Accounting for fleet complexity in the establishment of stock status determination criteria

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Magnuson-Stevens Reauthorization Act (MSRA)

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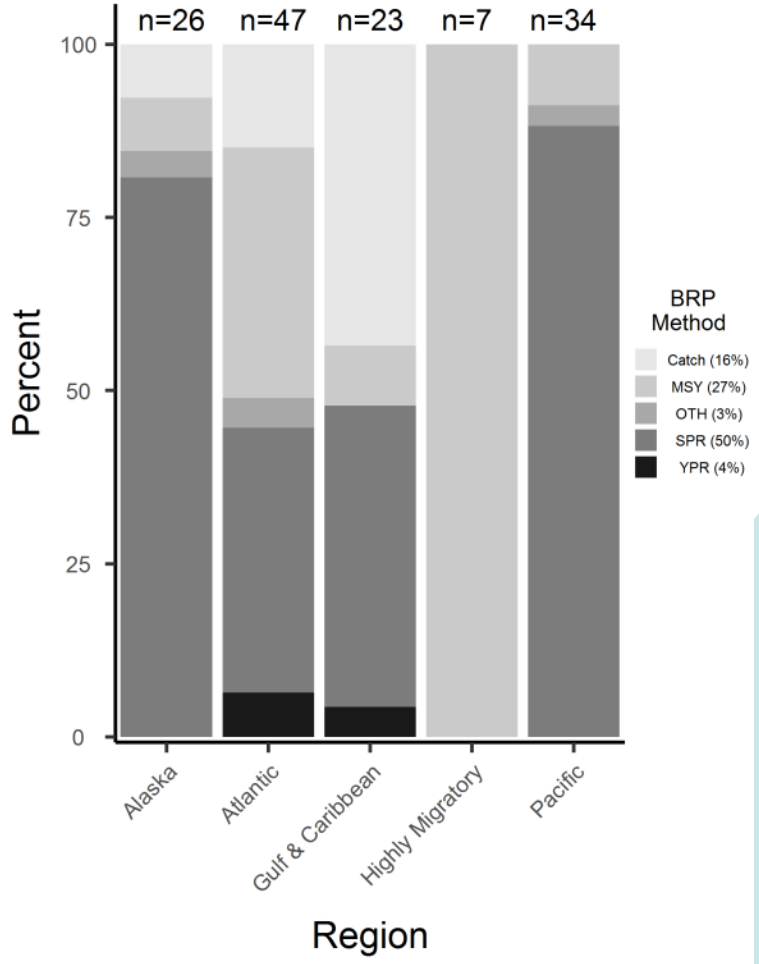
- Requires that stocks be rebuilt to a biomass level that is able to consistently provide MSY
- What is MSY?



Magnuson-Stevens Reauthorization Act (MSRA)

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- (28) The term "optimum", with respect to the yield from a fishery, means the amount of fish which--
- (A) will provide the *greatest overall benefit* to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems;
- (B) is prescribed as the basis of the *maximum sustainable yield* from the fishery, as reduced by any relevant economic, social, or ecological factor; and
- (C) in the case of an overfished fishery, provides for *rebuilding to a level consistent with producing the maximum sustainable yield* in such fishery.

MSY is undefined by the Act!

Global MSY

- Depends on growth, natural mortality and the *relationship between spawners and recruits*
- Achieved when fishing is begun at an optimal age that balances production (growth, recruitment) with losses owing to natural mortality

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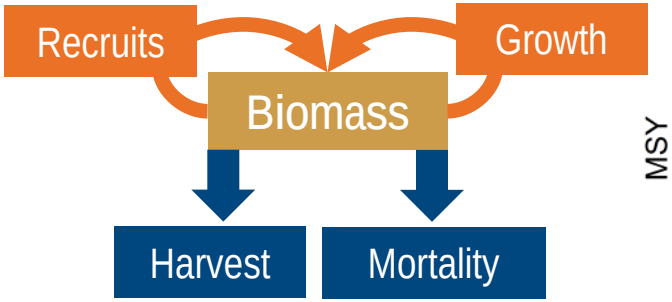

