SPR-Based MSY Proxies for SAFMC Stocks: An Alternative Perspective

Luiz Barbieri
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission

SAFMC Meeting

June 2025

Request from SAFMC:

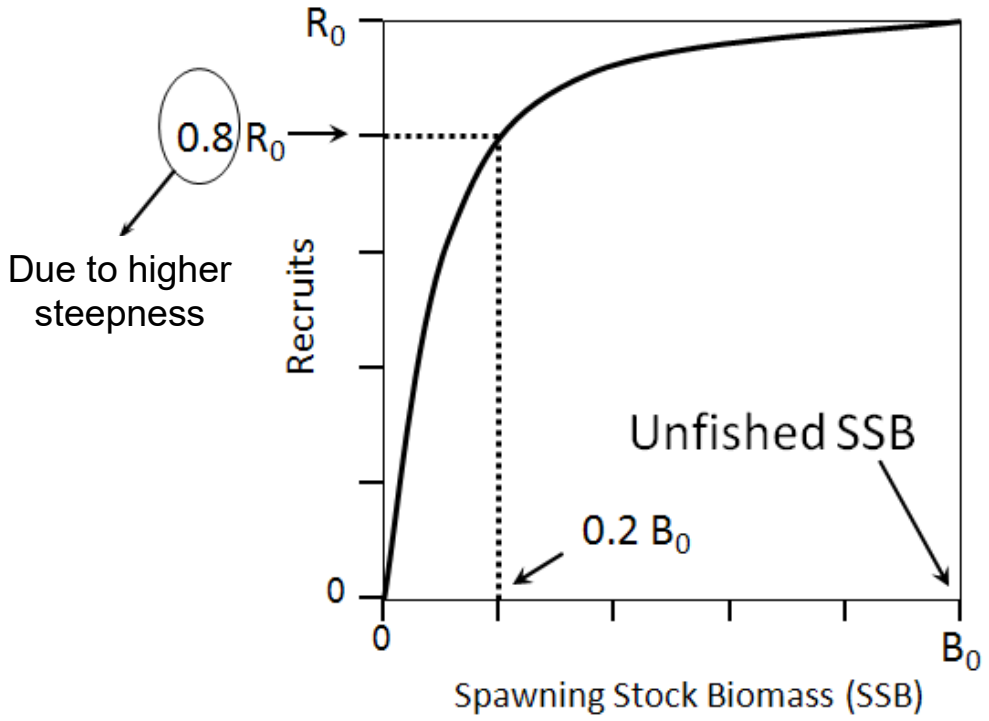
- A non-technical presentation from the Florida Fish and Wildlife Research Institute's stock assessment group discussing their perspectives on developing spawning potential ratio (SPR)-based MSY proxies for state and federally-managed species.
- A compilation and comparison of SPR proxies for Southeastern stocks that have MSY estimates based on stock-recruitment relationships.
- A discussion of management situations that would require a higher or lower SPR.

Request from SAFMC:

😬

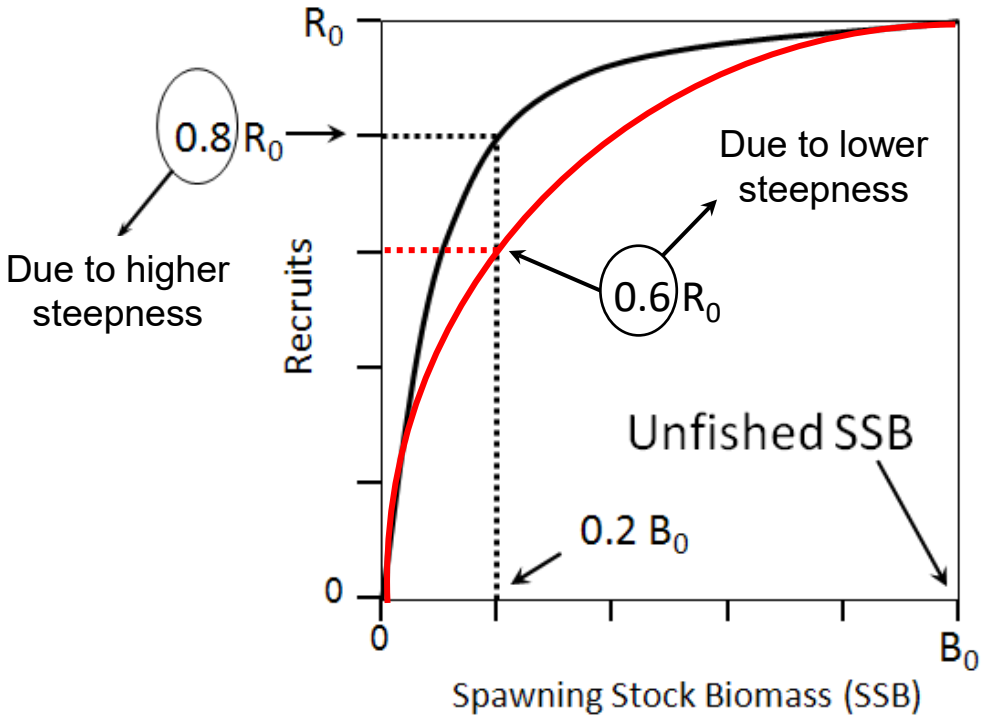
- A ~~non-technical~~ presentation from the Florida Fish and Wildlife Research Institute's stock assessment group discussing their perspectives on developing spawning potential ratio (SPR)-based MSY proxies for state and federally-managed species.
- A compilation and comparison of SPR proxies for Southeastern stocks that have MSY estimates based on stock-recruitment relationships.
- A discussion of management situations that would require a higher or lower SPR.

