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NMFS/SEFSC
Sustainable
Fisheries Division

# Review of Population Projections from Stock Assessments

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# Steps in providing Population Projections

1. SEDAR Stock Assessment
   - Determines the methodology and set-up
   - Preliminary information (e.g. P*, management action, etc.)

2. SSC Review
   - Refine set-up
   - May set ABC or conditional ABC

3. Follow-up Projections to SSC
   - Final ABC determination

4. Follow-up Projections to SAFMC/SERO
   - Amendment alternatives, other considerations

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# Steps with Population Projections

**Step 1**: SEDAR Population Projections

- Prescribed by SEDAR TORs

- Simple, use constant fishing mortality (*F*) adjustment
  - Assumes ratio of *F* among fleets remains the same
  - Assumes no change in fleet selectivity and thus overall selectivity

- Assumption made about start year for management action
  - Various methods for dealing with interim years (after terminal year of assessment, but before management action)

- Potential constraints on projections
  - Overfished – rebuilding plan
  - Overfishing – reduce F<Fmsy

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# Steps with Population Projections

**Steps 2-4**: SSC Population Projections

- Prescribed by SSC, SERO, or SAFMC requests

- May modify the following:
  - Set P* and re-compute
  - Change interim years/starting year of management action
  - Modify rebuilding time frame

- Final ABC determination, made before management actions are determined

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# Population Projections Assumptions

**Major Assumptions:**

- Projections are highly uncertain, particularly in the long term (e.g., beyond 5 years).
- Projections do not include structural (model) uncertainty. Projection results are conditional on one set of functional forms used to describe population dynamics, selectivity, recruitment, etc.
- Fleets (e.g. landings and discards) are assumed to continue at their estimated current proportions of total fishing mortality rates.
- Projections assume no change in the selectivity.
- Projections use a one-year time step, assuming mortality occurs throughout the year. Seasonal closures may violate this assumption, introducing additional and unquantified uncertainty into the projection results.

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# Steps with Population Projections

**Decision Points**

- Interim years between terminal year of assessment and start of management action

- Recruitment ($R$)
  - May include need to fill in terminal years of assessment where $R$ cannot be estimated
  - Future recruitment values

**Depends on Management Action**

- Changes in total $F$ and ratios of fleet specific $F$'s

- Changes in selectivity

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# Review of Population Projections

Landings and Discards (***C***)
- Estimated Values
- Average Values
- Actual Values (rare)

Landings and Discards (***F***)
- Constant ***F***
- Estimated ***F***

Landings and Discards Selectivity (***s***)
- Fixed
- Modified
- Estimated (rare)

Recruitment (***R***)
- Recent Average
- Long-term Average
- S-R Relationship

$$C = (R+N) * F * s$$

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# Review of Population Projections

$\boldsymbol{Y}$ = last year in the assessment
$\boldsymbol{Y}_m$ = first year of management action implementation
$\boldsymbol{Y}_{end}$ = ending year of projections

($\boldsymbol{Y}$-$\boldsymbol{t}$)…$\boldsymbol{Y}$
- may need to re-draw $\boldsymbol{t}$ random $\boldsymbol{R}$ values, depending on assessment set-up

$\boldsymbol{Y}$…$\boldsymbol{Y}_m$ (interim years)
- Option1: apply recent average $\boldsymbol{F}$ to get interim landings and discards (constant $\boldsymbol{F}$ method)
- Option2: apply recent average $\boldsymbol{C}$ (constant $\boldsymbol{C}$ method)
- Option3: actual values of $\boldsymbol{C}$ (rarely available)

$\boldsymbol{Y}_m$…$\boldsymbol{Y}_{end}$ (management years)
- Option1: Constant $\boldsymbol{F}$ applied to landings and discards
- Option2: Constant $\boldsymbol{C}$ assumed for landings and discards

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# Review of Population Projections

