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# Management Strategy Evaluation Made Operational with Stock Synthesis

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## Coauthors -

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Thanks also to Matthew Damiano, Allan Hicks, Huihua Lee, Desiree Tommasi, Corrine Bassin, Christine Stawitz

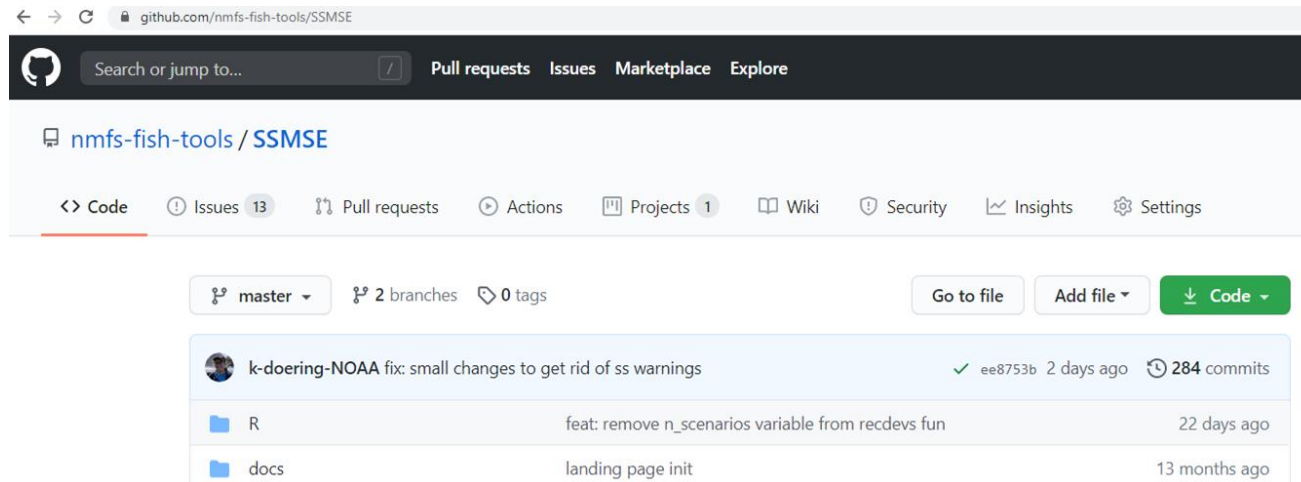
R packages used directly by SSMSE and in this presentation: assertive, dplyr, ggplot2, r4ss, ss3sim, scales, stats, tidyr, lubridate, utils, furrr

# What is management strategy evaluation (MSE)?

- Examples:
  - How often should **sampling** occur to adequately inform a stock assessment?
  - Which **harvest control rule(s)** provide the least catch variability and the most catch?
  - Could a simple **stock assessment model or method** perform as well as a more complex one?
- MSE uses simulation to test the performance of alternative management procedures against pre-specified objectives over a range of uncertainties
- In this case, I will be talking about the **MSE modeling process** from a **single-species** (not ecosystem) **perspective**

# What is the SSMSE project?

- Our goal is to create a generalized, standardized tool that enables MSE to be performed more directly using SS Operating Models (OMs) and (if desired) SS as the Estimation Method (EM)
- Developing as an R package, available at <https://github.com/nmfs-fish-tools/SSMSE>



# Why use Stock Synthesis models as OMs?

- Many SS assessment models already exist due to widespread use (e.g., >220 U.S. federal stock assessments used SS since 2010)
- SS models are often complex, so can be nuanced operating models

