Gulf of Carpentaria Crimson Snapper Stock Status Summary - 2020

Crimson Snapper (*Lutjanus erythropterus*)

Assessment Authors and Year

Saunders T. and Roelofs A. 2020.

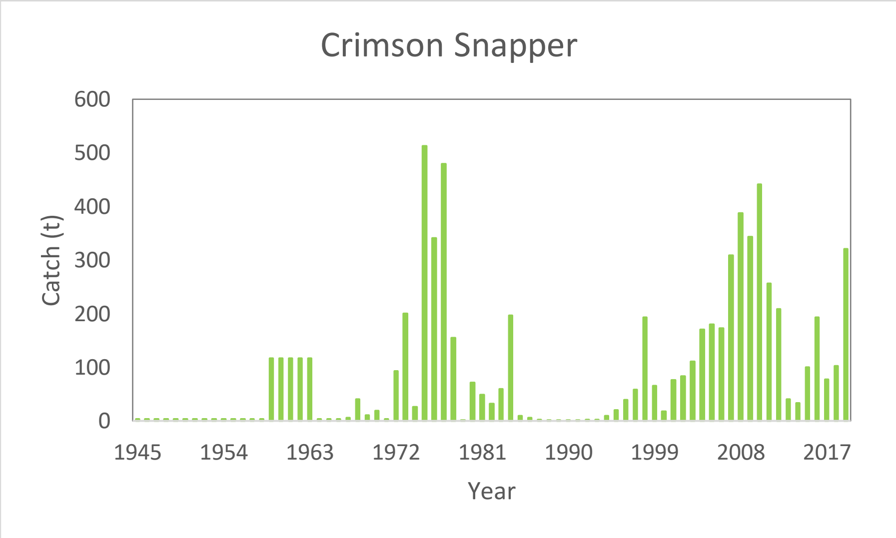
Stock Structure

Crimson Snapper is a long-lived, widespread Indo-Pacific species found throughout tropical northern Australia (Fry and Milton, 2009; Newman et al., 2000). Genetic analyses indicate that there is broad scale connectivity of Crimson Snapper across the Australian Arafura and Timor Seas (Salini et al, 2006). However, more recently Crimson Snapper were found to have separate stocks in Joseph Bonaparte Gulf, Timor and Arafura seas and Gulf of Carpentaria and it is assumed that Crimson Snapper have the same stock structure due to the similarities in their distributions and biology (Saunders et al. 2018).

Here, assessment of stock status is presented for the Gulf of Carpentaria management unit.

Stock Status

Catch trends



Total annual Crimson Snapper catch by all fishing sectors from 1945 - 2019.

Stock Assessment Methodology

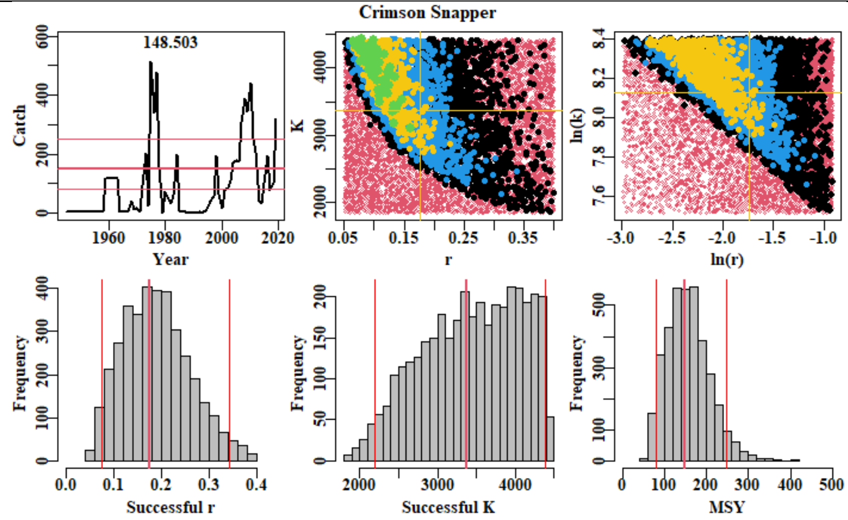
Year of most recent assessment	2020
Assessment method	Catch-MSY model-assisted catch-only assessment (Martell and Froese, 2013) using the 'datalowSA' package in R (Haddon et al. 2018). This uses population productivity (*r*) and carrying capacity (*K*) parameters of an underlying Schaefer production model, applied to total annual catches, to estimate the ranges in biomass and harvest rate that could have resulted in the annual catches.
Main data inputs	Annual total landed catch of Crimson Snapper by calendar year across all sectors and all fishing gears from 1981 - 2019, derived from catch return logbooks for the commercial and Fishing Tour Operator sectors and periodic recreational surveys.
Key model structure and assumptions	'Resilience' was manually set in the Catch MSY model specification and allowed for a possible range in population growth rate (*r*) of 0.05-0.4.
Sources of uncertainty evaluated	Initial *K* set to 1-60 x maximum catch due to there having been relatively small catches by all fishing sectors. The Catch-MSY analysis explored wide ranges of underlying Schaefer production model *r* and *K*, achieving successful biomass and harvest rate trajectories over 95% ranges of: *r* = 0.07 - 0.34; and *K* = 2197 t - 4381 t. The assessment successfully covered modes in the probability distributions of *r*, *K* and MSY.

