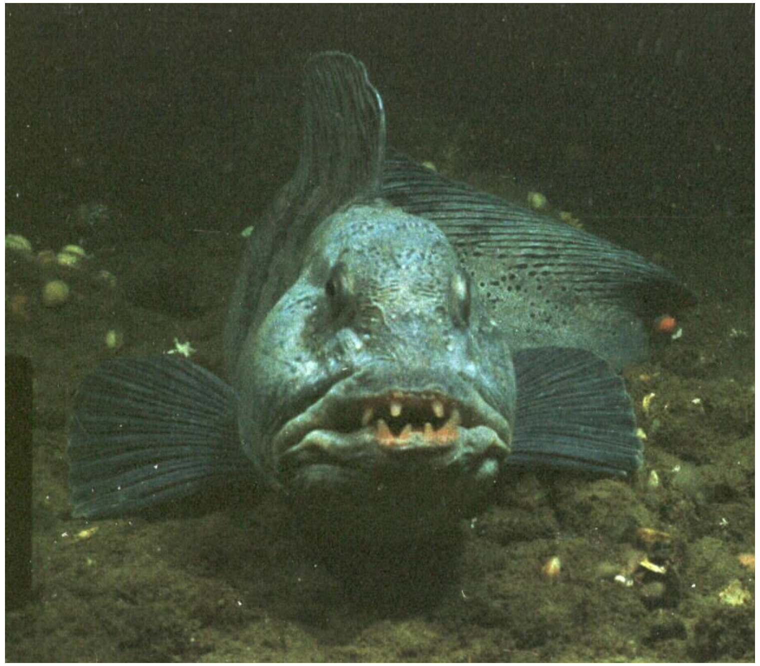


eFEP Spatial Management



Peter Auster
UConn Marine Sciences & Mystic Aquarium
EBFM PDT Member

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The SSC (NEFMC 2010) noted that a transition to EBFM offered opportunities for:

- The potential for simplification of management structures with associated cost savings in ultimately moving from a large number of species/stock-based management plans to a smaller number of integrated plans for ecological units defined by location.
- More realistic consideration of the effects of both fishery interactions (e.g. bycatch in different fleet sectors) and biological interactions (e.g. consideration of predator-prey interactions) within ecological units, including consideration of effects on biodiversity.
- Direct consideration of environmental/climate-related change, its effect on productivity and biological reference points.
- Consideration of the ecosystem constraints on simultaneous rebuilding of stocks to long-term target levels and evaluation of whether or not stock – specific recovery plans are compatible.
- More effective coordination among management actions taken for fishery management and protected resources (i.e., species protected under the Endangered Species Act or Marine Mammal Protection Act).

Goals and objectives adopted by the NEFMC for use in this eFEP, as a starting point for focusing debate:

Strategic Objectives

- Maintain/restore functional production levels (ecosystem, community scale emphasis)
- Maintain/restore functional biomass levels (community/species scale emphasis)
- Maintain/restore functional trophic structure
- Maintain/restore functional habitat

Strategic Goals (Derived from Magnuson definition of OY as in Risk Policy Document)

- Optimize Food Provision through targeted fishing and fishing for species for bait
- Optimize Employment
- Optimize Recreational Opportunity
- Optimize Intrinsic (Existence) values
- Optimize Profitability
- Promote stability in both the biological and social systems

Operational Objectives (SMART: Specific, Measurable, Achievable, Relevant, Time-bound)

- Fishing-related mortality for threatened/endangered/protected species is minimized (Strategic Objective 2)
- Managed and protected species biomass is above established minimum threshold (Strategic Objectives 1, 2 and 3)
  - Probability according to risk policy
  - Specified for each spatial scale and time unit
  - Dynamic to account for environmental/climate shifts
- Maintain ecosystem structure within historical variation, recognizing inherent dynamic properties of the system; Ecosystem structure includes size structure, trophic structure, and Species Complex structure. (Strategic Objective 3)
  - Maintain size structure within acceptable limits
  - Maintain trophic structure within acceptable limits
  - Maintain Species Complex structure within acceptable limits
- Maintain habitat productivity and diversity (Strategic Objective 4)
- Habitat structure and function are maintained for exploited species
- Minimize the risk of permanent (>20 years) impacts
  - Corals and sponges
  - Other vulnerable biogenic habitats
  - Habitats vulnerable to Aquatic Invasive Species (AIS)
  - Vulnerable physical habitats (e.g. relict glacial gravel banks)