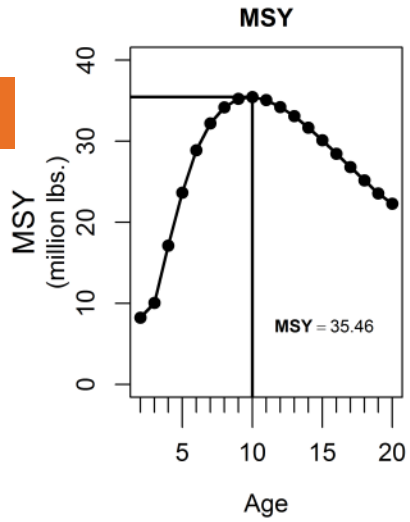

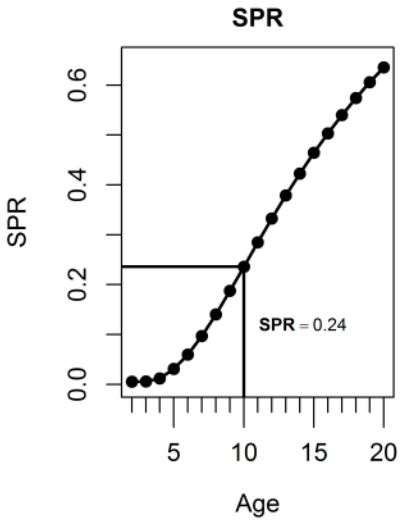

Conditional MSY

- Allow suboptimal selection patterns and bycatch from other fisheries (conditional yields)
- MSY|fixed_discards
  - Directed yield is maximized AFTER bycatch/discard mortality has occurred (similar to treatment of natural mortality)
- MSY|linked
  - Maximizes yield assuming all fleets (directed and discard) are equally scalable or linked

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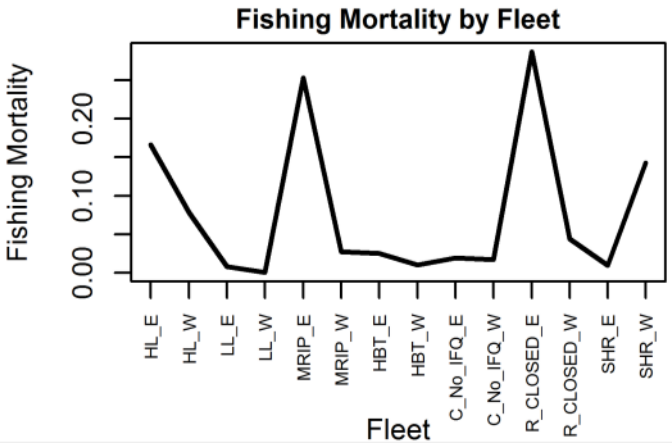