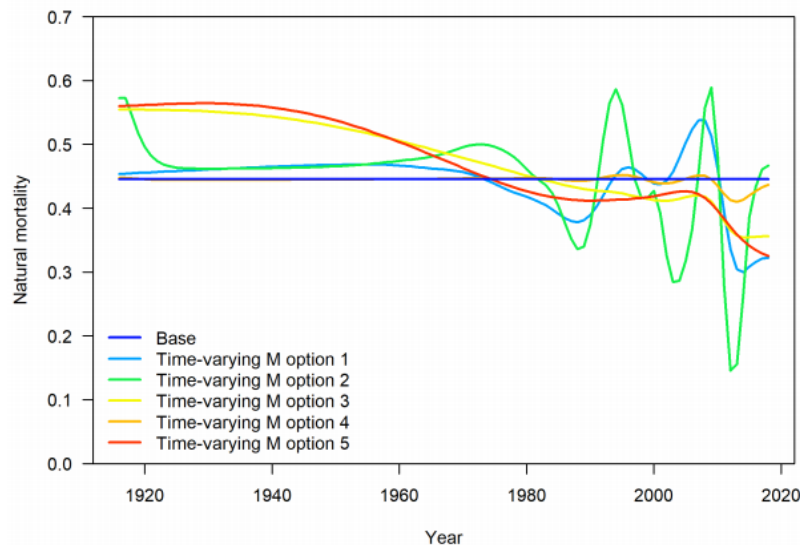
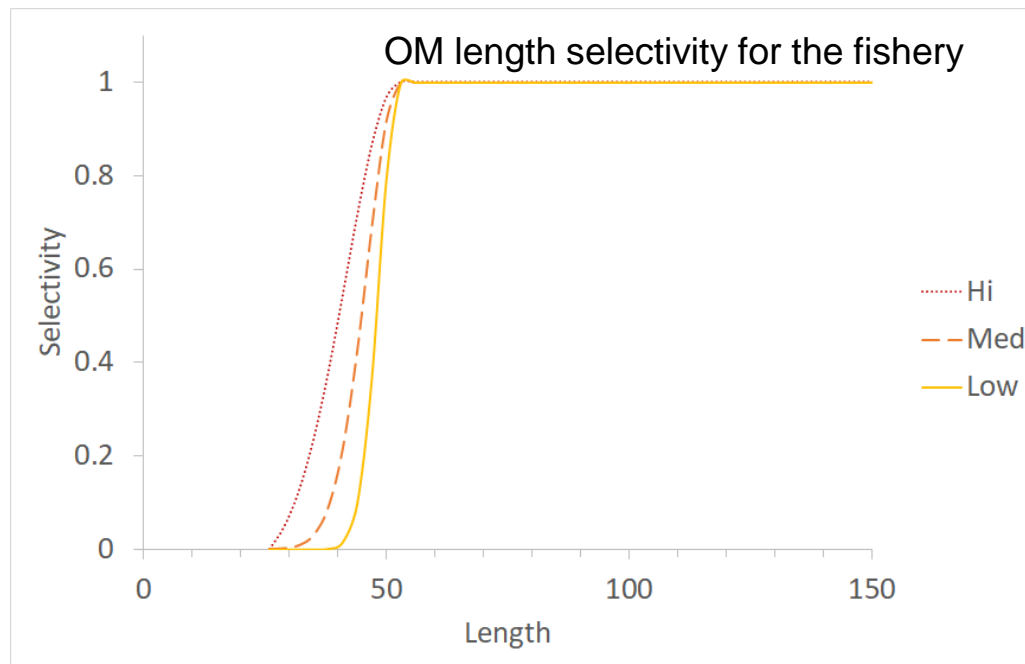


Figure from [Taylor et al. \(2019\) - Status of Big Skate \(\*Beringraja binoculata\*\) Off the U.S. Pacific Coast in 2019.](#)