Steepness of the Stock Recruitment Relationship (SRR): A metric of stock productivity



- The productivity and resilience of exploited stocks are frequently quantified by the parameter steepness (h) of the SRR.
- h measures the expected reduction in recruitment when SSB declines to 20% of its unfished level.
- h is also a metric of the stock's compensatory capacity, (e.g., the ability to produce more recruits per spawner as the stock declines).

Steepness of the Stock Recruitment Relationship (SRR): A metric of stock productivity

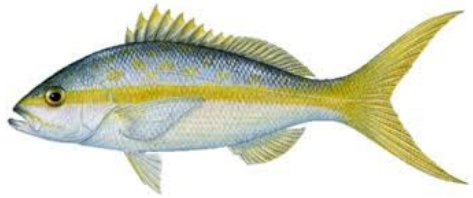


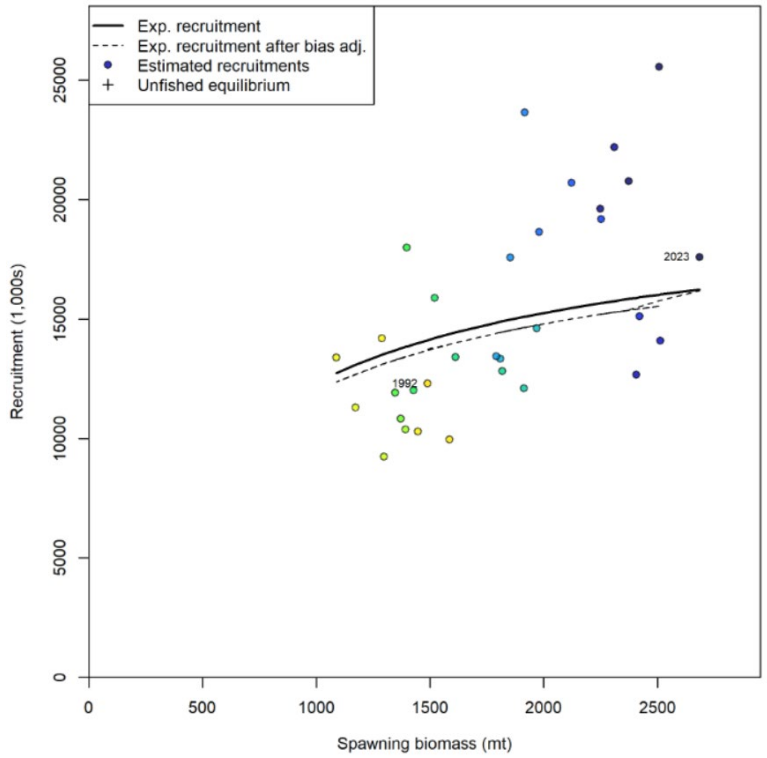
- The <u>productivity</u> and <u>resilience</u> of exploited stocks are frequently quantified by the parameter steepness (h) of the SRR.
- h measures the expected reduction in <u>recruitment</u> when SSB declines to 20% of its unfished level.
- h is also a metric of the stock's <u>compensatory capacity</u>, (e.g., the ability to produce more recruits per spawner as the stock declines).

Steepness is difficult to estimate reliably

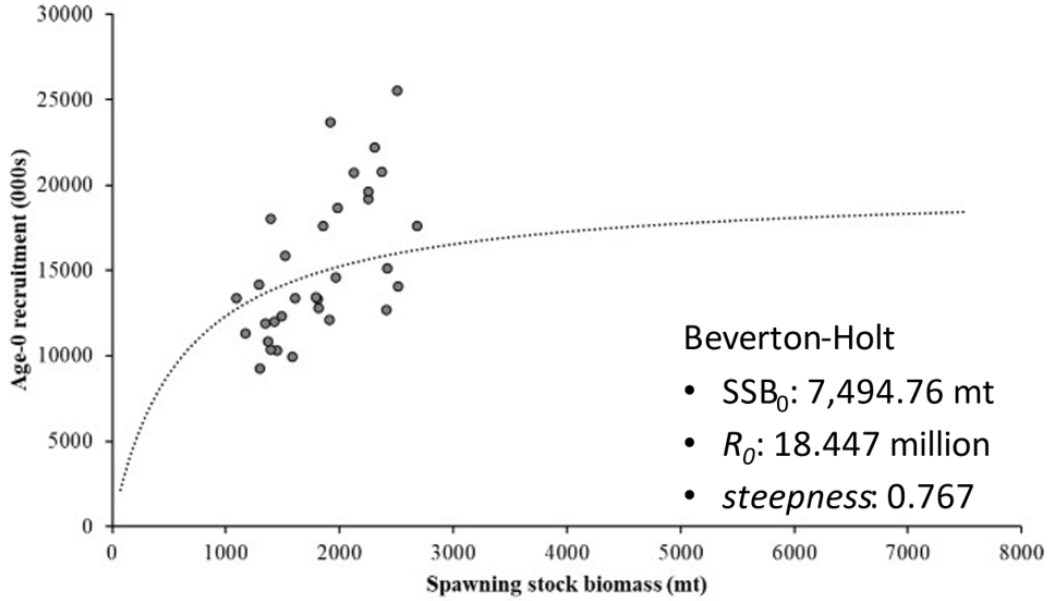
- Stock-Recruitment functions are often non-informative due to data limitations.
- If steepness cannot be estimated ➡ MSY not estimable ➡ Use SPR proxy.

