Stock status summary

Information provided in this summary constitutes a review of stock structure and indicators consistent with informing a species status determination using a weight-of-evidence approach, such as is used in the Status of Australian Fish Stocks reports (SAFS; www.fish.gov.au/). Where data are unavailable or insufficient to reliably inform those criteria, this has been indicated by 'NA', rather than removing the criteria. This has been done to clearly indicate what data are available and to highlight areas where alternate or additional data sources or analyses may be required to improve species status determination in the future.

Biology and stock structure

Beachworms are dioecious, broadcast-spawning polychaete worms in the family Onuphidae. In NSW, the predominant species are *Australonuphis teres* (stumpy or kingworm) and *A. parateres* (slimy). Other species of Beachworms that occur in NSW and are recognised as different species by fishers include *Kinbergonuphis taeniata* (stripy) and *Hirsutonuphis mariahirsuta* (wiry or white headed wiry) but these species are less abundant than stumpies and slimies (Paxton 1996).

Preliminary genetic work on *A. teres* sampled from hierarchically nested spatial scales indicated no clear population structure, suggesting that along the NSW coast Beachworms constitute a single population. Little is known about the genetic structure of the other species of Beachworms but as they are broadcast spawners (Paxton 1986), it is also likely that they would form single populations.

For the purposes of this assessment, all the harvested Beachworm species are assumed to constitute a single multi-species stock or management unit.

Length at maturity is 42 cm for *A. teres*, and 39 cm for *A. parateres* and fecundity increases with length. Spawning occurs throughout the year (Paxton 1986), with reproductive peaks reported in February and October (Fielder and Heasman 2000).

Rates of growth of Beachworms have not been determined.

The abundance of Beachworms is highly patchy, with dense patches (>15 m^{-2} or >190 $g.m^{-2}$) interspersed by large areas of few worms, making catch per unit effort (CPUE) from commercial catches in favourable areas potentially subject to hyper-stability and/or positive bias.

Stock status and assessment method

As a result of uncertainties in the indicators reviewed, the NSW stock status of Beachworms is classified as **undefinedError! Reference source not found.**.

A review of indicators (weight-of-evidence) approach has been used to assess the Estuary General Fishery (Hand Gathering) – Beachworms.

Current minimal understanding of Beachworm stock structure, together with a series of commercial fishery catch and effort data that require further analyses to determine its utility for temporal comparison, and substantial but unknown levels and spatial distribution of annual recreational catch, preclude the application of more quantitative or model-based assessment approaches.

Fishery statistics summary

Commercial fishery data aggregated at the scale of years for the state-wide fishery comply with the confidentiality policy and are presented in this stock status summary. A minimum number of 21 fishers have contributed to annual estimates of catch and effort and a total of 66 different fishers have participated in the fishery from at least 2009/10.

Information presented in figures and tables below is summarised by fiscal year (July–June). Reference to 'year' refers to the first year of a fiscal year unless otherwise stated. For example, 2010 refers to the fiscal year 2010/11.

Catch was reported by number of worms between 1997/98 and 2008/09, and a conversion factor (of unspecified origin) of 50 worms to the kilogram was used to infer catch during this period. In all other years, catch was reported by weight. Prior to 1997/98, effort units (days) were not linked to catch on fishers' monthly catch returns. Effort (days) during this period is attributed to a species or each species in a species group only where a single fishing method was reported in a month. Between 1997/98 and 2008/09 (inclusive) fishers reported monthly catch and effort in days fished. From 2009/10, monthly reports of daily catch and effort in hours have been required. From 2009/10 to present, effort (days) is derived from the number of distinct fishing dates entered on daily catch returns for each fisher in each month where the method was reported, irrespective of whether the species was reported on those days, to be consistent with earlier reporting periods.

Catch information

Commercial

Reported commercial catch increased exponentially from about 2 t in 1984/85 to a peak of 24.7 t in 1995/96 (Figure 1). Catches averaged 22.2 t over the period 1995/96–2001/02, but general declined from 1995/96 onwards to 17.4 t by 2004/05 (Figure 1). Catches dropped to 12.2 t in 2005/06 and then declined steadily to 5.1 t in 2015/16, the lowest level of reported catch since 1991/92. Patterns of change in the annual catch at smaller spatial scales differ from this aggregated pattern across the fishery, with some regions showing declines but others showing fluctuating catches.

