SEFSC Research on Cetacean Abundance, Distribution & Stock Structure in the Gulf of Mexico

Keith D. Mullin
Southeast Fisheries Science Center

Gulf of Mexico Marine Mammal
Research & Monitoring Meeting

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SERVICE**

U.S. Marine Mammal Protection Act

- **Species or population stocks should remain a significant functioning element of the ecosystem they inhabit (throughout range)**
- **Therefore, stocks should remain above their optimum sustainable population size (OSP)**
- **OSP – number of animals that results in the maximum productivity of the population keeping in mind carrying capacity & the health of the ecosystem**
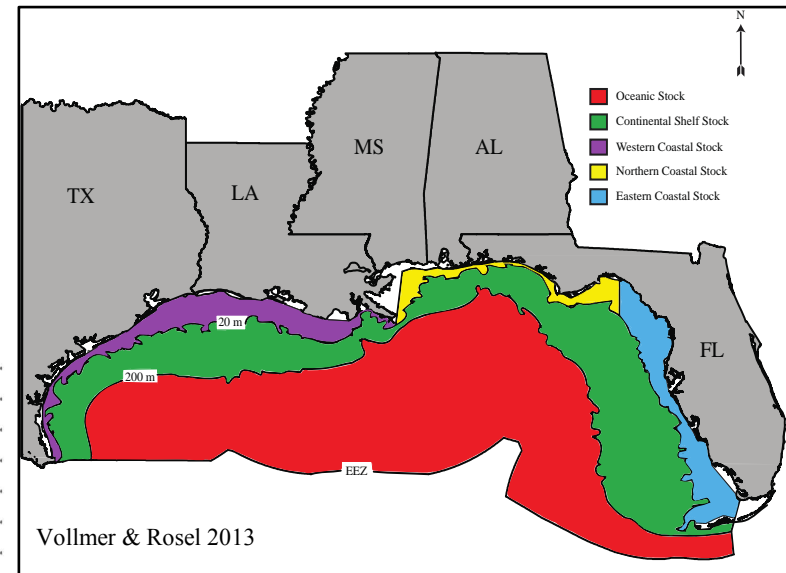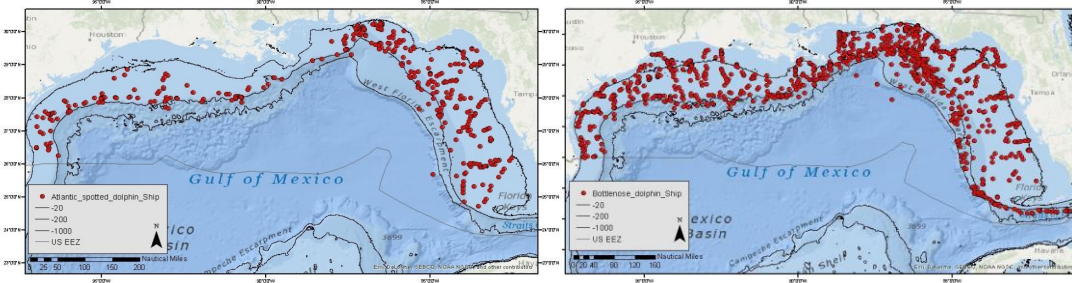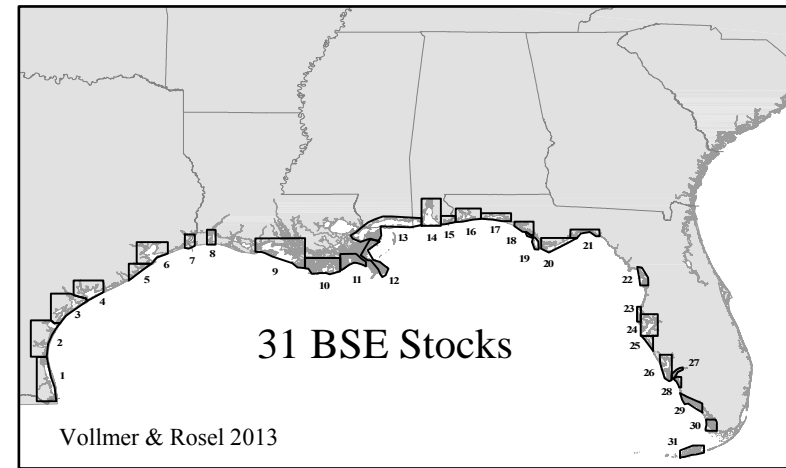- **If a stock is already below OSP, then measures should be taken to replenish the stock (>OSP)**

