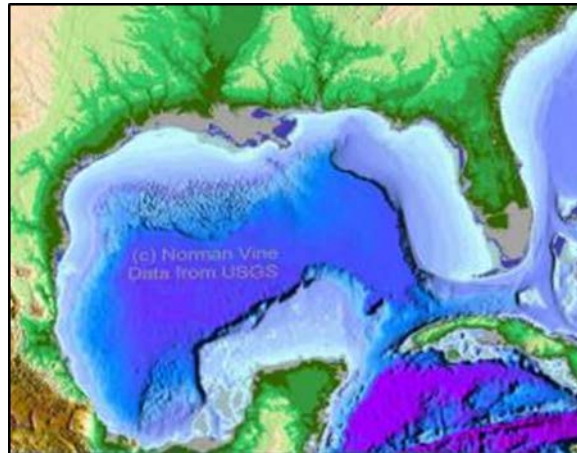




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Science Center

Gulf of Mexico Marine Assessment Program for Protected Species -GoMMAPPS- Marine Mammals



Keith D. Mullin
06 February 2017
New Orleans, Louisiana

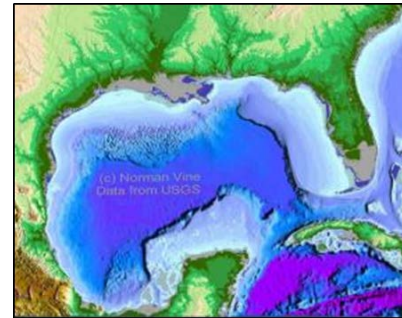
GoMMAPPS Marine Mammals

Primary Objective

Gulf of Mexico cetacean species:

Up-to-date seasonal
Spatially Explicit Density Maps

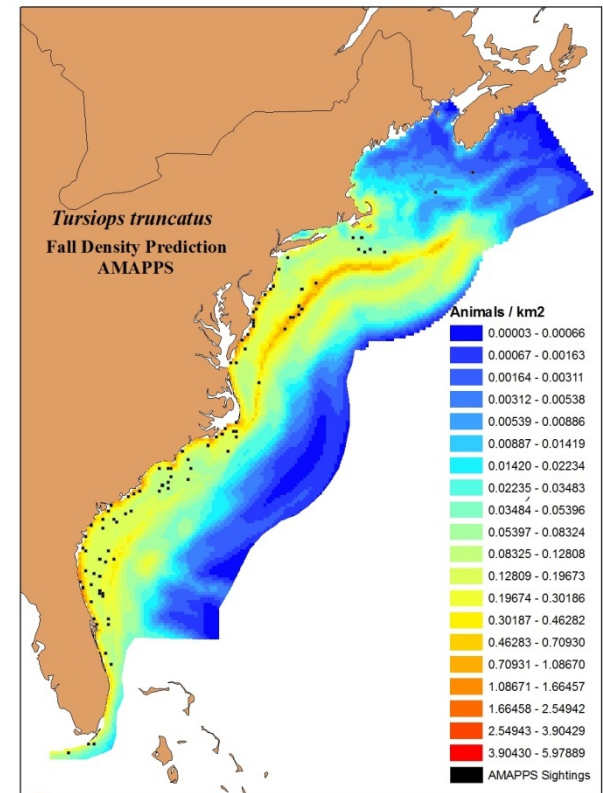
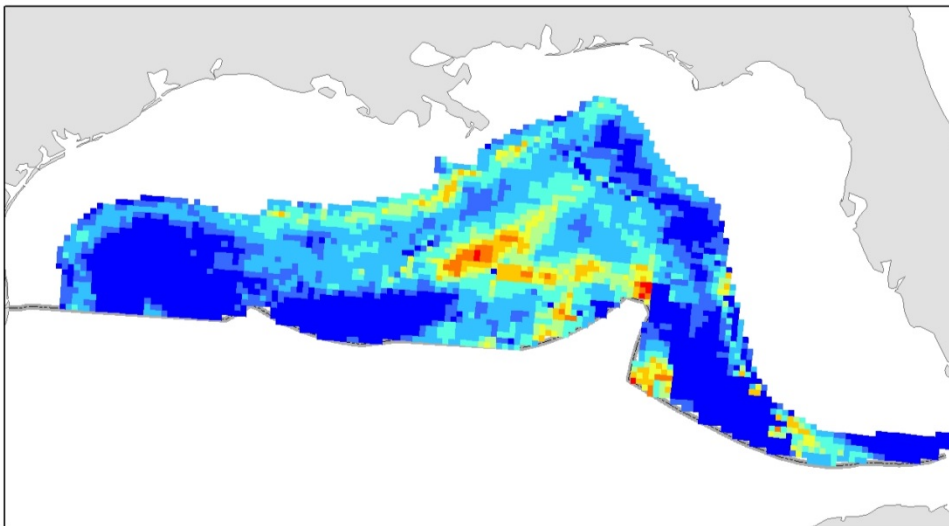
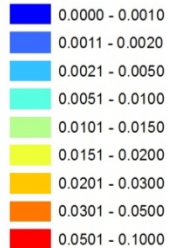
- inform stock assessments
- assist with management decisions related to energy development



