Evaluation of harvest control rules for joint management of Atlantic menhaden and striped bass

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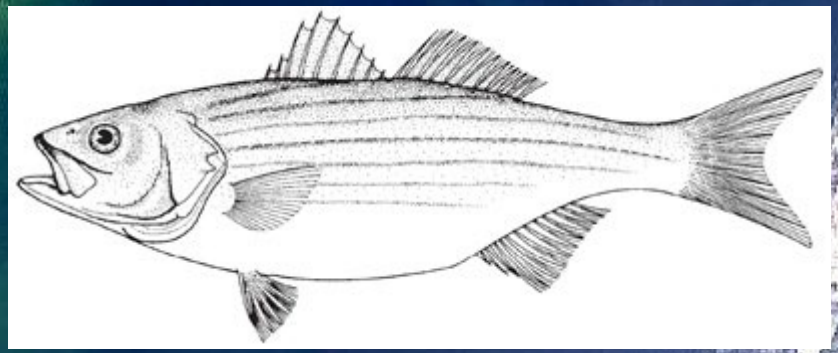
Striped bass and Atl. Menhaden

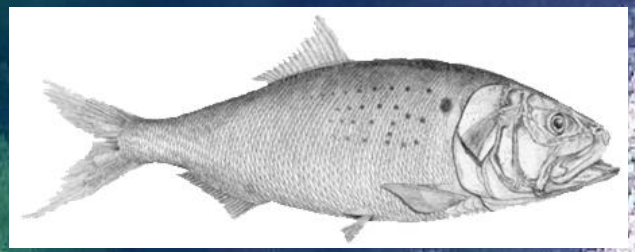
Atlantic Striped Bass

- Supports one of the largest recreational fisheries in the U.S.
- Flagship species for fisheries management on the East Coast

Atlantic Menhaden

- Largest commercial fishery by volume on the U.S. East Coast
  - Primarily used as fish oil/meal and bait





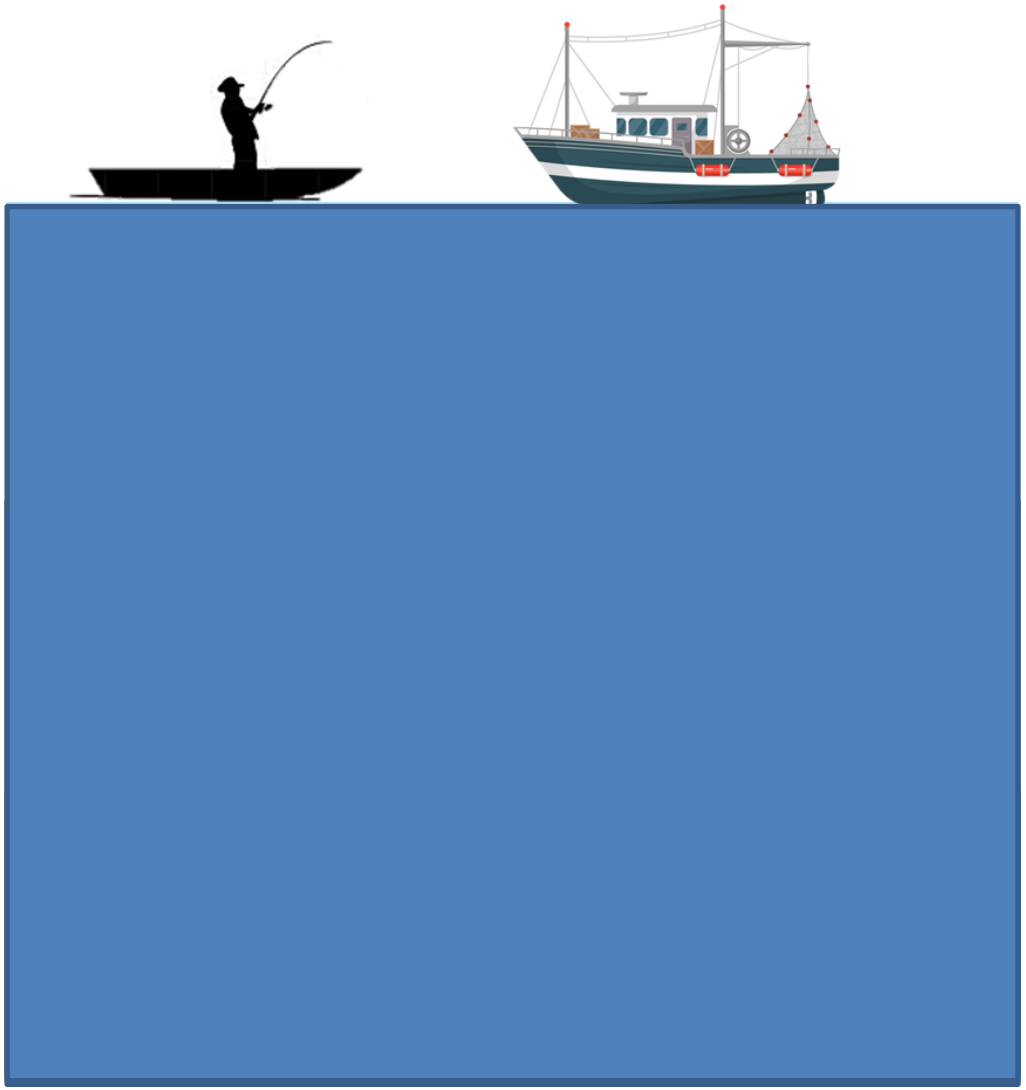
- Both species are managed by the Atlantic States Marine Fisheries Commission

