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Summary of data and population trends 2022

Trout Cod (Maccullochella macquariensis)

Citation details

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Introduction

Trout Cod are endemic to the Murray Darling System of NSW, Victoria and the ACT. The range of Trout Cod substantially contracted up until the late 1900's which prompted a recovery program for the species (Koehn et al. 2013). Trout Cod are currently listed in NSW and Commonwealth legislation as Endangered following legislative assessment processes by the Fisheries Scientific Committee and the Commonwealth Threatened Species Scientific Committee, respectively. Those committees regularly review available information and status of Trout Cod and other threatened species, however there have not been any assessments of evidence for population trends since the species was listed.

A 2019 assessment of Trout Cod across its full range (NSW, ACT and Victoria) using the IUCN Red List of Threatened Species criteria assessed it as 'Vulnerable' based on its restricted distribution in south-eastern Australia (Koehn et al. 2019). The assessment was part of a larger assessment of Australian freshwater fish, but has no legal basis and does not affect its current listing status in NSW. The assessment does however provide an important reference document for consideration by Committee's dealing with listing of threatened species under state and commonwealth legislation, and noted the following key points:

- The populations are fragmented with the majority of breeding individuals coming from three localities (Ovens River Victoria, Murray River NSW and Murrumbidgee River NSW).
- The only remaining natural population is in the Murray River between Yarrawonga and Barmah State forest (approximately 200 km of river).
- Four additional stocked populations established from early 2000s are now self-reproducing. These are in the lower Ovens River (Vic), lower Goulburn River (Vic), mid-Murrumbidgee River (NSW), Bendora Dam (Cotter River ACT).
- Small populations exist in the Upper Murray, mid-Macquarie and upper Macquarie catchments, though reproduction from these populations is uncertain.

This document summarises available data sources which report Trout Cod in NSW waters, and evaluates time series in light of management interventions (primarily hatchery releases) intended to aid population recovery in the species.

Available data sources reporting Trout Cod in NSW

In order to examine population trends and management interventions for Trout Cod in NSW, three data sources were examined. These included data on the interaction of anglers with Trout Cod

from recreational fishing surveys, NSW fish stocking information and fishery independent monitoring data.

Recreational fishing incidental bycatch data obtained from a state-wide survey of recreational fishers is presented to provide context around the level of angler interaction with the species across the survey periods. In addition, historical stocking data has been provided to aid in the understanding of abundance and distribution trends. The critical data set used in this report originates from the NSW DPI Freshwater Ecosystems Research (FER) database of fish community sampling comprising records from over 30 years. Together, these data sources will be used to evaluate Trout Cod population data in NSW.

Recreational fishing (incidental bycatch)

Trout Cod are listed as threatened species and targeted catch for this species is prohibited in NSW. However, anglers do incidentally catch Trout Cod when fishing for other freshwater species. The most recent estimate of the recreational incidental catch and release of Trout Cod in NSW was approximately 42,932 ($\pm 22,803$) fish (Figure 1) (Murphy et al. 2020). This estimate encompassed catches from NSW households within which a long-term (1-3 year) Recreational Fishing Fee licence holder resided (RFL household). Comparison across the three survey periods (2013/4, 2017/18 and 2019/20) suggested that incidental catches were increasing over this period (West et al. 2015, Murphy et al. 2020). Noting that this estimate was potentially impacted by misidentification of Trout Cod which is still problematic (Miles et al 2021, Lyon et al 2018). While these survey results are not directly comparable due to different sampling frames, the two most recent surveys likely represent an increase in recreational incidental catch and release (which could contribute to increased post-release mortality) through time.

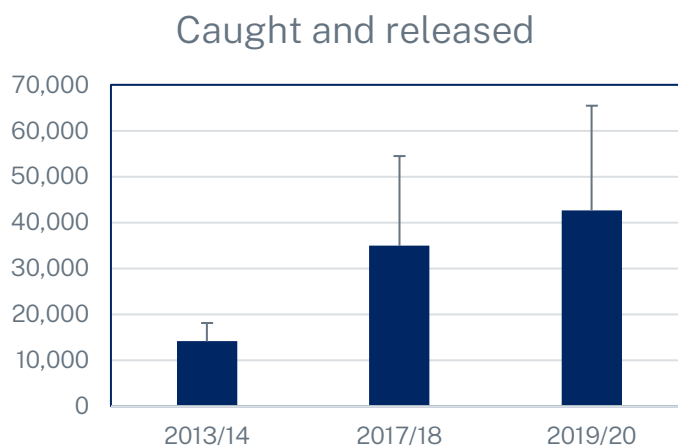


Figure 1. NSW recreational fishing incidental catch and release estimates for the numbers of Trout Cod from 2013/14, 2017/18 and 2019/20 surveys.

Few other data sources exist on the incidental catch of Trout Cod by anglers, with just two creel surveys covering the NSW distribution of the species (Miles et al. 2021). The main finding is that the Murray River (2.4- 3.5 Trout Cod released/ha) study near the Trout Cod Protection Area had slightly higher catch-and-release rates than the Murrumbidgee River study (1.5-2.6 Trout Cod released/ ha) (see Miles et al. 2021). Further citizen science programs involving fishing tournament monitoring have also commenced and will be used to build a long-term time series of incidental catches at a series of sites in the Murray and Murrumbidgee Rivers. Initial trials during this program showed that encounters with Trout Cod were far fewer than other species, and were typically smaller fish, when compared to Murray Cod in the mid Murrumbidgee River at Gogeldrie

Weir (Figure 2). This program uses catch, photo and release format, to ensure correct identification of species. Further understanding of incidental catches of Trout Cod will be required for future assessment of their populations and potential recovery in the future.

