Fisheries Management Response

So What?

LO: interpret how responses by ELH stages of marine fish to environmental change will impact resource management

Climate Science Strategy Objectives

2017-2022

1. Identify appropriate, climate-informed reference points for managing LMRs.
2. Identify robust strategies for managing LMRs under changing climate conditions.
3. Design adaptive decision processes that can incorporate and respond to changing climate conditions.
4. Identify future states of marine, coastal, and freshwater ecosystems, LMRs, and LMR-dependent human communities in a changing climate.
5. Identify the mechanisms of climate impacts on ecosystems, LMRs, and LMR-dependent human communities.
6. Track trends in ecosystems, LMRs, and LMR-dependent human communities and provide early warning of change.
7. Build and maintain the science infrastructure needed to fulfill NOAA Fisheries mandates under changing climate conditions.

LMR= living marine resources

NOAA Strategic Plan and Guidance

1. Foster healthy and sustainable marine resources, habitats, and ecosystems
2. Listen and respond to stakeholder concerns
3. Ensure the productivity and sustain ability of fisheries and fishing communities through science-based decision-making and compliance of regulations
4. Recover and conserve protected resources through the use of sound natural and social sciences
5. Improve organizational excellence

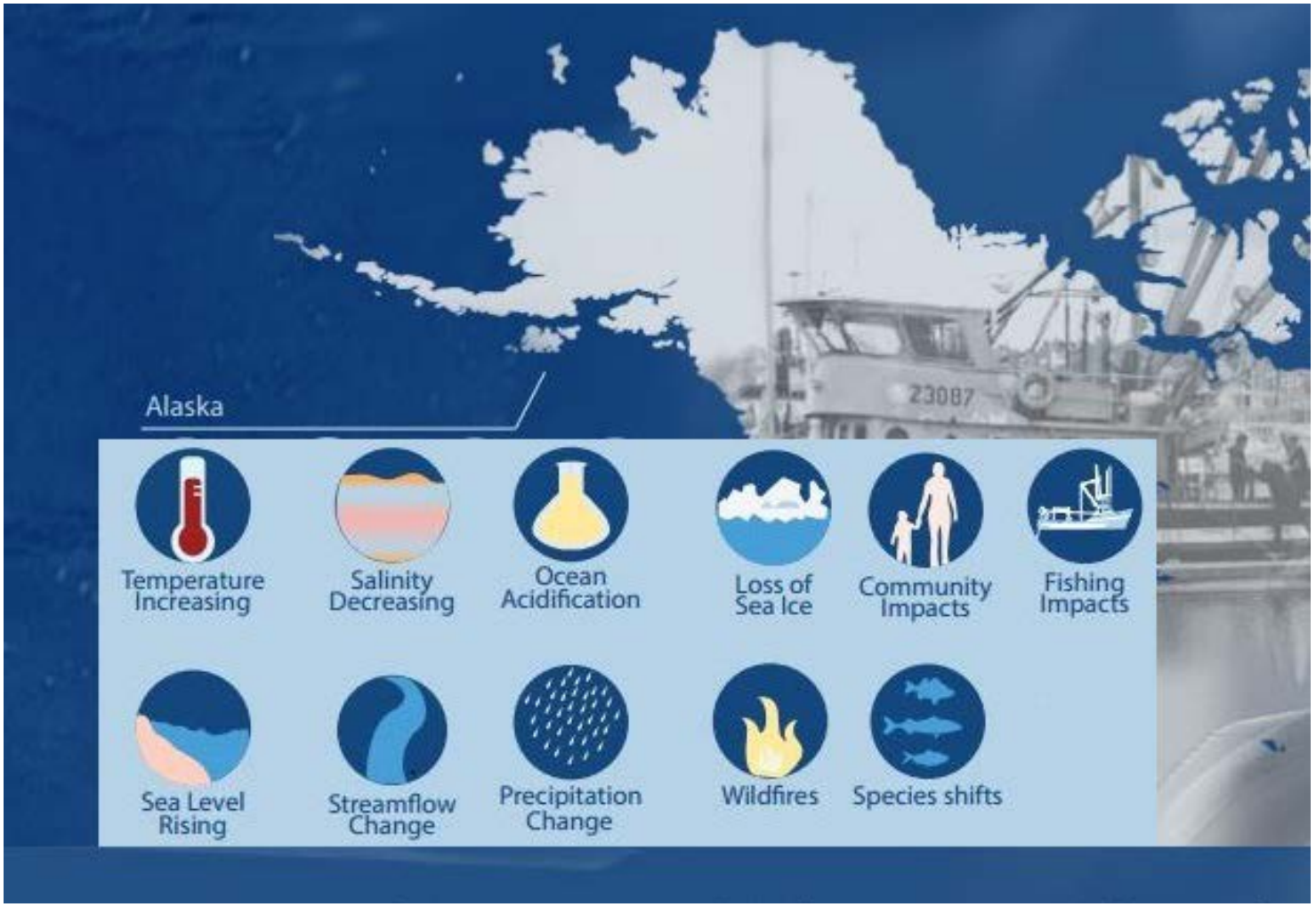
AFSC Mandate Themes

Theme 1:	Monitor and assess fish, crab, and marine mammal populations, fisheries, marine ecosystems, and the associated communities that rely on these resources.
Theme 2:	Understand and forecast effects of climate change on marine ecosystems.
Theme 3:	Achieve organizational excellence in our administrative activities through innovation and the use of best practices.

AFSC Research Themes and Foci

1. Support fishery management through providing core research products used in annual management decisions.
