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A biological and economic assessment of the 2001  
change in the Minimum Legal Length (MLL) of  
snapper in NSW

by  
Robert Gale, Veronica Silberschneider and John Stewart

*A report to the NSW Ocean Trap & Line Management Advisory Committee*

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## SUMMARY

In 1999, fisheries scientists with the New South Wales state government recommended a 4 cm increase in the Minimum Legal Length (MLL) of snapper from 28 to 32 cm to reduce the problem of growth overfishing. Given concerns about the financial impacts of a 4 cm size increase for some commercial fishers, the Minister for Fisheries at the time committed to implementing two separate size limit increases of 2 cm increments. The first increase from 28 to 30 cm took effect 1 July 2001; the second increment was to occur after a study of the biological and economic effects of the first increment. Accordingly, the purpose of this study is to report on the biological and economic impacts of the 2 cm increase in the legal catch size of snapper from 28 to 30 cm. The implications of the findings for an increase to 32 cm are also considered.

The research method for assessing the impact of the 2 cm size increase is a “before-and-after” comparison of biological, catch and economic information, complemented by a statistical analysis of price information for four years preceding and five years following the change. The Ocean Trap and Line (OTL) Fishery constitutes the scope of the study because 95% of all commercially caught snapper are from this fishery.

This summary reports on the results of the first change to increase the MLL by 2 cm from 28 to 30 cm, as well as the second anticipated change for an additional 2 cm increase in the MLL from 30 to 32 cm (as originally recommended by NSW fisheries scientists). Key points about biological, catch and economic issues are reported.

### **Effects of increasing the MLL by 2 cm from 28 to 30 cm**

Three key outcomes arise with regard to biological issues:

- The shift in size composition of landed snapper is consistent with previous expectations about the impacts of a 2 cm increase. This shift suggests that the snapper protected by the new size limit have grown and are now contributing to the fishery at these larger sizes and increasing the average weight of fish caught and hence the weight of fillets.
- There has been an increase in the proportion of 3- and 4-year-old snapper in landings since the MLL change. This is a very desirable shift because it reduces the dependency of the fishery on 2- and 3-year old fish and therefore reduces the risks associated with a year or two of poor recruitment. However, the age composition of the fishery is still typical of a heavily fished stock with more than 65% of the catch in 2002/03 and 2003/04 being 2- and 3-year-old fish. The snapper stock and its fishery would likely benefit from a further reduction in reliance on 2- and 3-year-old fish.
- The analyses of trends in average snapper catch per day from trapping indicate that snapper greater than or equal to the 30 cm MLL, and hence available to commercial fishers remaining in the OTL fishery, has increased markedly since the period prior to the 2 cm increase.

Five key points on catch are important to note:

- The total volume of commercial catch of snapper has declined markedly since the early 1990s. This overall decline is part of a long-term trend (even prior to the years discussed in this report) and is mainly associated with a corresponding decline in the numbers of commercial fishers who target snapper. More specifically, the trends between 1997/98 and 2005/06 are as follows:
  - OTL catch declined by 35.2% from 2,299 tonnes to 1,491 tonnes.

- Snapper catch declined by 27.3% from 278 tonnes to 202 tonnes.
  - For the period 2001 to 2005, the number of fishing businesses voluntarily surrendered by (active) OTL fishers catching snapper for the creation of Recreational Fishing Havens was 24; the number for Marine Protected Area buy out programs was 32.
  - In the OTL fishery, there was a 47.4% decline in the number of fishers catching any snapper from 380 to 200 fishers. Regarding the 180 fishers who stopped catching snapper, approximately 78 fishers participated in the buy out programs between 2001 and 2005, and another 102 fishers stopped fishing for snapper in the OTL fishery for other reasons (between 1997/98 and 2005/06), although they may still be participating in the OTL fishery catching other species or participating in other fisheries.
  - The number of fishers in the OTL fishery who contribute to catching 90% of the total landings of snapper also declined by 47.4% between 1997/98 and 2005/06 from 116 to 61 fishers (though these fishers may still be participating in the OTL fishery or other fisheries).
- Even with the declines in snapper landings and fishers, individual fishers caught on average a greater weight of snapper per fisher in 2005/06 than in 1997/98. This is evident for all fishers catching snapper and for those who contribute to catching 90% of the total-catch for both categories increased by 39%.
  - On a regional basis, dedicated snapper fishers (i.e., those contributing to catching 90% of landed snapper) caught 70% more fish per person in the Northern area, 14% more in the Mid-North in 2005/06, and 40% more in the Central area, compared to 1997/98. These increases in catch per fisher are consistent with expectations following the increase in MLL; they may also be associated with naturally productive years in those areas and/or the reduction in the number of participating fishers. The South was the only area to experience a decline in catch, a 7% drop compared to 1997/98.
  - The relative importance of the MLL change with respect to other reasons for leaving the snapper fishery is difficult to isolate given the available data. While the change to a 30 cm MLL may account for a proportion of the impact on fishers choosing not to continue fishing snapper or to continue at a lower level, other factors such as natural variation in biological production, buy outs of fishing entitlements or uneconomic operating costs, may also contribute to lower levels of total catch. While year-to-year variations make it difficult to distinguish other factors from the effectiveness of the size limit increase, the analysis of trends within data sets, combined with the comparison of means, immediate impacts, and overall trends, suggests that the change in MLL has had a positive overall impact.

The following six points on economic issues are particularly relevant:

- The estimated Gross Value of Production (GVP) of all catch from the OTL fishery was already in decline before the MLL change for snapper and this decline has been at a faster rate than the decline in GVP from snapper. For example, after taking inflation into account, the OTL GVP declined by 38% over the nine years of record. Over the same period, snapper GVP declined by 32%. This means that factors other than the snapper MLL change are important in the declining GVP of the OTL fishery.
- While the estimated GVP from fishers catching 90% of the total landings of snapper declined in absolute terms, overall average income from snapper per OTL fisher contributing to catching 90% of the total snapper catch (after adjusting for inflation) increased by 40% between 1997/98 and 2005/06 (from \$24,493 to \$34,277).

- On a regional basis, over the nine years of record, average income from snapper per OTL fisher contributing to catching 90% of the total snapper catch (after adjusting for inflation), increased by 64% in the North (from \$27,246 to \$44,758), by 10% in the Mid-North (from \$25,361 to \$27,785), and by 35% in the Central area (from \$26,499 to \$35,569). It decreased by 11% in the South area (from \$12,850 to \$11,479).
- There were increased catches of leatherjackets and bream in the year immediately following the MLL change. Although average incomes from snapper fishing declined by 18.9% for OTL snapper fishers contributing to 90% of the total snapper catch in the year following the change, for many of these snapper fishers the increase in catch of leatherjackets and bream offset short-term losses in income from snapper. In other words, large increases in landings of leatherjackets and bream by fishers since 2000/01 may have offset the short-term losses in income from not catching snapper under 30 cm in length. After adjusting for inflation, the GVP of the OTL fishery – already in decline – decreased slightly from 2000/01 to 2001/02, suggesting that the change to snapper MLL did not have a significant overall impact on the OTL fishery as a whole.
- Over the five years of record after the change, there is a 7 per cent increase in the inflation-adjusted price of snapper per kilogram sold at the Sydney Fish Market, i.e., a comparison of the before-and-after periods demonstrates that the price of snapper has increased in real terms.
- Although the proportion of all NSW snapper sold at the Sydney Fish Market is unknown, records of NSW sales kept according to grade size allow some comparative analysis. The grade categories are small (less than 34 cm), medium (34 to 48 cm) and large (greater than 48 cm). For the four years of record before the size limit change, there is a price premium of 5.1% and 7.4%, respectively, for small snapper compared to medium and large snapper. For the three years after the size-limit change, the price premium increases to 14.6% and 20.5%, respectively. This suggests that a refinement of the small grade size category has occurred through the elimination of snapper less than 30 cm, i.e., the removal of sizes below the legal size limit. This information indicates that, taking inflation into account, the increase in MLL has been positive for size grade and price.

### **The next step: Increasing the MLL by 2 cm from 30 to 32 cm**

In summary, the biological information indicates that the increase in MLL contributes to increases in snapper catch per fisher and the available biomass of larger fish. Associated with these benefits are increases in the spawning biomass and egg production and therefore probable increases in recruitment. Nevertheless, the composition of the catch indicates that the east-coast snapper stock is still a very heavily fished stock. The next step in continuing to improve yield in this fishery is to shift the size composition of landed snapper by an additional 2 cm. This is consistent with the original scientific advice in the late 1990s that further benefits would occur by increasing the MLL to 32 cm and beyond. It is also consistent with the original Ministerial decision to implement a 2 cm increase from 28 to 30 cm in 2001 as the first part of a planned 4 cm increase, with the second increase to take place following an assessment of the impact of the initial increase.

The following four points about the merits of increasing the size limit by 2 cm from 30 to 32 cm are noted:

- **Increasing yield:** The original MLL change from 28 to 30 cm was associated with immediately excluding a large proportion, i.e., more than 30% of the fish landed (see Figure 1). The immediate impact was a 20% decline in catch per unit of effort (CPUE) in 2001/02; the CPUE subsequently increased each year to be currently approximately 15% on average higher than pre-MLL change levels. It would be logical to expect that a further increase in MLL to 32 cm would cause a similar decline in catch rates in the year immediately following the change, but that yield per recruited fish (i.e., the average size of snapper caught), would



increase from current levels. A further increase in yield would address a desirable and sought after scientific, management and economic objective. Because a 30 cm snapper grows at an average rate of 4 cm per year, harvesting at larger sizes takes advantage of this rapid growth. Harvesting from a population with a higher proportion of older age classes is consistent with risk-averse fisheries management and has the potential to reduce the costs of monitoring the stock in the longer-term.

- **Protection of more juvenile snapper:** The age-composition of landings remains indicative of a heavily fished stock. Biologically, there is too much fishing mortality on 2- and 3-year-old fish. Not all 2-year-old snapper are sexually mature and a further increase in MLL would protect a greater proportion of 2-year-old snapper. Protection of more juvenile snapper should result in increases in spawning biomass and egg production. It is important to note that snapper in NSW are growth overfished and that reducing fishing mortality will assist in reducing the risk of recruitment overfishing.
- **Size limits in other jurisdictions:** NSW fisheries scientists have consistently argued that the 4 cm increase in size limit from 28 to 32 cm recommended in the late 1990s was always the minimum recommended increase and that in other jurisdictions where overfishing is a concern larger size limits have already been implemented. For example, the MLL for snapper in Queensland, South Australia and Western Australia is 35 cm, 38 cm and 41 cm (most regions), respectively. In Victoria, where snapper stocks are not believed to be overfished, the size limit was increased on 1 October 2007 from 27 to 28 cm.
- **Recreational fishing:** A survey of recreational fishing in New South Wales for 2000/01 estimated the recreational catch of NSW snapper at 117 tonnes. This was about 43% of the 273 tonnes of commercial catch, yielding a combined catch of about 390 tonnes. The high proportion of recreationally caught snapper provides an additional factor in favour of a 32 cm size limit because it provides additional protection to a proportion of the snapper that would otherwise be caught without the increase in size limit.

