# Ocean/Wind Power Ecological Baseline Studies

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF SCIENCE, RESEARCH, & TECHNOLOGY

## Interested Party Group Meeting Presentation

**09 November 2007**

GMI
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# GMI Overview

- Founded in 1972 in Dallas, Texas  Diversified environmental planning, cultural resource, engineering design, construction management, & technology company
  - 140 scientists, planners, engineers, & managers
  - 6 U.S. office locations
- Commercial and State experience since 1972:
  - Oil & Gas companies
  - Utilities & Energy Companies
  - Telecommunications Companies
  - Departments of Transportation and Port Authorities
  - Cities, Counties, State Governments
  - Commonwealths (Puerto Rico, Guam, Virgin Islands)
- Department of Defense experience since 1985:
  - US Navy and US Marine Corps
  - US Air Force and UK Royal Air Force
  - US Army and National Guard Bureau
  - Air National Guard, NASA
- Federal Government
  - USDA and USDOI
  - USDOS, USDOJ
  - GSA, NOAA/NMFS, EPA

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# GMI Project Experience

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# GMI Service Categories

## Natural Resources

- Biological Studies
- T&E Studies
- Habitat Surveys
- Ecosystem Restoration
- Wetland Studies
- Marine & Aquatic Sciences
- Biological Assessments
- Wildlife Mgt
- Radar Surveys
- Thermal Imaging
- GIS and Support Technologies

## Planning & Analysis

- NEPA Analysis & Documentation
- Public Involvement
- Administrative Record
- Noise Studies
- Land Use Planning
- Socioeconomic Analysis
- Environmental Justice
- Water Quality
- Noise Studies

## Environmental Services

- Storm Water Plans
- Spill Prevention
- Air Quality
- Clean Water
- RCRA
- CERCLA
- EPCRA
- UXO
- Lead-Based Paint
- Asbestos
- Demilitarization
- Risk Assessment

## Cultural Resources

- Archaeology
- Native American Consultation
- Historic Architecture
- Ethnography
- Historical Research
- Osteology
- Section 106 Compliance
- Public Outreach
- Visualization Technologies

## Engineering & Construction

- Condition Assessment Surveys
- Engineering Design
- Construction
- Design-Build
- Commissioning
- Retro-commissioning
- Monitoring & Operations

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# GMI Overview

NJDEP

***project manager:***
DAN WILKINSON, PHD

***advisory team/quality oversight:***
CHRISTOPHER CLARK, PHD - acoustics
SCOTT ECKERT, PHD - turtles
SIDNEY GAUTHREAUX, PHD - PI birds
BOB KENNEY, PHD - marine mammals

***support personnel:***

***vessel operators:***
AMBROULT AVIATION - aircraft
DAVID MORGAN - ship, lift platform
JAMES NICKELS - ship, lift platform
MARK PANDOVE - crew boat
MATT HAWKINS - survey vessel

***radar operators:***
DAMIEN EDWARDS
DAVID PITTS
JOHN LIVINGSTON

***selected observers:***
JIM COTTON
DAGMAR FERTL
MICHAEL FORCE
GREG FULLING, PHD
RICHARD ROWLETT
JC SALINAS

***technical resources:***
CHRIS CLARK - avian studies/radar
KEN DESLARZES, PHD - reefs and habitat features
DAMIEN EDWARDS - avian studies/biologist
DAGMAR FERTL - marine mammal biologist
GREG FULLING, PHD - PI modeling and marine mammal survey
SIDNEY GAUTHREAUX, PHD - PI avian studies
PETER GEHRING - PI GIS
NORA GLUCH - impacts assessment
KEVIN KNIGHT - GIS
ANU KUMAR - PI acoustic
PHIL MUELLER - data analyst/programmer
LIZ PRUITT - PI impacts
ROSS RASUMSSEN - avian studies/biologist
ALEC RICHARDSON, PHD - statistician
JASON SEE, PHD - PI oceanography
CARTER WATERSON - EFH

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# Ecological Baseline Study Components

- Ship Board Avian, Marine Mammal, and Sea Turtle Surveys
- Aerial Marine Mammal, Sea Turtle
- Small Vessel Coastal Avian Surveys
- Acoustical Surveys
- Oceanographic Surveys
- Offshore Radar Surveys
- Thermal Imaging-Vertically Pointed Radar Surveys

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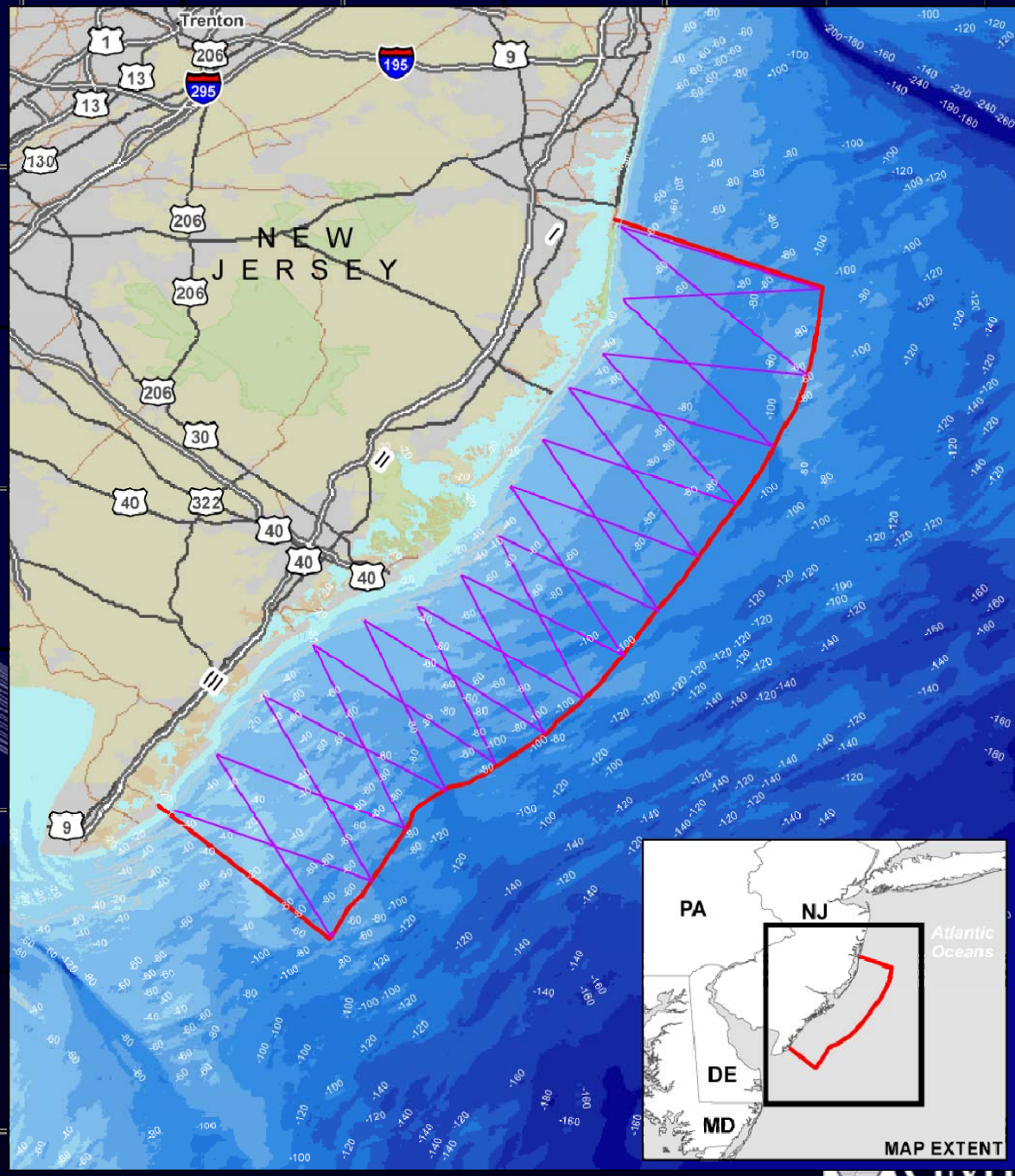
# Marine Mammal/Sea Turtle and Avian Studies

