Stock status summary – Beachworms - 2020

This stock status summary presents available information to inform criteria required to determine a stock status consistent with the Status of Australian Fish Stocks reports (www.fish.gov.au)

Where data are unavailable or insufficient to reliably inform the SAFS criteria outlined below this has been indicated by 'NA' in the preceding tables, rather than removing the criteria. This has been done to clearly indicate what data are and are not available for assessment and to highlight areas where alternate or additional data sources or analyses may be required to improve species status determination in the future.

Assessment authors and Year

Chick, R.C and Barnes, T.C. 2020. Stock assessment report 2019 – Estuary General Fishery (Hand Gathering) – Beachworms (Onuphidae). NSW Department of Primary Industries. Fisheries NSW, Port Stephens Fisheries Institute. 64 pp.

Stock structure

This is a multi-species fishery. A genomic study on *A. teres*, sampled from hierarchically nested spatial scales along 900 km of NSW coast, identified six genetic groups with no clear geographic pattern to their distribution, suggesting considerable gene flow among populations (Padovan et al. in press; Appendix 3). Little is known about the genetic structure of the other species. However, as they also adopt a broadcast spawning life history (Paxton 1986), with larval distribution a function of oceanographic processes and likely larval behaviour, it is highly probable they represent similarly broad, interconnected populations.

The scale of assessment is made at the jurisdictional level (state-wide)

Stock Status

On the basis of the evidence provided the NSW stock status of beachworms is classified as **sustainable**.

A weight-of-evidence approach has been taken to assess stock status of NSW beachworms.

The data and information available in the current assessment reduce the level of uncertainty associated with many of the indicators of stock status from the previous assessment, where stock status was classified as undefined, these include; : i) State-wide levels of catch have been at historically low levels in recent years and have increased recently, whilst levels of catch rate ($CPUE_{day}$ and $CPUE_{hr}$) have been increasing for 3-4 years, to levels at or among recent (since 2009/10) historical highs; ii) Catches and catch rates ($CPUE_{hr}$) from Region 3 (from which the majority of the catch is harvested) have steadily increased or been stable above long-term average levels, respectively, and patterns of monthly catches have been consistent with previous years and at relatively high and consistent catch rates; iii) Catch rate ($CPUE_{hr}$) within Region 4 (the next most important region by total catch contribution) has demonstrated consistent increases within the last few years to levels in excess of its long-term average; iv) Uncertainty associated with recreational harvests has been reduced with recent estimates, from 2017/18, indicating recreational harvest equates to about 9% of the

commercial harvest, with the majority of that recreational catch coming from the Mid South Coast of NSW; v) Uncertainty associated with the population structure of beachworms has substantially reduced with a recent genetic study describing considerable gene flow among NSW populations; and vi) preliminary data from fishery-independent surveys are reducing uncertainty associated with the species composition of commercial catches, age and size/weight structures of beachworms and their distribution, abundance and biomass.

Catch trends

Commercial

Peak catches were recorded from 1994/95 to 2004/05, during which time there was some reporting of catch by number with total catch converted using an estimate of an average weight of a commercially harvested beachworm. Even taking a more conservative estimate of beachworm weight than has been reported previously, it is likely catches were substantially higher during this time than in more recent years. Since this time, annual catches declined to ~5.5 t in 2016/17 and have increased in recent years, with these changes mirrored by that of effort, with the exception of years from 2005/06 to 2008/09 (reflected in a substantial decline in $CPUE_{dy}$, acknowledging uncertainty in estimates of effort prior to 2009/10. Since 2009/10 catch rates ($CPUE_{dy}$ and $CPUE_{hr}$) have shown similar trends, with increases in recent years driven principally by changes in catch rate in Regions 3 and 4.

Catches from Regions 3 and 4 have consistently supported a high proportion of the NSW EGHG Fishery - Beachworm total commercial catch and in 2018/19, catches from these two regions consisted of 87% of the total catch. Each of the other regions have supported <~10% of the total annual commercial harvest. For seven years from 2011/12, catches from Region 3 were ~3 t and about half that of the previous two years. Increases in catch rate ($CPUE_{hr}$) over this period together with recent increases in catch, suggest the period of lower catches supported an increase in the available biomass. Levels of catch and catch rate ($CPUE_{hr}$) in Region 4, whilst catch is of a lower magnitude, suggest a more dynamic interaction with peaks and troughs in catch offset against a 2-3 year lag of similar patterns in catch rate ($CPUE_{hr}$). In Region 4, annual catch increased between 2009/10 and 2012/13, to a peak of 3.6 t (as catches in Region 3 decreased substantially), subsequently decreased to <2 t in 2015/16, increased again to >2 t in 2017/18 and in 2018/19 was 1.1 t, the lowest level since 2009/10. Change in catch rate ($CPUE_{hr}$) in Region 4 has generally mirrored that of catch, with the exception that the recent increase in $CPUE_{hr}$ has continued into 2018/19, to the highest level since at least 2009/10. The other regions (Region 1, 6 and 7) of the fishery have supported <~10% of the total annual commercial harvest. Patterns of catch and catch rate ($CPUE_{hr}$) from these other regions provide some contrast to the state-wide classification of sustainable and suggest the stock and fishery's performance in these areas could be improved.

