Ecosystem-Based Management Work Group

1. Marine life data development
2. Benthic/pelagic data development
3. Options for defining ecologically rich areas and ecological marine units

September 30, 2015

OCEAN PLANNING IN THE NORTHEAST

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Marine life data development

- Presentation (15-20 min)
- Questions and discussion (20-25 min)

OCEAN PLANNING IN THE NORTHEAST

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MDAT Data Synthesis

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NOAA   LOYOLA   Marine Geospatial Ecology Lab Duke University   NCCOS

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Marine-life **D**ata & **A**nalysis **T**eam

- Marine Geospatial Ecology Lab – Duke University
- NOAA – NCCOS
- NOAA – NMFS/NEFSC
- Loyola University

NOAA   LOYOLA   Marine Geospatial Ecology Lab Duke University   NCCOS

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## MDAT: Distribution and abundance of Marine mammals, turtles, birds and fish

- Study area is ecologically-focused, not entirely based on political boundaries
- Overlapping study area with Mid-Atlantic acknowledges connectivity
- Guided by **expert work groups** composed of academic, private and agency scientists, tribes, managers, regulators, etc.
- Spatial models integrate animal observations with environmental and climatological features
- Distribution and abundance (for each species):
  - Multiple temporal **scales**
  - Persistence
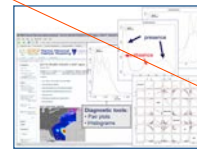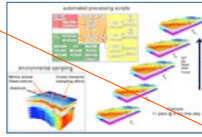 - Probability of occurrence
  - **Uncertainty**

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Marine habitat modeling process

1: observation data aggregation
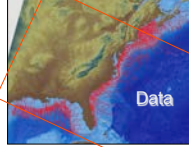
2: fusion with oceanographic data

Data

4: model product development

Information

3: statistical modeling

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❖ Marine mammal and sea turtle work group
- Marine mammal & sea turtle work group invited participants (PDF) (2pp, 44k)
- Mammals & Turtles work group Call 1 Agenda and Materials (PDF) (7pp, 375k)
- Mammals & Turtles work group Call 1 Summary (PDF) (3pp, 155k)
- Mammals & Turtles work group Call 2 Agenda and Materials (PDF) (4pp, 272k)
- Mammals & Turtles work group Call 2 Summary (PDF) (3pp, 164k)
- Mammals & Turtles work group Call 3 Agenda and Materials (PDF) (2pp, 3.6M)
- Mammals & Turtles work group Call 3 Summary (PDF) (3pp, 146k)

❖ Avian work group
- Avian work group invited participants (PDF) (2pp, 43k)
- Avian work group Call 1 Agenda and Materials (PDF) (8pp, 504k)
- Avian work group Call 1 Summary (PDF) (3pp, 156k)
- Avian work group Call 2 Agenda and Materials (PDF) (4pp, 286k)
- Avian work group Call 2 Summary (PDF) (3pp, 164k)
- Avian work group Call 3 Agenda and Materials (PDF) (6pp, 10M)
- Avian work group Call 3 Summary (PDF) (3pp, 150k)

❖ Fish work group
- Fish work group invited participants (PDF) (2pp, 42k)
- Fish work group Call 1 Agenda and Materials (PDF) (6pp, 244k)
- Fish work group Call 1 Summary (PDF) (3pp, 155k)
- Fish work group Call 2 Agenda and Materials (PDF) (6pp, 394k)
- Fish work group Call 2 Summary (PDF) (3pp, 154k)