Marine Mammal Stock Definition

- ## MMPA
  - A group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature

- ## Functional
  - Groups delineated by a very low rate of genetic exchange
  - Groups that are demographically independent
 - OR management – groups that experience differential risks

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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)**
 - **20 species – 20 stocks (tropical cetacean community)**

31 BSE Stocks

Vollmer & Rosel 2013

Legend:
- Oceanic Stock
- Continental Shelf Stock
- Western Coastal Stock
- Northern Coastal Stock
- Eastern Coastal Stock

Vollmer & Rosel 2013

Gulf of Mexico Oceanic Cetacean Species & Stocks

- **Bryde's whale**
- **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**
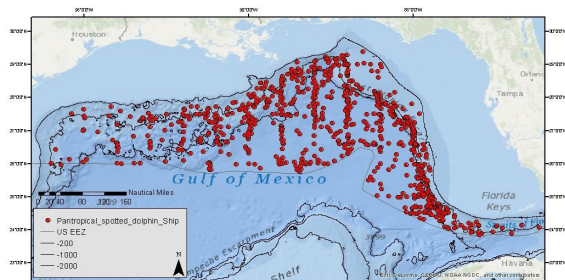
- **Melon-headed whale**
- **False killer whale**
- **Risso's dolphin**
- **Bottlenose dolphin**
- **Rough-toothed dolphin**
- **Fraser's dolphin**
- **Pantropical spotted dolphin**
- **Striped dolphin**
- **Clymene dolphin**
- **Spinner dolphin**
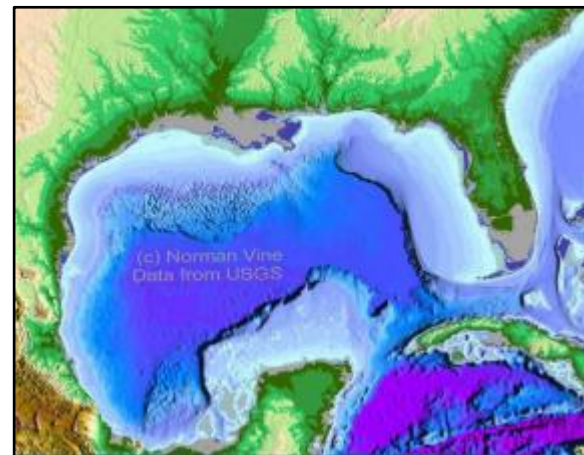
NOAA research driven by information needs of
MMPA-mandated Stock Assessment Reports

- **STOCK DEFINITION & RANGE**

- **POPULATION SIZE**
  - **Minimum Population Estimate**
  - **Population Trend**

- **MAXIMUM NET PRODUCTIVITY RATE**

- **POTENTIAL BIOLOGICAL REMOVAL (PBR: N_{min} x ½ R_{max} x Rec. Factor)**

- **ANNUAL HUMAN-CAUSED MORTALITY & SERIOUS INJURY**
  - **Fishery Information**
  - **Other Mortality**

- **STATUS OF STOCK (Endangered? Depleted? Strategic? Stable? Declining?)**

SEFSC Marine Mammal Research Activities

- **<u>Abundance surveys</u>** – surveys to estimate/monitor stock abundance & distribution over time (estimate N_{min} & calculate PBR)

- **<u>Stock Definition</u>** – genetics (primary), photo-identification & tagging

- **<u>Habitat studies</u>** – oceanographic & biological data from surveys & remote sensing

- **<u>Assess human-caused mortality</u>** – estimates from fisheries observer programs & stranding response/evaluation

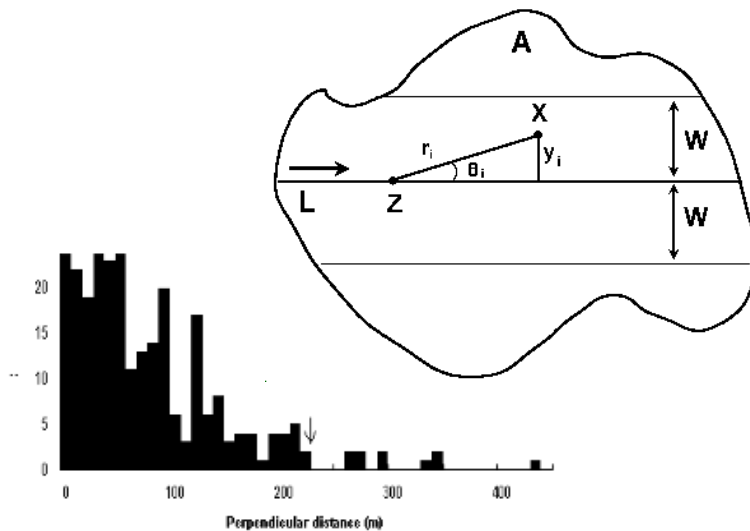**Research methods used differ by habitat &, in some cases, species**