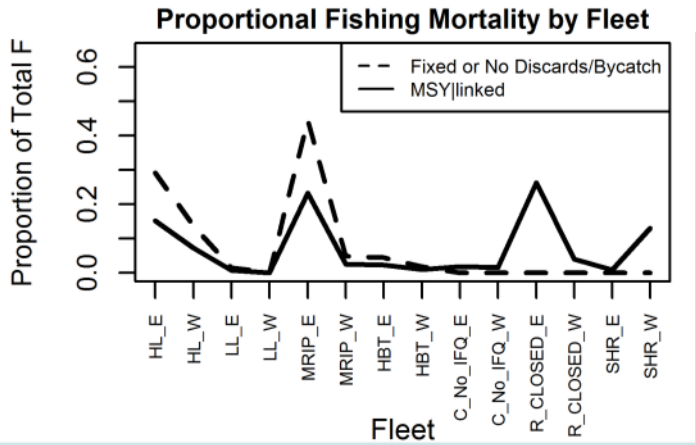

Spawning Potential Ratio (SPR) proxies

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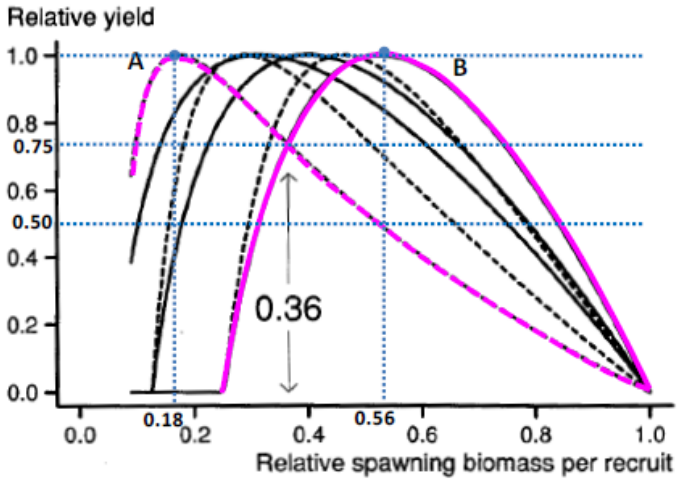
- Based on life history (longevity, natural mortality, etc.)
- Does not account for spawner - recruit relationship
- Goal is to maintain SSB within safe biological limits, while also limiting foregone yield
  - Minimize the maximum foregone yield (Clark's min-max approach)
  - Targets range from 20-60% (e.g., Clark 1991, 1993, 2002)
- Targets can be arbitrary



MSY for Red Snapper

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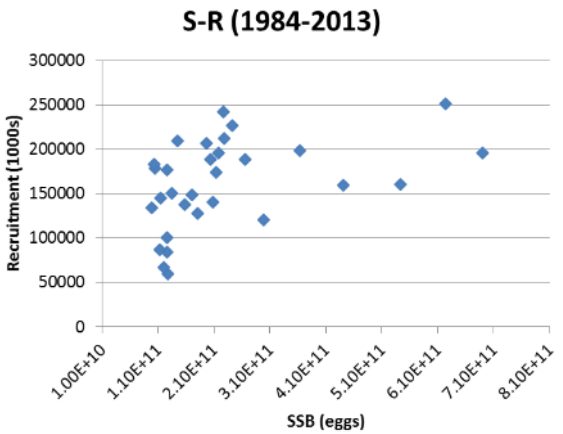
- Determining MSY for red snapper is problematic because the stock-recruit function is not well-defined
- Conditional MSY approaches provide widely varying reference points, because the various fisheries have different selectivities



Project Goals

- Illustrate how complex fishery dynamics convolute the choice of MSY metrics
- Demonstrate an alternate approach to defining objective SPR proxies corresponding to SSB_{MSY} that conform to Magnuson-Stevens Act guidelines

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40 YEARS
A Journey to Sustainable Fisheries
MAGNUSON STEVENS ACT

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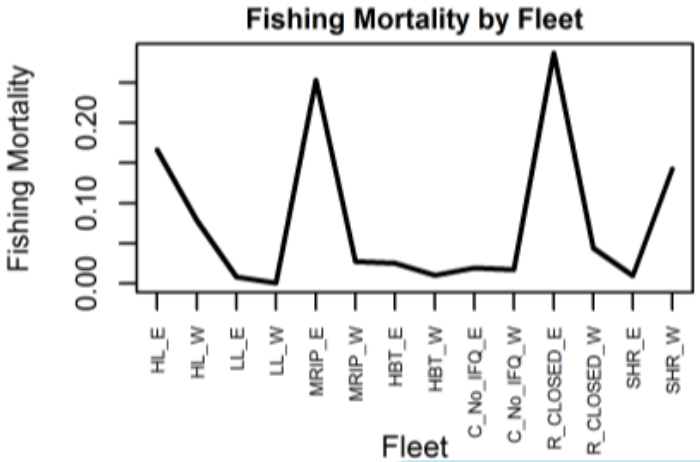
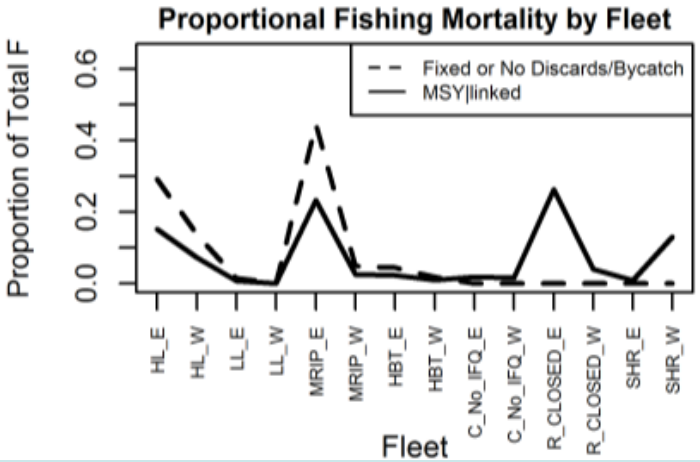
Methods