Adapting products from **ongoing modeling efforts**, with eye toward consistency and regional priorities
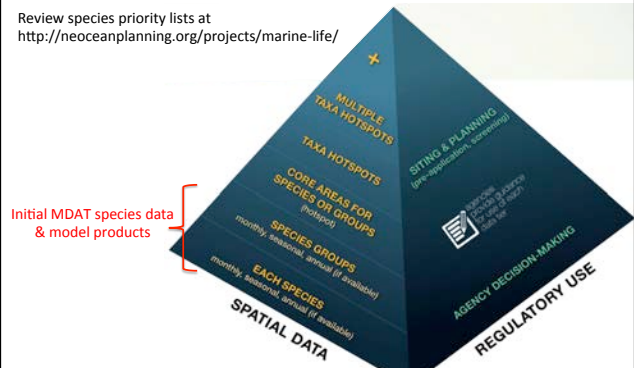
- ~80 individuals across 3 working groups
- Each group met 3 times over 7 months

Review species work plans and priority lists at
http://neoceanplanning.org/projects/marine-life/

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Data Product Overview

Review species priority lists at
http://neoceanplanning.org/projects/marine-life/

Initial MDAT species data & model products

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Species products:

Winter

Summer

Humpback whale
(Megaptera novaeanglia)

Basic building block:
Seasonal, species-specific models

Great shearwater (fall)
Relative Occurrence

Great shearwater (fall)
Relative Abundance
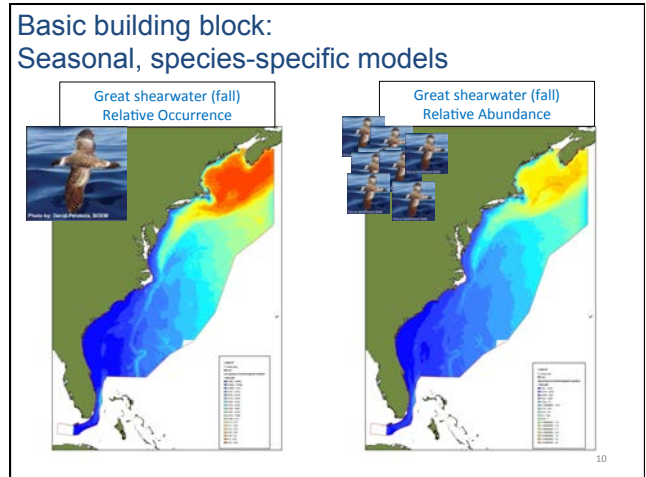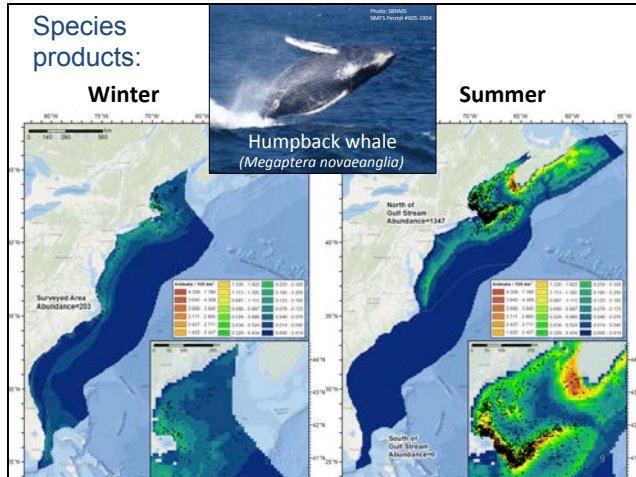
Avian base products: Identifying large aggregations

PRODUCT: Threshold maps (threshold determined from 90th percentile of observed count per transect segment in region). Probability of exceeding threshold in at least one month of the year. [e.g., figure below]

From Balderama, Gardner and Reich, in prep.