Sperm Whale Density

July 2010

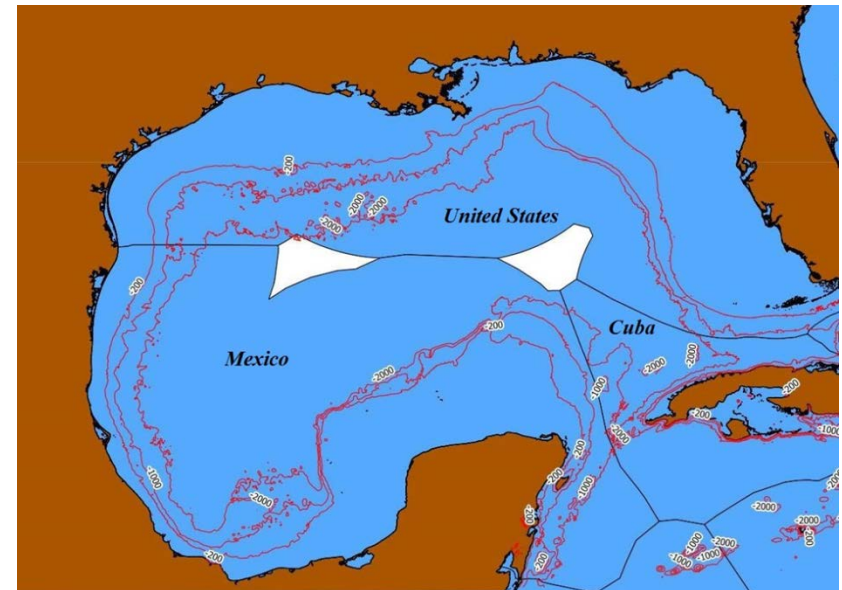
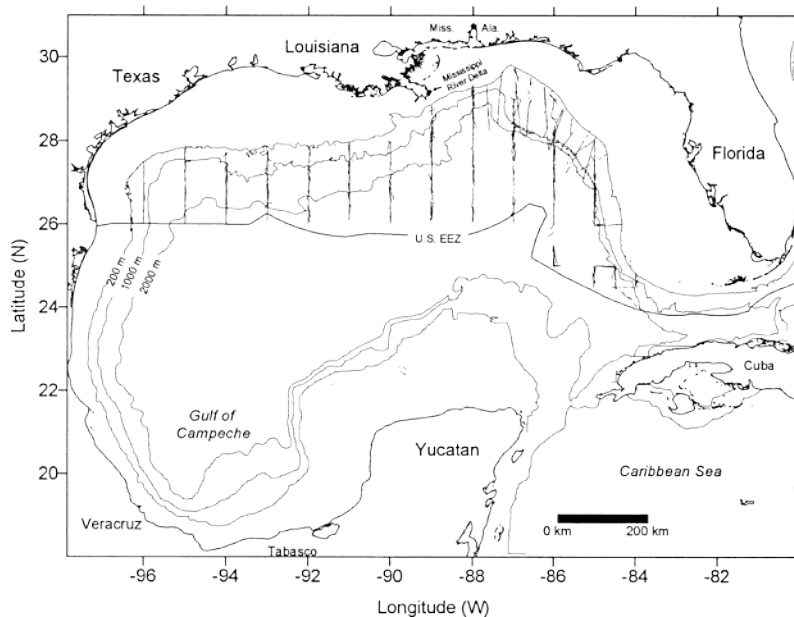
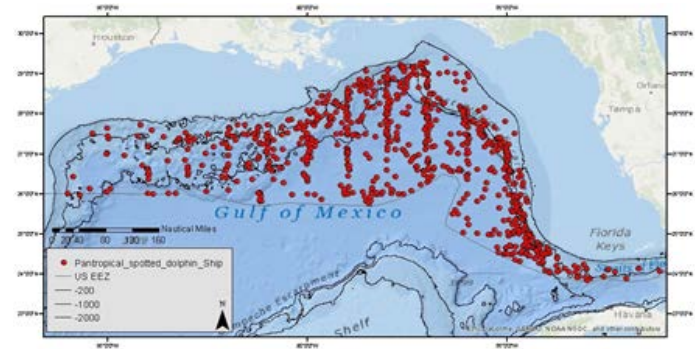
density



Gulf-wide Approach

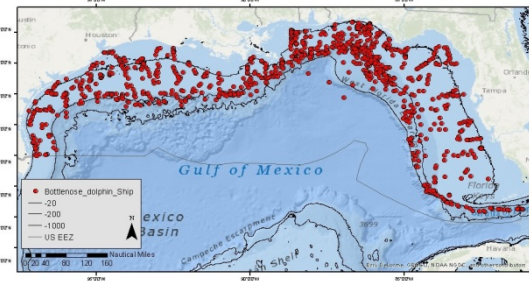
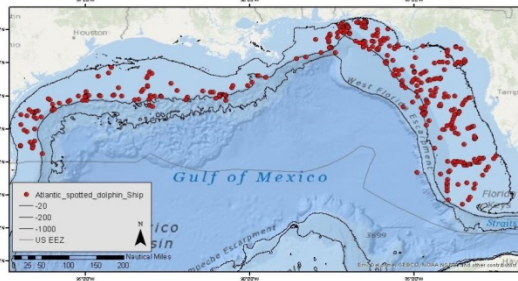
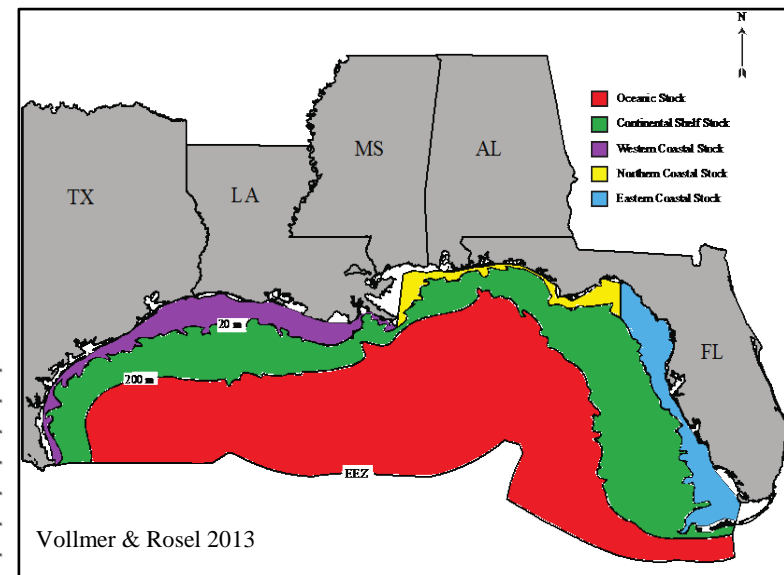
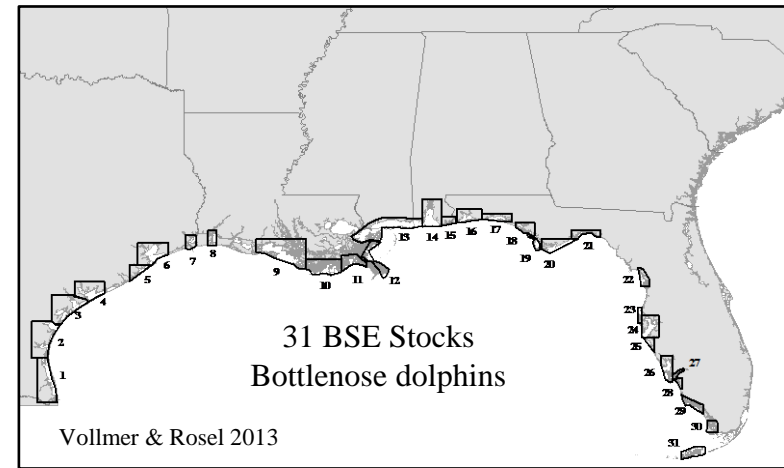
(future funding)

- GOMx small relative to cetaceans' ability to travel
- >50% of GOMx non-U.S.: Mexico & Cuba
- Southern Gulf not assessed by any country with broad scale surveys
- Changes in abundances & distributions difficult to interpret without GOMx-wide perspective