- MSY projections performed with Stock Synthesis (SS3)
- Based on 2014 update of SEDAR 31 stock assessment
- 100 year (2015-2115) deterministic equilibrium projections
- Recruitment based on Beverton-Holt stock-recruit curve for varying levels of steepness (0.7, 0.85, and 1.0) assuming constant apportionment to each area
- Relative fishing mortality retained in constant proportion





Methods

- 4 directed fleets (each with an east and west component):
  - Commercial handline (HL), commercial longline (LL), recreational private (MRIP), and recreational headboat (HBT)
  - Each directed fleet includes discards due to size and bag limits (based on retention functions)
- 3 discard fleets (each with an east and west component):
  - Shrimp bycatch (SHR), commercial discards due to lack of IFQ (C_No_IFQ), and recreational discards due to closed seasons (R_Closed)

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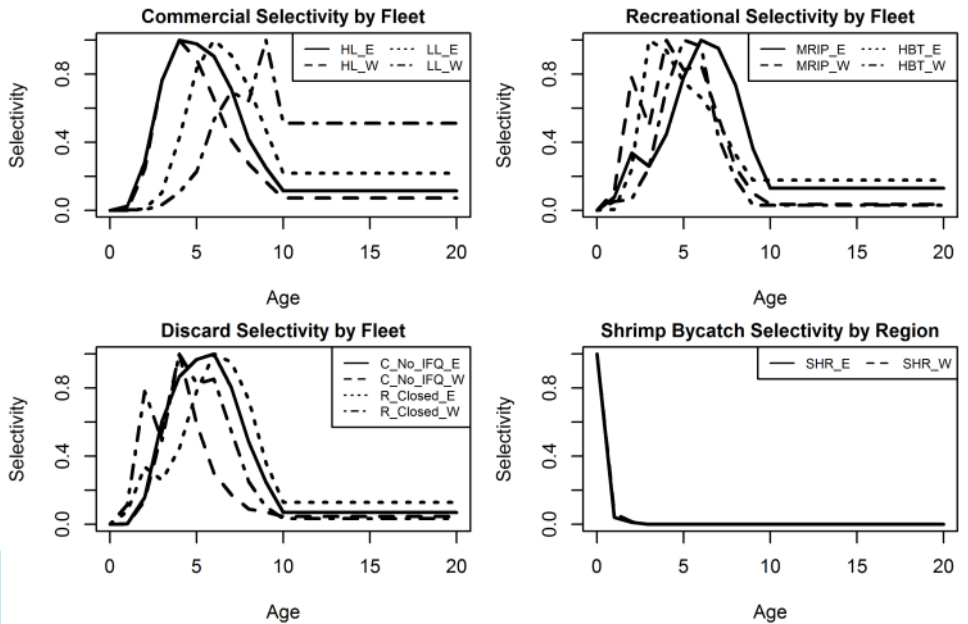

Conditional MSY

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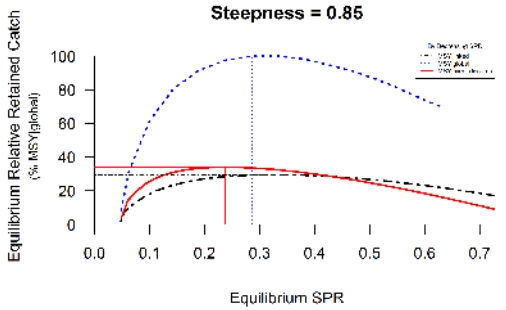