Status Indicators and Limits Reference Levels

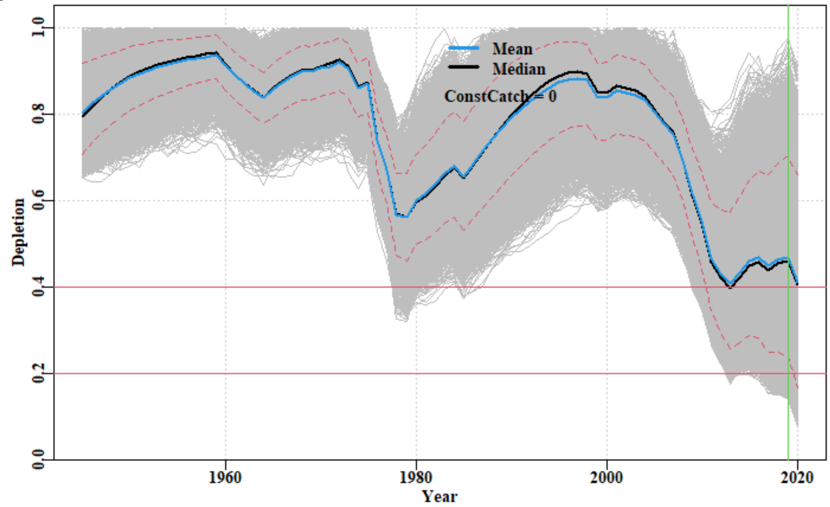
Biomass indicator or proxy	Mean annual biomass and depletion level, as estimated in this assessment.
Biomass Limit Reference Level	B_{lim}, expressed as 20% of *K* (B_0), the carrying capacity for the stock as estimated in this assessment.
Fishing mortality indicator or proxy	Mean annual harvest rate, as estimated in this assessment.
Fishing mortality Limit Reference Level	F_{targ}, being the estimated harvest rate that should prevent the stock from declining below the biomass target B_{targ} (B_{MSY}).

Stock Assessment Results

Crimson Snapper Catch MSY assessment results showing: annual catch trajectory (t) with estimated MSY and 90th percentile; scatter plots of *K* vs *r* combinations explored with red dots depicting failure and other colours depicting combinations of initial depletion that succeeded for each *r*-*K* pair (right-hand plot is the log-transformed version of the left-hand plot); and histograms of the probability distributions of successful *r*-*K* pairs and the resulting MSY estimates, with red lines showing the median and 90th percentile confidence intervals.



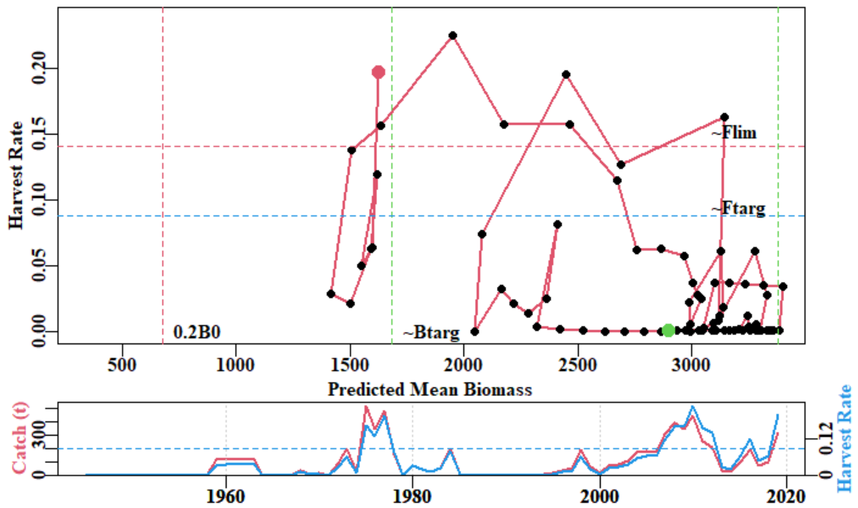
Range of depletion trajectories for successful *r*-*K* pairs, showing mean and median annual depletion and 80th and 90th percentiles (dashed lines). The lower red line is the $0.2B_0$ limit reference point, while the upper is the Schaefer B_{MSY} ($0.5B_0$) target reference point. The vertical green line indicates 2019, the final year for which data are available.



Crimson Snapper stock status trajectory from 1945 - 2019, showing annual stock status in estimated biomass (t) and harvest rate.

