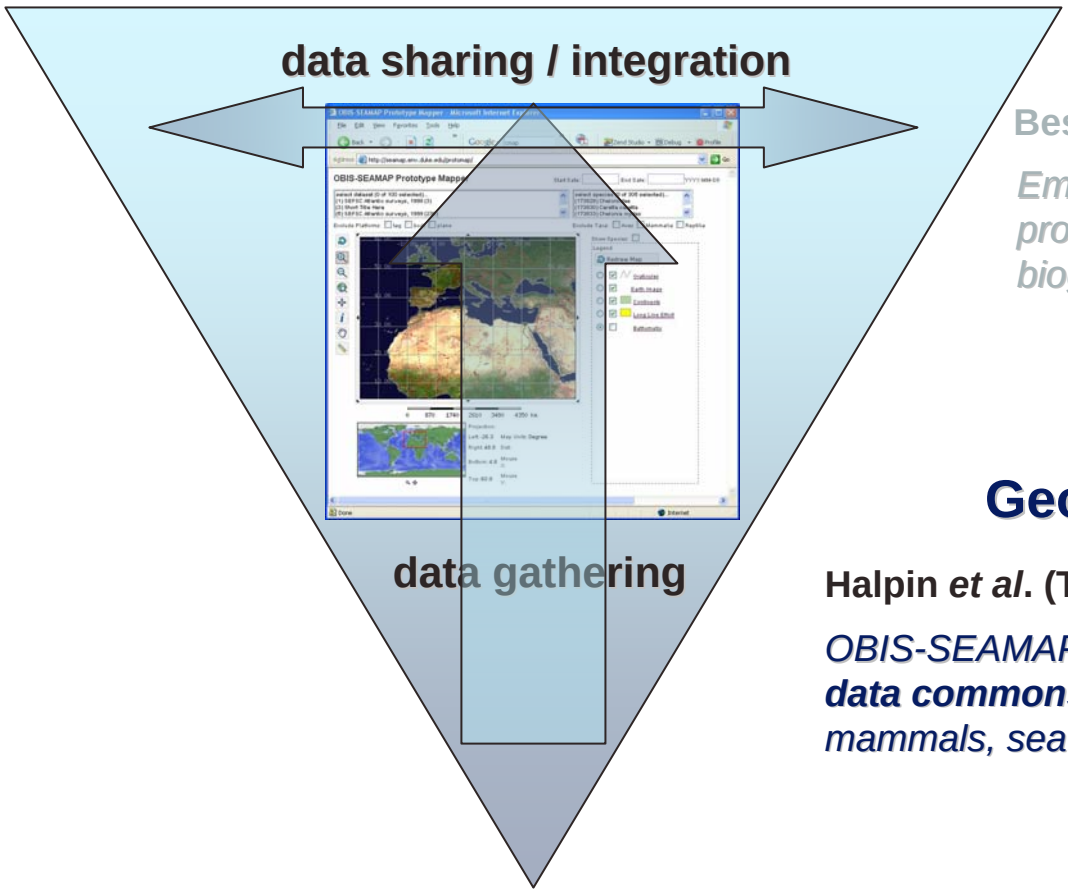
National Oceanographic Partnership Program

Promoting Partnerships for the Future of Oceanography

Overview

The inverted pyramid…

(Quoting: Edward Vanden Berghe)



Information Systems

Best, Coyne & Halpin (Monday)

*Emerging open source software, standards and protocols used for **sharing** and analyzing marine biogeographic data*

Geographic Systems

Halpin *et al*. (Tuesday)

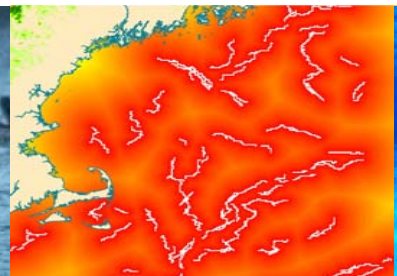
*OBIS-SEAMAP: Developing a biogeographic research **data commons** for the conservation of marine mammals, sea birds and sea turtles*

Topics

- ✓ OBIS-SEAMAP: overview / current status
- ✓ OBIS-SEAMAP: architecture / process
- ✓ Example Analyses:
  - ✓ Habitat modeling
  - ✓ Spatio-temporal modeling

Conserving Marine Animals in a Dynamic Ocean…



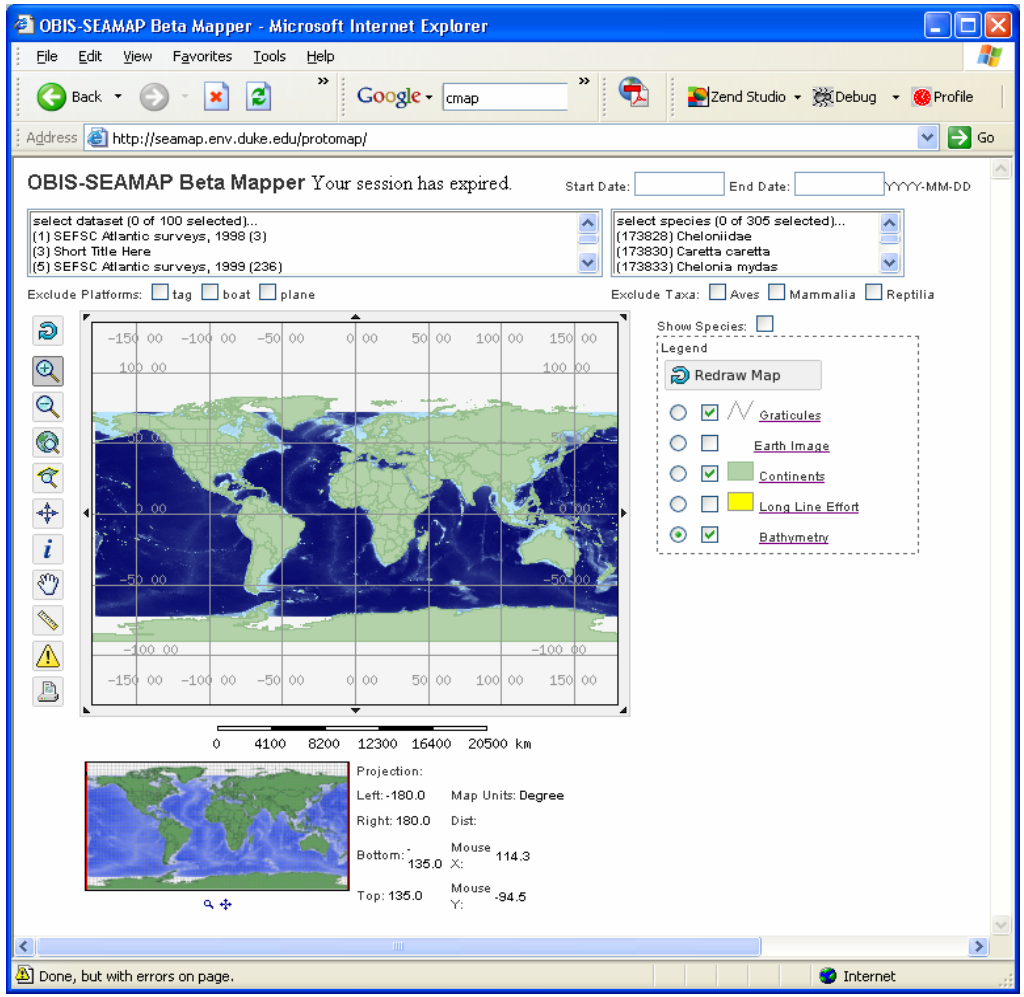

SEAMAP

Spatial Ecological Analysis of Megavertebrate Animal Populations

Internet data collection

- Animal observations
- Oceanographic data
- Species profiles
- Analysis Tools

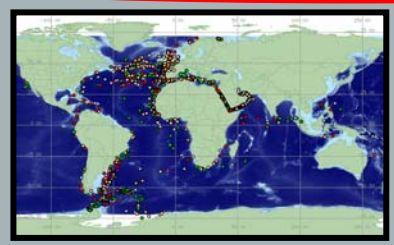
Currently ~300,000 observations and growing

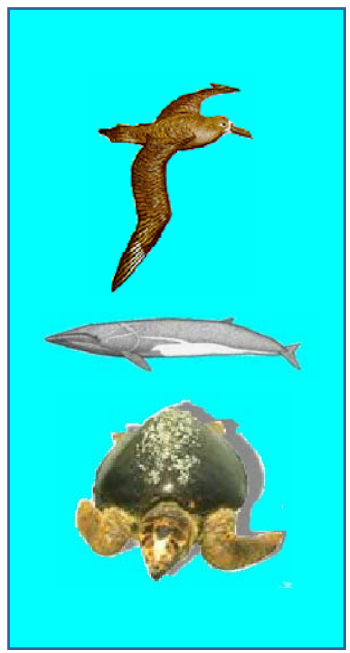


NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

OBIS – SEAMAP Team

Geospatial Analysis	Marine Animals
Halpin (CO-PI)	Read (CO-PI)
Best	Crowder (CO-PI)
Coyne	Hyrenbach
	Freeman





OBIS-SEAMAP Project Strategy

Attract Data Providers with **Tools**

mapping tools; analysis with other biological, physical and anthropogenic data layers; FGDC / ISO metadata creation; download / upload facility

Build Online **Archive**

searchable by: species, location, time, methodology, provider; results mapped, and cross-referenced to species profiles and dataset details

Substantiate with **Research**

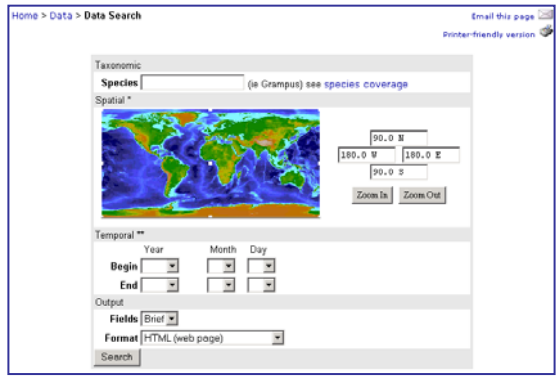
applied and fundamental research relating species distribution and abundance to ocean habitats, climate change, seasonal variability, and anthropogenic impacts

OBIS-SEAMAP

Ocean **B**iogeographic **I**nformation **S**ystem

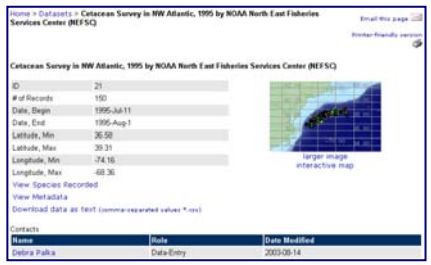
Spatial **E**cological **A**nalysis of **M**egavertebrate **P**opulations

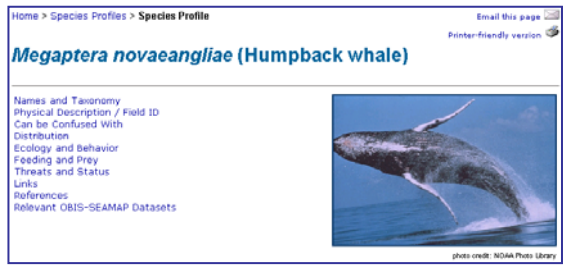
marine mammals, seabirds, sea turtles



Search

- *Query taxonomic, spatial and temporal data*



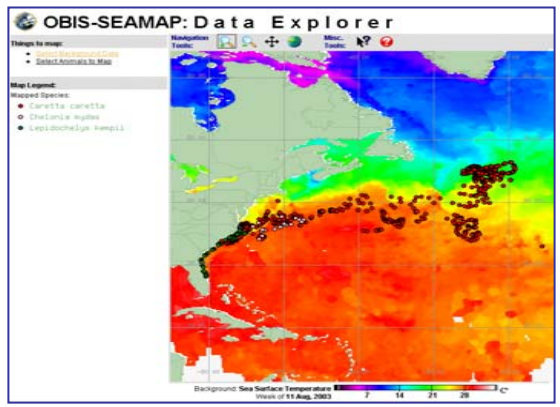


Explore

- *Browse datasets and species profiles*

Map

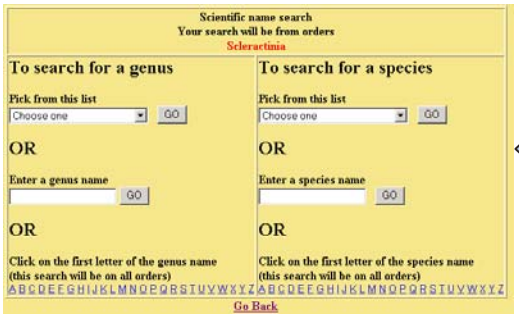
- *Interactively map biological and environmental data*



Online Archive

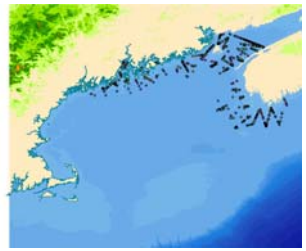
Design Principle: *Central database – multiple views*

Taxonomic Search View

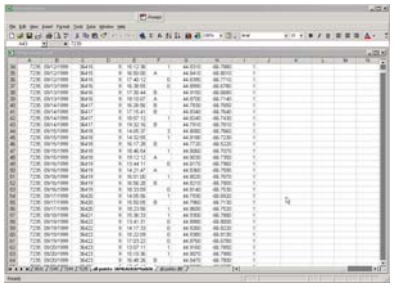


Central Database(s)

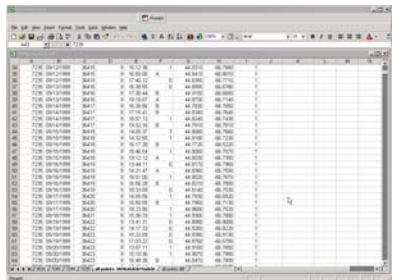
GIS Files View



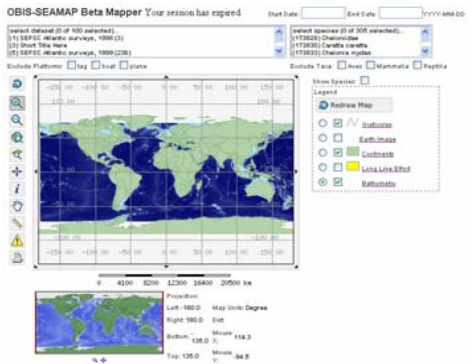
DODS Client View



Database View



Internet Map Server View



Current Status

100 datasets, spanning 1947 – 2004, (297,105 records)

Browse Datasets

tip: column headings are sortable				years				
title	map	platform	effort	begin	end	birds	mammals	turtles
Aerial surveys of marine birds and mammals in support of oil spill response and injury assessment		boat	no	1994	1997	15892	887	6
Allied Whale / College of Atlantic North Atlantic Humpback Whale Catalog, 1976 - 2003, ver2		boat	no	1976	2003	0	8	0
Allied Whale North Atlantic Finback Whale Catalogue		boat	no	1977	1991	0	648	0
BIOMASS		boat	no	1980	1985	16712	0	0
Cascadia Research Blue Whale Photo IDs for US West Coast, 1972-2002		boat	yes	1979	2002	0	5532	0
Cascadia Research Marine Mammal Surveys in US West Coast, 2002		boat	no	2002	2002	0	1220	0
Duke Marine Lab Albatross Tagging, 1997-1999		tag	yes	1997	1999	657	0	0
Duke North Atlantic Harbor Porpoise Tracking		tag	yes	1995	2000	0	5938	0
Duke North Atlantic Turtle Tracking		tag	yes	2002	2004	0	0	3383
East Pacific Sea Turtle Tracking Project (1996-1997)		tag	yes	1996	1997	0	0	394
Indian Ocean Marine Bird and Mammal Survey, 2003		boat	no	2003	2003	2893	31	0
IPHC Opportunistic Short-tailed Albatross		boat	no	1998	2002	141	0	0