# An example of SSMSE: How do 2 different management procedures perform across different selectivities?

Manage to relative Spawning Stock Biomass (SSB) of 0.4 or 0.6

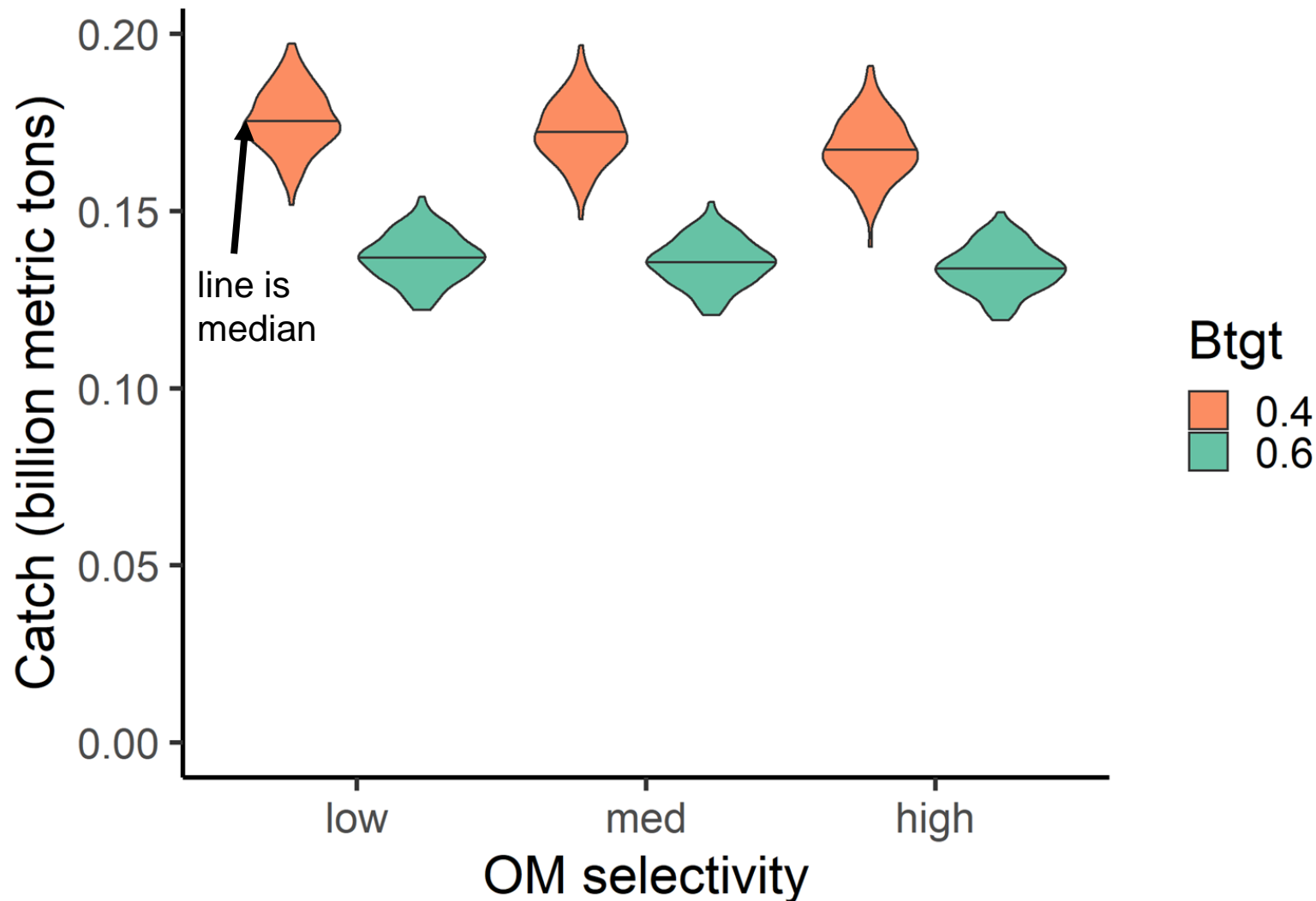


Scenario	OM fishery selectivity	EM fishery selectivity	Relative (to unfished) biomass forecasting target in EM
1	low	estimated	0.4
2	med	estimated	0.4
3	hi	estimated	0.4
4	low	estimated	0.6
5	med	estimated	0.6
6	hi	estimated	0.6

- Used a simple cod-like model with 1 fishery and 1 survey.
- Process error included through recruitment deviations, which are the same across scenarios. Observation error included. Used 100 iterations/scenario
- Use historical values for years 1 to 100, then run MSE for 50 years with a stock assessment and management procedure implemented every 10 years.
- **Performance metrics (over yrs 126 to 150):**
  - long term average catch
  - long term catch variability (CV)
  - long term average achieved relative SSB
- Code available at <https://github.com/k-doering-NOAA/ssmse-afs>