Line-transect Surveys

Method used to collect data from ships & aircraft for large open habitats (*e.g.*, oceanic & continental shelf waters) to estimate density & abundance
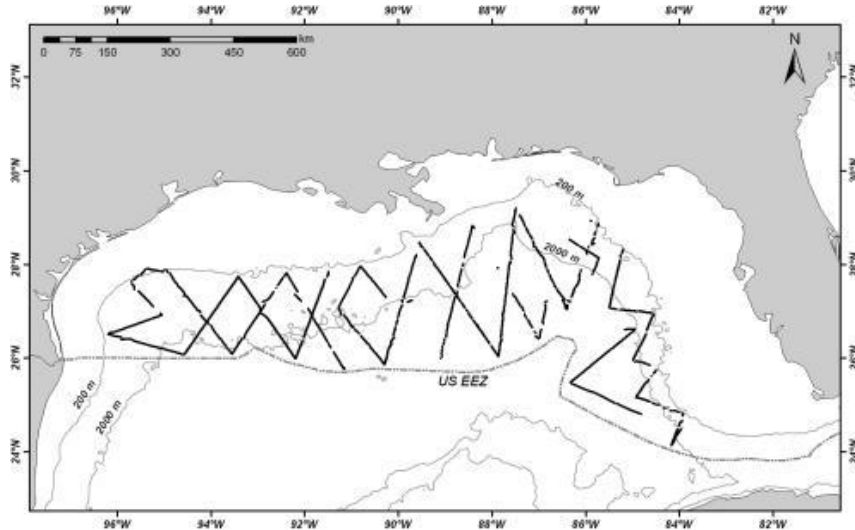
$$N_i = \sum_{j=1}^{3} \frac{A_j \cdot n_{i,\,j} \cdot S_{i,\,j} \cdot f_i(0)}{2 \cdot L_j \cdot g(0)}$$

Ship-based Abundance Surveys
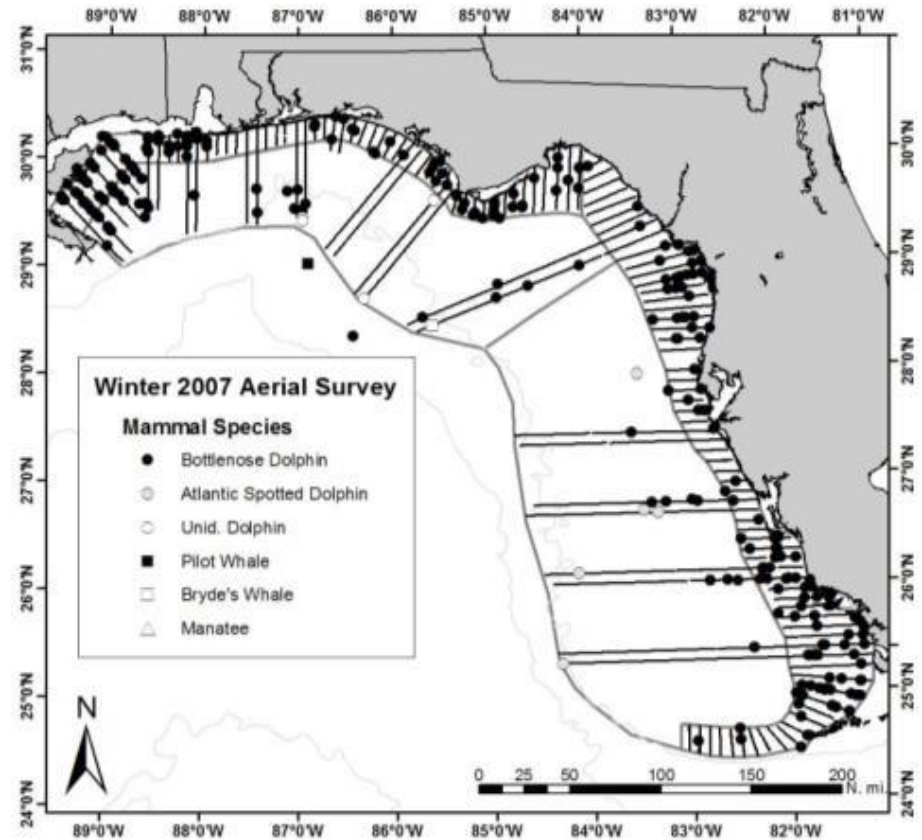### continental shelf & oceanic waters