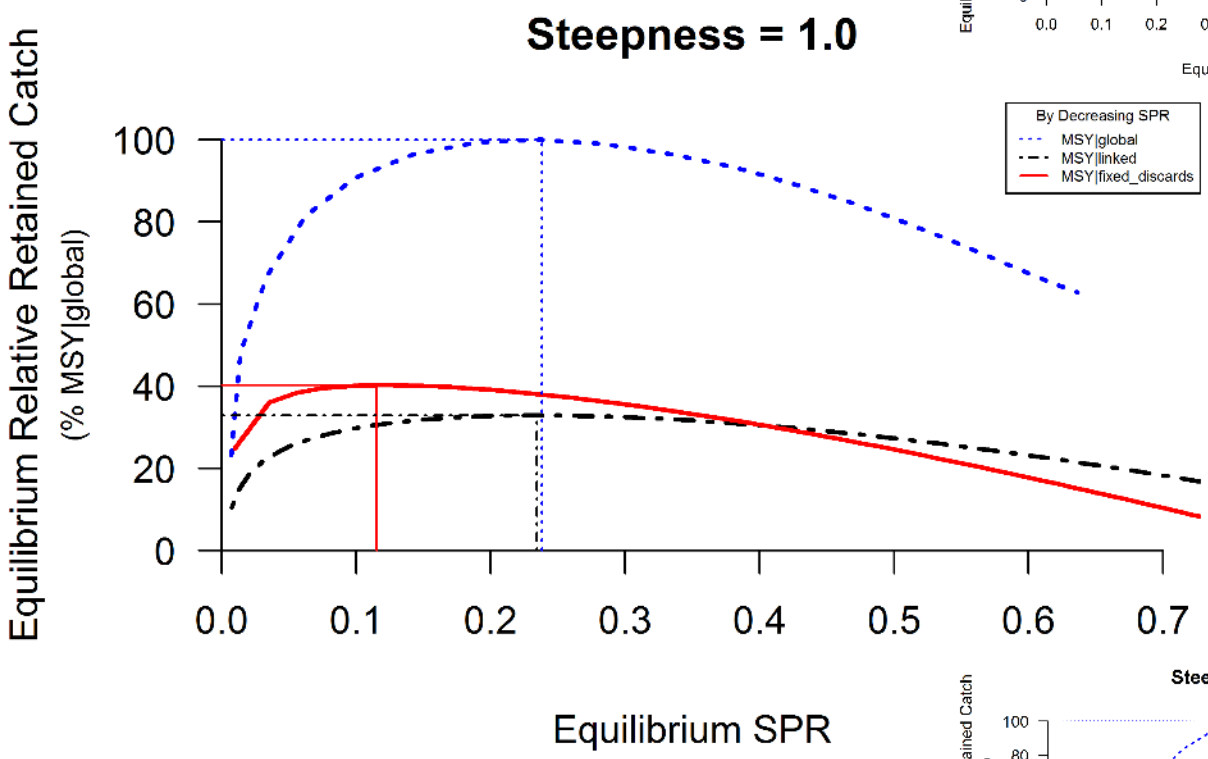

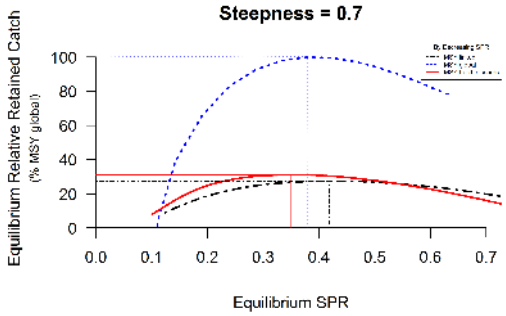

Conditional MSY

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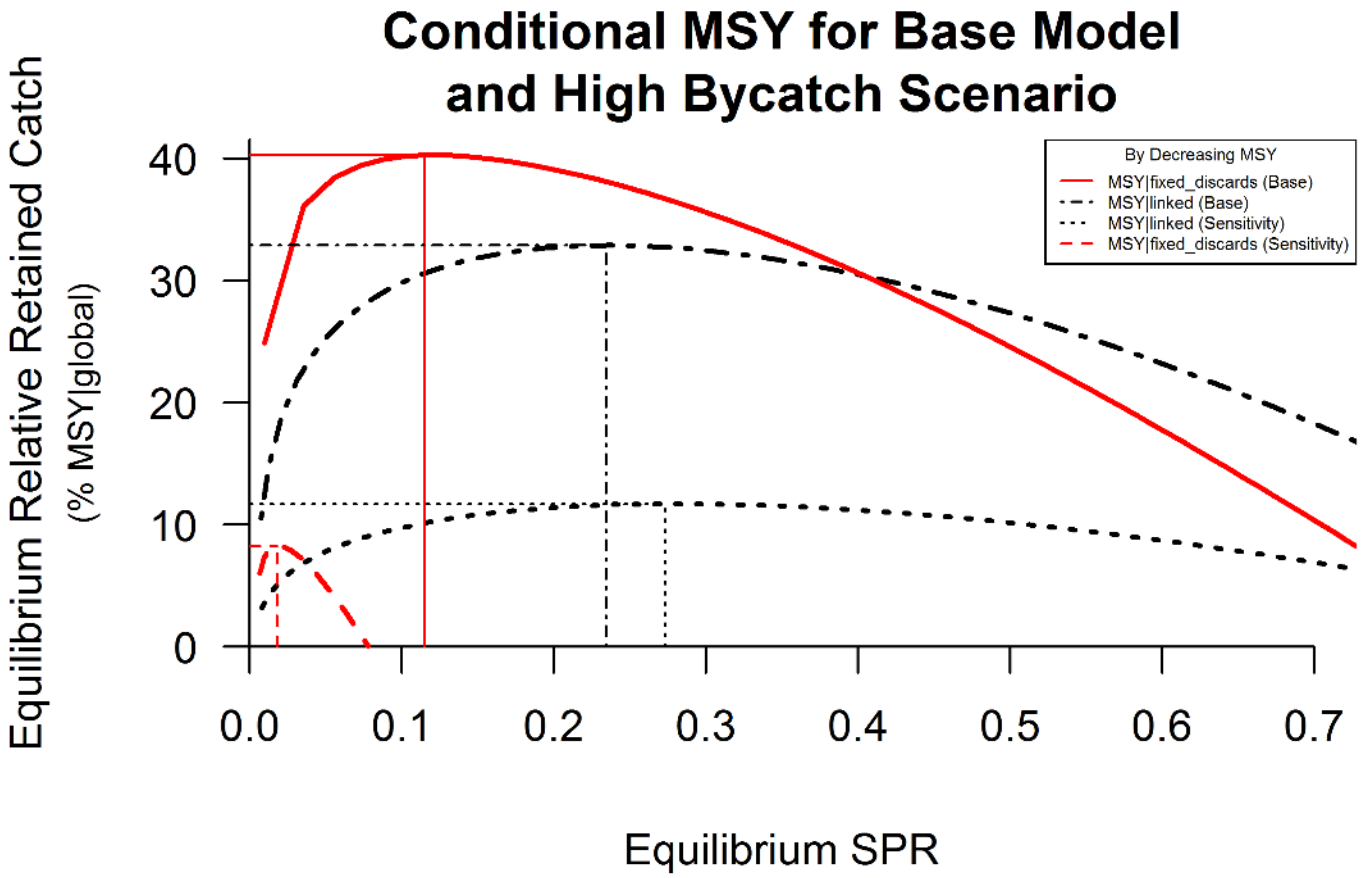

Summary

- Is there a best proxy for MSY that fulfills MSRA guidelines? – NO
  - MSY indeterminable when stock-recruit function unknown