# Long-term average catch (years 126-150)

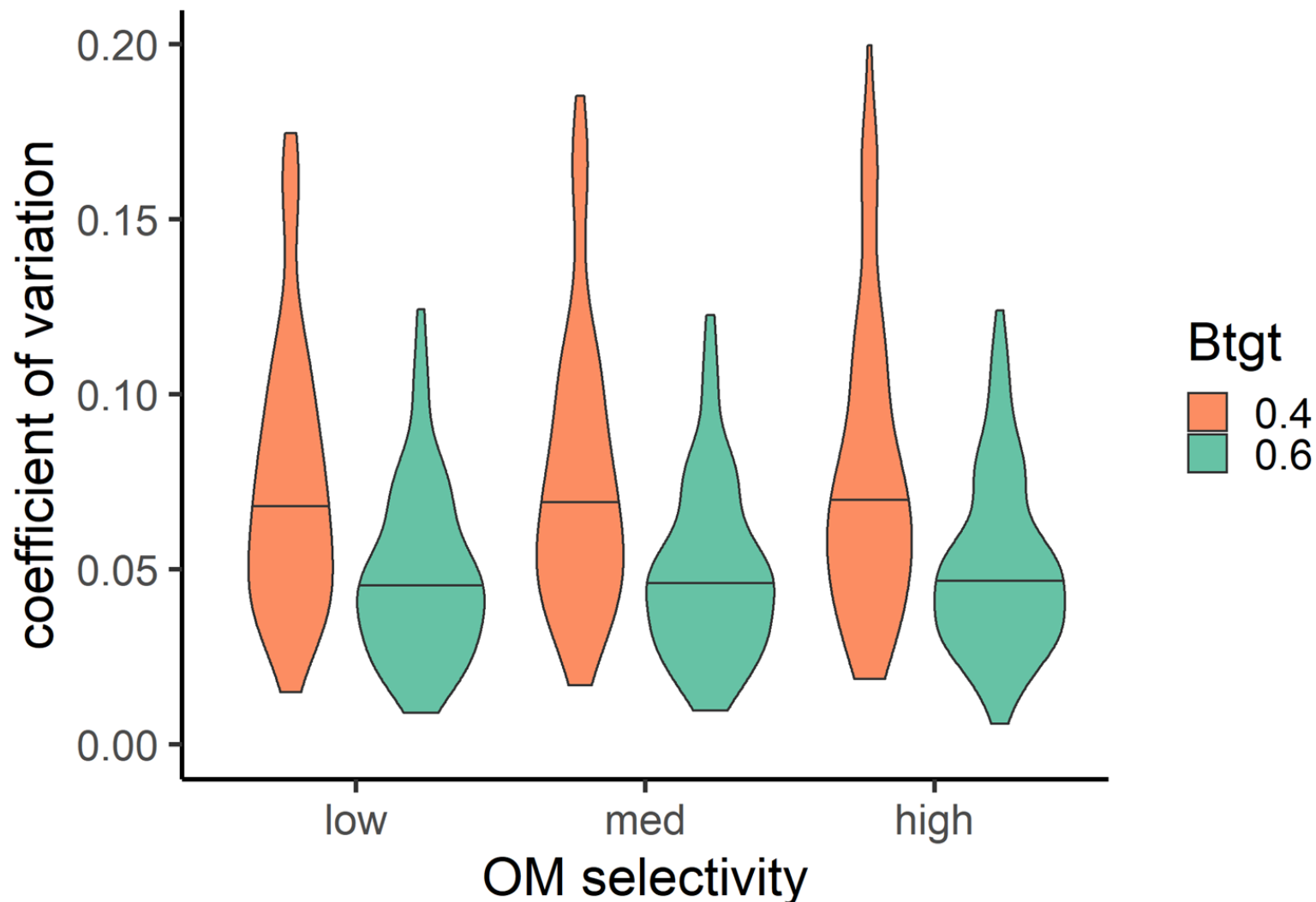


**Higher catch (across selectivities) for lower relative biomass target**



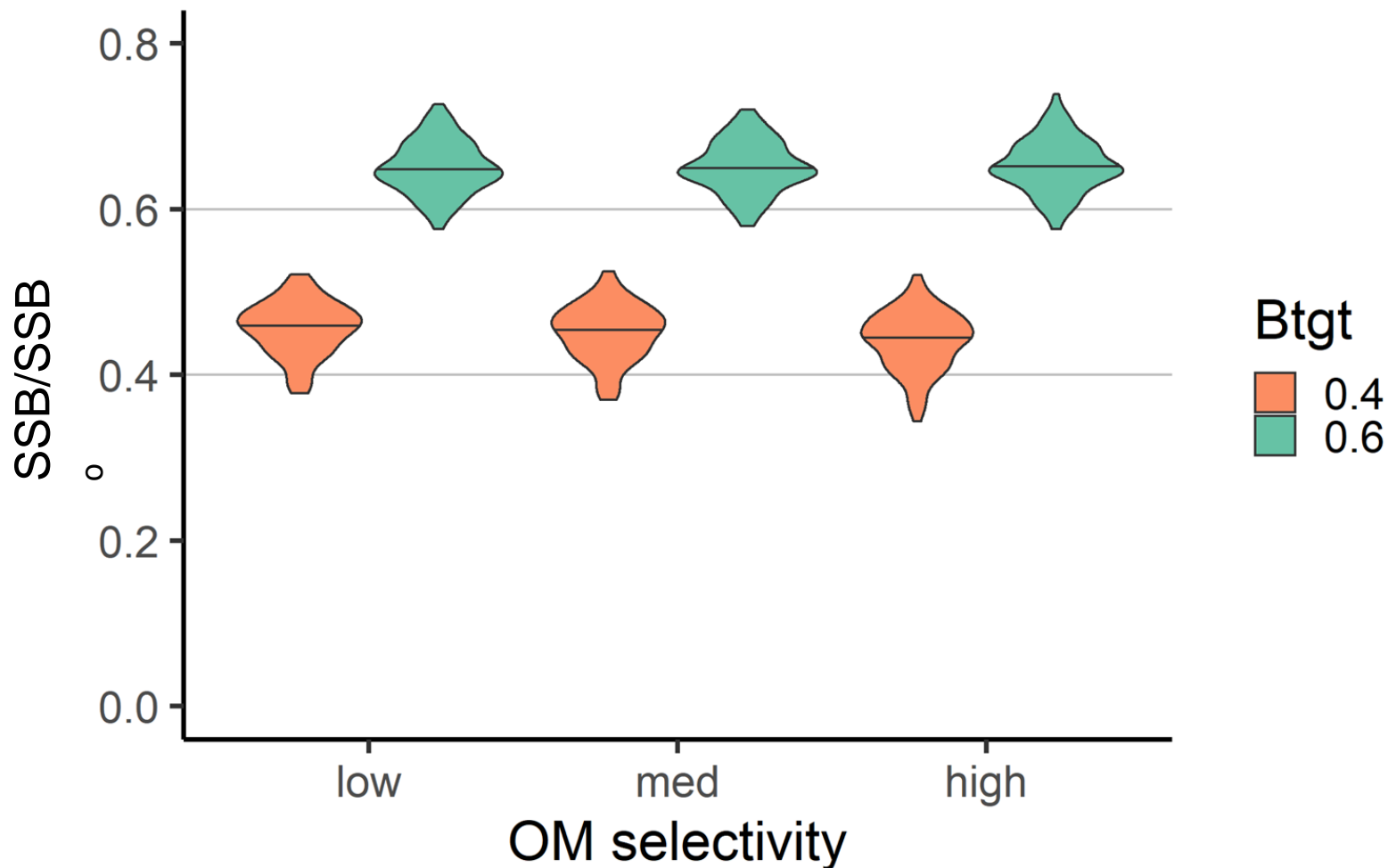
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# Long-term catch variability (years 126-150)



**Slightly higher variation (across selectivities)  
for lower relative biomass target**

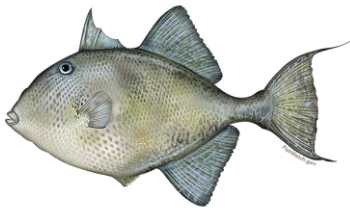
# Long-term average relative SSB (years 126-150)