Auster, UConn, SBNMS

Valentine, USGS, Georges Bank 2003

Potential spatial management approaches to address management objectives

- Habitat
- Spawning
- Protected species

Fishing impacts on ecosystem and spatial management (Section 9.6)

- eFEP management strategy component is not intended to duplicate or replace the Omnibus Habitat Amendment 2 measures
- broaden the scope of considering spatial effects of fishing as they relate to ecosystem function, e.g.
  - **effects on juvenile survival and growth,**
  - **energy flow through the ecosystem, and**
  - **abundance and availability of prey for apex predators and protected species**
- focus on the role of spatial processes on ecosystem function and health, as well as the benefits accrued from taking these processes into account, in order to minimize risk to managed populations

1. Assessing spatial distribution of effort by gear type and fishery functional group to evaluate patterns of impact and recovery to habitat, spawning, and protected species within each EPU.

- Quantifying spatial and temporal variation in fishing effort by gear type, linked to spatial variation of habitat types within EPUs.
- Output could be used to assess effects of fishing on vulnerable attributes of habitat and the potential for interactions within and between fishery functional groups and protected species.
- Geospatial data products, based on the SASI (v2) model framework, can be used to assess spatial variation of habitat impacts in regard to recovery rates, timing of gear effects, and co-occurrence with managed and protected species.

2. Evaluate allocations of catch to fishery functional groups to achieve management objectives for habitat, spawning, and protected species within each EPU.

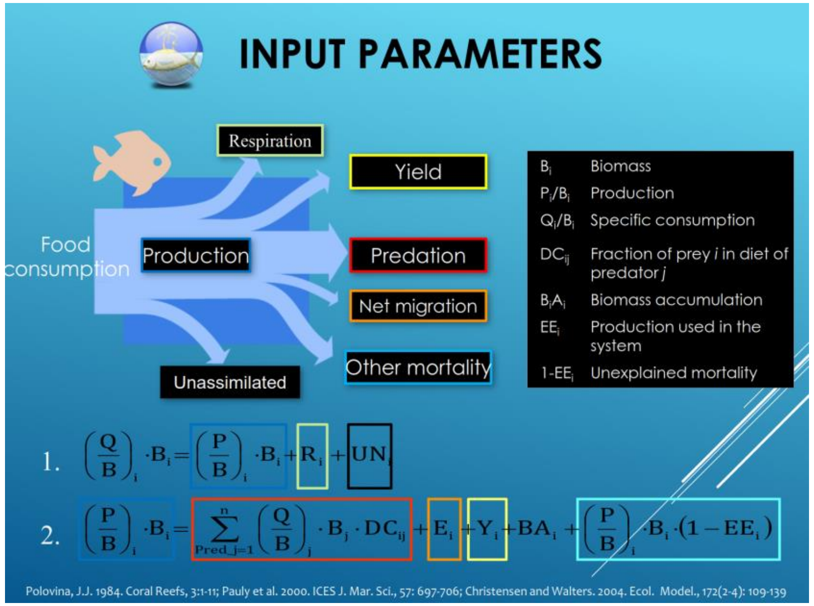
- Evaluate spatial distribution of catch based on gear-effort and fishery functional groups where:
  - impacts to habitat are highest and where recovery times longest,
  - highest effort coincides with important life-history stages of managed species (e.g., settlement), and
  - where fishing coincides with aggregations of protected species (e.g., based on patchiness of distributions).
- Evaluate management objectives and approaches to reduce effects through the allocation process.
- adaptive process to identify where interventions could enhance ecosystem objectives and where (collaborative) research could be implemented to test responses and refine assumptions