Species products:

Longfin Squid- biomass
(Doryteuthis pealeii)

NOAA fishwatch

Longfin Squid
Fall surveys, 1970 - 2014

Marine mammals

September 2015
"Base Products"

- Choose from 29 species/groups
- Choose time period
- Active data type
- These are currently not active; will be made active as data develop
- Legend units are "individuals per 100 km²"

- This is the first draft viewer developed to display the Marine-life Data Analysis Team's (MDAT's) spatial data products
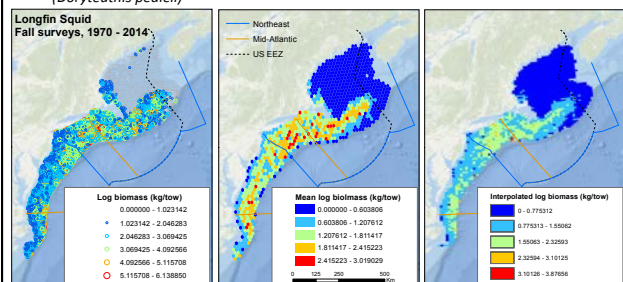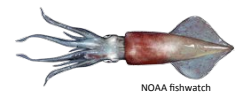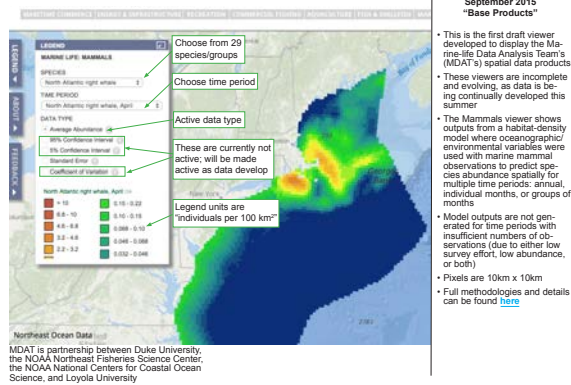- These viewers are incomplete and evolving, as data is being continually developed this summer
- The Mammals viewer shows outputs from a habitat-density model where oceanographic/ environmental variables were used with marine mammal observations to predict species abundance spatially for multiple time periods: annual, individual months, or groups of months
- Model outputs are not generated for time periods with insufficient numbers of observations (due to either low survey effort, low abundance, or both)
- Pixels are 10km x 10km
- Full methodologies and details can be found here

MDAT is partnership between Duke University, the NOAA Northeast Fisheries Science Center, the NOAA National Centers for Coastal Ocean Science, and Loyola University

http://services.asascience.com/MapApp/neoddev/mdat/duke/

Avian species

September 2015
"Base Products"

- Two tabs toggle between model outputs. Only "NCCOS" is currently active. Loyola tab will be activated as data are developed.
- Choose from 40 species
- Choose time period
- Radio button selects active data type
- Currently not active
- Legend units are relative number of individuals per strip transect segment, or relative probability of occurrence per strip transect segment (approx. 2.5 Nm)

- This is the first draft viewer developed to display the Marine-life Data Analysis Team's (MDAT's) spatial data products
- These viewers are incomplete and evolving, as data is being continually developed this summer
- The Avian viewer shows outputs from the NCCOS model where oceanographic/ environmental variables were used with avian observations to predict species abundance and occurrence seasonally and annually. The Loyola model will predict extreme and persistent aggregations at monthly intervals.
- Observation data are from the Avian Compendium January 1978-April 2014
- Model outputs are not generated for time periods with insufficient numbers of observations (due to either low survey effort, low abundance, or both)
- The extent of the model output reflects a 100km buffer from observations (> 100km from observations is greyed-out)
- Pixels are 2km x 2km
- Full methodologies and details can be found here

MDAT is partnership between Duke University, the NOAA Northeast Fisheries Science Center, the NOAA National Centers for Coastal Ocean Science, and Loyola University

http://services.asascience.com/MapApp/neoddev/mdat/avian/

Fish species

September 2015
"Base Products"

- Four tabs toggle between data sources.
  FED = NOAA NEFSC
  MDMF = Massachusetts Division of Marine Fisheries
  NEAMAP = NorthEast Area Monitoring and Assessment Program
  ME/NH = Maine/New Hampshire states
- Choose from 78 species of fish/invertebrates or 8 groups
- Choose time period
- Choose data type. See guide on right
- Legend units are log-kilograms

