Coping with information gaps in stock productivity for rebuilding and achieving maximum sustainable yield

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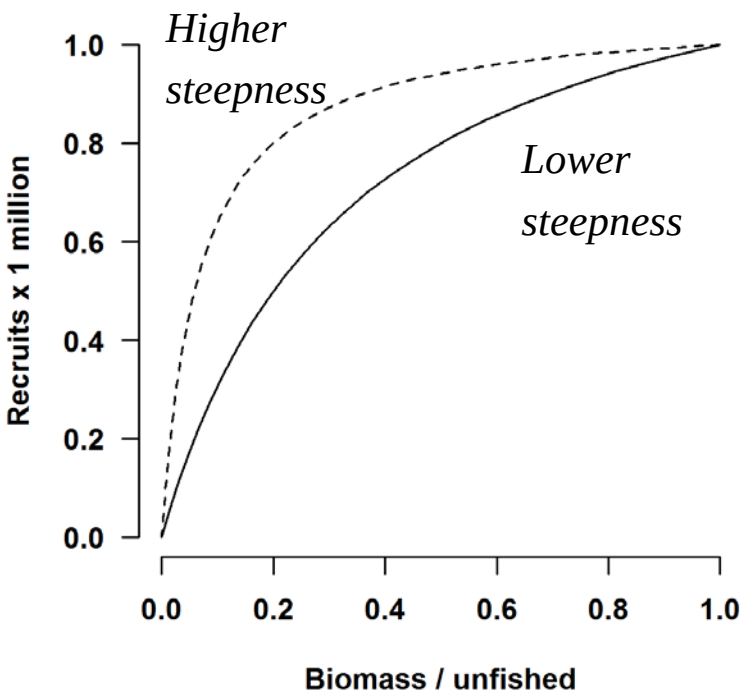
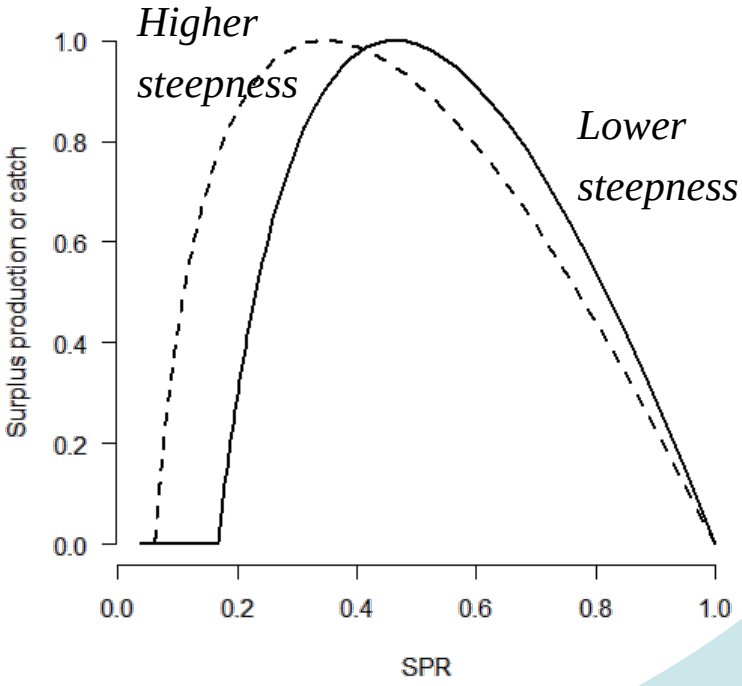
Productivity, namely stock-recruitment steepness, influences selection of MSY proxies

Beverton-Holt stock-recruitment



Steepness affects selection SPR reference points, which in turn affects MSY achievement



Coping with information gaps in stock productivity for rebuilding and achieving maximum sustainable yield

- National Standard 1 Guidelines, MSY-based reference points, notwithstanding other economic and ecosystem-based objectives

- Lacking sufficient information, proxies sometimes used in status determination criteria:
  $F_{x\%SPR}$ *for Fmsy*

  $F_{x\%SPR}$ → *MFMT, defining overfishing*
  Yield at $F_{x\%SPR}$ → *MSY proxy*
  *X * Biomass at* $F_{x\%SPR}$ → *MSST, overfished status*

- Uncertainty in stock productivity, namely steepness, is driving the need for proxy reference points in both data-rich and data-limited situations.

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ORIGINAL ARTICLE

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Coping with information gaps in stock productivity for rebuilding and achieving maximum sustainable yield for grouper–snapper fisheries

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Can we identify Fspr proxy for Fmsy in the face of steepness uncertainty?