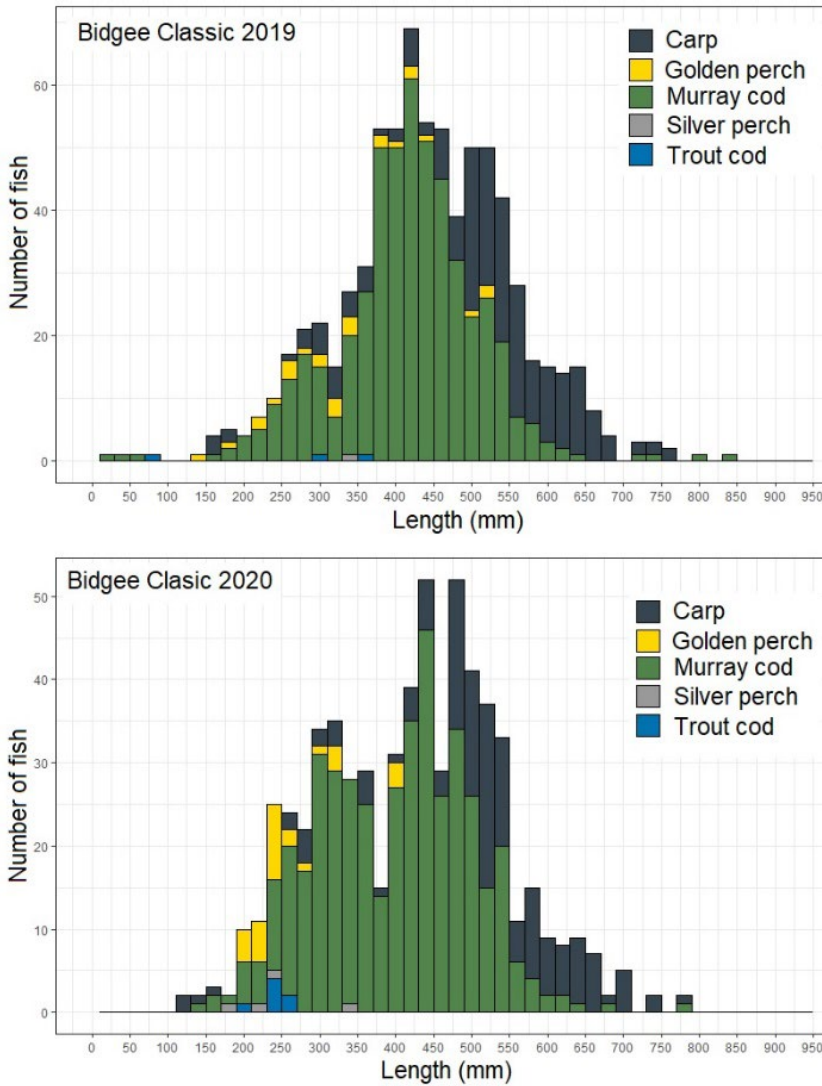


Figure 2. Length frequency distributions from fishing tournament monitoring on the Murrumbidgee River, showing relatively small incidental catches of smaller-sized Trout Cod in the area covered by the tournament.

Fish stocking records

Over 1.1 million Trout Cod have been stocked in NSW waters since 1987 (Table 1). The Murrumbidgee River below Burrinjuck Dam is the only NSW system to have re-established a naturally recruiting population of Trout Cod during this time (as indicated by fish community and larval sampling). With populations in the other locations (e.g. the Murray River) suspected to have originated from historical events or range expansion (e.g., natural recruitment is not detected). Further details on stocking history of Trout Cod has been provided for each location in the section below.

Table 1. Summary of Trout Cod stocking across NSW since 1987.

Trout Cod reporting unit	Number stocked (1987-2000)	Number stocked (2001-2022)	Established self-sustaining population
Upper Murrumbidgee River	48000	213000	No
Murrumbidgee River	254200	24500	Yes
Macquarie River	63800	297500	No
Upper Murray River	63600	0	No

Fishery independent monitoring

There are 2688 records of Trout Cod captures from 98 sites across NSW reported in the NSW DPI-Fisheries Freshwater Ecosystems Research database between 1970 and 2022 (Figure 3). The largest number of captures came from surveys undertaken between 2005 and 2015 (Figure 4). Boat electrofishing has captured the majority of Trout Cod over the past 30 years. Boat electrofishing data are most appropriate for analysis of population trends, and thus form the basis of analysis in the following section.

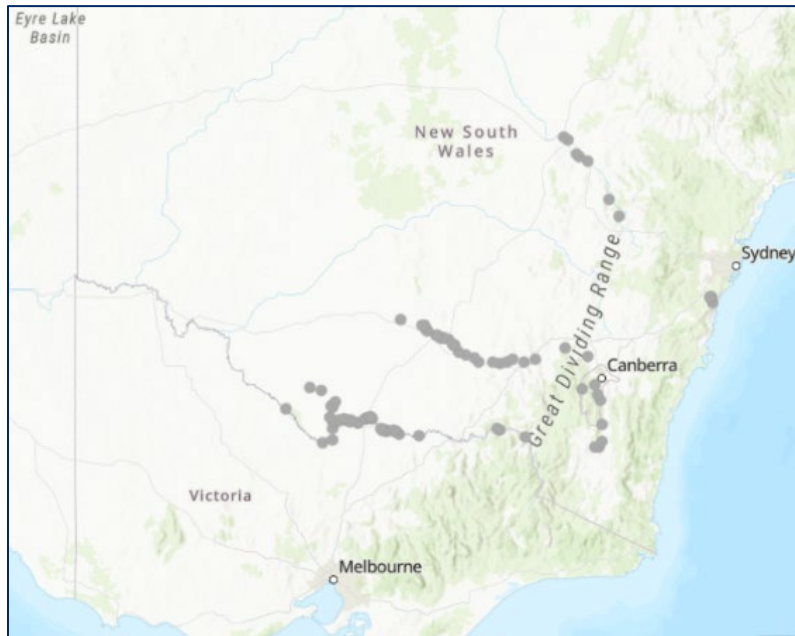


Figure 3. Freshwater Ecosystems Research (FER) records for Trout Cod in NSW (indicated by grey dots).

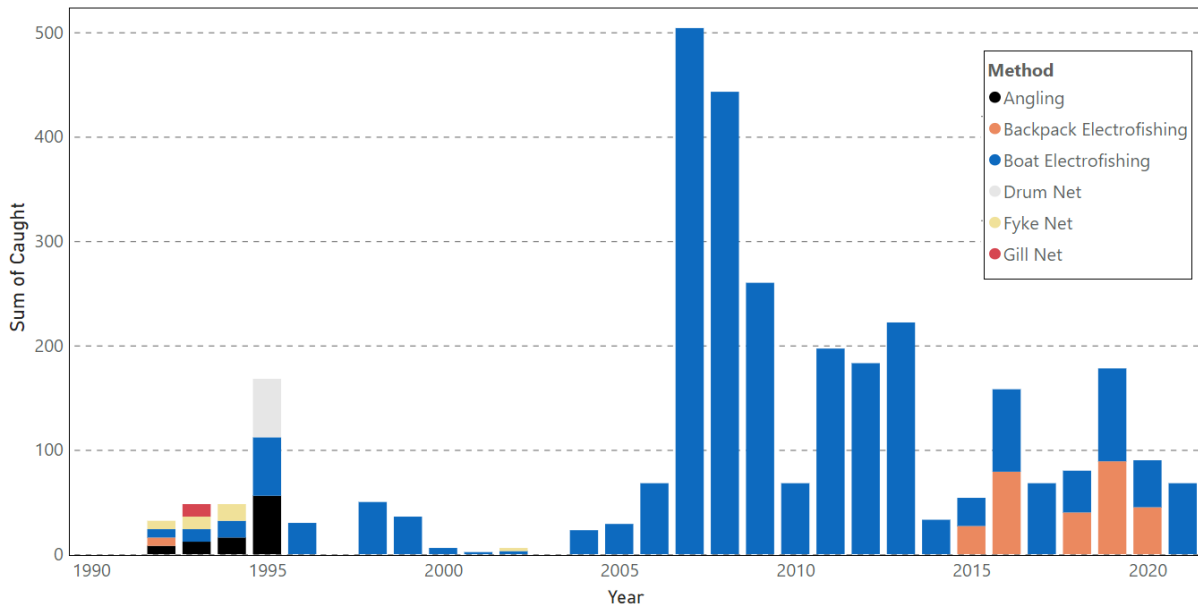


Figure 4. Total number of Trout Cod caught during electrofishing surveys in NSW from 1990-2022.

Trends in catch-per-unit-effort (CPUE) time series and length composition for Trout Cod in NSW

Data on the distribution and abundance of Trout Cod has been collected across a range of research projects within the NSW Murray - Darling Basin between 1994 and 2022. In order to assess the current population trends for Trout Cod in NSW, the distribution of Trout Cod has been divided into Trout Cod reporting units (TCRU) (Figure 6) to reflect the fragmented populations of the species. These reporting units were selected based on environmental barriers (e.g., weirs), changes in environment (e.g., sections of river subject to inflows from tailraces/below impoundments), stocking locations and management units (e.g., the Trout Cod Protection Area). These units have been examined individually below, where sufficient data is available. Translocated populations in eastern drainages were not considered. Data from all sites in the reporting units were used to calculate both catch per unit effort (CPUE), and to examine length composition.