Current Management Challenges

- Striped bass are overfished and experiencing overfishing
- Striped bass health is thought to be declining from disease
- Growing concern among stakeholders that there may not be enough menhaden for predators
- ASMFC uses an ecosystem approach to fisheries management
  - Striped bass are managed on a single species basis
  - Menhaden management considers predatory needs
- Impacts of predator harvest control rules on prey have not yet been used for management

Model description

- Age-structured predator prey model
  - One primary predator (striped bass)
  - One primary prey (menhaden)
  - Eight “other” forage categories based on size
  - Seasonal time step
- Menhaden ages 0-6+
- Striped bass ages 1-20+



Model Schematic

Mortality

- Continuous mortality within a season
- Menhaden
  - Z=M1+M2+F
  - M1 age-specific (constant over time)
  - M2 based on consumption by predators
  - F age-specific selectivity
- Striped bass
  - Z=M+Mc+F
  - Mc low-condition-related additional mortality
  - F age-specific selectivity

Consumption

- Type II functional response for multiple prey
- Attack rate is a symmetrical function of the ratio of prey to predator size
  - Optimal ratio 0.24 (Ruderhausen et al. 2005)
  - Tuned so that predators consume 90% of C_{max} in the first season of the first year (2017)
- Parameters of the functional response and "other" prey abundance were specified to achieve ~30% and ~70% menhaden in the striped bass diet

