Appropriate Limit Reference Points for WCPO Elasmobranchs

Shijie Zhou, Matthew Dunn, Ashley Williams

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Related projects

- 2014: Clarke, S. and Hoyle, S. Development of limit reference points for elasmobranchs. WCPFC-SC10-2014/ MI-WP-07.
  - Thoroughly reviewed appropriate limit reference points (LRPs).
  - Recommended a tiered framework.
  - Suggested risk-based approaches for defining LRPs.
  - Identified the collation of information on LHPs as a priority issue.
- 2015: Clarke, S., et al. Report of the Pacific shark life history expert panel workshop, 28-30 April 2015. WCPFC-SC11-2015/ EB-IP-13.
  - Compiled a comprehensive LHP data for 16 WCPO elasmobranch stocks.
- 2019: Zhou, S., Deng, R., Hoyle, S., and Dunn, M. Identifying appropriate reference points for elasmobranchs within the WCPFC. WCPFC-SC15-2019/MI-IP-04.
  - Derived risk-based reference points for 15 elasmobranch stocks.
  - Reviewed potential methods for estimating fishing mortality for data-poor species.
  - Reviewed other potential management procedures.

Objectives of current report

- Summarize existing results relevant to identifying appropriate LRPs for elasmobranchs in the WCPO;
- Discuss additional new developments in defining reference points for elasmobranchs

Two types of reference points

- Biomass-based (*B*-based):

  e.g. B_{msy}, B_{mey}, B_{lim}, B_{pa}, x%SSB_0, x% B_0 (depletion).
- Fishing mortality-based (*F*-based):

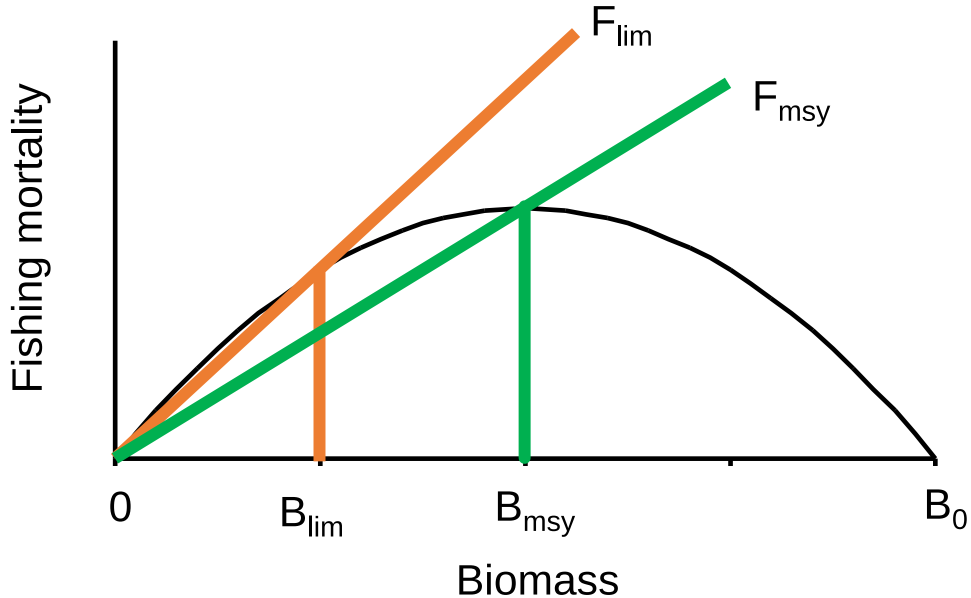
  e.g. F_{msy}, F_{mey}, F_{lim}, F_{pa}, $F_{x\%SPR}$ ($F_{x\%}$)

Ideally, both biomass and fishing mortality based RPs should be developed.

Spawning biomass per recruit (SPR) approach is a F-based reference point.