Notwithstanding the above points, there is still a need to address bycatch issues that might result from a further increase in MLL for snapper. The implementation of the smallest-sized escape panel mesh in fish traps will do little to reduce the bycatch of currently undersized snapper and nothing to prevent the catching and discarding of 30 and 31 cm snapper. The survival of discarded snapper and the relationship of survival rates with the depth released require further consideration.

In summary, the evidence supports the view that the implementation of a 30 cm MLL in 2001 has contributed to the following three major outcomes:

- Increasing yield per recruit;
- Spreading the fishery across more than a couple of young year classes (thus reducing the potential for fishery collapse following a year of poor recruitment), and
- Increasing the reproductive potential of the snapper stock.

A further increase in the MLL by an additional 2 cm to 32 cm (as originally recommended), will likely lead to enhanced biological benefits by shifting catch to a larger proportion of 3- to 6-year-old fish. Expected benefits also include reduced risks to the stock, reduced yearly variations in catches due to recruitment and probable increased egg production. The size limit increase and short-term reduction in the landed weight of snapper is a cost to participants that would likely be offset by other catch as occurred after the first size limit change. On balance, the longer-term benefit of improvements to CPUE compensates the industry for short-term economic costs.

The MLL change is one component of other policy changes (including input controls and buy outs for Marine Protected Areas and Recreational Fishing Havens) that have taken place in NSW fisheries. While no one policy change explains the current catch and income figures for OTL fishers catching snapper, there is no basis for arguing that the first 2 cm increase has had an adverse ongoing impact on snapper fishers continuing in the industry. From an economic perspective, increased catches by weight have slightly improved the viability of fishers catching snapper.

The decision to further increase the MLL to 32 cm can be justified on biological grounds. Given the significant biological benefits (i.e., an increase in yield per recruit and reproduction), it can also be expected that any short-term economic costs will be offset by medium and longer-term economic gains.

Although there are too many confounding factors to link a size increase directly to a price increase, this is not essential information in increasing the MLL. The need for a biological adjustment to promote the sustainability of the snapper stock is the fundamental policy goal. Given the results presented in this analysis, there is no compelling economic reason to object to an additional 2 cm increase in MLL to 32 cm. The results and conclusions of this study accordingly lead to the following recommendation:

**Recommendation:** That the Department of Primary Industries increase the MLL by 2 cm from 30 to 32 cm.

## **1. INTRODUCTION**

This report responds to undertakings by the New South Wales Department of Primary Industries to study the biological and economic impacts of increasing the Minimum Legal Length (MLL) of snapper by 2 cm as of 1 July 2001. A before-and-after comparison of trends in commercial fisheries data guides the assessment. Ninety-five per cent of commercially caught snapper are from ocean trap and line methods: therefore, this assessment focuses on the impact of the change in size limit from 28 to 30 cm in the Ocean Trap and Line (OTL) Fishery. As approved by the Minister for Fisheries in 2001<sup>1</sup>, the reported results form the basis for estimating the biological and economic impacts of a further 2 cm increase from 30 to 32 cm.

## **2. BACKGROUND**

Scientific studies in the late 1990s indicated that most of the snapper caught in NSW were 2- or 3-year-old fish and that the stock of snapper was in a depressed state.

Given the length-weight relationship, the following two points about snapper size limits were noted in particular (NSW Fisheries, 1999):

- The average growth of snapper at a MLL of 28 cm is 4 cm or about 140 grams per year. Harvesting at a MLL of 28 cm does not take the best advantage of the rapid growth of fish at this size.
- An increase of 4 cm in MLL should provide a benefit of about 20% increase in weight (yield) per fish. The basis of this calculation came from estimates of the growth rate relative to the death rate for snapper in NSW.

Recommendations from departmental fisheries scientists provided the basis for the decision to make a fishery adjustment by increasing the MLL. The goal of the size increase was to increase yield. Associated benefits included protecting more juveniles, increasing egg production, and decreasing the mortality of 2-year-old snapper to provide some protection to the stock during years of poor recruitment. To this end, departmental fisheries scientists recommended a 4 cm increase in the MLL of snapper from 28 to 32 cm. An increase to 32 cm would further address the problem of growth overfishing.

Given concerns about the financial ramifications of a 4 cm size increase for some commercial fishers, particularly on the Mid-North coast, the Minister of the day committed to implementing the size limit increase in two separate 2 cm increments<sup>2</sup>. The first increase from 28 to 30 cm took effect 1 July 2001; the second increment was to occur after assessment of the biological and economic effects of the first increment.

In 2006, a management response contained within the draft Fishery Management Strategy for the Ocean Trap and Line Fishery sought to assess the economic impacts of increasing the size limit for snapper to 32 cm (DPI, 2006a: 226). The response stated that 'an economic study will be undertaken to determine whether the longer term biological and economic benefits of increasing the limit outweigh the short term economic costs' (DPI, 2006a: 226–227). More generally, the response is part of the objective to 'prevent overfishing of the stocks of primary and secondary species by ocean trap and line fishers'. The 2006 OTL Fishery Management Strategy, subsequently approved by the Minister for Primary Industries, contains a specific provision to 'Review the economic impacts of increasing the size limit for snapper to 32 cm and implement the outcomes of the review' (DPI, 2006b: 51).

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<sup>1</sup> In 2004, NSW Fisheries became part of the Department of Primary Industries.

<sup>2</sup> Fishers expressed concerns about the economic impact of a size increase at meetings of the OTL Management Advisory Committee and in correspondence to the Minister.

### 3. RESEARCH METHODOLOGY

The research method for assessing the impact of the 2 cm size increase in the commercial snapper fishery is a ‘before-and-after’ comparison of biological, catch and economic information. Microeconomic studies of input costs such as fuel prices, bait, traps, and prices received for catch from regional areas (i.e., not sold through the Sydney Fish Market) are beyond the scope of the study.<sup>3</sup>

The assessment of the biological status involves a study of the combination of sizes and ages landed as well as reported catch and effort information provided by fishers as part of their monthly returns to DPI.<sup>4</sup> Information is presented on the sizes and ages of snapper landed. The information on sizes is for the two years prior to the size limit increase from 28 to 30 cm total length (TL) (1999/00 and 2000/01) and for five years after (2001/02 to 2005/06). The information on ages is for the two years prior to the size limit increase (1999/00 and 2000/01) and for three years after (2001/02 to 2003/04). Researchers measure the fork length (FL) of fish for monitoring purposes. They estimate ages by counting the number of annual zones in sectioned otoliths. The fork length measures the distance between the snout and fork in the tail, whereas the total length is a measure of overall size. The relevant MLL total lengths of interest and their corresponding fork lengths are provided in Table 1. The provision of information on catch and the numbers of fishers is from 1991/92, and particularly from 1997/98.

**Table 1:** Conversion of Total Length to Fork Length.

MLL Total Length	Fork Length
28 cm	23.7 cm
30 cm	25.4 cm
32 cm	27.1 cm

The catch assessment includes the record of OTL catch of all species, OTL total snapper catch, regional OTL snapper catch and regional OTL snapper catch per snapper fisher. The analysis applies to all fishers reporting *any* snapper and to fishers contributing to catching 90% of the total landings of snapper. The 90% category of fishers is useful for assessing the success of the most productive snapper fishers.

Assessing the economic status of the MLL change involves research on the Gross Value of Production (GVP) of the OTL fishery as well as the snapper component of this fishery, average income per snapper fisher, and average income per snapper fisher by area. In addition, accounting for income from other selected fish species assists in understanding their contributions to total earnings in the OTL fishery. In this report, income is from the Ocean Trap and Line Fishery, or specifically from snapper fishing depending on the context of the explanation. It does not incorporate any other sources of income fishers derive either from within, or external to, the wider fishing industry.

There are four years of wholesale snapper price records before the MLL change (from 1997/98 to 2000/01) and five years of record after the change (from 2001/02 to 2005/06). For yearly data, there is too much variability around the means to draw statistically significant inferences about the differences between the two periods. However, catch and price data for 16 quarters before the

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<sup>3</sup> Information on these topics depends on financial information from industry operators and their accountants that would have to be gathered through surveys.

<sup>4</sup> This is a statutory requirement under the *Fisheries Management Act 1994*.

change and 20 quarters afterwards is available for analysis. This is sufficient information to undertake a statistical analysis of variance of catch and price. Since the analysis of catch is already available through the CPUE indicator, an analysis of variance may help to uncover trends in price. Although bio-economic modelling of population dynamics is beyond the scope of the research, it is possible to draw some inferences about the relationship between a size limit increase and economic consequences.

For the purposes of this assessment, the NSW snapper fishery consists of four areas: the North, Mid-North, Central and South (Table 2). These areas are important for monitoring purposes.

**Table 2:** NSW snapper fishery areas.

<b>Area</b>	<b>Boundaries</b>
North	Tweed Heads to Coffs Harbour
Mid-North	Nambucca Heads to Newcastle
Central	The Entrance to Wollongong
South	South of Wollongong to the NSW/VIC border

## 4. ANALYSIS

The study assesses the biological, stock and economic findings of the 2 cm size increase of the snapper component the OTL fishery that became effective 1 July 2001 as well as economic findings for other relevant species in the OTL fishery.

### 4.1. Biological assessment

A growth model of the length-weight relationship shows that snapper can be expected to grow between 3 and 4 cm in each of the two years after reaching a total length of 28 cm. Converting these estimates into growth in weight shows (by interpolating) that the snapper doubles in weight in those two years (Table 3) (NSW Fisheries, 1999).