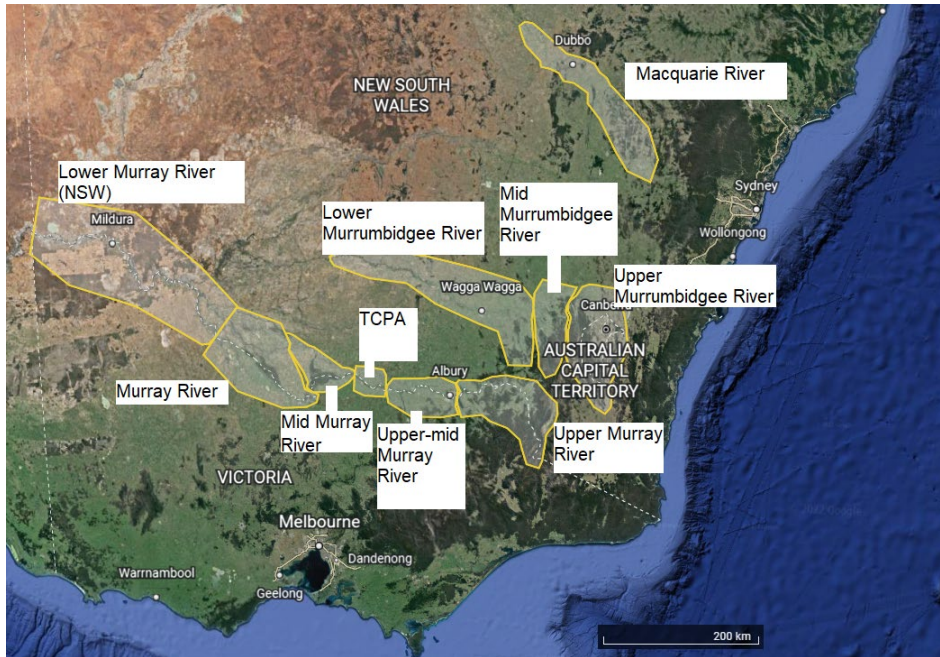


Figure 5. Trout Cod reporting units (TCRU) reported in the assessment below. TCRPA refers to the Trout Cod Protection Area.

Independent survey CPUE trends

Boat based electrofishing data combined across NSW showed that the highest CPUE estimates (fish per minute) were reported between 2005 and 2010 (Figure 5). CPUE stabilised over the period to 2020 (Figure 5). However, the fragmented populations of Trout Cod across NSW displayed varied trends, and these have been examined in more detail below.

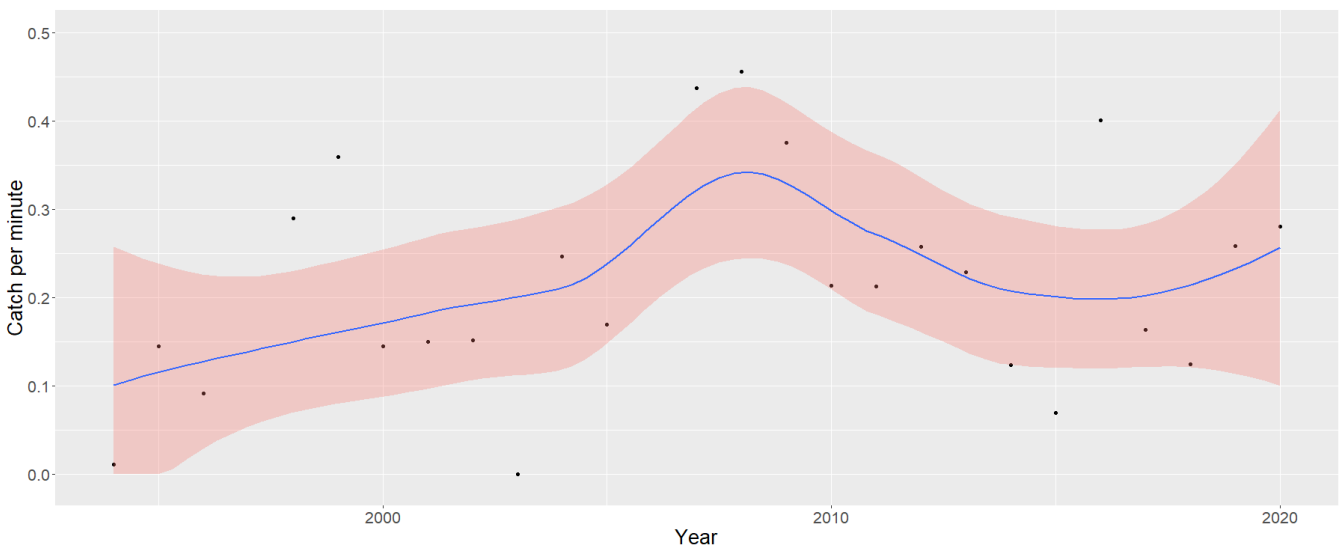


Figure 6. CPUE (fish per minute) LOESS plots (with 95% CI) for Trout Cod recorded during electrofishing surveys across NSW between 1994 and 2020.

Macquarie River TCRU

Summary statement – Intensive releases failed to establish population, and Trout Cod not detected during recent sampling

- Locally extinct since the 1950s (or earlier)
- Reintroduction attempted through stocking between 1991 and 2018 in the upper Macquarie and 1998 to 2004 in the lower Macquarie.
- No samples detected during NSW boat electrofishing surveys since 2016.
- Population has never re-established.
- Has received regular stockings since 2003, with most recent being 26,000 fry in 2018/19.
- Largest stocking numbers were 2003-2005 with 31% of the 361,300 Trout Cod stocked in this TCRU released during that period.