- This is the first draft viewer developed to display the Marine-life Data Analysis Team's (MDAT's) spatial data products
- These viewers are incomplete and evolving, as data is being continually developed this summer
- The Fish viewer shows observed abundance of fish species/groups caught in four separate trawl surveys (tabs across the top of the legend) for the entire length of the trawl survey and for the most recent decade (under TIME PERIOD)
- Only Fall data are currently shown; Spring trawl results will also be available
- Data are displayed four different ways for each species/ group (under DATA TYPE)
- Full methodologies and details can be found here

GUIDE TO DATA TYPE
Log biomass: circle size is proportional to the log of the biomass in the tow
Mean log biomass: average log biomass for all tows within a 10km hexagon
Variance of mean log biomass: variance of log biomass for all tows within a 10km hexagon
Interpolated log biomass: algorithm smooths log biomass, 5km grid size

MDAT is partnership between Duke University, the NOAA Northeast Fisheries Science Center, the NOAA National Centers for Coastal Ocean Science, and Loyola University

http://services.asascience.com/MapApp/neoddev/mdat/fish/

Species grouping options…

- Ecological
  – "Elasmobranch"
- Regulatory
  – "ESA-listed"
- Sensitivity to particular impacts
  – Sound
  – Vertical infrastructure
 – Benthic disturbance

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Species grouping options…

Marine mammals	Avian	Fish
• All cetaceans • Baleen whales • Small delphinoids • Large delphinoids • Sperm and beaked whales • All ESA-listed species • Sensitivity to sound	• Spatial (nearshore, offshore) • Taxonomic (terns, gulls, etc.) • Ecological/functional (plunge-divers, surface divers) • Conservation/authority (State-listed, BCR priorities, AMBCC priorities)	• All species • Elasmobranch • Flatfish • Forage • Gadoid • Invertebrate • Other demersal • Other fish • Pelagic • EFH • Fishery Management Plans

Groups are not mutually exclusive

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Example Mammal groups - Abundance

Delphinoids

Baleen whales

Toothed whales

Roberts et al. (in prep)
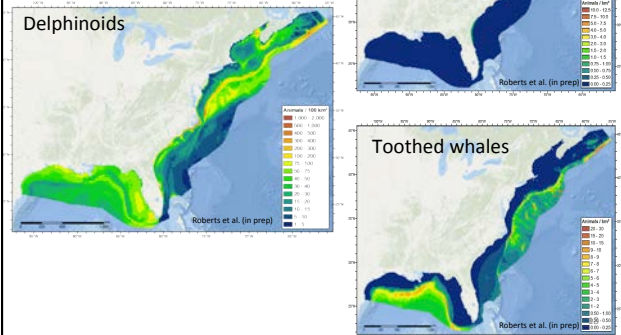
Group-level synthesis example

Nearshore Species | Gulls and Gannets | Pelagic Species
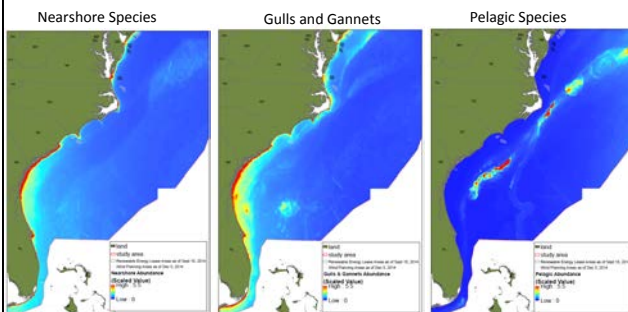
Because typical group sizes vary widely among species of interest, modeled relative abundances have been scaled to their annual mean for each species, then averaged over all species in a group. Abundances reflect long-term climatological values for the period 1978-2014[9]

Example Fish groups - Biomass

Forage fish
Elasmobranchs
Flatfish
Gadoids
Invertebrates
Pelagics
Other demersals
Other fishes