**Table 3:** Length and weight of snapper aged one to five estimated from growth model and length-weight relationship.

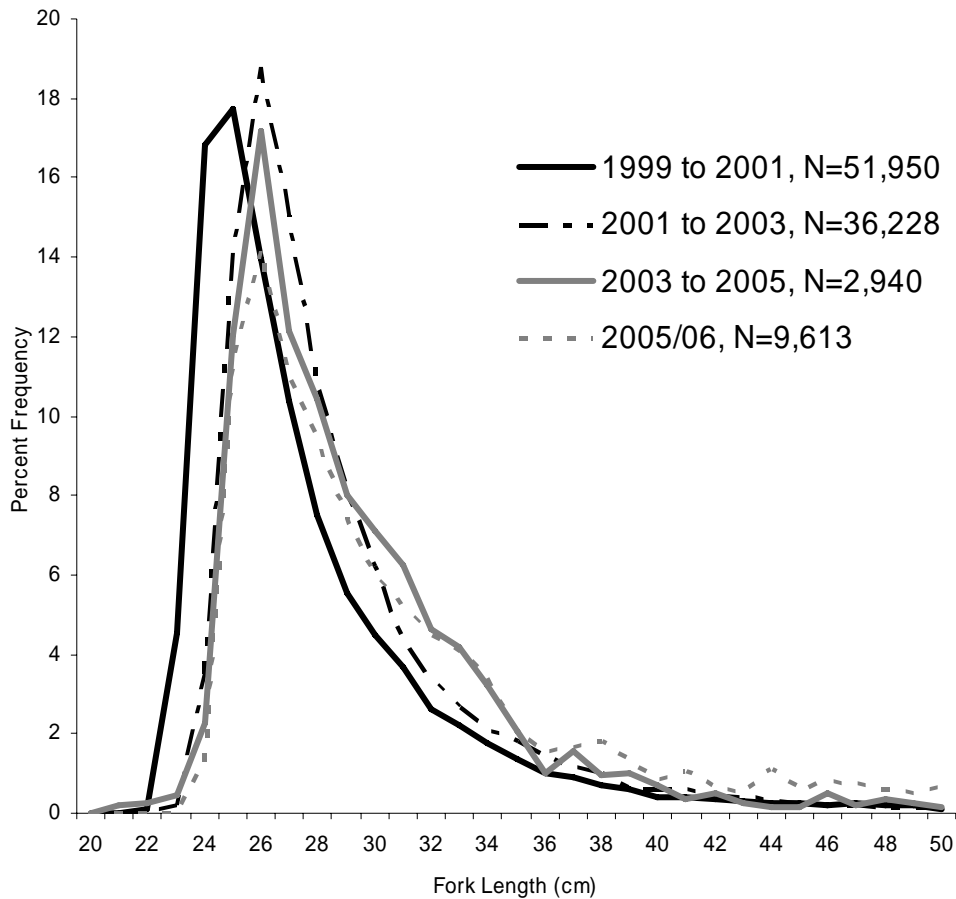
Age	Fork Length (cm)	Total Length (cm)	Weight (g)
1+	21.0	24.6	239
2+	25.7	30.2	415
3+	29.8	35.1	621
4+	33.4	39.4	846
5+	36.5	43.1	1,078

*Source: NSW Fisheries, 1999*

An additional benefit of the proposed 4 cm increase in MLL is increased egg production, an outcome of allowing more snapper to attain sexual maturity before potential harvesting. Whilst some snapper mature at small sizes (22 cm TL), some snapper on the east coast do not mature until about 38 cm TL (4 to 5 years old). Consequently, not all 2-year and 3-year old fish are sexually mature: an increase in MLL will increase snapper egg production and decrease the number of fish caught prior to first spawning.

Prior to the increase in MLL in July 2001 approximately 70% of fish were within 5 cm of the MLL of 28 cm TL (~23.5 cm FL) (Table 1 and Figure 1). The most abundant size classes were 24 and 25 cm FL. After the change in MLL the distribution of lengths remained concentrated against the MLL with more than 75% of fish being within 5 cm of the new MLL. This situation has improved during subsequent years, with approximately 70% of fish being within 5 cm of the MLL between 2003 and 2005, and 60% during 2005/06. The abundance of larger (30 to 40 cm FL) snapper has increased over time. The most abundant size-class in landings has been 26 cm FL each year since the change in MLL.

The age composition of snapper in commercial landings changed after the increase in MLL in July 2001 (Figure 2). The most abundant year class shifted from 2- to 3-year-old fish. The apparent increase in abundance of slightly larger fish each year following the size limit change (Figure 1) is evident in the relative abundance of 3- and 4-year-old fish. The relative abundance of these year classes in the OTL fishery has doubled in recent years. Nevertheless, the overall age composition indicates that snapper remains heavily fished, with approximately 75% of the catch being 2- and 3-year-old fish in 2002/03 and 2003/04. There was no monitoring of the age composition of snapper during 2004/05, and the assessment of data for 2005/06 has yet to be undertaken.



**Figure 1:** Size composition of snapper landed in the NSW commercial fishery since 1999. The size limit changed from 28cm to 30cm in July 2001.

The index of relative abundance of legal-sized snapper used is the reported catch of snapper per day's effort of fish trapping – the catch per unit effort (CPUE) (Figure 3). There was a decline in catch rate in the year immediately following the size limit change (2000/01), but the catch rate has increased in each subsequent year. The overall catch rate of snapper in NSW has increased 15% since the year before the size limit increase (22.9 kg/day compared to 19.9 kg/day) and by 51.6% compared with 1997/98. On a regional basis, catch rates for 2005/06 compared to the year before the size limit increase are noted as follows:

- An increase of 69% in the Northern area (45.2 kg/day compared to 26.7 kg/day);
- An increase of 11% in the Central area (23.9 kg/day compared to 21.5 kg/day);
- An increase of 35% in the Southern area (16.6 kg/day compared to 12.2 kg/day); and
- A decrease of 12% in the Mid-North area (14.7 kg/day compared to 16.7 kg/day) (Figure 4).

Note that this index of relative abundance of snapper (kg/day trapping) will be an underestimate because many fishers have used the method of fish trapping to target ocean leatherjackets during the past few years.

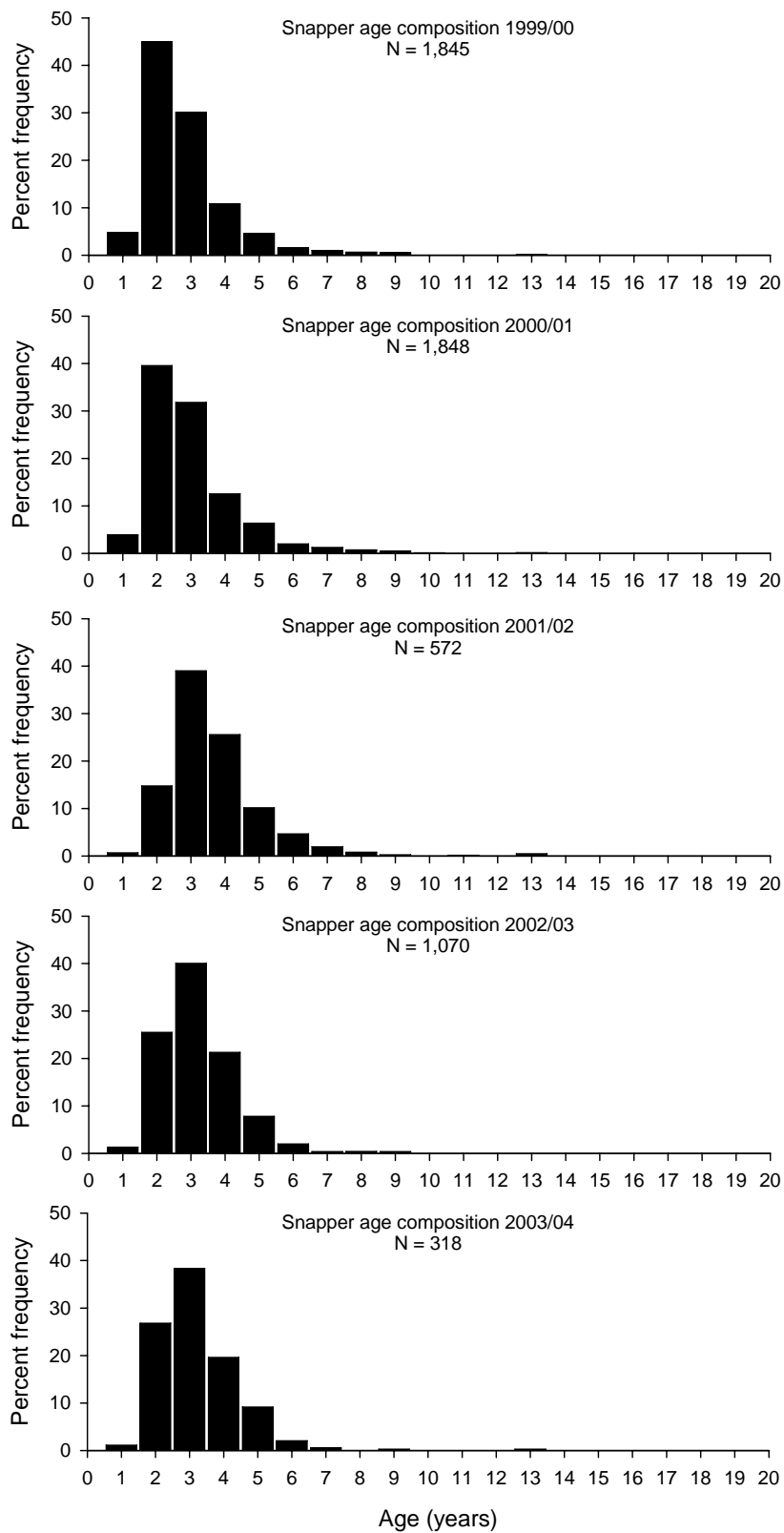
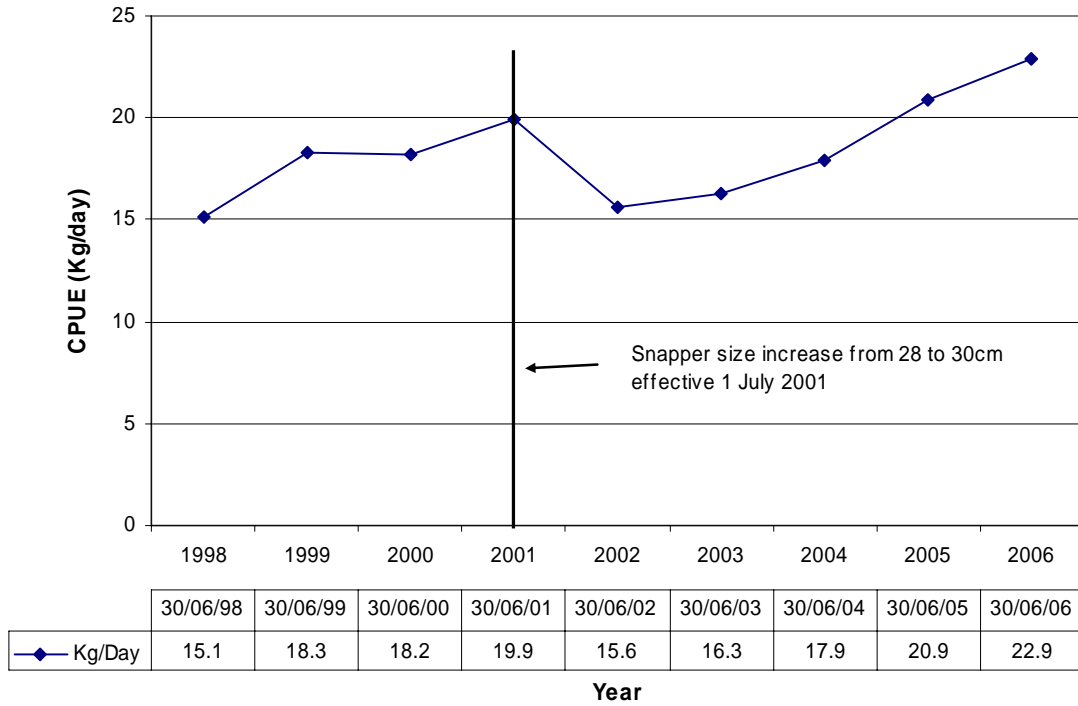
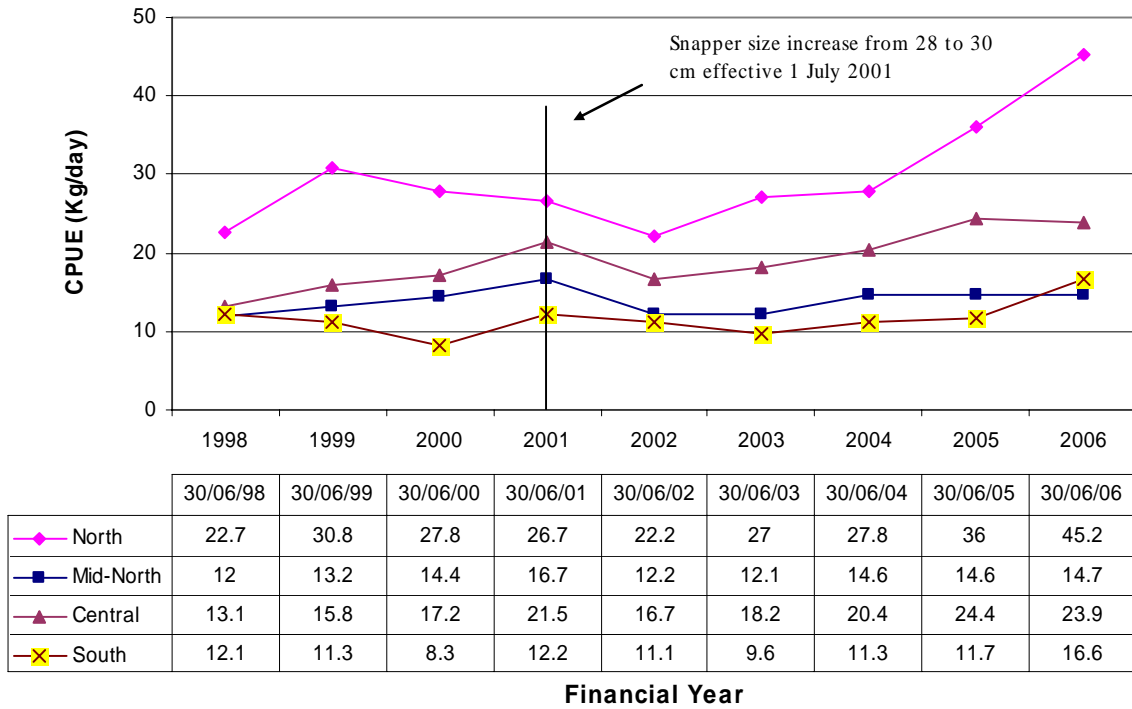


