Applying CEATTLE to GOA groundfish

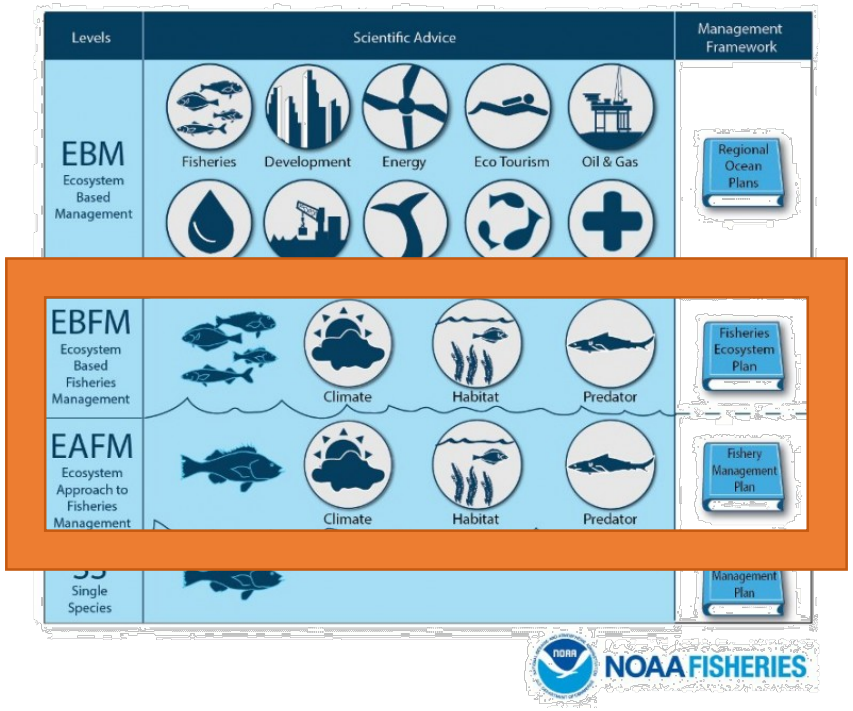
Grant Adams

NPFMC Groundfish Plan Team Meeting

September 2018

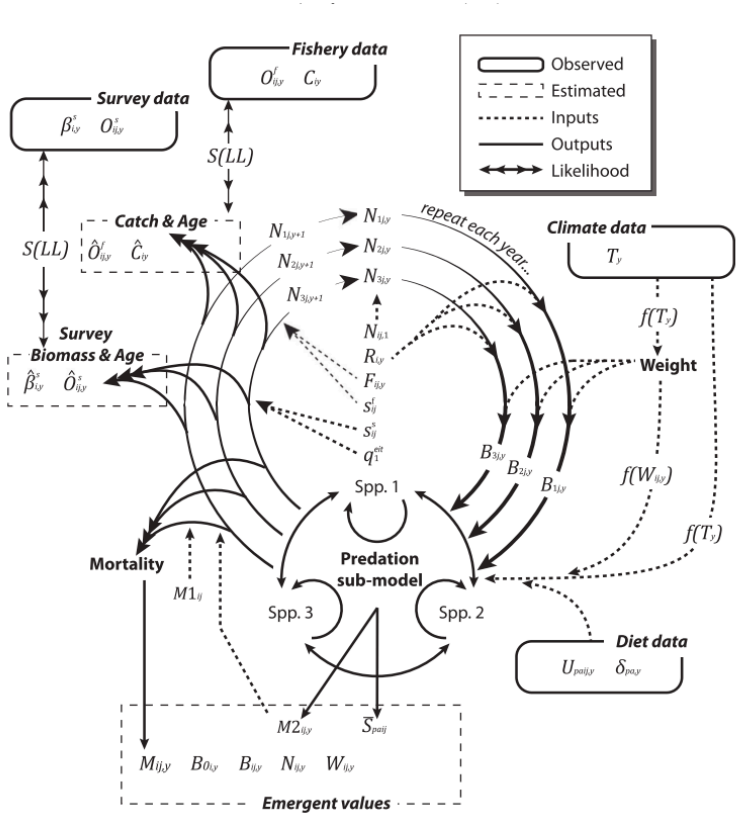
EBFM

- Incorporate physical, biological, and fishery interactions into resource management
- Rarely used in tactical management
- Multispecies statistical catch-at-age (MSCAA) models are one tool that can provide both tactical and strategic advice
- Development of MICE models is needed for EBFM implementation