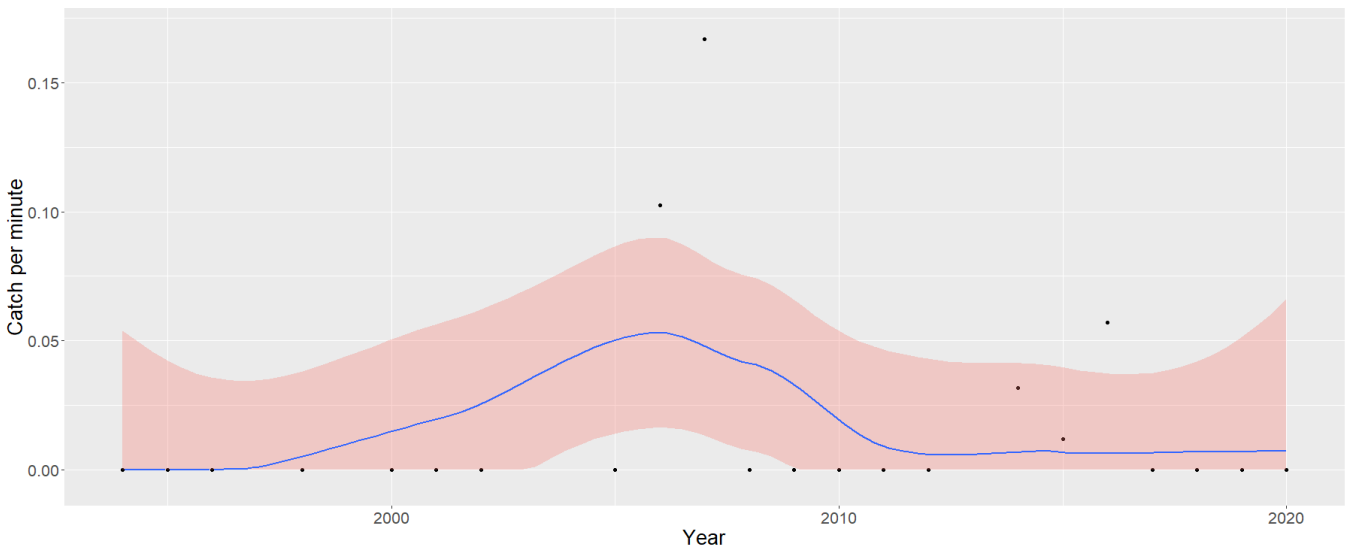


Figure 7. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the Macquarie River.

Upper Murrumbidgee River TCRU

Summary statement – Intensive releases failed to establish population, and Trout Cod not detected during recent sampling

- Locally extinct since mid-1970s.
- Reintroduction attempted through intensive stocking between 1988 and 2008.
- No samples detected during NSW boat electrofishing surveys since 2015.
- Population did not re-establish



Figure 8. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the upper Murrumbidgee River.

Mid and Lower Murrumbidgee River TCRU

Summary statement – CPUE appears comparatively stable

- Locally extinct since 1969.
- Reintroduced through stocking between 1992 and 2001. Last stocking event was 32,000 fish in 2008.
- The first natural recruitment was detected in 2006.
- No records have been recorded in the mid Murrumbidgee River since 2005.
- Population in the lower Murrumbidgee River reached a peak in abundance during the mid-2000's. Subsequently declined and has now stabilised (Figure 9).
- CPUE data for larger fish (>400mm) has indicated a steady decline from 2005 onwards (Figure 10).

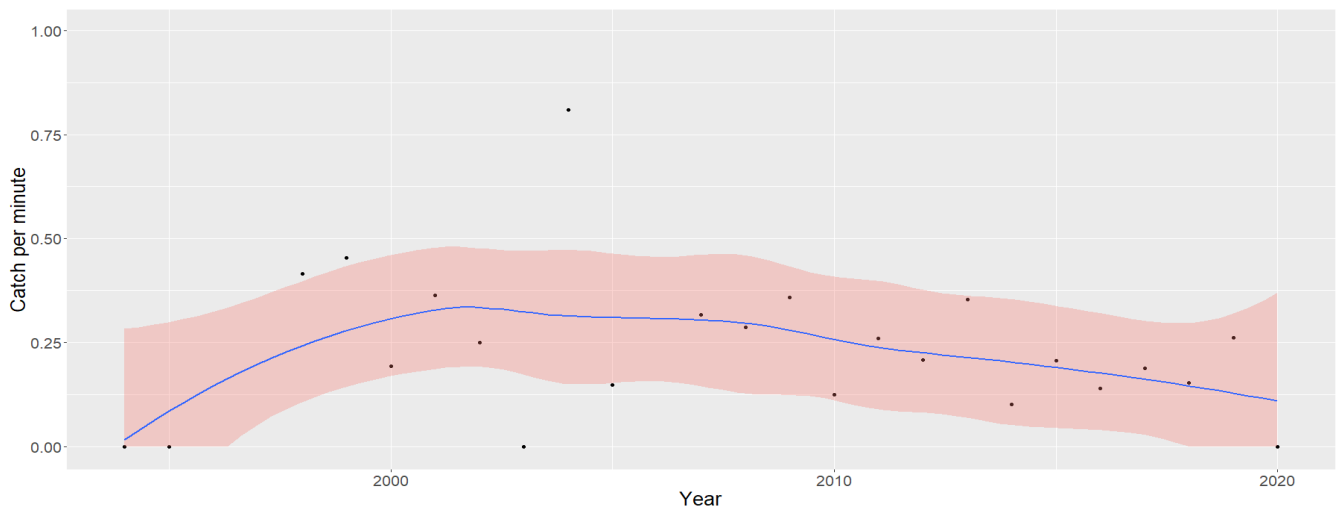


Figure 9. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the lower Murrumbidgee River.

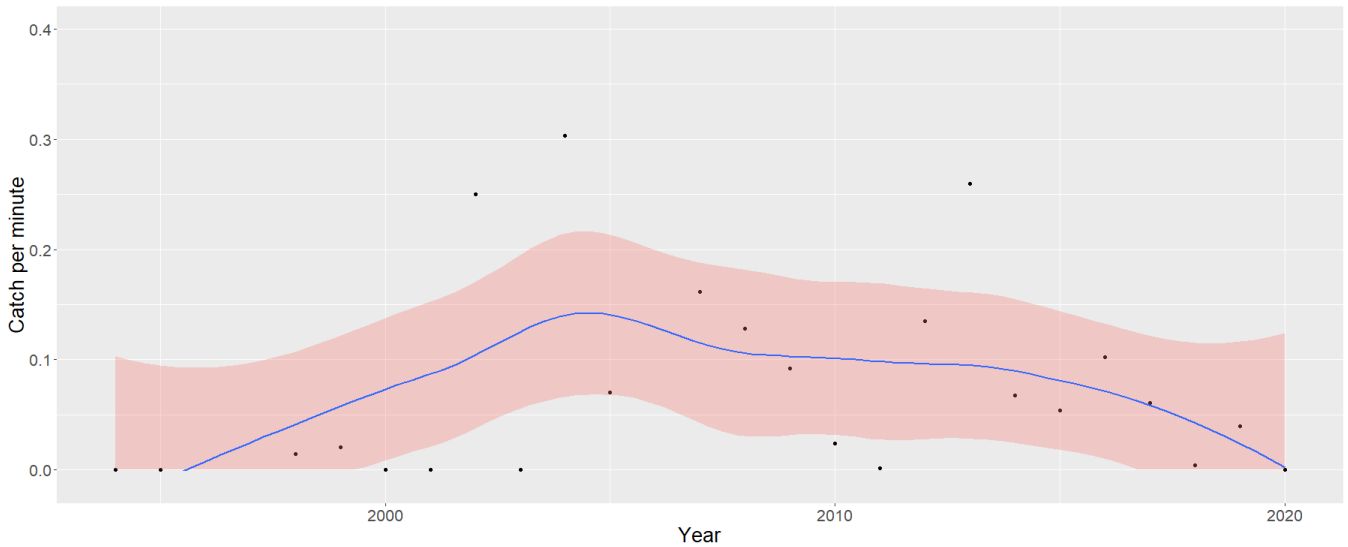


Figure 10. CPUE (fish per minute) LOESS plots (with 95% CI) for Trout Cod >400mm from the lower Murrumbidgee River.

Upper Murray/upper-mid Murray River TCRU

Summary statement – Trout Cod historically present in TCRU, but have not been detected in recent years

- Very low numbers, with only incidental catch records from recreational fishers.
- Currently below detectable limits in formal sampling programs.
- Reintroduction attempted through stocking between 1986 and 1997.
- The FER database has only one record of Trout Cod being recorded in the upper-mid Murray River. Hence no data has been presented on this TCRU.
- Stocked fish persisted in the upper Murray River– but did not appear to successfully recruit.
- Trout Cod recorded during 2020 fish kill. Six fish were aged between 5 (392mm) and 22 (697mm) years.