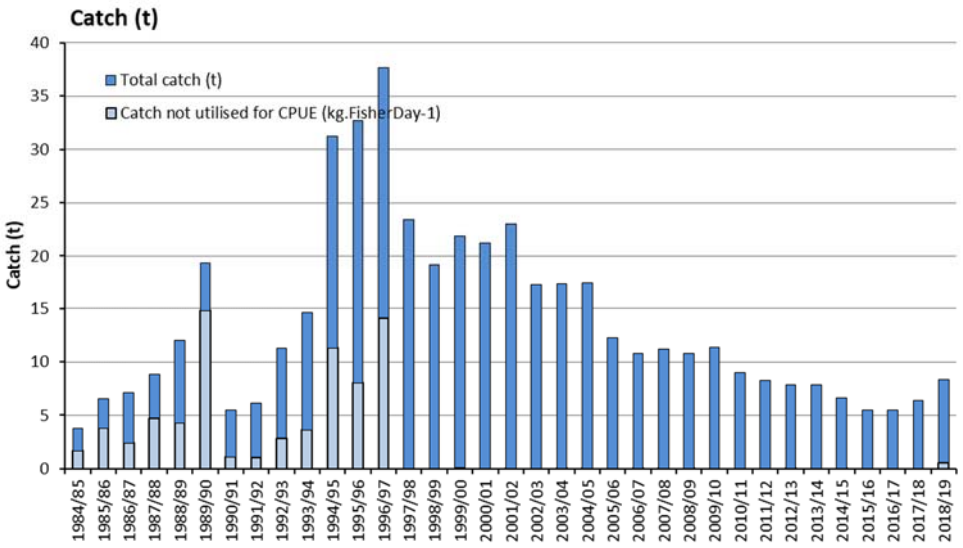

Figure A1 - 1 Annual commercial catch (t) of beachworms and catch not allocated to fishing days (for the purpose of calculating catch rate (kg.day^{-1}), from 1984/85 to 2018/19.

Recreational and Indigenous cultural fishing

Recreational fishers either catch beachworms or purchase commercially caught beachworms for bait. In NSW, recreational fishers with a recreational fishing licence (unless exempt) may take up to 20 worms (or part thereof) per day. Estimates of recreational catch (total number retained) are available from the National Recreational and Indigenous Fishing Survey (2000/01; Henry and Lyle 2003) and NSW state-wide surveys (2013/14; West et al. 2015; and 2017/18, DPI unpublished (preliminary data)).

In 2000/01, the recreational harvest (kept numbers) was estimated to be 285,663 ± 72,697 worms (mean ± SE). At an average weight of 10 g (as defined for the conversion of commercial numbers of beachworms to weight), the 2000/01 estimate equates to a total recreational harvest of ~2.9 ± 0.7 t.yr^{-1}. In 2013/14 and 2017/18 the state-wide survey estimated the retained recreational catch of beachworms at 239,085 ± 85,662 and 56,765 ± 26,247 beachworms (i.e. ~2.4 ± 0.9 t.yr^{-1} and ~0.6 ± 0.3 t.yr^{-1} (preliminary estimate)), respectively. These annual estimates of recreational catch represent 13%, 30% and 9% of the reported commercial catch for those years, respectively.

The benefits (and costs) of fishing and professional fishing to the cultural, broader social, health, wellbeing and economic value to Indigenous people and communities are substantial (Voyer et al. 2016). A synthesis of catch composition from Indigenous cultural fishing in NSW indicated that there are at least 18 species in the Estuary General Fishery that overlap with Indigenous fisheries (Schnierer and Egan 2016). Further, Schnierer and Egan (2012) described a case study in NSW of the impact of management changes on the viability of Indigenous commercial fishers and the contribution commercial fishing makes to Indigenous communities. The contribution made to Indigenous communities by Indigenous commercial fishers was, on average, 9.8% of annual catch and the contribution from broader Indigenous commercial fishers was greater than that made by fishers in the EGHG Fishery, with this being a consequence of hand gathering being a "…traditional skill that is widely practiced by coastal families so they can fulfil their own needs." (Schnierer and Egan 2012). Moreover, Schnierer and Egan (2012) report substantial harvests of hand gathered species (principally Pipi) by