1. Formalize knowledge as a prior probability distribution

2. Evaluate F*spr* proxies across states of nature and produce probabilistic outcomes

3. Decision-support for proxy selection based on probabilistic outcomes

Methods

Factorial simulations:

- Two reef fish assemblages
  (1) gonochoristic stocks – snappers/other demersal species
  (2) protogynous hermaphroditic stocks - groupers

- Simulated long-term outcomes, under each of five SPR proxy levels

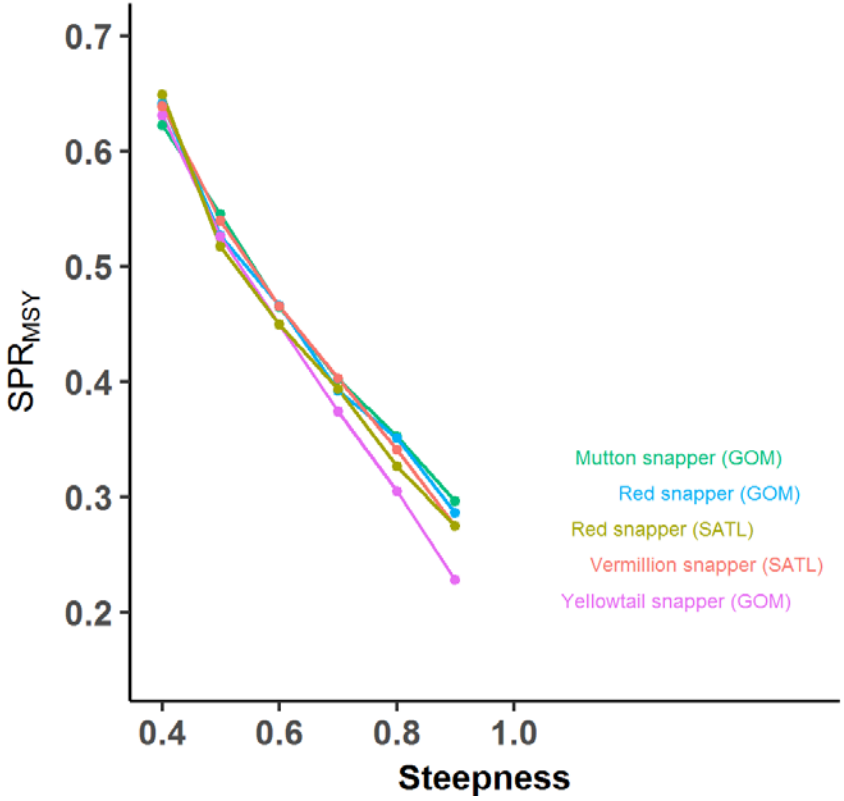
- Steepness: 0.4, 0.5, 0.6, 0.7, 0.8, 0.9
- Steepness was modeled in discrete steps for simplicity

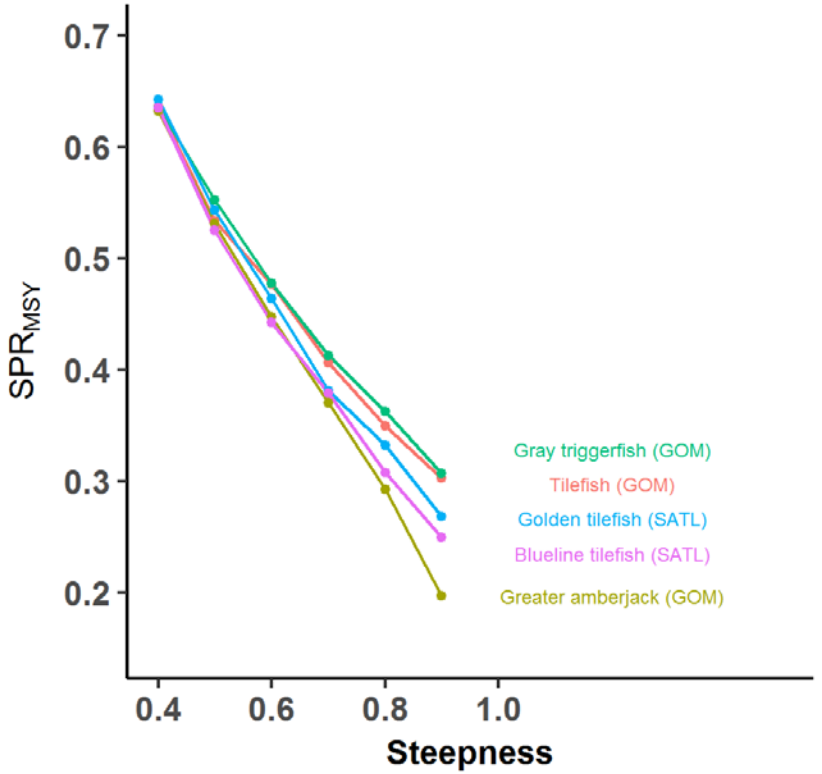
- Stochastic outcomes based on annual stock-recruitment deviations