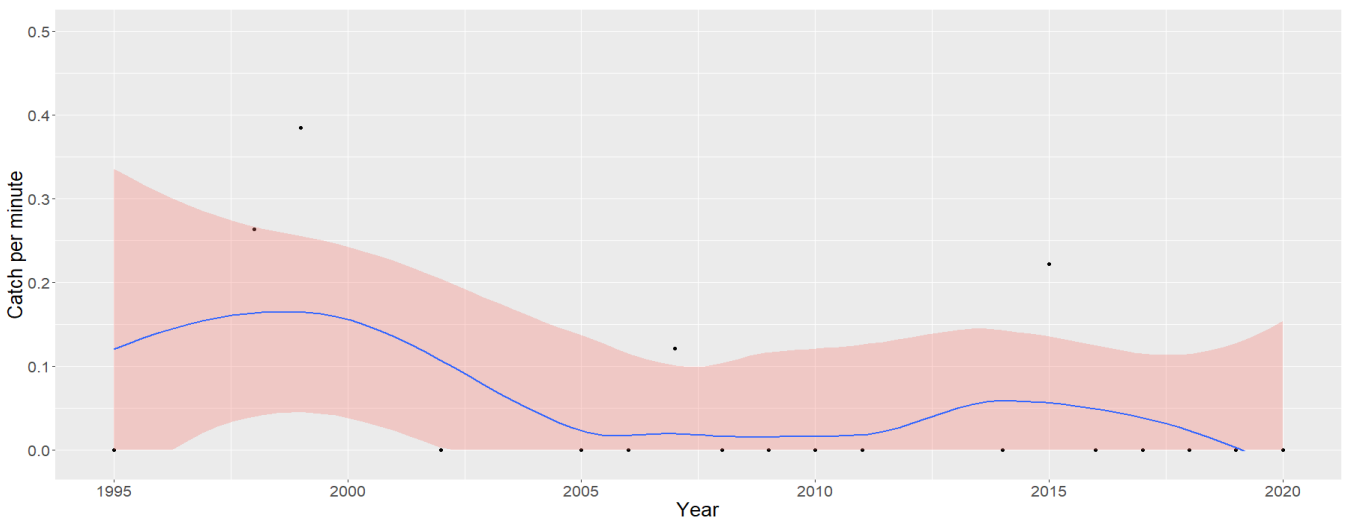


Figure 11. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the upper Murray River.

Trout Cod Protection Area (TCPA) TCRU

Summary statement – Evidence for a decline in CPUE for most recent survey

- Part of a natural population.
- Peak in CPUE detected around 2016, followed by a potential recent decline.
- No recent NSW data for this stretch of river, however annual data from Arthur Rylah Institute is presented below)

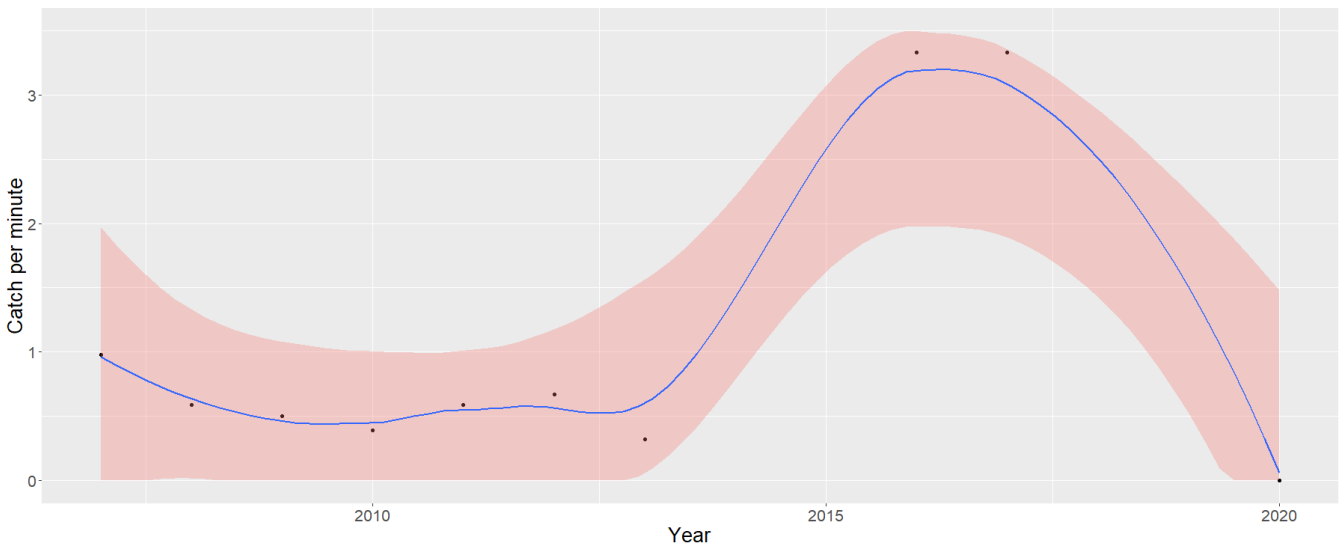


Figure 12. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the TCPA.

- Victorian Fisheries have been monitoring the TCPA for over 20 years also using boat electrofishing. Summary of the data shows CPUE peaked around 2005 and have experienced an overall decline since that time (Figure 13). However, numbers in recent years remain similar to Murray Cod which has remained more stable since 2012.