Figure 2: The age composition of snapper landed in the OTL fishery 1999/00 to 2003/04.





**Figure 3:** Reported catch of snapper per day fish trapping for all areas.



**Figure 4:** Reported catch of snapper per day fish trapping by area.

## 4.2. Catch assessment

Total reported landings of snapper from all NSW fisheries declined since the early 1990s along with a corresponding decline in the number of commercial fishers catching snapper during this period (Table 4). Over the 1997/98 to 2005/06 period, there was a 47% decline in the number of OTL fishers reporting *any* snapper catch from 380 to 200. During this time, the number of fishers contributing to catching 90% of landed snapper catch also declined by 47% from 116 to 61. The decline in fishers reporting snapper catch does not mean that they have left the industry; they may still be participating in the OTL or other fisheries.

**Table 4:** Reported commercial snapper catch from all NSW fisheries.

Financial Year	<u>ALL NSW SNAPPER CATCH</u>			<u>OTL SNAPPER CATCH</u>		
	Snapper (tonnes)	# fishers reporting snapper	# fishers taking 90% of all snapper	OTL snapper (tonnes)	# OTL fishers reporting snapper	# OTL fishers taking 90% of OTL snapper
1991/92	516.2	762	204			
1992/93	606.2	730	191			
1993/94	518.2	692	184			
1994/95	412	653	170			
1995/96	323.6	634	173			
1996/97	307.8	621	159			
1997/98	287.6	522	130	277.9	380	116
1998/99	302.8	503	124	293.8	357	111
1999/00	298.6	482	132	286.5	332	114
2000/01	295.6	447	116	284.9	306	103
2001/02	205.8	405	104	199	287	90
2002/03	175.4	356	94	169.2	249	85
2003/04	182.9	309	78	175.9	211	72
2004/05	213.7	325	85	206.8	216	75
2005/06	209.1	297	69	202.6	200	61

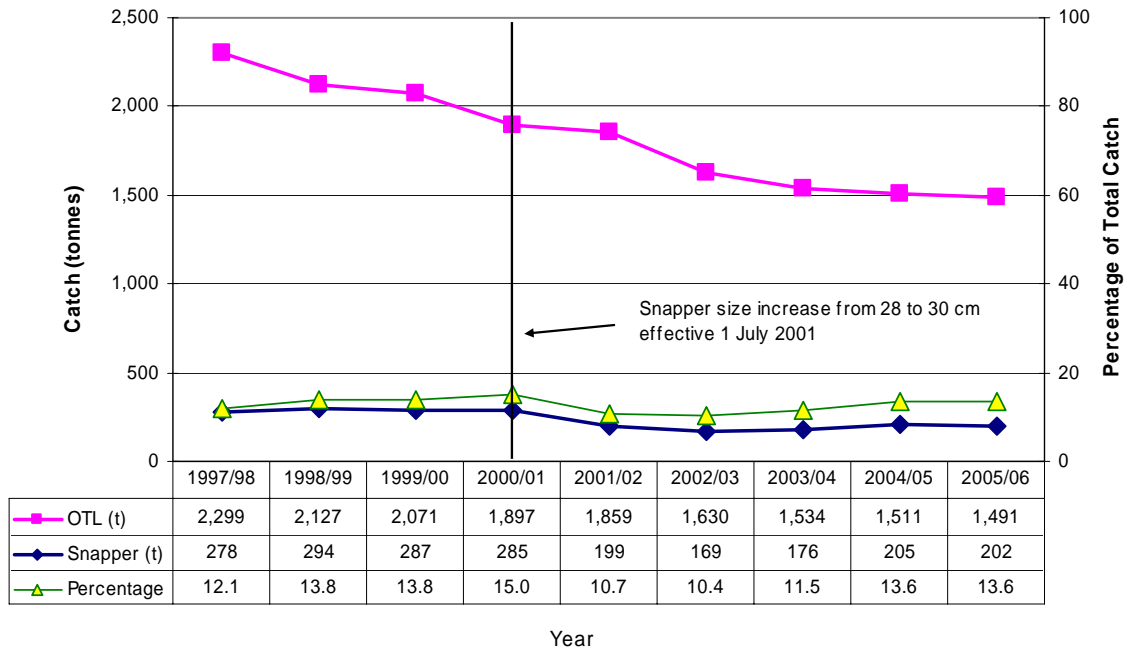
*Snapper size increase from 28 to 30 cm effective 1 July 2001*

The catch assessment of fishers catching snapper in New South Wales covers research findings for OTL catch of all species, OTL snapper catch per fisher, regional OTL snapper catch and regional OTL snapper catch per snapper fisher. The following sections cover the main points. Appendix 1 contains specific details.

### 4.2.1. OTL catch

In 1997/98 the total OTL catch of all species was 2,299 t (Figure 5). This declined to 1,491 t in 2005/06. For the years of record available, snapper catch declined from 278 t to 202 t between 1997/98 and 2005/06. It has nevertheless remained relatively stable as a percentage of total OTL catch, oscillating between 10% and 15% (Figure 5).

The date of the snapper size increase marks the biggest change in the percentage of snapper that contributed to the total OTL catch: it dropped from 15% in 2000/01 to 10.7% in the year immediately following the size limit change. At the same time, the OTL catch remained relatively constant at 1,897 t in 2000/01 and 1,859 t in 2001/02.