Size and growth

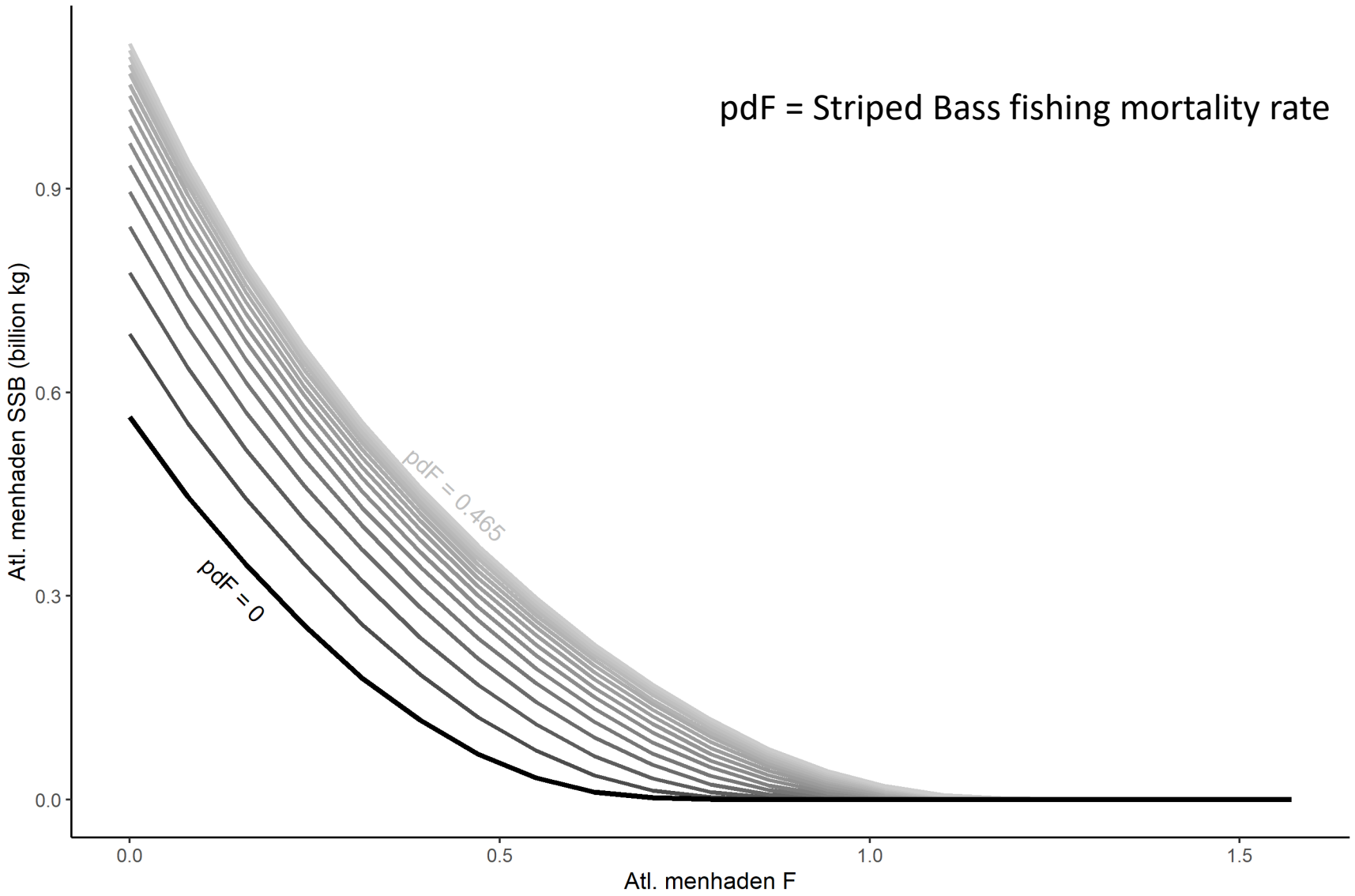
- Menhaden have constant seasonal length at age and weight at age
- Striped bass have constant length at age
- Weight at age is a function of consumption

