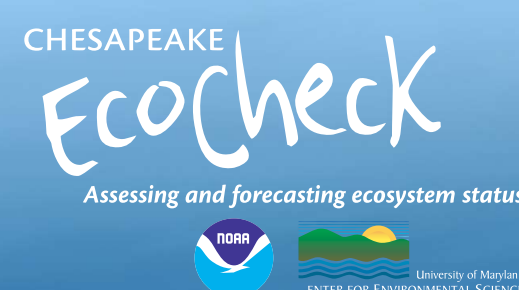


# FUTURE DIRECTIONS IN FISHERIES MANAGEMENT: AN ECOSYSTEM-BASED APPROACH

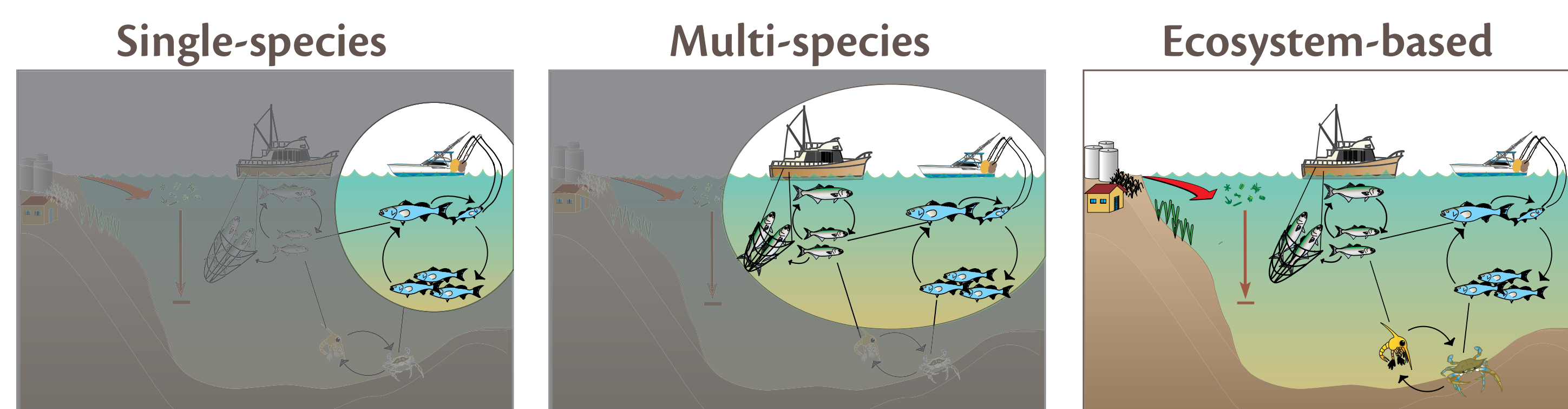


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## BROADER HORIZONS IN FISHERIES MANAGEMENT

The standard approach to fisheries management has been to focus on one species at a time, using catch level, life history, and economic yield in order to determine a management plan for the fishery (Figure 1). The challenge at hand is to successfully incorporate pivotal information such as habitat characteristics, interactions between species, and natural variability.



### Major research & assessment required:

- Species' life history
  - Catch data (e.g. biomass, fishing effort)
  - Stock assessment
  - Fisheries-independent monitoring
- +
- In addition to the requirements of single-species management:
  - Diet composition and ecological interactions
  - Bycatch and fleet monitoring
  - Assessment of value
- +
- In addition to the requirements of multi-species management:
  - Analysis of the relationships between habitat, land use, fishing effort, distribution and population, and water quality/physical-chemical properties

### Major management options & tools:

- Quotas, maximum sustainable yield
  - Fishing mortality thresholds
  - Biological reference points as a means of determining targets and quotas
  - Licensing and seasons
- +
- In addition to those used in single-species management:
  - Bycatch limits
  - Multi-species committee meetings to analyze management options
  - Multi-species assessment models
- +
- In addition to those used in multi-species management:
  - Ecosystem models linking living resources and habitat characteristics listed above
  - Integrative ecosystem committees
  - Habitat restoration, nutrient reduction

Figure 1: The evolution from single-species to ecosystem-based fisheries management involves a widening of scope toward our current position - on the verge of implementation.