- Ship/aerial surveys will be designed to maximize coverage of the study area
- Extensive experience in survey design and data analysis:
  - Guam (MISTCS, Fulling et al. 2007 in preparation)
  - Gulf of Mexico (Fulling et al. 2004; Mullin and Fulling 2004)
  - US Atlantic Coast (Mullin and Fulling 2003; MATS 2004)

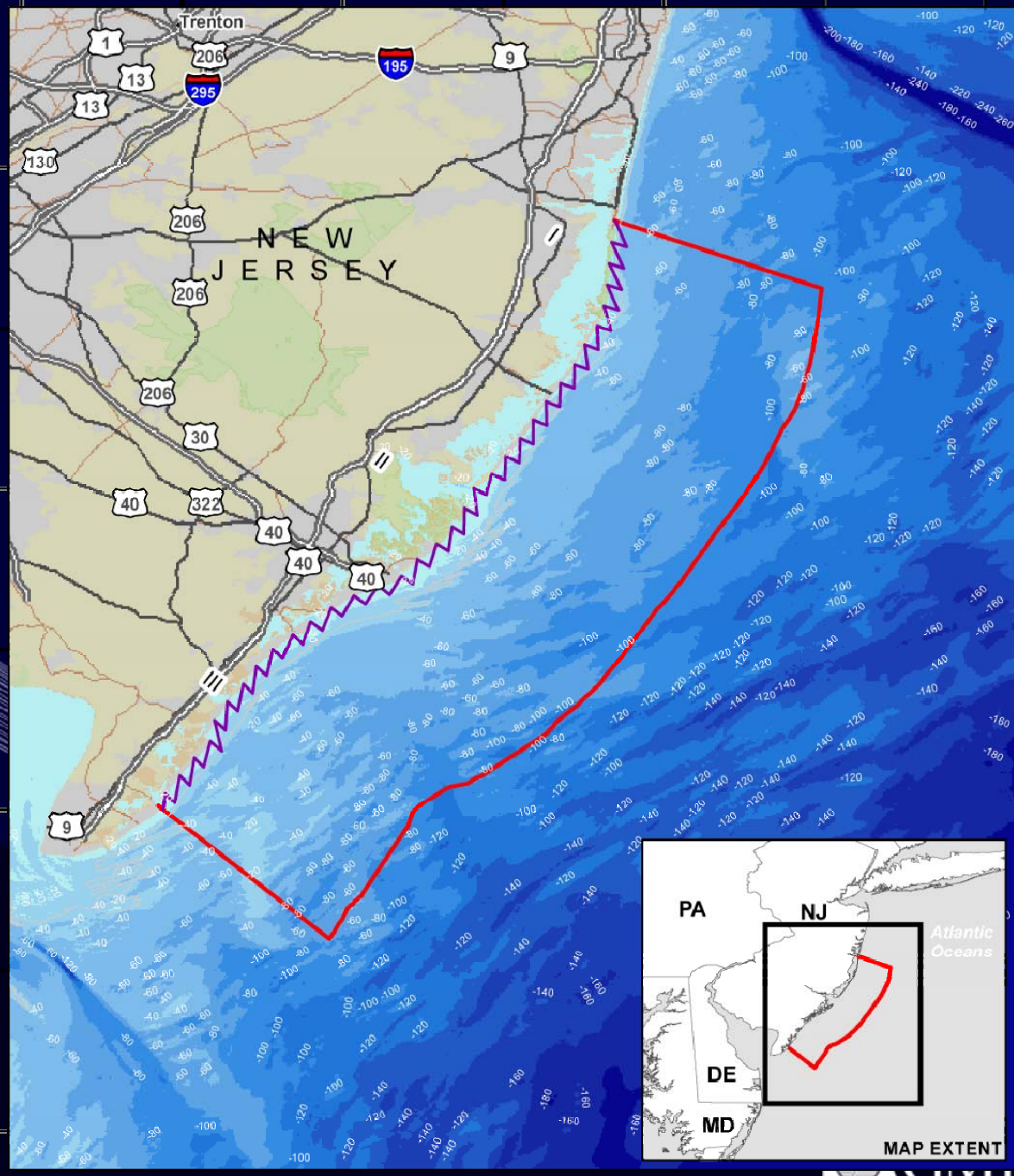
# Shipboard Survey Tracklines

- 18 monthly surveys
- Double saw-tooth sample design
- Random start location



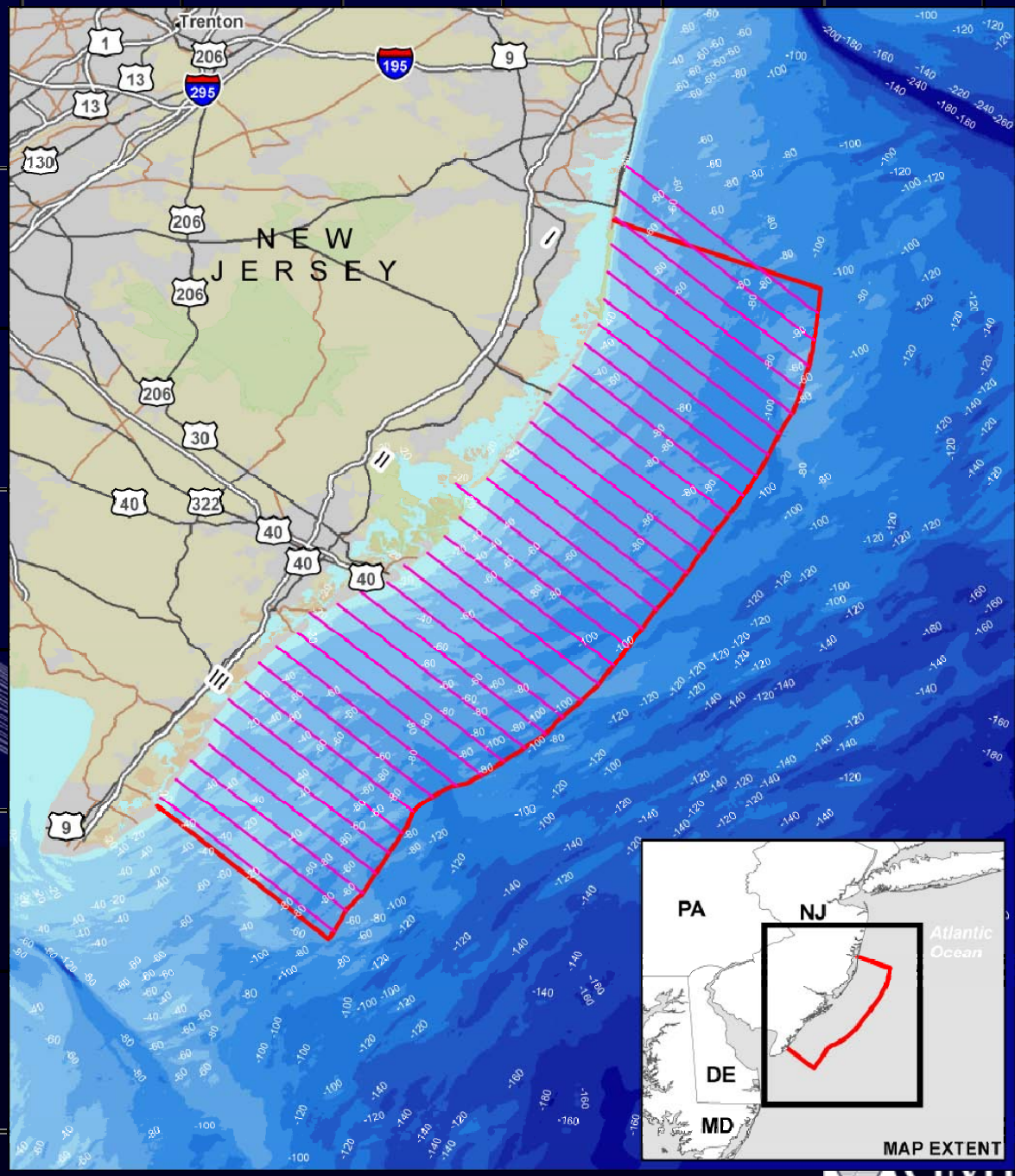
# Small Vessel Coastal Avian Surveys

- Line-transect survey method (single saw-tooth)
- Extending to 10 meter isobath



# Aerial Survey Tracklines

- 34 tracklines
- 2 nautical mile separation
- Random start location



# Aircraft Cessna 337 Skymaster

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# Density Estimation

- Spatial modeling requires “hands-on” experience
  - We have learned from the leader’s in this field
    - Centre for Research in Environmental and Ecological Modeling (CREEM), University of St. Andrew’s, UK; Buckland, Borchers, Thomas, et al.