- Selectivity knife-edge at length at 50% maturity

Methods

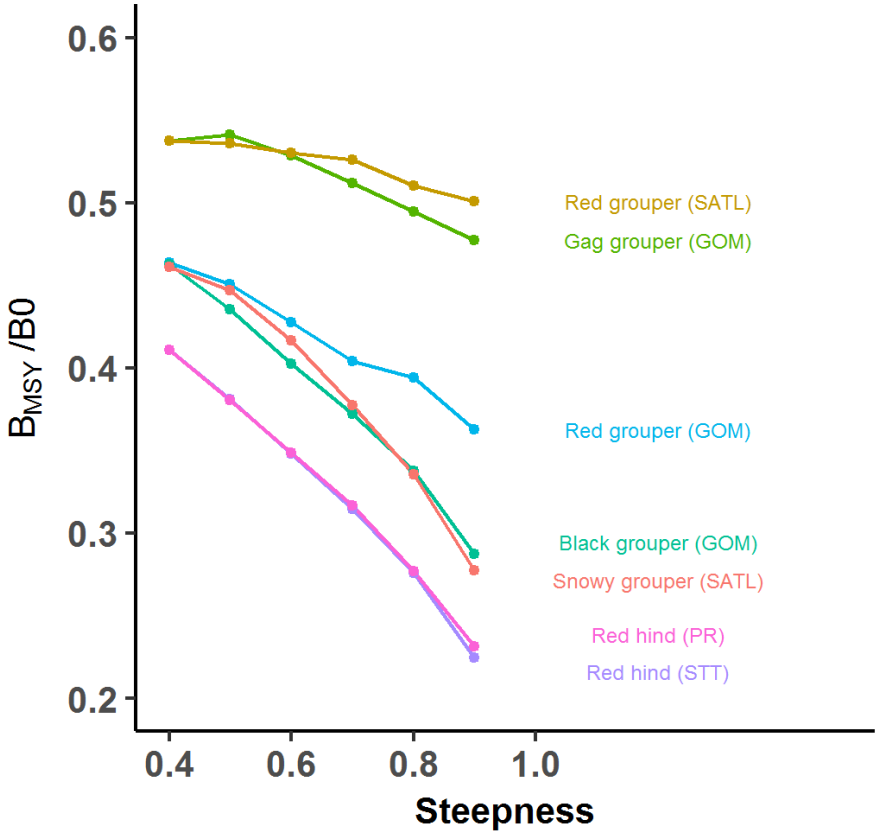
Gonochoristic stocks





Methods

Hermaphroditic stocks



Stock selection:

- Been subject to quantitative stock assessment
- Judged to have sufficient life history information for inclusion in analysis

Methods – Producing probabilistic outcomes

1 Simulations

Each, conditional on:

- Steepness
- Stock *x*
- SPR proxy

Catch / MSY

2 Summarize

Performance vs. Steepness

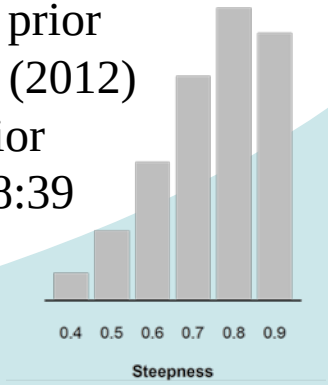
h=0.4	h=0.5	h=0.6	h=0.7	h=0.8	h=0.9
0.10	0.15	0.20	0.25	0.30	0.35
0.30	0.35	0.40	0.45	0.50	0.55
0.40	0.35	0.30	0.25	0.20	0.10
0.10	0.10	0.10	0.05	0	0
0.10	0.05	0	0	0	0

3 Define steepness prior

Shertzer & Conn (2012)