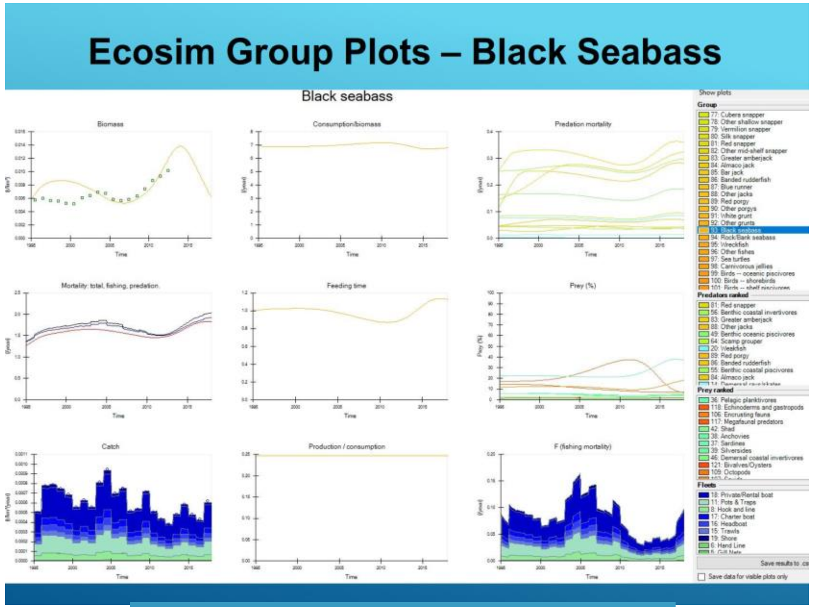
2. Evaluate allocations of catch to fishery functional groups to achieve management objectives for habitat, spawning, and protected species within each EPU.

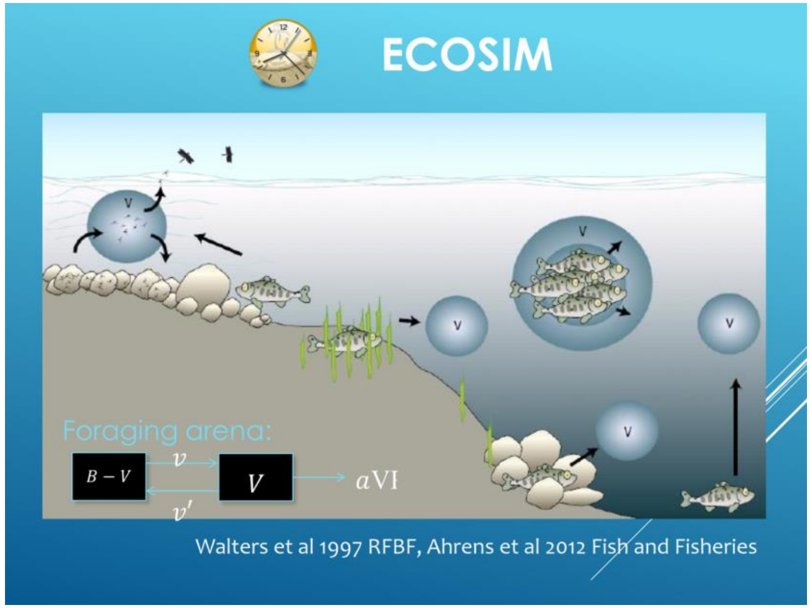
- Interventions could include gear restrictions, time-area rotations or closures, or allocating catch/effort such that some areas are fully fished, some are moderately fished, and some areas lightly fished or closed.
- Intention would be to ensure high quality habitat at all life stages to support productive fisheries and reduce technical interactions among protected species and the fleets.