Gulf of Mexico Habitats and Cetacean Species & Stocks

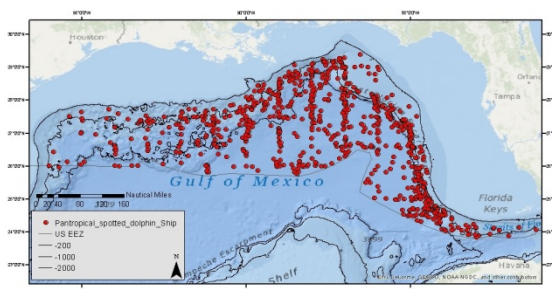
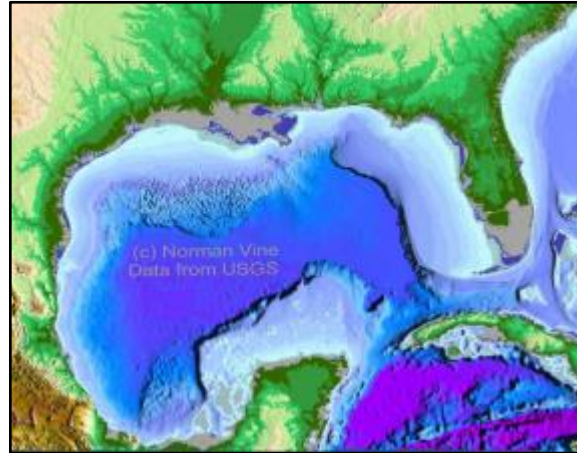
- Bays, Sounds & Estuaries (BSE)
 - Bottlenose dolphins – 31 stocks
- Coastal Waters (0 – 20 m)
 - Bottlenose dolphins – 3 stocks
- Continental Shelf (20 – 200 m)
 - Atlantic spotted dolphins – 1 stock
 - Bottlenose dolphins – 1 stock
- Oceanic Waters (≥ 200 m)
 - 21 species – 21 stocks (tropical cetacean community)



Gulf of Mexico Oceanic Cetaceans

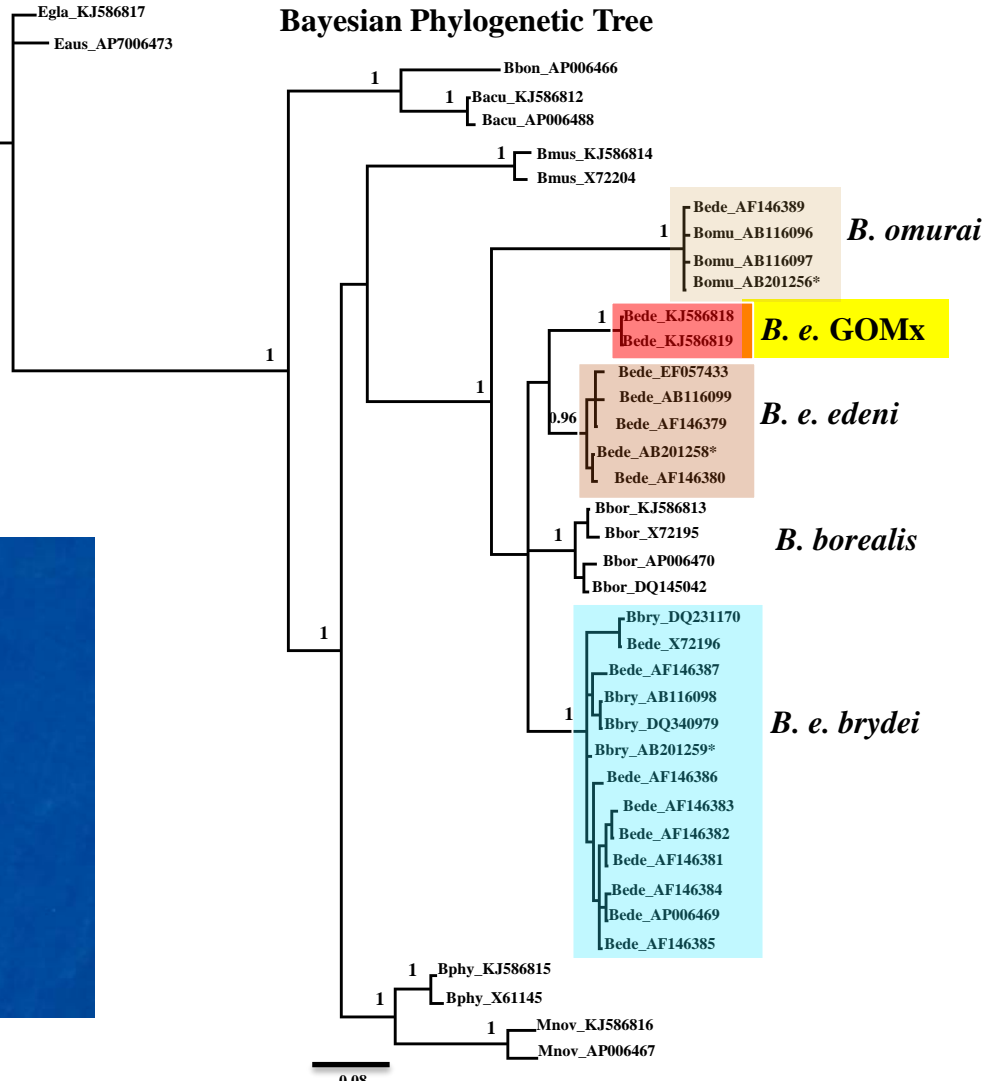
21 species routinely inhabit oceanic waters; currently – 21 stocks

- Bryde's whale (ESA listing proposed)
- Sperm whale (ESA-listed)
- Dwarf sperm whale
- Pygmy sperm whale
- Cuvier's beaked whale
- Blainville's beaked whale
- Gervais' beaked whale
- Short-finned pilot whale
- Killer whale
- Pygmy killer whale
- Melon-headed whale
- False killer whale
- Risso's dolphin
- Bottlenose dolphin
- Rough-toothed dolphin
- Fraser's dolphin
- Atlantic spotted dolphin
- Pantropical spotted dolphin
- Striped dolphin
- Clymene dolphin
- Spinner dolphin



Bryde's Whales in the Gulf of Mexico

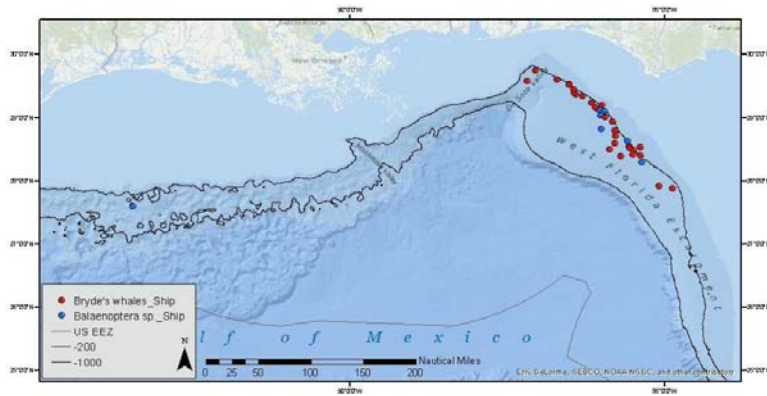
- Genetic analyses
 - Significantly different from Bryde's whales worldwide
 - Unique evolutionary lineage
 - Extremely low genetic diversity



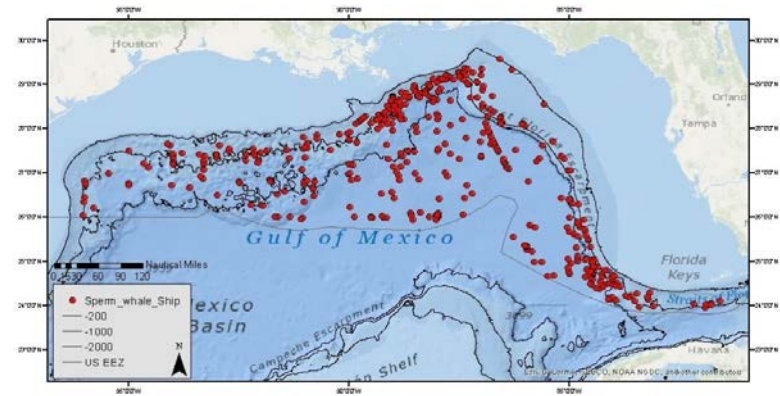
Rosel, P. and L. Wilcox. 2014. Genetic evidence reveals a unique lineage of Bryde's whales in the northern Gulf of Mexico. *Endangered Species Research* 25:19-34.