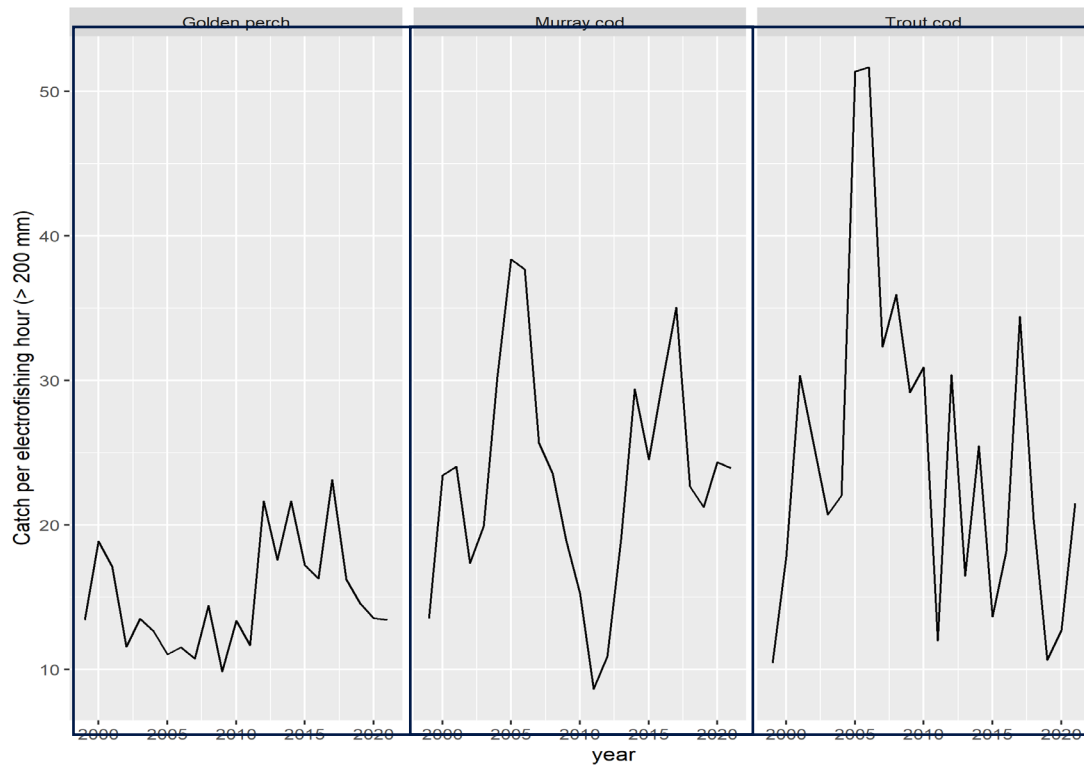


Figure 13. CPUE (fish per hour) for Golden perch, Murray cod and Trout Cod above 200mm from the TCPA as collected by and Arthur Rylah Institute, Victoria.

Mid-Murray River TCRU

Summary statement – Evidence for increasing trajectory in CPUE

- The only remaining natural population.
- Population increased from 1994 to the late 2000's with another increase since 2015 (Figure 14).
- Recruitment is detected regularly.
- CPUE for larger fish (>400mm) showed an increase from 2010 to 2015 but this has since declined (Figure 15).

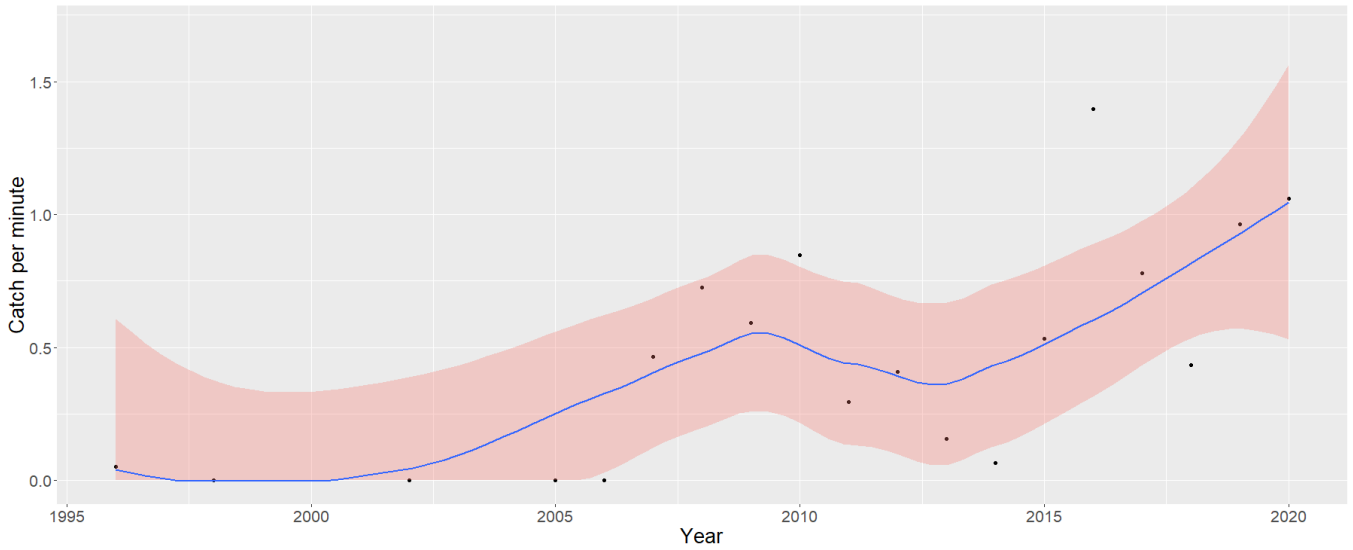


Figure 14. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the mid-Murray River.



Figure 15. CPUE (fish per minute) LOESS plots (with 95% CI) for Trout Cod >400mm from the mid-Murray River.

Murray River TCRU

Summary statement – Some evidence for potential spatial expansion

- Natural downstream population expansion occurring, although detections remain irregular.
- CPUE reflects the irregular nature of detections.

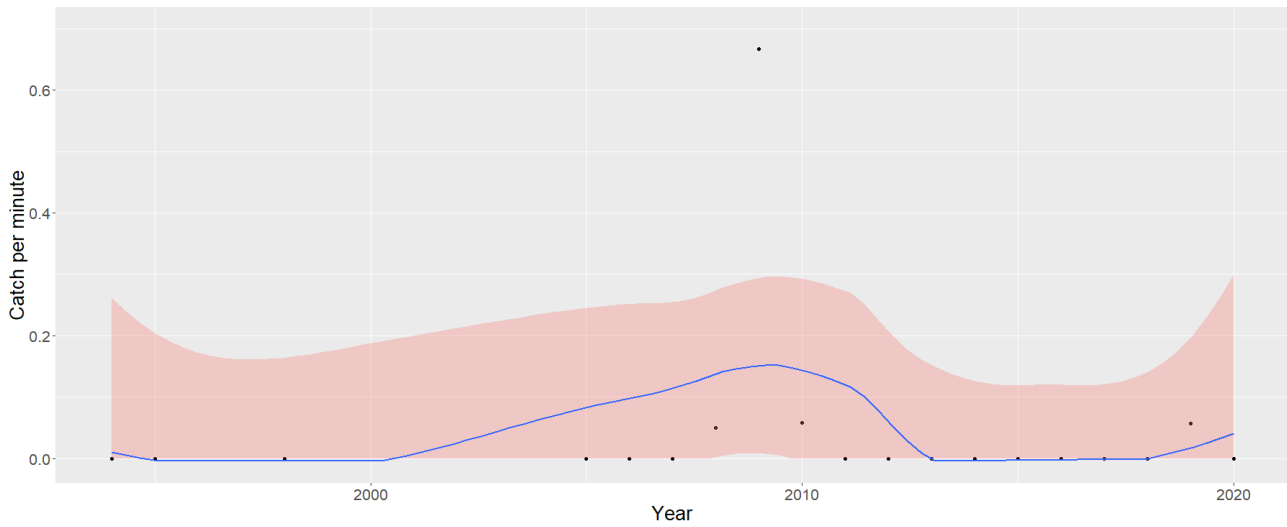


Figure 16. Trout Cod CPUE (fish per minute) LOESS plots (with 95% CI) from the Murray River.