Hypothetical N-at-age Matrix

| | | | Age | | | |
|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5+ | |
| 2018 | 863 | 424 | 288 | 235 | 30 | Assessment Years |
| 2019 | 561 | 468 | 224 | 145 | 119 | |
| 2020 | 1232 | 303 | 243 | 109 | 71 | |
| 2021 | 991 | 655 | 149 | 106 | 48 | Projection Years |
| 2022 | 2176 | 518 | 305 | 58 | 42 | |
| 2023 | 497 | 1153 | 253 | 131 | 25 | |
| 2024 | 258 | 257 | 515 | 90 | 47 | |
| 2025 | 296 | 117 | 74 | 73 | 13 | |
| 2026 | 542 | 150 | 50 | 23 | 24 | |
| 2027 | 368 | 275 | 63 | 16 | 7 | |

**Last year of assessment**

**Interim years of projection**

**Management years of projection**

**Recruitment Predictions**

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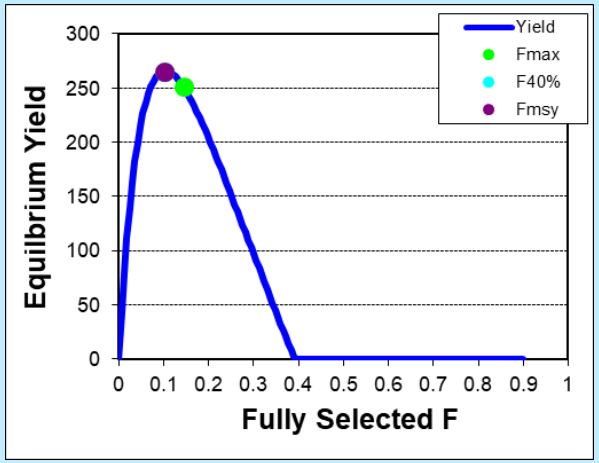
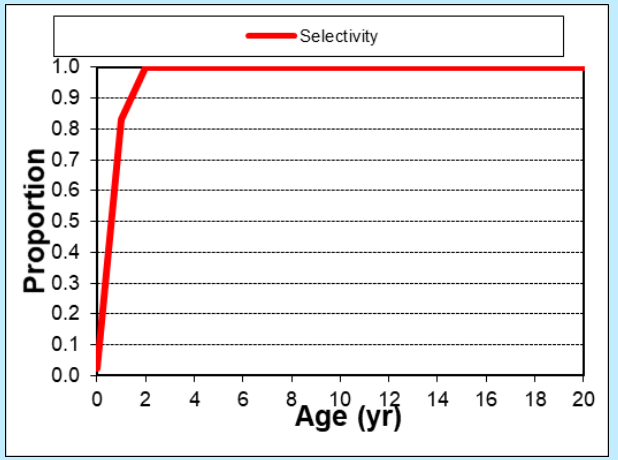
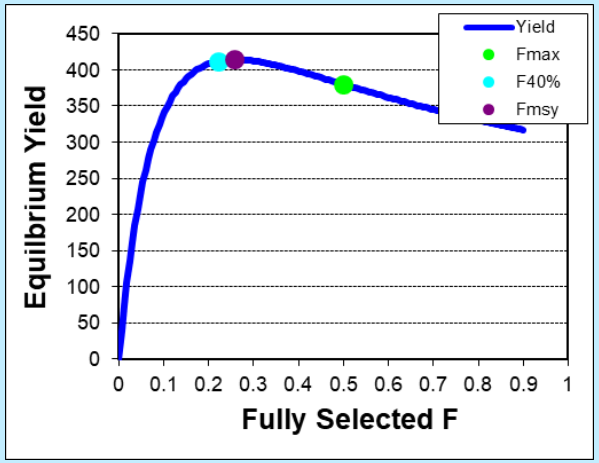
# Management effects on stock assessment benchmarks