Examples of Oceanic GOMx Abundance & Distribution Results

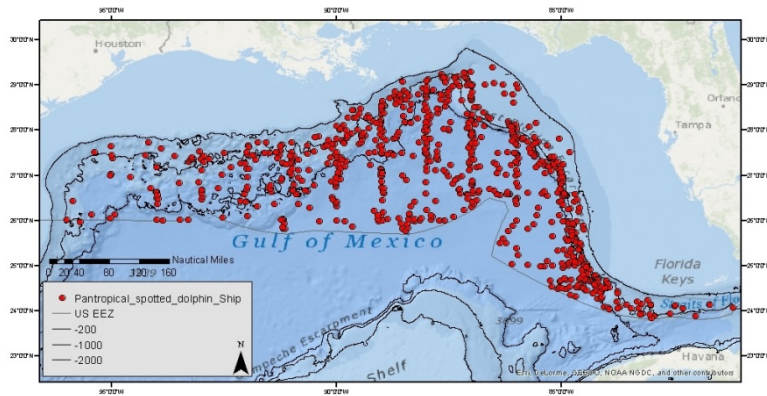
Group sightings from 1992-2009; abundances from Waring et al. (2012)



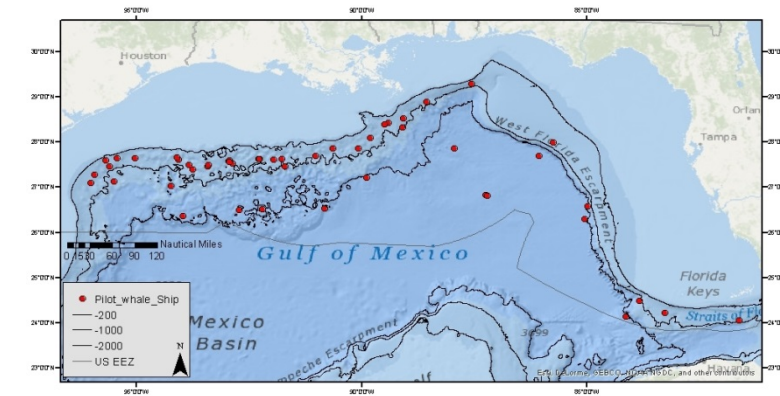
Bryde's whale: $N = 33$ (1.07)



Sperm whale: $N = 763$ (0.38)



Pantropical spotted dolphin : $N = 50,880$ (0.27)



Short-finned pilot whale: $N = 2415$ (0.66)

GoMMAPPS Marine Mammal Objectives

Broad-scale multi-year seasonal abundance & distribution data

1. Continental shelf (0–200 m) – Seasonal aerial surveys
2. Oceanic waters (> 200 m) – Seasonal ship surveys

Data Analyses

1. Assemble and evaluate historical aerial and ship surveys
2. Assess bias-corrected population size of species/stocks
3. Develop models that incorporate habitat characteristics to translate current and past surveys into spatially-explicit maps of species density & uncertainty

stock/species abundance

spatially explicit density

Program Management

Data Management

GoMMAPPS Marine Mammal Fieldwork Schedule

Month/year	FY 2017		FY 2018		FY 2019	
Oct					Fall Aerial Survey	
Nov						
Dec						
Jan			Line Transect Vessel Survey			
Feb				Winter Aerial Survey		
Mar						
Apr						
May						
Jun						
Jul	Line Transect Vessel Survey	Summer Aerial Survey	**Line Transect Vessel Survey			
Aug						
Sep						

** The timing of the proposed summer 2018 survey may change to a more optimal season if needed based upon a seasonal environmental variability analysis and availability of ship time.

Line-transect Surveys

Abundance estimates negatively biased for oceanic GOMx species

$g(0)$ = probability of detecting an animal group/animal directly on the transect line

$g(0) = 1$: assumed for GOMx oceanic species but not always true

Perception bias – missed by observers (varies by survey conditions)

Availability bias – below surface

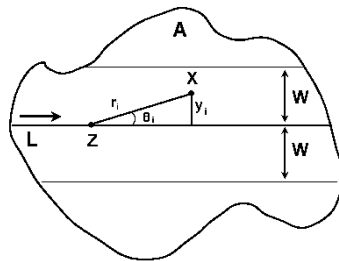
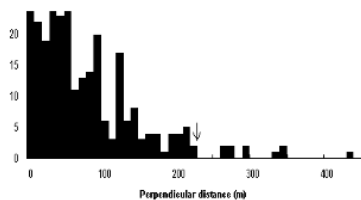
e.g., Barlow et al. (2015) (North Pacific Ocean):

$g(0) \approx 1$ for large schools of delphinids

$g(0) < 1$ (0.40 – 0.70) for large whales

$g(0) \ll 1$ (0.25 – 0.45) for *Kogia* and beaked whales

$$N_i = \sum_{j=1}^3 \frac{A_j \cdot n_{i,j} \cdot S_{i,j} \cdot f_i(0)}{2 \cdot L_j \cdot g(0)}$$



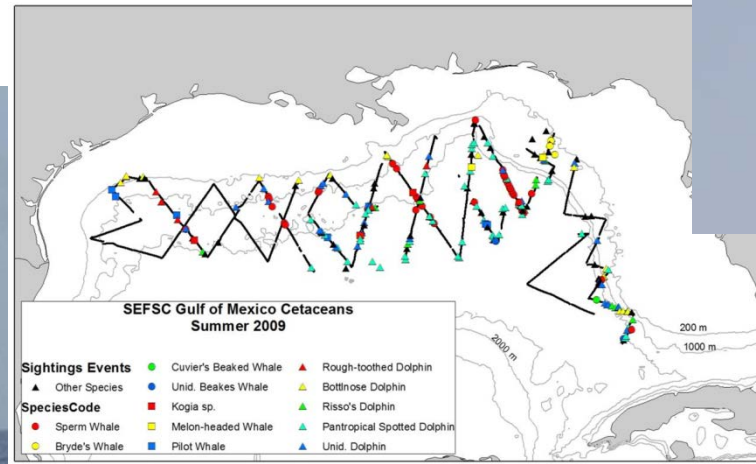
Short-finned pilot whales, GOMx: SEFSC MMPA Permit

Ship-based Surveys

- Seasonal line-transect survey (60 days duration)
 - Two-teams to account for perception bias
- Biopsy samples
 - Stock structure
- Oceanographic data
 - CTD, XBT, EK60, Thermosalinograph
- Passive acoustic sampling
 - towed array
- Seabird survey