Demersal fish prior

Bull. Mar. Sci. 88:39

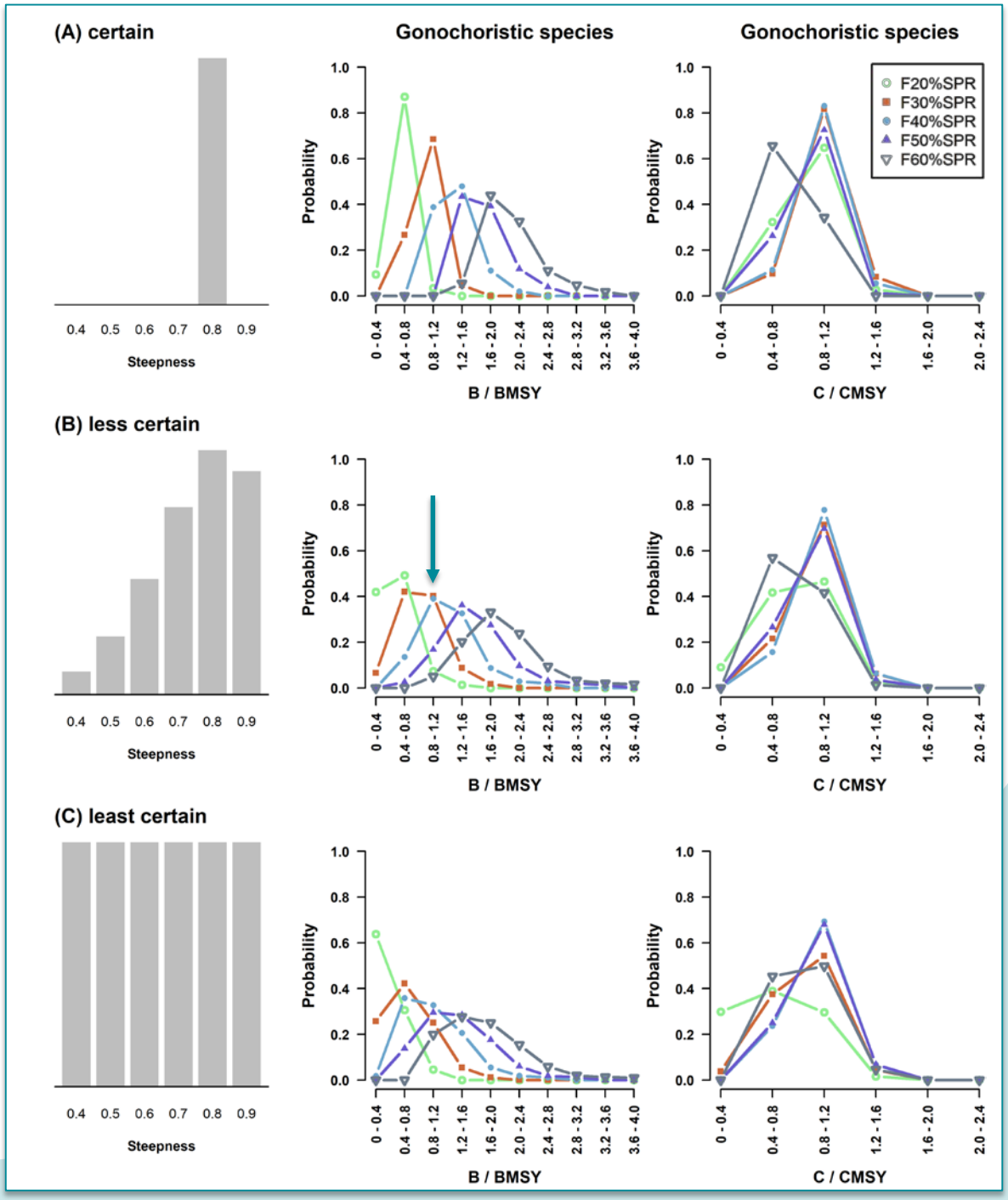


4 Marginalize performance according to probability rules

- Results not conditional on any specific steepness, but reflect steepness uncertainty

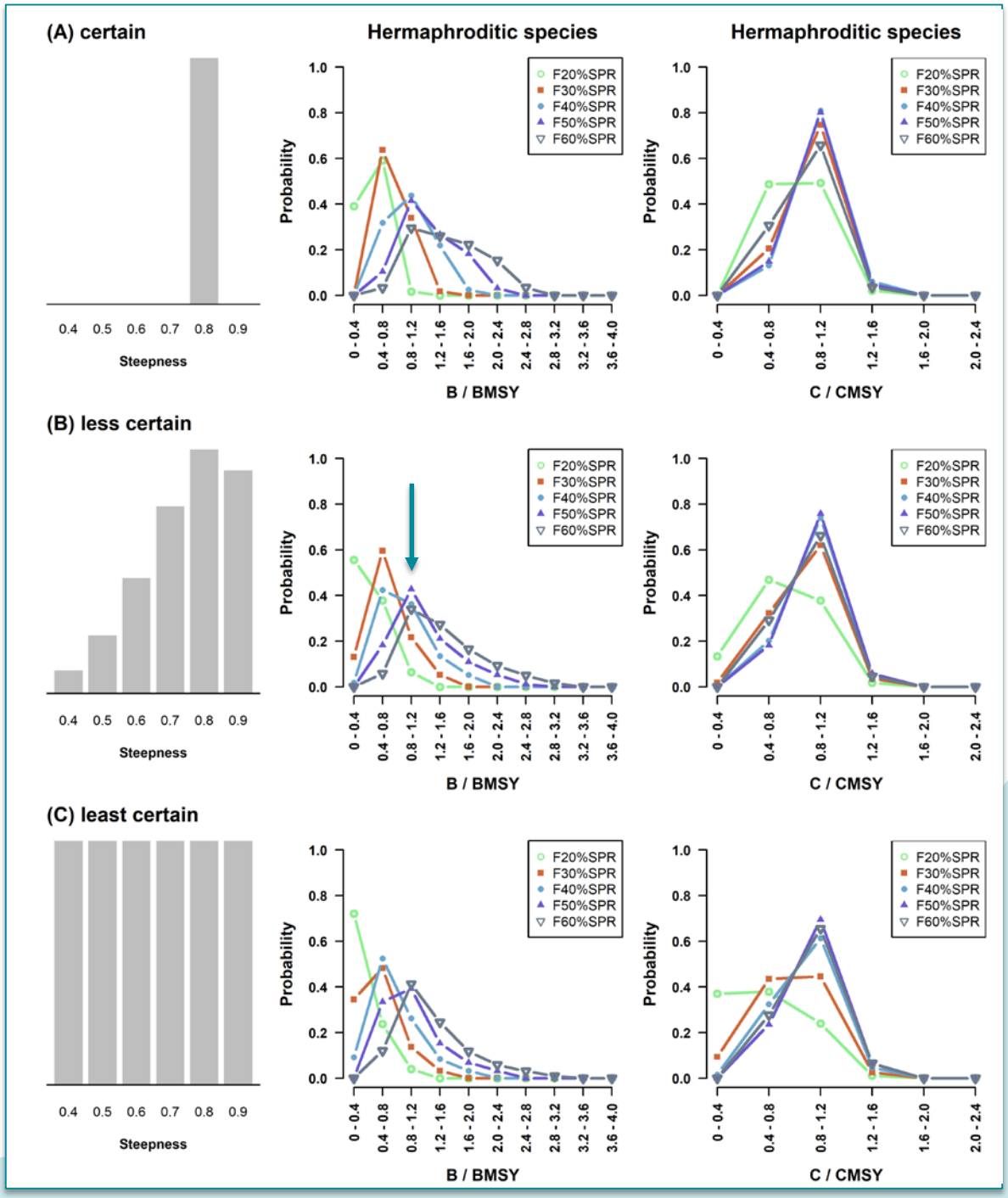
Results: Gonochoristic stocks

- *F*40%SPR has the greatest probability mass centered around long-term achievement of MSY,
- While also maintaining biomass in proximity to *B*MSY
- Alternative priors can be specified, reflecting degree of uncertainty used in integrating across states of nature.