Steepness is difficult to estimate reliably
Yellowtail Snapper example





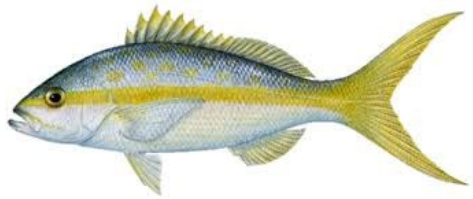
SRR estimated by the SEDAR 96 stock assessment model for the observed range of SSB

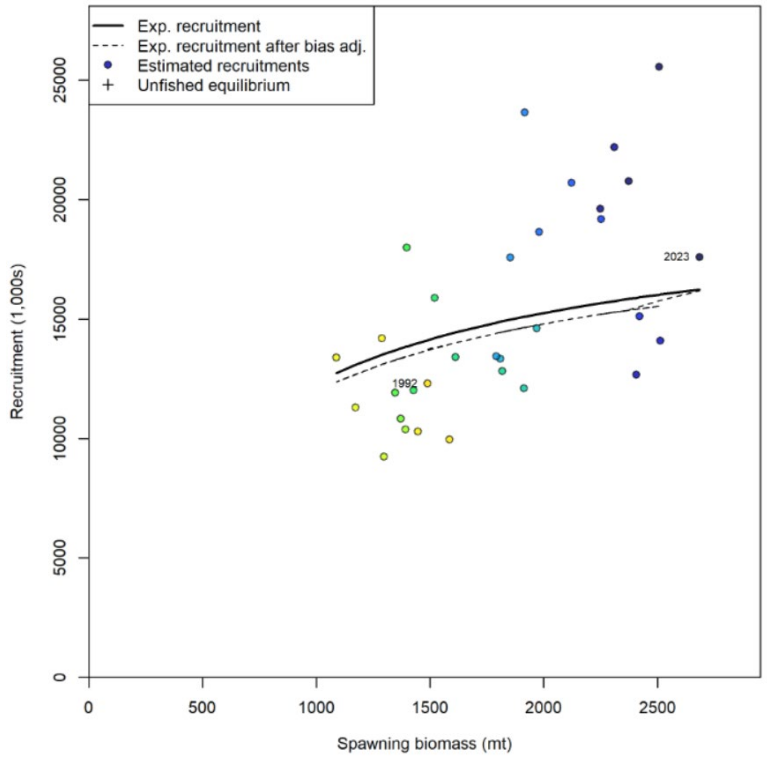


A graph with the same data but showing the entire curve and estimated parameters

From a presentation by Chris Swanson

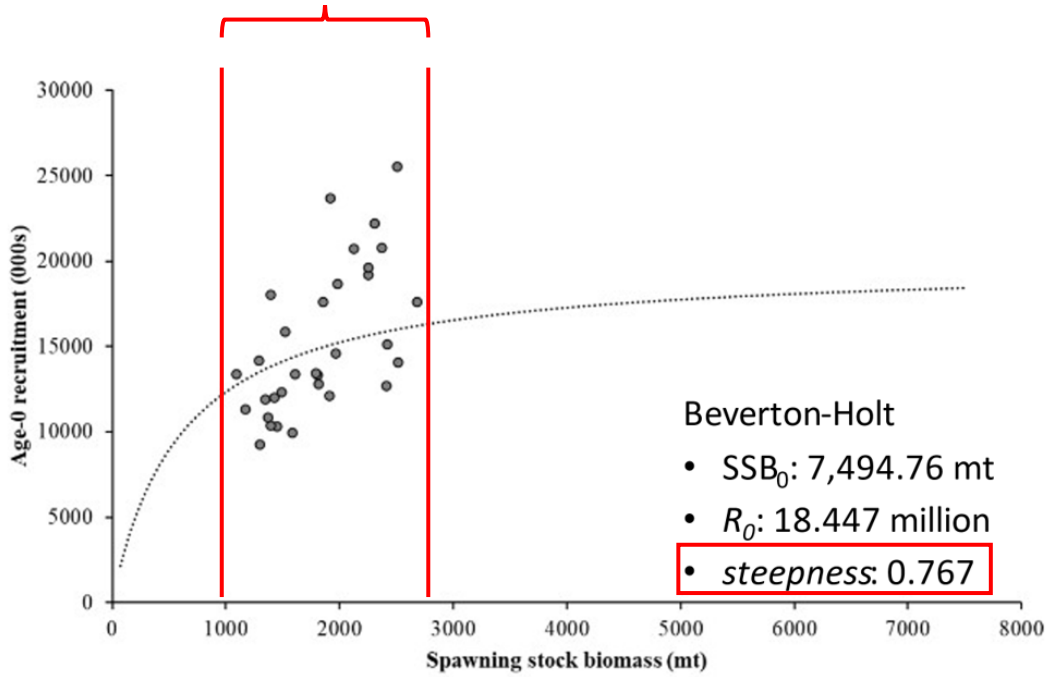
Steepness is difficult to estimate reliably
Yellowtail Snapper example





SRR estimated by the SEDAR 96 stock assessment model for the observed range of SSB