$$W_t = W_{t-1} + G_{max}(C_t/C_{max})$$

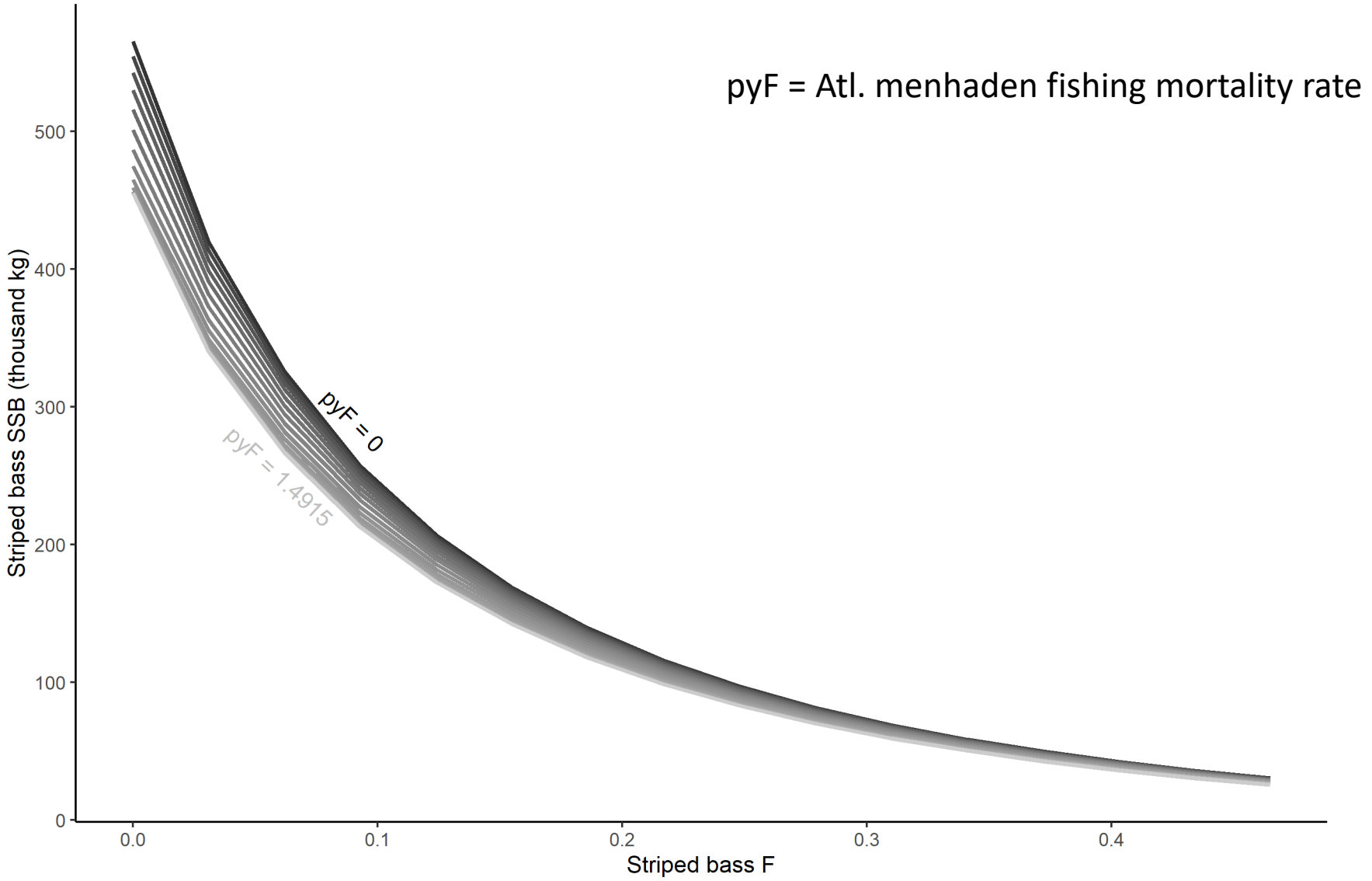
Simulation

- 3 operating models (only showing the first one in this presentation)
- 176 Harvest control rules
  - 11 menhaden fishing mortality rates (F) (0-1.49 yr^{-1})
  - 16 striped bass Fs (0-0.47 yr^{-1})
- 100 100-year simulations for each scenario
- Summarized median spawning stock biomass (SSB) and catch for last 10 years of each simulation