- Line-transect data
- Biopsy samples
- Oceanographic data
- Acoustic data

Aerial Abundance Surveys
coastal & continental shelf waters
line-transect data

Winter 2007 Aerial Survey

Mammal Species

- ● Bottlenose Dolphin
- ◍ Atlantic Spotted Dolphin
- ○ Unid. Dolphin
- ■ Pilot Whale
- □ Bryde's Whale
- △ Manatee

Capture-Mark-Recapture Methods

- **Abundances of bay, sound & estuary bottlenose dolphin stocks**
- **Survival rates**
- **Identify resident individuals**
- **Information on individual ranging patterns & habitat use**
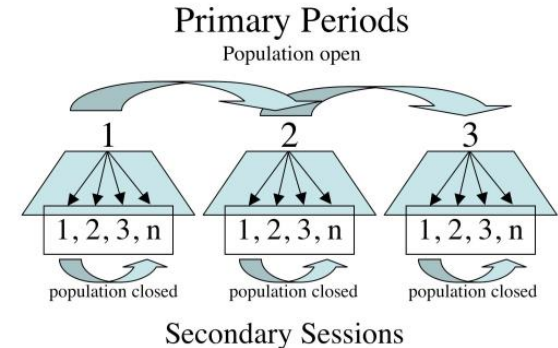

## Primary Periods
Population open

Figure 3. Schematic of robust design with three primary periods across which the sampled population is considered open and "n" secondary sessions within each primary period. The population is considered closed within each secondary session, but temporary emigration/immigration may occur between primary periods
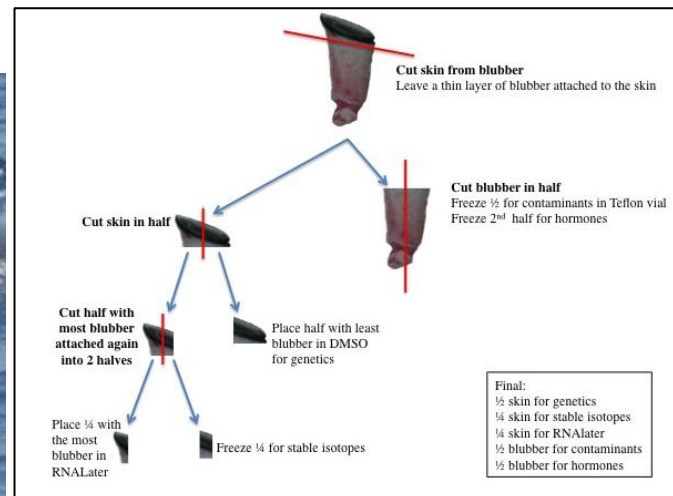
Rosel *et al*. 2011
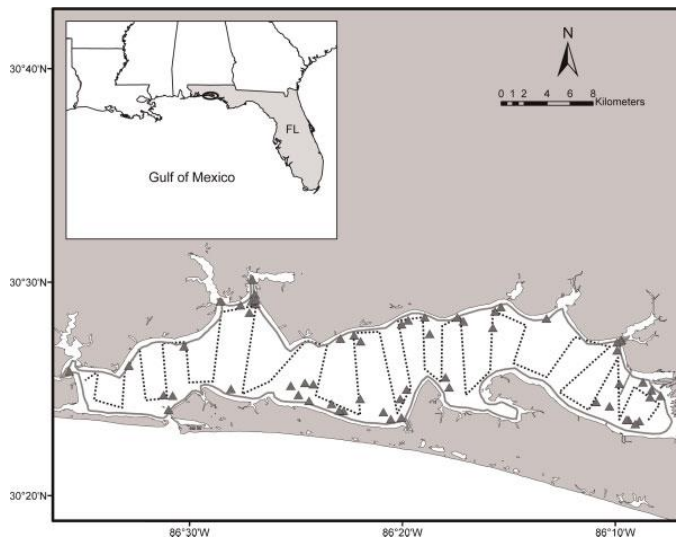
**Choctawhatchee Bay, Florida (Conn *et al*. 2011)**