Observed SSB range



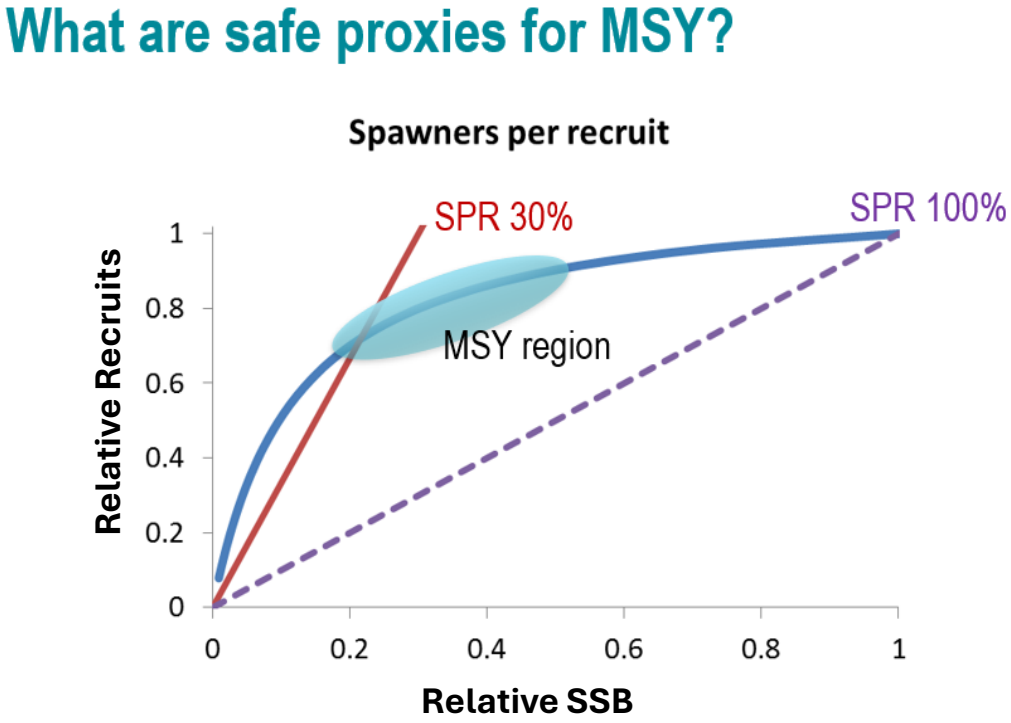
A graph with the same data but showing the entire curve and estimated parameters

From a presentation by Chris Swanson

How do we relate stock productivity to the choice of SPR proxies for MSY?

$$\textbf{SPR} = \frac{\textit{Spawning Biomass Per Recruit in Fished Condition}}{\textit{Spawning Biomass Per Recruit in Unfished Condition}}$$

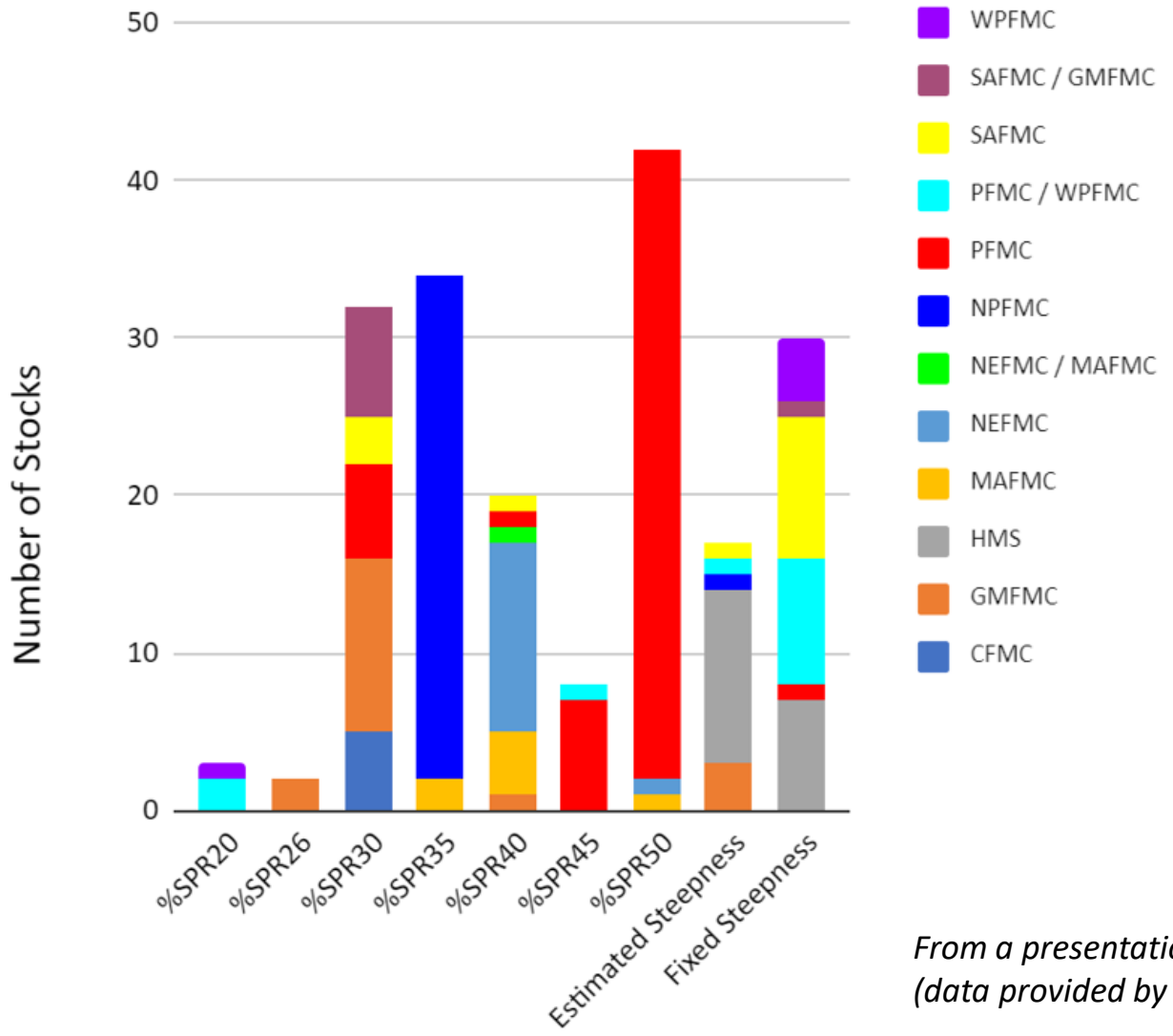
- SPR is based on life history (growth, reproduction, etc.) **for a given selectivity pattern**.
- Choice of SPR proxy can be arbitrary but the goal is to maintain SSB within safe biological limits, while also limiting foregone yield.