Catch information

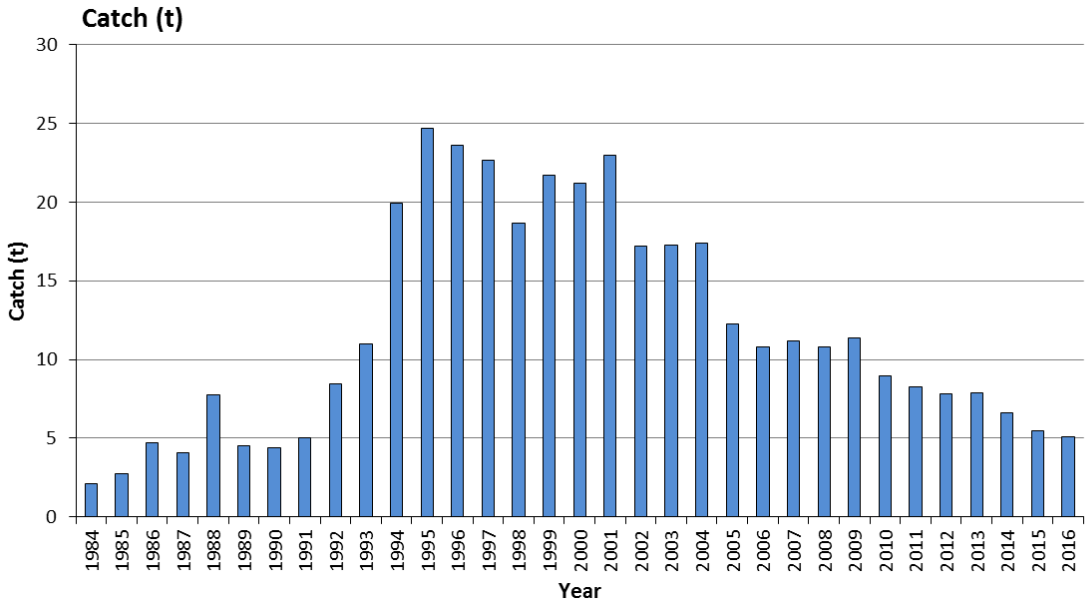

Figure 1 Annual reported commercial catch (t) of Beachworms from 1984/85 to 2016/17. Note: changes in reporting requirements limit consistent interpretation of the catch (t) data series.

Recreational and Indigenous

Recreational fishers either catch Beachworms or purchase commercially caught Beachworms for bait. In NSW, recreational fishers with a licence 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 survey (2013/14; West et al. 2015). In 2000/01, the recreational harvest (kept numbers) was estimated to be 285,663 ± 72,697 (mean ± SE) worms. At an average weight of 11 g (whole live weight) this estimate equates to a total recreational harvest of ~3.14 t.year^{-1} (± 0.8 t). In 2013/14, the state-wide survey estimated the retained recreational catch of Beachworms as 239,085 (± 85.662; ~2.6 ± 0.9 t.yr^{-1}). These annual estimates of recreational catch represent 14% and 33% of the reported commercial catch for those years, respectively. More recent recreational catches or effort is not known.

Synthesis of catch composition information from Indigenous fisheries in NSW indicated that there are at least 18 species in the Estuary General Fishery that overlap with Indigenous fisheries (Schnierer and Egan 2016). In a survey based in the Tweed region in 2010, annual catch of Beachworms by Indigenous fishers was estimated to be between 1,869 and 4,350 worms (Schnierer 2011). Based on the average weight of a Beachworm of 11 g, Indigenous fishery catch is the Tweed Region in NSW is estimated to be <0.05 t.year^{-1}. Schnierer (2011) described Beachworms as among the top 10 culturally most important species but they contributed less than 5% of the total cultural catch in terms of total numbers of all species. Total effort of the Aboriginal fishery was recorded to be 542 hours or 92 days (Schnierer 2011). Cultural catch of bait including Beachworms was also seen to be important in

Catch information

delivering economic benefits to the community and they have been harvested by Aboriginal people in the Tweed region for many generations (Schnierer 2011).

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 estuaries, related to commercial fishers misreporting and recreational fishers exceeding bag limits or fishing without a licence. The extent, frequency and the change in either commercial or recreational IUU fishing has not been documented

Effort information

Commercial

Effort in FisherDays ($effort_{dy}$) prior to 2009/10 is a problematic data series as a result of changes to fisher reporting requirements and challenges in accurately allocating daily effort between species within a fishing method. Data collected across periods with different reporting requirements may therefore not be comparable, making it difficult to interpret longer-term trends.

$Effort_{dy}$ increased from 945 fisher days in 1984/85 to a peak of 7,442 fisher days in 1996/97, during a clear developmental phase in the fishery. Since 1997/98, $effort_{dy}$ has decreased steadily from >6,000 fisher days to 1,443 fisher days in 2016/17 (Figure 2). Effort in reported hours fished ($effort_{hr}$) since the change in reporting requirements in 2009/10 has declined from >10,000 hours in 2009/10 to 4,530 hours in 2016/17. It was fairly stable over 2010/11–2014/15, but has dropped substantially over the past two years (Figure 2).