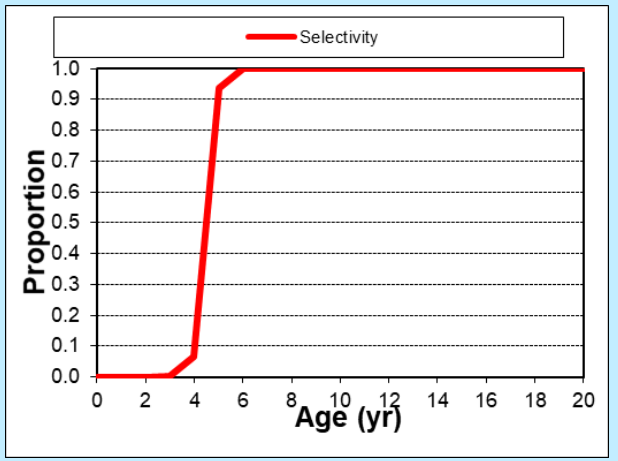
**Changes in selectivity = change in benchmarks**



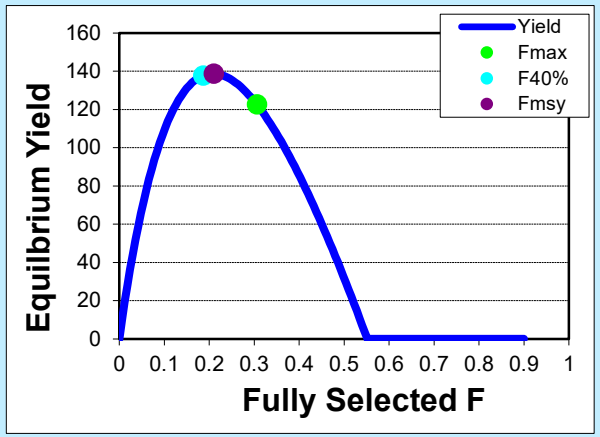



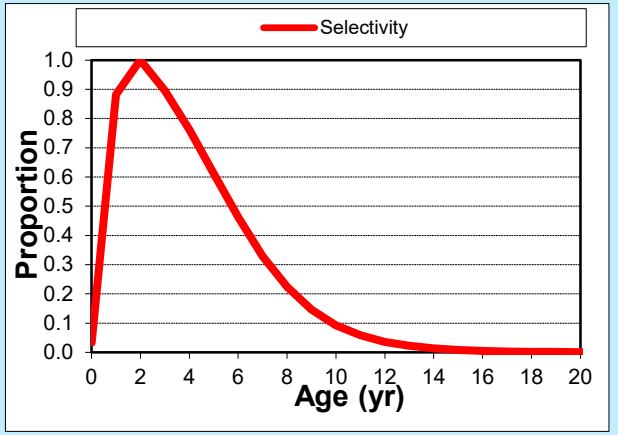

$F_{MSY} = 0.10$
$S_{MSY} = 1459$
$MSY = 265$




$F_{MSY} = 0.26$
$S_{MSY} = 1304$