  - MSY|global is unobtainable in practice
  - MSY|fixed_discards may lead to unsustainable proxies if bycatch/discards are high OR productivity overestimated
  - MSY|linked relies on scaling F on all fleets proportionally

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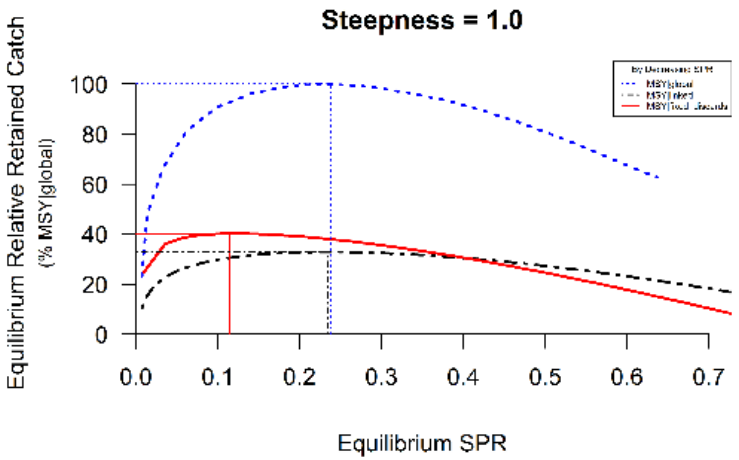