CEATTLE Pt. 1

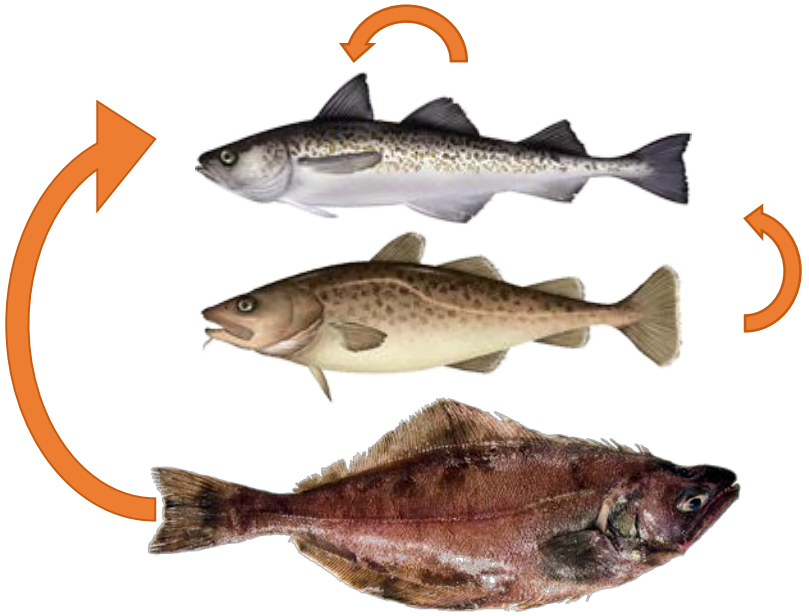
- MSCAA model developed for groundfish in the Bering
- Age-structured models linked by bioenergetics based predation mortality
  - Holling type II
- Parameterized to incorporate temperature forcing
- Supplement to current SAFE



Holsman et al. (2015)

CEATTLE Pt. 2

- ADMB based
- Survey inputs:
  - biomass
  - catch-at-age
  - diet proportion
- Fishery inputs
  - Total catch
  - Catch-at-age
- Model outputs:
  - Predation and fishing mortality
  - Biomass
  - Multispecies reference points



Holsman et al. (2015)

Management role of CEATTLE in the BSAI

- Estimate time varying M
  - Estimates of M from Van Kirk et al. 2010 used in previous Dorn assessments
- Explain underlying mechanisms related to population fluctuations
  - Predation mortality
  - Climate impacts
- Inform more strategic management decisions
  - Trade-offs, future climate impacts, etc
- Operating model for MSE

Research needs to advance CEATTLE

- Estimating the variance of recruitment and fishing mortality variation
- Evaluate alternative hypothesis regarding the form of predation
- “Bottom-up” predation
  - i.e. impacts of prey on predators (growth, recruitment, condition)
- Including uncertainty in diet proportion
  - Predator suitability is currently assumed known
- Spatial considerations (movement and overlap) as climate changes distribution of favorable habitat
- Likelihood weighting (sample size for age-comps)
- Move to GOA - add in additional species