Northern sand lance
Alewife
Atlantic herring
Butterfish
Blueback herring
Atlantic mackerel
Atlantic menhaden
American shad
Hickory shad
Capelin
American sand lance
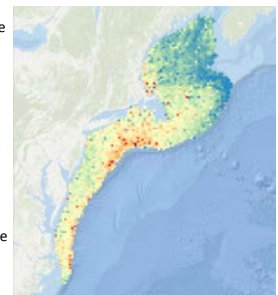
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Hierarchy of marinelife data products & regulatory use

Initial MDAT species data & model products

ocean planning applications

Example core areas

Example mammal core areas

Example avian core areas
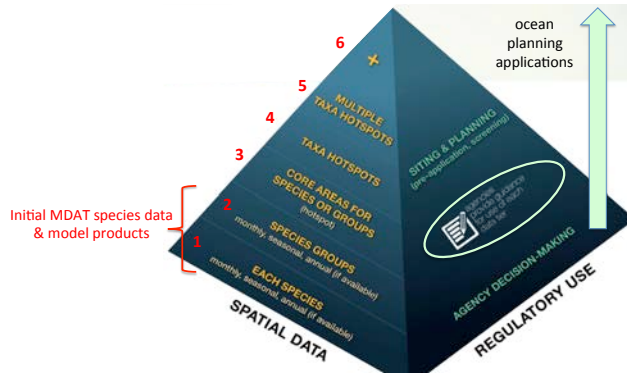
Example fish core areas
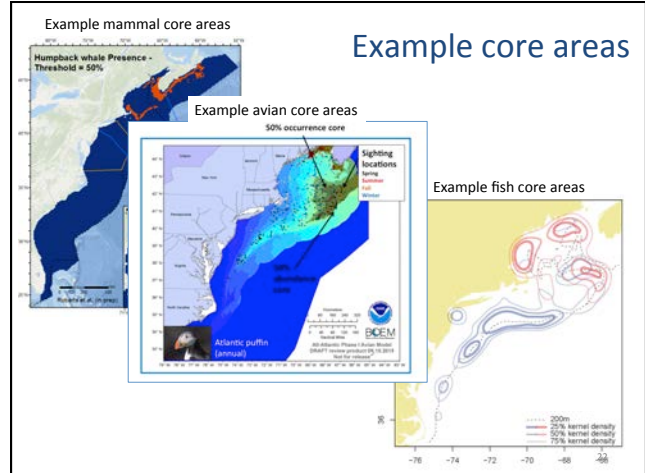
For each group…

Marine mammals	Avian	Fish
• All cetaceans • Baleen whales • Small delphinoids • Large delphinoids • Sperm and beaked whales • All ESA-listed species	• Spatial (nearshore, offshore) • Taxonomic (terns, gulls, etc.) • Ecological/functional (plunge-divers, surface divers) • Conservation/authority (State-listed, BCR priorities, AMBCC priorities)	• All species • Elasmobranch • Flatfish • Forage • Gadoid • Invertebrate • Other demersal • Other fish • Pelagic

…Abundance, richness, diversity

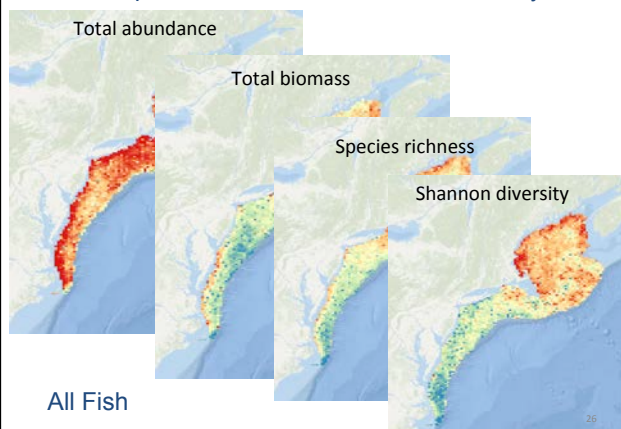Taxa Hotspots: Abundance, Richness, Diversity
Using 99% pop threshold
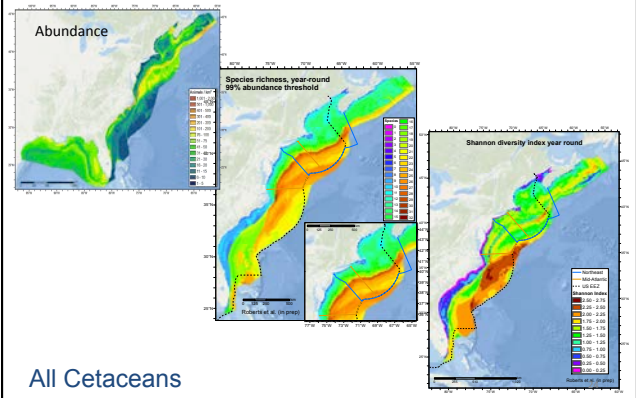
Abundance