Results: Hermaphroditic stocks

- *F*50%SPR has the greatest probability mass centered around long-term achievement of MSY,
- While also maintaining biomass in proximity to *B*MSY
- Where knowledge exists, formalize and bring that knowledge to forefront of policy discussions



Discussion #1: SPR reference point selection

Gonochoristic stocks
(Snappers, etc.)

Simulation outcomes most consistent with MSY-based reference points:

$F_{40\% \text{ SPR}}$

Hermaphroditic stocks
(Groupers)

Simulation outcomes most consistent with MSY-based reference points:

$F_{50\% \text{ SPR}}$

Discussion #1: SPR reference point selection

- Clark (2002), F40%SPR should be close to optimum F, particularly when recruitment to the fishery coincides with maturity

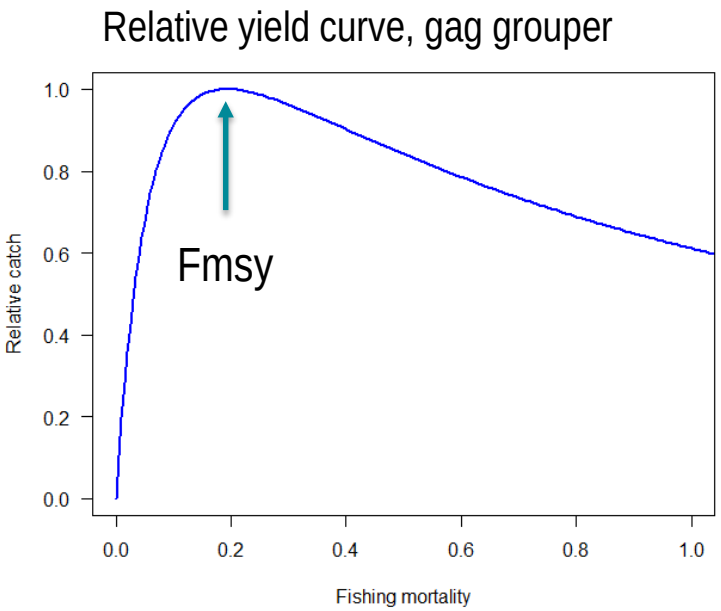
- Mace (1994) similarly suggests that F40%SPR be adopted as a target fishing mortality rate when the stock–recruitment relationship is unknown.

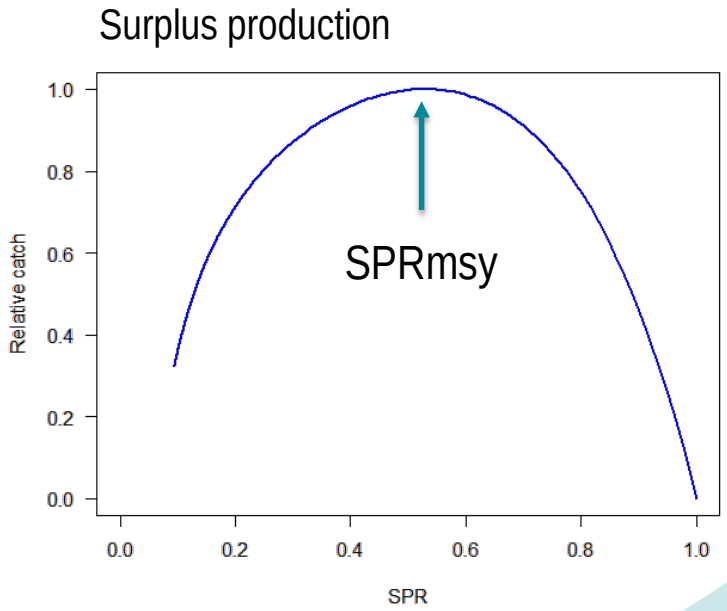
- Brooks et al. (2010) suggested that a SPR of 30% would only be appropriate for very resilient stocks and reinforced the importance of selecting a level of SPR based on life history characteristics.

- However, several studies caution that F40%SPR may be too low for a variety of life histories, under prevailing environmental conditions, and where there is considerable uncertainty in growth parameters and the rate of natural mortality. (Brodziak, 2002; Cadrin, 2012; Dorn, 2002; Restrepo et al., 1998).

Discussion #2: Should hermaphroditic stocks be able to sustain higher fishing mortality because of their life history?