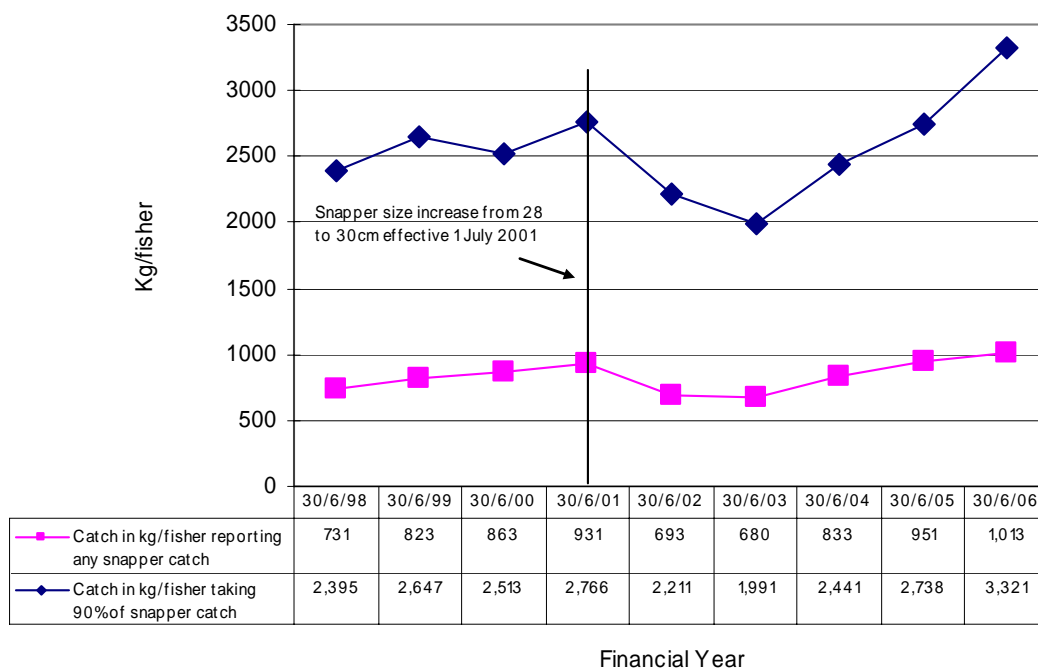


**Figure 5:** Snapper catch as a percentage of total OTL catch.

4.2.2 *OTL snapper catch per snapper fisher*

A graph of the average annual catch of snapper per fisher reporting snapper in the OTL fishery reveals some key trends (Figure 6):

- There was a 39% increase in catch from 731 kg per fisher in 1997/98 to 1,013 kg per fisher in 2005/06 for fishers reporting *any* snapper catch (Appendix 1, Chart 1). Catch per fisher fell by 26% in the year following the size limit increase but gradually increased each year, surpassing the pre-MLL increase amount after 2004/05.
- There was a 39% increase in catch from 2,395 kg per fisher in 1997/98 to 3,321 kg per fisher in 2005/06 for fishers contributing to catching 90% of landed snapper catch (Appendix 1, Chart 1). Catch per fisher fell by 20% in the year after the size limit increase.



**Figure 6:** Average annual catch of snapper per OTL fisher reporting snapper.

#### 4.2.3. Regional OTL snapper catch

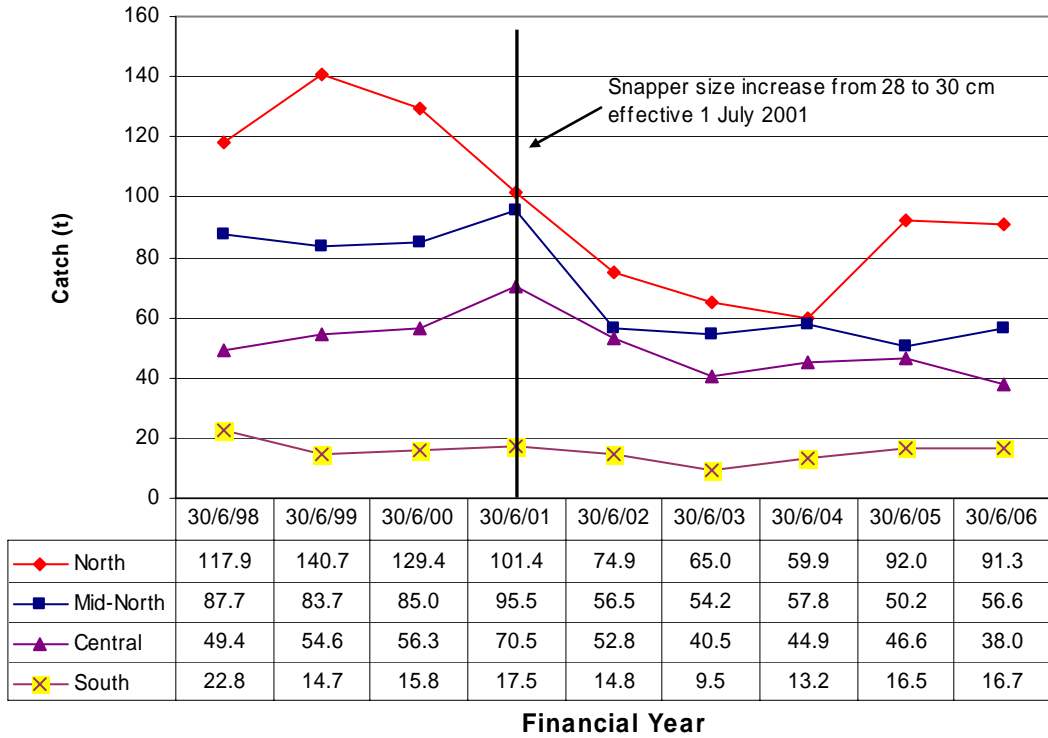
Catch records are available on a regional basis (Figure 7 and Appendix 1, Chart 2). The overall decline in catch between 1997/98 and 2005/06 for the North, Mid-North, Central and South areas is approximately 23%, 35%, 23% and 27%, respectively.

In the year following the size limit increase, catch decreased by 26% in the North area (the most productive area), by 41% in the Mid-North, by 25% in the Central area, and by 16% in the South.

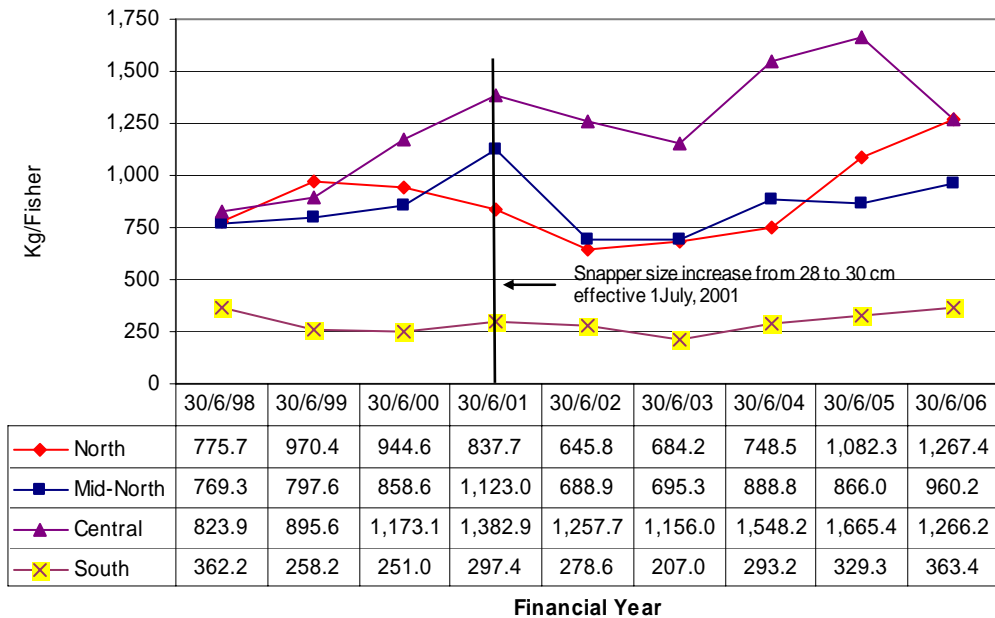
#### 4.2.4. Regional OTL snapper catch per fisher catching any snapper

Catch can also be analysed according to a regional catch per fisher catching *any* snapper (Figure 8 and Appendix 1, Chart 3). The overall trend in catch between 1997/98 and 2005/06 shows an increase of 63% for the North, and 25%, 54% and less than 1% for the Mid-North, Central and South areas, respectively.

In the year following the size limit increase, catch per fisher catching *any* snapper decreased by 23% in the North area, by 38.7% in the Mid-North area, by 9% in the Central area and by 6% in the South.



**Figure 7:** OTL snapper catch (kg) by region 1997/98 to 2005/06.

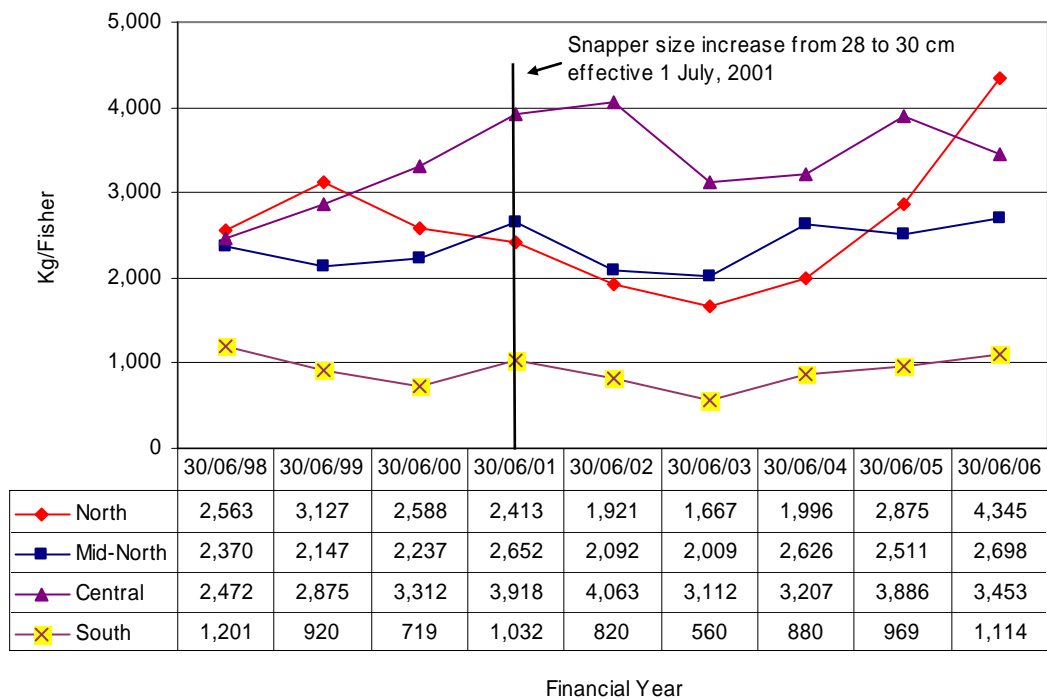


**Figure 8:** Regional catch per fisher catching any snapper.

4.2.5. *Regional OTL snapper catch per fisher contributing to catching 90% of the total landings of snapper*

The regional catch per fisher contributing to catching 90% of the total landings of snapper shows a more positive trend than for fishers catching *any* snapper (Figure 9 and Appendix 1, Chart 4). The overall trend in catch per fisher between 1997/98 and 2005/06 shows an increase of 70% in the North, 14% in the Mid-North, and 40% in the Central area. There was a 7% decrease in the South.

In the year following the size limit increase, catch per fisher decreased by 20% in the North area, by 21% in the Mid-North area and by 20% in the South. It increased by 4% in the Central area.