From a presentation by Clay Porch

Use of SPR-based MSY proxies by US Council Region

- Different Councils use different SPR proxy values for MSY.
- **17** out of **188** stocks have estimated steepness.
- Only **1** for stocks managed by SAFMC.

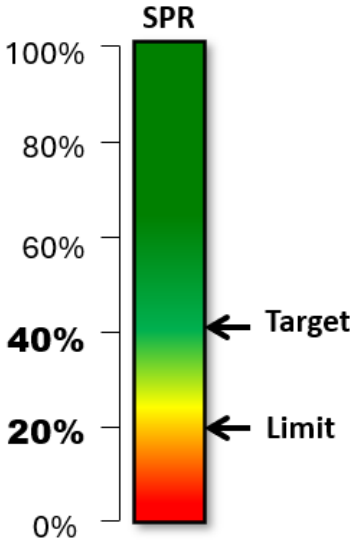


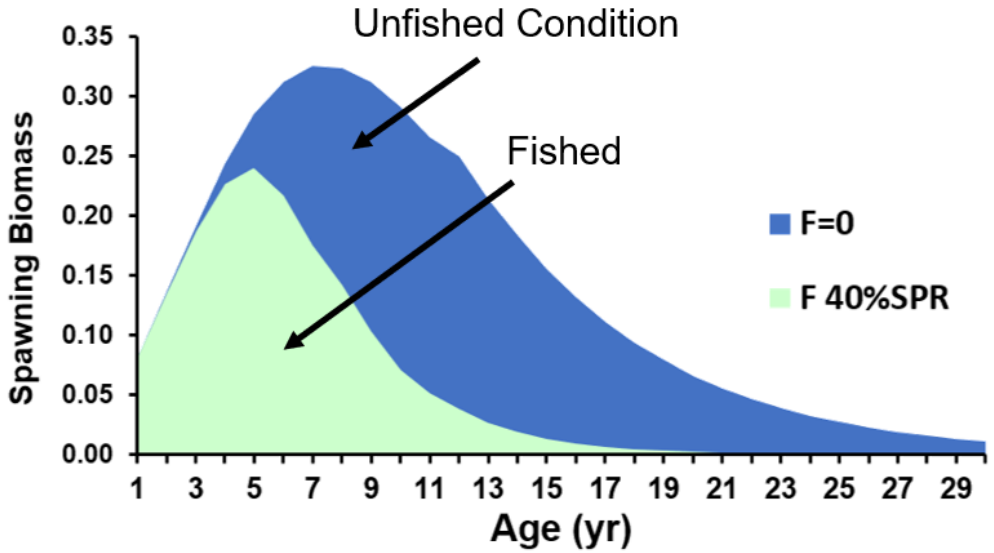
From a presentation by John Walter (data provided by Rick Methot)

Examples of SPR Values for Florida-Managed Fisheries

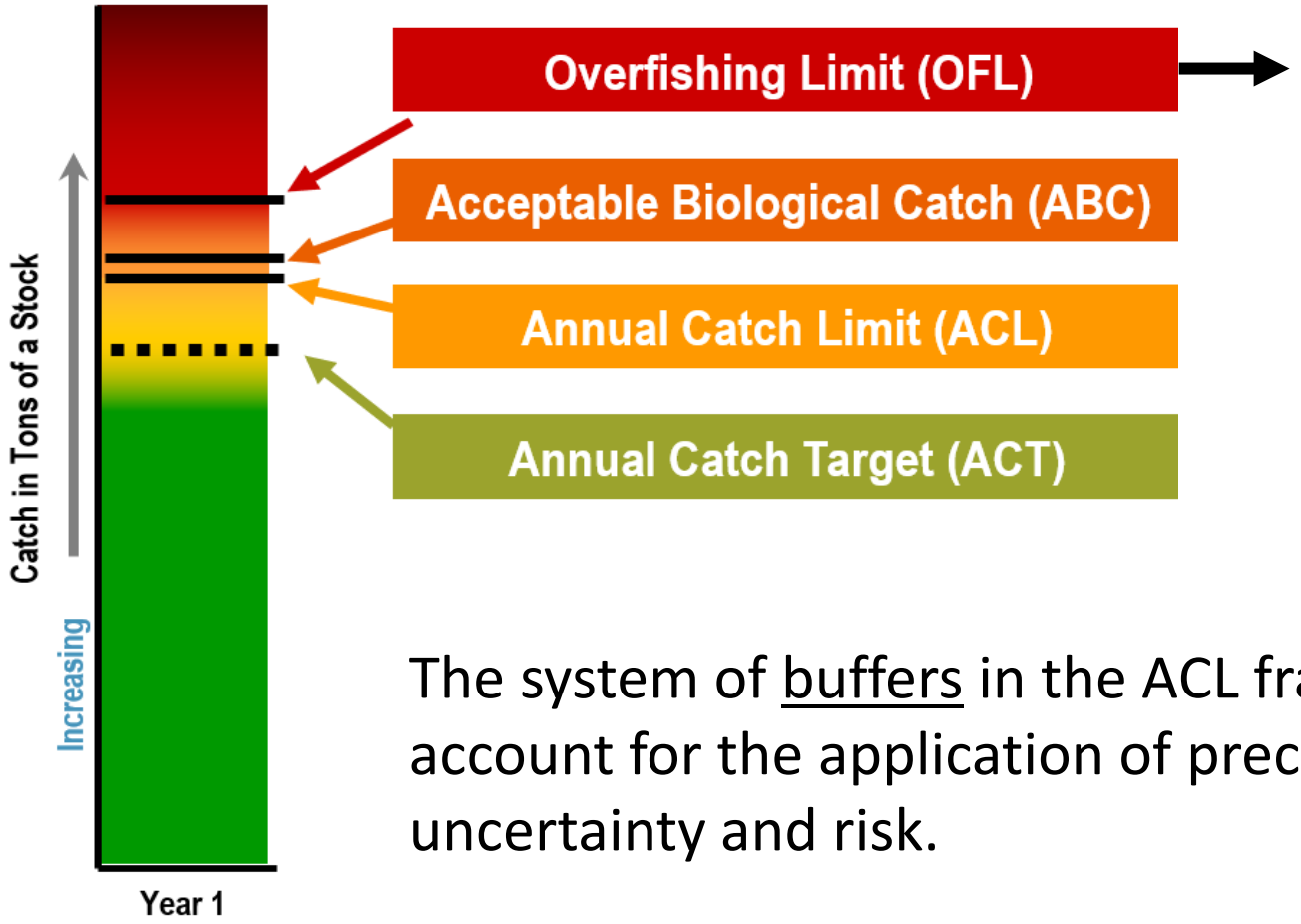
- Florida FWC manages Snook based on 40% SPR to provide anglers with high abundance, larger sizes, and resilience from cold kills and red tides.
- Red drum: 40% Escapement; Spotted Seatrout: 35% SPR.