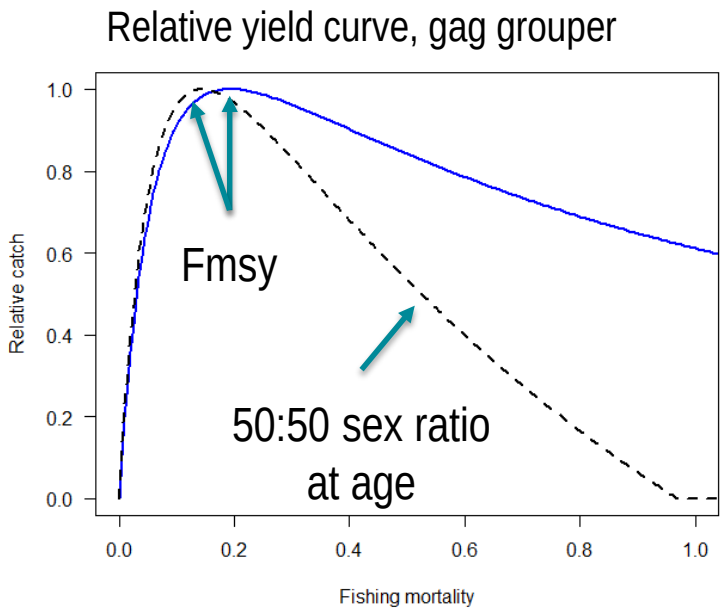
- Does such a statement conflict with our F50%SPR recommendation? (no…here's why)
- Let's do a thought experiment…

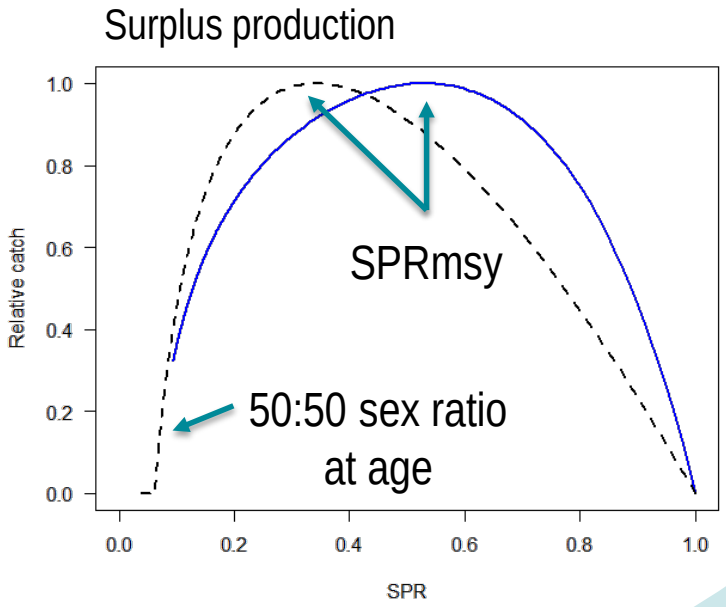




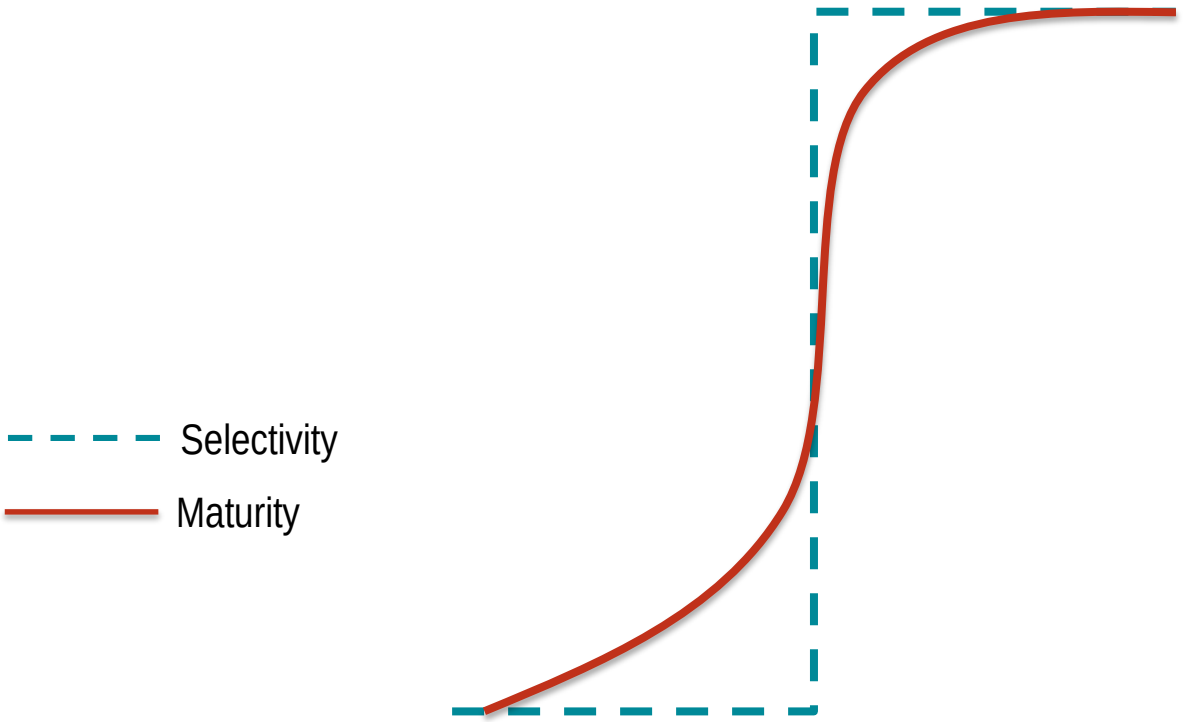
Discussion #2: Should hermaphroditic stocks be able to sustain higher fishing mortality because of their life history?