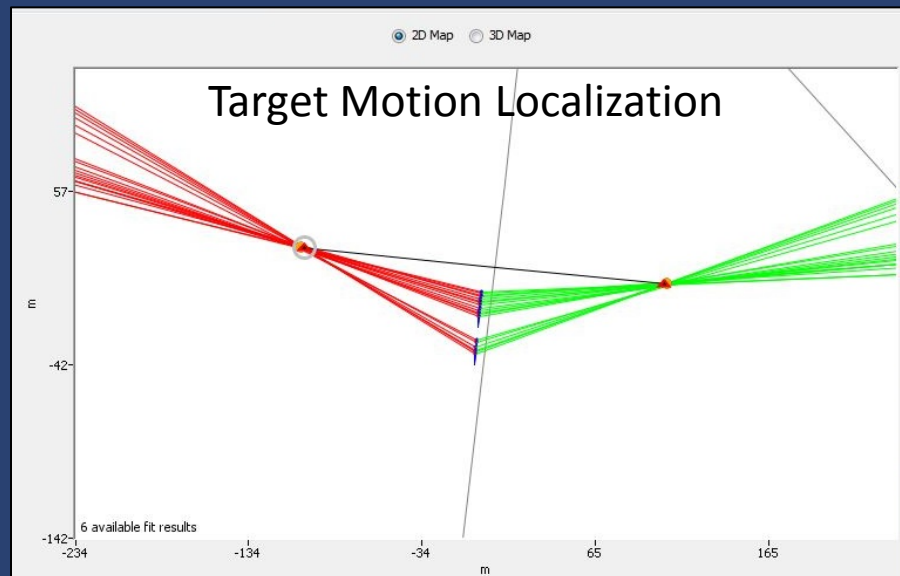
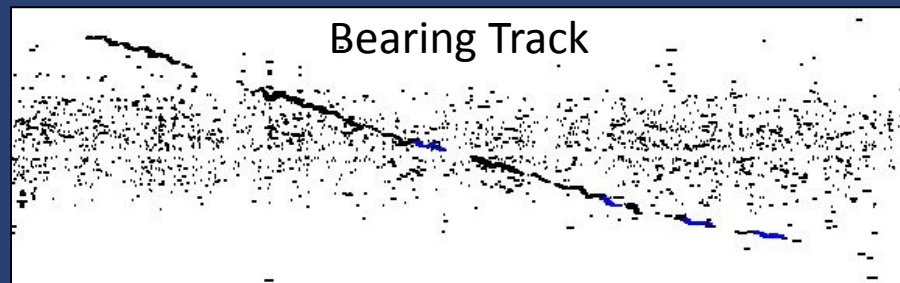
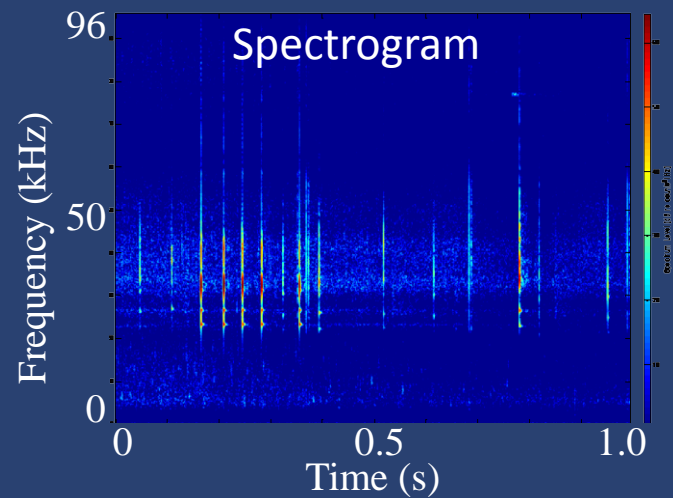
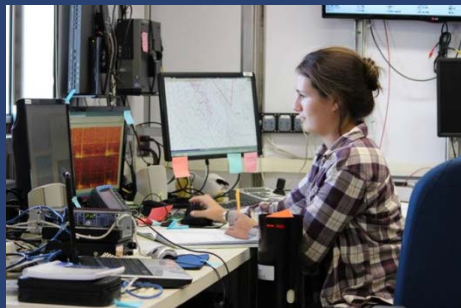
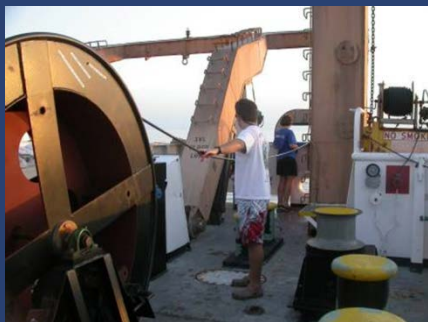
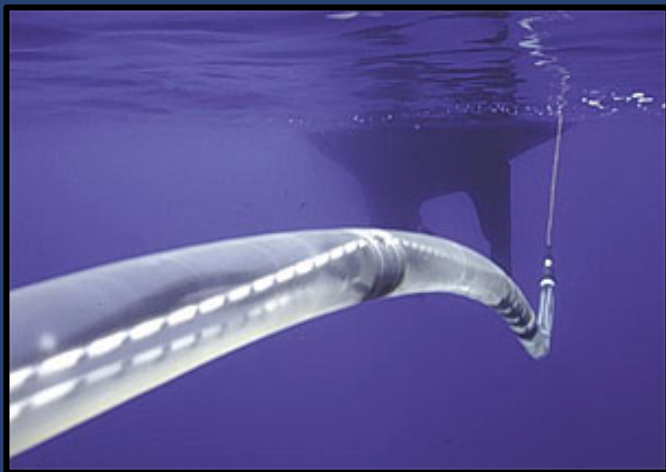


© 2010 Greg Lavaty pbase.com/dadas115



GoMMAPPS Passive Acoustics

Towed Hydrophone Array

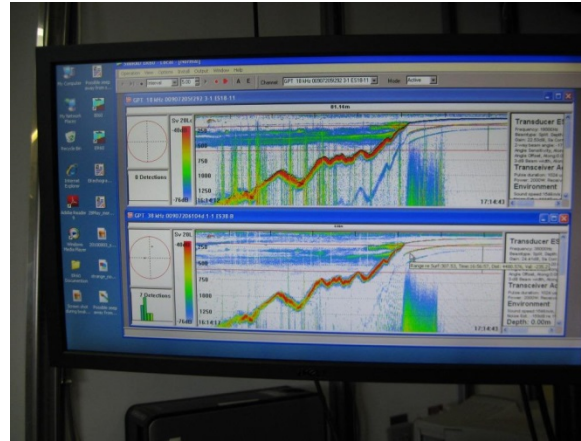


In-situ Oceanographic Sampling

XBT Stations



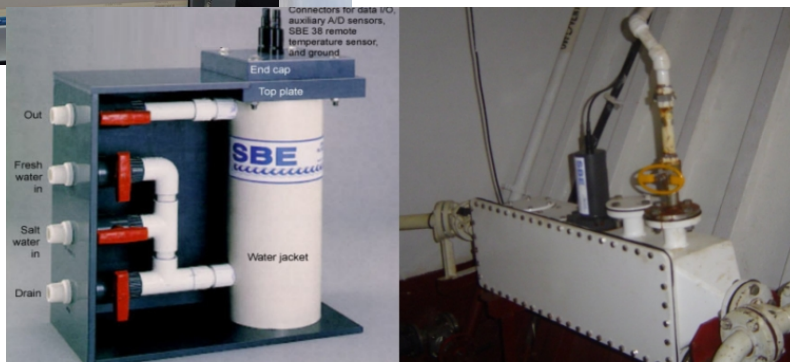
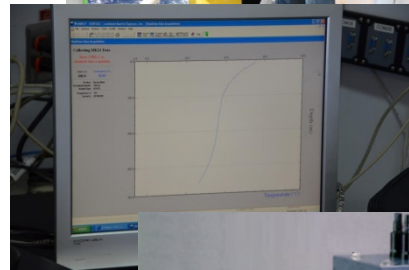
EK60 at night