  - Two year working relationship
  - Numerous training workshop in DISTANCE
  - Combine ship and aerial surveys
- Recently completed projects
  - Guam Density Estimation (using traditional approach)
  - Navy OPAREA Density Estimation (NODE) projects – spatial modeling for the Navy
  - Gulf of Mexico, Southeast US Atlantic coast and the Northeast US Atlantic coast

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# Aquatic Baseline Studies

- GMI scientists have:
  - Collected oceanographic data from shipboard surveys (Atlantic, Pacific, and Gulf of Mexico)
  - Collected data remotely from in situ instrumentation (Indian Ocean, Caribbean and Gulf of Mexico).
  - Performed post collection analysis of oceanographic parameters.

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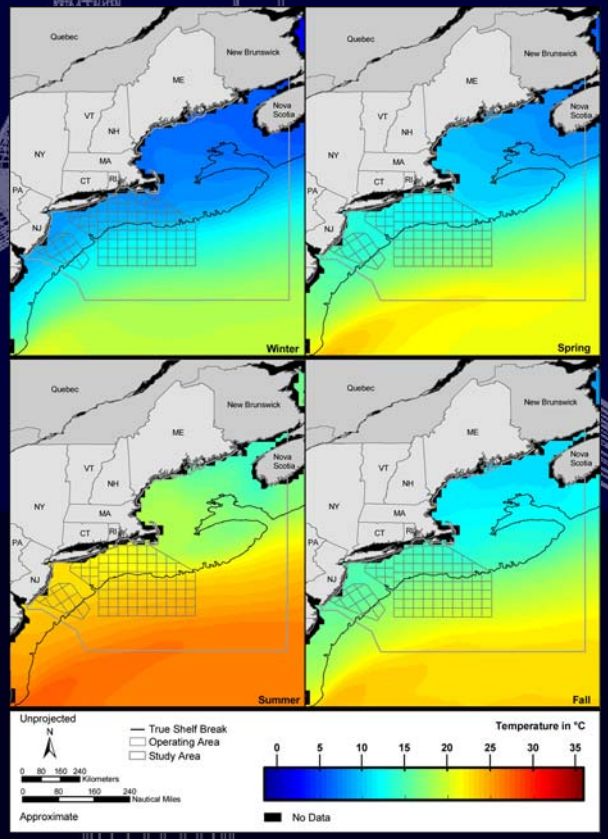
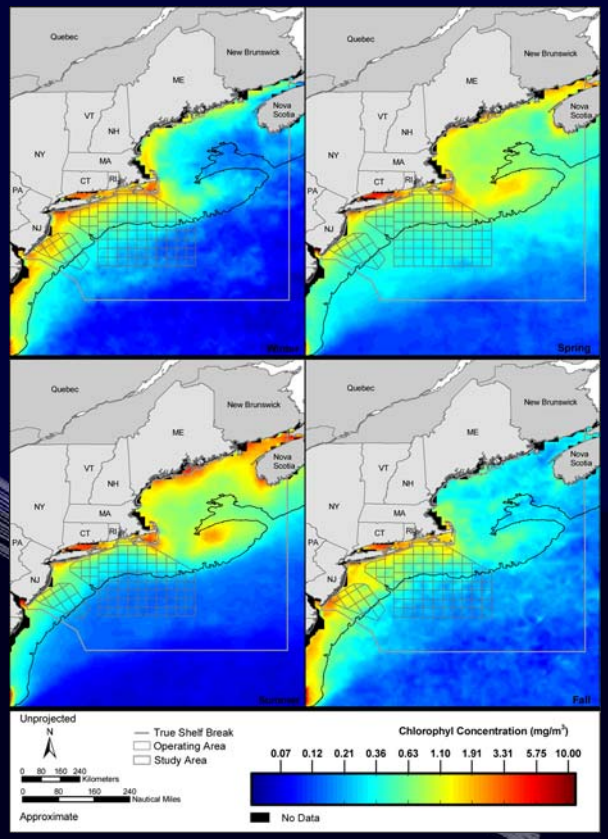
# Aquatic Baseline Studies

GMI scientists have used satellite data (Sea Surface Temperature [SST] and chlorophyll) to create seasonal GIS maps of a region. These “layers” will be used for modeling animal densities.