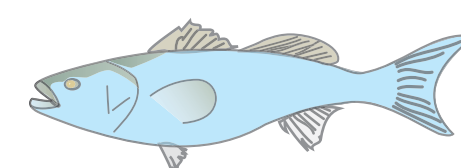
## BROADER HORIZONS INCREASE COMPLEXITY

All approaches, even the least complex (single-species management) require substantial research and monitoring effort before a management plan may be developed.

### Single-species

- Largely based upon assessing population in relation to fishing mortality rate targets & thresholds; fishing mortality rate (Figure 2A) is used to adjust harvests.

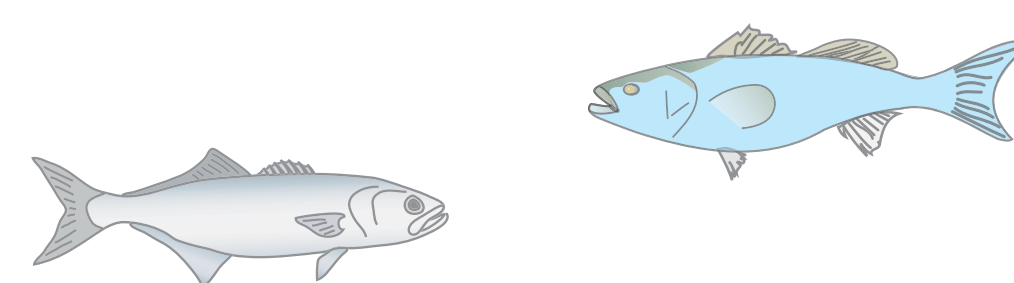
- Goal = a **maximum** sustainable yield (Figure 2A)



### Multi-species

- Adds a new level by addressing species interactions

- Relies mainly upon diet composition and recruitment data (fish added to the exploitable stock each year) to predict the effects of varied fishing effort (Figure 2B)

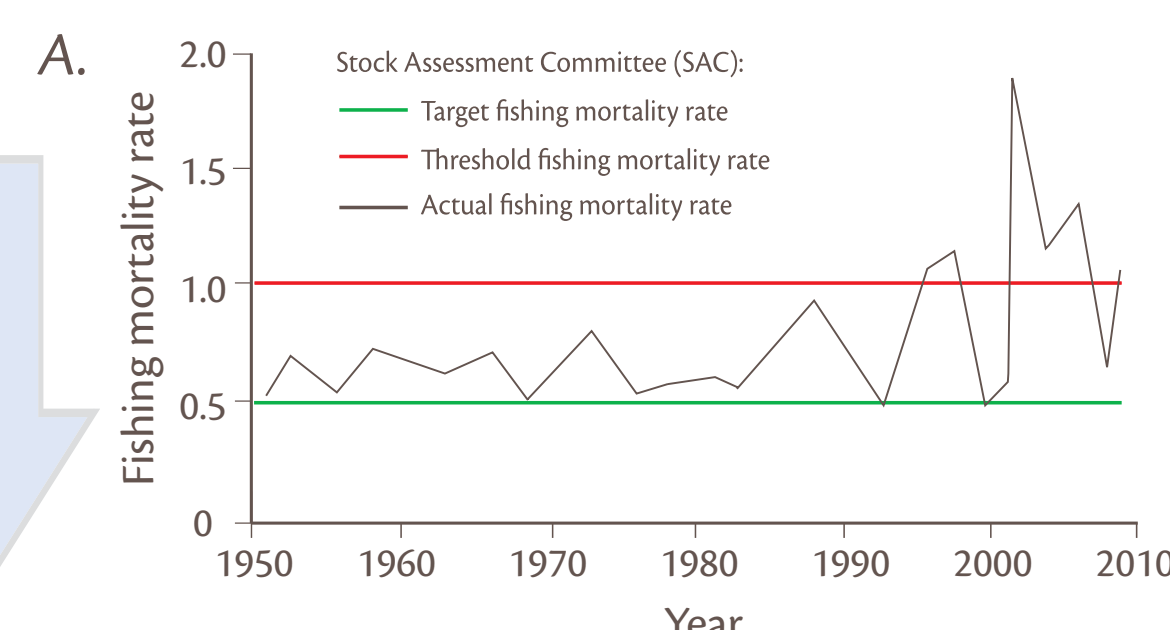
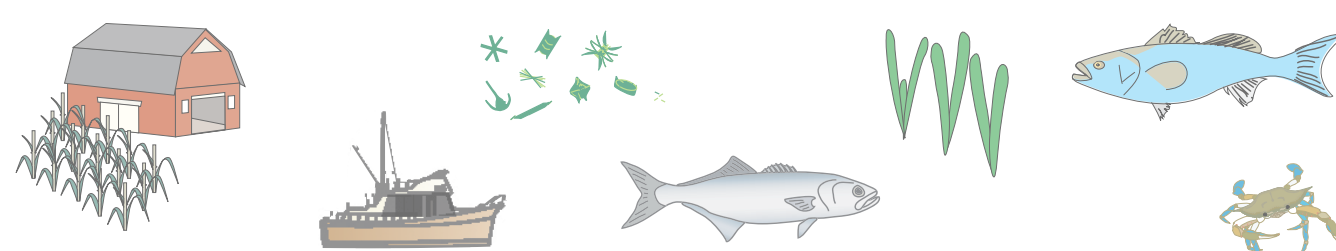