$SPR_{MSY}|global$

- Essentially flip the Clark min-max method to focus on SPR_{MSY} instead of MSY
  - Use global MSY as the comparative metric as opposed to a conditional MSY
  - When bycatch rates change projected SPR target remains constant
    - Only projected yield is altered

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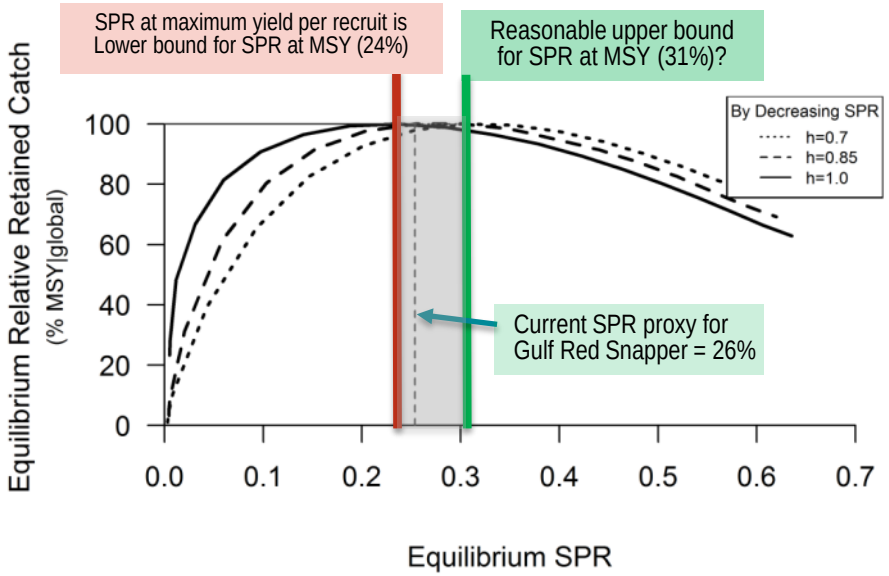

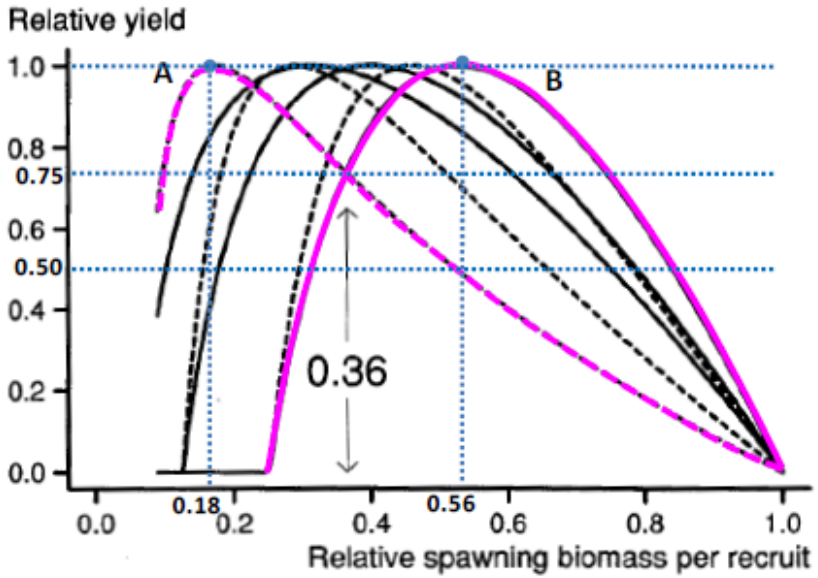

$SPR_{MSY}|global$

- SSB at MSY|global is attainable even though associated yield is not
- Inherently sustainable (SSB where birth = death)
- Rebuilds to a biomass level that should provide MSY (fulfills Magnuson-Stevens Act requirements)
- *Time-invariant SPR target over the rebuilding schedule*
- Calculate yield to achieve it from MSY|fixed_discards curve (update as needed)
- Resulting $SPR_{MSY}|global$ when a Beverton-Holt stock-recruit function is assumed with a steepness value of 1.0 can provide a lower SPR bound