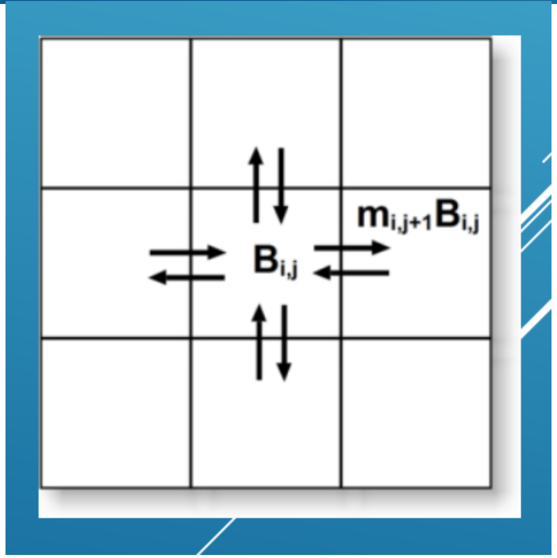
3. Estimate effort and gear impacts to habitat for each managed species (or complex/functional group) regarding variation in productivity (growth, survival, reproduction) to evaluate performance of management objectives.

- The role of habitat is a primary but not exclusive factor mediating the demography of managed species.
- In order to develop alternatives for habitat management that conserve habitat and sustain or enhance managed species, a modeling approach that evaluates variation in habitat attributes and links to the life history of managed species is needed.
- The EcoPath-EcoSpace model platform, for example, can be used to predict population responses to variation in habitat attributes, that affect survival and energetics, based on implementation of foraging arena theory.
- Models can test multiple impact and intervention scenarios that can be used to further inform allocation decisions and research needs.









- Ecosim for every cell in a grid
- Inputs re movement, habitat, environment
- F and fleet behavior

- Ecopath - A snapshot of the ecosystem: predators, prey, linked trophic levels.
- Ecosim - Model is calibrated w time series of abundance and biomass, simulations and "what-if" scenarios.
- Ecospace – Spatially related questions can be addressed including spatial management and spatial expression of environmental change.