### Ecosystem-based

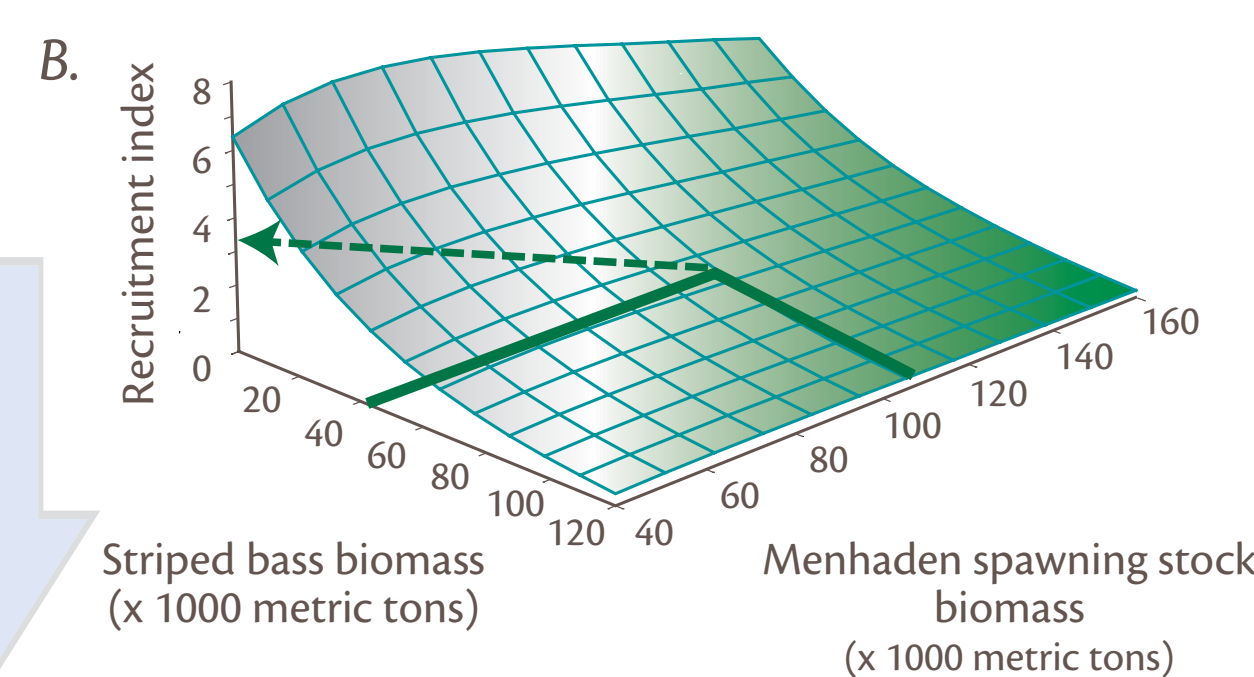
- Addresses factors affecting all species (e.g. habitat availability and quality, primary production)
- Supports a comprehensive look at an entire system, rather than a narrow representation of one species at a time.