Remote Biopsy Sampling

- **Genetics (stock structure)**
- **Contaminants**
- **Stable isotopes**
- **Reproductive hormones**

Cut skin from blubber
Leave a thin layer of blubber attached to the skin

Cut skin in half

Cut blubber in half
Freeze ½ for contaminants in Teflon vial
Freeze 2nd half for hormones

Cut half with most blubber attached again into 2 halves

Place half with least blubber in DMSO for genetics

Place ¼ with the most blubber in RNALater

Freeze ¼ for stable isotopes

Final:
½ skin for genetics
¼ skin for stable isotopes
¼ skin for RNAlater
½ blubber for contaminants
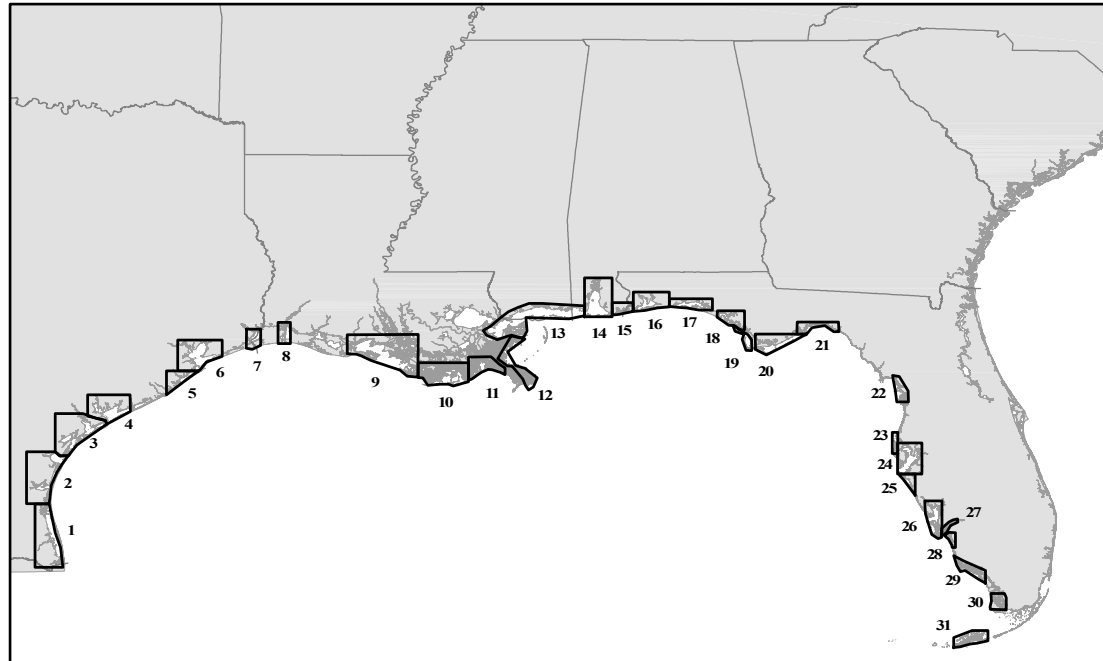½ blubber for hormones

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Bottlenose Dolphin BSE Stock Structure
What is known?

- **Most of the 31 designated stock boundaries have yet to be tested**
- **Bottlenose dolphins do partition their habitat on a fine-scale**
- **Are they all realistic units? Combine some? Delete some?**
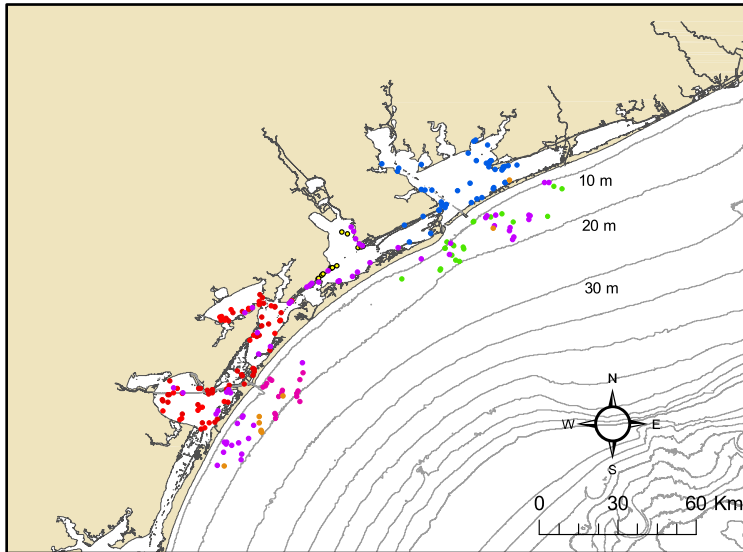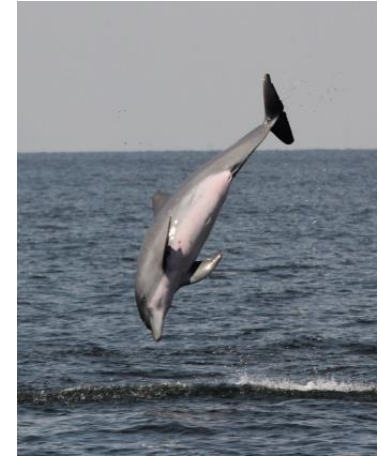
**Central Texas bays & coastal waters biopsy samples**