4. Effects of spatial variation in demographics of prey species for managed and protected species.

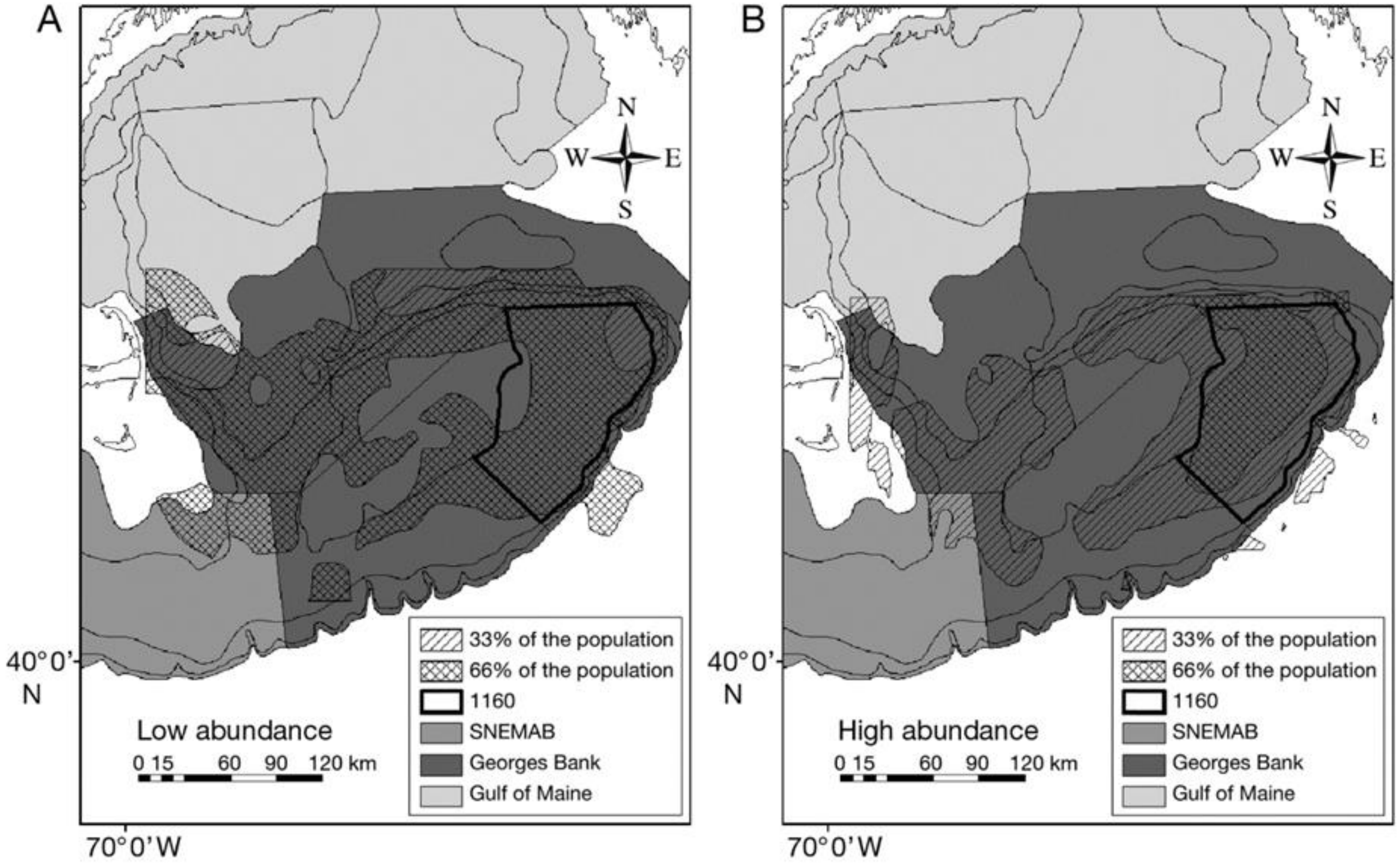
- The spatial variation in density, size, and patchiness of prey available to predators directly affects patterns of energy intake and subsequent patterns of survival, growth, and reproduction.
- Analysis of existing data sets (split-beam acoustic surveys, trawl survey and observer data) for spatial distribution of principal prey (e.g., Atlantic herring, sand lance, mackerel, pollock, decapod zooplankton) over seasonal periods with comparison to patterns of catch, and patterns of protected species, can inform development of spatial management alternatives related to protected species interactions with fisheries.

Research Needs – Example 1 – Habitat and productivity

- Examination into spatial variation, condition factor for managed and protected species could be examined spatially with data from the NEFSC trawl survey (e.g., Pereira et al. 2012, 2014, Howell et al. 2016).

