Shark Resource Assessment Group (SharkRAG)

Out of session advice – School shark bycatch TAC setting

Preamble

As requested at the SharkRAG2 2023 meeting (held on 4 December 2023), updated calculations for setting a school shark bycatch TAC for the 2024 SESSF season were initially emailed to SharkRAG members for advice on 18 December 2023 and finalised on 22 December 2023. **Table 1:** outlines the members emailed and dates advice was received (those deemed to have a conflict of interest were not emailed (industry members)). An explanation of the calculations used for providing advice on the school shark bycatch TAC is provided at **Attachment A**.

At SharkRAG2, meeting participants agreed to use the same approach as per 2022 and 23 for setting the bycatch TAC, noting that:

- updated catch and discard information was needed (including the application of 10% survivorship across all gear methods),
- the assumption that the school shark stock continues to rebuild at 3% per year
- the assumptions regarding Gummy Shark catch and RBC would still apply, and
- non-conflicted members would consider a bycatch TAC out of session.

Table 1: SharkRAG member out of session advice participants.

Member	Position	Dates comments/emails
Mr. Sandy Morison	Chair	18 & 22 December 2023
Dr. Robin Thomson	Scientific member	20 December 2023
Dr. Andrew Penney	Scientific member	21 December 2023
Dr. Charlie Huveneers	Scientific member	22 December 2023
Dr. Julian Morison	Economic member	19 December 2023
Ms. Anissa Lawrence	Conservation member	21 December 2023
Ms Cate Coddington	A/g AFMA member	18 & 20 December 2023
Ms. Michelle Henriksen	Executive officer (cc'd)	

Outcome

SharkRAG members pragmatically recommended **that the 'no state' TAC option (of 214,686 kg) be used to set the school shark bycatch TAC**, noting:

1. it is consistent with how the TAC has been set for the last two years, and the intent of the unavoidable bycatch of the gummy shark fishery.
2. while state catches do occur and are deducted from the RBC for species that are not under rebuilding strategies; in the case of overfished species the intent of the Commonwealth TAC is to constrain catches to the unavoidable bycatch level when targeting other species.

3. the recommended TAC does not make allowance for changes in the gummy shark TAC, given:

    a. the main determinant of unavoidable school shark catch would be fishing effort directed at gummy shark and not the actual gummy shark catch.

    b. the reason that the gummy shark TAC was reduced was that its population was estimated to have declined and therefore its overall density was also likely to have been reduced.

    c. The calculations pertain to the 2024 fishing season for which TAC has yet to be set but for which reduction has not been recommended.

    d. this would be expected to result in a decreased CPUE for all gears and a greater level of effort would be needed to catch each tonne of gummy shark.

    e. therefore, effort directed at gummy shark is unlikely to be reduced by the same amount as the gummy shark TAC, if at all.

    f. as the amount of total effort across this sector is the critical factor in determining the 'unavoidable' school shark catch, the default assumption should be that effort will not change.

4. the discard survival rate was set to 11.5%:

    a. this is based on Braccini et al (2012)[1], which estimated the total post-capture survival (PCS) for school shark taken in a gillnet fishery in Australia.

    b. anecdotally, a 10% survival rate had been previously suggested.

5. concerns were expressed by members on the underlying assumptions and inputs and, as such, the approach will need to be reconsidered going forward until an updated CKMR assessment is available. Concerns included:

    a. Ms Lawrence, Dr Huveneers and Dr Penney regarding not accounting for state catches.

    b. allowance for a change in the gummy shark TAC

        i. Dr Penney suggested that it would be possible to undertake additional analyses that might allow a better estimation of school shark bycatch rates, including of

            1. fisher behaviour on gummy shark CPUE, additionally industry is reporting substantial changes in the availability of school shark in areas or months where they were not commonly observed previously.

            2. shifts in distribution of school and gummy shark.

    c. Dr Huveneers raised concerns about the 11.5% survival rate as it: is based solely on gillnet methods and could be unrepresentative for hook and line methods, and half the estimate is based on a semi-quantitative method rather than an actual measurement of post-release survival.

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[1] Braccini, M., Van Rijn, J. and Frick, L., 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS one*, 7(2), p.e32547

Attachment A – Calculations towards RBC for school shark

Robin Thomson, CSIRO (with thanks to Paul Burch, Franzis Althaus, Sandy Morisson, Michelle Henriksen, Lara Ainley and Cate Coddington)

20 December 2023

The calculations described below were performed using a spreadsheet (Updated SHS RBC calcs 20 Dec 2023.xlsx) which is provided along with this Word document and used figures presented in the AUGUST 2023 version of the "catch report", Burch et al (2023). The 20 December 2023 version of the catch report will differ from the August version in that GAB trawl CDR landings will be incorporated into the calculation of total catches and discards will be estimated for that sector (Paul Burch pers. comm.) and to both the August and December versions in that the live discard survival rate has been increased to 11.5% as per Braccini et. al. 2012.

