2011 Stock Assessment Report for Gummy Shark (*Mustelus antarcticus*)

Prepared by the Shark Resource Assessment Group (SharkRAG)

Stock Structure

Gummy Shark is endemic to southern Australia and harvested by the SESSF from a single genetic stock extending from Bunbury in Western Australia to Jervis Bay in NSW. This single genetic stock is assessed as four separate sub-stocks within the four broad regions on the continental shelf of Bass Strait (BS), Tasmania (Tas), South Australia (SA), and Western Australia (WA). A second genetic stock is located off New South Wales in the region from Newcastle to Clarence River. A third genetic stock (potentially a separate species) is located off Queensland near Townsville (Gardner and Ward 1998; 2002).

For assessment purposes, Tas is defined as the broad region of waters south of latitude 41° South, which is just south of the north coast of Tasmania. BS is the broad region of waters south of the Victoria–NSW border, north of Tas, and east of the South Australia–Victoria border. SA is the broad region of waters between the Western Australia–South Australia border and South Australia–Victoria border. WA is the broad region of waters west of the Western Australia–South Australia border. SharkRAG assesses the BS, Tas and SA sub-stocks and the Western Australia fisheries agency assesses the WA sub-stock.

Biological indicators

Biological productivity:	Medium
Trophic level:	3 (Scale: planktivorous whale shark 1, top predator white shark 5)
Associated species:	School shark, Common Sawshark, Southern Sawshark and Elephantfish are byproduct
Percentage of gillnet catch targeted:	Most
Percentage of otter trawl catch targeted:	Negligible
Suggested environmental drivers:	Not examined, moon phase & water temperature affect targeting

Recent catch history

	2004	2005	2006	2007	2008	2009	2010	2011
Agreed TAC (Global) (t)	1800	1800	1800	1800	1800	1717	1717	1717
Calculated RBC (t)				1682	1682			
Actual Cmwth TAC (t)	1698	1717	1708	1701		1771	1821	1826
Actual State TAC (t)	102	83	83	82				
GHATF catch (t)	1495	1455	1358	1557	1762	1522	1408	1308
Trawl catch (SETF & GABTF) (t)	100	171	163	123	132	127	129	151
Estimated GHATF discards (t)	0	0	0					
Estimated trawl discards (t)	4	3	10					
% trawl discards	4	2	6					
State catch (t)	124	130						
Total catch (t)	1723	1759	1531	1680	1892	1649	1537	1558*

* 2011 figures still incomplete

The above catches are those reported from catch disposal records by calendar year. Additional catch was taken off Western Australia outside the SESSF; these were 239, 278, 338, and 337 t during 2002, 2003,

2004, and 2005, respectively. Historic GHATF discard rates have not been monitored, but are considered to be negligible. Current discard rates are being determined.

From the mid-1920s to the early 1970s Gummy Shark were mainly taken by the southern shark fishery of southern Australia as a by-product of targeting School Shark (*Galeorhinus galeus*) with baited hooks set on demersal longlines. Monofilament gillnets, which are more effective than hooks at catching Gummy Sharks, were first introduced in 1964, but it was not until the early 1970s that gillnets replaced longlines as the preferred fishing method, and then starting with Bass Strait (BS) Gummy Shark became the target species. In South Australia (SA) the targeted Gummy Shark fishery did not develop until the 1980s. Of the total catch of Gummy Shark from southern Australia, by all fishing methods, during 2002–04, 77% was taken by GHATF, 3% by SETF, 2% by GABTF, 3% by State-licensed vessels in South Australia, Victoria, Tasmania, and New South Wales, and 15% by State-licensed vessels in Western Australia. For management purposes, Gummy Shark is now the only species of shark recognised as a target species in the GHATF.

The targeted gillnet fishery for Gummy Shark has two important distinctive features, which strongly influence assessment and management. The first notable feature of the fishery is that the catch is comprised principally of just 4 year classes of sub-adult animals and the adult biomass remains relatively unfished. Secondly, catches remain remarkably stable over wide ranges of effort, in BS since 1973 when the fishery can be considered to have been fully developed effort has ranged from 15 - 54 thousand km.lifts while annual catch has remained between 732 - 1488t per annum, while in SA since 1981 when the Gummy Shark fishery developed in that region effort has ranged 11 – 45 thousand km.lifts while annual catch has remained between 223 - 680t (Walker & Gason 2009). These dynamics of the fishery mean that there is no index of adult abundance, and commercial catch rate data provide a poor index of sub-adult abundance for the quantitative stock assessments developed for the fishery (SharkRAG 2000). In contrast the stability of the catch of 4-7 year old sub-adults through a thirty year period of fishing and a four-fold range in effort levels, means that the wide variety of assessment models applied by SharkRAG over the years since its inception in 1994 all estimate that recruitment to the fishery has remained stable at its original level. Consequently SharkRAG members are confident of the current stability of recruitment to this fishery and far less confident of estimates of adult biomass or of pup production derived from the estimates of adult biomass.

2011 Assessment

There was no new assessment of Gummy Sharks during 2011. Thus the 2010 assessment was the basis for the setting of the TAC for 2012. During the 2010 assessment there were two developments in relation to the assessment of Gummy Sharks. Firstly, SharkRAG developed a new Tier 1 assessment (the results of which are reported below). Secondly, FRDC funded a Tactical Research Project led by Dr Jeremy Prince that is examining the potential of empirical indicators as an additional resource in setting of the RBC.