SPR = 40%





How do we fit SPR-based MSY proxies into the ACL framework?



Corresponds to MSY or its proxy

The system of buffers in the ACL framework explicitly account for the application of precaution due to both uncertainty and risk.

From a presentation by Rick Methot

Workshop Goals:

- Provide a forum for a national discussion on the status of the science needed for ACL implementation.

- Conducted jointly with the Regional Fishery Management Councils and involving nationally recognized experts.

NOAA
FISHERIES
SERVICE

Science – Management Flow

- Science informs development and evaluation of a potential harvest policy
  - —Shape, level, included factors in control rules
  - —Tradeoff analysis of buffer size vs. foregone catch & stock protection
  - —Tailored to expected information available for subject fisheries
- Council adopts policy (the control rule) and codifies in FMP amendment
- Annual implementation of policy according to Best Scientific Information Available

Science does not decide the policy; policy-makers cannot make informed policy without the science

From a presentation by Rick Methot

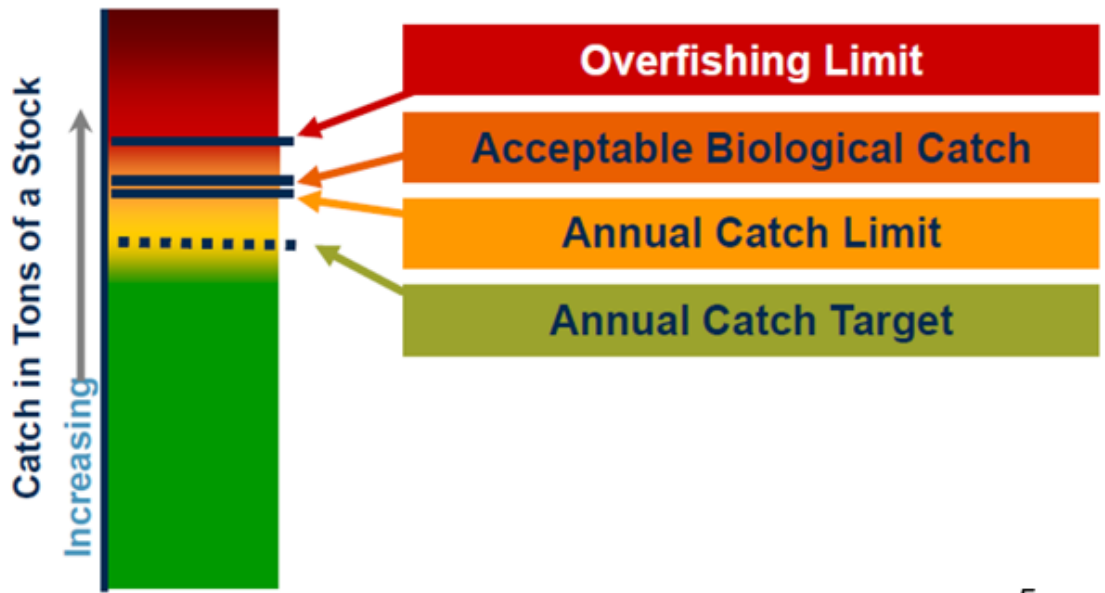
Role of Uncertainty and Forecasting in determining ACL's

OFL should not account for precaution, but does have uncertainty

— should correspond to long-term MSY

↑**Uncertainty** *leads to* ↑**Precaution** *leads to* ↑**Buffer** *and* ↓**ACL/ACT**

— Tolerance for risk is an important part of this



From a presentation by Erik Williams

Management situations that would require a higher or lower SPR

- SPR proxies should be determined for each stock depending on its life history, biology (i.e., productivity, resilience) and fishery characteristics.