$MSY = 414$




$F_{MSY} = 0.21$
$S_{MSY} = 1274$
$MSY = 139$

*Steepness = 0.75*
*Age at 50% maturity = 2*

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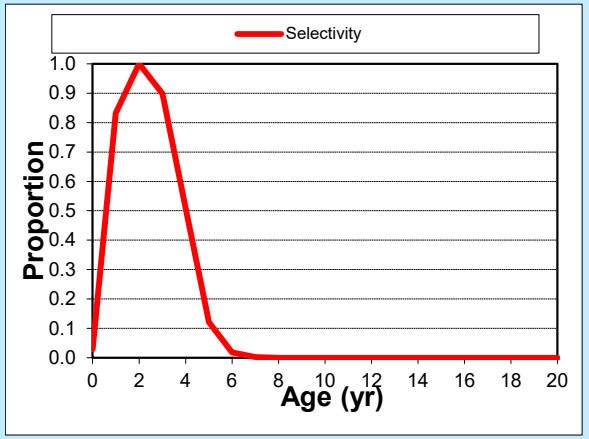
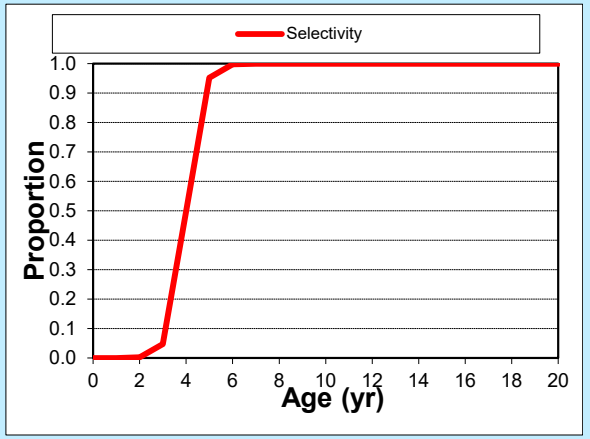
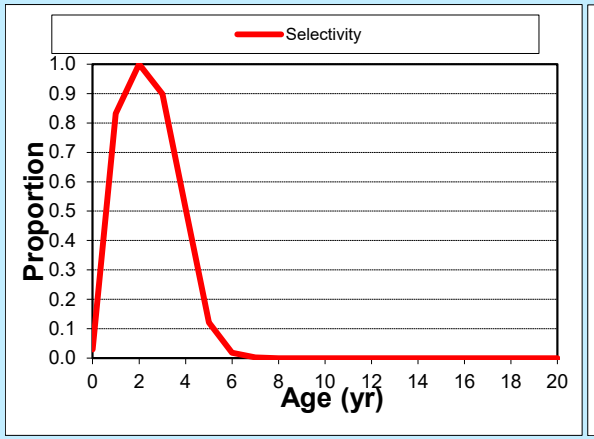
