

Population structure of Murray cod (*Maccullochella peelii*) in two river systems in the Northern Murray-Darling Basin before and after the implementation of a 550-750 mm harvest slot.

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Report to:

NSW Recreational Fishing Trust

June 2018



Department of
Primary Industries



Background

Murray cod (*Maccullochella peelii*) is one of the most socially and economically important freshwater fish species in south-eastern Australia. Management of the species employs an adaptive approach, with regular reviews and amendments in rules and regulations undertaken based on the best available scientific information at the time. Up until 2014 the minimum take size for Murray cod was 600 mm and there was no maximum or upper size limit in place. In a collaborative arrangement between NSW and Victoria, in late 2014 a harvest slot size of 550–750 mm was implemented for all waters across both States, with the broad goals being to protect larger breeding fish from angler harvest, have higher numbers of large breeding fish in the population and potentially also reduce the overall numbers of cod harvested. However, as is the case with any change to management practices, the introduction of harvest slot limits is not without risk. Murray cod populations have previously been shown to truncate at the minimum harvest size limit, with any reduction in the legal harvest size potentially resulting in the average length of fish declining and as a result a reduction in the perceived angling quality of the fishery. Also, there is an increased risk of fish being harvested whilst in the slot if the slot is set too wide, resulting in there being fewer larger individuals within the population than there was previously. The aim of this current study was to determine if the slot limit is having an effect on Murray cod population size structure within two river systems from the Border Rivers region of northern NSW.

Methods

Electrofishing surveys were undertaken at sites in the Dumaresq and Gwydir rivers from 2010–18. Sampling effort followed the standardised Fisheries NSW electrofishing protocols (12 X 90 second “shots” of electrofishing on-time). Additional sampling effort was also undertaken where possible at all sites, with the specific aim being to simply increase the overall numbers of Murray cod caught and measured. All Murray cod captured were measured to the nearest mm before being released at the site of capture. Sampling post-implementation of the harvest slot was undertaken in the Dumaresq River in 2015, 2016, 2017 and 2018 and in the Gwydir in Years 2017 and 2018 (Table 1). The majority of sites had been sampled at least once prior to the introduction of the new slot. Pre-slot sampling was undertaken at 11 sites in both river systems; in 2010 and 2011 in the Dumaresq and in 2012 in the Gwydir (Table 1). For analyses, the data was combined for all sites for each river individually and for each year individually. Length frequency histograms (expressed as a percentage of the total sample), were then created to visualise the population structure pre- and post-slot.

Table 1. Sites sampled in the Dumaresq River pre- (2010–11) and post-implementation (2015–18) and in the Gwydir River pre- (2012) and post-implementation (2017 & 2018) of the 550–750 mm harvest slot.

Site Name	River	Co-ordinates		2010	2011	2012	2015	2016	2017	2018
Powerball hole UP	Gwydir	-29.436033	149.78426			✓			✓	✓
Powerball hole DS	Gwydir	-29.435575	149.82960			✓				
Pallamallawa	Gwydir	-29.28654	150.08119			✓			✓	✓
Gravesend Bridge DS	Gwydir	-29.58307	150.37049			✓			✓	✓
Gravesend Bridge US	Gwydir	-29.6505	150.4055			✓				
Benbraggie	Gwydir	-29.8478	150.5417			✓				
Keera	Gwydir	-29.982545	150.78813			✓			✓	✓
Gum Flat Reserve	Gwydir	-29.46208	150.09016			✓			✓	✓
Peter Glennie's	Gwydir	-29.417879	149.75701			✓				
Yagobe Crossing	Gwydir	-29.52231	150.26004			✓			✓	✓
Peach Trees	Gwydir	-29.417879	149.75701			✓				
Redbank	Gwydir	-29.43086	150.00138						✓	✓
Riverton	Dumaresq	-29.03342	151.49510	✓	✓		✓	✓	✓	✓
Glen Hill Winery	Dumaresq	-29.17262	151.33087	✓	✓					
Anton's hole	Dumaresq	-29.17236	151.40078	✓	✓		✓	✓		
Bonshaw township	Dumaresq	-29.057146	151.286644	✓	✓					
Riverton Bridge	Dumaresq	-29.04477	151.49515	✓	✓					
Glen Innis turnoff	Dumaresq	-29.153698	151.309768	✓	✓					
Mingoola Bridge	Dumaresq	-28.987071	151.527546	✓	✓					
Zappa's Winery	Dumaresq	-29.1411	151.4313	✓	✓				✓	✓
Bonshaw Weir	Dumaresq	-29.016717	151.283578	✓	✓					
Reedy Creek	Dumaresq	-29.05997	151.49434	✓	✓					
Anton's Old House	Dumaresq	-29.17585	151.37352	✓	✓		✓	✓	✓	✓
Coventry's	Dumaresq	-28.94536	151.27851				✓	✓	✓	✓
Riverstone	Dumaresq	-29.12563	151.30826				✓	✓	✓	✓
Cornvale	Dumaresq	-29.10529	151.28297				✓	✓	✓	✓