Lower Murray River (NSW) TCRU

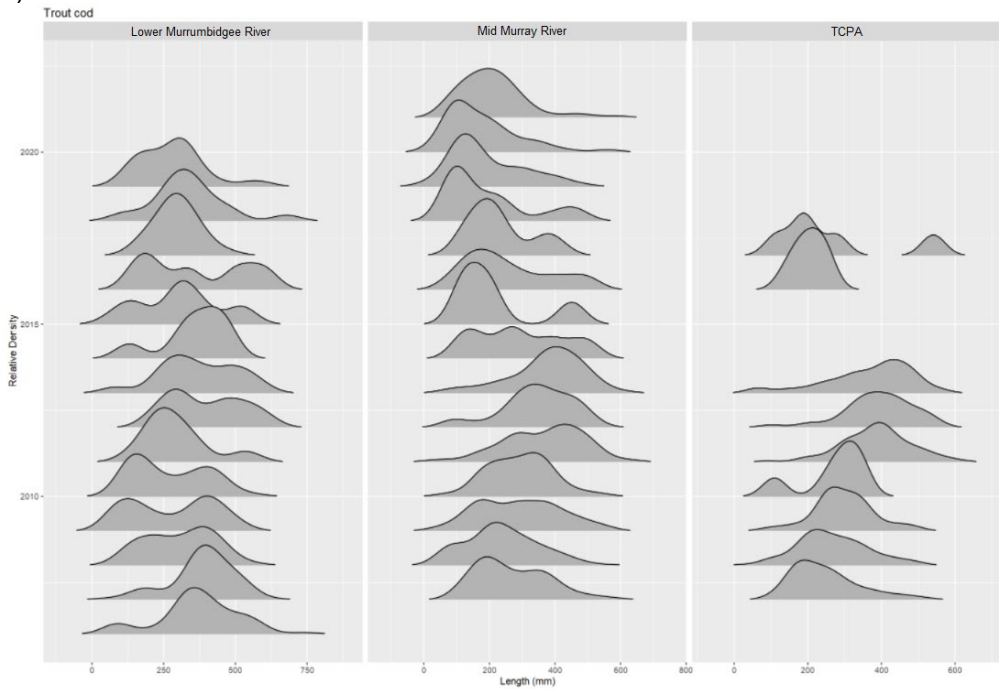
Summary statement – *Not yet detected during sampling at this TCRU*

- Monitoring is present and will detect further downstream expansion should that occur.

Length compositions

Length frequency data for the Trout Cod reporting units showed an increased proportion of smaller fish in the lower Murrumbidgee River and mid Murray River from around 2015 until present (Figure 17a). This increase in smaller fish would potentially suggest recruitment events or successful stocking in some TCRU. No recent stocking of the TCPA or mid Murray River has occurred by NSW Fisheries, however, Victorian Fisheries regularly stock nearby tributaries (e.g., the Ovens River).

a)



b)

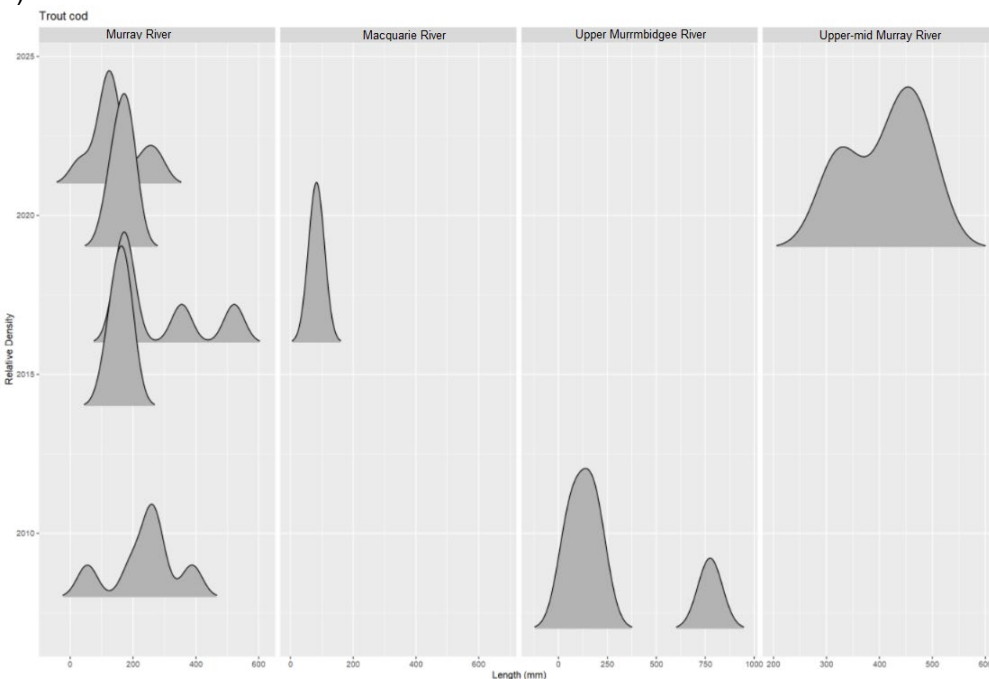


Figure 17. Ridgeline plots of Trout Cod lengths from 2005 to 2021 across Trout Cod reporting units with sufficient data.

Across all years of data, larger fish (>500 mm) were represented in higher numbers in the upper Murray River, upper Murrumbidgee River, the Macquarie River and upper Murrumbidgee Rivers (Figure 17b and 18). Despite the presence of these large fish, natural recruitment events have not been detected in these areas. Smaller fish (<300 mm) tended to dominate the other reporting units (Figure 17b and 18). This might suggest historical stocking practices are still influencing the size structure of this species across the TCRU. For example, large Trout Cod from the upper Murray have been aged to over 20 years, which traces back to the initial stocking programs for this species in that area.

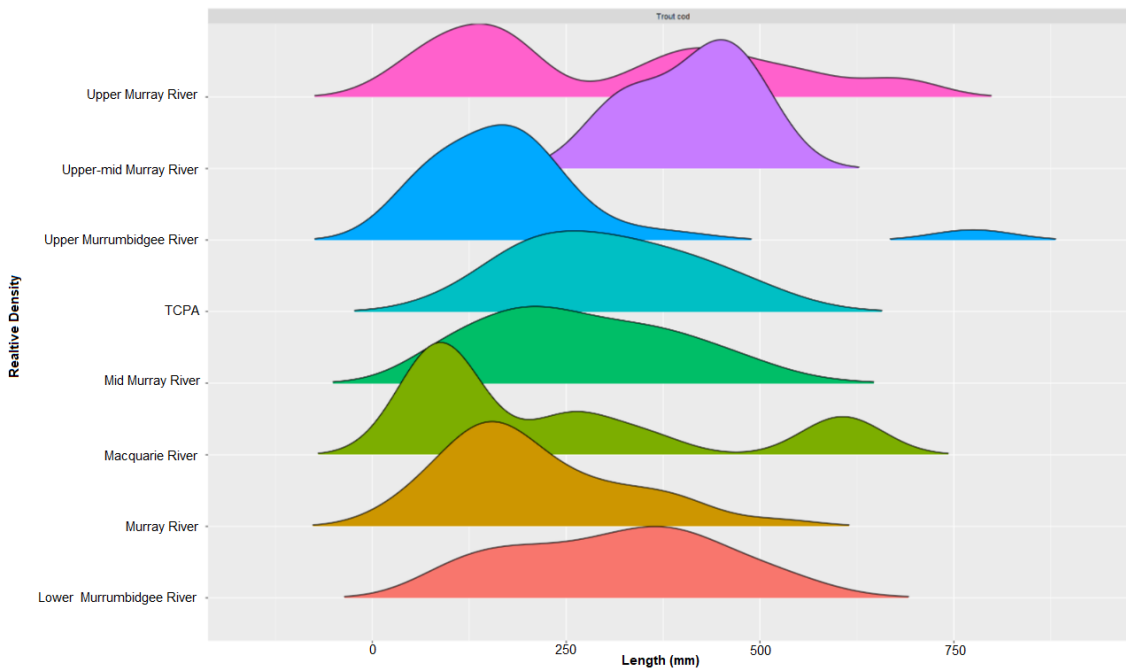


Figure 15. Ridgeline plots of the Trout Cod populations combined across years (1990-2021) for each of the TCRU in NSW.