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Gulf of Mexico Stock Structure: Shelf & Oceanic Species

- **Currently, each species in continental shelf (2) and oceanic (20) waters is defined as one stock**
- **Is there intra-Gulf stock structure? For the one species examined thus far – Yes**
  - **Atlantic spotted dolphins: Viricel & Rosel (2014) found eastern & western Gulf genetic clusters**
- **Genetic samples from pantropical spotted dolphins will be examined next**

Atlantic spotted dolphin
(*Stenella frontalis*)

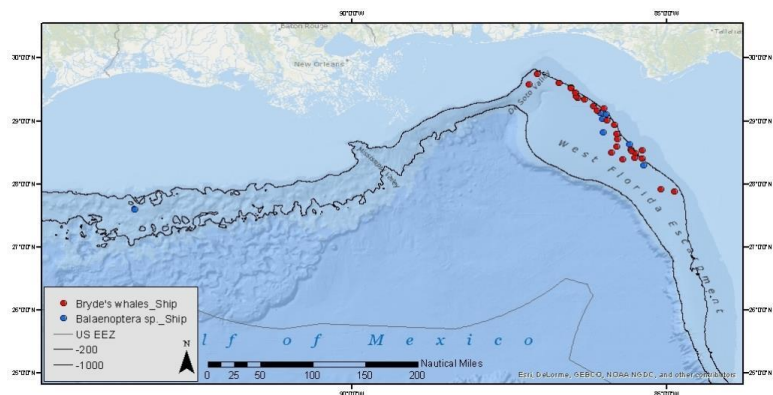Pantropical spotted dolphin
(*Stenella attenuata*)
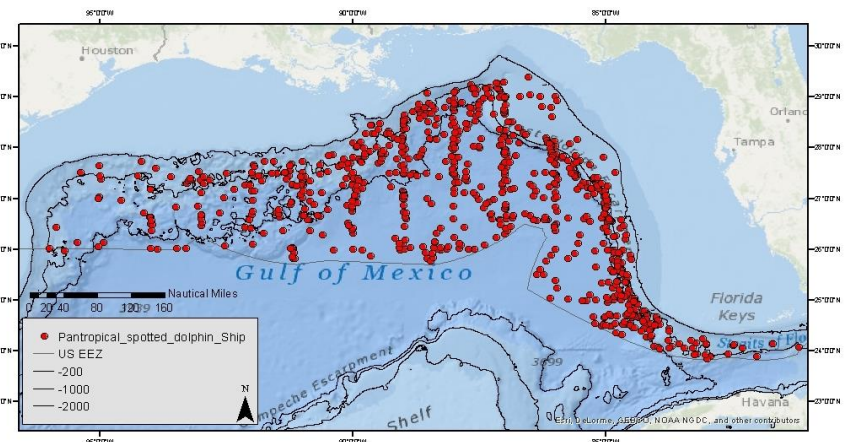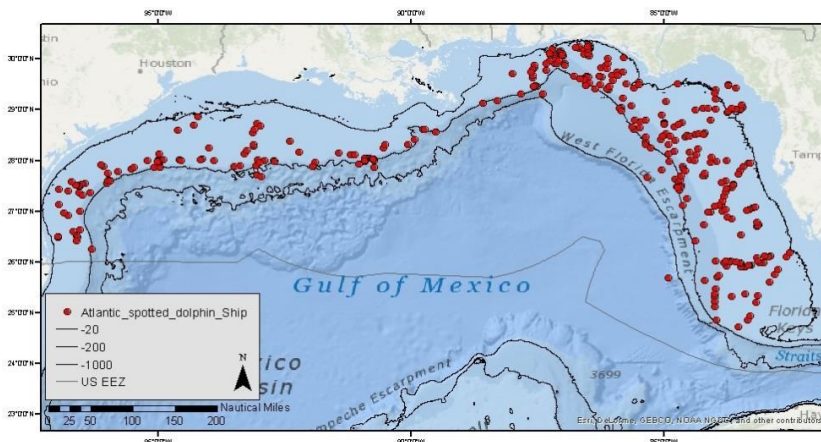
A Few (of many) Challenges