Results

Length truncation in Murray cod populations from both the Dumaresq and Gwydir rivers was evident in all samples taken pre-introduction of the harvest slot in 2014 (Figure 1 & 2). In the Dumaresq 85% and 88% of the population were below 600 mm in 2010 and 2011 respectively, whilst in the Gwydir 94% of the Murray cod sampled in 2012 were below the legal harvest size. Post-reduction in the legal minimum harvest length to 550 mm, ~90% of the population in the Dumaresq in 2015, 2016, 2017 and 2018, whilst 87% and 77% of Murray cod were below 550 mm and in the Gwydir in 2017 and 2018 respectively. However, what is apparent is that effectively the truncation has shifted backwards post-implementation of the harvest slot, particularly in the Dumaresq (Figure 1). Pre-implementation of the slot, ~24% of the population was between 550 and 650 mm in the Dumaresq, whilst post-introduction only 5.5%, 4.6%, 3.1% and 2.9% were in the same range in 2015, 2016, 2017 and 2018, respectively. In the Gwydir there was a marginal increase from 5% to 12% to 14% in the 550–650 mm range in 2012, 2017 and 2018, respectively. Whilst this could be construed as fish growing and moving out of the harvest slot in the Dumaresq (as is the intended outcome of implementing a harvest slot), there was no increase in the abundance of larger fish in the system and as such this appears not to be the case. What is most likely happening is that those fish that were in 550–600 mm size range pre-implementation of the new slot were quickly harvested and now any new fish entering the slot are also being harvested before they have the chance to pass out of the upper limit. In the Gwydir, the small number of larger cod (>650 mm) captured in 2018 ($n = 11$) may indicate that there are some fish getting through the slot, however, ongoing monitoring is needed to track this through time. The average (\pm S.E.) and median length of Murray cod pre- and post-implementation of the harvest slot was 437 ± 14.45 and 485 mm before, and 385 ± 6.5 and 406 mm after in the Dumaresq, whilst in the Gwydir it was 412 ± 11.3 and 413 mm before, and 410 ± 11.7 and 417 mm after.

Recommendations

A risk when implementing a new management strategy is that there is a chance that it may not produce the intended outcome. The introduction of a reduced minimum harvest size for Murray cod in NSW appears to have negatively altered the population size structure of Murray cod in both the Dumaresq and Gwydir river systems. The overall result has been a reduction in the average and median size of cod in the Dumaresq and the appearance of only a small number of larger individuals in the Gwydir with no overall substantial increase in the average or median length. Continued monitoring will reveal if this effectively "corrects" itself in the Dumaresq with greater numbers of larger fish over 750 mm appearing over time and if there is a continuation of the increase in the abundance of larger fish in the Gwydir. Also worth noting is the high abundance of 0+ and 1+ Murray cod in the Dumaresq despite there being few larger cod over 750 mm. This somewhat contradicts one of the key justifications for implementing a harvest slot, that being the premise that larger fish produce more offspring resulting in increased recruitment. As suggested previously for Murray cod and for the closely related species eastern freshwater cod (*Maccullochella ikei*), successful breeding and the early survival of larvae most likely relies more on the relative experience of the parent rather than their size.

Based on the sampling undertaken to date, in the short term the introduction of a slot limit for Murray cod appears to have resulted in a shift in the size structure of the populations in the two rivers sampled. Ongoing monitoring is required to confirm if this change is manifested over the long term. While impoundments were not monitored as part of this study, we would anticipate that the higher growth rates of Murray cod in these environments would result in a more positive outcome as a result of the introduction of the harvest slot. As such we recommend future monitoring include impoundments as well as rivers to ascertain if this is the case, with the end result being that multiple strategies may be required to effectively manage populations of Murray cod occupying different habitats or waterbodies.