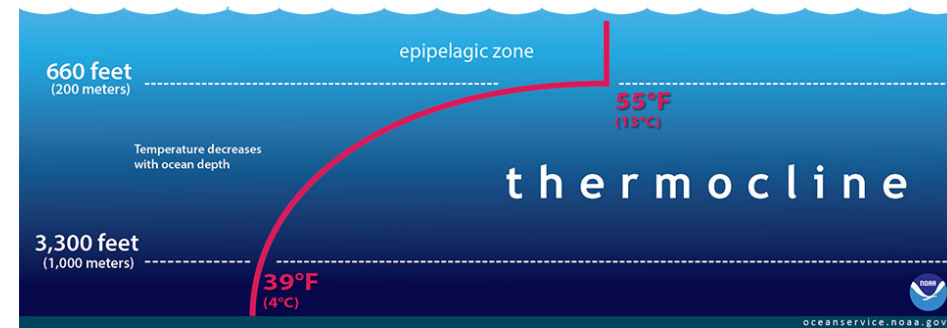
CTD Stations



24 hour Thermosalinograph



(left) Overall view of the SBE 21 SEACAT Thermosalinograph model. (right) Thermosalinograph installed onboard the NOAA ship Ronald H. Brown.

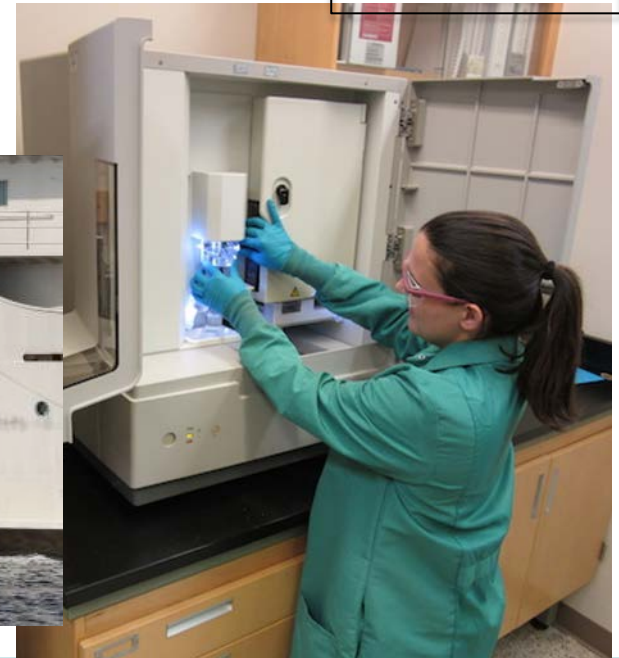


Stock Structure – Sample Collection

- Large vessel surveys - shelf and oceanic species
- Skin samples for genetics
 - From the bow - bowriding species (small delphinids)
 - Deploy RHIB for large whales & larger delphinids

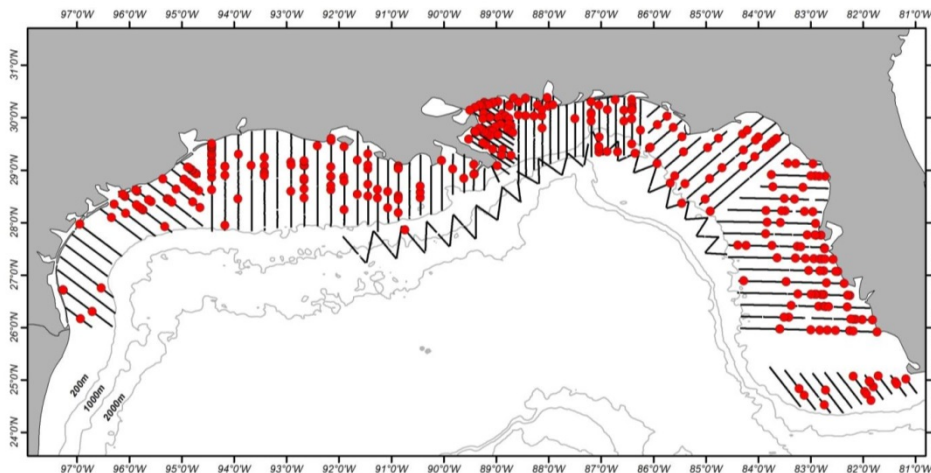


Typical biopsy sample which is subsampled for multiple analyses



Continental Shelf: Aerial Surveys

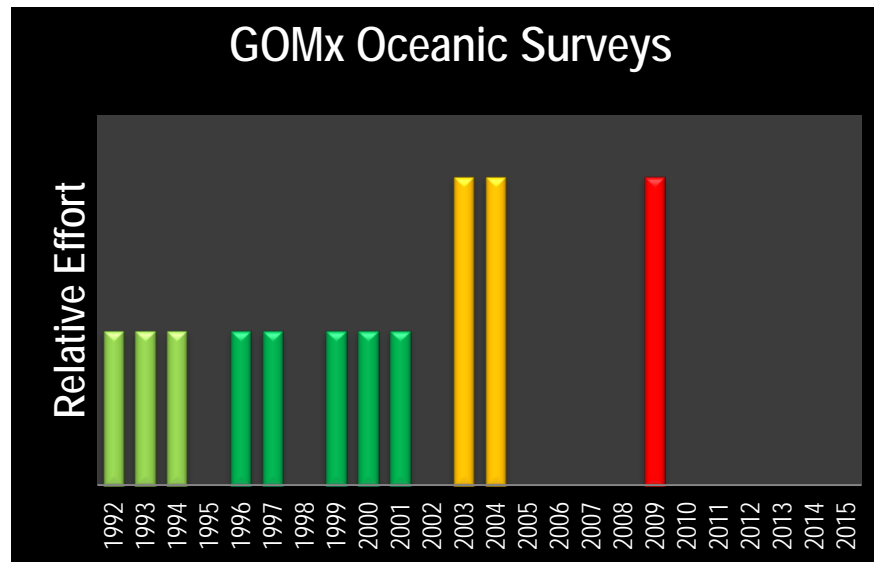
- Visual line-transect surveys (60 days duration)
- Two-team method to account for perception bias
- Seasonal surveys
- Bottlenose dolphins, Atlantic spotted dolphins & sea turtles