Higher Productivity
and Resilience

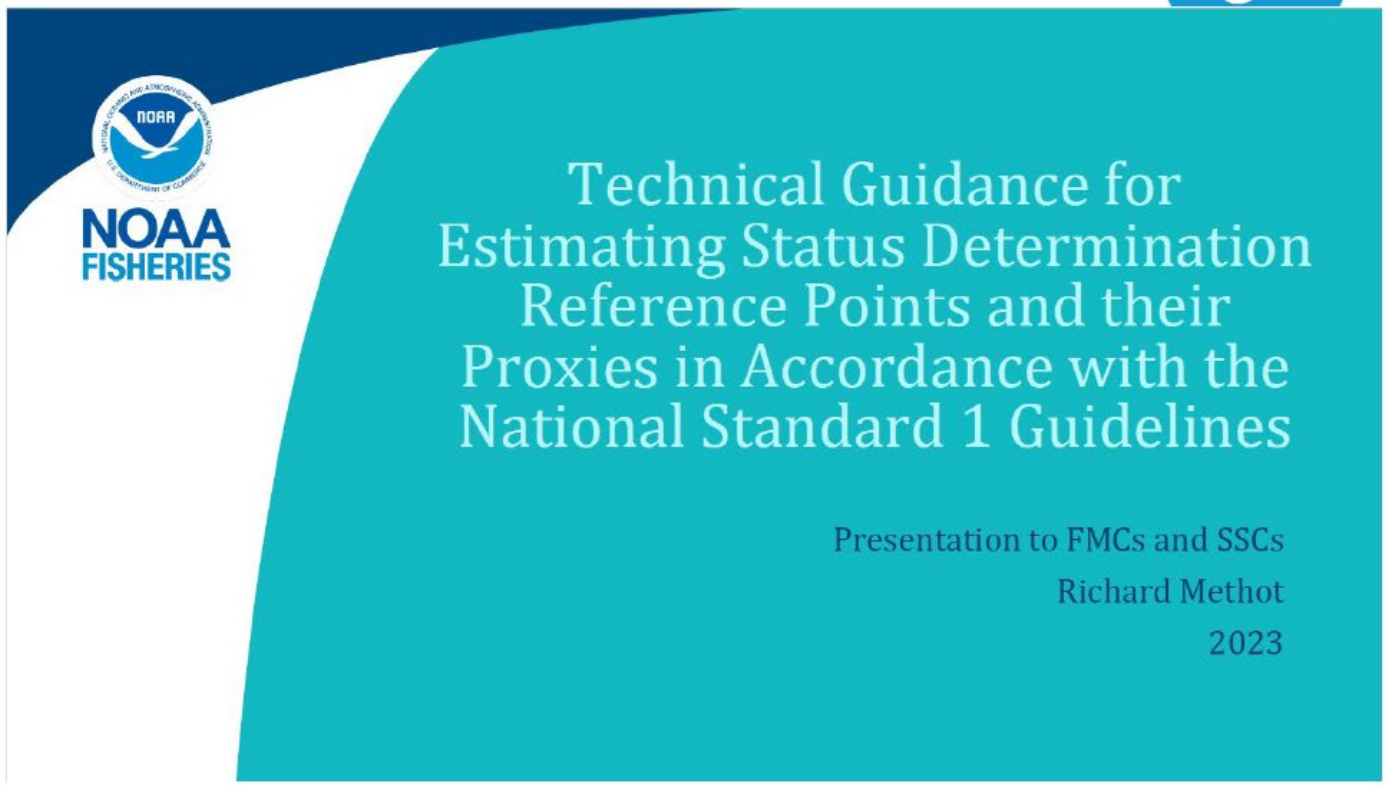
Versus

Lower Productivity,
Higher Vulnerability

- Ideally, should account for the species density-dependent compensatory capacity (i.e., as fishing reduces population density, the population responds with altered life-history traits: earlier maturation, faster growth, increased fecundity, etc.).

NS1 recommendations for SPR proxies

SSC received presentation at the July 27, 2023 webinar meeting.



From a presentation by John Walter

Approaches to calculating MSY-related quantities and SDCs: Age-structured methods

Direct Estimation

- Choosing the SRR functional form and parameterization
- Estimating parameters of the SRR curve
- Using priors for one or more of the SRR parameters
- Regional differences have evolved - tailored to local data and situation

Data-moderate MSY-based Proxies

- Proxies for Fmsy: recommended %SPR in range of 30-60%, with default of 40-45% for most stocks
- Proxies for Bmsy: Mean Recruitment x SSB/R @ Fproxy; %B0

NOAA FISHERIES

From a presentation by Rick Methot

Recent: Zhou et al. (2020) Results

- Used records from the RAM Legacy Database (RAMLD)
- SPR_{MSY} predicted from life-history parameters and gear selectivity.
- The calculated SPR_{MSY} ranges from about 13% to 95% with a mean of 47%.
- About 64% of the stocks in the RAMLD require $SPR_{MSY} > 40\%$.