Aboriginal fishers that were either not reported in commercial catch records, or reported as 'other' species and went unrecorded as species specific catches and were utilised for personal and community use. In a survey based in the Tweed region, annual catch of beachworms by Indigenous fishers was estimated at between 1,869 and 4,350 worms (Schnierer 2011). Based on an average weight of 10 g, the catch from Aboriginal fishers in the Tweed region in NSW is estimated at <0.5 $t.year^{-1}$. Schnierer (2011) described beachworms as among the top 10 culturally most important species but they consisted of less than 5% of the total cultural catch in terms of total numbers of species.

Illegal Unregulated and Unreported

The level of Illegal Unregulated and Unreported (IUU) fishing has not been quantified.

There are anecdotal reports of IUU fishing occurring at the scale of beaches, related to minor incidents in both the commercial and recreational fishing sectors. The extent, frequency and the change in either, for any IUU fishing has not been documented.

Effort trends

Commercial

Effort in FisherDays ($effort_{dy}$) prior to 2009/10 is a problematic data series with changes to reporting requirements and challenges in accurately allocating daily effort among species within a fishing method. Estimated $effort_{dy}$ has generally reflected that of catch over the history of the fishery. It has increased from 945 FisherDays in 1984/85 to a peak of 7,442 FisherDays in 1996/97. Noting that during this period fishers were required to report their catch monthly and effort (in days fished) by gear type, not linked to catch unless only a single gear type was used and then not linked to species catch within a gear type. Therefore, prior to 1997/98 total $effort_{dy}$ reported within the EGHGF cannot be allocated to a species catch and is the total $effort_{dy}$ reported by the EGHG fisher for each month where one method was reported. From 1997/98 to 2008/09, $effort_{dy}$ generally decreased from >6,000 fisher days to about 4,000 fisher days. Since 2009/10, $effort_{dy}$ continued declining until 2015/16. In the last 3 years, as similarly described for catch, $effort_{dy}$ has increased and in 2018/19 was 2164 FisherDays. Similarly, effort in hours fished ($effort_{hr}$) declined from >10,000 hours in 2009/10 to 5,629 hours in 2015/16. $Effort_{hr}$ has increased within the last few years and in 2018/19 was 7,634 hrs.

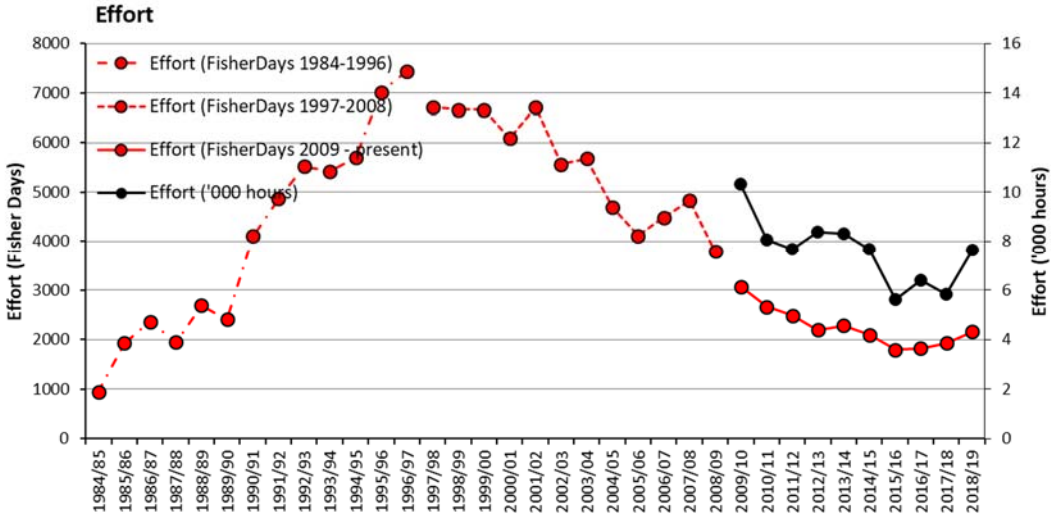

Figure A1 - 2 Annual reported commercial effort in units of FisherDays* (1984/85 to 2018/19) and hours (2009/10 to 2018/19). Note: changes in reporting requirements limit consistent interpretation of the effort (FisherDays) time series.