- With such a comprehensive look, both sensitive and more resilient species may be more fully represented (Figure 2C)

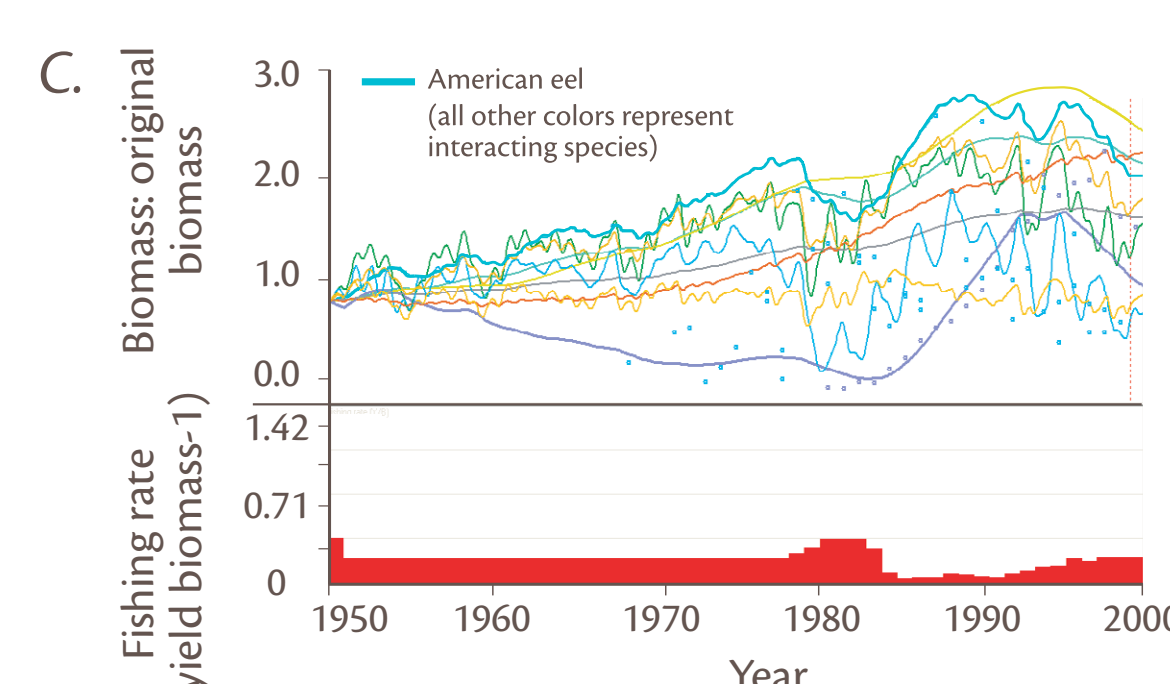
- Goal = an **optimum** sustainable yield



Adapted from the 2005 Chesapeake Bay Blue Crab Advisory Report, Fisheries Steering Committee



Zhang et al., in prep.



Adapted from Eel output by H. Townsend, NOAA

Figure 2: A-C: Examples of modeling tools used or in development: (A) standard target and threshold system; (B) multi-species theoretical model predicting recruitment based upon biomass from the previous year; (C) example of an ecosystem-based model simultaneously modeling species interactions, fishing pressure, and nutrient loading