1. Background

The calculations described here aim to estimate the unavoidable bycatch of school shark, and to identify the component of that bycatch that are under quota in the SESSF. The components of the calculation of total removals of school shark, and other quantities used in these calculations, are:

1. **Commonwealth** commercial **landed** catches of school shark reflected in the CDR (Table 45, Burch et al, 2023) for the
    a. GHAT
    b. CTS trawl
    c. GAB trawl (GABT),
2. **Commonwealth** commercial **discarded** catches of school shark from
    a. Logbook reported discards (weights) for the GHAT sector from the logbook dataset (Table 57, Burch et al, 2023)
    b. Estimated discards for the CTS (excluding GABT) from ISMP observations scaled to the whole CTS (Deng et al, 2023; Table 55, Burch et al, 2023)
    c. Estimated GABT discards calculated by applying the CTS discard rate (2b above) to GABT CDR landings (1b above),
3. **state landed** catches (Table 45, Burch et al, 2023),
4. **state discards**, which are unknown – a 4% discard rate to reflect discarding of lice damaged fish was assumed as this is similar to the rate observed for gummy shark and, historically, for school shark before quota availability began to drive discarding,
5. the Close Kin Mark Recapture model for school shark (Thomson et al 2020) estimated a **3% p.a. increase** in the size of the school shark population therefore unavoidable catches are forecast to increase at that rate,
6. consideration could be given to likely change in school shark bycatch resulting from increased or decreased gummy shark quota and consequent change in fishing effort by the GHAT, as well as to likely changes in future fishing location (because school to gummy shark catch ratios vary (somewhat) predictably by region), the metier approach is a valid method for estimating this,
7. a **11.5% survival rate** (88.5% mortality rate) has been assumed for school shark across all gear types (survival rate inclusion from 87th Commission meeting - rate from Braccini et. al. 2012).

The CKMR model was used to project the school shark population forward, using an average future fishing mortality rate equal to the average over the final five model years (2013-2017). The resulting catches (total removals) are considered to be the upper limit for sustainable removals for school shark (Table 1). Caveats on this assumptions are (a) that the recovery rate of the population to 20% B_0 cannot be calculated because historical B_0 is neither calculated by that model nor likely to be attainable due to likely reduction in size of at least one sub-stock (Thomson et al 2020), and (b) that the deterministic projection can be regarded as the median of a very wide confidence interval that encompasses possible stock decline rather than 3% p.a. increase.

Table 1. Projected school shark catches (total removals) for the CKMR base case model project assuming the average exploitation from 2013-2017. These are taken by SharkRAG to be "maximum sustainable" catches.

Year	Catch (t)
2023	287
2024	296
2025	306
2026	316
2027	326
2028	336

2. Alternative scenarios

Calculations similar to those presented here were made in 2021 and 2022. The 2022 calculation was very similar to those presented here in its treatment of the Commonwealth catches and discards but is different in that it:

- did not consider any state catches or state discards,
- applied a single 3% p.a. increase instead of recognising that two years pass between calculations based on last year's catches, and their application to next year's fishing
- it is assumed that last year's discard will be discarded again next year (this assumption was made in 2021, but in 2022 we allowed forecast discards to be part of the TAC instead of subtracting them from the TAC, reasoning that quota limitation had forced those discards to occur).

The calculation that ignores state catches was repeated, and two alternatives that include state catches are presented – one including and the other excluding Western Australian (WA) catches. Note that WA landings:

i. were included in the CKMR assessment (for the years 2000 to 2017),
ii. more than doubled from 2019 to 2020 and more than tripled from 2020 to 2021, rising from 4.3t in 2019 to 33.2t in 2021,
iii. have not been received for 2022; the agreed practice is to assume the value from the most recent year for which data are available (i.e. 33.2t for 2021).

Table 2. School shark removals (catches and discards) during 2019 to 2022, and four year weighted averages that will be used to forecast future removals (copied from spreadsheet named *(Updated SHS RBC calcs 20 Dec 2023.xlsx*).

Year	CDR landings (2023 catch report)	Burch discards (2023 catch report)	Trawl disc %	CDR_GABT	GABT disc	Tot Commn CDR	Tot Commn discards	TOT removals (no state) 88.5% disc mortality	State catches (excl WA)	State catches (incl WA)	State removals (excl WA)	State removals (incl WA)	TOT removals (incl state) 88.5% disc mortality	TOT removals (incl WA) *88.5%* disc mortality	Weights
2019	221,423	78,609	0.250	2,524	841	223,947	79,450	294,260	35,067	39,424	36,528	41,066	330,788	335,327	1
2020	134,170	80,190	0.250	2,516	839	136,686	81,029	208,396	20,115	30,259	20,953	31,520	229,349	239,916	2
2021	200,091	43,965	0.239	2,659	835	202,750	44,800	242,398	29,141	62,304	30,355	64,900	272,752	307,297	4
2022	205,624	63,744	0.116	4,327	568	209,951	64,312	266,867	29,127	62,290	30,341	64,885	297,208	331,752	8
Wted ave:							62,347	254,372			29,505	58,852	283,877	313,224	

2.1 Total removals

The landed and discarded catches and trawl discard rate listed above (in Background) are shown in Table 2 below. The three columns that have red headings represent three alternative methods for calculating school shark removals.