**Figure 9:** Regional catch/fisher contributing to catching 90% of snapper catch.

### 4.3. Economic assessment

Assessing the economic impact of the 30 cm MLL introduced on 1 July 2001 requires a comparison of trends before and after the size change for Gross Value of Production (GVP), for average OTL snapper income per snapper fisher and for average regional OTL snapper income per snapper fisher. Consideration of fishing business buy out programs and prices for different grade sizes of NSW snapper sold at the Sydney Fish Market is also relevant.

#### 4.3.1. Fishing Business Buy Out Programs

The economic impact of the MLL coincides with the economic impact of fishing business buy out programs for Recreational Fishing Havens (RFHs) and Marine Protected Areas (MPAs). These two buy out programs started to reduce the number of OTL fishers catching snapper within one year of the implementation of the new 30 cm MLL for snapper (Table 5). The buy out information shows that the number of Fishing Businesses (FBs) with OTL snapper catches that were surrendered in the RFH and MPA programs were 24 and 32, respectively, between April and August 2002. Given the influence of these buy out programs on participation and catch, isolating the impact of the size limit increase in terms of cause-and-effect is beyond the scope of this study. Changes in the economic circumstances of OTL snapper fishers are not only attributable to the effect of change in MLL on 1 July 2001. Other explanations, including the effect of the buy out programs, are also important.

**Table 5:** Fishing Business Buy Out Programs that may Impact Snapper Catches in the Ocean Trap and Line Fishery July 1997 – June 2005\*.

Buy Out Program	Number of FBs Surrendered	Date of Surrender	Number of these FBs with OTL entitlements at the time of surrenders	Number of these FBs with snapper catches in OTL fishery July 1997 – surrender	Weight (kg) of snapper reported by these FBs 2001/02	Value (\$) of snapper reported by these FBs 2001/02 – estimated at first point of sale (SFM average monthly prices)
Recreational Fishing Havens	251	April – August 2002	35	24	2,213.5	\$19,698
Marine Parks (Jervis Bay and Solitary Islands)*	47	June – November 2002	38	32	26,001.8	\$235,866

\* A small number of Lobster and Abalone shares acquired as part of the buy out are not included in the table.

4.3.2. Gross Value of Production

The Gross Value of Production (GVP) is a calculation of catch multiplied by price from Sydney Fish Market records (though only a portion of the catch is sold at this market). The GVP of all species caught in the OTL was approximately \$11.5m in 1997/98 (Figure 12). In 2005/06, the GVP was about \$8.5m, a 26% decline.<sup>5</sup> For snapper, the GVP was approximately \$2.5m in 1997/98 and \$2m in 2005/06, equating to a 20% decline. Snapper GVP as a percentage of total OTL GVP ranged between 16% and 25%.

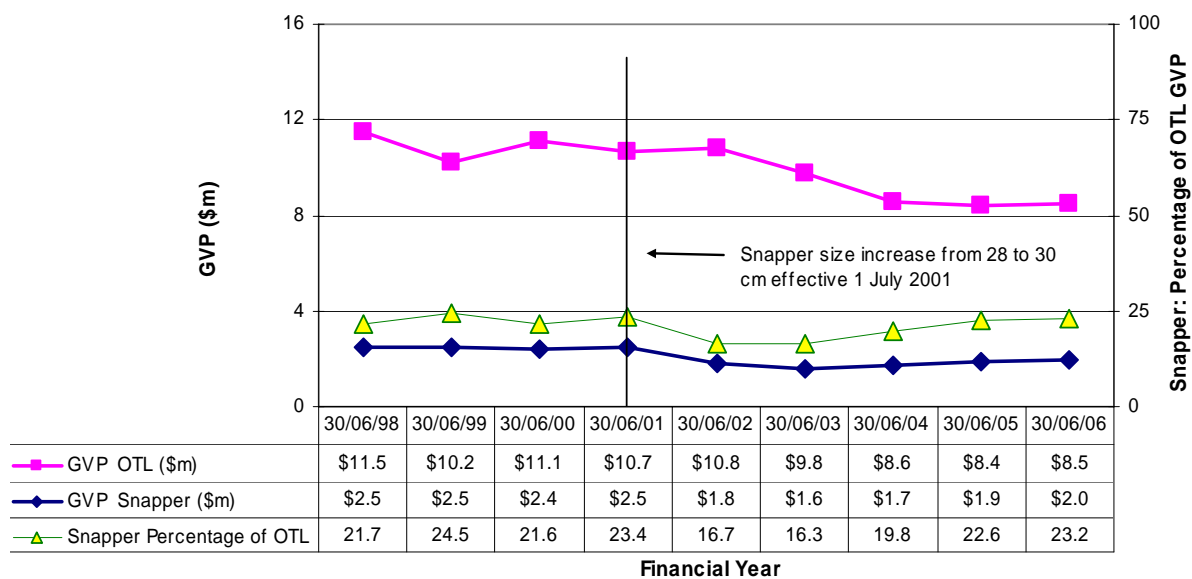


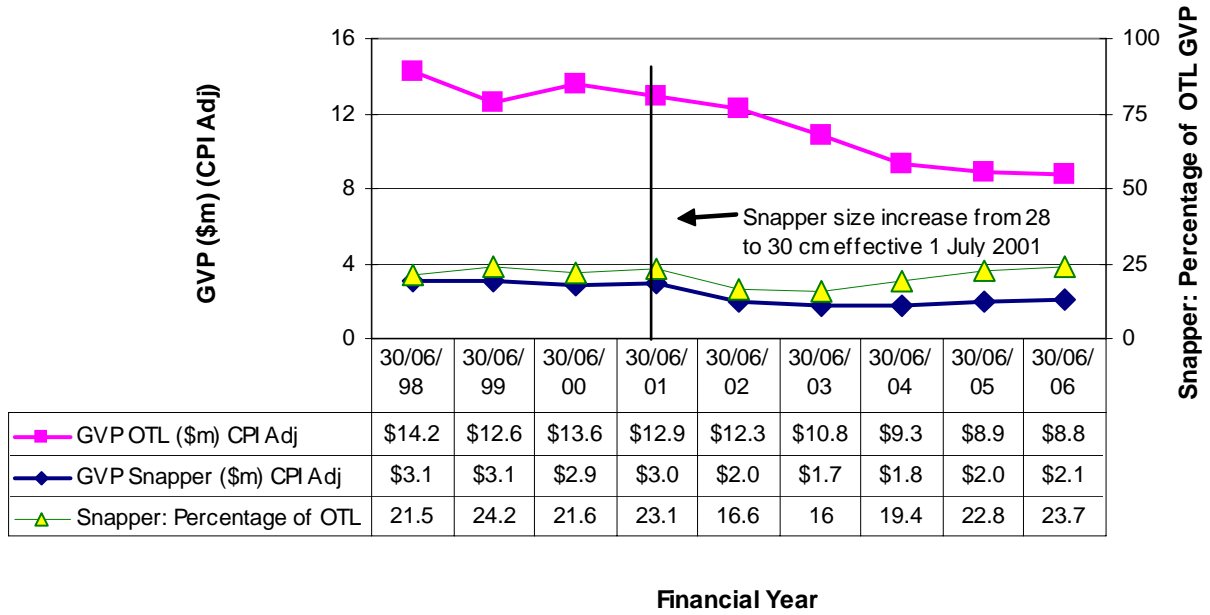
Figure 10: Gross Value of Production of OTL fishery.

Changes in price over time can vary with inflation or deflation of the currency unit used for measurement, and with changing market conditions of supply and demand. Nominal value includes both these effects. Real value removes the effect of inflation such that only the change in market conditions is considered.

Taking adjustments for inflation into account yields a slightly more pronounced trend (Figure 11). The real GVP of all species caught in the OTL was approximately \$14.2m in 1997/98 compared to \$8.8m in 2005/06, a 38% decline (Appendix 2, Chart 5). This calculation includes a consumer price index adjustment to 30 June 2006.

<sup>5</sup> The basis of this calculation is landed weight in kilograms.





**Figure 11:** Gross Value of Production in OTL fishery (CPI adjusted).

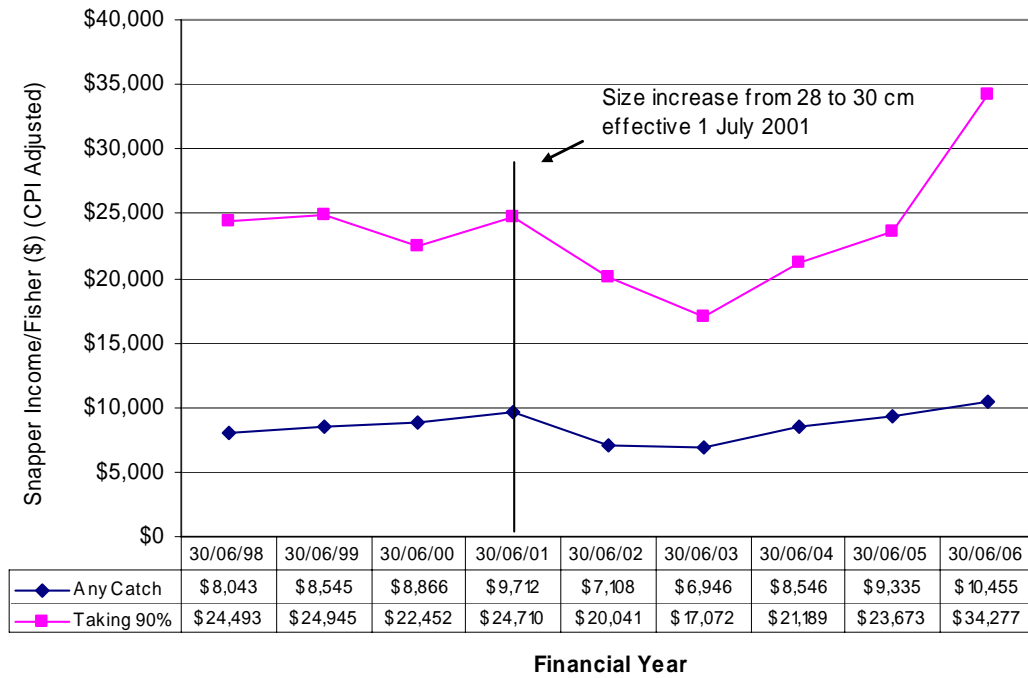
For snapper, the real GVP was approximately \$3.1m in 1997/98 and \$2.1m in 2005/06, equating to a 32% decline over the nine years of record (Appendix 2, Chart 5). Snapper GVP as a percentage of total OTL GVP ranged between 16% and 24% (Figure 11).