Current Status

369 *Species Profiles*

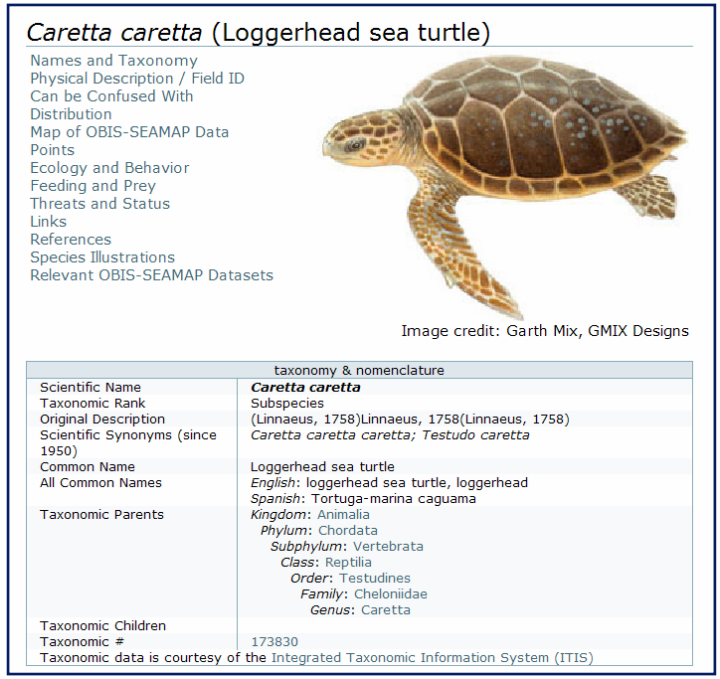
Browse Species Profiles

marine mammals	Sousa teuszii	Atlantic humpback dolphin	
marine mammals	Stenella attenuata	Pantropical spotted dolphin	
marine mammals	Stenella clymene	Clymene dolphin	
marine mammals	Stenella coeruleoalba	Striped dolphin	
marine mammals	Stenella frontalis	Atlantic spotted dolphin	
marine mammals	Stenella longirostris	Spinner dolphin	
marine mammals	Steno bredanensis	Rough-toothed dolphin	
marine mammals	Tasmacetus shepherdi	Shepherd's beaked whale	
marine mammals	Trichechus manatus	manatee	
marine mammals	Tursiops aduncus	Indo-Pacific bottlenose dolphin	
marine mammals	Tursiops truncatus	Bottlenose dolphin	
marine mammals	Ursus maritimus	polar bear	
marine mammals	Zalophus californianus	California sea lion	
marine mammals	Zalophus japonicus	Japanese sea lion	
marine mammals	Zalophus wollebaeki	Galapagos sea lion	
mammals	Balaenoptera physalus	Fin whale	
marine mammals	Berardius arnuxii	Arnux's beaked whale	
marine	Berardius bairdii	Baird's beaked whale	

Current Status

369 *Species Profiles*

- *Natural history information*
- *Taxonomic classification*
- *Bibliography / Web Links*
- *Links to "prey" profiles*



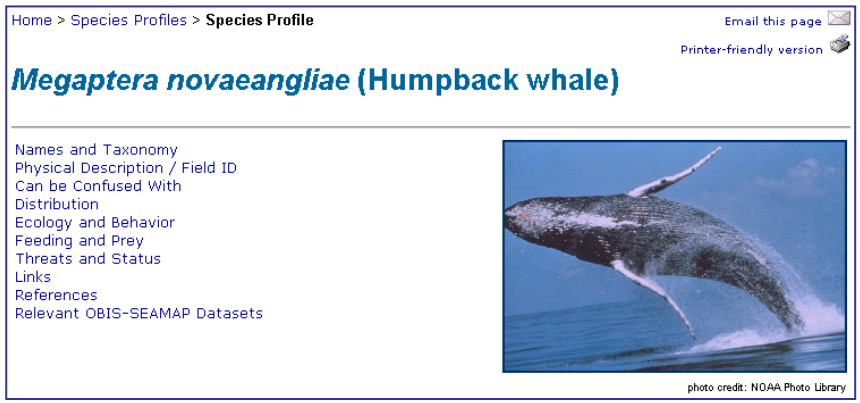
Caretta caretta (Loggerhead sea turtle)

Names and Taxonomy
Physical Description / Field ID
Can be Confused With
Distribution
Map of OBIS-SEAMAP Data Points
Ecology and Behavior
Feeding and Prey
Threats and Status
Links
References
Species Illustrations
Relevant OBIS-SEAMAP Datasets

Image credit: Garth Mix, GMIX Designs

taxonomy & nomenclature	
Scientific Name	***Caretta caretta***
Taxonomic Rank	Subspecies
Original Description	(Linnaeus, 1758)Linnaeus, 1758(Linnaeus, 1758)
Scientific Synonyms (since 1950)	*Caretta caretta caretta; Testudo caretta*
Common Name	Loggerhead sea turtle
All Common Names	*English*: loggerhead sea turtle, loggerhead *Spanish*: Tortuga-marina caguama
Taxonomic Parents	*Kingdom*: Animalia *Phylum*: Chordata *Subphylum*: Vertebrata *Class*: Reptilia *Order*: Testudines *Family*: Cheloniidae *Genus*: Caretta
Taxonomic Children	
Taxonomic #	173830

Taxonomic data is courtesy of the Integrated Taxonomic Information System (ITIS)



Home > Species Profiles > **Species Profile**

Email this page
Printer-friendly version

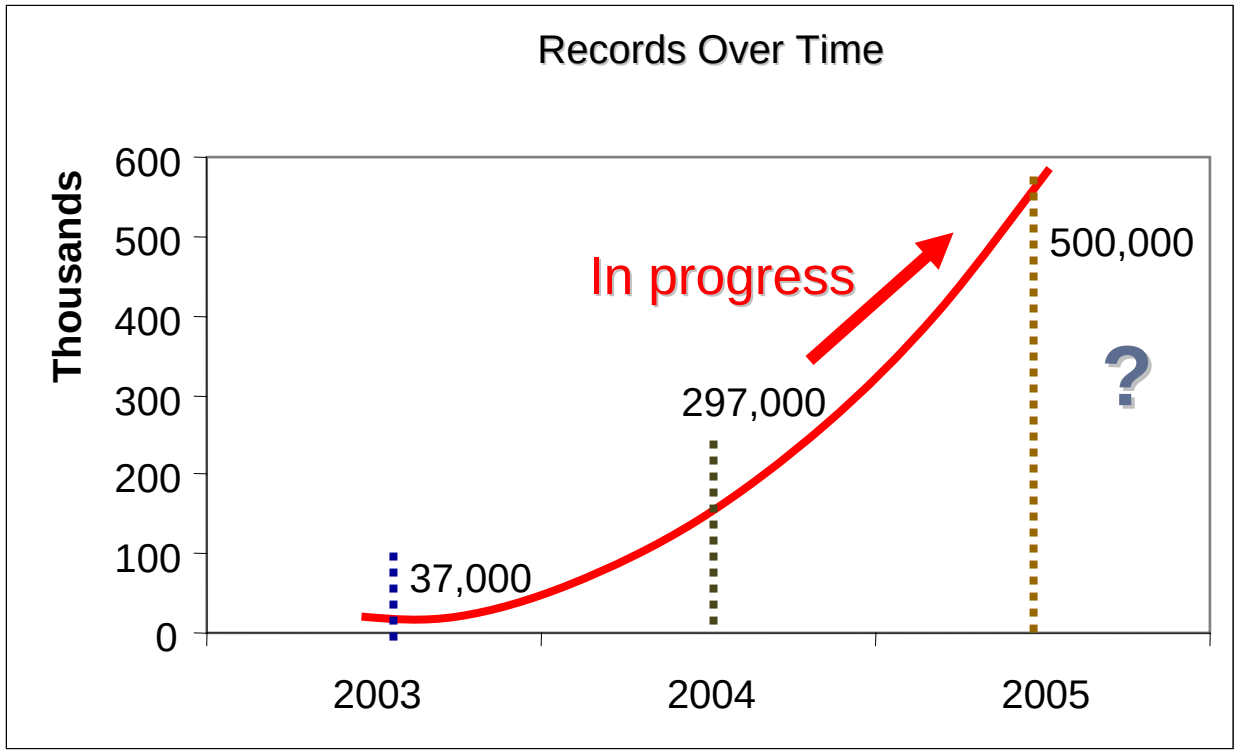
***Megaptera novaeangliae* (Humpback whale)**

Names and Taxonomy
Physical Description / Field ID
Can be Confused With
Distribution
Ecology and Behavior
Feeding and Prey
Threats and Status
Links
References
Relevant OBIS-SEAMAP Datasets

photo credit: NOAA Photo Library

Work in progress …

Approximately ~50 additional datasets in progress



Startup

Capacity

Tools & Analysis

Data provider tools

cruise	year	month	day	time	lat	long	species	size
aj9701	1997	8	23	9:43:34	40.646	-68.507	SADDLEBACK DOLPHIN	8
aj9701	1997	8	23	13:35:07	40.378	-68.126	SPERM WHALE	5
aj9701	1997	8	23	14:01:05	40.335	-68.068	PILOT WHALE	4
aj9701	1997	8	23	14:25:26	40.293	-68.014	FIN WHALE	1
aj9701	1997	8	24	6:41:17	39.973	-67.331	SPERM WHALE	1
aj9701	1997	8	24	6:42:22	39.975	-67.328	KILLER WHALE	2
aj9701	1997	8	24	6:52:31	39.99	-67.301	KILLER WHALE	3
aj9701	1997	8	24	6:54:30	39.993	-67.295	SPERM WHALE	15
aj9701	1997	8	24	6:59:05	40	-67.283	SPERM WHALE	3
aj9701	1997	8	24	7:17:04	40.027	-67.233	STRIPED DOLPHIN	1
aj9701	1997	8	24	8:22:10	40.122	-67.047	UID LARGE WHALE	1
aj9701	1997	8	24	9:58:12	40.265	-66.767	FALSE KILLER WHALE	1
aj9701	1997	8	24	10:13:22	40.287	-66.725	FALSE KILLER WHALE	2

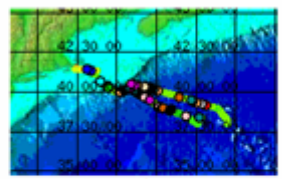
Go from **raw** data to **mapped** data with **taxonomies** and **metadata**

Using the *MyData* interface

Cetacean Survey in NW Atlantic, 1997 by NOAA North East Fisheries Services Center (NEFSC)

ID	19
# of Records	60
Date, Begin	1997-Aug-23
Date, End	1997-Sep-4
Latitude, Min	38.38
Latitude, Max	41.40
Longitude, Min	-69.36
Longitude, Max	-61.84

View Species Recorded
View Metadata



larger image
interactive map

Data Provider Profiles

Profile

Dr. David Hyrenbach

Title	Research Scientist
Organization	Duke University Marine Laboratory acronym: DUML
Address (line 1)	135 Duke Marine Lab Road
Address (line 2)	
City	Beaufort
State	NC
Zip	28516
Country	USA
Phone	+1 (252) 504-7576
Fax	+1 (252) 504-7648
Email	khyrenba@duke.edu
URL	http://moray.ml.duke.edu//david_hyrenbach.shtml
Comments	

Edit My Profile

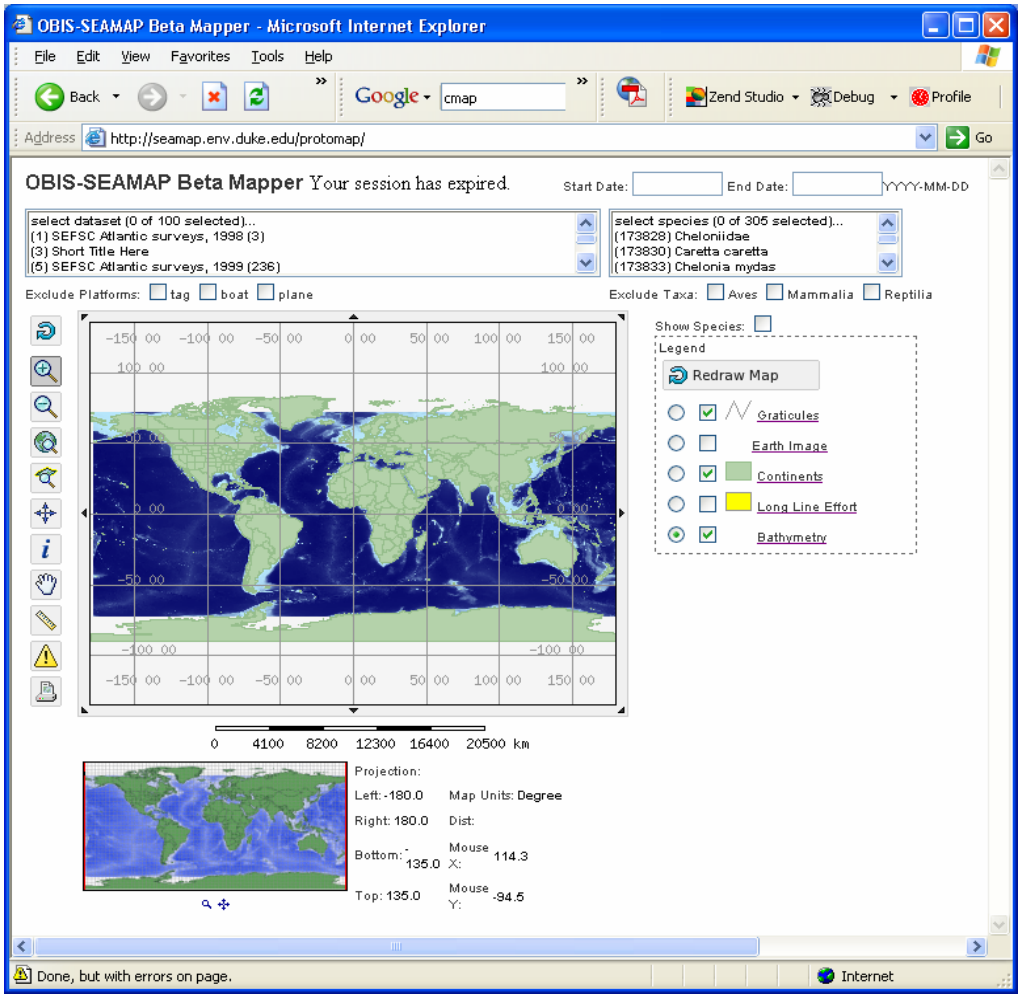
Datasets

ID	Title	Taxonomy	Metadata	Published	Owner	Actions
7	Duke Marine Lab Albatross Tagging	X	X	X	David Hyrenbach	