   - 1.1. Maintain the current assessment tier of fish, crab, and marine mammal stocks (Core Activity)
   - 1.2. Support NOAA Fisheries and North Pacific Fishery Management Council analyses and international obligations (Core Activity)
   - 1.3. Create next generation fish, crab, and marine mammal stock assessments and biological and socioeconomic data collections, including priority for Cook Inlet beluga whales
   - 1.4. Conduct bycatch analyses and support conservation engineering advances
2. Understand and forecast effects of climate change on marine ecosystems
   - 2.1. Finalize and implement the Regional Action Plan for Climate Science Strategy in the Southeast Bering Sea
   - 2.2. Develop and implement Regional Action Plans for the Gulf of Alaska and the Aleutian Islands by 2017 and 2019, respectively
   - 2.3. Conduct integrated ecosystem assessments
   - 2.4. Implement NOAA Fisheries' components of NOAA's Arctic Action Plan
   - 2.5. Forecast direct and indirect effects of climate change on fish, crab, and marine mammal species, their habitats, and the associated communities which rely on these resources

Current & Expected Climate-Related Impacts on Marine Ecosystems



Potential Responses of LMRs to Climate Change

Shifts in:

- zooplankton prey distributions
- fish phenology (amplify match-mis-match)
- vital rates (growth, mortality, maturity)
- adaptive flexibility (genetic diversity, flexibility in life history (spawning distribution, food habits))
- species interactions (predator-prey, competition)
- foodweb structure
- community composition and dominant species

Possible Solutions…

- Survival, Growth & Recruitment: incorporate bio-physical process into assessment and estimate relationship. Project relationship forward.
- Movement (availability/selectivity): Account for shifts by incorporating bio-physical relationship in assessment (effects on q or selectivity).
- Movement (species interactions): Spatial management, time varying natural mortality as function of environment.
- Phenology: Time area management.