All Cetaceans

Taxa Hotspots: Abundance, Richness, Diversity

All Birds
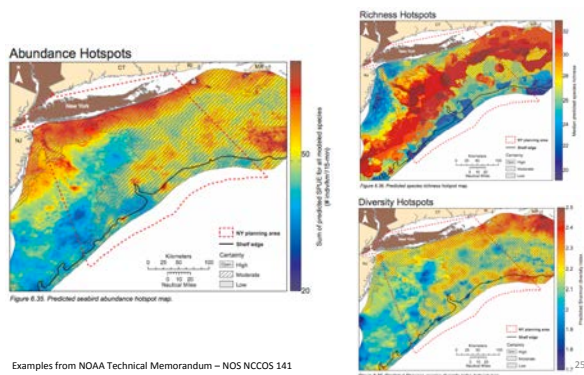
Examples from NOAA Technical Memorandum – NOS NCCOS 141

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Taxa Hotspots: Abundance, Richness, Diversity

Total abundance

Total biomass

Species richness

Shannon diversity

All Fish

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Marine Life –
Key Points from Agency Meetings To-Date

- NROC staff, MDAT and agencies will work together to define useful species groups

- Agencies recommended ecological and regulatory types of groups

- Sensitivity/vulnerability to impacts were identified by agencies as an important grouping important at the September Interagency Workshop

- Specific to fish, agencies suggested Fishery Management Plan would be a useful grouping, including whether we should characterize some individual species using trawl data alone

- It's important to show estimates of certainty for summary products

- Need to have consistency in number of classes/breaks for visualization

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Marine Life –
Key Points from Agency Meetings To-Date

- Summary data products can be used by agencies as screening tools, to consider broader ecological context , and to provide an entry point into detailed data

- Core areas as stand-alone products may not be desirable for agency use (confusion with Critical Habitat designation)

- Agencies recommend use of core areas as building blocks for summary products such as total abundance, richness and diversity (for each ecological, regulatory and sensitivity group)

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Benthic & pelagic data development

- Presentation (15 min)
- Questions (15 min)

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Habitat data in ocean planning

Nearshore data
- Immediate agency decision-making
- Region-wide+ state- and project-scale

Regional-scale data
- For comparison with marine life data
- EBM
- Future agency decision-making

What benthic and pelagic habitat variables best represent important ecological processes in the region?

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Importance of nearshore habitats

NOAA FISHERIES
Greater Atlantic Region Policy Series
14-01

Shallow Water Benthic Habitats in the Gulf of Maine:
A Summary of Habitat Use by Common Fish and Shellfish Species in the Gulf of Maine

Special Aquatic Sites (CWA sec. 404)
- Sanctuaries and refuges
- Wetlands
- Mud flats
- Vegetated shallows
- Coral reefs

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Importance of nearshore habitats
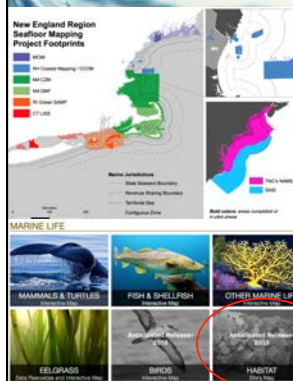
NROC Benthic habitat project