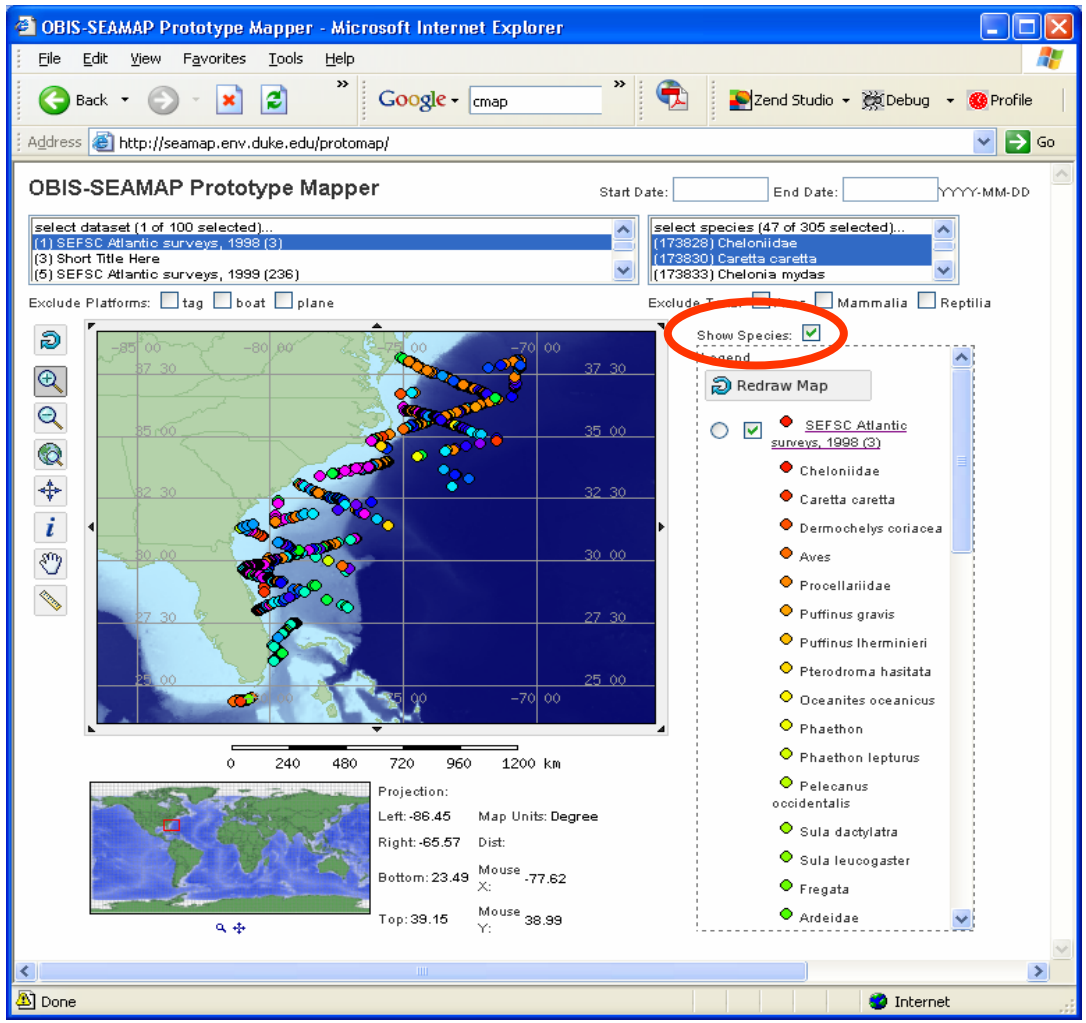
Personalized provider profiles:

- ✓ *acknowledge contributions*
- ✓ *facilitate dataset management*
- ✓ *promote cooperation*

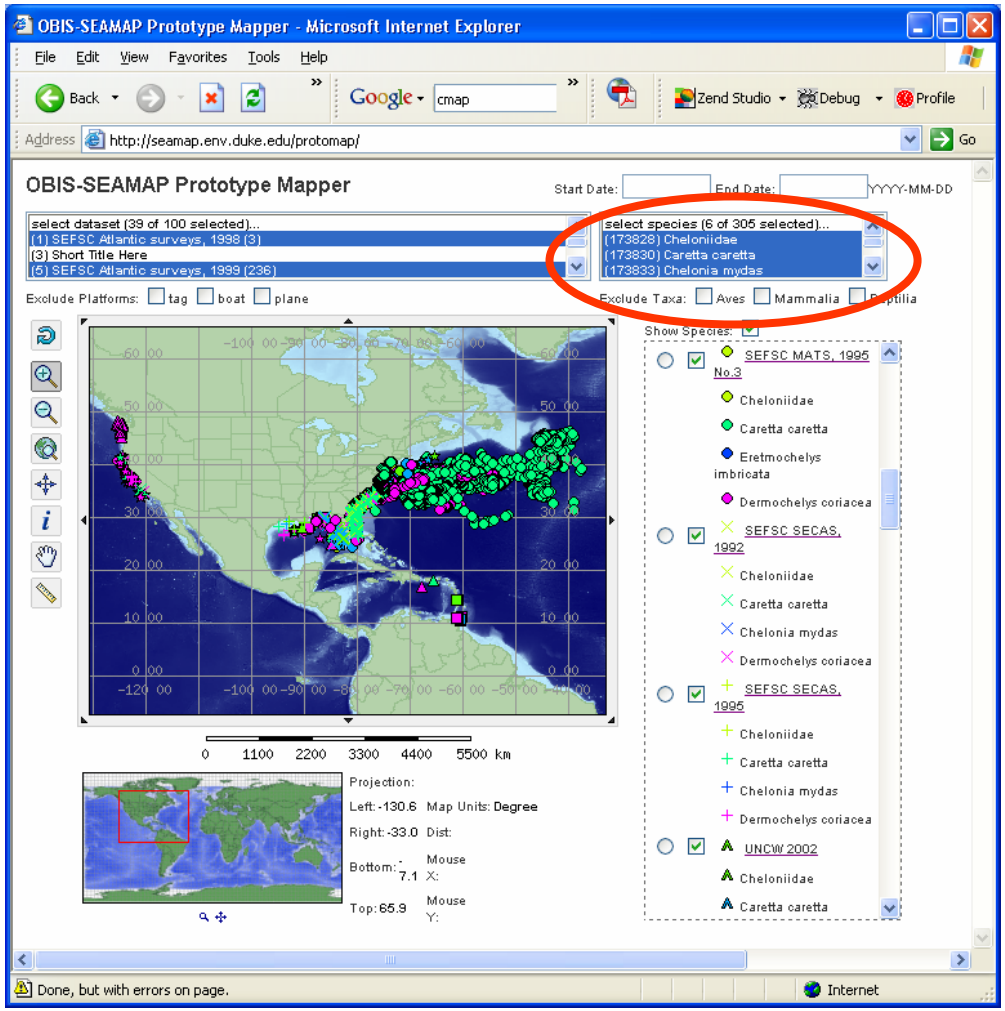
Mapping functionality:



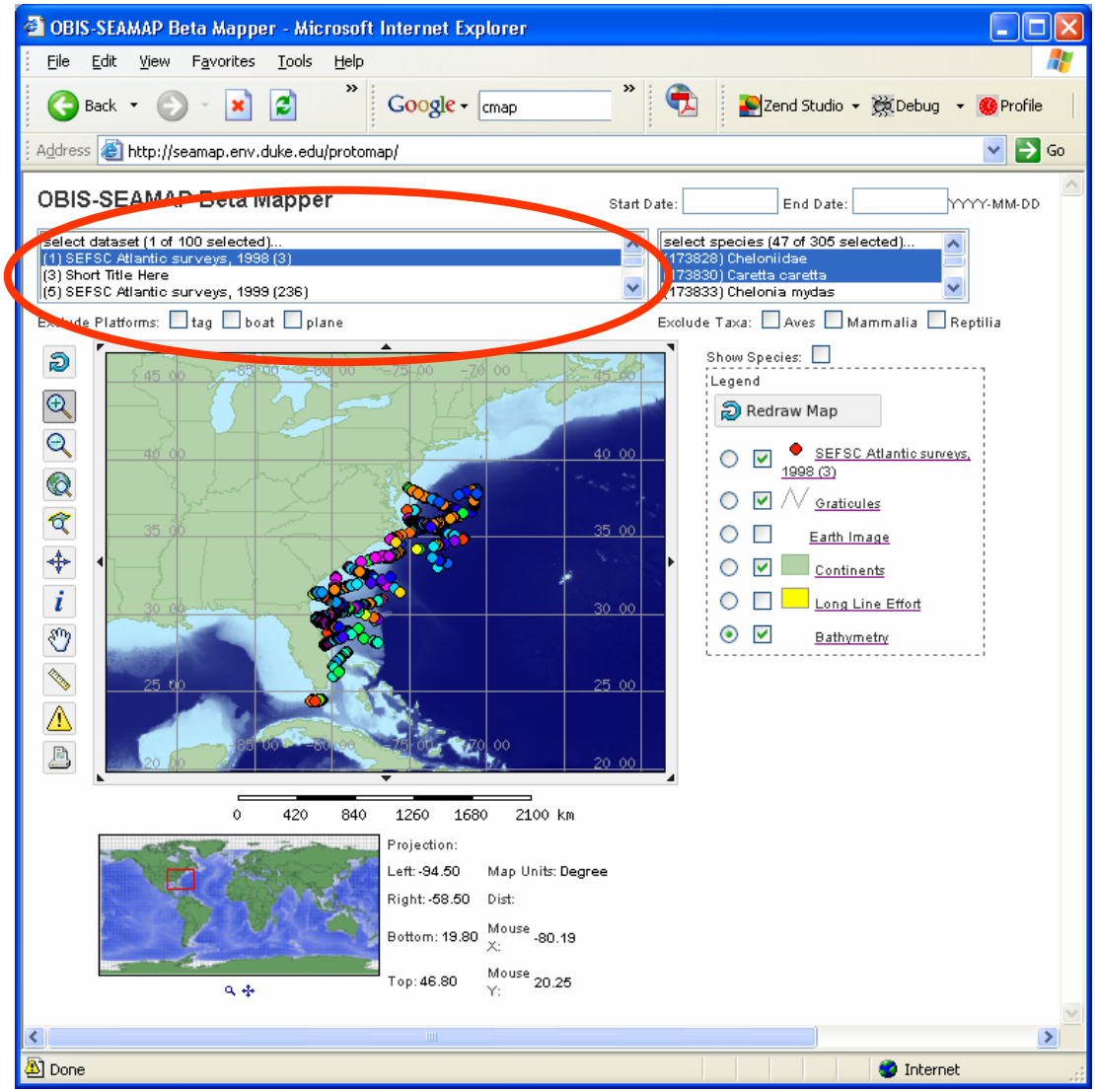
Mapping functionality:
Show species



Mapping functionality:
Select by species

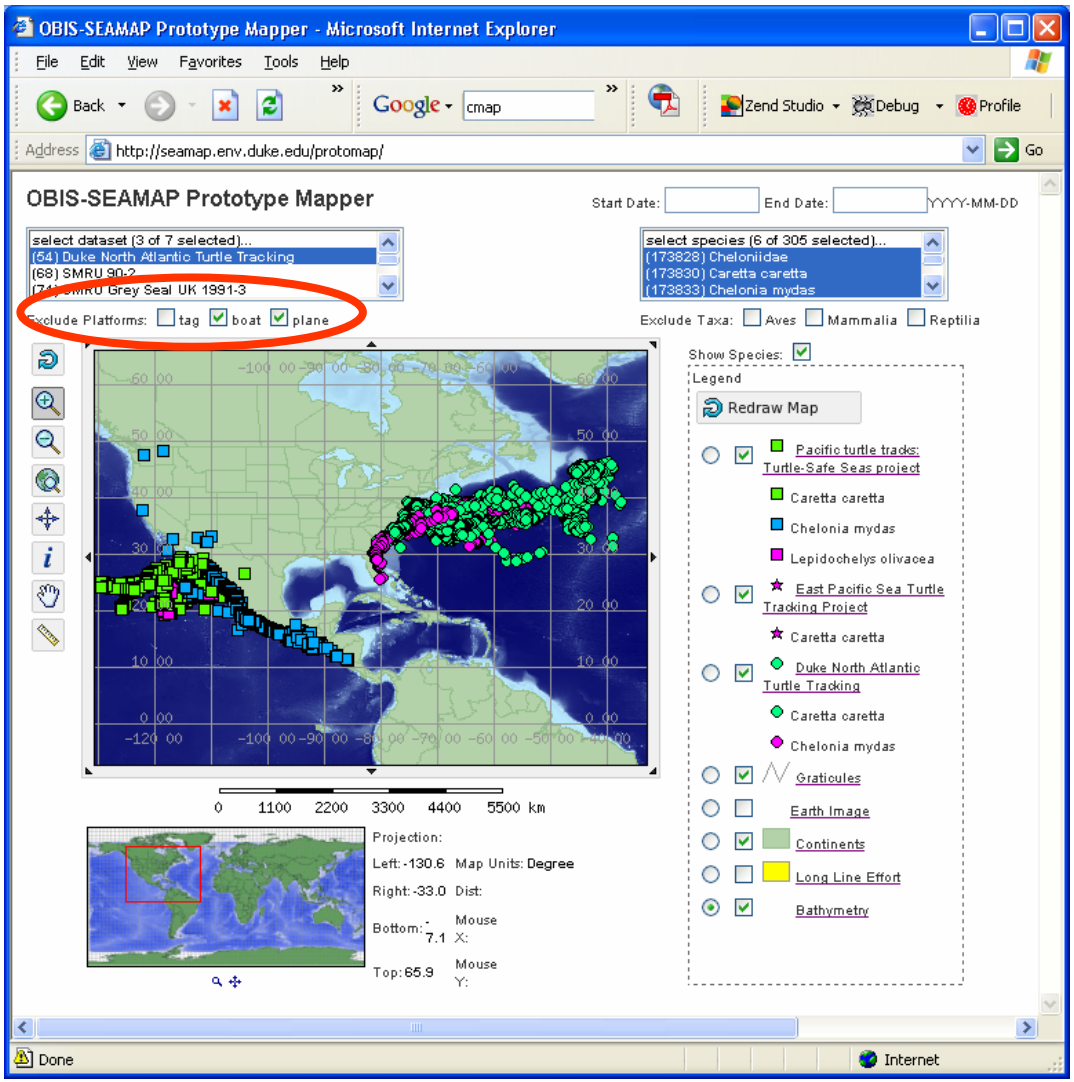


Mapping functionality:
Select by Survey

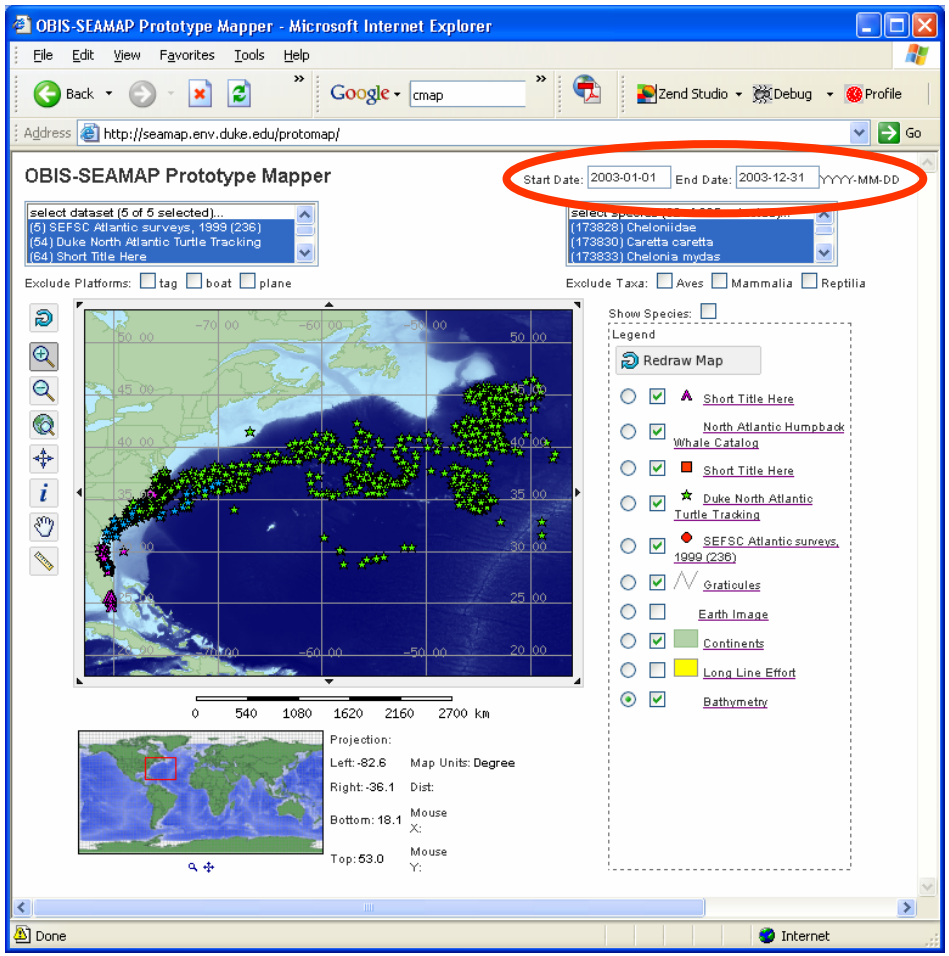


Mapping functionality:

Exclude by survey type



Mapping functionality:
Select by date



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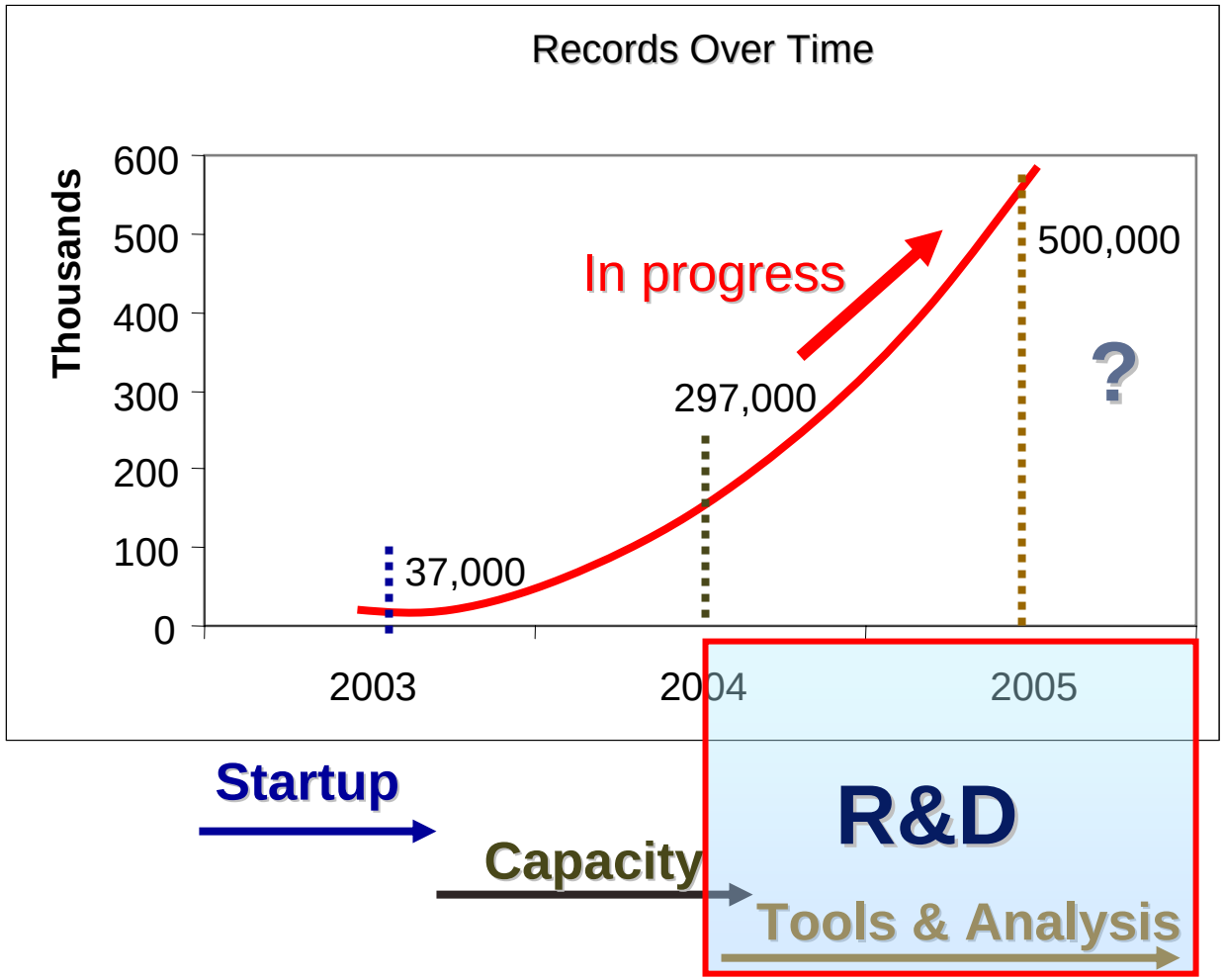
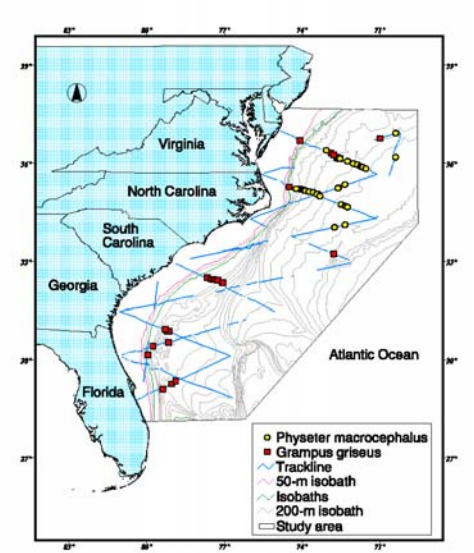


OBIS-SEAMAP
Marine habitat modeling

General Marine Mammal Habitat Modeling Approach

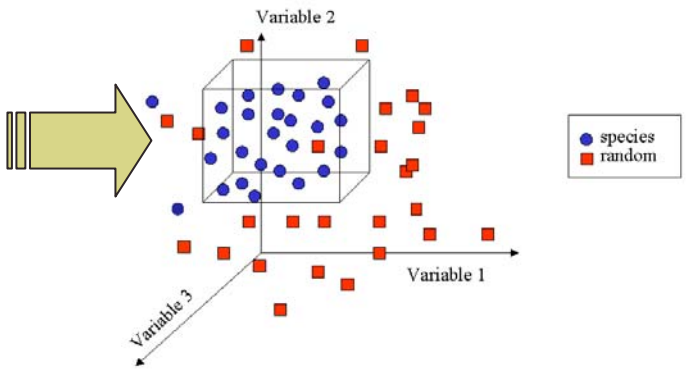
Geographic Space



Sample Data

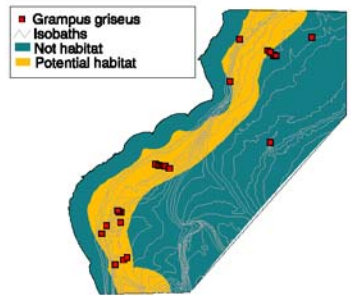
Statistical Applications Data Space

Species ~ Variable 1 + Variable 2 + Variable 3



Redefine Model

Geographic Space



Model Habitat

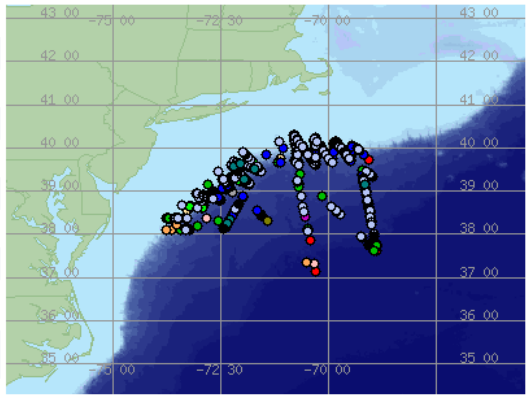
Sperm Whale: Physeter macrocephalus

Two NEFSC Data sets

NEFSC 98 1

ID	60
# of Records	505
Date, Begin	1998-Jul-8
Date, End	1998-Aug-3
Latitude, Min	37.14
Latitude, Max	40.30
Longitude, Min	-73.77
Longitude, Max	-68.88

View Species Recorded
View Metadata
Download Data
Download Shapefile



larger image
interactive map

Citation

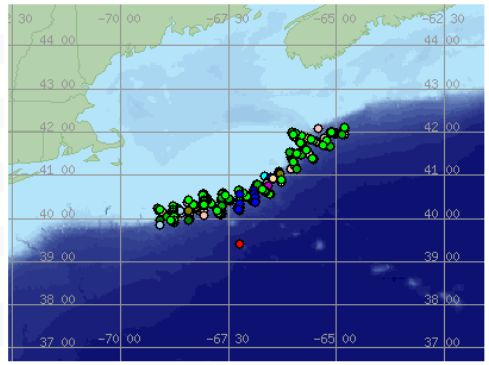
Palka, Debi. 1998. Northeast Fisheries Science Center 1998 Survey 1.

Sponsor: NOAA Northeast Fisheries Science Center (NEFSC)

NEFSC 98 2

ID	62
# of Records	315
Date, Begin	1998-Aug-9
Date, End	1998-Aug-31
Latitude, Min	39.40
Latitude, Max	42.10
Longitude, Min	-69.13
Longitude, Max	-64.80

View Species Recorded
View Metadata
Download Data
Download Shapefile



larger image
interactive map

Citation

Palka, Debi. 1998. Northeast Fisheries Science Center 1998 Survey 2.

Sponsor: NOAA Northeast Fisheries Science Center (NEFSC)

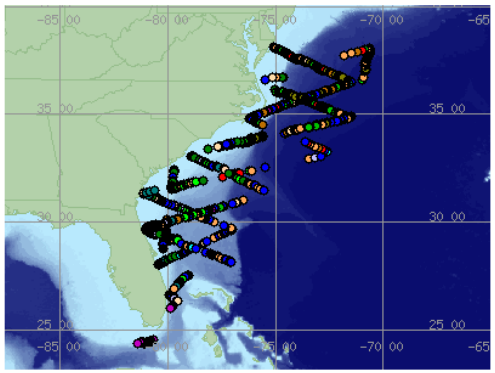
Sperm Whale: Physeter macrocephalus

Two SEFSC Data sets

SEFSC Atlantic surveys, 1998 (3)

ID	1
# of Records	1073
Date, Begin	1998-Jul-9
Date, End	1998-Aug-20
Latitude, Min	24.37
Latitude, Max	38.14
Longitude, Min	-81.40
Longitude, Max	-70.61

View Species Recorded
View Metadata
Download Data
Download Shapefile



larger image
interactive map

Citation

Roden, C. 1998. Summer Atlantic Ocean Marine Mammal Survey. Southeast Fisheries Science Center, NOAA.

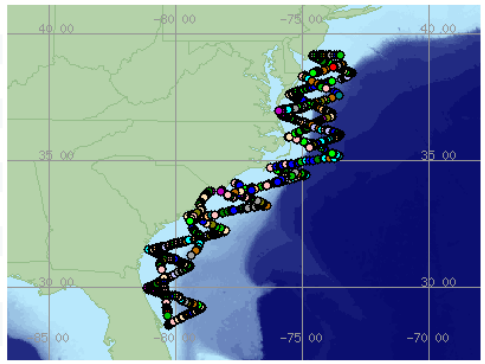
Sources: Cruise Results; Summer Atlantic Ocean Marine Mammal Survey; NOAA Ship Relentless Cruise RS 98-01 (3).

Sponsor: NOAA Southeast Fisheries Science Center (SEFSC)

SEFSC Atlantic surveys, 1999 (236)

ID	5
# of Records	1247
Date, Begin	1999-Aug-9
Date, End	1999-Sep-25
Latitude, Min	28.52
Latitude, Max	39.16
Longitude, Min	-81.14
Longitude, Max	-73.05

View Species Recorded
View Metadata
Download Data
Download Shapefile



larger image
interactive map

Citation

Roden, C. 1999. Summer Atlantic Ocean Marine Mammal Survey. Southeast Fisheries Science Center, NOAA.

Sources: Cruise Results; Summer Atlantic Ocean Marine Mammal Survey; NOAA Ship Oregon II Cruise OT 99-05 (236)

Sponsor: NOAA Southeast Fisheries Science Center (SEFSC)

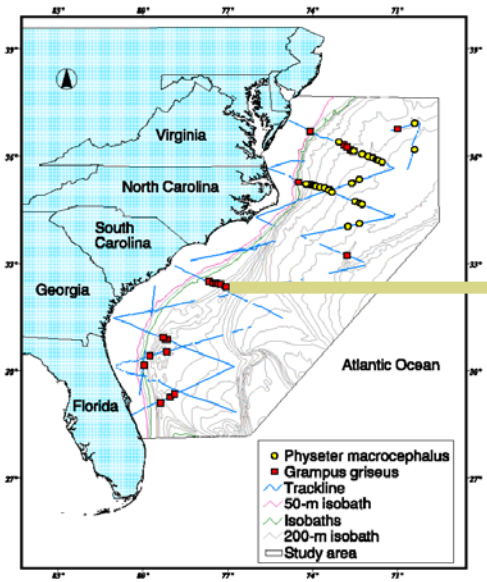
Environmental Variables

Regional / Seasonal: Classification / Regression Models

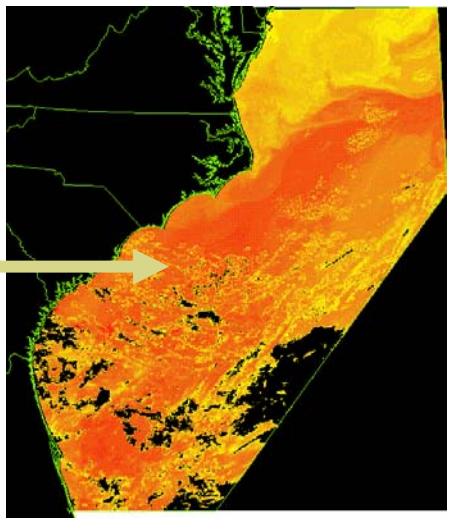
e.g., Depth, Slope, Sea Surface Temperature, Sea Surface Height,
Distance to Shore, Chlorophyll, Temperature Gradients

Multiple environmental variables associated across time series

Observation Dataset (Cruise)



Environmental Variable(s)



AVHRR-SST 1 Daily observation

Time-series Environmental Variable(s)

47 AVHRR-SST images
7/9/98 -8/17/98
temporally composited observations

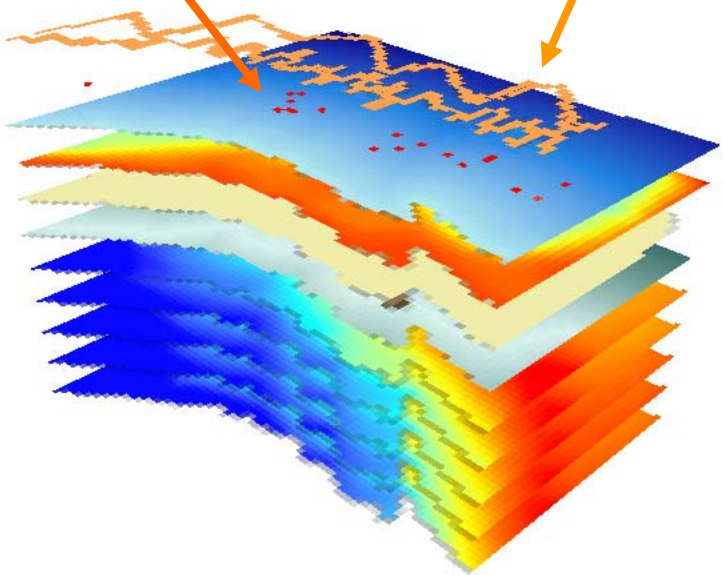
Environmental Variables

Regional / Seasonal: Classification / Regression Models

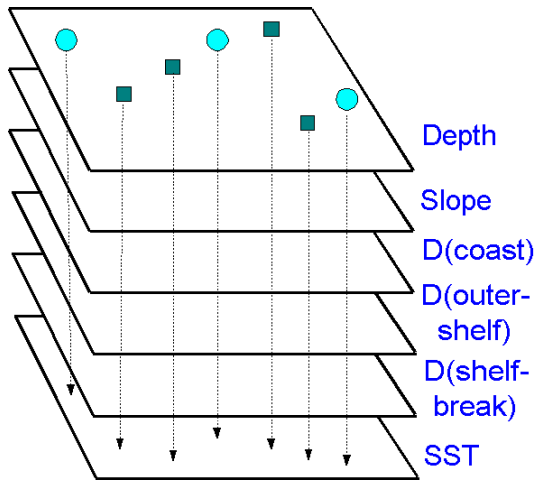
Multiple environmental variables associated with each observation point

Marine animal Observations

Cruise transects (sampling effort)