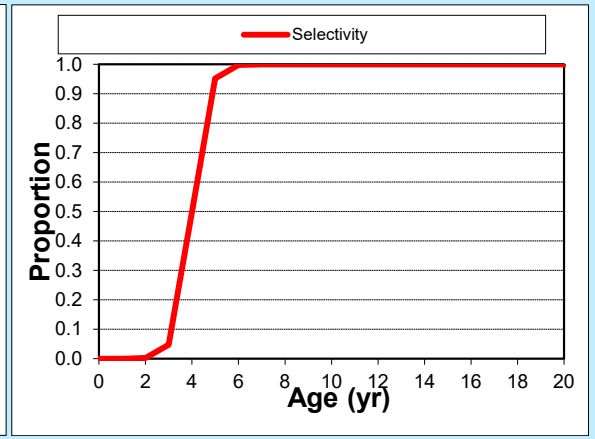
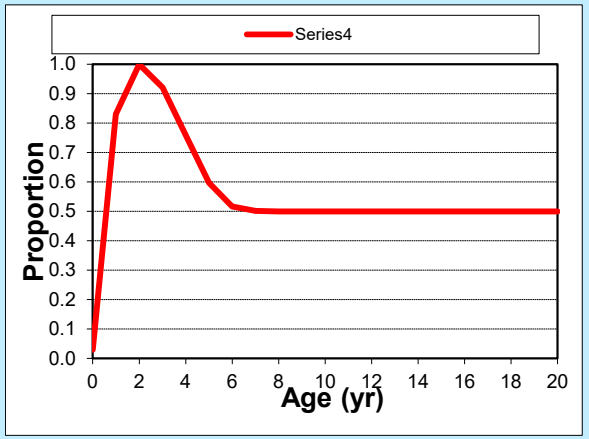
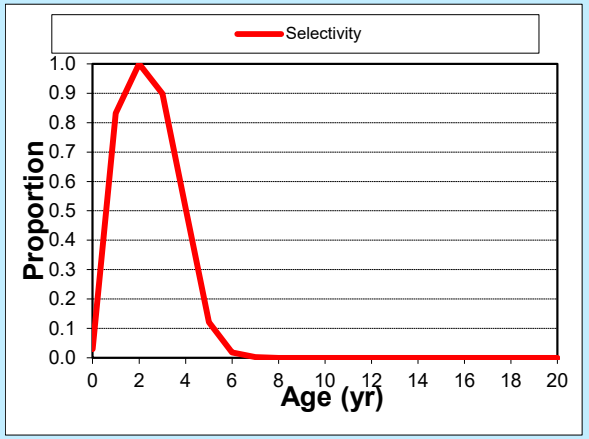
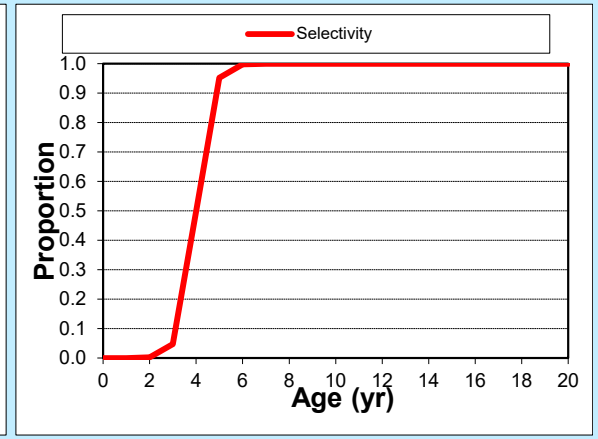
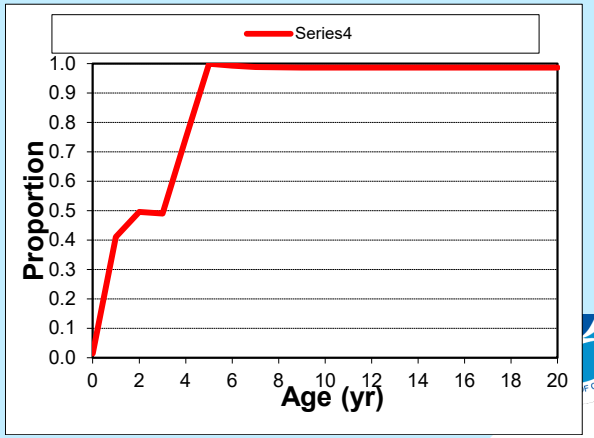
# Management effects on stock assessment benchmarks

