Conduct literature review

Assemble biological and climate datasets, and develop conceptual model as a decision support tool.

Timing and occurrence of breeding / courtship displays

Diet studies, predator

Reductions in individual size and fitness

Patchiness, decreased abundance, diversity, and resilience

Dates of first arrival, numbers of individuals, colony size, changes in

rapid climate change, and reveal gaps in monitoring networks intended to detect such responses among species of commercial, ecological, and conservation importance.

Timing of migration and feeding

TOP PREDATORS

Predatory fishes, marine mammals, shore/seabirds

FOREAGE SPECIES

Herring and other fishes, shrimp, squid

SECONDARY PRODUCERS

Zooplankton

PRIMARY PRODUCTION

Phytoplankton, picoplankton

In the above figure, dotted lines represent the average historical date of seasonal feeding behaviors. Green arrows depict trophic transfer of energy up the food web. Synchronous food web interactions are depicted in the left panel, while the right shows shifts in timing potentially leading to trophic mismatches and changes in food web structure.

Climate change causes spatial and temporal shifts that may lead to:

- Shifts and increased variability of migration and breeding timing
- Changes in foraging habitats
- Reductions in individual size and fitness
- Patchiness, decreased abundance, diversity, and resilience

Phenology of Coastal Fish and Wildlife Species in the Northeast

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Overview

Climate change is causing species to shift their phenology, or the timing of recurring life events, in variable and complex ways. This can potentially result in mismatches or asynchronies in food and habitat resources that impact individual fitness, population dynamics, and ecosystem function. This project seeks to improve our understanding of climate-induced shifts in the seasonal timing of migration, spawning or breeding, and rates of biological development in coastal fishes, marine mammals, and migratory shore and seabirds along the U.S Atlantic coast. Long-term biological observations and environmental monitoring data are being assembled to evaluate the spatial and temporal scales at which phenological shifts are occurring, the primary environmental variables driving them, and to identify shared traits or behavioral changes that are common among different species. Comparisons of phenological shifts among higher trophic level predators and marine forage species will help characterize the adaptive capacity and vulnerability of individual species and regional sub-populations to changing environmental conditions. It will also identify where potential trophic mismatches may occur due to rapid climate change, and reveal gaps in monitoring networks intended to detect such responses among species of commercial, ecological, and conservation importance.

Methods

- Conduct literature review
- Assemble biological and climate datasets, and digitize long-term data pertaining to phenology
- Model species' phenological responses and potential ecological effects
- Develop conceptual model as a decision support tool for evaluating adaptation and management decisions

Phenology-relevant datasets

Migration
- Dates of first arrival, numbers of individuals, colony size, biomass, last departure

Breeding
- Timing and occurrence of breeding / courtship displays

Early life history
- Egg, larval, post-chick development; life stages present; age / size composition

Food habits
- Diet studies, predator-prey body sizes, dependent relationships

Data sources

Local, state, and federal monitoring programs; trawl, seine, weir, aerial, bird count surveys; fish ladder passage; fishing logbooks; haul out sites; whale watching vessels; fisheries observers; citizen science; historical records

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Project Objectives

1. Synthesize phenological information and datasets on marine species of ecological, commercial and conservation importance including:

Coastal predators:
- Marine mammals - seals, whales
- Predatory fishes - striped bass, bluelfish, cod, flounder
- Shore and seabirds – penguins, terns

Forage species:
- Forage fishes – alewives, shad, herring, menhaden
- Invertebrates - shrimp, squid

Primary and secondary producers:
- Phytoplankton, zooplankton

2. Evaluate integrated datasets to identify if and how species are shifting or increasing the variability of phenology:

- Can phenological shifts be detected?
- At what spatial and temporal scales?
- What environmental variables are correlated with shifts?
- What characteristics exacerbate or protect species responses?

3. Explore potential for mismatches among species and trophic levels at different spatial and temporal scales:

- Are predators and prey shifting at different rates?
- What species or populations are most vulnerable to declines?
- Which species may benefit?

Above example shows a historical record of the first appearance of fish, seabirds, and seals in the Taunton River, 1871 to 1883, by Elisha Slade in a letter written to Spencer Baird, published in the Bulletin of the US Fish Commission.