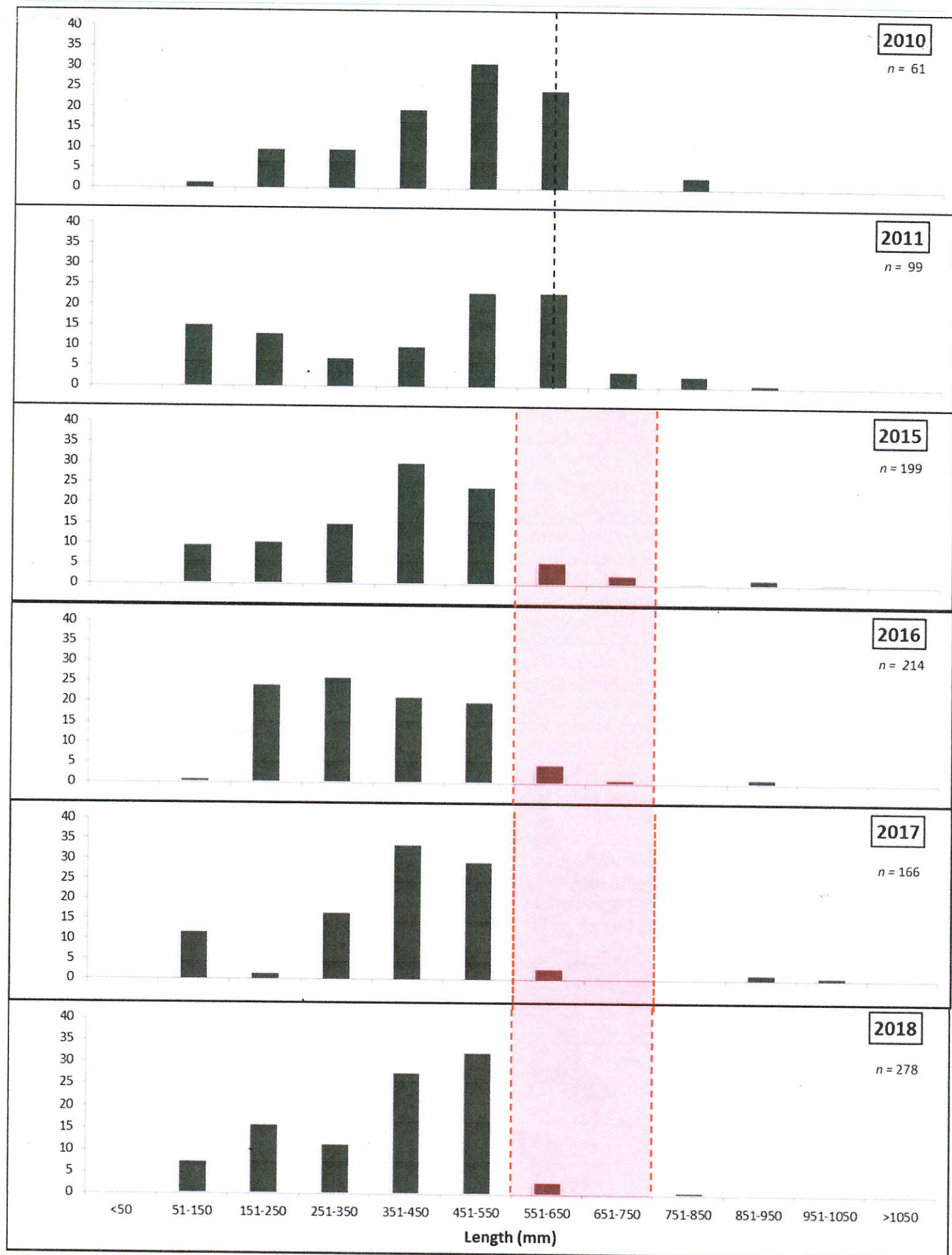


Figure 1. Length frequency (%) distribution of Murray cod (*Maccullochella peelii*) in the Dumaresq River pre- (2010-11) and post-implementation (2015-18) of 550-750mm harvest slot. Dashed lines represents minimum take size of 600mm 2010-2011 (black) and 550-750mm slot post-2014 (red).