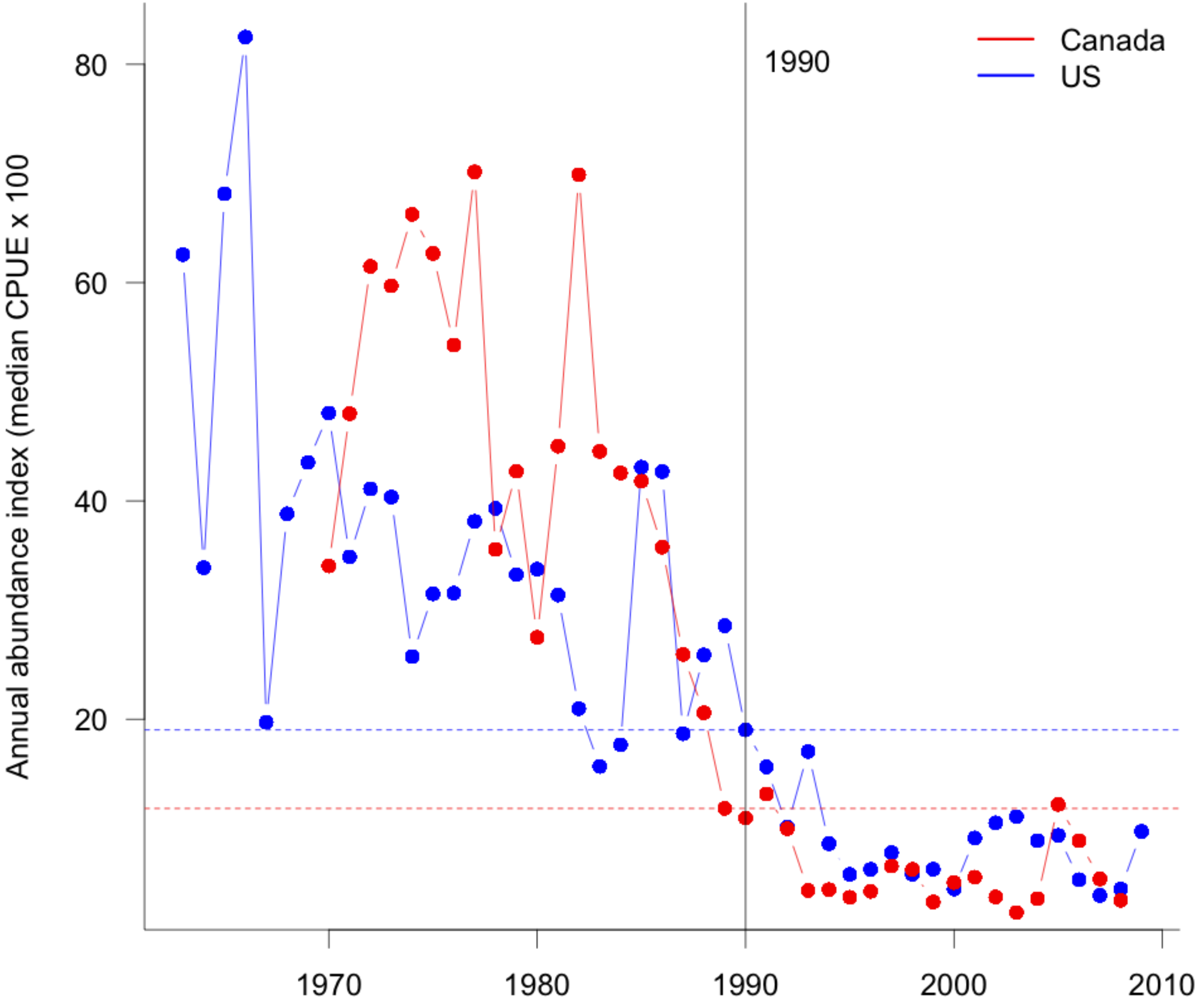
  - Data could be analyzed to determine if there were consistent patterns in variation in condition across Georges Bank (Northeast Shelf) by season and over time and if the patterns in condition factor were correlated with habitat types (taking sex, size, and population level into account).
  - The goal would be to identify productive areas or habitat types that could help define spatial regions that enhance fish productivity and could be examined in simulation testing and adaptive management actions.

- E.g., Pereira et al. (2012) demonstrated that data collected during standard fisheries assessment surveys (size, sex, weight, abundance, location) could be used to quantify spatial patterns of habitat use for yellowtail flounder on Georges Bank and identify areas that make significant contributions to species productivity



Yellowtail flounder population on Georges Bank during periods of (A) low and (B) high abundance. The cross-hatched area represents the area within which approximately 66% of the population occurred. The hatched area represents the distribution of an additional 33 % of the population. Together they account for 99% of the area occupied by the population. Overall area occupied by flounder increased by a factor of 2 when abundance was high, and local density increased predominantly in high quality habitat, with quality based on variation in size-weight relationships.

Research Needs – Example 2 – Habitat and climate



Decline in population indices of cusk in the USA and Canadian trawl survey. The year 1990 was used to separate data from these two surveys to investigate density dependent habitat associations.

Hare, J.A., Manderson, J.P., Nye, J.A., Alexander, M.A., Auster, P.J., Borggaard, D.L., Capotondi, A.M., Damon-Randall, K.B., Heupel, E., Mateo, I., O'Brien, L., Richardson, D.E., Stock, C.A., and Biege, S.T. 2012. Cusk (*Brosme brosme*) and climate change: assessing the threat to a candidate marine fish species under the US Endangered Species Act. – ICES Journal of Marine Science, 69: 1753–1768.