Effort information

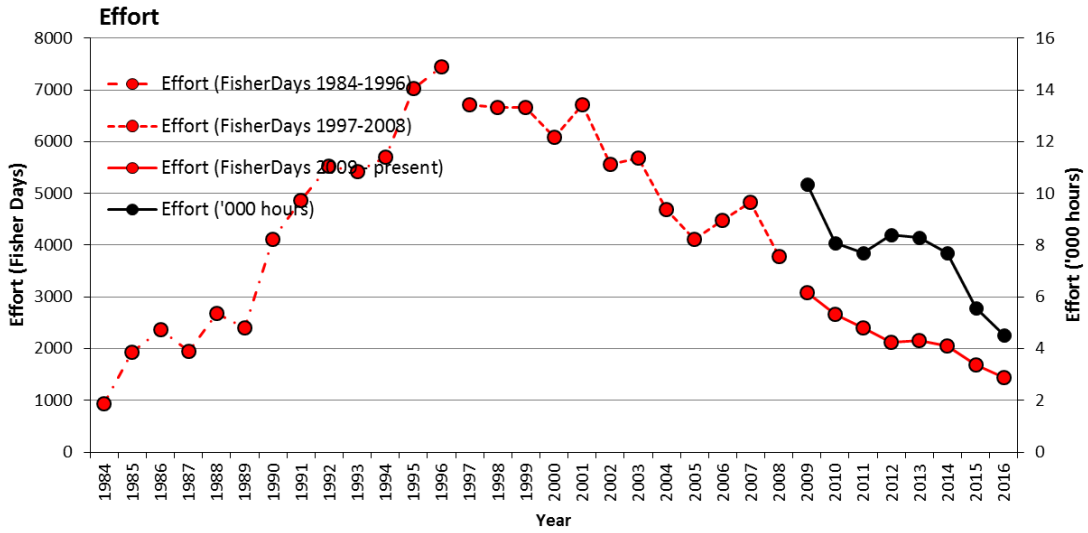

Figure 2 Annual reported commercial effort in units of FisherDays (1984/85 to 2016/17) and hours (2009/10 to 2016/17). Note: changes in reporting requirements limit consistent interpretation of the effort$_{dy}$ data series.

Catch rate information

Commercial

Catch per FisherDay (CPUE$_{dy}$) is a problematic index to interpret prior to 2009/10, as a result of changes in reporting requirements and resulting difficulties in relating catch to the effort$_{dy}$ time series over different periods. CPUE$_{dy}$ was highly variable (between 1 and 2.9 kg.day^{-1}) from 1984/85 to 1993/94. From 1994/95 to 2016/17, CPUE$_{dy}$ generally remained above 3 kg.day^{-1}, except in 2005/06–2008/09 when CPUE$_{dy}$ was between 2.3 kg.day^{-1} and 2.9 kg.day^{-1}. CPUE$_{dy}$ in 2016/17 was 3.5 kg.day^{-1}. Hourly catch rate (CPUE$_{hr}$) reported from 2008/09 to 2016/17 followed a similar trend to CPUE$_{dy}$ (Figure 3). During 1997/98–2008/9 and from 2009/10 to 2016/17 catch rates were generally higher than during the pre-1997/98 period, although catch reported as number of individuals and converted to weight during this period complicates comparisons through time (Figure 3). From 2014/15, CPUE$_{hr}$ has increased substantially in the state-wide fishery, and in 2016/17 was 1.2 kg.hr^{-1}, the highest since 2009/10 (Figure 3).

As described for fishery-wide levels of catch, changes in the levels of effort and CPUE$_{hr}$ are not necessarily consistent with patterns of CPUE$_{hr}$ at smaller spatial scales.