## THE ADAPTIVE PROCESS

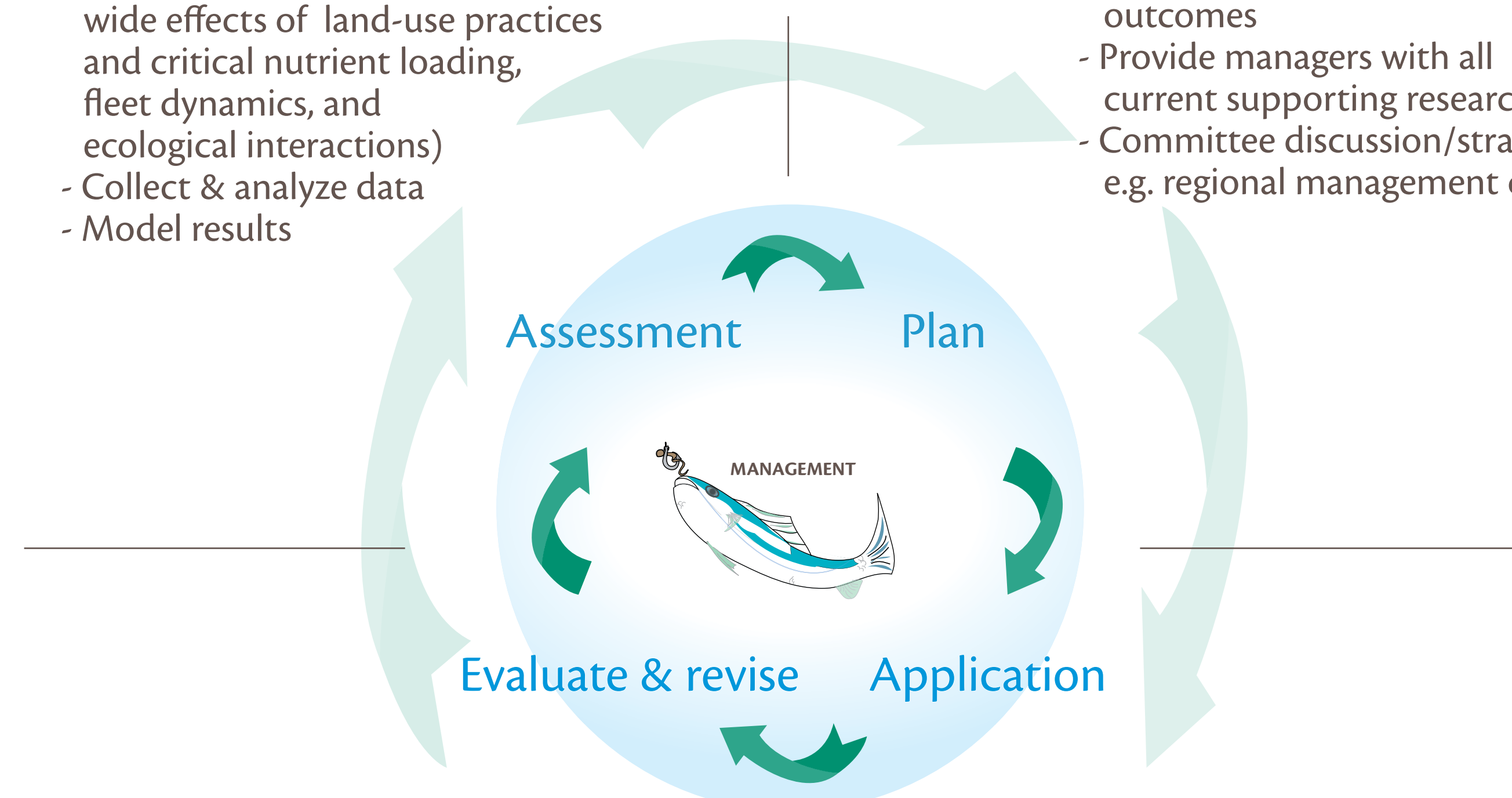
Sound management is an adaptive process, reducing costs and enabling feedback by continual evaluation and refinement of the plan's effectiveness. The first planning stages require an integrative ecosystem committee comprised of managers, researchers, and stakeholders.

### The assessment stage:

- Perform research (e.g. ecosystem-wide effects of land-use practices and critical nutrient loading, fleet dynamics, and ecological interactions)
- Collect & analyze data
- Model results

### The planning stage:

- Define values and desired outcomes
- Provide managers with all current supporting research
- Committee discussion/strategy e.g. regional management councils



### The evaluation & revision stage:

- Evaluate effectiveness; compare objectives to outcomes through committee review
- Report results and recommendations
- Refinement of management plans & applications already in place

### The application stage:

- Implementation of strategy (e.g. limiting impervious surface cover to increase striped bass recruitment)
- Monitor performance