**Changes in F ratios = change in selectivity**

*Steepness = 0.75*
*Age at 50% maturity = 2*

| Fleet1 | Fleet2 | F wgtd selectivity | |
|---|---|---|---|
|  |  |  | F1 = F2<br>$F_{MSY}$ = 0.11<br>$S_{MSY}$ = 1472<br>MSY = 266 |
|  |  |  | F1 > F2 (2x)<br>$F_{MSY}$ = 0.14<br>$S_{MSY}$ = 1458<br>MSY = 217 |
|  |  |  | F1 < F2 (2x)<br>$F_{MSY}$ = 0.14<br>$S_{MSY}$ = 1401<br>MSY = 310 |

# Issues with Current Practice for Population Projections

**Default projections apply constant *F* projections**

- This assumes management will reduce catch for all fleets (including catch and discards) at the same proportion

- No change in selectivity

- No change in fleet proportions

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# Issues with Current Practice for Population Projections

**Default projections apply constant *F* projections**

- This assumes management will reduce catch for all fleets (including catch and discards) at the same proportion

- No change in selectivity

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**Projection Assumptions Violated**

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# Issues with Current Practice for Population Projections

**Default projections apply constant *F* projections**
**Ex: Vermilion Snapper (SEDAR 55)**

*Table 21. Projection results with fishing mortality rate fixed at P*=0.40 starting in 2019. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $SSB \geq SSB_{MSY}$*. The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

| Year | R.b | R.med | F.b | F.med | S.b(mt) | S.med(mt) | L.b(n) | L.med(n) | L.b(w) | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 5752 | 5040 | 0.28 | 0.27 | 21 | 20 | 1167 | 1123 | 1220 | 1218 | 176 | 224 | 124 | 162 | 0.730 |
| 2018 | 5761 | 5067 | 0.28 | 0.28 | 21 | 20 | 1199 | 1168 | 1220 | 1218 | 182 | 238 | 128 | 169 | 0.727 |
| 2019 | 5774 | 5067 | 0.35 | 0.37 | 21 | 19 | 1457 | 1559 | 1454 | 1579 | 225 | 235 | 158 | 166 | 0.726 |
| 2020 | 5765 | 5057 | 0.35 | 0.37 | 21 | 19 | 1426 | 1492 | 1400 | 1478 | 225 | 233 | 157 | 163 | 0.707 |
| 2021 | 5746 | 5041 | 0.35 | 0.37 | 20 | 18 | 1409 | 1454 | 1366 | 1408 | 224 | 233 | 156 | 162 | 0.679 |
| 2022 | 5734 | 5035 | 0.35 | 0.37 | 20 | 18 | 1399 | 1433 | 1346 | 1362 | 224 | 232 | 156 | 161 | 0.663 |
| 2023 | 5725 | 5028 | 0.35 | 0.37 | 20 | 18 | 1391 | 1419 | 1333 | 1336 | 223 | 232 | 155 | 161 | 0.648 |

**Management action: Catch only control**

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# Default projections apply constant *F* projections
# Ex: Vermilion Snapper (SEDAR 55)

*Table 21. Projection results with fishing mortality rate fixed at P*=0.40 starting in 2019. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), and D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000* lb*), pr.reb = proportion of stochastic projection replicates with* $SSB \geq SSB_{MSY}$*. The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

| Year | R.b | R.med | F.b | F.med | S.b(mt) | S.med(mt) | L.b(n) | L.med(n) | L.b(w) | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 2023 | 5725 | 5028 | 0.35 | 0.37 | 20 | 18 | 1391 | 1419 | 1333 | 1336 | 223 | 232 | 155 | 161 | 0.648 |

Interim Years (Constant *F*)

Management Years (Constant *F*)

Predicted Discards (numbers)

# Management action: Catch only control

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# Default projections apply constant *F* projections
# Ex: Vermilion Snapper (SEDAR 55)

Predicted Discards (numbers)

| Year | D.b(n) |
|---|---|
| 2017 | 176 |
| 2018 | 182 |
| 2019 | 225 |
| 2020 | 225 |
| 2021 | 224 |
| 2022 | 224 |
| 2023 | 223 |

Actual Discards (numbers)

| Year | MRIP (B2)*0.38 (1000s) |
|---|---|
| 2017 | 254 |
| 2018 | 259 |
| 2019 | 205 |
| 2020 | 307 |
| 2021 | 461 |
| 2022 | 577 |

MRIP discards alone have already exceeded projection estimates

Discards composed of:
(9.6%) Commercial handline
(17.6%) Headboat
(72.8%) MRIP

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# Issues with Current Practice for Population Projections

**Management actions violating projection assumptions**

Not a modeling hurdle:

- Can change selectivity
- Can change proportions of ***F*** applied across fleets

Rather, a prediction hurdle:

- What will the final management action be?
- What will the fishing behavioral response be?

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# Possible Improvements

- Change default projections for SEDAR
- Inject a new step in process to adjust final projections and ABC setting
- Brute force, run a whole suite of options to cover many possibilities
- Set ABC for discards or include discards in management action and monitoring

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# Questions?

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