- Patchwork of nearshore (and offshore) habitat data in the region

- Navigate to project databases, geospatial data

- Unify under single classification

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Regional-scale habitat data

Benthic
- Substrate
- Seabed forms
- Slope
- Rugosity
- Canyons
- Seamounts

Pelagic
- Surface, bottom temp
- Max, mean surface/bottom current velocity
- Stratification

"Living"
- Eelgrass
- Corals
- Shellfish habitat
- Wetlands

What benthic and pelagic habitat variables best represent important ecological processes in the region?

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Options for defining ecologically important/rich areas and ecological marine units

- Presentation (15-20 min)
- Discussion (25-30min)

OCEAN PLANNING IN THE NORTHEAST

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Top of the Pyramid

Multi-taxa hotspots and "+" habitat, other important species

Why?

- Identified as a priority in the Northeast (Ecologically Important Areas) and Mid-Atlantic (Ecologically Rich Areas) whether marine life and habitat data can be synthesized in the short- and/or long-term
- Promotes ecosystem-based thinking
- Could be useful as a high-level screening tool
- Could highlight data gaps
- Potential case study where data are robust, demonstrate process/interpretation in NE Ocean Plan section 3.4 (EBM)
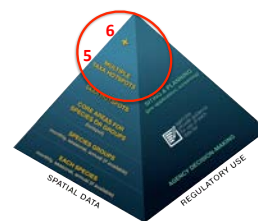
35
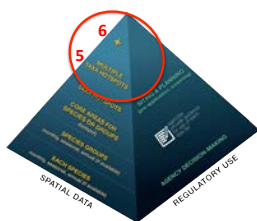
Top of the Pyramid

Multi-taxa hotspots and "+" habitat, other important species

- NE RPB asking for assistance thinking this through

Keep in mind:

- What what can we learn from previous similar efforts?
- What are the caveats?
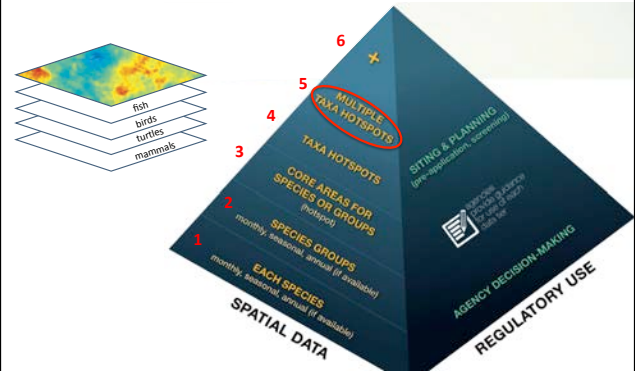- What is the best approach?

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REMINDER

**Note:** All individual data layers will be publically available for analysis and management applications.

Our discussion of multi-taxa "hotspots" is focused on the development of synthesis products to _supplement_ core data products.
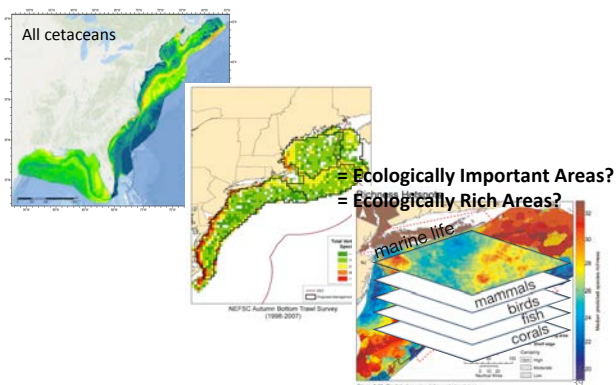