Historical Data: GOMx Oceanic Cetacean Abundance Surveys

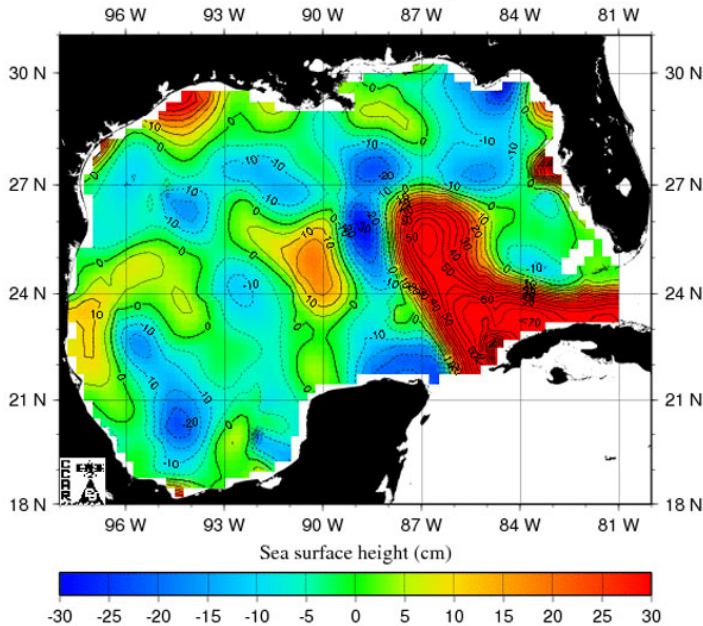
	Estimates	Years	Season	Type	Partners
	Hansen et al. 1995	1992-1994	Spring	"piggyback"	SEFSC/BOEM
	Mullin & Fulling 2004	1996-2001	Spring	"piggyback"	SEFSC/BOEM
	Mullin 2007	2003-2004	Spring/Summer	Dedicated	SEFSC/US Navy
	Waring et al. 2012	2009	Summer	Dedicated	BOEM

- "Piggyback" – conducted during spring bluefin tuna plankton surveys

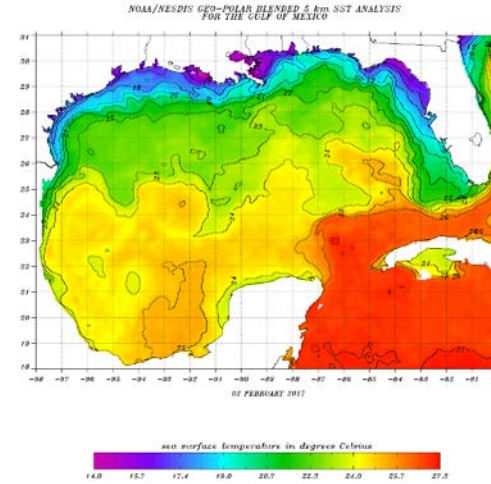


Remotely-sensed Data

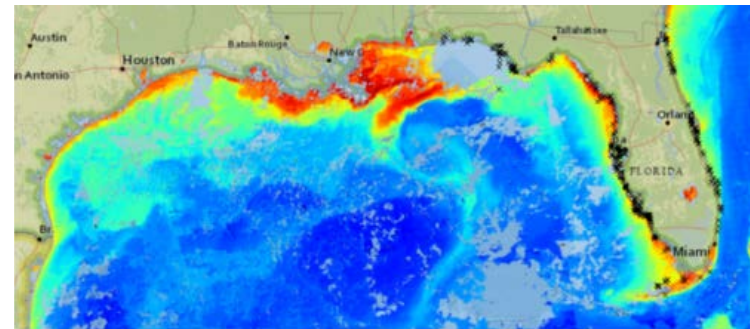
Real-Time Mesoscale Altimetry - Mar 24, 2012



Sea surface height anomaly



Sea surface temperature



CoastWatch chlorophyll 3-day composite viewed on NOAA's HABSOS.