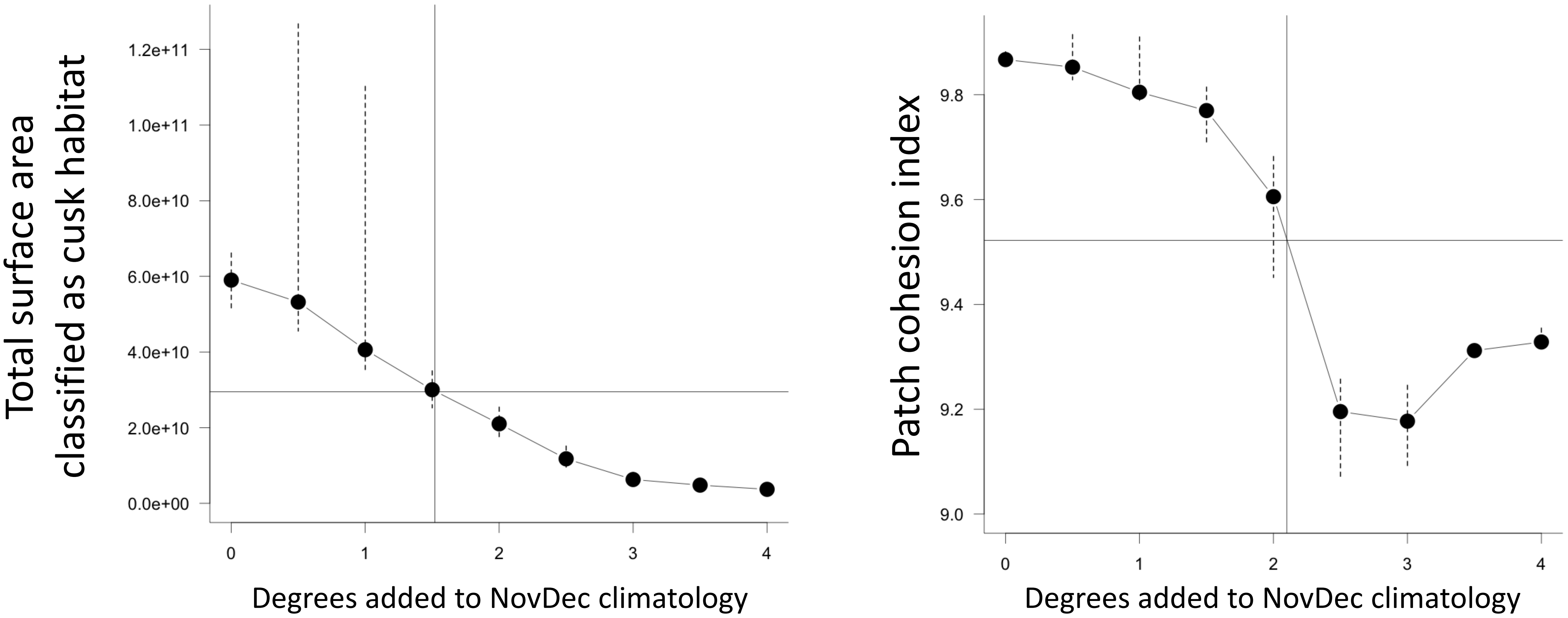
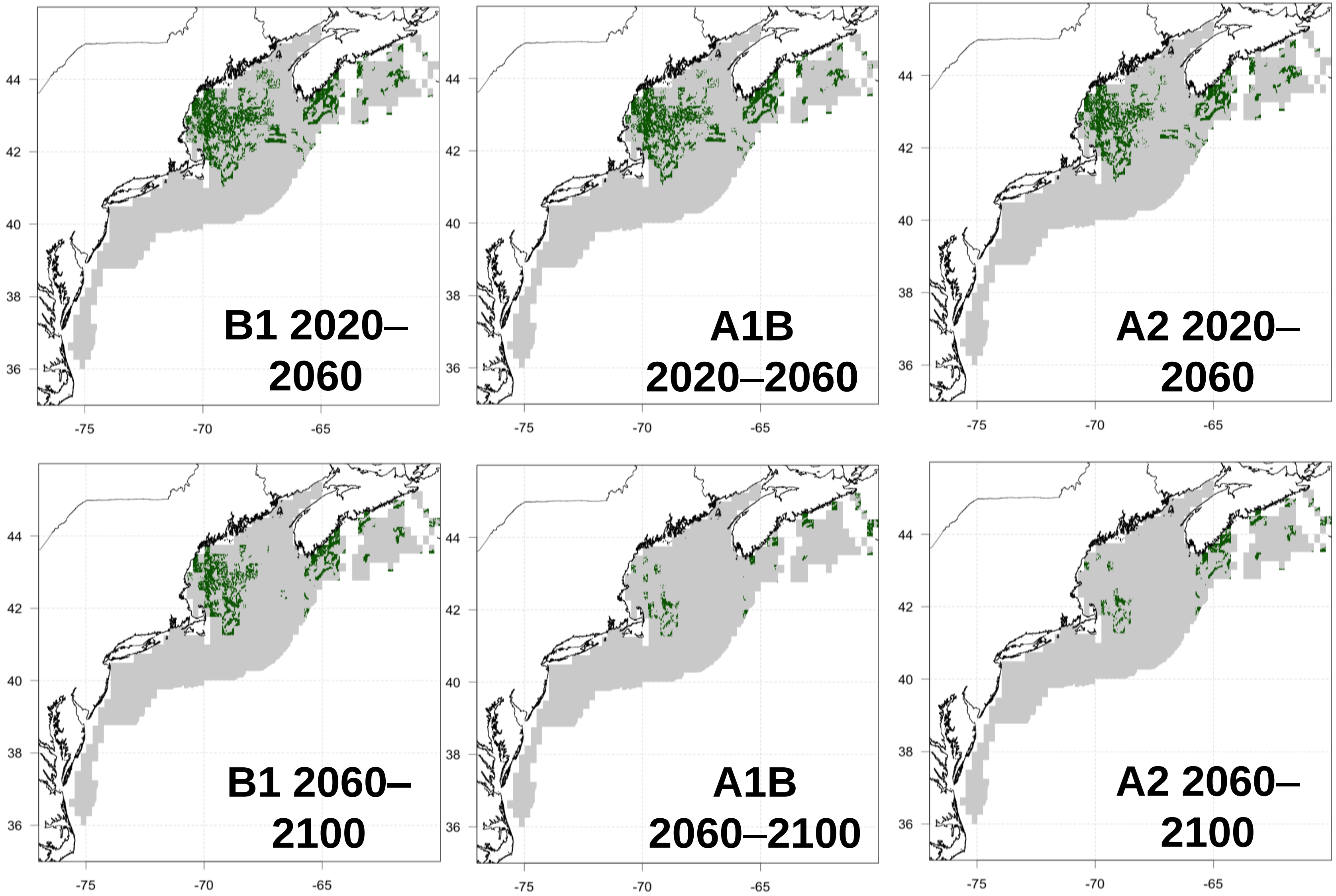


Figure 3: Decline in a) area classified as cusk habitat and b) the patch cohesion index as a function of temperature change.



Binary maps of potential habitat for adult cusk classified from projections of the statistical niche model that included bottom complexity and bottom water temperatures. Green areas indicate potential cusk habitat for 3 scenarios; “low” (B1), moderate” (A1B), and “high” (A2) emissions that were forecast using the ensemble mean change in temperature from seven Global Climate models.

Research Needs – Example 2 – Habitat and climate

- Results indicate cusk habitat in the region will shrink and fragment, which is a result of a spatial mismatch between high complexity seafloor habitat and suitable temperature.
- The importance of habitat patch connectivity for cusk is poorly understood, so the population-level consequences of climate-related habitat fragmentation are uncertain.


ANSWERS
QUESTIONS