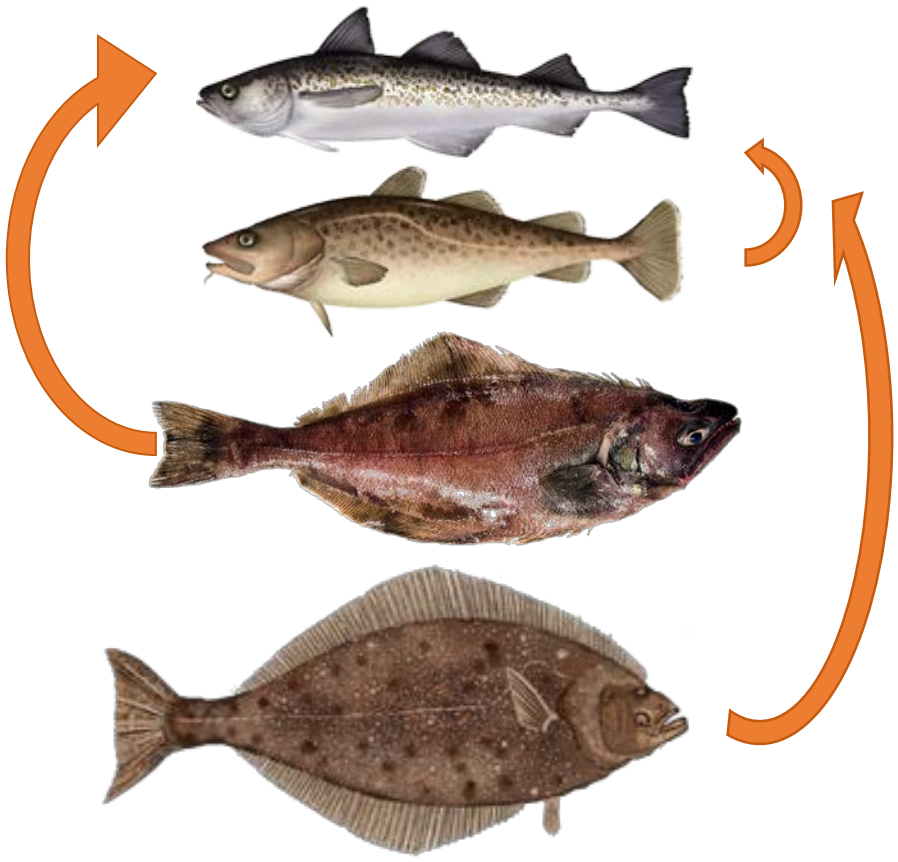
Dissertation objectives

1. Build CEATTLE in Template Model Builder (TMB)
   - Apply CEATTLE to GOA
     - Pacific cod, pollock, arrowtooth flounder, and halibut
- Develop/ Incorporate:
   2. Diet uncertainty and alternative functional forms
   3. Random effects (recruitment and fishing mortality)
   4. Spatial structure
   5. Incorporate IPCC climate projections with bottom-up prey effects



Objective 1

- Build CEATTLE in TMB
  - Currently single species version implemented in TMB
  - Modularize and make flexible
  - Benefits:
    - Random effects, faster estimation, flexible, relative ease
- Apply CEATTLE to GOA groundfish
- Synthesize and incorporate GOA data
  - Estimate parameters for pacific halibut



Objective 2

- Incorporate diet uncertainty and evaluate sensitivity to functional form into CEATTLE
- Current assumptions:
  - Proportion of prey in predator stomach is fixed
  - Predation follows a Type II (asymptotic) functional form
- Evaluate fits when including likelihoods for diet proportion
  - Potential inclusion of likelihood for predator size-selectivity
- Evaluate fits when using alternative functional forms (Kinzey and Punt, 2009)

Objective 3

- Evaluate random effects vs penalized likelihood

- CEATTLE currently specifies recruitment, fishing mortality, and selectivity via penalized likelihood
- *a priori* specifies level of process error
- Compare sensitivity of model outputs using random effects
- Effective sample size of age composition data

Objective 4

- Integrate spatial structure into CEATTLE
- Considering:
  - 1. species overlap into predation mortality via suitability multiplier (*sensu* Kempf et al. 2010)
  - 2. spatial multispecies assessment model (pending data availability)
  - 3. spatial multispecies operating model for MSE

Objective 5

- Integrate CEATTLE with short and long-term climate forecasts

- Incorporate down-scaled IPCC climate projections into CEATTLE
- Evaluate short- and long-term trade-offs of different harvest scenarios under climate change
- Develop performance metrics based on NPFMC and stakeholder input
- Improve biological realism of forecasts by including bottom-up interactions
  - Prey abundance on condition, growth, recruitment

Management use of GOA CEATTLE

- Provide strategic management advice
  - Trade-offs between alternative harvest scenarios
  - Multispecies reference points
  - Project groundfish under future climate scenarios
- Tactical management advice
  - Provide vectors of M to be used in single species assessments
- Research value
  - Uncertainty of MSCAA to diet likelihood, predation form, bottom-up impacts
  - Understand historic fluctuations in population dynamics
    - Impacts of the “blob”

Thanks

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