Ocean color - chlorophyll

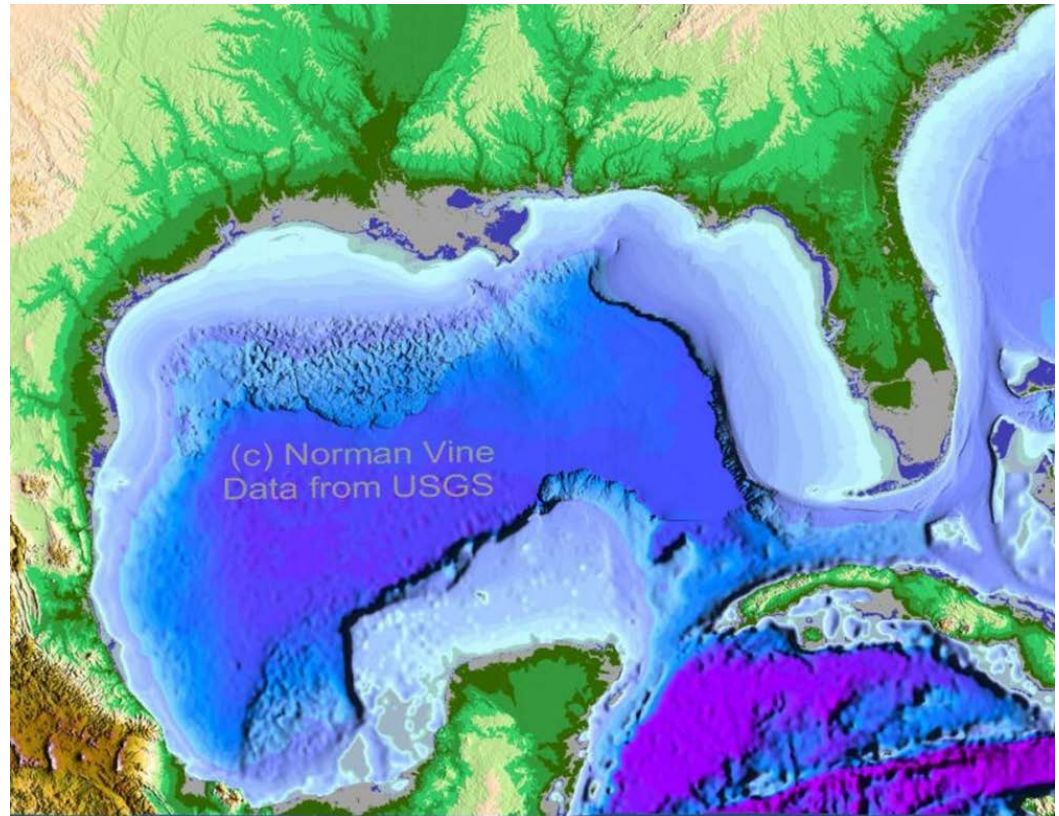
Topographic Data

Water depth

Bottom slope

Distance from features

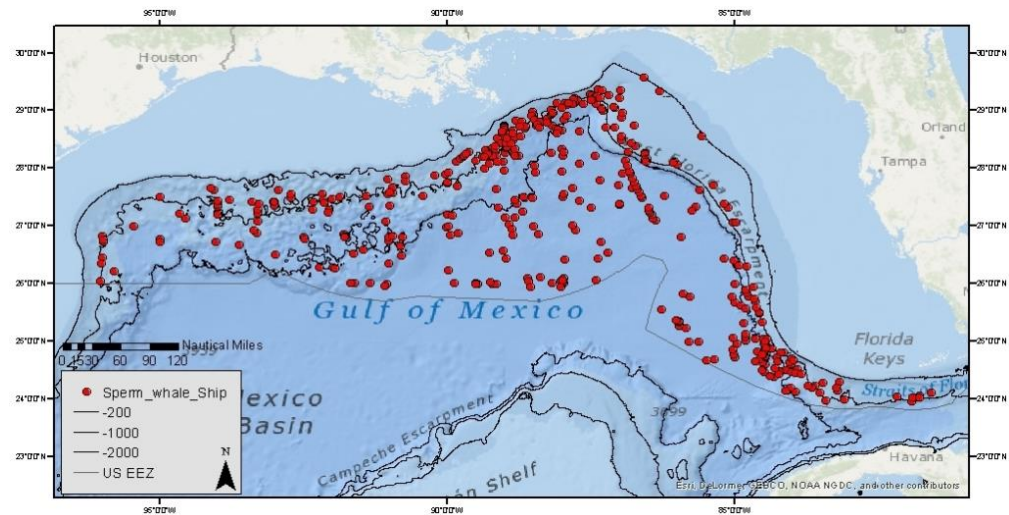
- MS River Delta
- Shelf break
- Canyons



Outcomes: Spatially Explicit Density Maps

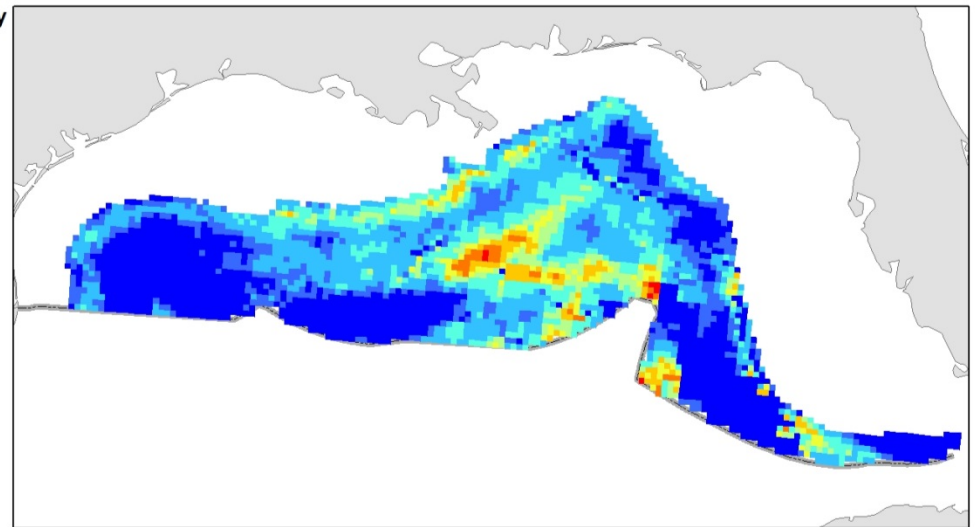
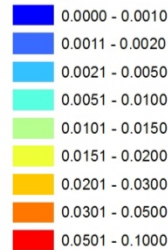
Integrate

- Historical data
- Seasonal survey data
- In situ* oceanographic data
- Remote sensing data
- Topographic data



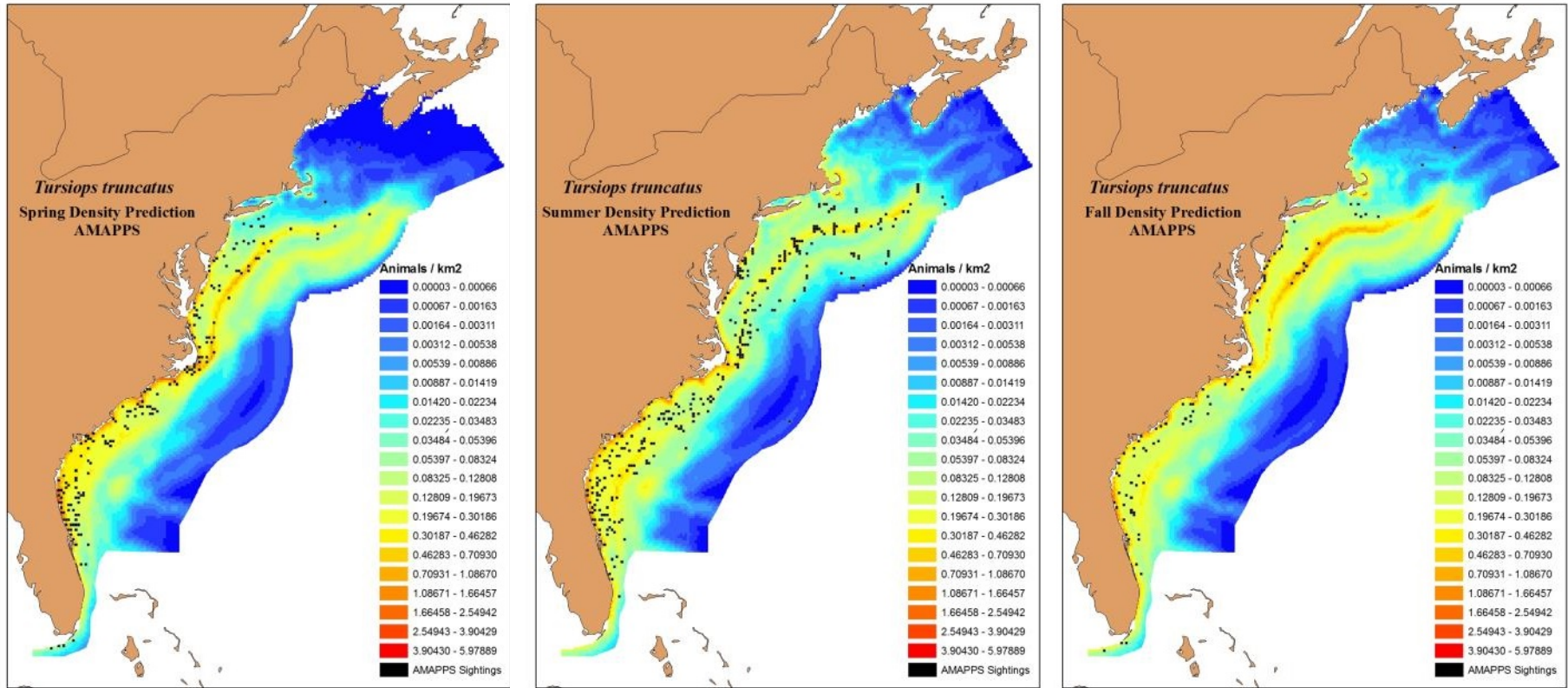
Sperm Whale Density

July 2010
density



Outcomes: Spatially Explicit Density Maps

AMAPPS example: Bottlenose dolphin density and spatial distribution



- AMAPPS seasonal maps of density from vessel and aerial survey data (SEFSC and NEFSC)
- A major GoMMAPPS objective is to produce and disseminate operational mapping products