**Test 1:** Single-species OM (fixed age-variant M); Single-species fixed M Tier 3 HCR:

**Test 2:** Single-species OM (fixed age-variant M); Single-species estimate M Tier 3 HCR:

**Test 3:** Single-species OM (estimated age-invariant M); Single-species fixed M Tier 3 HCR:

**Test 4:** Single-species OM (estimated age-invariant M); Single-species estimate M Tier 3 HCR:

**Test 5:** Multi-species OM; Single-species fixed M Tier 3 HCR:

**Test 6:** Multi-species OM; Single-species estimate M Tier 3 HCR:

**Test 7:** Single-species OM (fixed age-invariant M); Single-species age-invariant M Tier 3 HCR:

**Test 8:** Single-species OM (fixed age-invariant M); Single-species estimate M Tier 3 HCR:

**Test 9:** Multi-species OM; Single-species fixed age-invariant M Tier 3 HCR:

For tests 7-9 pollock mortality is set to 0.3 for all ages, when fixed in single-species models.

**Regen** indicates that the OM was fit to the conditioning data (1979-2017), while the EM was fit to the data generated from the OM for the conditioning period as well as the projection period.

**Plots**: time serioes of**:** spawning stock biomass depletion, fishing mortality, catch, age-1 (if fixed) or age-invariant (if estimated) natural mortality, recruitment, spawning stock biomass, and survey index fit.

**Plot description:** The OM is in black, the EM estimated at each year projected forward until 2060 is in the color gradient. Limits = blue, targets = red.

**Brief methods:**

**OM:** To parameterize the OMs, we utilized three models in single-species and multi-species models. Two single-species models either used an estimated time- and age-invariant natural mortality or used a fixed time-invariant, but age-varying for some species, natural mortality. All OMs were conditioned by fitting to historical survey and fishery data. OMs were projected forward from 2017 until 2060 1 time, with future recruitment assuming mean recruitment from 1979 to 2060. Projected selectivity, catchability, relative number of foraging days, bottom temperature, maturity-at-age, length-at-age, ageing error, and weight-at-age are time-invariant and set to the last year in which the OM was conditioned.

**EM:** Each species was assessed using a single-species age-structured assessment fit to the historical and projected survey and fishery data (sampled with no observation error). The estimation models (EMs) were fit to the data annually. EMs were fit using penalized likelihood, with the variance in recruitment set to the value in the OM. EMs either estimated a time- and age-invariant natural mortality or used a fixed time-invariant, but age-varying for some species, natural mortality.

**HCR:** Catch was determined by the estimation model and a harvest control rule derived target fishing mortality rate ) applied to the population projected forward one year assuming mean annual recruitment and terminal selectivity, maturity, and weight-at-age. Harvest control rules were used to define limit reference points to determine if a stock is perceived to be undergoing overfishing ( or is perceived to be overfished () and followed the NPFMC Tier 3 HCR. SPR based reference points were estimated assuming mean annual recruitment and terminal selectivity, maturity, and weight-at-age. The OMs were updated by inputting the catch and estimating an additional fishing mortality deviate for each fishery and fixing all other parameters.