Catch rate information

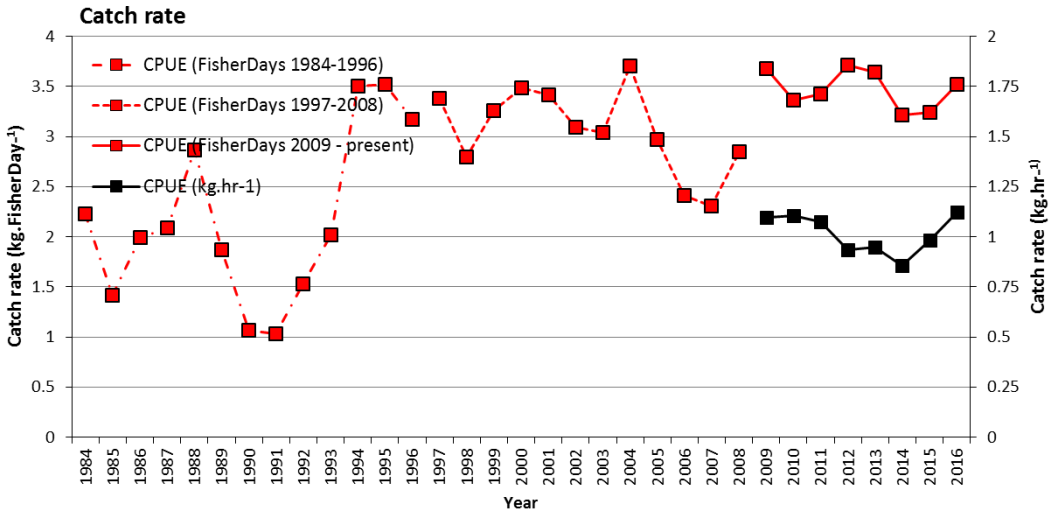

Figure 3 Annual reported commercial catch rate of Beachworms (kg.FisherDay^{-1} from 1984/85 to 2016/17 and kg.hr^{-1} from 2009/10 to 2016/17). Note: changes in reporting requirements limit consistent interpretation of the catch per FisherDay time series.

Stock assessment – list of indicators

Year of most recent assessment	2018 – **undefined**
Assessment method	Review of indicators (weight of evidence)
Main data inputs	Catch – 1984/85 to 2016/17 $CPUE_{dy}$ – kg.FisherDay^{-1} 2009/10 to 2016/17 $CPUE_{hr}$ – kg.hr^{-1} 20009/10 to 2016/17 Population structure – 2016 from fishery-independent surveys at key beaches Small scale biomass estimates – 2018 from fishery-independent surveys at key beaches
Main data inputs (rank) †	Catch – 1984/85 to 2016/17: (medium quality), long historical time series, but compromised due to some reporting changes, conversions from number of worms to weights, likely misreporting, and limited quality control/error validations

Stock assessment – list of indicators	
	$CPUE_{dy}$ – kg.FisherDay^{-1} 2009/10 to 2016/17: (low quality) compromised by significant reporting changes and inaccuracies in effort data $CPUE_{hr}$ – kg.hr^{-1} 2009/10 to 2016/17: (medium quality) compromised by limited internal quality assurance, the small number and changes in active fishers per year and spatial distribution of catch Population structure 2016: (medium quality) – data are preliminary, have not been subject to rigorous quality assurance and are unpublished. Data are generated from a DPI Fisheries project scheduled for completion in June 2018 Small scale biomass estimates 2018: (medium quality) – biomass estimates are preliminary, have not been subject to rigorous quality assurance and are unpublished. These estimates are generated from data collected by a DPI Fisheries project scheduled for completion in July 2019
Key model structure and assumptions	NA – no quantitative, model-based approach was used in this assessment
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 based on the resultant relative weighting of these indicators. Uncertainties in the catch and effort data used as the primary indicators, particularly as a result of changes in reporting requirements over different periods, assessment are discussed

† 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	CPUE, particularly for the period 2009–2016 following the most recent change to commercial reporting requirements. Used to indicate whether the biomass is likely to be increasing, decreasing or stable under current catches and effort
Biomass limit reference level	NA – no biomass limits or targets have been set
Fishing mortality indicator or proxy	Fishing effort is the key indicator of potential fishing mortality on the stock. There have been no substantial changes in fishing gear, fishing efficiency or potential fishable area, so per-unit effort is likely to exert similar fishing pressure across the history of the fishery. Effort has been declining steadily since 1996, although the reasons for this are not clear. This index may be compromised by changes in effort reporting, particularly in relating effort to catch of particular species
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	Recent CPUE near the historically high average level over 1994–2004 could indicate that availability in fished areas is well above a recruitment-overfished limit. However, substantial declines in effort and likely focus of current fishing on the most productive areas could be sustaining hyper-stable catch rates despite declining overall abundance. Status in relation to a limit is therefore uncertain
Fishing mortality in relation to limit	Fishing effort has been declining steadily since 1995, reaching the lowest level in 2016/17 since 1991. This could indicate that fishing mortality is at low levels, below a level that could result in recruitment overfishing. However, the reasons for this effort decline are unclear, and so the fishing mortality status in relation to a limit is uncertain

Stock assessment results – review of indicators	
Previous SAFS stock status	NA – not a SAFS-reported species
Current SAFS stock status	NA – not a SAFS-reported species

Fishery interactions

Fishery interactions described here comment on the possible dynamics within the NSW Estuary General Fishery (Hand Gathering) (EGHGF) that may influence understanding of the data for Beachworms. Within the EGHGF, fishing businesses may have access to Pipi, Beachworms, Estuary Cockles and Nippers, based on allocated quota shares. Since 2009/10, there were 49 fishing businesses within the EGHGF which have been active in the annual harvest of Beachworms. However, less than 1.5% of fishers report more than 500 kg of catch each year.

Because Beachworms are used for bait by recreational fishers with access to the resource in the same fishing areas as commercial fishers, there are likely to be interactions between commercial and recreational sectors. However, these have not been investigated.

References

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