Reference levels are shown for biomass target (B_{MSY}) and limit ($0.2B_0$) reference levels, and for the corresponding harvest rates that should keep biomass at or above the target F_{targ} (F_{MSY}) and above the limit F_{lim} (F_{B20})

The start of the trajectory in 1945 is indicated by a green point and final year 2019 by a red point. The red line on the bottom plot is catch and the blue line is harvest rate.S



<table>
<tr><td>Summary output of key parameters from the Crimson Snapper Catch MSY stock assessment, showing mean estimates for r, K and Current Depletion, with 95% Confidence Intervals.</td><td>

Parameter	2.5%	Mean	97.5%
r	0.07	0.18	0.34
K	2197	3375	4381
CurrDepl	0.14	0.41	0.75

</td></tr>
<tr><td>Biomass status in relation to Limit</td><td>The assessment estimates the higher catches during the 2000s and early 2010s followed by a recent high catch in 2019 has not caused the stock to become significantly depleted.
The mean estimate of current B is 41% of B_0, with a 95% Confidence Interval of 14% - 75%, well above the B_{lim} level of $0.2B_0$.</td></tr>
<tr><td>Fishing mortality in relation to Limit</td><td>Estimated mean harvest rate exceeded F_{lim} several times during the peak catches in the 1970s and again during 2005-2011 after a series of high catches during this time. In 2019, F (0.19) has again exceeded F_{lim} but this has been the first time this has happened since 2011.</td></tr>
<tr><td>Previous SAFS stock status</td><td>New stock.</td></tr>
<tr><td>Current SAFS stock status</td><td>Based on the results of this Catch MSY analysis, Crimson Snapper is considered to be Sustainable</td></tr>
</table>

Qualifying Comments

There is high uncertainty in the estimates of biomass depletion, harvest rate and MSY derived from catch data using Schaefer production model-assisted Catch MSY analysis. In particular, Catch MSY is particularly poor at providing precise estimates of depletion, but its negative biomasses are most likely to be over-precautionary outputs, especially in lightly fished stocks (Free et al. 2020). However, early peak catches during the 1970s followed by a period of low catches until the recent high catches in the 2000s and early 2010s probably gives the Catch MSY model sufficient contrast to estimate the model parameters. The model outputs indicate that the current biomass of Crimson Snapper is 41% of unfished levels and while the current F is above the limit point, 2019 was the first year since 2011 that this is happened so it is unlikely that the stock is depleting from this single breach of the limit.

References

Free CM, Jensen OP, Anderson SC, Gutierrez NL, Kleisner KM, Longo C, Minto C, Osio GC, Walsh JC. (2020). Blood from a stone: Performance of catch-only methods in estimating stock biomass status. *Fisheries Research* **223:**105452.

Fry G and Milton DA (2009). Age, growth and mortality estimates for populations of red snappers *Lutjanus erythropterus* and *L. malabaricus* from northern Australia and eastern Indonesia, *Fisheries Science*, **75**: 1219–1229. http://link.springer.com/article/10.1007/s12562-009-0157-2

Haddon M, A Punt and P. Burch (2018). simpleSA: A package containing functions to facilitate relatively simple stock assessments. R package version 0.1.18.

Martell S and R. Froese (2013). A simple method for estimating MSY from catch and resilience. *Fish and Fisheries* **14**: 504-514.

Newman, SJ, Cappo M, Williams DM (2000). Age, growth, mortality rates and corresponding yield estimates using otoliths of the tropical red snappers, *Lutjanus erythropterus*, *L. malabaricus* and *L. sebae*, from the central Great Barrier Reef. *Fisheries Research* **48**:1–14.

https://www.sciencedirect.com/science/article/abs/pii/S0165783600001156

O'Neill MF, Leigh GM, Martin JM, Newman SJ, Chambers M, Dichmont CM, & Buckworth RC (2011). Sustaining productivity of tropical red snappers using new monitoring and reference points. http://era.daf.qld.gov.au/id/eprint/2261/1/FRDC_2009-037-DLD.pdf

Salin, J, Ovenden J, Street R, Pendrey R, Haryantis and Ngurah (2006). Genetic population structure of red snappers (*Lutjanus malabaricus* Bloch and Schneider, 1801 and *Lutjanus erythropterus* Bloch, 1790) in central and eastern Indonesia and northern Australia, *Journal of Fish Biology*, **68** (suppl. B): 217–234. http://onlinelibrary.wiley.com/doi/10.1111/j.0022-1112.2006.001060.x/full

Saunders TM, Welch D, Barton D, Crook D, Dudgeon C, Hearnden M, Maher S, Ovenden J, Taillebois L and Taylor J (2016). Optimising the management of tropical coastal reef fish through the development of Indigenous capability. FRDC final report 2013/017. http://frdc.com.au/project?id=499

Saunders, T., Barton, D., Crook, D., Hearnden, M. and Newman S. R. (2018). Stock/Management unit division in the Northern Territory Offshore Snapper Fishery. Unpublished fisheries report.