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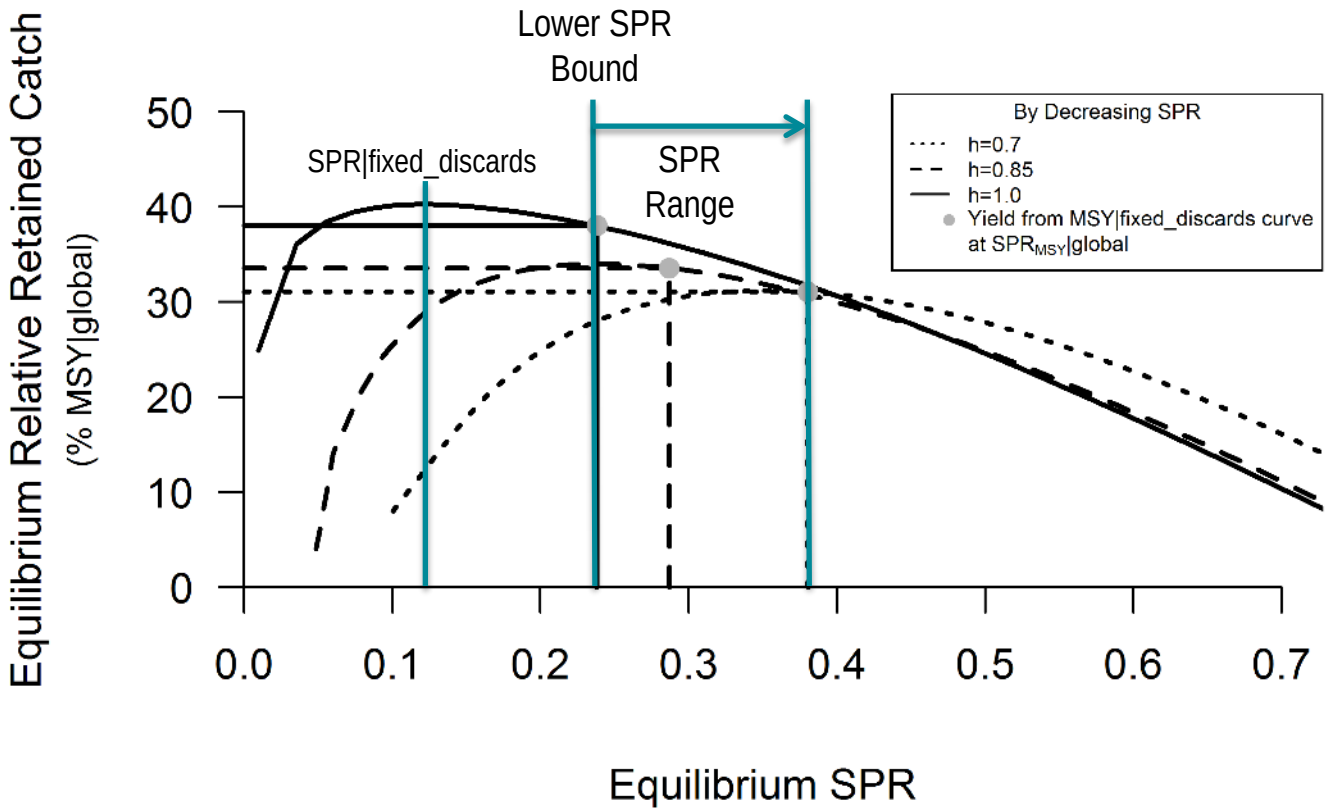
$SPR_{MSY}|global$

- Current SPR target (26%) for Red Snapper falls within the range of SPR|global (24-38%) based on reasonable values of steepness (0.7 – 1.0)



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Conclusions

- The SPR associated with the SSB at MSY|global can be a useful proxy that adheres to MSRA guidelines
- When productivity is uncertain (i.e., steepness is not well estimated) SPR_{MSY}|global associated with a steepness value of 1.0 can provide a lower SPR bound
- SPR 26% (current red snapper proxy) lies within reasonable bounds of SPR_{MSY}|global (24 – 38%)

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Questions?

For further information see:

Goethel, D.R., Smith, M.W., Cass-Calay, S.L., Porch, C. 2018. Establishing stock status determination criteria for fisheries with high discards and uncertain recruitment. North American Journal of Fisheries Management. 38: 120-139.

Acknowledgments

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