## MANAGING MIGRATORY SPECIES

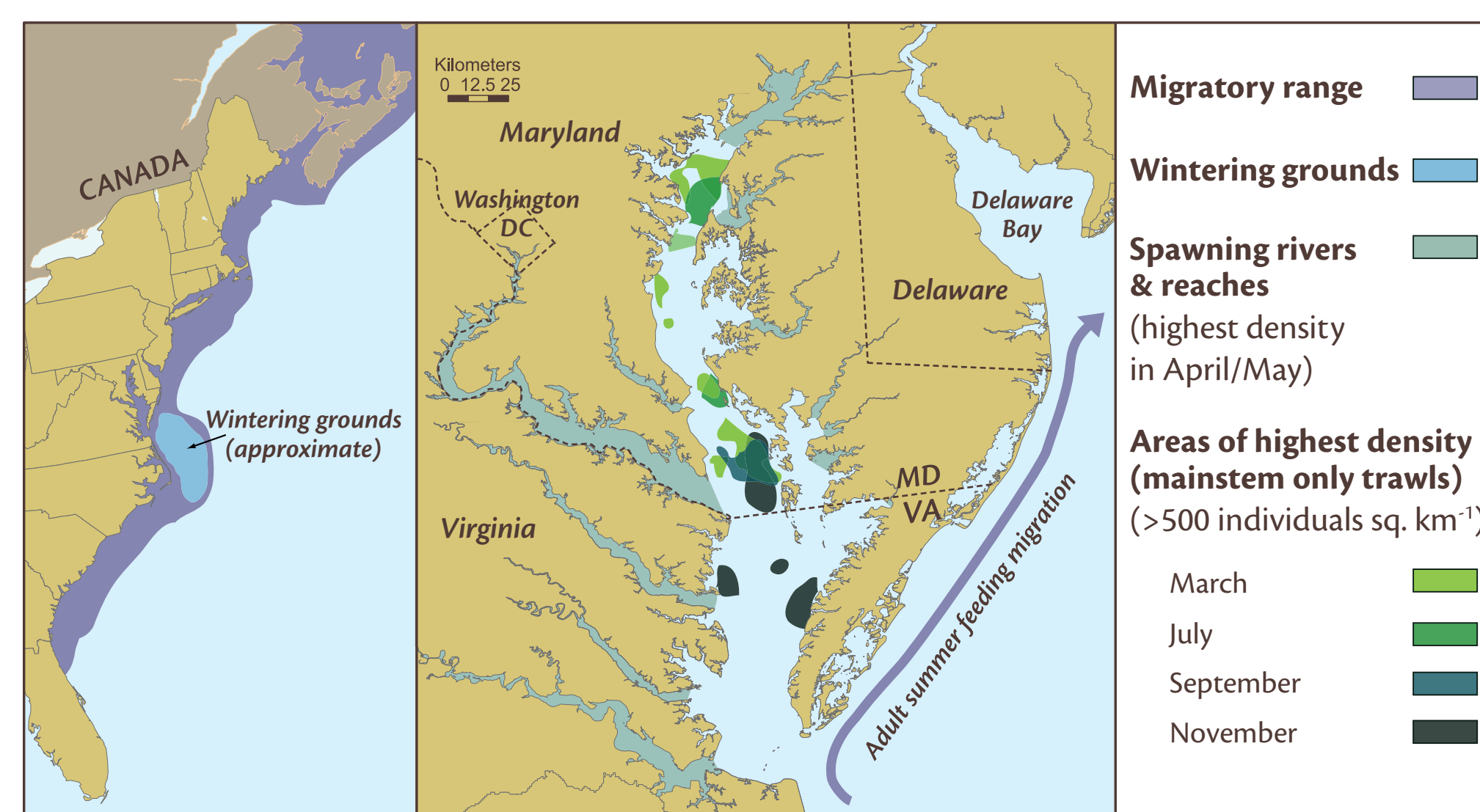
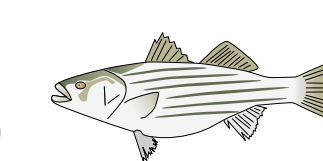


Figure 3: Distribution and migration of Atlantic striped bass populations reflected by a map of spawning rivers and reaches and high-density distribution (mainstem only) of striped bass in Chesapeake Bay.