***SST***




***CHLOROPHYLL a***

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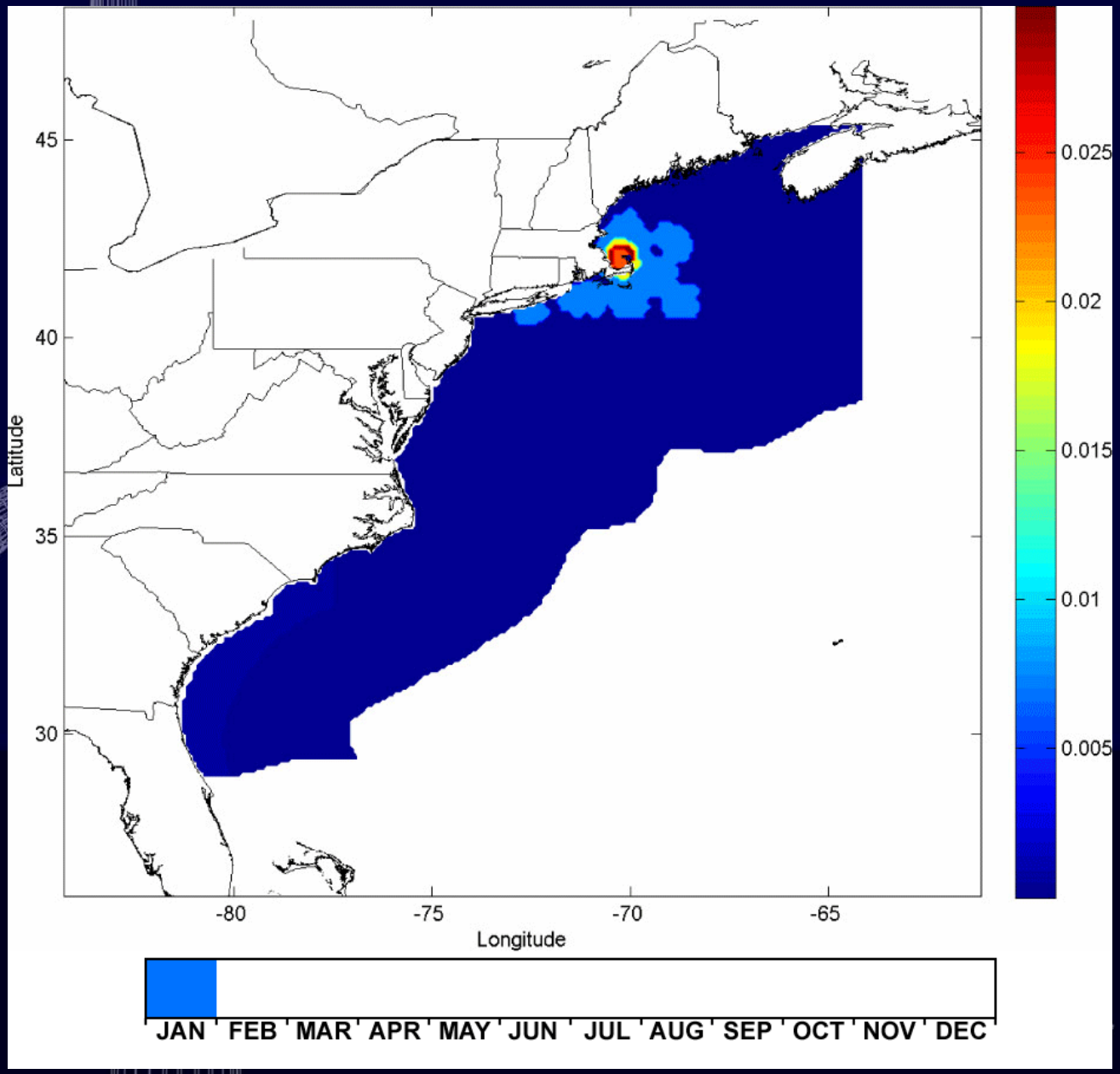
# Steps in Modeling Line Transect Data

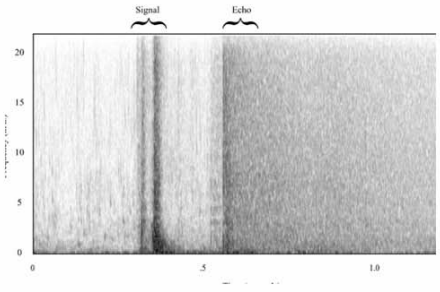
I. Survey data segmentation (program SAS®)
II. Detection function modeling (program DISTANCE)
   a. Diagnostics and model selection
   b. Interpretation of program DISTANCE output
III. Data preparation of covariates for the DSM (program MATLAB®)
   a. Import of dynamic variables (SST and chl)
   b. Import of static variables (bottom depth, bottom slope, distance from shelf break, latitude, and longitude)
   c. Define study area boundaries
IV. DSM modeling (GAM; programs R and MATLAB®)
   a. Diagnostics and model selection
   b. Significance of covariates
   c. Deviance explained
   d. Generalized Cross Validation (GCV) score
   e. Density estimate evaluation
V. DSM prediction (programs DISTANCE and R)
   a. Density estimation at the study area level
   b. Extrapolate to areas/seasons where survey data were not collected
VI. Density estimation at smaller scales
   a. Seasonal estimates
   b. Area specific estimates
VII. Measures of precision
   a. Variance estimation
   b. Bootstrap samples

# Density Results – North Atlantic Right Whale



# Underwater Acoustic Survey

- Deploy 5 pop-up buoys in study area
- Cornell University Bioacoustics Laboratory – Dr. C. Clark
  - 3 months life
  - 10-1000 Hz
  - ~10 km listening range
  - Quantify abundance of marine mammal vocalizations

