Use of Models

Production Potential Models
What is good habitat for a pelagic fish?

• How can it be quantified and compared...
  • Among species or age class?
  • Across physical and biological gradients?
  • Across time and space?
  • In response to environmental stressors?
Habitat Quality Defined by species-specific vital needs
Habitat Quality = Growth Rate Potential

• Expected daily growth rate of a fish if placed in a volume of water with known conditions such as prey size and density, temperature, oxygen and light
Why Fish Growth Rate?

• Integrative response of fish performance – related to survival rates and reproductive capacity
• Based on fish’s requirements and prevailing environmental conditions
• Differs among species and life stages
• Varies in time and space
• Nonlinear response to physical and biological factors
Striped Bass Growth

Brandt et al. 2009
Growth Rate Potential
Spatial/Temporal Model

Oxygen availability

PREY DENSITY, LIGHT

WATER TEMPERATURE

FORAGING (f)

GROWTH (g)

GROWTH RATE POTENTIAL

Distance or Time

Bottom

Depth
Baseline Field Sampling

Fish Biomass

Splitbeam Acoustics

PSS Winch

PSS
Baseline Field Sampling

- Zooplankton
- Temperature
- Dissolved oxygen
- Salinity
- Chlorophyll $a$
- 7 cruises between 2003 and 2011
- 140 trawls
- > 4,000 stomachs
- >> 234 h acoustic profiles
- >> 2.5 million data points
Fish Density and Oxygen levels

2003 DD

Fish relative biomass

DO (mg/l)

0 1 2 3 4 5 6 7 8 9

2003 F

Fish relative biomass

DO (mg/l)

0 1 2 3 4 5 6 7 8 9
Mapping EFH: Bluefish
Mapping GRP: Striped Bass
Total Growth Rate Potential

Gulf of Mexico 2004 Bluefish Growth Rate Potential (Sum Total)

Gulf of Mexico 2010 Bluefish Growth Rate Potential (Sum Total)
Next Steps: Leveraging Additional Data

- 14,600 CTD casts from NOAA NODC Ocean Climate Laboratory
- (1930 – 2014)
- Additional input from hydrodynamic models, food web models
Drivers

Observations

Models

GRP Models
- Menhaden
- Bay anchovy
- Bluefish

Temporal Scale

Habitat Quality Indices

Spatial Scale

Products

Models

• Menhaden
• Bay anchovy
• Bluefish
Tools & Products

• Parameterized and validated habitat models for ~ 6 species

• Quantitative habitat maps and annual production potential
  • Data Driven
  • Model driven with Nutrient loading scenarios

• Spatial/temporal indices of fish habitat quality and production
Next Steps: Better Coverage of the Food Web

Current models
- Menhaden
- Bay anchovy
- Bluefish
- Striped bass

Potential new species
- Atlantic croaker
- Red snapper
- Brown/White shrimp
- Atlantic bumper
Next Steps: Links to Production

• Incorporate indices of habitat quality in population models

• Conversion of growth to production through body size-fecundity-recruitment relationships
Links to Production: Chinook Salmon

Data base = 37,838 CTD, XBT casts for years spanning 1929 - 2013
Chinook Salmon Growth Rate Potential Across Different Years
GRP as an Index for Production

![Bar chart showing GRP and Landings over years 1976 to 2001. The x-axis represents the years, and the y-axis represents the Z-Score. The chart indicates fluctuations in GRP and Landings over the years.]
Drivers

Observations
- Cruise data
- Observing systems
- Satellites

Models
- Hydrodynamics
- Water quality
- Food web

GRP Models

Products

Temporal Scale
- Daily
- Seasonal
- Yearly

Spatial Scale
- 1-D, 2-D, 3-D
- Resolution
- Depth

Habitat Quality Indices
- Mean/max
- % change
- Volume/area

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Fish size & production
Habitat suitability
Questions?

Support from;
NOAA-CSCOR NGOMEX
NSF Rapid Response
National Academy of Sciences
Drivers
Observations
Models

Models
GRP Models
- Menhaden
- Bay anchovy
- Bluefish

Products
Temporal Scale
Habitat Quality Indices

Spatial Scale

Decision Options
1. Information about additional data sources
   - Historic / real time
   - Landings/survey data for validation

2. Fish species
   - Red snapper*
   - Atlantic croaker*
   - Brown shrimp*
   - White shrimp
   - Atlantic bumper

3. Temporal scale
   - Daily
   - Seasonal
   - Yearly
   - Other

4. Spatial scale
   - 1-D, 2-D, 3-D
   - 1 km, 10 km
   - Depth

5. Summary statistic
   - Mean/max
   - % change
   - % suitable habitat
   - Volume
   - Area
Consumption = Growth + Respiration + Wastes

G = growth
C = consumption
R = respiration
SDA = standard dynamic action
F = egestion
U = excretion
Preliminary Results: Red Snapper