**Higher** achieved relative biomass than the relative biomass target

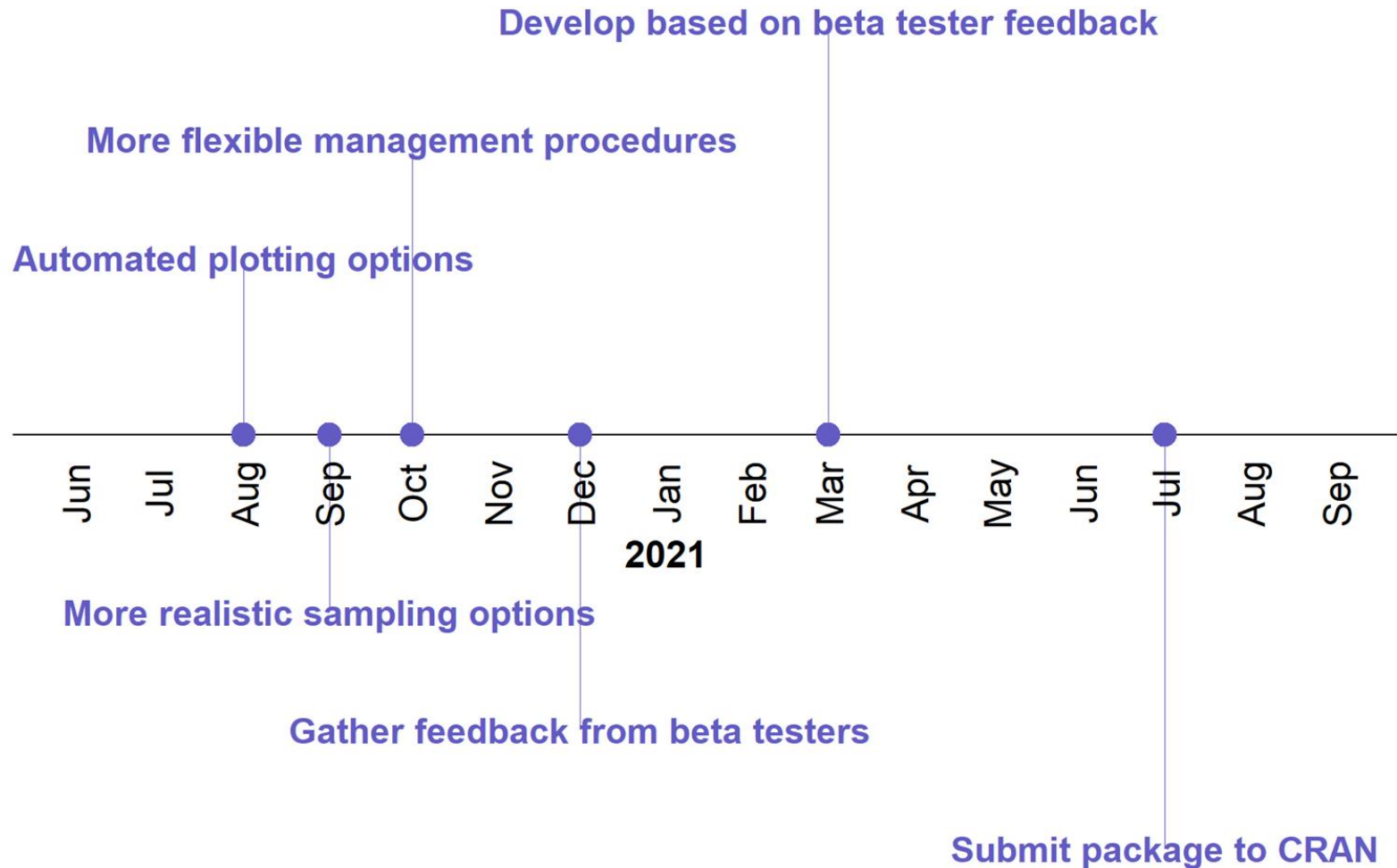
# How does SSMSE relate to stock assessment?

- Performance of the stock assessment model can be tested (by including uncertainty and mismatch between OM and EM)
- MSE analyses are becoming routine and complementary to stock assessments, so hopefully these can be made **simpler to conduct** and **more reproducible**



Example: Used SSMSE to examine approaches to adjust total allowable catch between assessments for Gulf of Mexico grey triggerfish

# SSMSE next steps



# Interested in learning more, contributing to, or using SSMSE? Contact us!

- Via our github repository: [github.com/nmfs-fish-tools/SSMSE](https://github.com/nmfs-fish-tools/SSMSE)
- The Stock Synthesis email: [nmfs.stock.synthesis@noaa.gov](mailto:nmfs.stock.synthesis@noaa.gov)
- My email: [kathryn.doering@noaa.gov](mailto:kathryn.doering@noaa.gov)



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