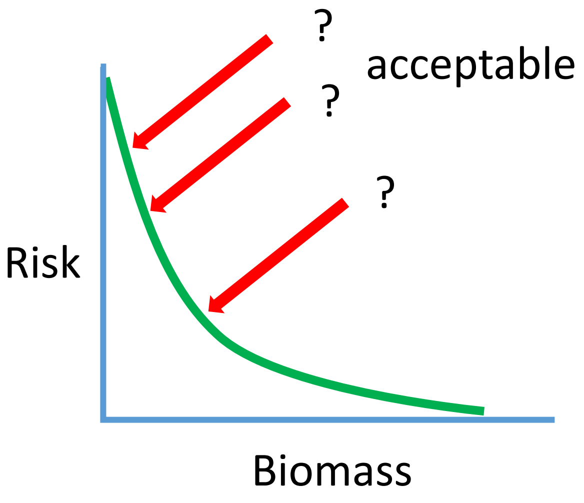
Relationship between B-based and F-based RPs

- A *B*-based RP has a corresponding *F*-based RP, e.g.,
- $B_{msy} \leftarrow\rightarrow F_{msy}$;
- $B_{lim} \leftarrow\rightarrow F_{lim}$;
- Theoretically, maintaining constant F_c (such as $F = F_{msy}$) year after year will lead to corresponding B_c (i.e. $B = B_{msy}$).



Appropriate limit reference points for elasmobranchs (1)

- LRPs are set primarily on biological grounds to protect the stock from serious and irreversible fishing impacts.
- Such a “biological risk” increases continuously as the stock becomes more depleted.
- What level of biological risk is considered as “unacceptable” is not only a scientific question but also a social choice.
- Managers, based on management objectives, should provide guidelines for developing LRP.



Appropriate limit reference points for elasmobranchs (2)

- The Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (CCMWCPO) adopts "a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened".
- The WCPFC has adopted a benchmark $20\%SB_{unfished}$ as the LRP for some target species.
- Acceptable biological risk should be the same for target and non-target species.

Appropriate limit reference points for elasmobranchs (3)

- In risk-based approach, biomass is “vulnerable biomass” instead of “spawning biomass”.
- We recommend LRP for non-target species as $B_{lim} = 0.25B_0$, consistent with commonly adopted $0.2\sim0.3B_0$, and similar to ERA LRP in Australia.
- This LRP can be linked to simple classic production model.
- Corresponding to biomass RPs, F-based LRPs are calculated as: $F_{lim} = 1.5F_{msy}$.

Methods for estimating F-based reference points

1. Empirical relationship: RPs ~ LHPs
2. Demographic analysis: Euler-Lotka equation
3. Intrinsic population growth rate from literature
4. SPR ($F_{40\%SPR}$ or $F_{60\%SPR}$)

The combined RPs from multiple methods are recommended:

$cF_{msy} = 1/n \sum F_{msy,i}$

$cF_{lim} = 1/n \sum F_{lim,i}$

Combined reference points (cF_{msy} and cF_{lim}) from multiple methods

		cF_{msy}				cF_{lim}			
ID	Stock	Mean	sd	L10%	H90%	Mean	sd	L10%	H90%
1	BSH-N	0.14	0.08	0.05	0.25	**0.21**	0.11	0.08	0.37
2	BSH-S	0.13	0.05	0.06	0.17	**0.19**	0.07	0.09	0.26
15	EUB	0.09	0.04	0.05	0.14	**0.14**	0.06	0.07	0.22
7	OCS	0.08	0.05	0.03	0.16	**0.12**	0.07	0.05	0.24
14	SPK	0.07	0.03	0.04	0.11	**0.11**	0.05	0.06	0.17
16	RHN	0.07	0.04	0.02	0.13	**0.11**	0.06	0.03	0.19
10	ALV	0.07	0.03	0.04	0.11	**0.10**	0.05	0.06	0.16
6	FAL	0.06	0.03	0.02	0.10	**0.09**	0.05	0.04	0.15
13	SPL	0.05	0.02	0.02	0.08	**0.07**	0.03	0.03	0.12
12	SPZ	0.05	0.04	0.00	0.10	**0.07**	0.06	0.00	0.14
11	POR	0.04	0.03	0.01	0.07	**0.06**	0.04	0.01	0.11
3	SMA-N	0.04	0.03	0.01	0.07	**0.06**	0.04	0.01	0.11
9	PTH	0.04	0.03	0.01	0.08	**0.06**	0.04	0.01	0.12
4	SMA-S	0.03	0.04	0.00	0.07	**0.05**	0.05	0.00	0.11
8	BTH	0.02	0.04	0.00	0.08	**0.04**	0.06	0.00	0.12
	Mean	0.07	0.04	0.02	0.11	0.10	0.06	0.04	0.17

Additional information and new development

- Cortés, E., and Brooks, E. N. 2018. Stock status and reference points for sharks using data-limited methods and life history. *Fish and Fisheries*, 19: 1110–1129.
- Zhou, S., Punt, A. E., Lei, Y., Aijun, R., and Simon, D. 2020. Identifying spawner biomass per-recruit reference points from life-history parameters. *Fish and Fisheries*, 21: 1–14.