4.3.3. *OTL snapper income per snapper fisher*

Trends for gross income (i.e., not including operating costs such as fuel, bait, boat maintenance and insurance) per fisher are reported according to snapper fishers catching any snapper and snapper fishers contributing to catching 90% of the landed snapper catch (Figure 12).

A comparison of pre- and post-MLL incomes of fishers catching any snapper shows that over the nine years of record, average income after adjustment for inflation increased by 30%, from \$8,043 in 1997/98 to \$10,455 in 2005/06, although it decreased by 27% in the year following the size limit increase (Figure 12 and Appendix 2, Chart 6).

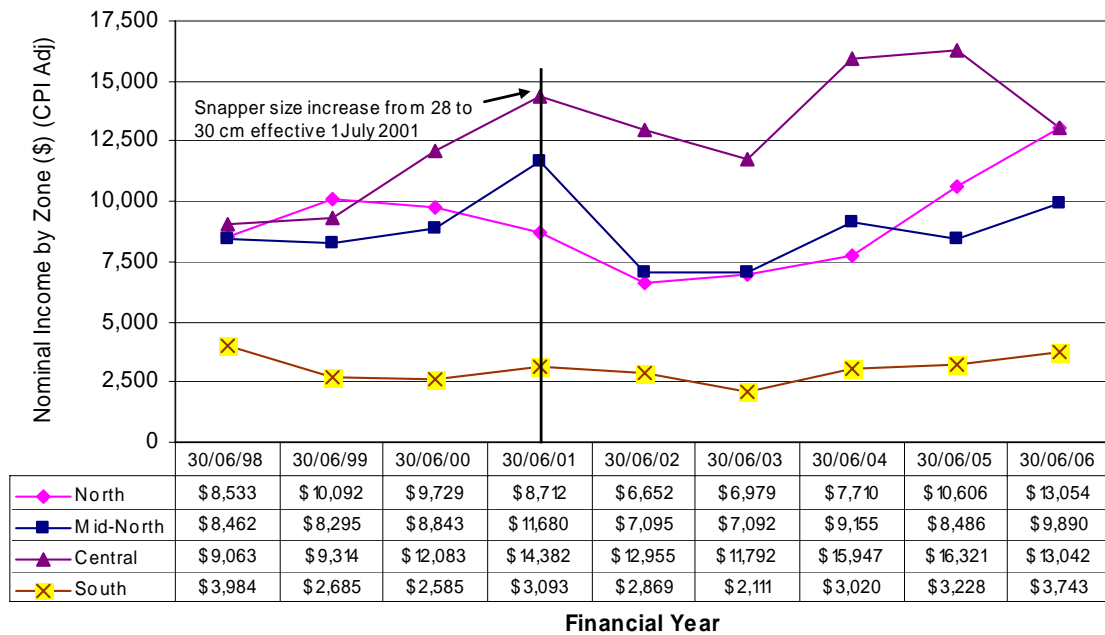
A comparison of pre- and post-MLL incomes of fishers contributing to catching 90% of the landed snapper catch shows that over the nine years of record, average income after adjustment for inflation, increased by 40% from \$24,493 to \$34,277 (Figure 12 and Appendix 2, Chart 6). There was a 19% decrease in income from snapper in the year following the size limit increase. Income from other OTL catch compensated for this decrease.



**Figure 12:** Snapper income from OTL fishers reporting snapper catch (CPI Adjusted).

4.3.4. Regional OTL snapper income per snapper fisher

Nominal average snapper income for fishers reporting *any* snapper catch (i.e., catching snapper on at least one occasion) from the OTL fishery varies by area (Figure 13 and Appendix 2, Chart 7).



**Figure 13:** Average income per fisher reporting any snapper catch by area.

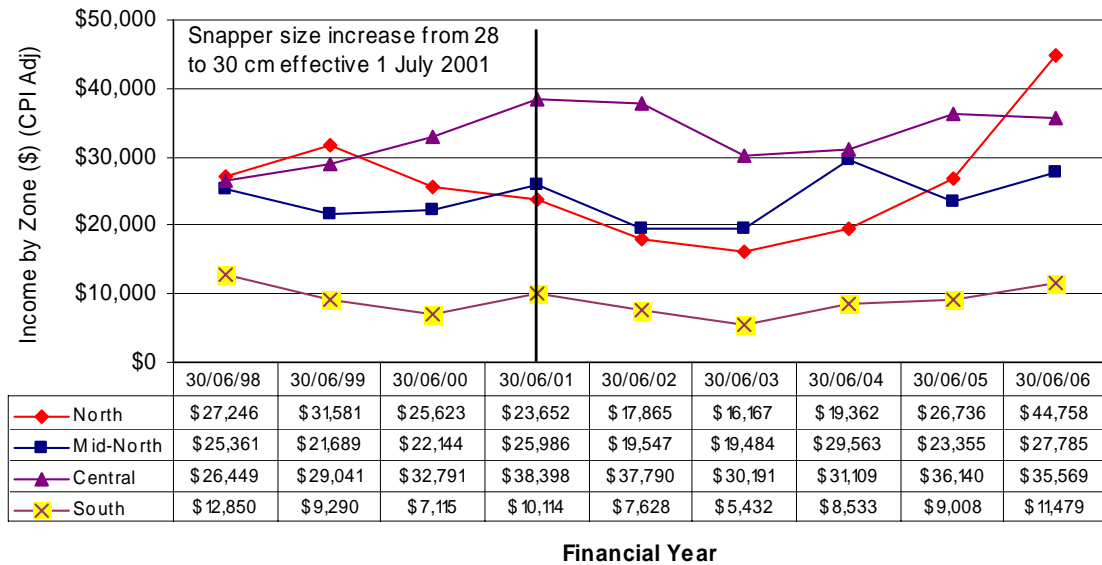
Examining differences in the trends before and after the size increase indicates that over the nine years of record, average income after adjustment for inflation, increased by 53% in the North (from \$8,533 to \$13,054), by 17% in the Mid-North (from \$8,462 to \$9,890), and by 44% in the Central area (\$9,063 to \$13,042). It decreased by 6% in the South area (from \$3,984 to \$3,743).

The trends also show that in the year following the introduction of the 30 cm size limit there was a 24% decrease in average income in the North, a 39% decrease in the Mid-North, a 10% decrease in the Central area, and a 7% decrease in the South (Appendix 2, Chart 7).

For OTL fishers contributing to catching 90% of the total landings of snapper, there is also a regional variation in the record for average annual nominal income (Figure 14 and Appendix 2, Chart 8).

Examining differences in the trends before and after the size increase indicates that over the nine years of record, average income after adjustment for inflation, increased by 64% in the North (from \$27,246 to \$44,758), by 10% in the Mid-North (from \$25,361 to \$27,785), and by 35% in the Central area (from \$26,449 to \$35,569). It decreased by 11% in the South area (from \$12,850 to \$11,479).

The trends also show that in the year following the introduction of the 30 cm size limit there was a decrease of 25% in average income in the North, the Mid-North and the South areas, and to a 2% decrease in the Central area (Appendix 2, Chart 8).



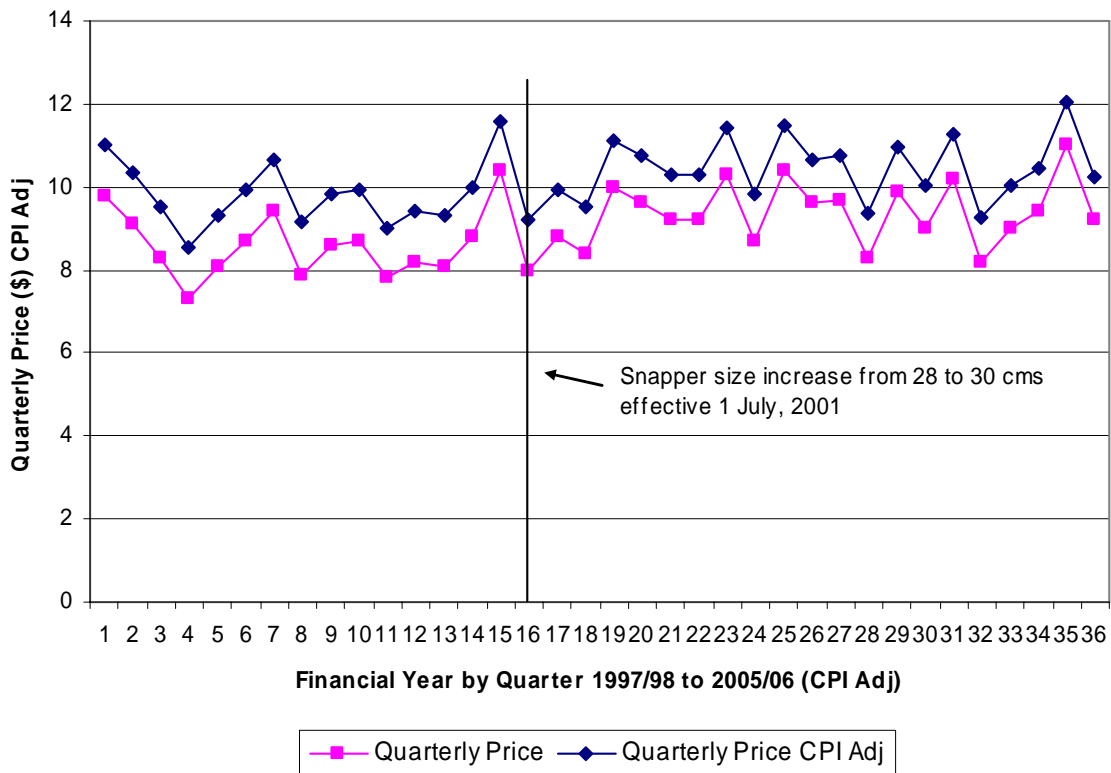
**Figure 14:** Average snapper income per OTL fisher contributing to catching 90% of landed snapper catch (by area).

#### 4.4. Statistical analysis of price per quarter (\$)

In addition to the descriptive statistics already reported, visual inspection of the graph of the data suggests that there is a before-and-after difference in price, and that this difference might be amenable to statistical analysis (Figure 15). A statistical analysis of variance undertaken on the price data for 36 quarters confirms a difference between the before-and-after periods (Nielsen, 2006).<sup>6</sup> This approach compares the 16 quarters before the change with the 20 quarters afterwards. A more detail explanation is provided in Appendix 4).