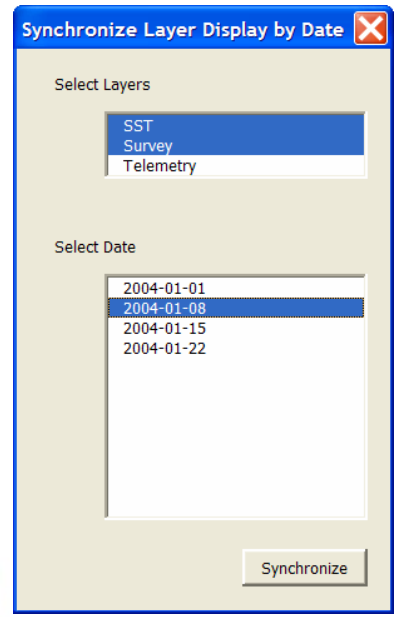


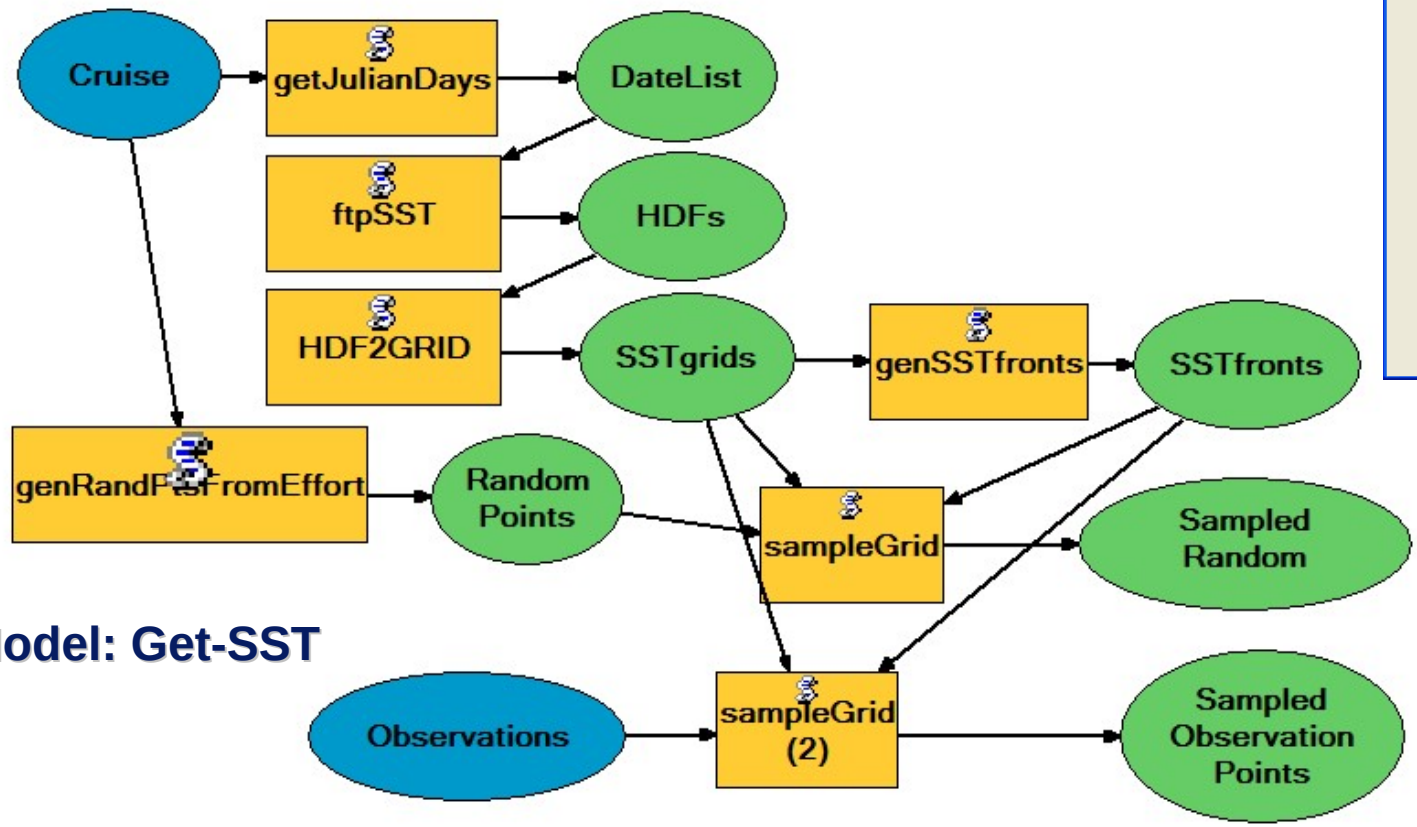
Sample points *vs.* **random** points



Analysis – Data Extraction Tools

Models to automatically extract environmental data layers for spatio-temporal analysis