*Effort (FisherDays) (a) for July 2009 to present was estimated from the number of distinct fishing dates entered on daily catch returns for each fisher in each month where the method was used, irrespective of whether the species was reported on those days, to be consistent with earlier reporting; (b) for July 1997 to June 2009, was taken from the number of days fished hand gathering as entered on monthly catch returns; and (c) for July 1984 to June 1997, limited to catch records where only a single fishing method was entered on a monthly catch return. Therefore, joining the dots from 1996/97 to 1997/98 or 2008/09 to 2009/10 may not be an accurate representation of changes in catch rate across these years.

Recreational and Indigenous

There are no data describing the recreational fishing effort expended in harvesting beachworms.

Schnierer (2011) report the total effort of Aboriginal fishers based in the Tweed region was recorded to be 542 hours or 92 days. Cultural catch of bait including beachworms was also seen to be important in delivering economic benefits to the community (Schnierer 2011).

Catch rate information

Commercial

Catch per FisherDay ($CPUE_{dy}$) is a difficult indictor to interpret prior to 2009/10, for reasons outlined for the catch and $effort_{dy}$ time series. Nonetheless, $CPUE_{dy}$ was relatively low but highly variable (between 1 and 2.9 $kg.day^{-1}$) from 1984/85 to 1993/94. From 1994/95 to 2018/19, $CPUE_{dy}$ has generally remained above 3 $kg.day^{-1}$, except between 2005/06 and 2008/09 when it declined to a 14 year low of 2.3 $kg.day^{-1}$ in 2007/08. The change in $CPUE_{dy}$ between 2008/09 and 2009/10 is commensurate with the change in reporting requirements and likely an artefact of improved reporting. Catch per hour ($CPUE_{hr}$) from 2009/10 to 2018/19 has followed a similar trend to $CPUE_{dy}$. From 2014/15, $CPUE_{hr}$ has generally increased, and in 2018/19 was 1.2 $kg.hr^{-1}$, the highest level since the reporting of $effort_{hr}$ began in 2009/10. It is also perhaps notable that the recent increase in $CPUE_{hr}$ is concurrent with relatively low levels of total catch prior to and during these years. This increase has been driven by levels and patterns of fishing in Regions 3 and 4 and differs from patterns in other regions.

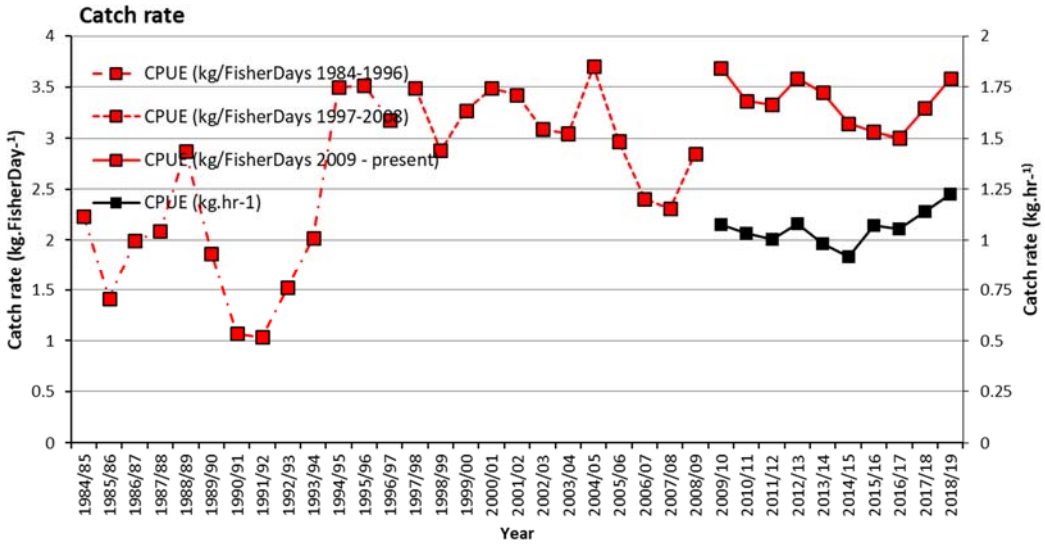

Figure A1 - 3 Annual commercial catch rate in units of kg.FisherDays^{-1}* (1984/85 to 2018/19) and kg.hr^{-1}# (2009/10 to 2018/19). Note: changes in reporting requirements limit consistent interpretation of the catch rate (kg.Fisher Day^{-1}) time series.