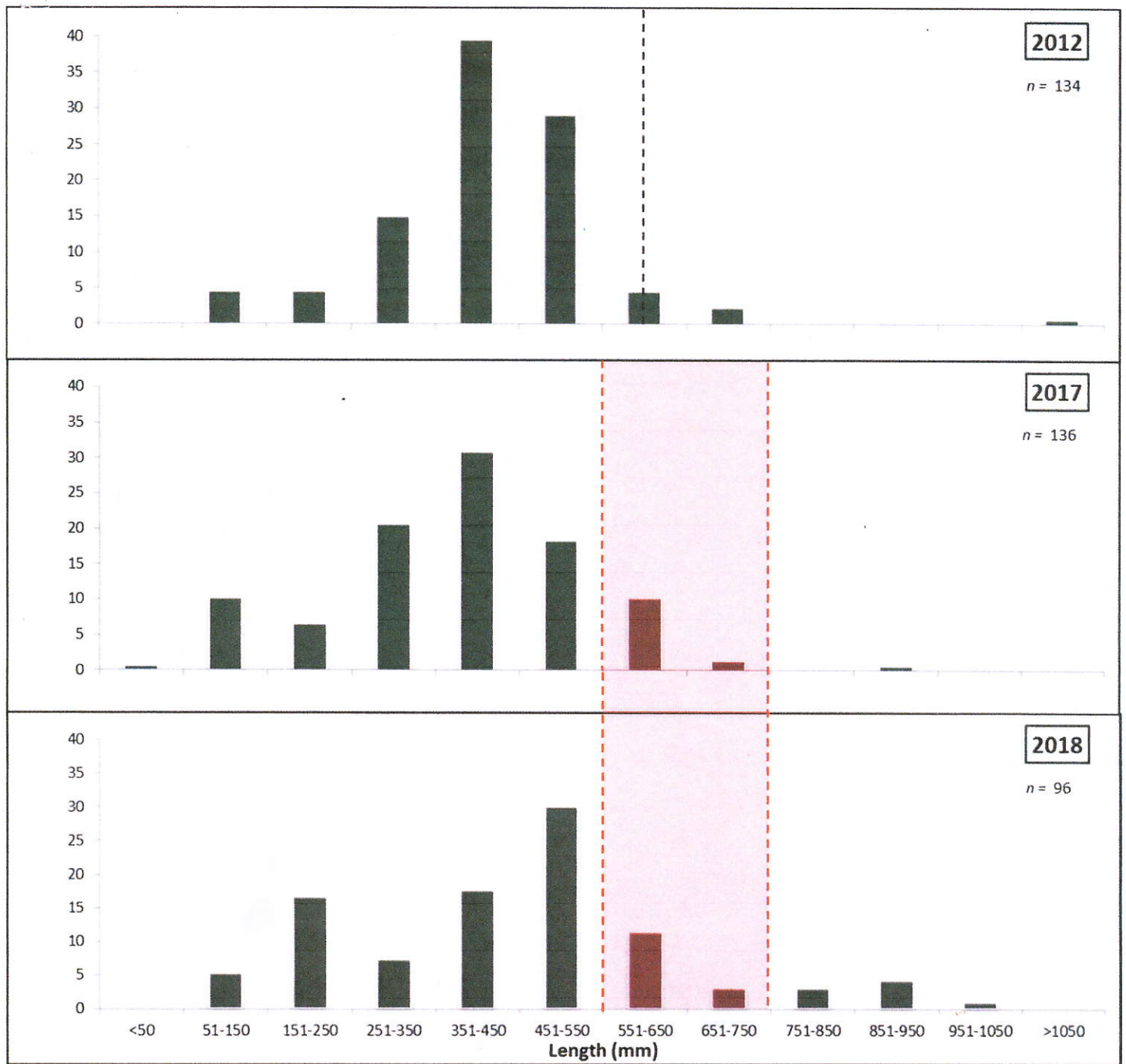


Figure 2. Length frequency (%) distribution of Murray cod (*Maccullochella peelii*) in the Gwydir River pre- (2012) and post-implementation (2017 & 2018) of 550-750mm harvest slot. Dashed lines represents minimum take size of 600mm 2012 sample (black) and 550-750mm slot post-2014 (red).