37
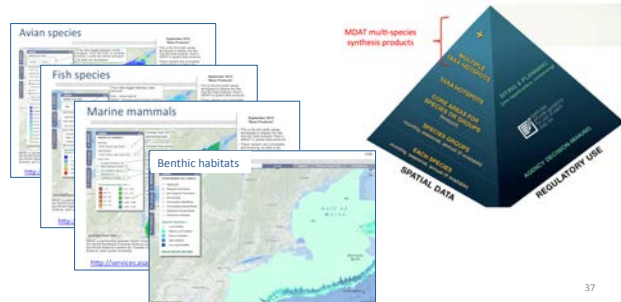
Synthetic Product Options
### Multi-taxa hotspots between taxonomic groups

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Multi-taxa hotspots between taxonomic groups:
Species Richness

= Ecologically Important Areas?
= Ecologically Rich Areas?

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Options for benthic/pelagic data

1. Use existing NAMERA EMUs
   – Ecological Marine Units (EMUs) are the three-way combination of physical variables - depth, sediment grain size, and seabed forms. The breaks in bathymetry and substrate grain size are based on the ecological thresholds revealed by the benthic organism relationships.
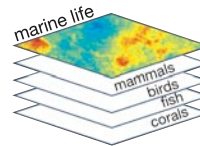2. Create new, broad units
3. Something else


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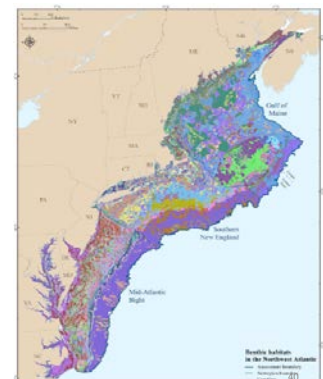
Example variables captured in the models

Variable	Type	Dynamic
chlorophyll-a	spatial	yes (seasonal)
turbidity	spatial	yes (seasonal)
upwelling index	spatial	yes (seasonal)
sea surface temperature	spatial	yes (seasonal)
sea surface temperature SD	spatial	yes (seasonal)
sea surface temperature front probability	spatial	yes (seasonal)
sea surface height	spatial	yes (seasonal)
sea surface height SD	spatial	yes (seasonal)
probability of cyclonic eddy ring	spatial	yes (seasonal)
probability of anticyclonic eddy ring	spatial	yes (seasonal)
water current (u direction)	spatial	yes (seasonal)
water current (v direction)	spatial	yes (seasonal)
water current divergence	spatial	yes (seasonal)
water current vorticity	spatial	yes (seasonal)
wind stress (u direction)	spatial	yes (seasonal)
wind stress (v direction)	spatial	yes (seasonal)
wind divergence	spatial	yes (seasonal)
depth	spatial	no
slope (1.5 and 10 km resolution)	spatial	no
slope of slope (10 km resolution)	spatial	no
planform curvature (10 km resolution)	spatial	no
profile curvature (10 km resolution)	spatial	no
distance to shelf break (200 m isobath)	spatial	no
distance to land	spatial	no
longitude (projected)	spatial	no
latitude (projected)	spatial	no
year	temporal	yes (yearly)
day of year	temporal	yes (daily)
Monthly North Atlantic Oscillation (NAO) index (current and 1-year lag)	temporal	yes (monthly)
Monthly Multivariate El Nino-Southern Oscillation index (MEI) (current and 1-year lag)	temporal	yes (monthly)
Monthly Trans-Nino Index (TNI) (current and 1-year lag)	temporal	yes (monthly)
Monthly Atlantic Multidecadal Oscillation (AMO) index (current and 1-year lag)	temporal	yes (monthly)

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Marine life composite   Habitat composite
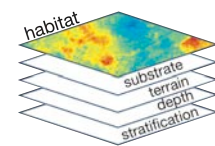
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Discussion

1. General feedback on approach

2. Feedback on the specific methodology
   – What benthic/pelagic variables?
   – What approach should be used to combine or synthesize?
   – How best to ensure usable products (short and long-term)?

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