The average length of Trout Cod in NSW boat electrofishing samples has decreased since 2011 (Figure 19a). This could indicate a decrease in spawning stock or an increase in recruitment of juvenile fish to the population. A decrease in spawning stock could be the result of accidental harvesting of large Trout Cod which are misidentified as Murray Cod in up to 40% of cases (Lyon et al. 2018, Miles et al. 2021).

Length data from the mid Murray River also displayed a decline in average size of Trout Cod from 2013 up until 2021, with the average size remaining between 200-250 mm since 2018 (Figure 19b). The Murrumbidgee River recorded a larger average size (~300mm) and although there was some indication of a decline in average size since 2012, the lengths of Trout Cod recorded in this TCRU were more varied (Figure 19c).

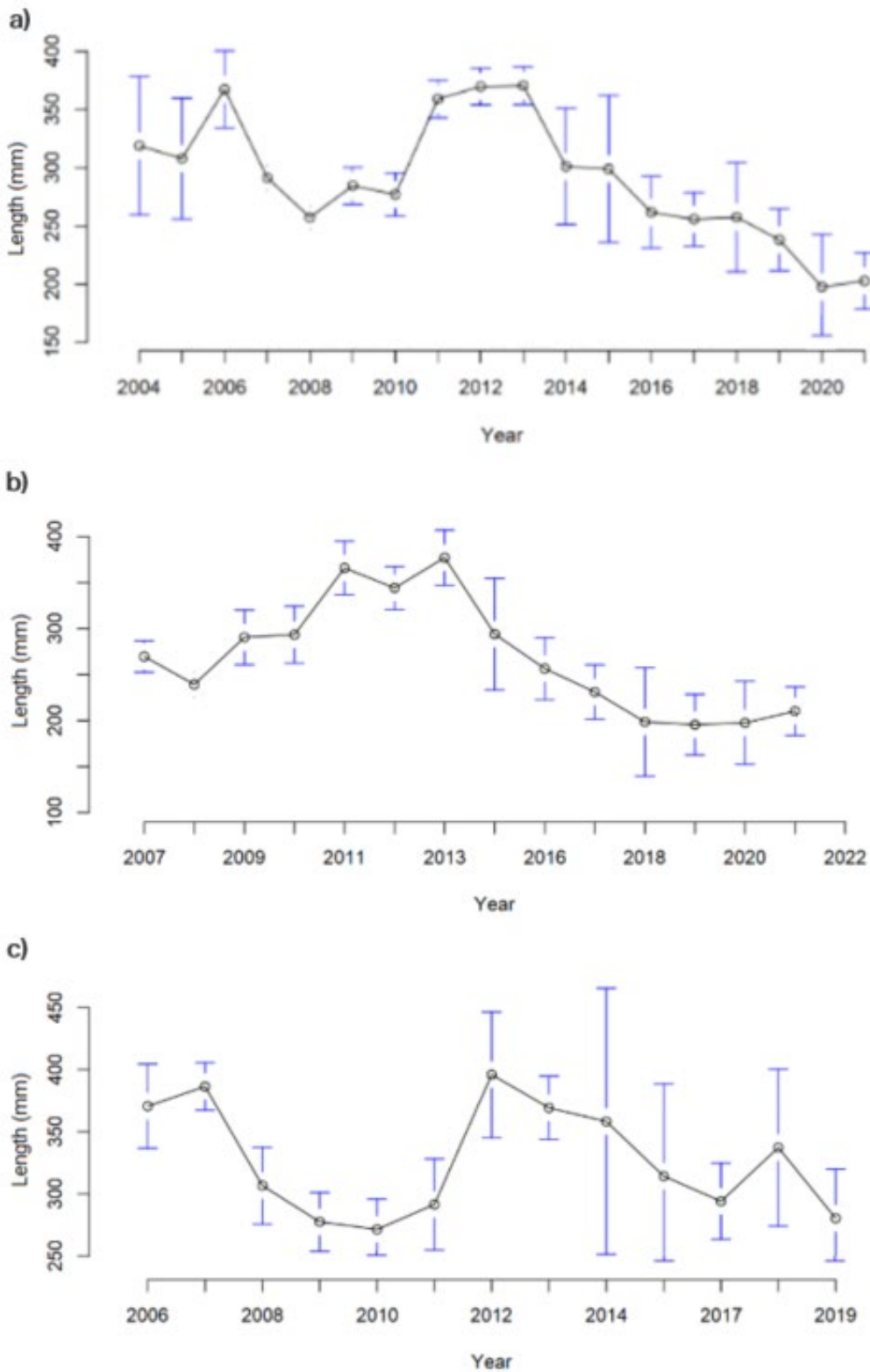


Figure 19. Average total length (mm \pm SE) for NSW Trout Cod populations across a) all TCRU's, b) mid-Murray River and c) the lower mid Murrumbidgee River. Figures include data from 2004-2022 (Note: x-axis scale varies across a, b and c depending on data available)

Potential limitations and sources of uncertainty

This report relies on data collected from a single survey method (boat electrofishing). The key uncertainty of this technique would be the ability to evenly sample the population across all size classes. If boat electrofishing surveys are not representative of size composition of the Trout Cod in NSW waters (or reporting units), then size compositions may not accurately reflect changes in the population. A non-representative length composition could occur if electrofishing practices bias certain size classes (due to flow, water clarity or susceptibility to the gear type). Previous work has suggested river turbidity associated with increased river discharge negatively influenced capture probability in *Maccullochella* species. Increasing fish length increased detection of fish up to 500 mm (for Murray cod), but capture probability decreased again after this size (Lyon et al. 2014).

Nevertheless, this potential uncertainty or bias was comparatively consistent across the dataset, so long term trends in boat electrofishing should reflect changes in the populations being sampled.

Conclusion

Overall, the CPUE from electrofishing surveys suggest a slight decrease in abundance in Trout Cod stocks across NSW, when aggregated at the statewide level. When data were considered for individual TCRUs, there was further evidence for reduction in CPUE through time, and the failure of stocking efforts to establish populations in the upper Murray River, upper Murrumbidgee and the Macquarie River. Many areas of the population remain reliant on stocking events to sustain populations, although there is some evidence for CPUE improvements and range expansion in the lower section of the Murray River. Length composition from independent monitoring indicates that populations have become dominated by smaller size classes. In addition, some TCRUs (e.g., upper-mid Murray River) had few smaller fish recorded suggesting that natural recruitment or stocking in those areas has not been successful.

The data presented here does not provide convincing evidence for population recovery in the NSW population of Trout Cod. Although there is some evidence for recovery in the Murray River, the failed reintroductions, and overall reliance on hatchery releases for recruitment in most areas indicate that the suite of current management provisions have not yet resulted in measurable and consistent improvements across the population. The patterns reported in this assessment broadly align with the previous determinations for this species, including:

- Listed as “Endangered” under NSW and Commonwealth legislation based on previous assessments
- Assessed as “Vulnerable” in Australia by IUCN (2019)

Stocking has recently commenced in new areas of the upper Murrumbidgee River. However, it will take a number of years before any natural recruitment can be detected (if it indeed occurs), and the success of these new release sites can be convincingly evaluated.

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