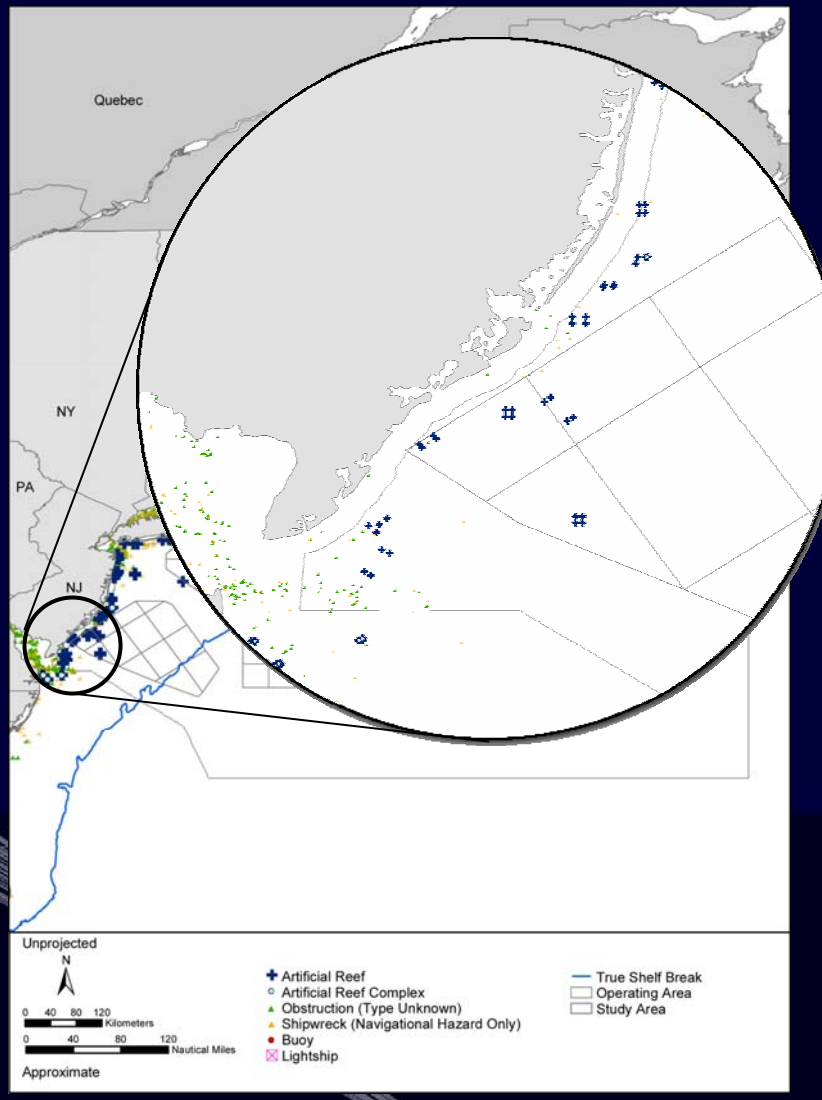



**Photos: Cornell, NOAA**

# Aquatic Baseline Studies

**Data fields in house for Aquatic Baseline Studies:**

- ***Oceanography/Geology***
  Bathymetry, Sediments, SST, chlorophyll
- ***Human Activities***
  Artificial Reefs, Shipwrecks, Dive Sites, Navigable Waterways
- ***Habitats***
  Seagrass beds, live/hard bottom communities, coastal marsh




***ARTIFICIAL REEFS***

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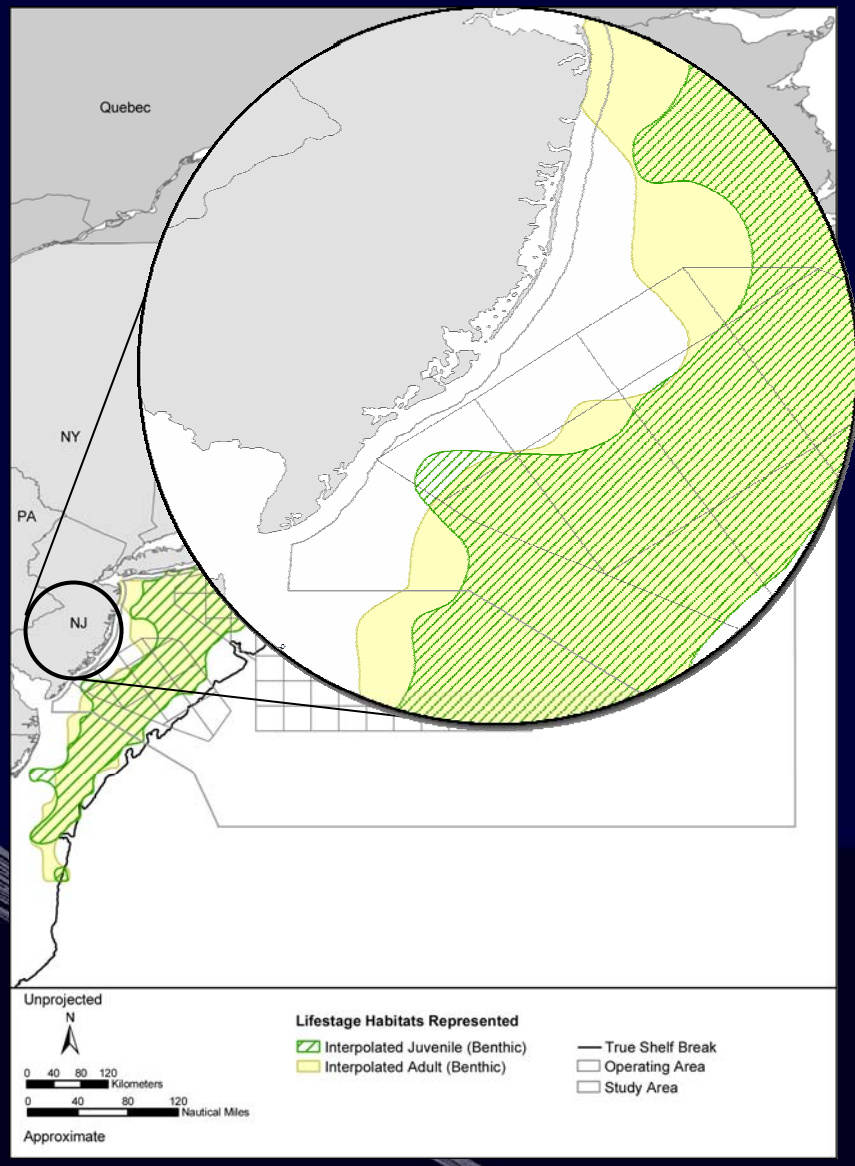
# Aquatic Baseline Studies

**Data fields in house for Aquatic Baseline Studies:**

- ***Fishing Activities***
  Sink Gillnets, Clam Dredges, Pots, Recreational Fishing Spots/ local tournaments
- ***Fishery Landings for 36 species including:***
  Atlantic Cod, Atlantic Surfclam, Ocean Quahog, Red Hake, Flounder (summer windowpane, winter, witch, and yellowtail), King Mackerel/ Spanish Mackerel/Cobia, Bluefin Tuna, and swordfish.