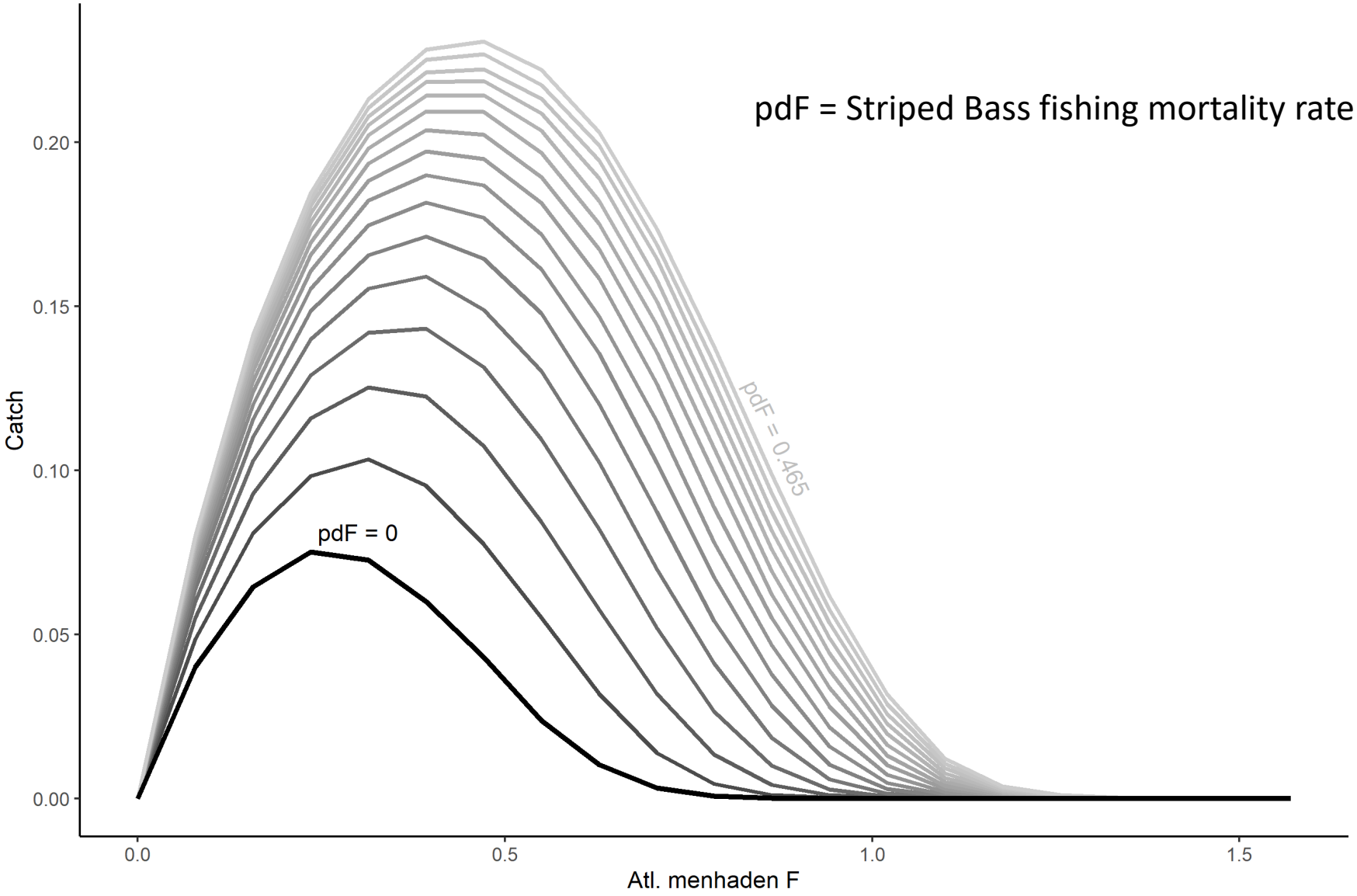
Atl. Menhaden SSB



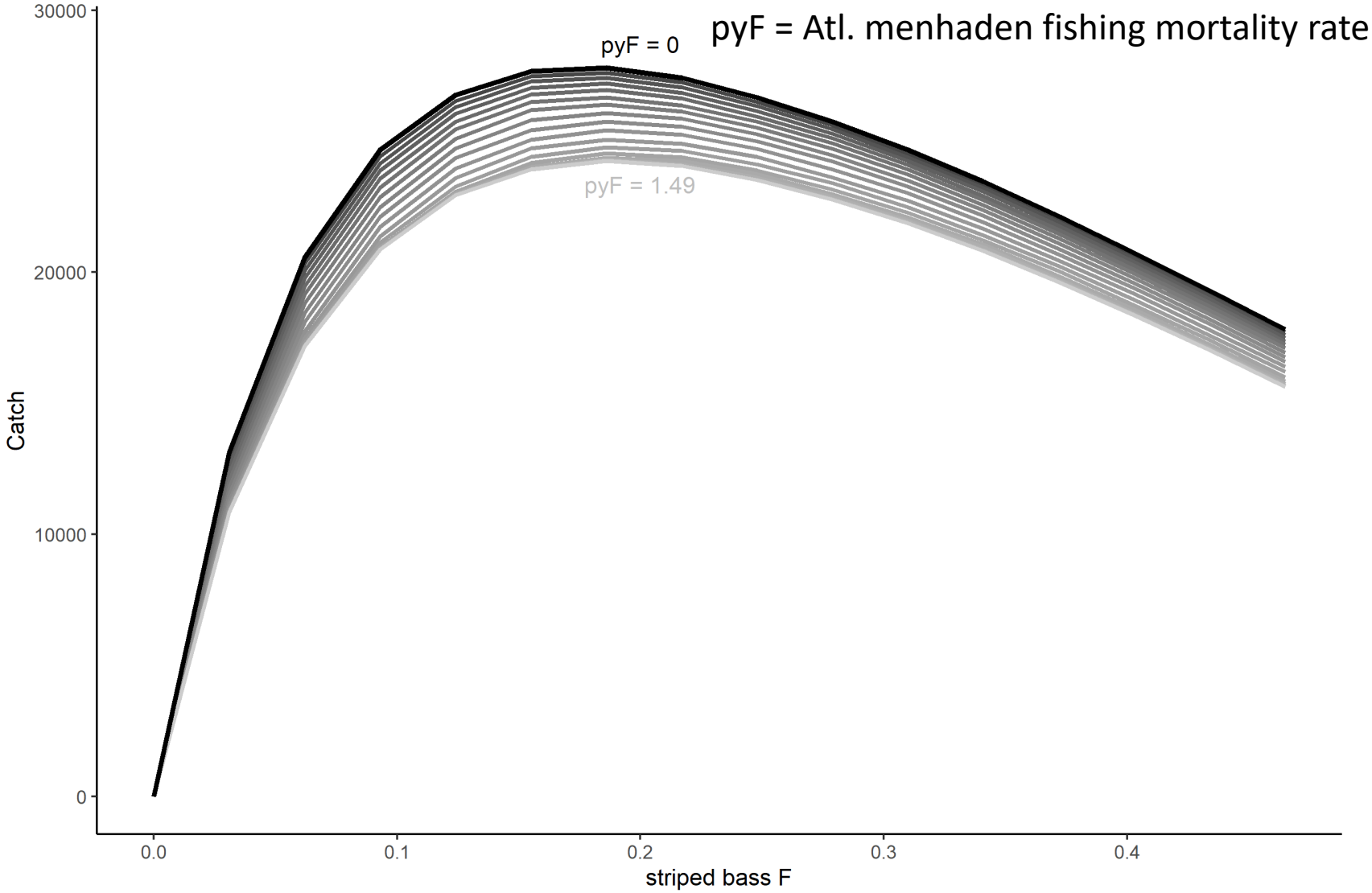
Striped Bass SSB



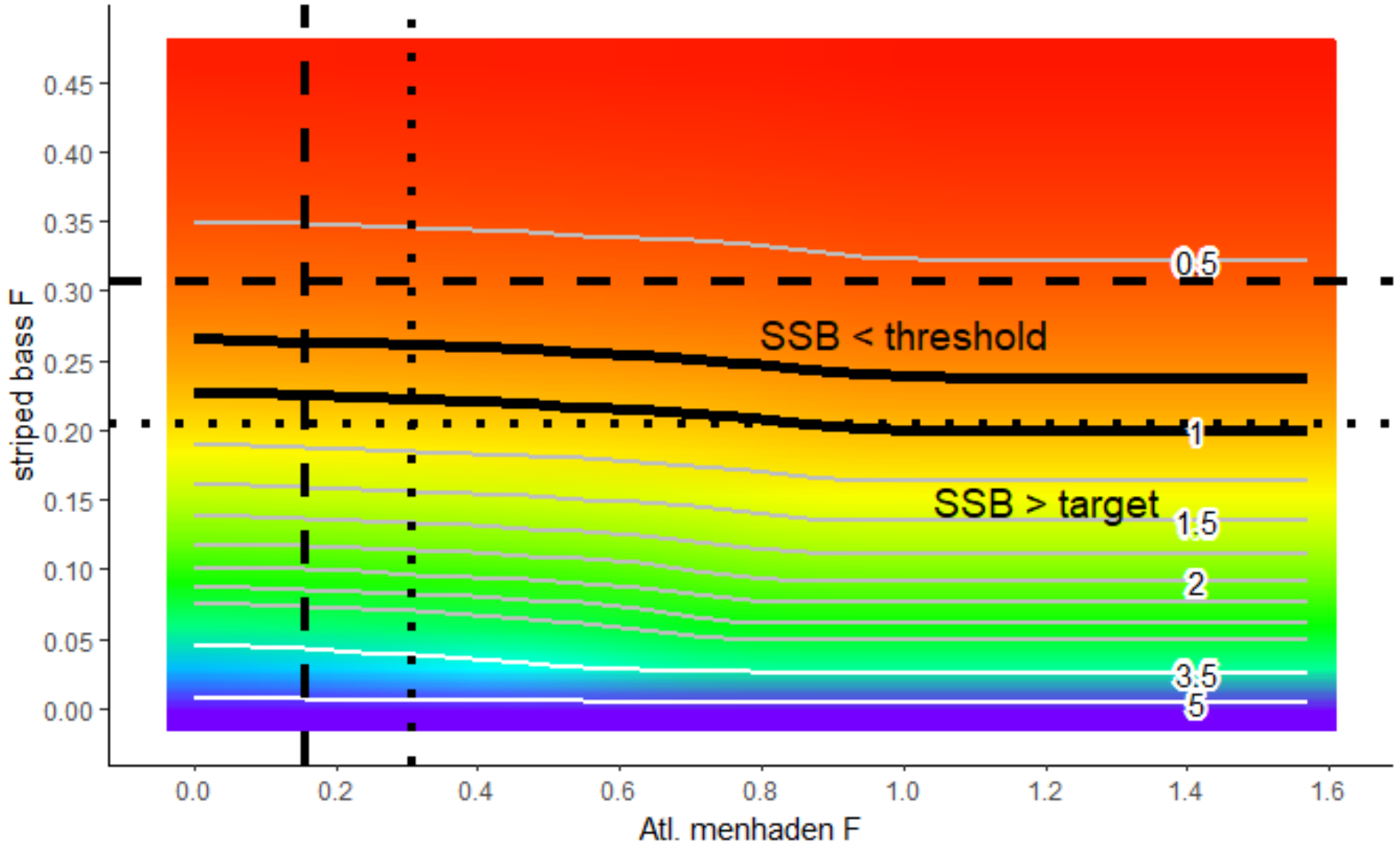
Atl. Menhaden catch



Striped Bass catch



Striped bass SSB as a function of menhaden and striped bass Fs



Conclusions

- Atlantic menhaden SSB and catch were highly influenced by striped bass abundance
- Striped bass abundance was influenced more by fishing mortality than by menhaden abundance
- SSB and F reference points for both species should be revisited

Acknowledgments

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