- **Transboundary Stocks** – the ranges of oceanic cetaceans that occur in U.S. waters almost certainly include international waters and/or waters of other countries.

- **Southern Gulf of Mexico** – a specific transboundary problem: Gulf is relatively small & abundance & trends information are very difficult to interpret without the context of the southern Gulf.

- **Timely Abundance Estimates** – Abundance & PBR need to be updated at least every 8 years. This is very difficult for the Gulf's BSE bottlenose dolphins stocks – It has not been done even once for many of these stocks using unbiased methods (*i.e.*, capture-mark-recapture).
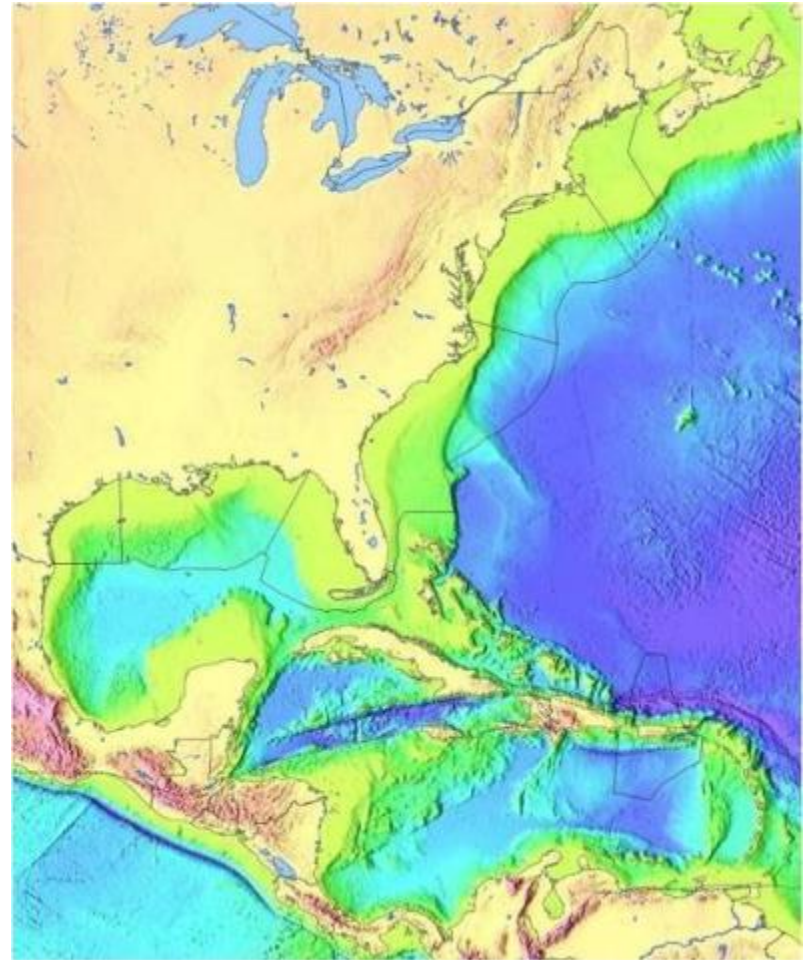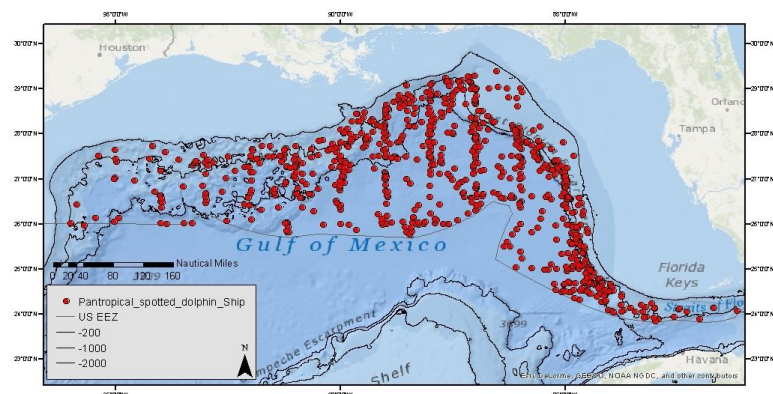
Examples of Abundance & Distribution Results
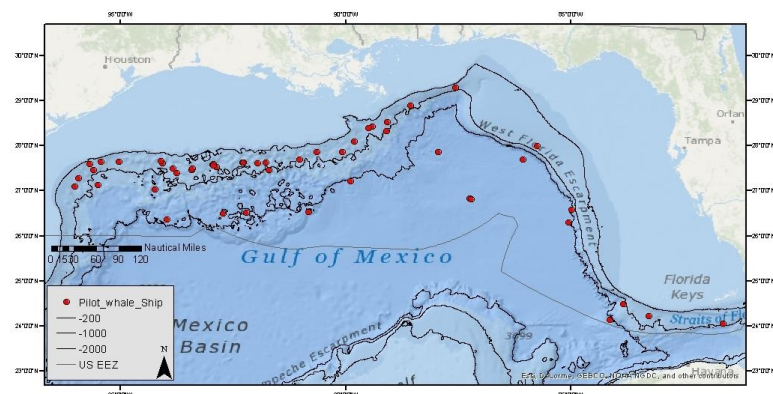