From a presentation by John Walter

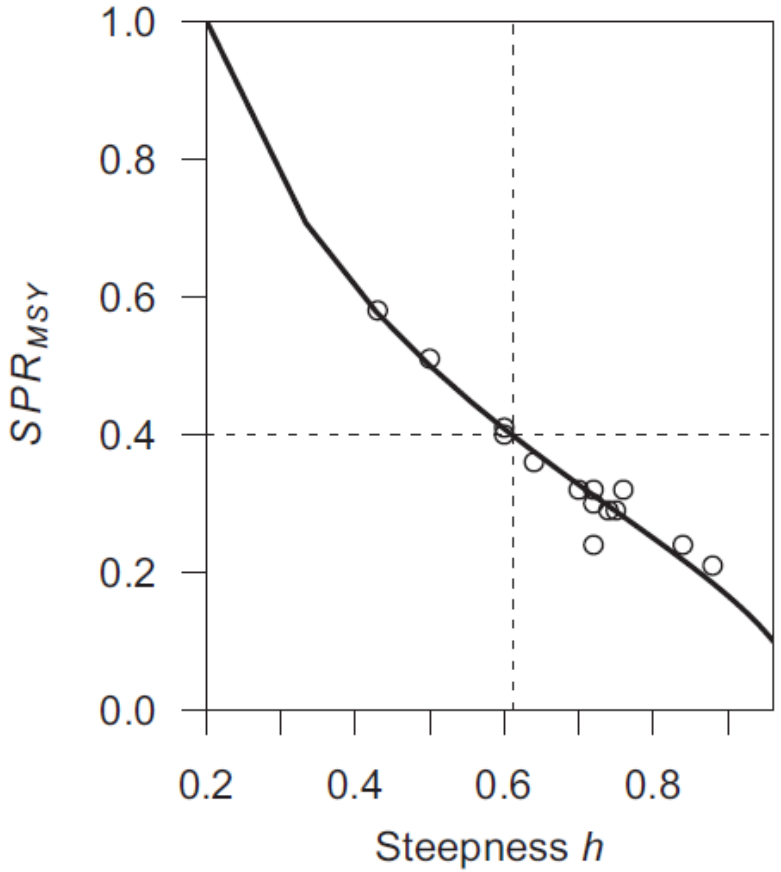
Main Concerns

- Based on 185 global stocks (US, Antarctica, Indian Ocean, Mediterranean, South America, etc.)
- Includes species ranging from anchovies and sardines all the way to rockfishes, sharks and rays.
- Not enough info on the quality of F_{MSY} estimates obtained from the RAMLD.
- Opted to use as many estimates as possible to increase sample size because it was difficult to determine which estimates in the RAMLD were accurate.

Fish Reproduction in Cold-Water Systems

- Cold-water systems are often food-limited and exhibit high seasonality with a short window in which offspring can survive.
- Fish species in these systems have slow gonadal development, restricted spawning seasons, and determinate fecundity.
- Sequential hermaphroditism is uncommon in these systems.

From Zhou et al. 2020



"Initial value" recommended in Shertzer and Conn (2012) for southeast US stocks is 0.84

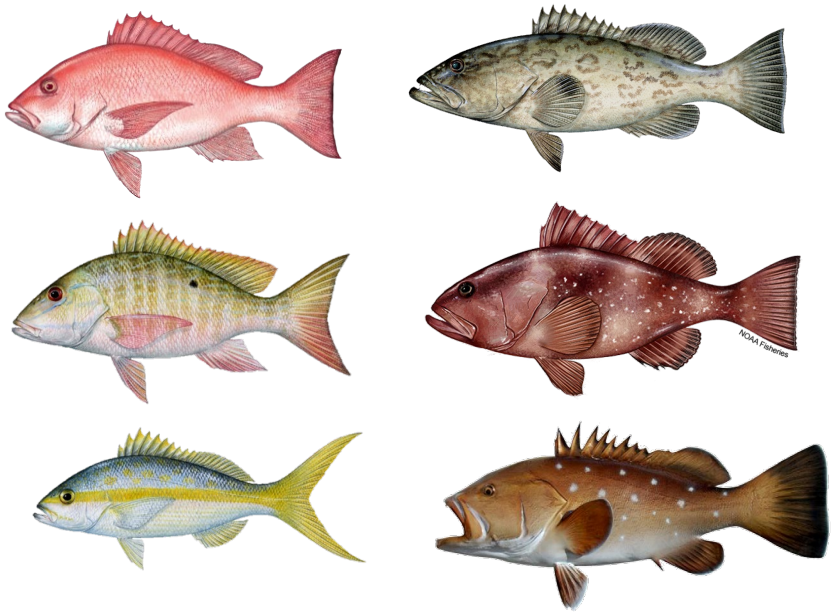
Fish Reproduction in Warm-Water Systems

FEATURE ARTICLE

2023

A unified framework and terminology for reproductive traits integral to understanding fish population productivity

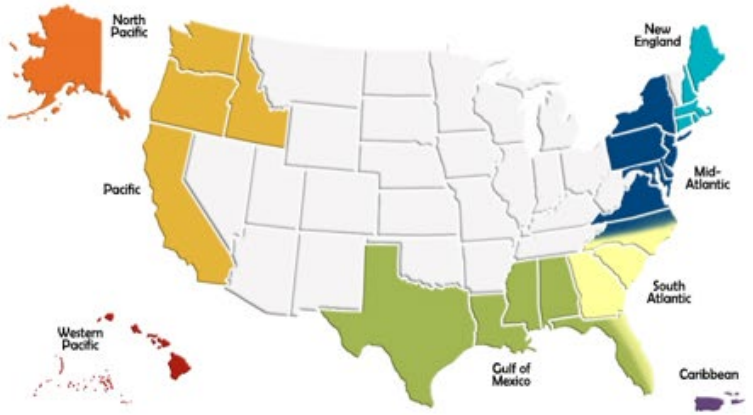
Susan K. Lowerre-Barbieri[1,2] | Nancy J. Brown-Peterson[3] | David M. Wyanski[4] | Heather E. Moncrief-Cox[1,5] | Kevin J. Kolmos[4] | Hayden S. Menendez[2] | Beverly K. Barnett[6] | Claudia Friess[2]



Southeast US federally-managed finfish stocks:

- 100% have <u>indeterminate fecundity.</u>
  - Multiple batch spawners that recruit new oocytes during the spawning season.
- 96% produce pelagic eggs ~ 1 mm diameter.
- Most (68%) have extended (≥ 5 months) spawning seasons.
- A third are sequential hermaphrodites.

The nationwide Council structure requires a nationally-cohesive but regionally-specific approach



New England | Mid-Atlantic | South Atlantic | Caribbean | Gulf of Mexico | Pacific | Western Pacific | North Pacific

Main Takeaways:

- Ideally, estimate MSY directly. However, this is rare given data limitations. Thorough evaluation of the quality of steepness estimates is critical.
- SPR proxies should be stock-specific and account for the stock's biology (productivity and resilience) and fishery characteristics.
- MSY is a limit reference point. The SPR proxy for MSY should not be precautionary. Address uncertainty and precaution through the appropriate buffers (i.e., ABC, ACL, ACT).
- The default %SPR values recommended in the Draft NS1 Technical Guidance Memo do not properly account for the biology of SAFMC-managed stocks.
- For SAFMC stocks, SPR proxies in the range of 30-40% seem more appropriate.