courtesy Anne Hollowed

Ecosystem Indicators in Stock-Recruitment Equations

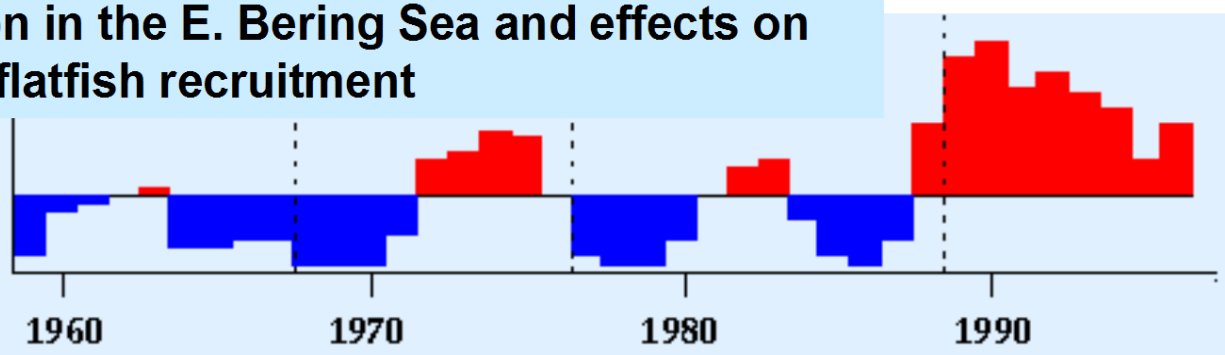
Generalized compensation in stock–recruit functions:

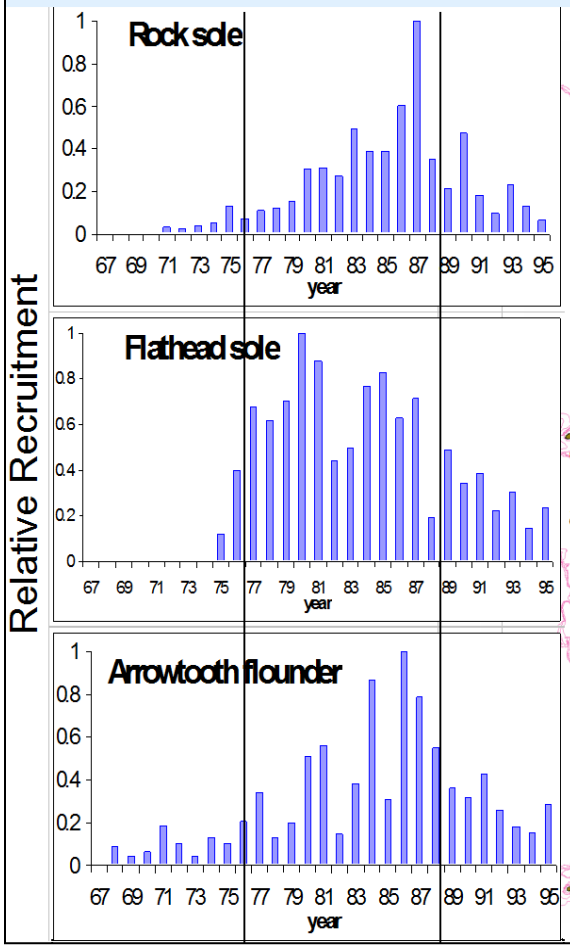
$$R_{y+1} = \left(\overline{R}_1 e^{\left(\sum_{i=1}^{n} a_i I_{i,y}\right)} e^{(\varepsilon_y - \sigma_R^2/2)} \right); e_y \sim N(0, \sigma_R^2)$$