- Migratory species are a management challenge, ranging across jurisdictional zones.
- The variability of certain habitat characteristics (e.g. dissolved oxygen) further compounds the difficulty of managing species.
- Requires the partnering of multiple authorities such as the Atlantic States Marine Fisheries Commission with regional and state agencies.

## BEYOND THE THEORY

Despite still being in its infancy, the ecosystem-based strategy is increasingly being evidenced in international and national documentation. The greatest challenges to implementing EBFM lie in coordinating multiple stakeholders and government agencies and defining desired outcomes.

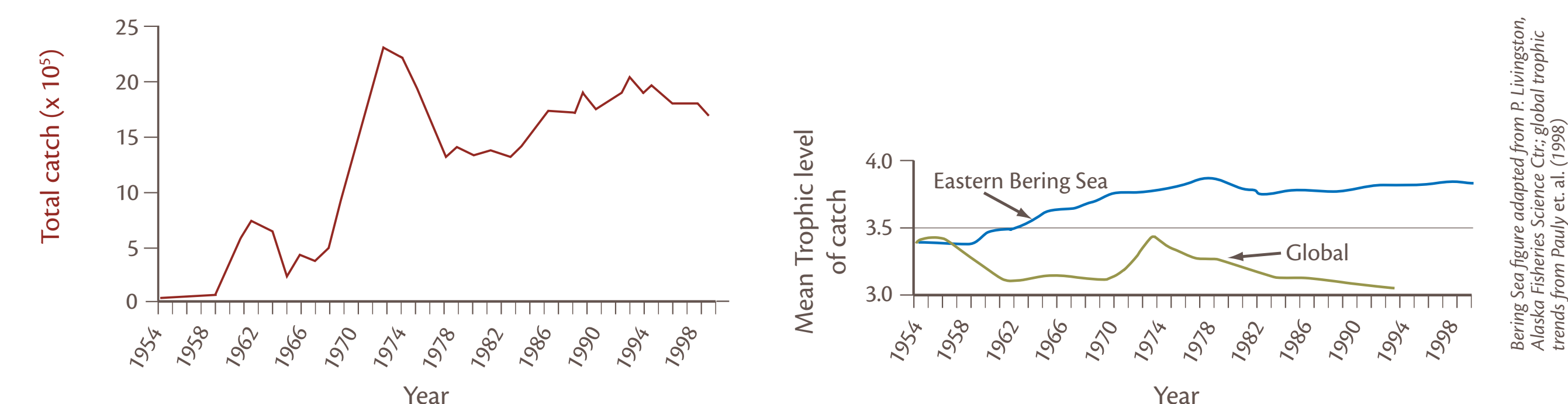


Figure 4: Total catch and mean trophic level of the Bering Sea fishery compared with global trends in mean trophic level of landings. The Sea's relative trophic stability is unique, indicating that its higher-level consumers are not being overfished whereas globally, the larger, spawning-age populations are being depleted.

- The Bering Sea has maintained relative stability in its groundfish population and mean trophic levels of catch using an EBFM approach (Figure 4).
- Translating an EBFM approach that works in an open-ocean system into a estuarine or coastal ecosystem is a great challenge to be faced.
- Success in the Bering Sea can be attributed to annual trawl surveys of populations (Figure 4) and a network of Marine Protected Areas providing fish habitat.
- At present, EBFM has made its way into research and planning efforts, but implementation is still in its early stages of development.



Pacific trawl surveys and catch sorting aboard the research vessel Miller Freeman.