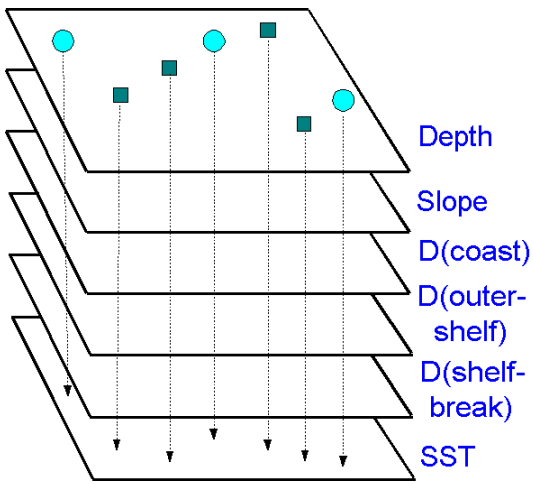
Model: Get-SST

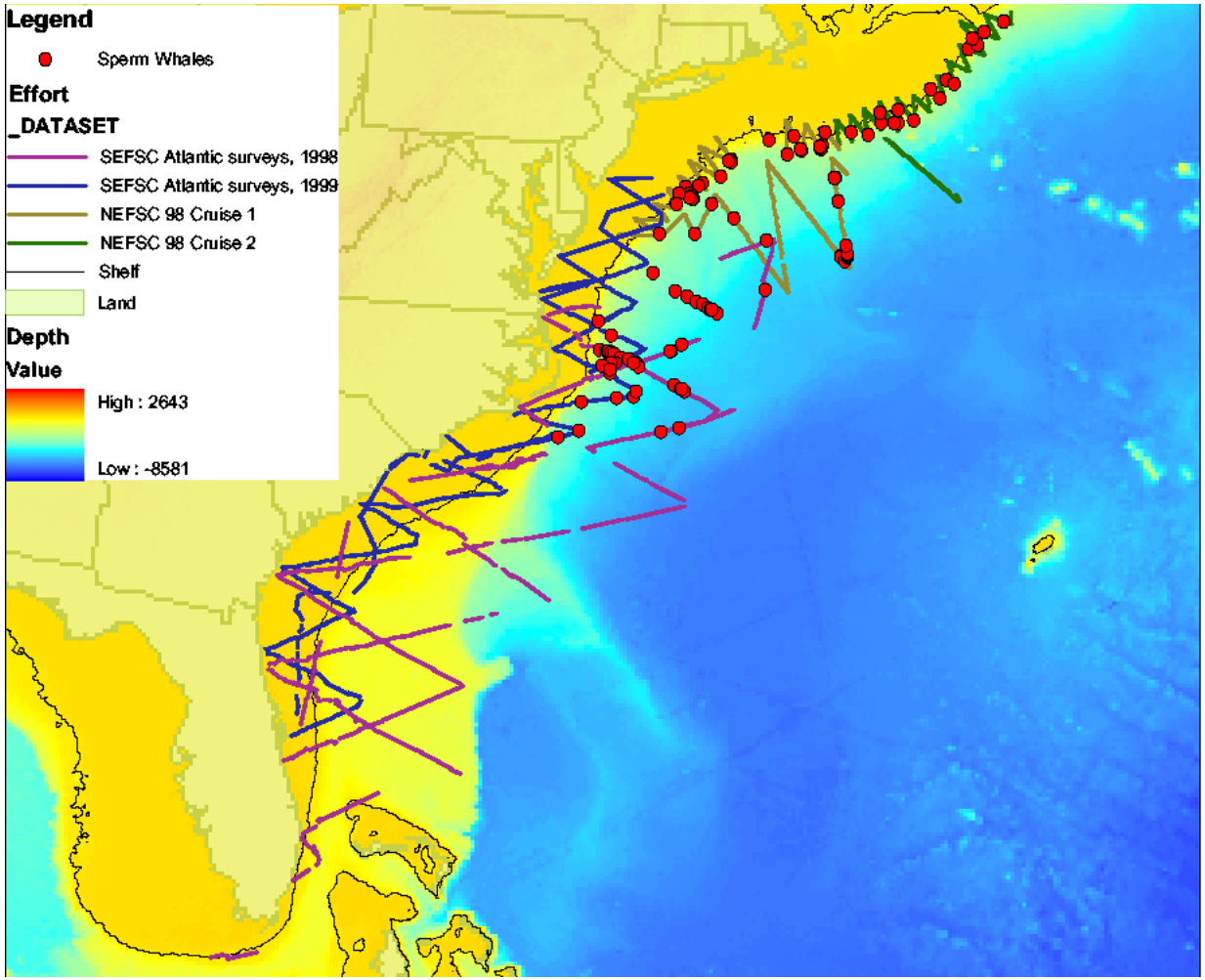
Sperm Whale: Physeter macrocephalus

Physeter macrocephalus

Image credit: Garth Mix, GMIX Designs

Sample points
vs. **random** points



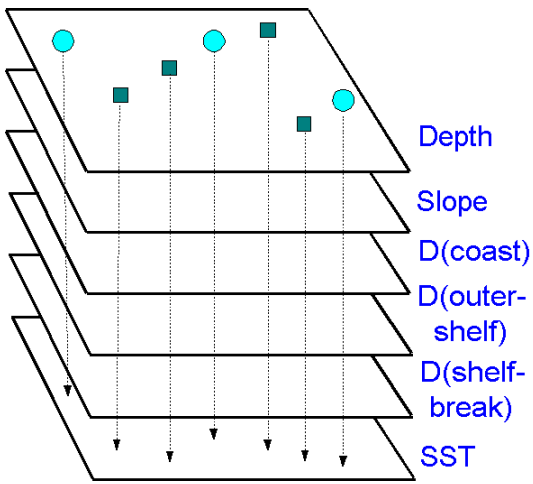


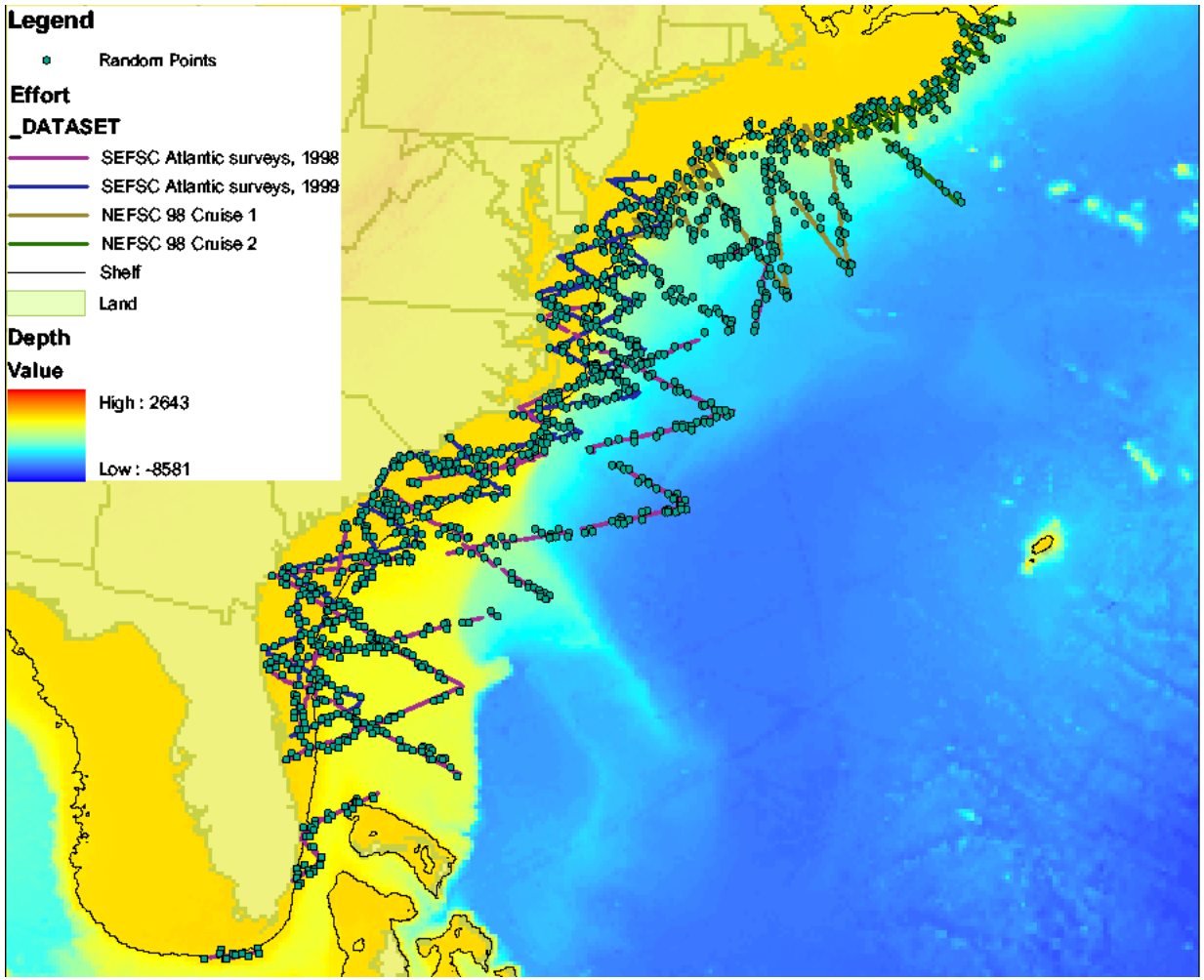
Sperm Whale: Physeter macrocephalus

Physeter macrocephalus

Image credit: Garth Mix, GMIX Designs

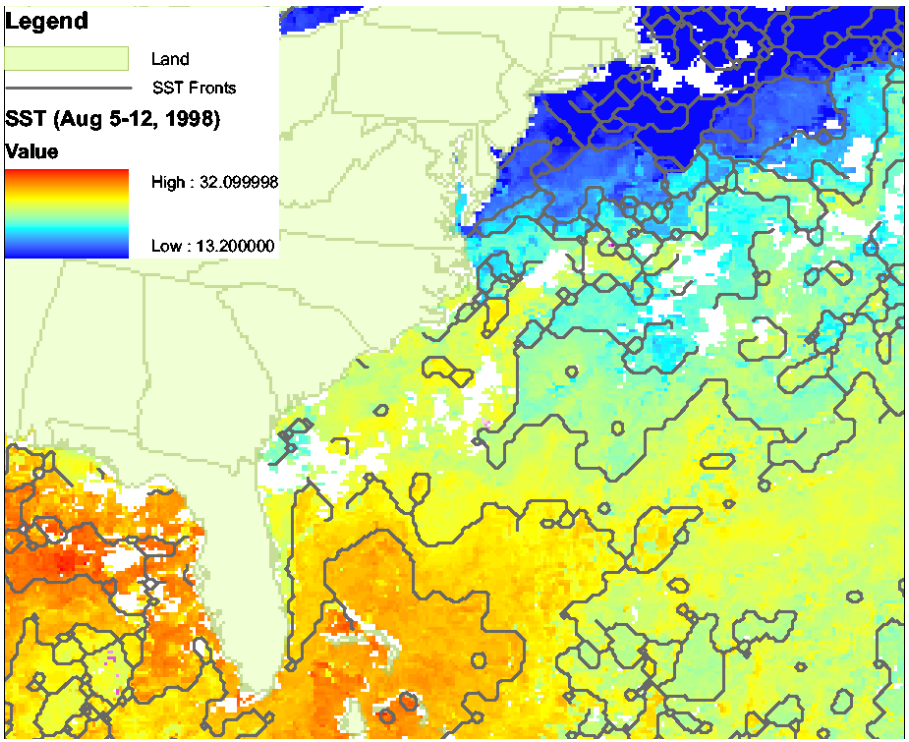
Sample points
vs. **random** points

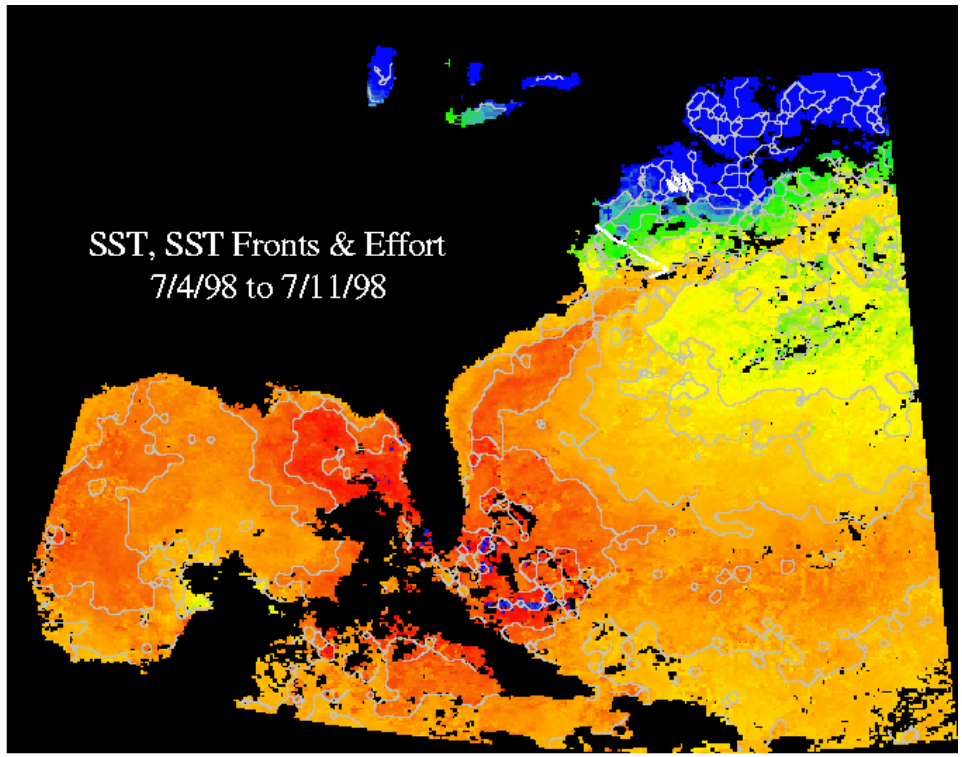




Sperm Whale: Physeter macrocephalus

Environmental data: SST, fronts & distance to fronts

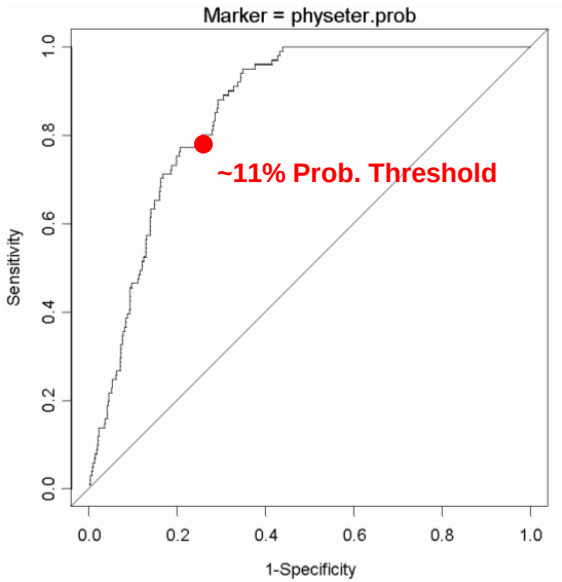




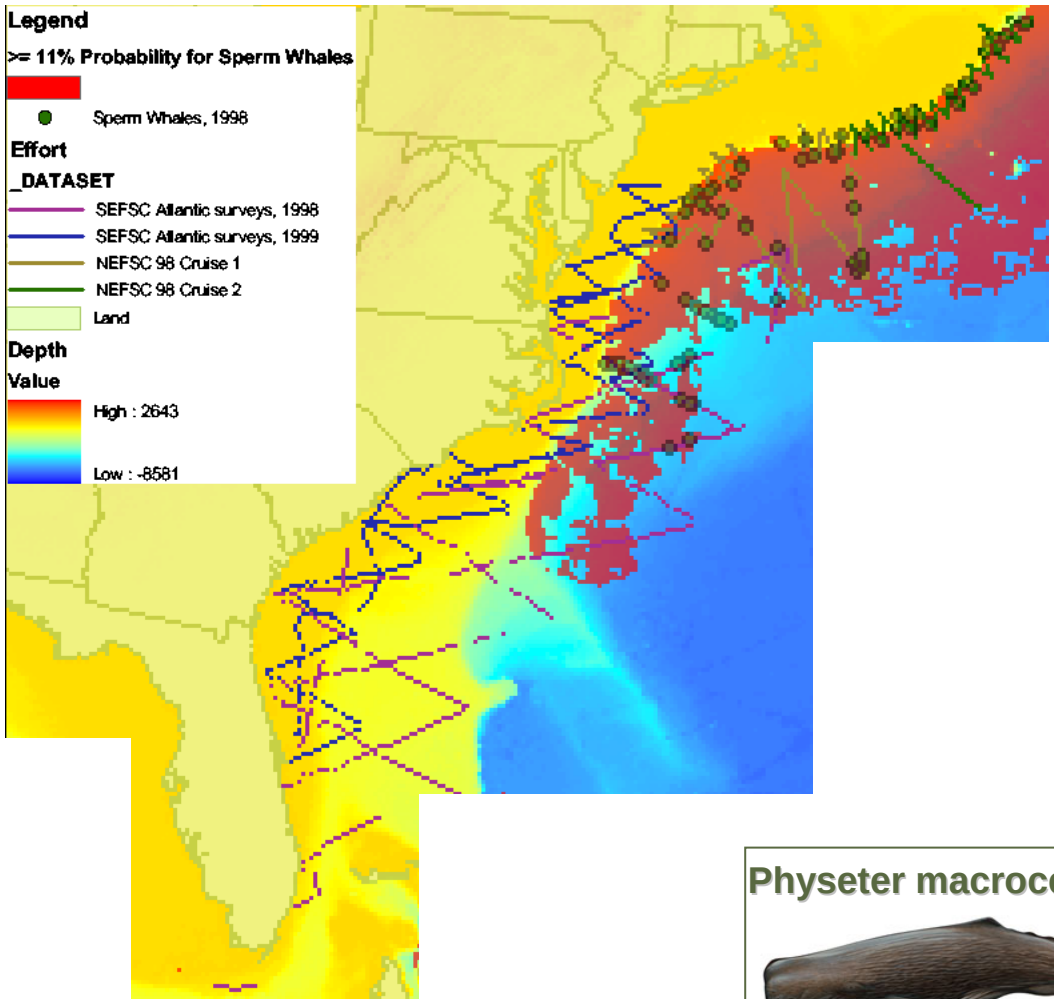
Sperm Whale: Physeter macrocephalus

Using a >11% probability threshold:

Optimizes
"errors of omission" vs.
"errors of commission"



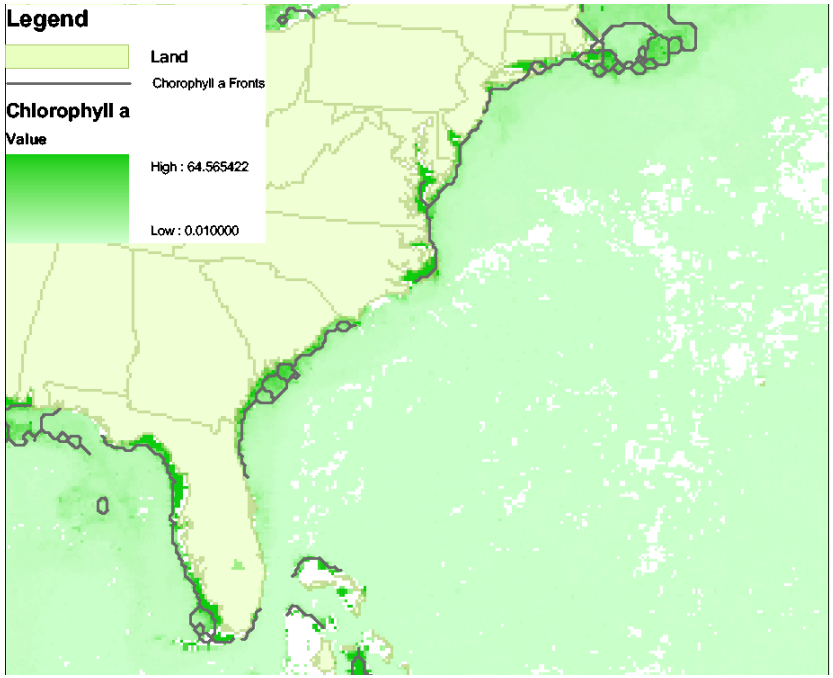
Model output calculated for: oceanographic conditions, August 5-12 1998

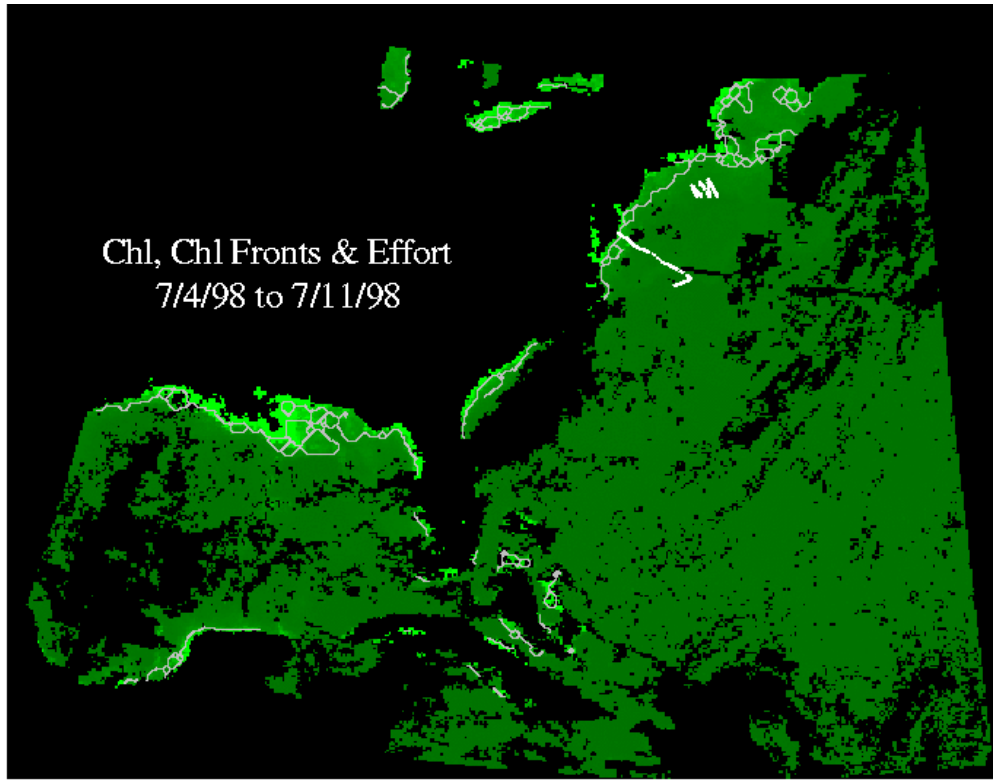


Physeter macrocephalus

Image credit: Garth Mix, GMIX Designs

Sperm Whale: Physeter macrocephalus



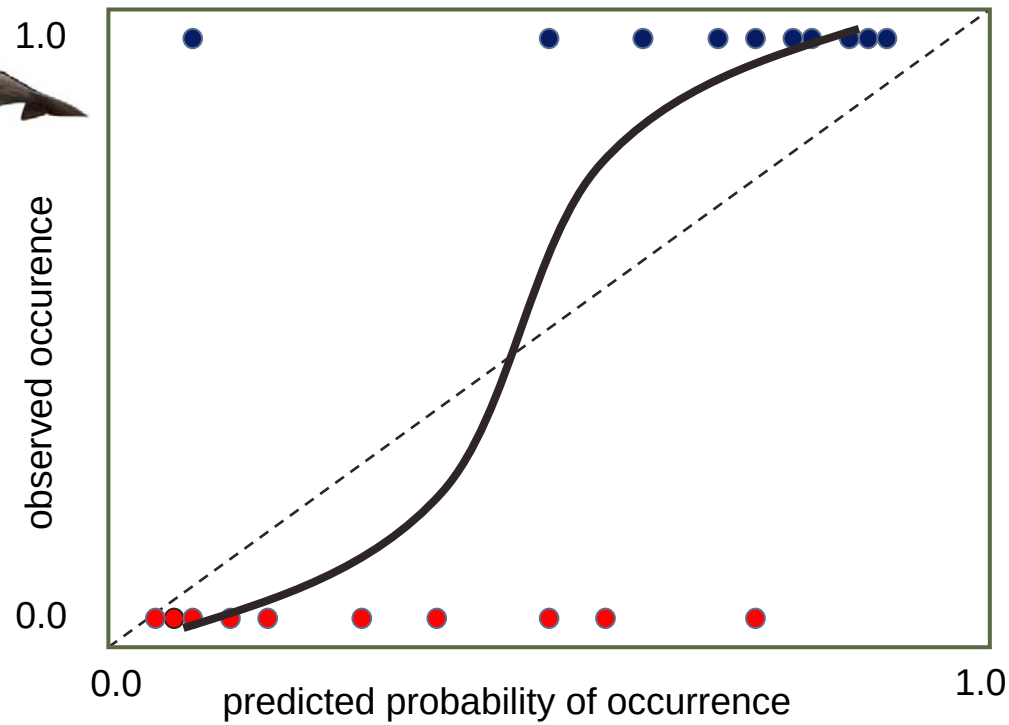


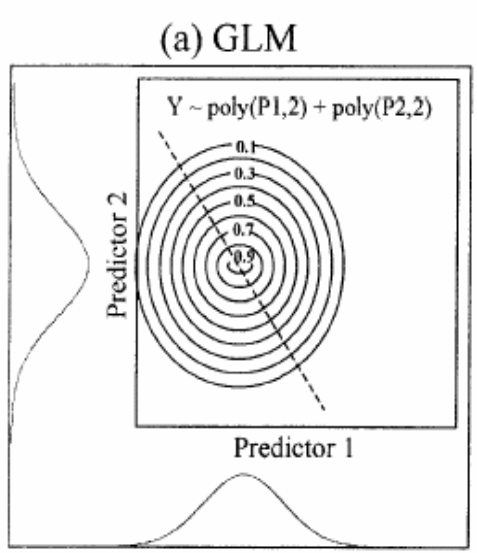
Logistic Regression

Describes how a binary (0 or 1) response variable is associated with a set of explanatory variables

physeter.logit < glm (OCC ~SST + SSTDIS2FR + CHL + CHLDIS2FR + DEPTH + DIST2SHELF + DIST2SHORE,