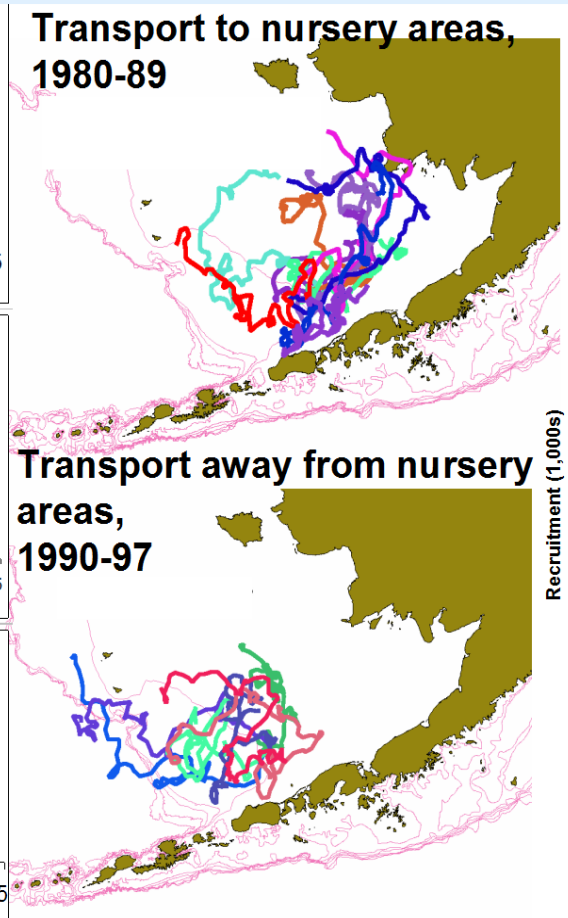
$$R_t = \left(\alpha * S_t * e^{-(\beta S + E1 + E2 \ldots)} \right)$$

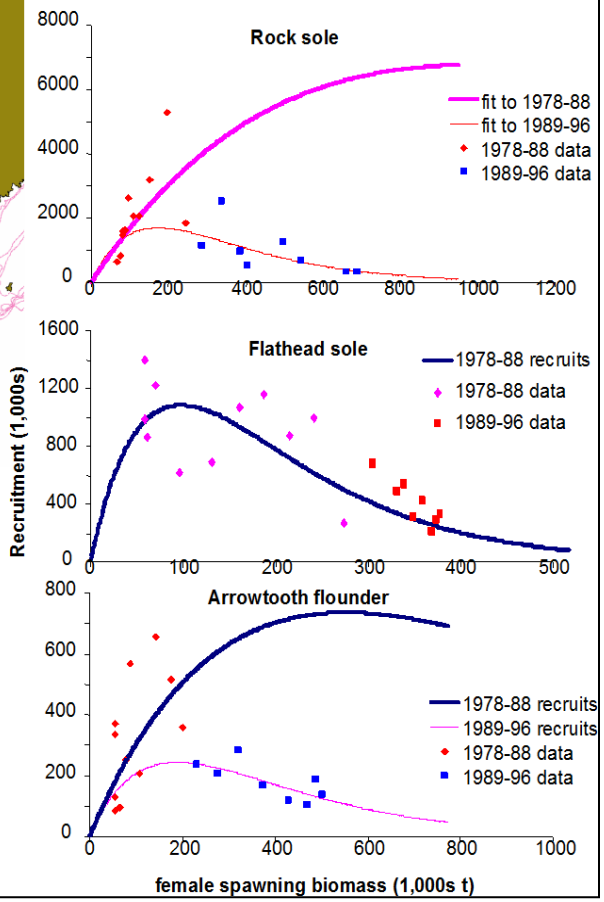
Brooks and Powers 2007

Index of Advection in the E. Bering Sea and effects on winter-spawning flatfish recruitment