Bryde's whale: $N = 33$ (1.07)
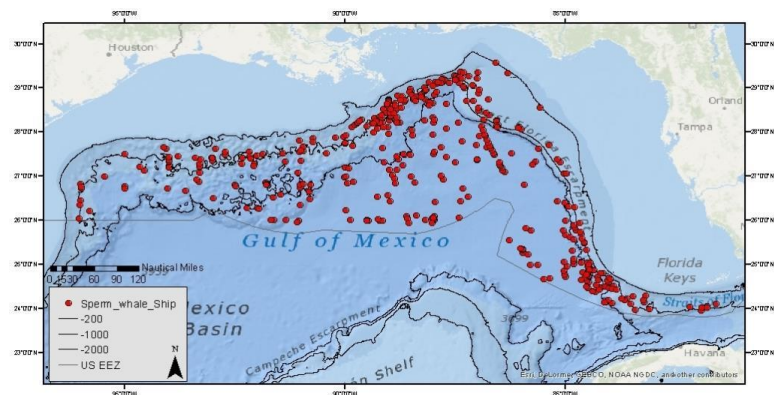
Sperm whale: $N = 763$ (0.38)

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

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

Some Resources for Consistency Among Studies

Biopsy sampling & sample processing:
Sinclair *et al.* 2015. Remote biopsy field sampling procedures for cetaceans used during the Natural Resource Damage Assessment of the MSC252 Deepwater Horizon Oil Spill.
NOAA Technical Memorandum NMFS-SEFSC-670. 28 p.

Photo-ID data collection & photo-analysis:
Melancon *et al.* 2011. Photo-identification field and laboratory protocols Utilizing FinBase Version 2.
NOAA Technical Memorandum NMFS-SEFSC-627. 46 p.

BSE capture-mark-recapture survey design & implementation:
Rosel *et al.* 2011. Photo-identification capture-mark-recapture techniques for estimating abundance of bay, sound and estuary populations of bottlenose dolphin along the U.S. East Coast and Gulf of Mexico.
NOAA Technical Memorandum NMFS-SEFSC-621. 30 p.

Literature Cited

Conn *et al*. 2011. Accounting for transients when estimating abundance of bottlenose dolphins in Choctawhatchee Bay, Florida. The Journal of Wildlife Management 75(3): 569–579.

Rosel *et al*. 2011. Photo-identification capture-mark-recapture techniques for estimating abundance of bay, sound and estuary populations of bottlenose dolphin along the U.S. East Coast and Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-621. 30 p.

Viricel, A. & P.E. Rosel. 2014. Hierarchical population structure and habitat differences in a highly mobile marine species: the Atlantic spotted dolphin. Molecular Ecology 23:5018–5035.

Vollmer, N.L. & P.E. Rosel. 2013. A review of common bottlenose dolphins (*Tursiops truncatus*) in the northern Gulf of Mexico: population biology, potential threats, and management. Southeastern Naturalist 12 (Monograph 6): 1–43.

All marine mammal photos:
NOAA/SEFSC MMPA Permit 779-1633

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