- We need to re-frame our thinking, asking what is process for identifying an SPR proxy for hermaphroditic stocks that aligns with achievement of Fmsy



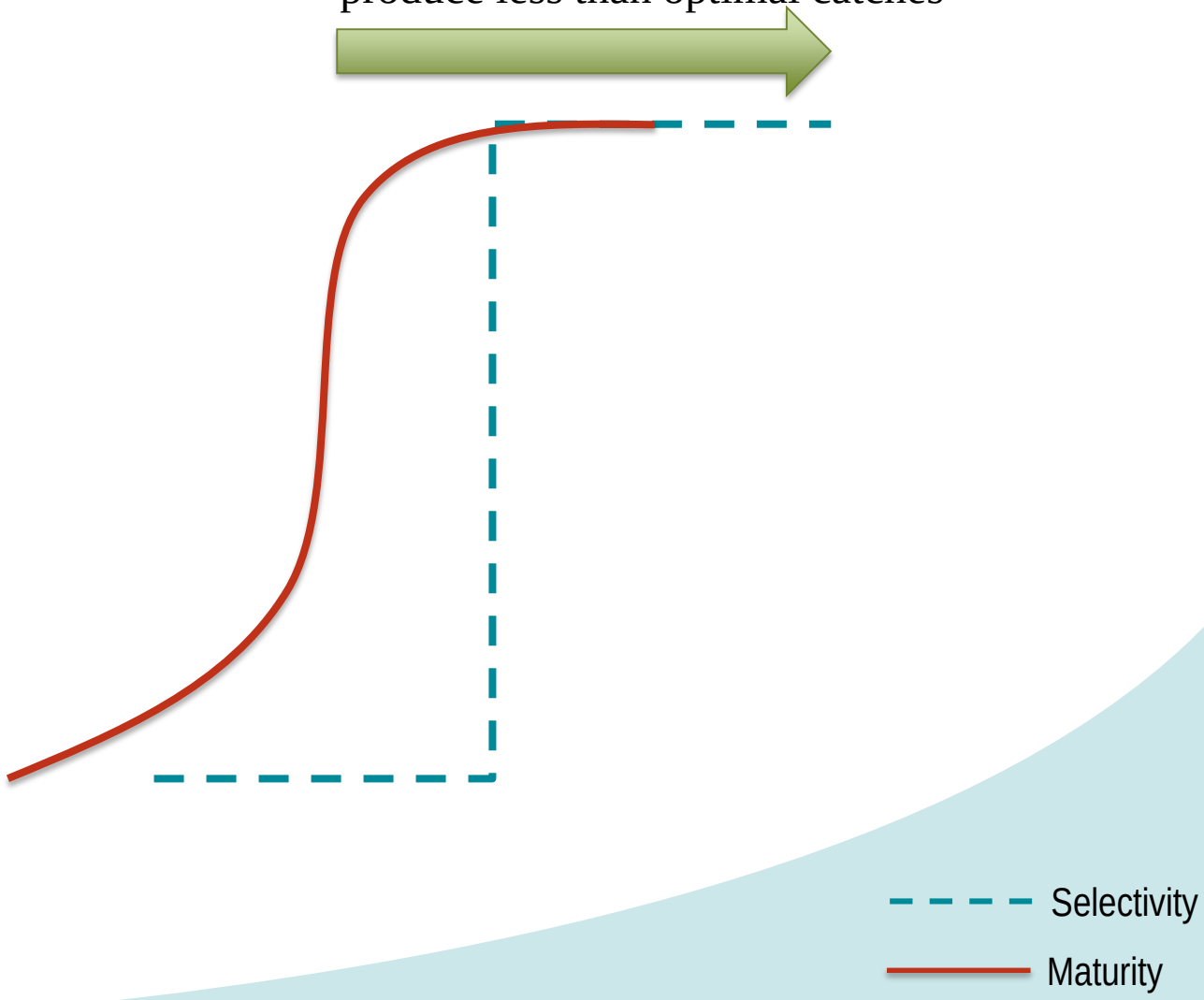


Discussion #3: What to do if selectivity is not consistent with L50?