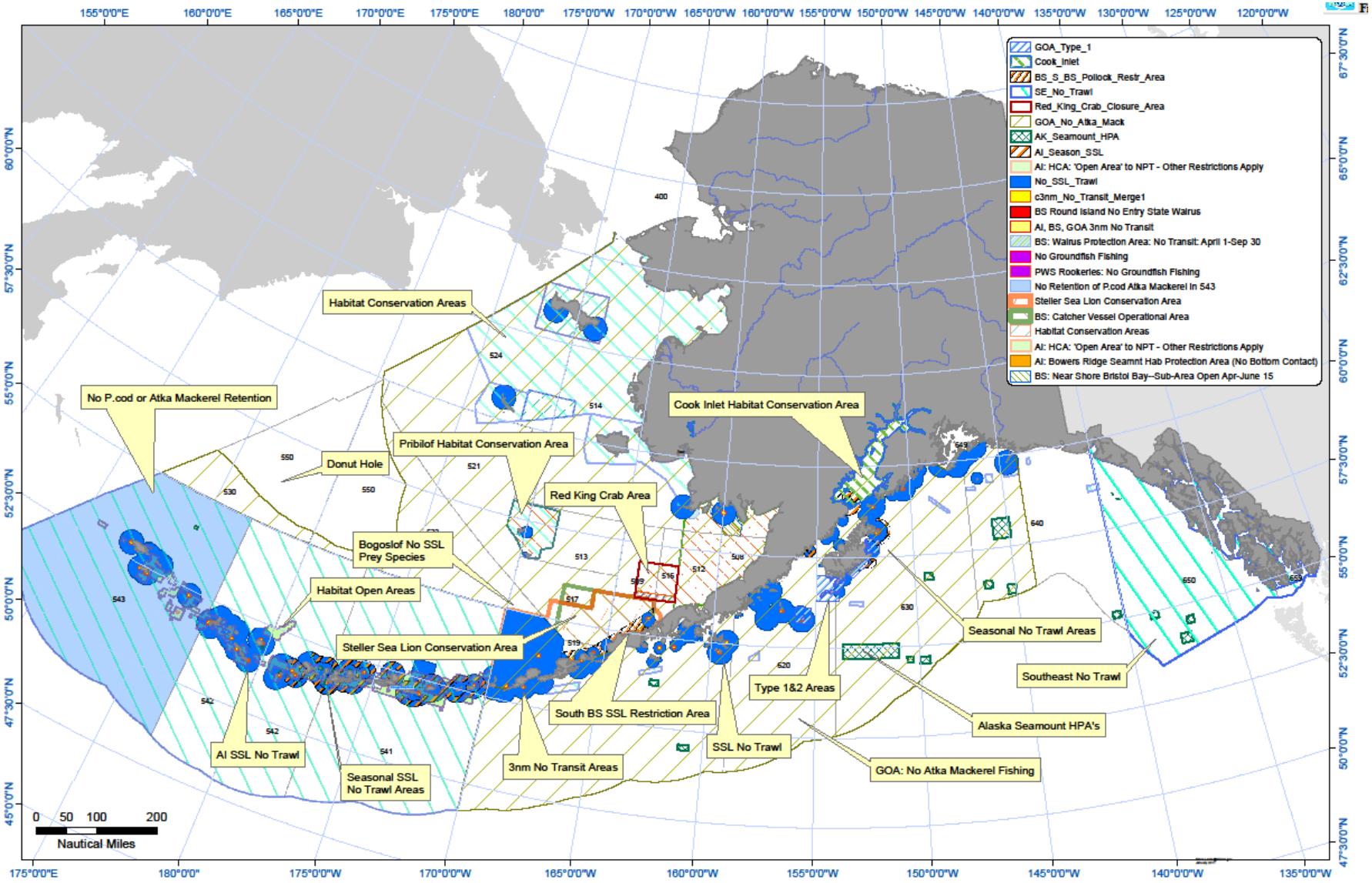




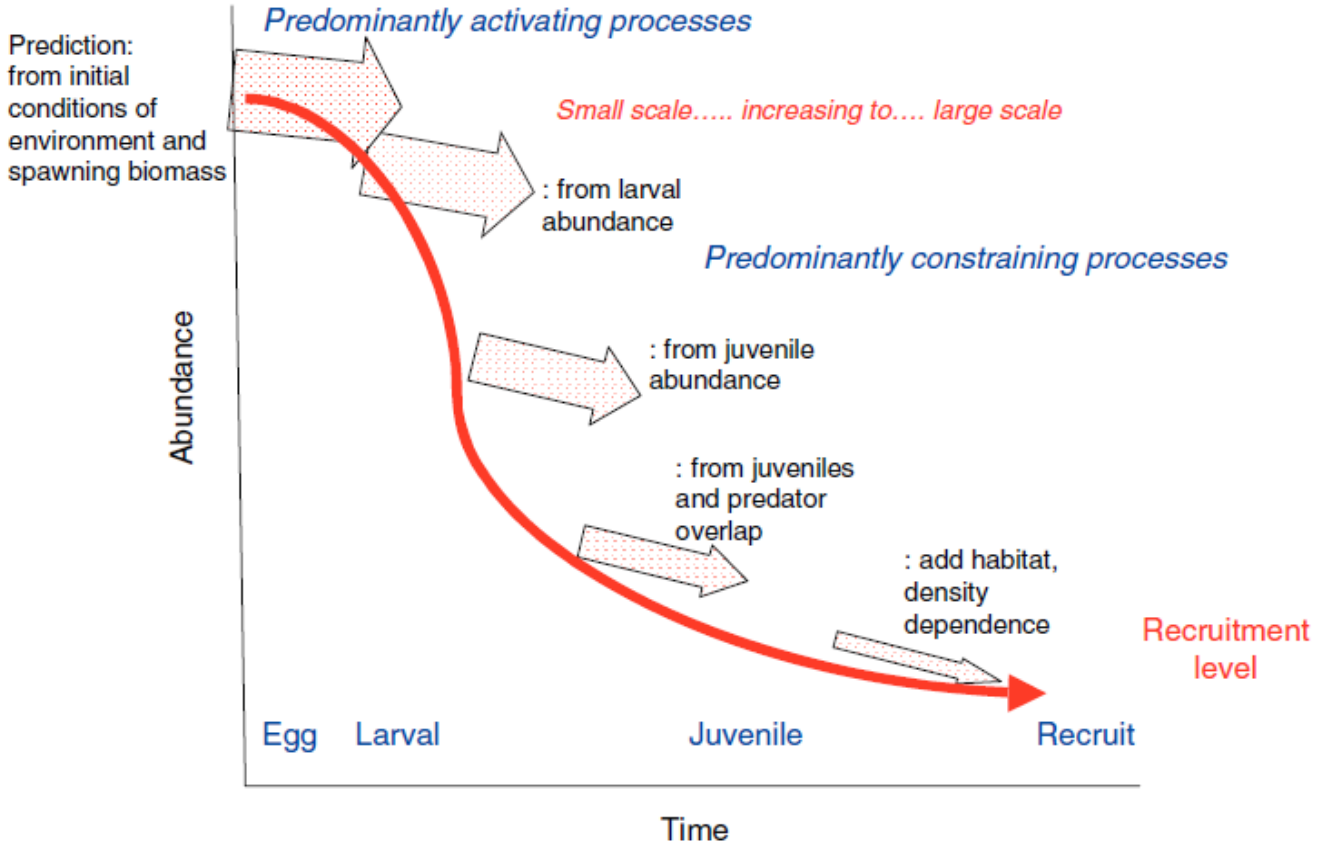


Wilderbuer et al. 2002

Current NOAA Spatial Management



Include Life Stages in Recruitment Indices



- adjust index at each life stage

Hollowed & Bailey 2009

Management Adaptations

- Commitment to monitoring will allow ACLs to adjust for climate impacts on growth, catchability and selectivity
- Commitment to in-season catch accounting will allow tracking of shifts in spatial overlap of species (incidental catch rates)
- Risk adverse harvest guidelines account for declining stock size
- Defining biological reference points may be challenging.

ACL= Annual Catch Limits

courtesy Anne Hollowed

Perceived Challenges

- Catch shares limit flexibility in re-tooling vessels to adapt to shifting species composition and abundance.

  (e.g. halibut Prohibited Species Catch cap may limit expansion of flatfish fisheries)
- Fixed closed areas limit flexibility to adapt to shifting fish distributions.
- Adjustments to fishing seasons may be required to adjust for shifts in peak spawning.

My interpretation: limited flexibility to respond to change

courtesy Anne Hollowed