***EFH FOR OCEAN QUOHOG***

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# Marine Radar Sensing

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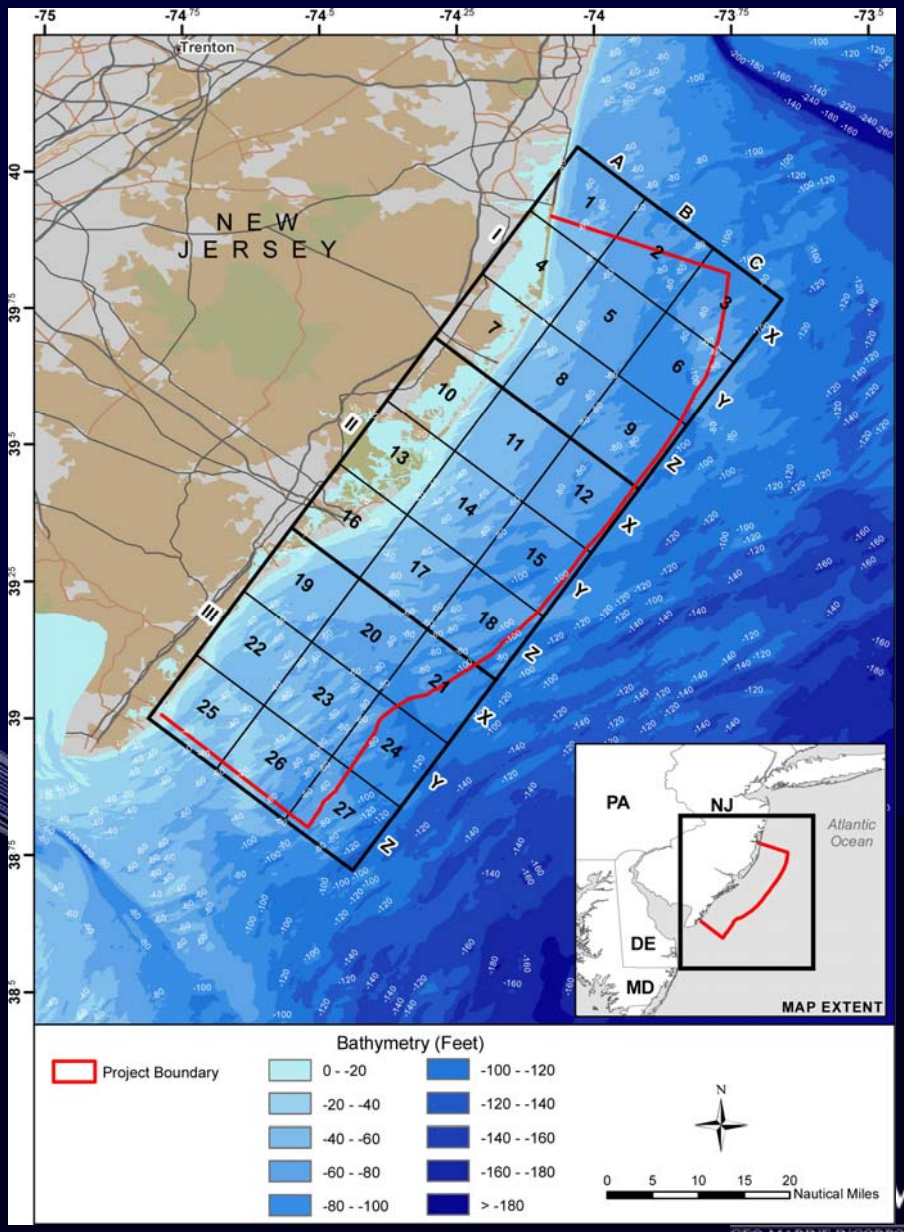
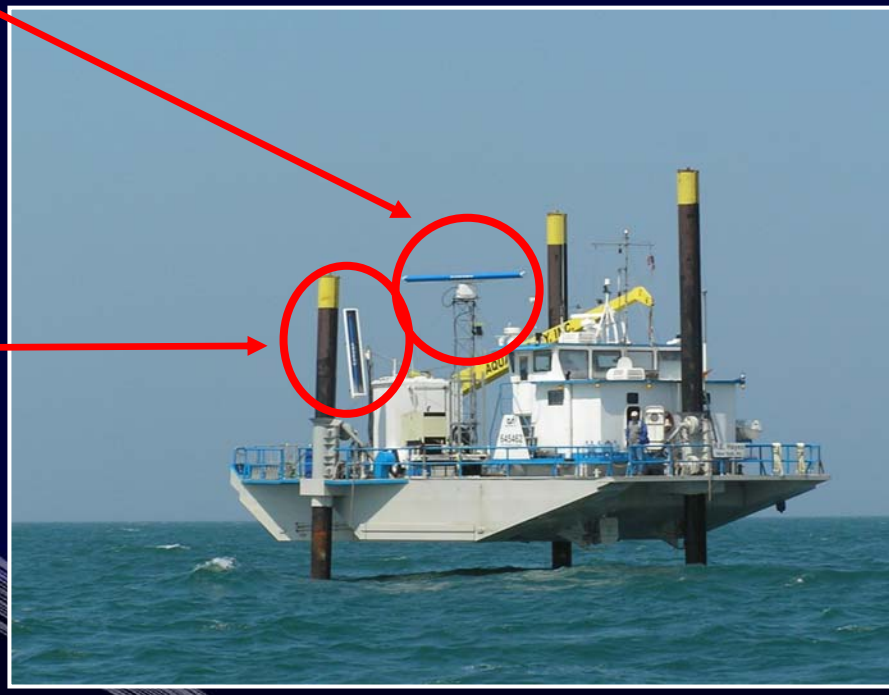
# Radar Survey Sampling Design

- Fixed and randomly sampled sites
- Divided into 3 latitude strata of equal area
- 3 zones aligned by offshore distance
- Each strata consists of 9 grid cells
- Each grid cell represents 8nm X 8nm square grid (twice the 4nm radius radar coverage area)



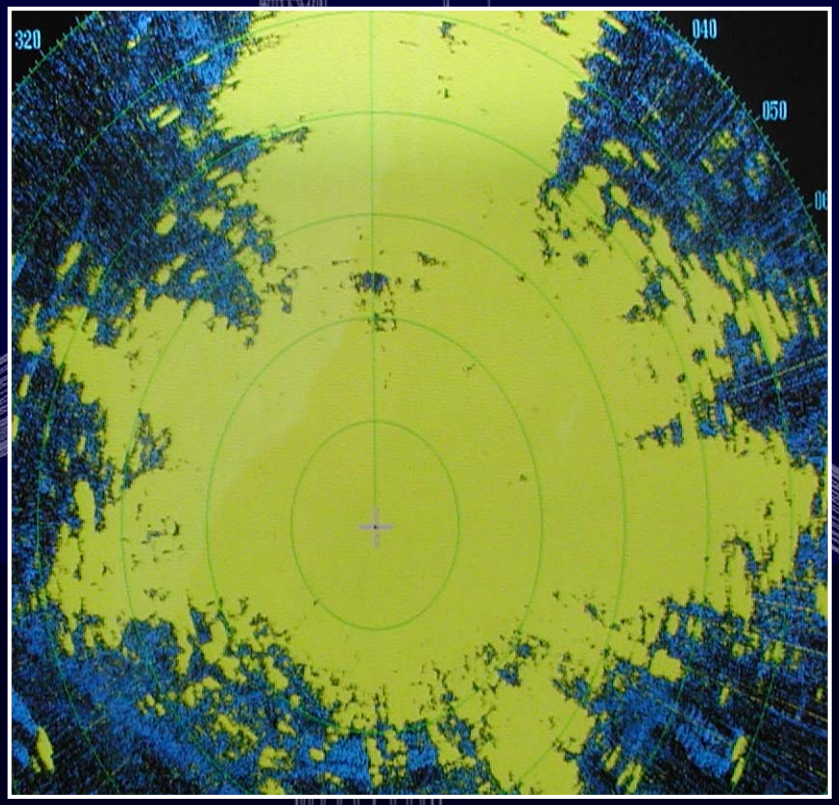
# Mobile Avian Radar System (MARS®)