*Effort (FisherDays) (a) for July 2009 to present was estimated from the number of distinct fishing dates entered on daily catch returns for each fisher in each month where the method was used, irrespective of whether the species was reported on those days, to be consistent with earlier reporting; (b) for July 1997 to June 2009, was taken from the number of days fished hand gathering as entered on monthly catch returns; and (c) for July 1984 to June 1997, limited to catch records where only a single fishing method was entered on a monthly catch return. Therefore, joining the dots from 1996/97 to 1997/98 or 2008/09 to 2009/10 may not be an accurate representation of changes in catch rate across these years.
^Effort ('000 hours) only available from 2009/10.
#CPUE (kg.hr^{-1}) calculated from average daily CPUE (kg.hr^{-1}), excluding records with catch <10 kg/day; and/or effort >0 and <10 hrs/day. Data only available from 2009/10.

Stock assessment methodology	
Year of most recent assessment	2020 – **sustainable**
Assessment method	Review of indicators (weight of evidence)
Main data inputs	Catch (commercial) – 1984/85 to 2018/19 Catch (recreational) – 2000/01, 2013/14, 2017/18 $CPUE_{dy}$ – kg.FisherDay^{-1} 2009/10 to 2018/19 $CPUE_{hr}$ – kg.hr^{-1} 20009/10 to 2018/19
Main data inputs (rank) †	Catch (commercial) – 1984/85 to 2018/19: (medium quality), long historical time series, but some reporting changes and likely misreporting, limited quality control/error validations Catch (recreational) – 2000/01, 2013/14, 2017/18 (medium quality), different survey methods add uncertainty to comparisons

Stock assessment methodology	
	$CPUE_{dy}$ – $kg.FisherDay^{-1}$ 1984/85 to 2018/19: (low quality) compromised by significant reporting changes and inaccuracies in effort data. $CPUE_{hr}$ – $kg.hr^{-1}$ 2009/10 to 2018/19: (medium quality) relatively short time series, some misreporting, some quality control/error validations.
Key model structure and assumptions	Weight-of-evidence – incl. a catch MSY model assisted catch-only assessment (as a line of evidence).
Sources of uncertainty evaluated	Known or likely uncertainties in the key indicators were taken into consideration in ranking of the quality of key indicators, and in reaching a conclusion regarding stock status.

† Main data inputs (rank)

1 – High quality: data have been subjected to documented quality assurance and peer review processes, are considered representative and robust and provide a high level of confidence to support fisheries management decisions.

2 – Medium quality: data have been subjected to some internal quality assurance processes, have some documented limitations, but are still considered sufficiently accurate and informative to be useful to inform management decisions with some caveats.

3 – Low quality: data have been subjected to limited or no quality assurance processes, may be compromised by unknown or documented limitations that have not been fully explored, but are considered the best available information and require a high level of precaution to be exercised when interpreted to inform management decisions.

Status indicators and limits – reference levels	
Biomass indicator or proxy	NA - no formal indicators or reference points determined
Biomass limit reference level	NA – no biomass limits or targets have been set
Fishing mortality indicator or proxy	NA - no formal indicators or reference points determined
Fishing mortality limit reference level	NA – no fishing mortality limit has been set
Target reference level	NA – no fishing mortality targets have been set

Stock assessment results – review of indicators	
Biomass status in relation to limit	NA - no biomass limits or targets have been set
Fishing mortality in relation to limit	NA – No fishing mortality limit has been set
Previous stock status	Undefined
Current stock status	Sustainable

Qualifying comments

NSW catch and effort logbook data vary spatially and temporally across different eras, delineated by changes in catch reporting requirements and management changes.

Inconsistencies in the methodology to estimate recreational fishing catch through time provides some uncertainty around the direct comparison of estimates from different times.

Factors other than fishing, including land-based effects and other environmental factors, may affect change in the abundance and productivity of beachworms and are not considered in this assessment.

The lines of evidence presented in the section Stock Status (see body of the assessment report - ***Error! Reference source not found.***) support a stock status determination of sustainable, the determination is made understanding that the large scale (state-wide and dominant regions, by catch) patterns of fishery-dependent data that underpin it do not reflect a consistent interpretation of data from other regions or from a number of smaller scales within the fishery (e.g. beaches). Further, whilst some levels of uncertainty associated with levels of recreational catch and population structure have been reduced, there remain knowledge gaps and a need for ongoing information to inform these aspects for future assessments, However, the weight of evidence provided is sufficient to support an understanding that the biomass of beachworms is at a level sufficient to ensure that on average, future levels of recruitment are adequate and fishing mortality is at a level to avoid the stock being recruitment impaired. As such the beachworm stock status is classified as sustainable (www.fish.gov.au/).