First paper

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ORIGINAL ARTICLE

WILEY FISH and FISHERIES

Stock status and reference points for sharks using data-limited methods and life history

Enric Cortés[1] | Elizabeth N. Brooks[2]

[1]National Marine Fisheries Service, Southeast Fisheries Science Center, National Oceanic and Atmospheric Administration, Panama City, Florida

[2]National Marine Fisheries Service, Northeast Fisheries Science Center, National Oceanic and Atmospheric Administration, Woods Hole, Massachusetts

Abstract

Worldwide, many shark populations are classified as data poor, making it difficult to assess their status. However, for many sharks, their longevity, late maturation and low production of pups make them highly vulnerable to exploitation and highlight the need to assess their status. We compared reference points and stock status estimated from full stock assessments for 33 shark populations with those derived ana-

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Findings in the first paper

- Very good agreement between F_{msy} from stock assessments to those derived from natural mortality M.
- F-based reference points and associated uncertainty were more affected by selectivity than by adding more comprehensive data.
- For many shark stocks the F_{msy}/M ratio should not exceed ≈ 0.4.

Second paper

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ORIGINAL ARTICLE

FISH and FISHERIES WILEY

Identifying spawner biomass per-recruit reference points from life-history parameters

Shijie Zhou[1] | André E. Punt[2,3] | Yeming Lei[1] | Roy Aijun Deng[1] | Simon D. Hoyle[4]

[1]CSIRO Oceans and Atmosphere, St Lucia, Brisbane, Queensland, Australia

[2]CSIRO Oceans and Atmosphere, Hobart, Tasmania, Australia

[3]School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, USA

[4]NIWA, Port Nelson, New Zealand

Abstract

Analysis of spawning biomass per-recruit has been widely adopted in fisheries management. Fishing mortality expressed as spawning potential ratio (SPR) often requires a reference point as an appropriate proxy for the fishing mortality that supports a maximum sustainable yield—F_{MSY}. To date, a single generic level between $F_{30\%}$ and $F_{40\%}$ is routinely used. Using records from stock assessments in the RAM Legacy

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Findings in the second paper

1. Spawning potential ratio at MSY is not constant but a declining function of F_{msy}.
2. Using $F_{40\%}$ as F_{msy} proxy is equivalent to assuming F_{msy} = 0.28 for all species.
3. SPR_{msy} can be determined by life-history traits.
4. Elasmobranchs require about 20% higher SPR_{msy} than teleosts (median SPR_{msy} = 0.77).

It is not appropriate to use a fixed percentage such as $F_{60\%SPR}$ as an reference point for all stocks

Discussion and recommendation

- We continue to support the tier-based approach by Clarke and Hoyle:
  - For stocks assessed using a stock assessment model, reference points estimated in the same stock-assessment should be adopted.
  - For stock without stock assessment, or when the results are not robust, use risk-based RPs.
- Adopt B_{lim} = 0.25B_0 and corresponding F_{lim} = 1.5F_{msy} as LRPs for WCPO elasmobranchs. This is more consistent with 20%$SB_{unfished}$ for target species.
- Do not use a constant percentage of SPR such as $F_{60\%SPR}$ as a reference point for all stocks.
- This study focuses on single species paradigm. If ecological interactions and ecosystem structure are considered essential in management decision, using F_{msy} as LRP is less risky.
- It is important to continue research to provide or improve estimates of life-history parameters and gear Selectivity.

Thank you

Shijie Zhou, Ph.D.
Senior Principal Research Scientist
Oceans and Atmosphere
Commonwealth Scientific and Industrial Research Organization
Brisbane, Australia
Phone: +61 7 38335968
Email: shijie.zhou@csiro.au