Presence .*vs* Absence Model





Sperm Whale: Physeter macrocephalus

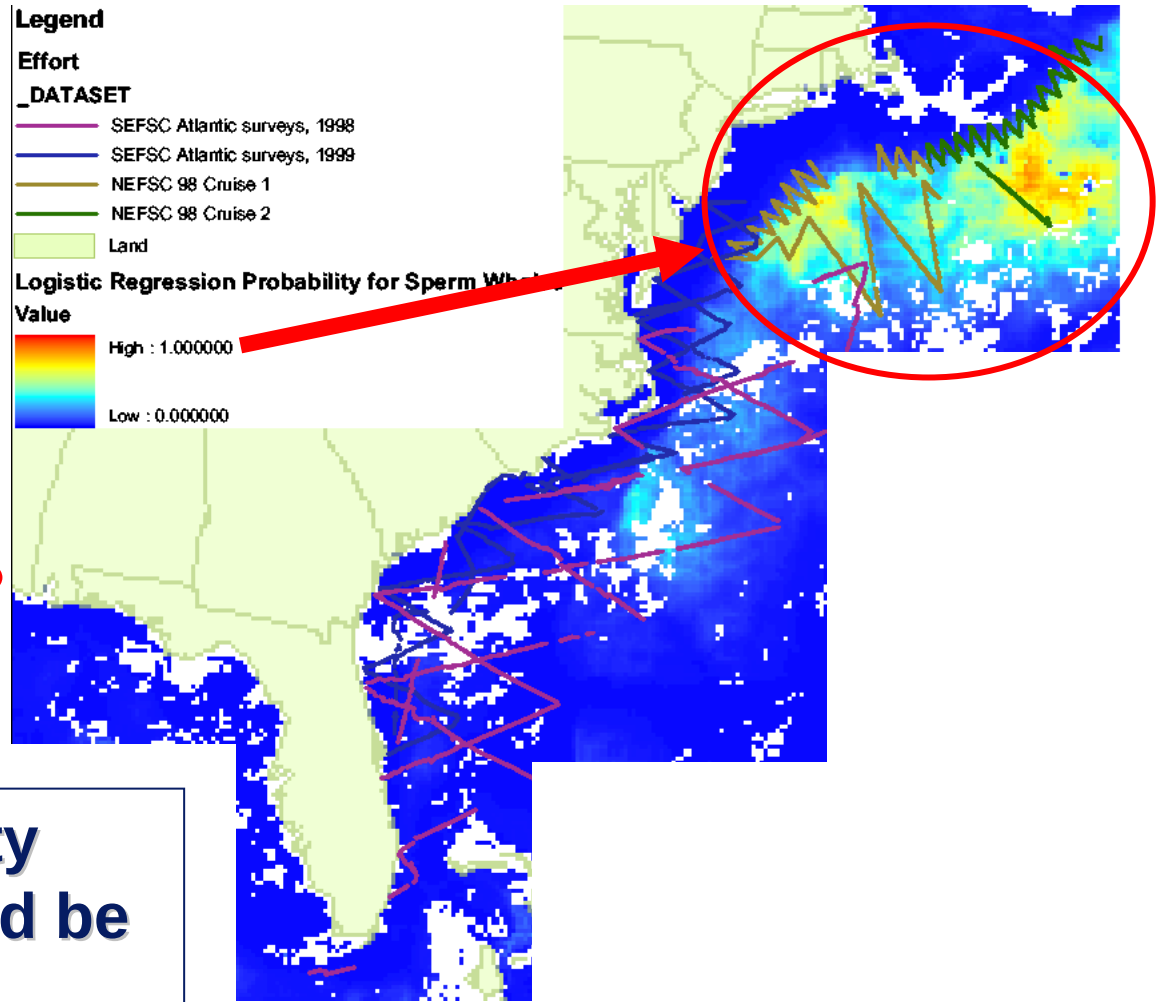
Physeter macrocephalus

Image credit: Garth Mix, GMIX Designs

0 - 100% probability range

No threshold set for habitat

***.vs* non-habitat**



Model output calculated for: oceanographic conditions, August 5-12 1998

What probability threshold should be used?

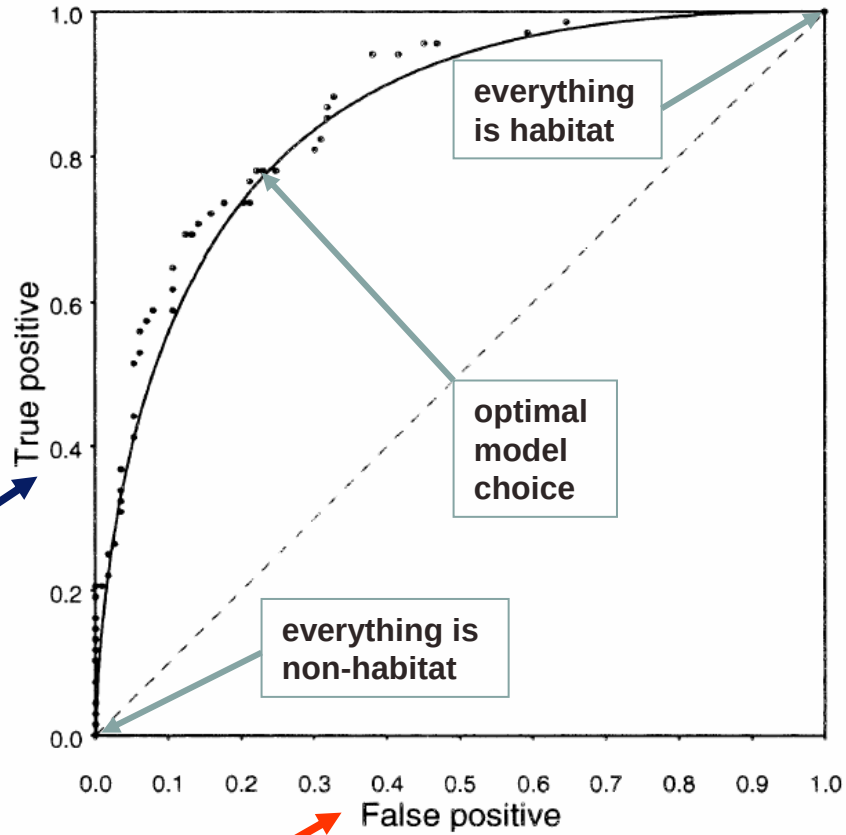
Model evaluation:

ROC: Receiver Operator Curves

- Select the optimal threshold (***not just guess at >0.5 probability***)
- Maximum sensitivity and specificity

Sensitivity = a/a+b (true positive)
Specificity = d/b+d (true negative)

The 45° line represents the sensitivity and false positive values expected to be achieved by chance alone for each decision threshold.



True Positive Fraction

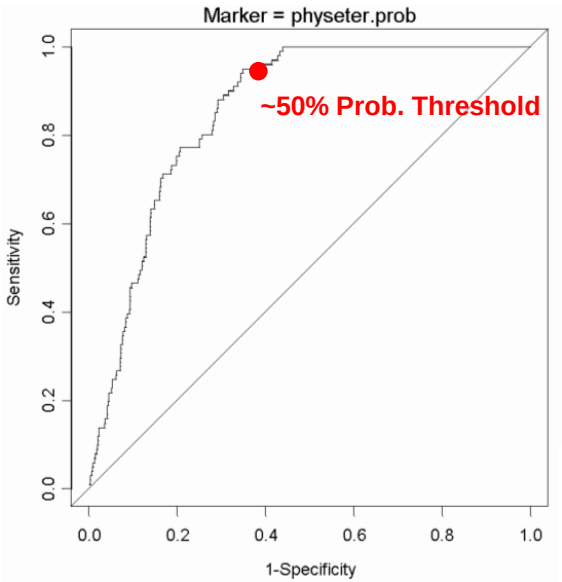
	Recorded present	Recorded absent	
Predicted present	A	B	$A + B$
Predicted absent	C	D	$C + D$
	$A + C$	$B + D$	$A + B + C + D$

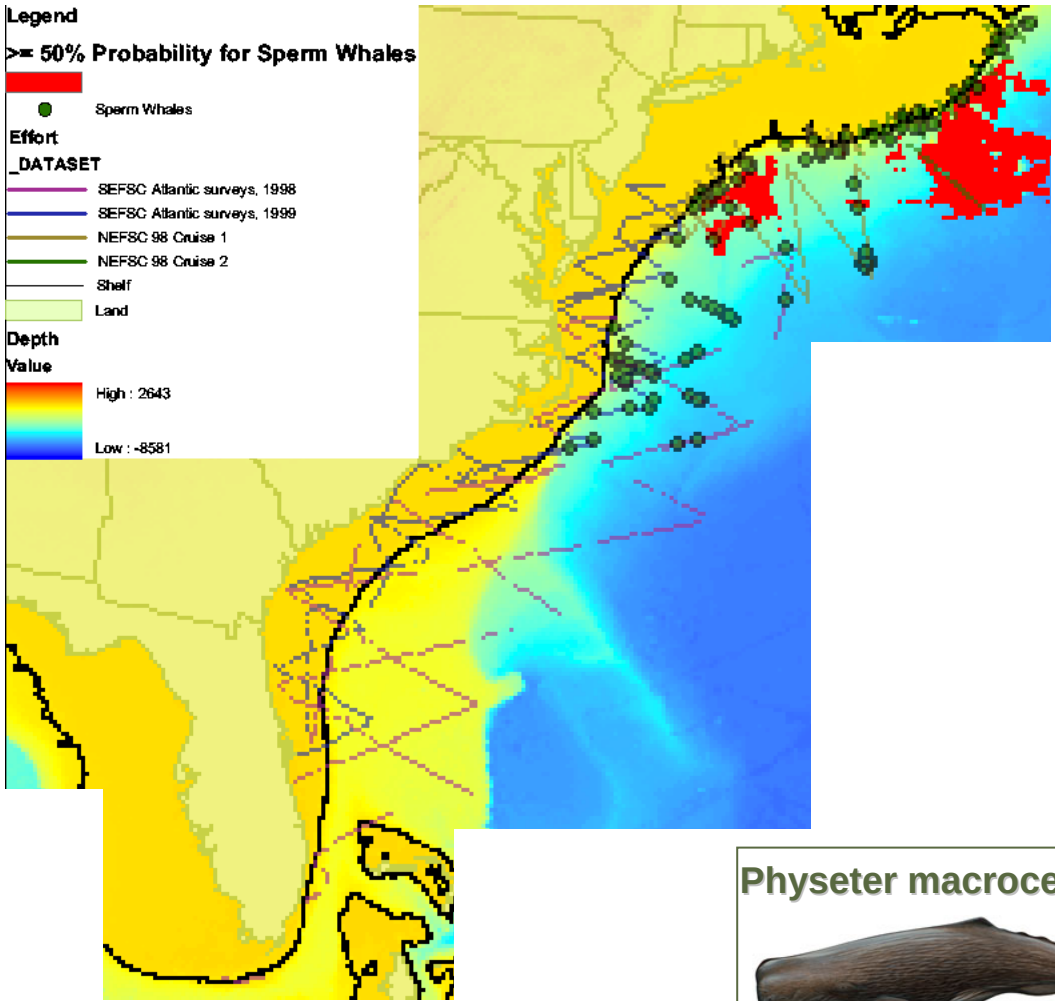
False Positive Fraction

Sperm Whale: Physeter macrocephalus

Using a >50% probability threshold:

Too conservative
many "errors of omission"





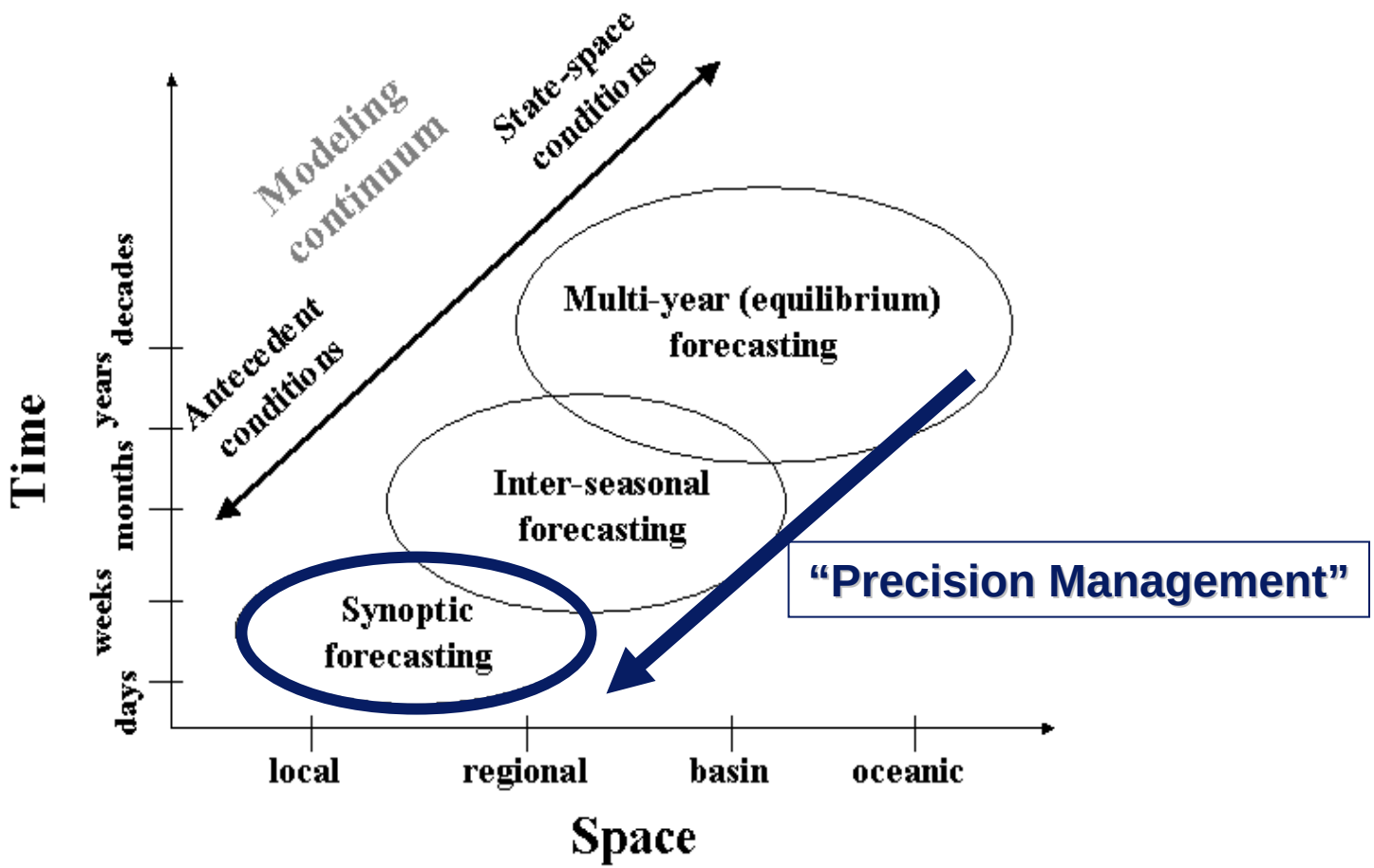
Model output calculated for: oceanographic conditions, August 5-12 1998

Physeter macrocephalus

Image credit: Garth Mix, GMIX Designs

Marine animal habitat modeling

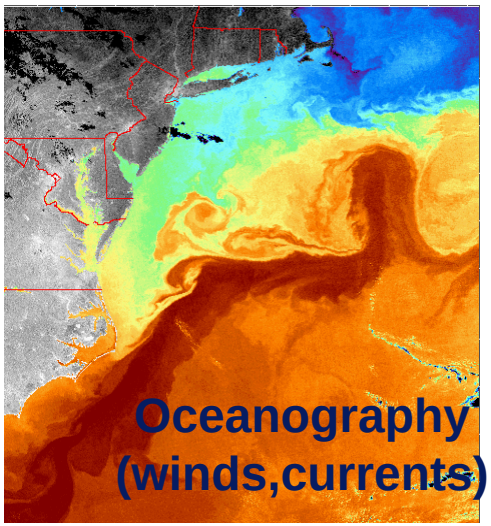
Spatio - Temporal Modeling Approaches



The emerging management applications are at these finer temporal scales…

Spatio - temporal habitat modeling

At large spatial scales:



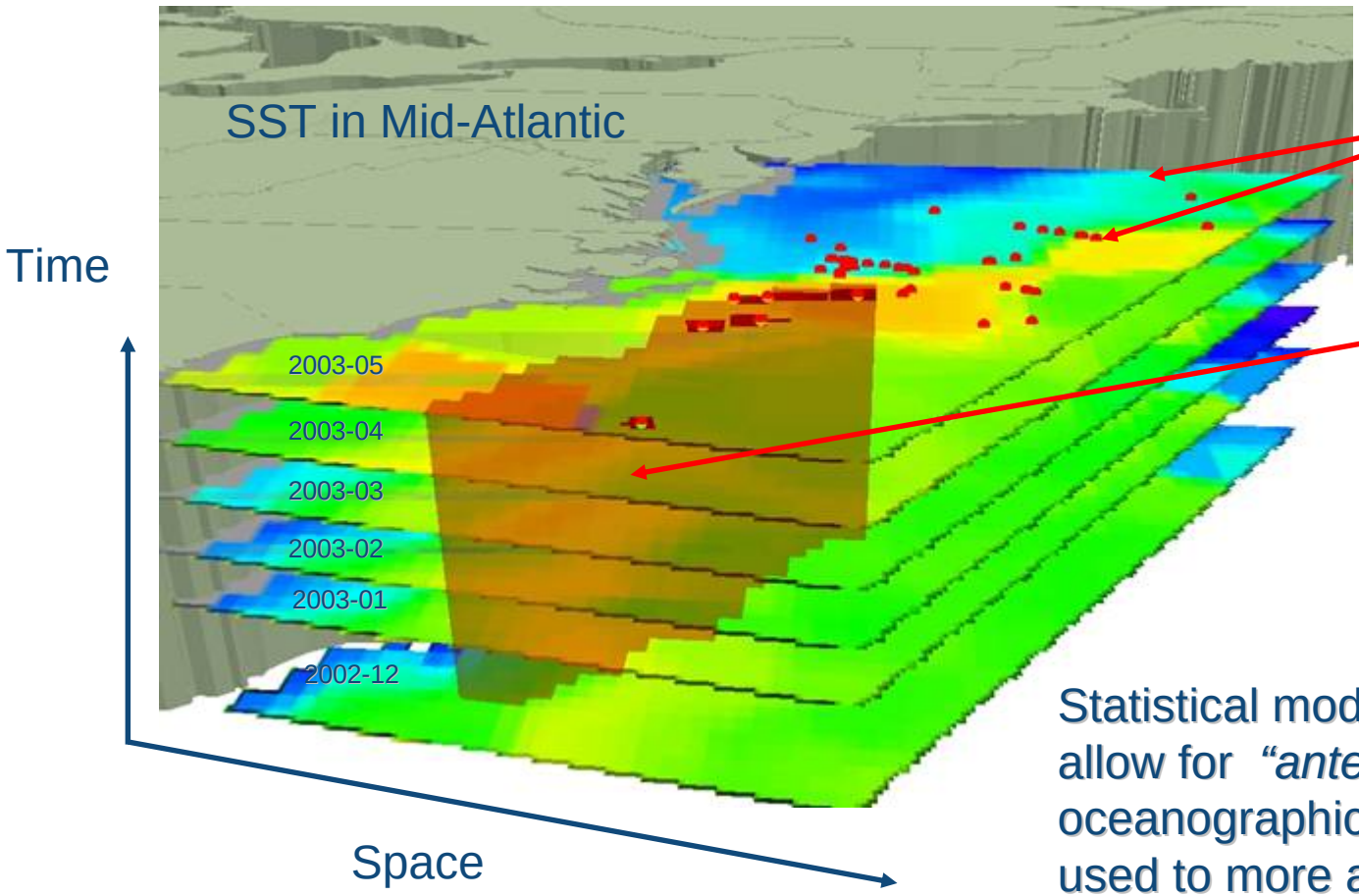
Temporal lags

At finer spatial scales:

Bathymetric and water temperature gradients → Prey availability → Marine mammal distribution

Marine animal habitat modeling

Spatio-Temporal Models



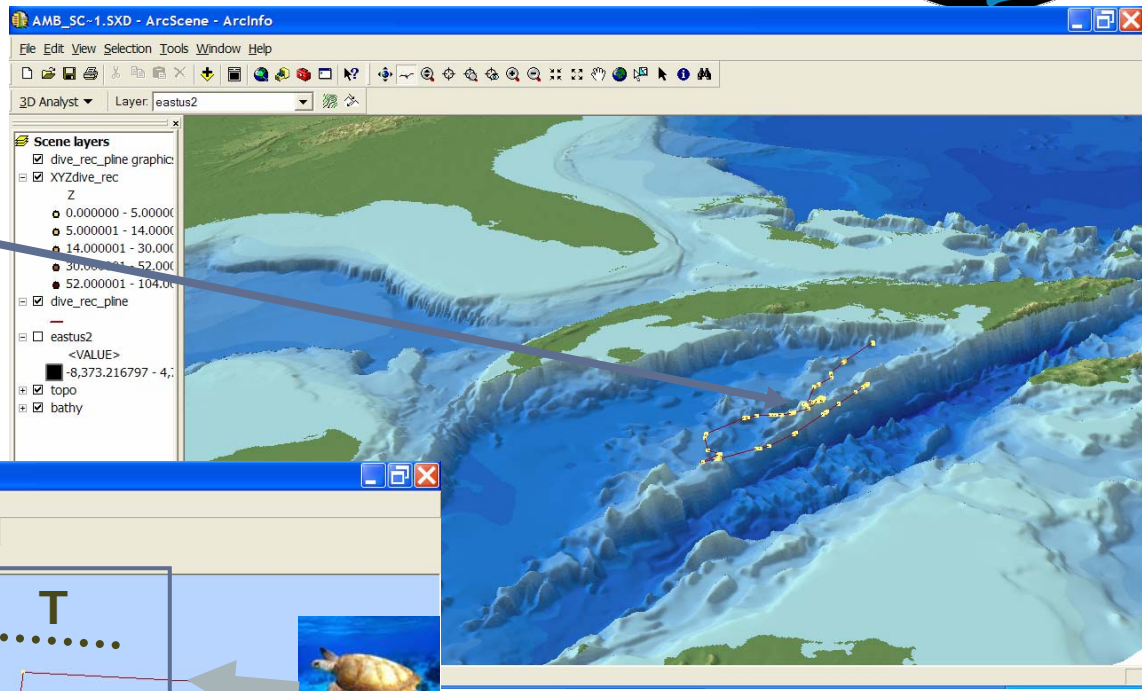
Marine mammal distribution

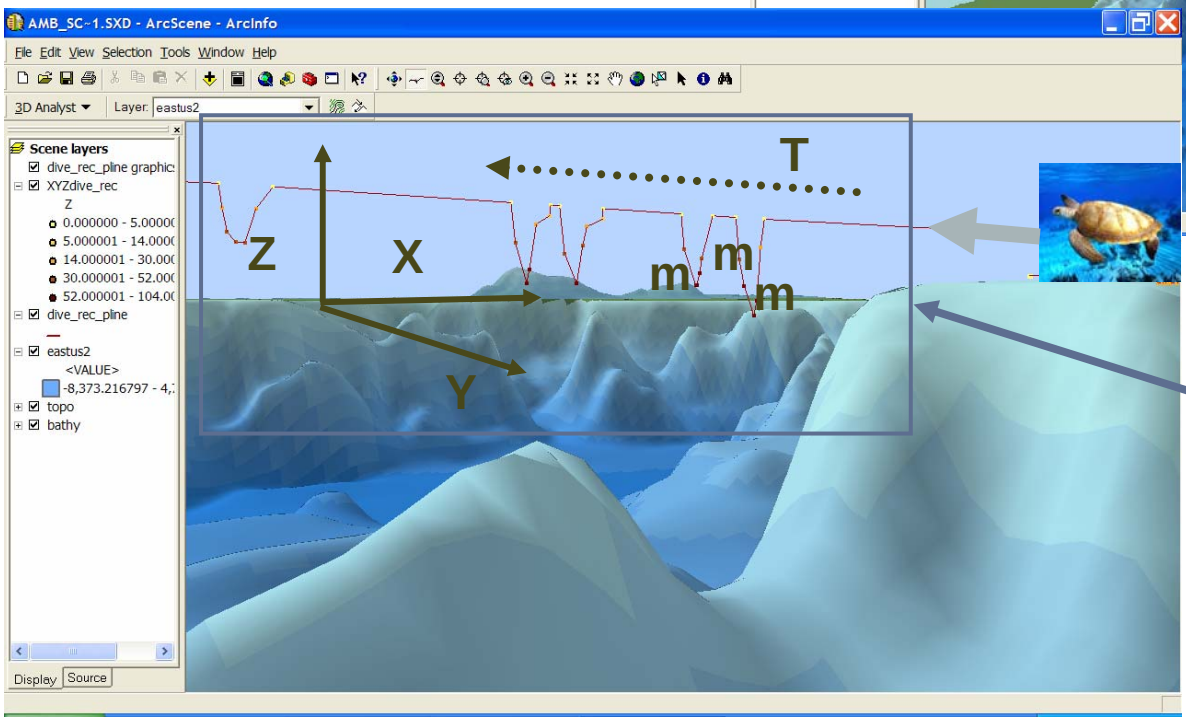
"Persistent" SST Event

Statistical modeling approach will allow for *"antecedent"* oceanographic conditions to be used to more accurately predict potential habitat.

Animal Tracking (telemetry location series)

Turtles: Cayman Islands

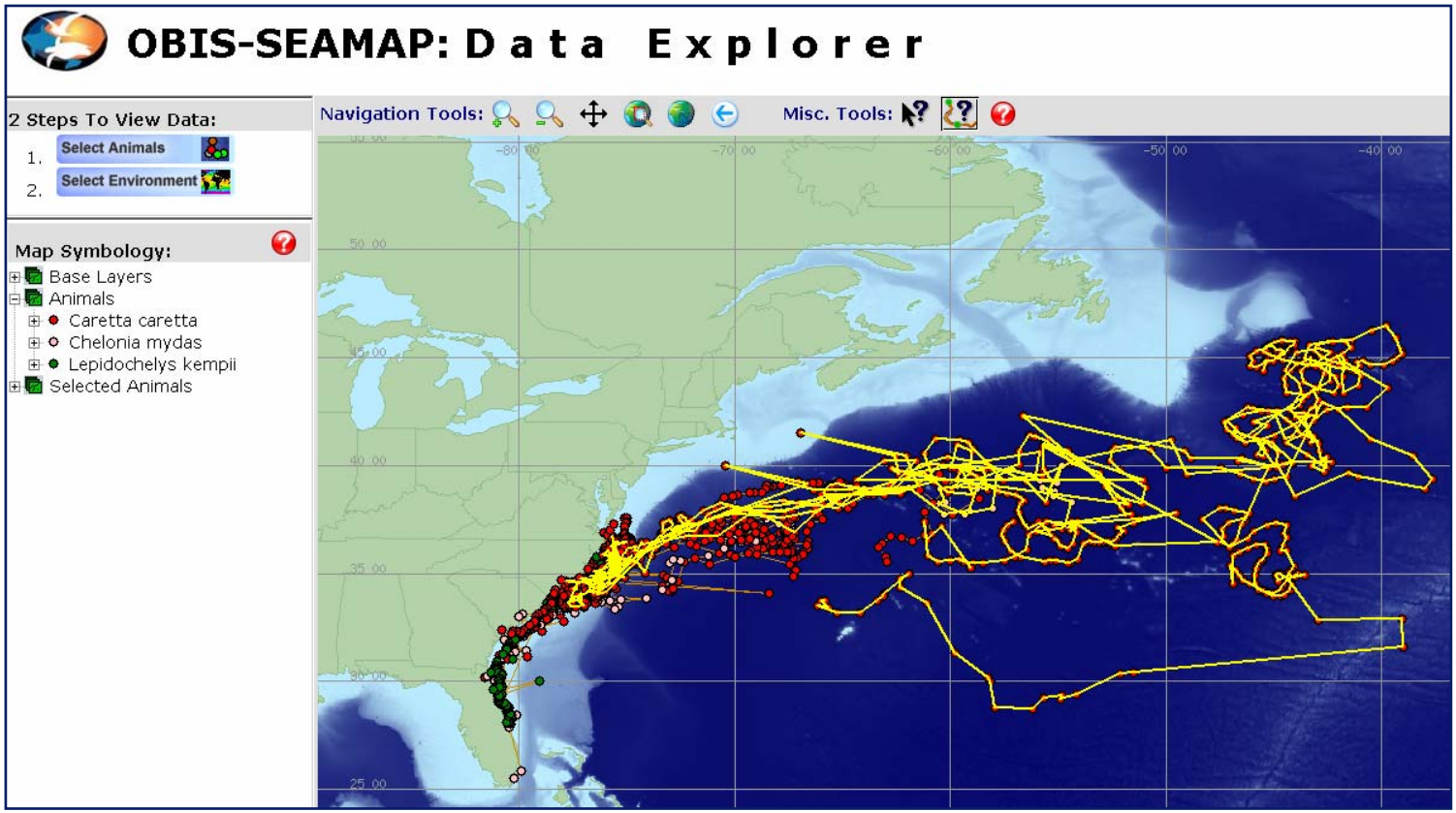




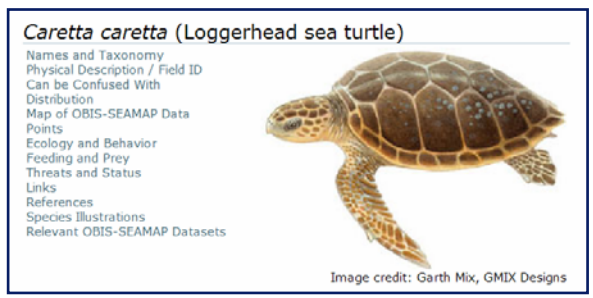
Dive Profiles:
~4D Data (X,Y,Z,T m…m)

OBIS-SEAMAP

Dynamic marine habitat modeling



Data source: McClellan, C. & A. Read. 2004. N. Atlantic Sea Turtle Tracking, Duke University Marine Lab, Beaufort, NC, USA



OBIS-SEAMAP Project Strategy

Attract Data Providers with **Tools**

mapping tools; analysis with other biological, physical and anthropogenic data layers; FGDC / ISO metadata creation; download / upload facility

Build Online **Archive**

searchable by: species, location, time, methodology, provider; results mapped, and cross-referenced to species profiles and dataset details

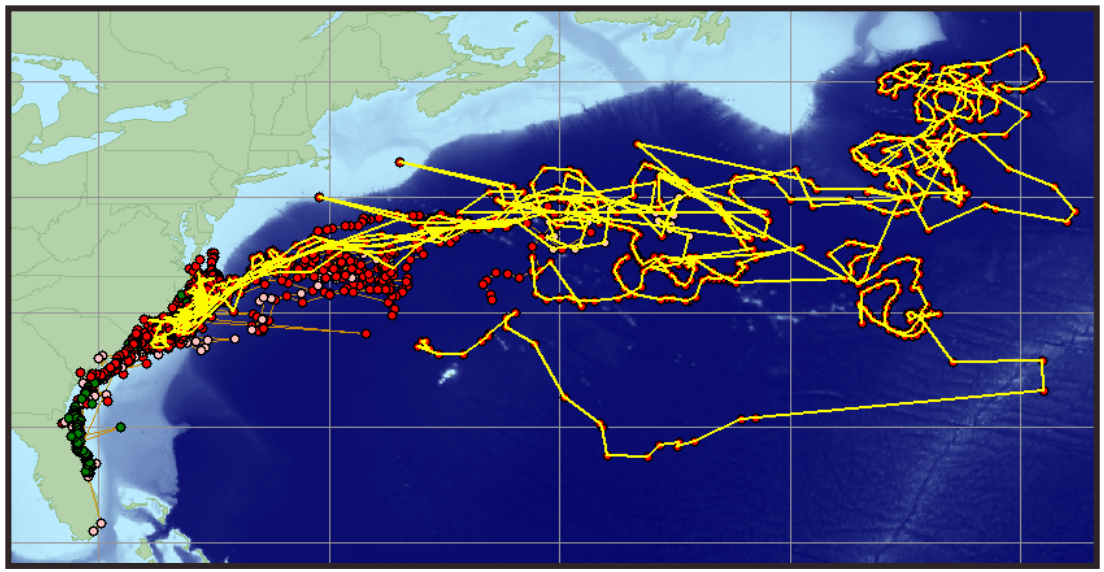
Substantiate with **Research**

applied and fundamental research relating species distribution and abundance to ocean habitats, climate change, seasonal variability, and anthropogenic impacts

OBIS•SEAMAP

mapping marine megavertebrates

http://seamap.env.duke.edu



Questions / Comments?

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES

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