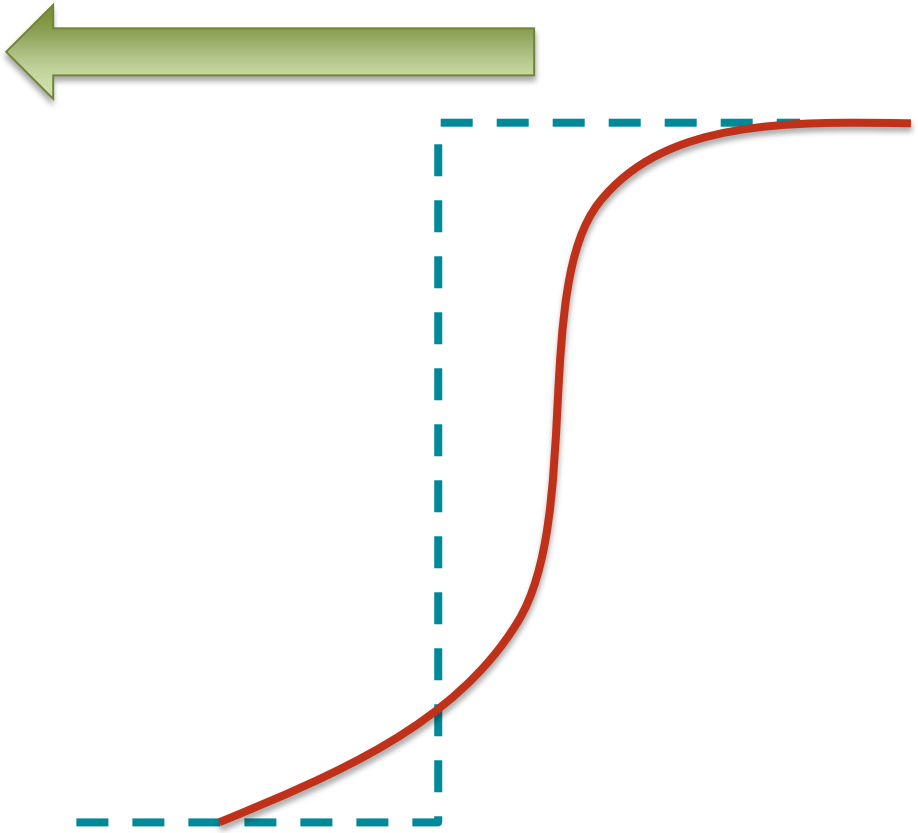
Discussion #3: What to do if selectivity is not consistent with L50?

Given our F%SPR recommendations, this circumstance would be less risk prone, but produce less than optimal catches



Discussion #3: What to do if selectivity is not consistent with L50?

Priority should be given to address harvest of immature fish



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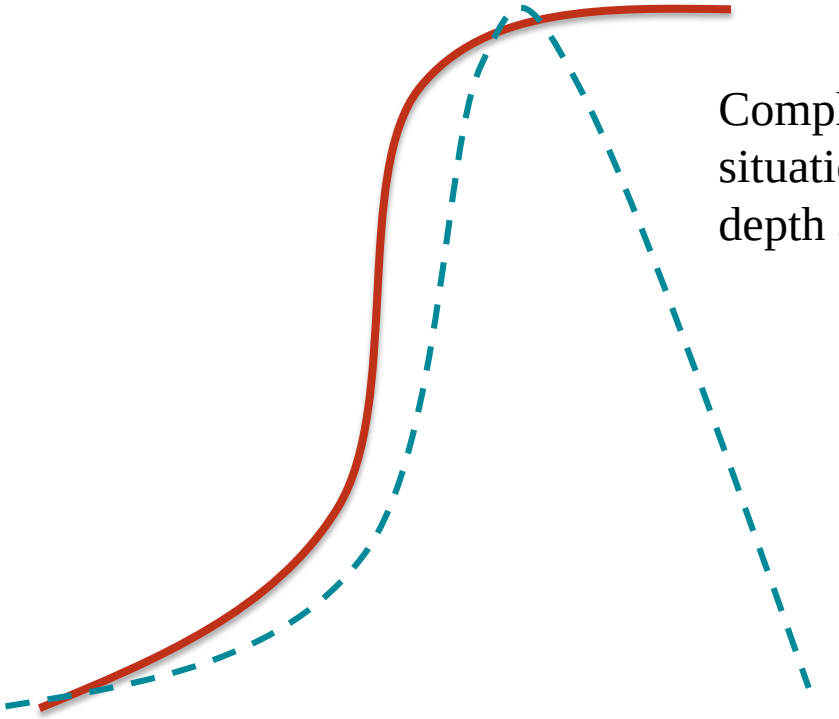

Complex selectivity, data-rich situation, consider more in-depth analysis

Discussion #3: What to do if selectivity is not consistent with L50?

Common name	A50	L50	Federal commercial regulatory size limit
Gonochoristic assemblage			
Mutton snapper (GOM)	3	433 mm TL	406 mm TL
Red snapper (GOM)	2	315 mm TL	330 mm TL
Red snapper (SATL)	2	348 mm FL	–
Yellowtail snapper (SATL & GOM)	2	305 mm TL	305 mm TL (GOM)
Vermilion snapper (SATL)	1	211 mm TL	305 TL
Tilefish (GOM)	2	345 mm TL	–
Golden tilefish (SATL)	3	399 mm TL	–
Greater amberjack (GOM)	4	832 mm FL	914 mm FL
Grey triggerfish (GOM)	1	183 mm FL	356 mm FL
Blueline tilefish (SATL)	3	445 mm TL	–

Hermaphroditic assemblage		L50	Federal size limit
Red grouper (GOM)	3	328 mm TL	457 mm TL
Red grouper (SATL)	3	459 mm TL	508 mm TL
Black grouper (GOM)	7	904 mm TL	610 mm TL
Gag grouper (GOM)	4	605 mm TL	559 mm TL
Snowy grouper (SATL)	5	557 mm TL	–
Red hind (STT)	3	251 mm FL	–
Red hind (PR)	3	232 mm FL	–

Thanks

NOAA FISHERIES

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