- Dual Radar Bird Detection System
  - TracScan provides horizontal surveillance and tracks targets reporting:
    - position, speed, direction, and echo strength
    - S-band for “seeing beyond” precipitation and provides maximum range coverage
  - VerCat provides vertical surveillance and records:
    - Altitude, size of echo
    - X-band, finer altitude resolution
  - On-board weather station
- Automated, Digital signal capture
- 24/7 Radar Operations
- De-cluttering, target tracking software, data archiving for post-study analysis

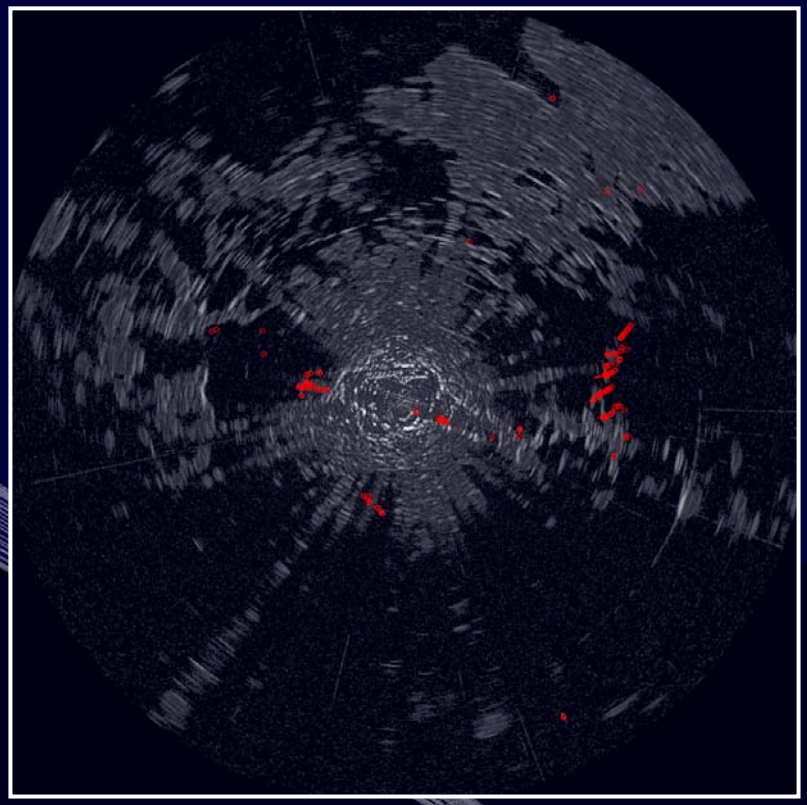


# MARS® Processing Effect

- Sample Raw image:




- Sample Processed image:



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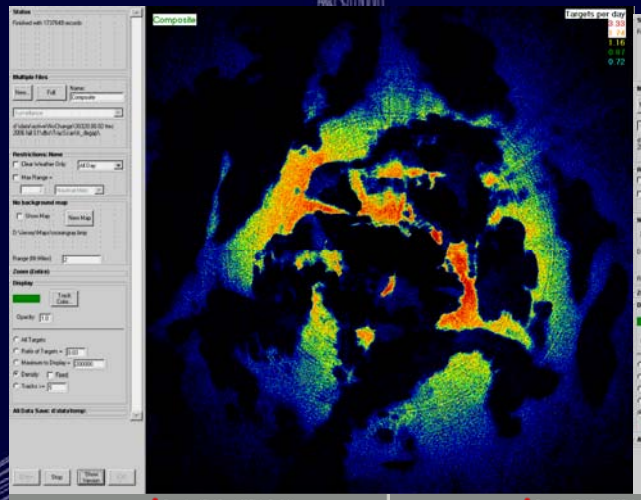
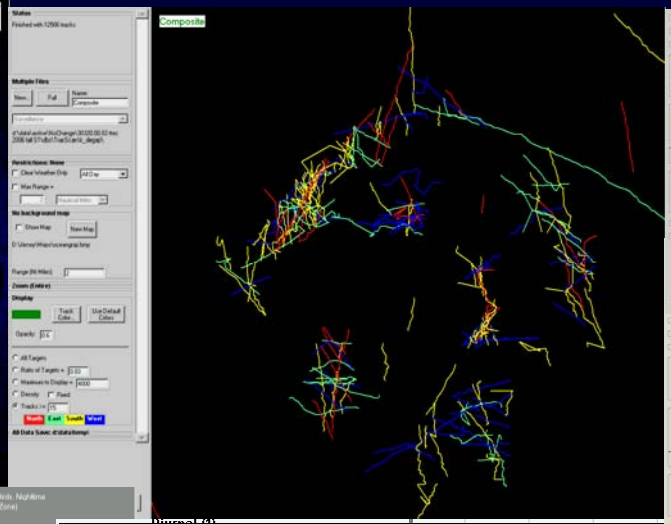
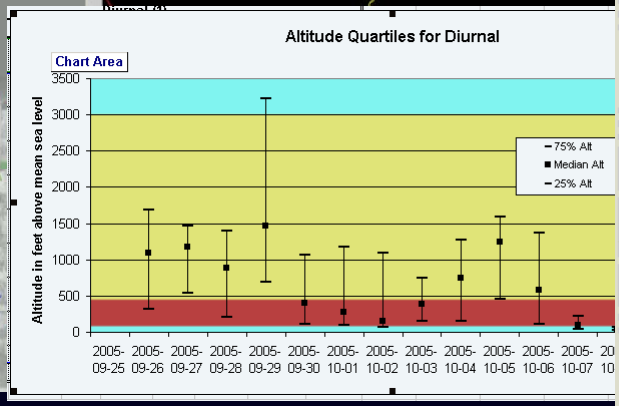
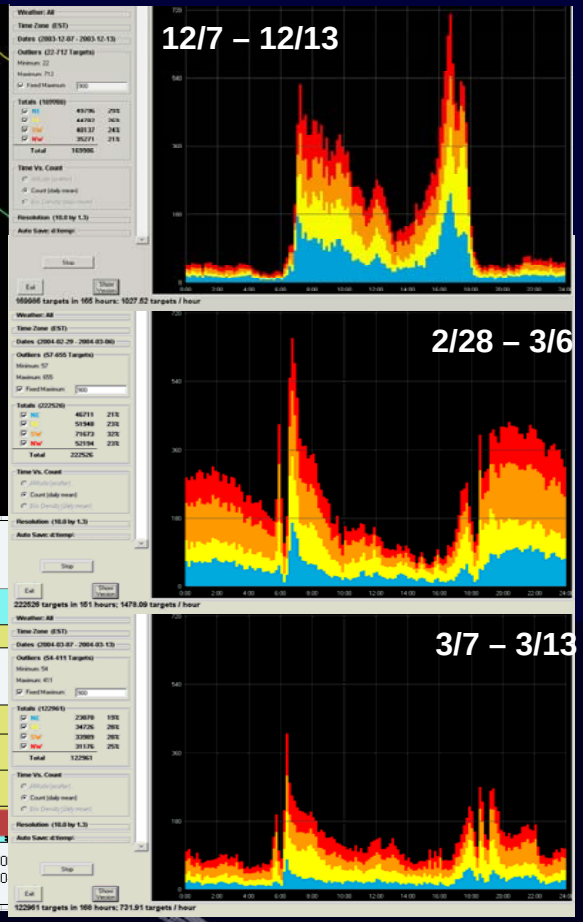
# Radar Data Outputs