The ***TOT removals (no state) 88.5% disc mortality*** column in Table 2 is composed of:

1. the sum of all CDR reported landed catches (for the CTS, GHAT, GABT and a single year of 'Other'),
2. this discard total from Burch et al (2023) which sums the logbook reported GHAT discards, and the ISMP-derived trawl discard rate applied to the CTS (but not to the GABT, in error) multiplied by 0.885 to allow a 11.5% survival rate of discarded sharks,
3. GABT discards calculated by applying the CTS discard rate estimate to the GABT landings (from CDR) multiplied by 0.885 to allow a 11.5% survival rate of discarded sharks.

The **TOT removals (incl state) *88.5%* disc mortality** column in Table 2 is composed of everything listed above (points 1, 2 and 3), and:

4. state reported landings for NSW, Victoria, Tasmania, South Australia but not Western Australia (WA),
5. estimated discards of 4% from state catches to reflect (lice) damaged sharks.

The **TOT removals (incl WA) *88.5%* disc mortality** column in Table 2 is essentially the same as the previous calculation except that the landings (and 4% discards) from WA are included.

A weighted average, which gives greater weight to more recent figures, is shown below some of the columns.

2.2 Sustainable catch

If the projected catches from the CKMR model (Table 1) are considered to be sustainable catches, then the total removals should not exceed that amount. The calculation of total removals, as made in 2021 and 2022, does not exceed the 2024 figure of 296t, however, when state catches are considered, the total does exceed this amount.

2.3 TAC

Starting with the lower figure – either 296t or the calculated total removals, removals that are not deducted from quota have to be subtracted in order to calculate the TAC.

Table 3 shows the estimated total removals (four year weighted average) which is not adjusted to reflect a chance in the gummy shark TAC because this is hard to predict and might have little impact, but which is increased at a rate of 3% per annum over two years (2022 to 2024) to allow for higher unavoidable bycatch due to school shark population growth.

Total removals are capped at 296t, state removals are subtracted (with or without WA, depending on whether or not WA is included in the total removal) and average discards (which have already been discounted to allow for 11.5% survival) are removed. The resulting suggested TACs are shown in the final row of Table 3.

Table 3. Suggested TAC derived from the lower of 296t or the estimated total removals, increased by population growth, with deductions made for removals that are not under quota (copied from spreadsheet named *(Updated SHS RBC calcs 20 Dec 2023.xlsx*).

	No States	Incl States (no WA)	Incl States & WA
Total catch	**254,372**	**283,877**	**313,224**
Gummy TAC change	1	1	1
Popn increase	1.0609	1.0609	1.0609
Forecast removal	**269,863**	**301,165**	**332,300**
CKMR for 2024	296,000	296,000	296,000
Capped removals	**269,863**	**296,000**	**296,000**
Forecast State removals		31,302	62,437
Discard average (88.5%)	55,177	55,177	55,177
Comm TAC	**214,686**	**209,521**	**178,387**

3. Discussion

The median projection of the CKMR model using average exploitation rate over 2013-2017 resulted in a catch of 296t in 2024 that would allow the population to continue to increase at roughly 3% per annum (with 50% likelihood).

Recreational catches are poorly known and are ignored here.

The CKMR base case model did include catches from WA, as did all of the models considered by SharkRAG/SharkFAG in the past (Punt et al).

4. Reference list

AFMA (2023) 87th AFMA Commission meeting – Chair's Summary.

Deng R and Burch P (2023) Integrated scientific monitoring program for the Southern and Eastern Scalefish and Shark Fishery - discards for 2022. Prepared for the SESSFRAG meeting, 30-31 August 2023. Report for the Australian Fisheries Management Authority.

Braccini, M., Van Rijn, J. and Frick, L., 2012. High post-capture survival for sharks, rays and chimaeras discarded in the main shark fishery of Australia? *PloS one*, 7(2), p.e32547

Burch P, Cannard T and Sutton C (2023) SESSF catches and discards for TAC purposes using data until 2022. Prepared for the SESSFRAG Data Meeting, 30-31 August 2023. Report for the Australian Fisheries Management Authority.

Thomson RB, Bravington MV, Feutry P, Gunasekera R and Grewe P (2020) Close Kin Mark Recapture for School Shark in the SESSF. Final Report for FRDC Project No 2014/024.