## PROGRESS IN THE CHESAPEAKE BAY

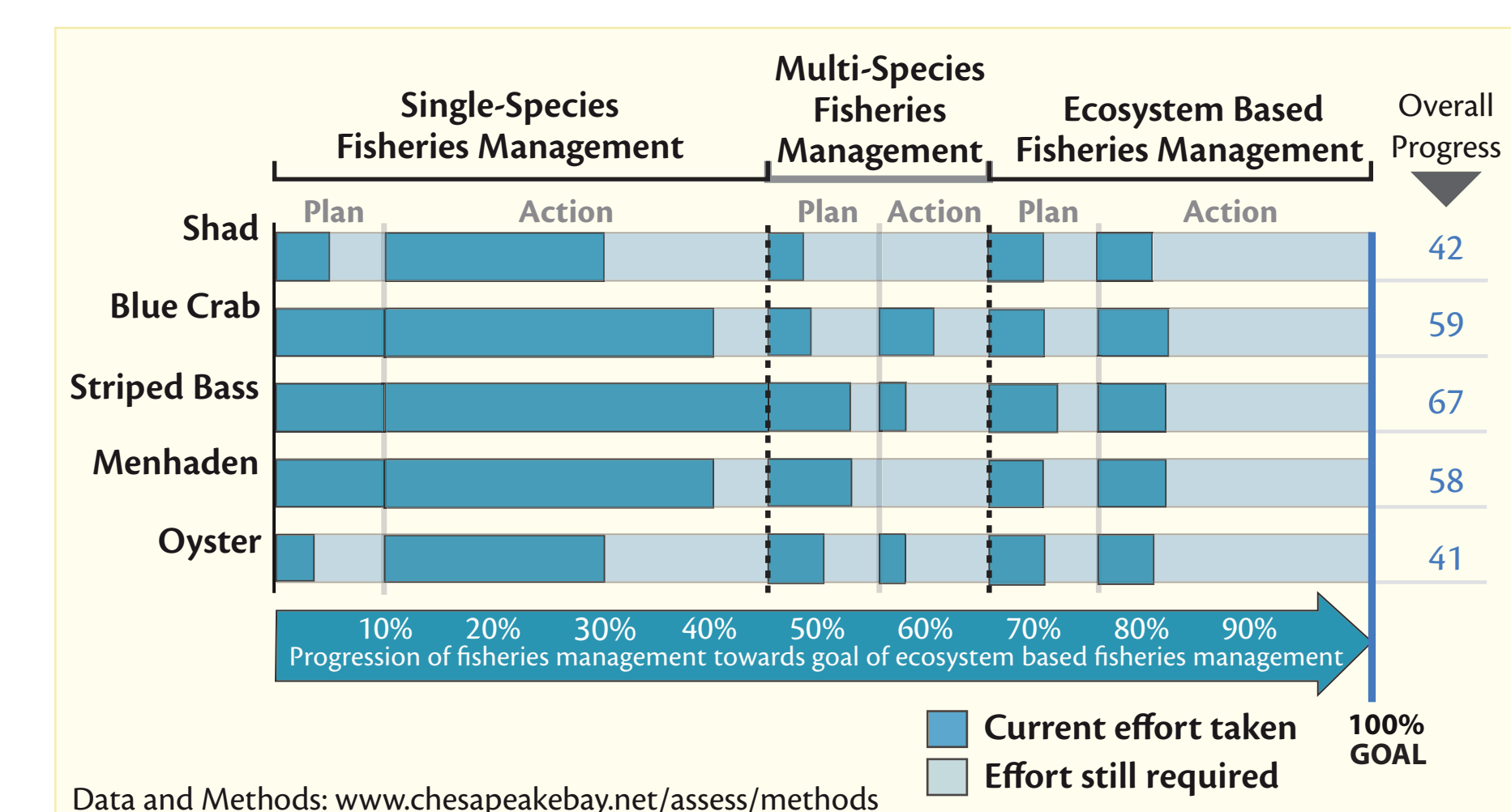


Figure 5: An index of fisheries management effort in the Bay according to the Chesapeake 2000 Agreement.

- Currently in Chesapeake Bay, a fisheries ecosystem plan (FEP) has been published, serving as a guide for ecosystem-based fisheries management.
- Recent estimates of effort towards implementation of the plan ranged from 41-67% for each of five species (Figure 5).
- Ecosystem-based modeling efforts may help to account for new parameters, such as the effects of habitat restoration or varied nutrient loading into the Bay.
- Recommendations include defining essential habitat and critical areas as well as considering how the population of each species affects the entire ecosystem.

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Further Information:  
• EBFM at NOAA Chesapeake Bay Office: <http://noaa.chesapeakebay.net/fisheriesecosystem.aspx>  
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