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# Visual Vessel Survey/Ground Truthing

- Provide validation of the marine radar data
- Ground truthing once per sample location each season
- Recorded data
  - Targets crossing the transect (vessel bow)
  - Select individual birds and different sized flocks (small, medium, large) of birds
  - Record: observation time, target identity, number, flight direction, estimated distance to bird, and estimated flight altitude

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# Thermal Imaging and Vertically Pointing Radar (TI-VPR)

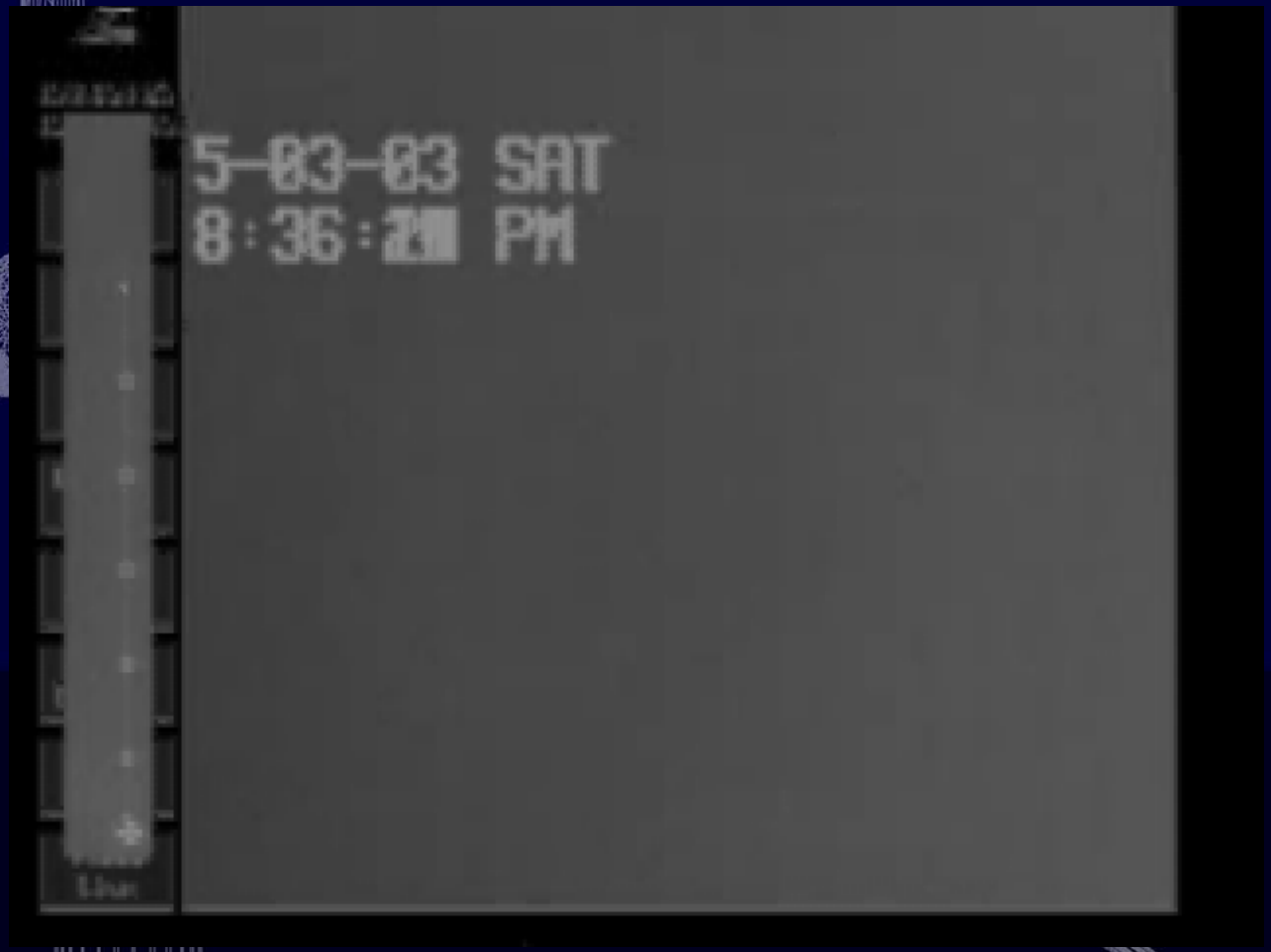
- Thermal imaging can detect individual birds/bats out to a maximum range of 2 km.

A **TI camera** **TI-VPR antenna**

The combination of thermal imaging (TI) and vertically pointing radar (VPR) enables the determination of:

- Altitude of target(s)
- Direction of target(s)
- Target identification and flock size

# Thermal imager/vertical radar showing two flocks of birds flying overhead, a single migrating bird, and a foraging bat



# Environmental Impacts Analysis Process

- Ensure a thorough understanding of proposed activities
- Define the potential impacts
- Determine methods for assessing impacts
- Gather data and assess impacts
- Coordinating and consulting with regulators
- Determine significance of impacts

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# Schedule

- Ship Board Avian, Marine Mammal, and Sea Turtle Surveys
  - Start date Jan 2008
- Aerial Marine Mammal,  Sea Turtle, and Avian Surveys
  - Start date Jan 2008
- Small Vessel Coastal Avian Surveys
  - Start date Jan 2008

# Schedule (cont'd.)

- Acoustical Surveys for Marine Mammals
  - Start date Mar 2008
- Oceanographic Surveys
  - Start date Jan 2008
- Offshore Radar Surveys
  - Start date Mar 2008
- Thermal Imaging-Vertically Pointed Radar Surveys
  - Start date Mar 2008