A new Tier 1 stock assessment was developed by SharkRAG in 2010. This new assessment was based on the 2006 stock assessment and implemented by Drs Robin Thomson and André Punt from CSIRO. Briefly, the model treats the sharks in BS, SA and Tas as completely separate populations with no movement of sharks among these regions, no exchange of pups, and no density dependent effects of one population on another. However, some model parameters concerned with Gummy Shark biology are shared among regions. Several biological relationships, such as that between age and length, length and weight, number of embryos per female and length, as well as gear selectivity, are fixed using information collected from fieldwork. Although gear selectivity (as a function of shark length), is fixed for each gear type, the model estimates an overall availability function which is taken to be a function of age. This reflects the assumption that larger sharks become less available for capture by the fishery, as indicated by observations made during multi-gear surveys. The model estimates adult natural mortality and, given demographic relationships along with the assumption that the stock was at carrying capacity prior to the fishery, computes natural mortality for pups. Since shark populations typically show a close relationship between the number of pups produced and the number and size of mature females, the model calculates the number of pups from the estimated number of mature females, and an annual pregnancy rate at length. This may be adjusted using a density dependence function, which assumes that the more sharks there are in the population the fewer pups will survive their first year.

The 2010 assessment included a change in how effort saturation/gear competition was modelled and a chance to allow for more appropriate consideration of SA catches which have not been taken by a single dominant gear type over the years for which catch-rate indices are available, which was assumed to be the case by the previous assessment. The inputs to the assessment have been updated to include catch data up to and including 2009, a revised set of catch-rate indices which include catch and effort data up to 2009, age-composition data for 2007 and 2008, and length-frequency data for 2007, 2008 and 2009.

The current status of the population relative to the 1927 level varies markedly among the various model configurations (posterior medians 34.3-73.4% for BS; 58.0-119.5% for SA; 68.2-85.9% for Tas) (Figure 1). This results in a range of RBC estimates (1121 - 2302 t) that depended on model structure and input parameters (Table 1). SharkRAG noted that the uncertainty captured within each individual assessment substantially underestimates that associated with model structure uncertainty. SharkRAG decided, that in the absence of any information to select between these results, that the appropriate approach was to set the RBC based on the mean of the median estimates from the plausible models, assuming equal weighting (Table 2).

Recommended Tier Level

Tier 1

RBC calculation

The RBC calculated from the the 2010 Tier 1 assessment was 1836 t. As noted above this was the mean of the median estimates from the plausible models (Table 2). With no new assessment, and no indications in the available data of concerns about the stock, SharkRAG recommended that the RBC from the 2010 assessment should be carried forward to the 2012 season, and that there be an overcatch and undercatch allowance of 10% for the 2012 season.

Additional comments from the RAG

- SharkRAG considers that the Gummy Shark stock is currently at a biomass level that is close to its target level. However, the changes in management arrangements for South Australia to address concerns about Australian Sea Lion and dolphin interactions are likely to have significant affects on the catch rates in this region which will need to be accounted for in future assessments. In addition, related gear changes (i.e., from net to line) will have profound implications for the assessment. Research is currently underway to begin to understand how these management changes will affect the fishery and the assessment.
- SharkRAG continues to consider Gummy Shark as a good candidate for a multi-year TAC once breakout rules have been developed. This is because of its stability over multiple years and long 40 year catch data history.
- SharkRAG noted that although the assessment had a good handle on recruitment size signature it is highly uncertain about adult sizes.
- SharkRAG noted a lack of understanding how density dependence works in this species and is supportive of further research that may shed light on this.

Tables and Figures

Table 1. Summaries of RBC (t) distributions by model configuration and region. The definition of the models can be found in Punt & Thompson (2010).

Model	Bass Strait			South Australia			Tasmania			All Combined		
	Low 5%	Median	Upper 5%	Low 5%	Median	Upper 5%	Low 5%	Median	Upper 5%	Low 5%	Median	Upper 5%
B	949	1274	1685	409	505	632	238	302	392	1708	2090	2533
D	806	1054	1369	359	440	561	203	255	332	1472	1764	2123
F	997	1377	1889	497	629	821	211	274	371	1875	2302	2862
G	867	1183	1624	448	572	748	180	239	322	1642	2017	2503
I	258	615	941	258	316	392	144	186	247	746	1121	1477
J	623	908	1273	301	369	457	140	182	245	1169	1472	1850

Table 2. Summaries of RBC (t) by region and overall, after combining results over all models.

RBC			
	Low 5%	Median	Upper 5%
Bass Strait	492	1088	1637
South Australia	293	467	712
Tasmania	154	240	352
All Combined	994	1836	2546

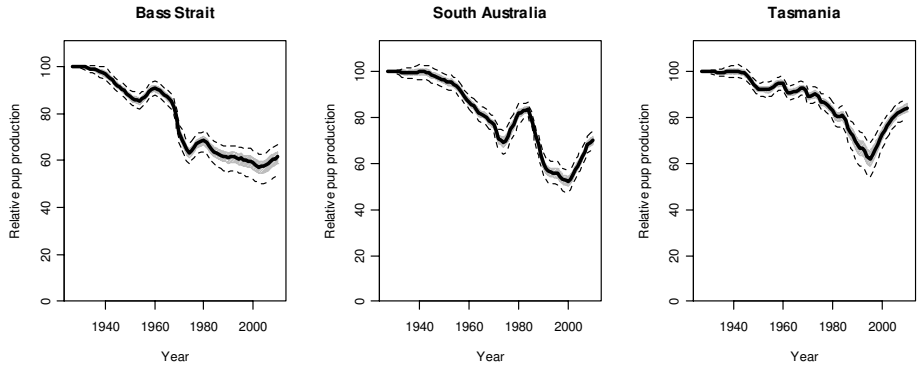

Figure 1. Posterior time-trajectories for pup production (relative to that in 1927) for the base case scenario. The solid line is the posterior median, the shaded area covers the most likely 50% of the posterior, and the dotted lines denote the posterior 90% intervals.