Interpreting the results leads to the following points:

- Before adjustments for inflation, there is a statistically significant difference in price for the two periods before and after 1 July 2001. The price after 1 July 2001 is 92 cents per kg higher than before, i.e., 11% higher (Appendix 4).
- Including adjustments for inflation, there is a statistically significant difference in price before and after 1 July 2001. The price after 1 July 2001 is 69 cents per kg higher than before, i.e., 7% higher (Appendix 4).



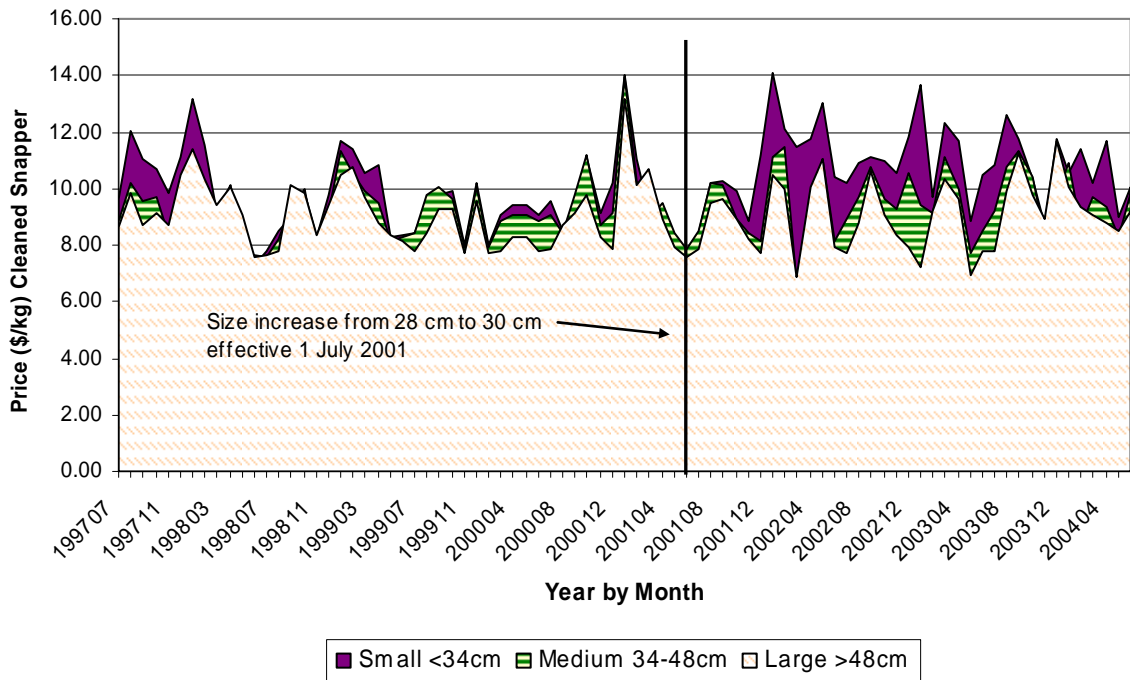
**Figure 15:** Quarterly price data.

<sup>6</sup> Sharon Nielsen, Biometrican, DPI, undertook the statistical analysis.

#### 4.5. Grade size and price at the Sydney Fish Market

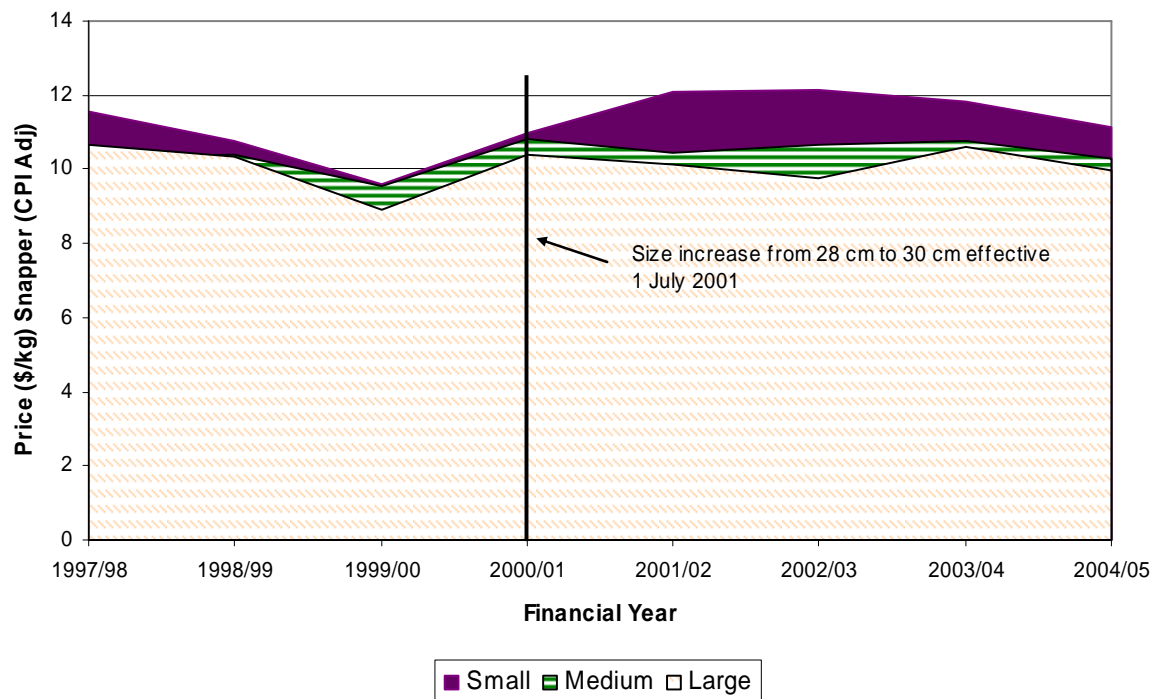
The Sydney Fish Market records the price of NSW snapper according to grade size. The grade categories are small (less than 34 cm), medium (34 to 48 cm) and large (greater than 48 cm).<sup>7</sup> Although the proportion of all NSW snapper sold at the Sydney Fish Market is unknown, a comparative analysis of different grade sizes using monthly SFM data from July 1997 to June 2004 indicates that there is a price premium for small grades compared to medium and large grades. The information is presented on a quarterly basis (Figure 16) as well as on a yearly basis (Figure 17), with the later figure also accounting for inflation.

For the four years of record before 1 July 2001, there is a price premium of 4.5% and 6.3%, respectively, for 30 to 34 cm snapper compared to medium and large snapper (Table 6). For the three years after the size-limit change, the price premium increases to 12.7% and 18.2%, respectively (Table 6). This suggests that a refinement of the small grade size has occurred by eliminating snapper less than 30 cm and indicates that the increase in MLL has been positive for price for snapper less than 34 cm.



**Figure 16:** Quarterly price premium: small grade snapper compared to medium and large.

<sup>7</sup> The small category was 28 to 34 cm between 1997/98 and 2000/01 and 30 to 34 cm after 2000/01.



**Figure 17:** Yearly price premium: small grade snapper compared to medium and large (CPI adjusted).

**Table 6:** Grade size and price at the Sydney Fish Market.

Before 30 cm MLL	Small (\$)	Medium (\$)	Large (\$)
1997/98	11.55	10.35	10.68
1998/99	10.77	10.38	10.35
1999/00	9.62	9.52	8.88
2000/01	10.96	10.8	10.37
Average	<b>\$10.73</b>	<b>\$10.26</b>	<b>\$10.07</b>
Premium of small over medium =			4.5%
Premium of small over large =			6.5%
After 30 cm MLL			
2001/02	12.11	10.45	10.15
2002/03	12.13	10.76	9.75
2003/04	11.82	10.78	10.6
Average	<b>\$12.02</b>	<b>\$10.66</b>	<b>\$10.17</b>
Premium of small over medium =			12.7%
Premium of small over large =			18.2%

**4.6. Economic assessment of other catch**

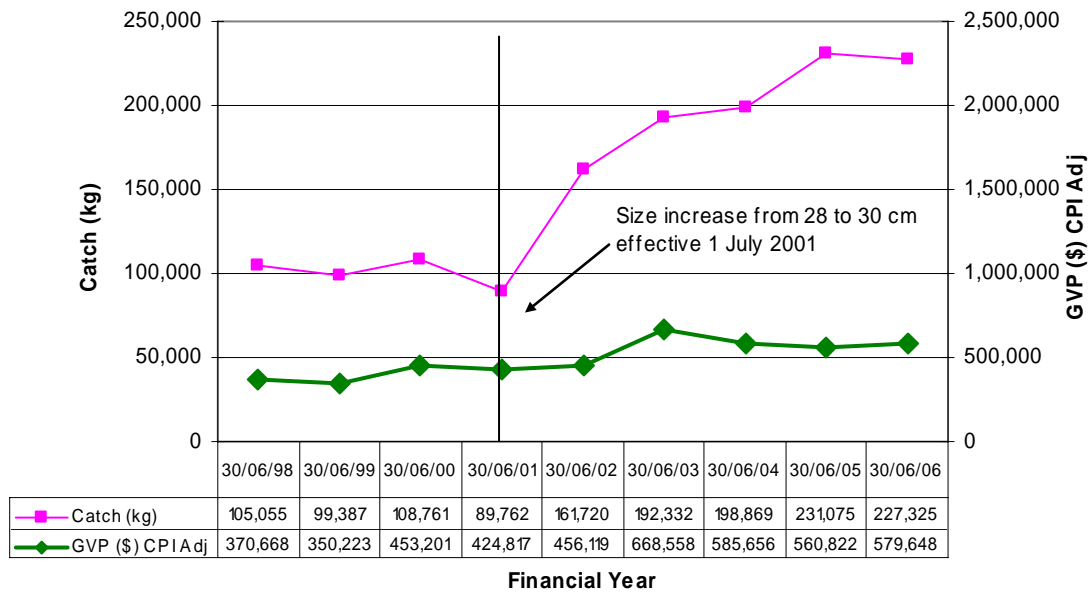
Background information on the economic status of other fish in the OTL fishery is also relevant in assessing the economic impact of the 2 cm size limit increase on snapper catch. The following four sections provide details on leatherjacket, rubberlip morwong, silvery trevally and bream. Appendix 3 contains detailed supporting information.

*4.6.1. Leatherjacket*

Of the two dominant categories for the reporting of leatherjackets, unspecified and Chinaman, the majority are reported in the former but are comprised of the latter. Combined, the two categories account for more than 80% of the leatherjacket catch in the OTL fishery (Figure 18).

For fish trappers catching leatherjackets, total catch increased by 80% in the year following the size limit increase (Appendix 3, Chart 9). Over the nine years of record, total catch increased by 116%.

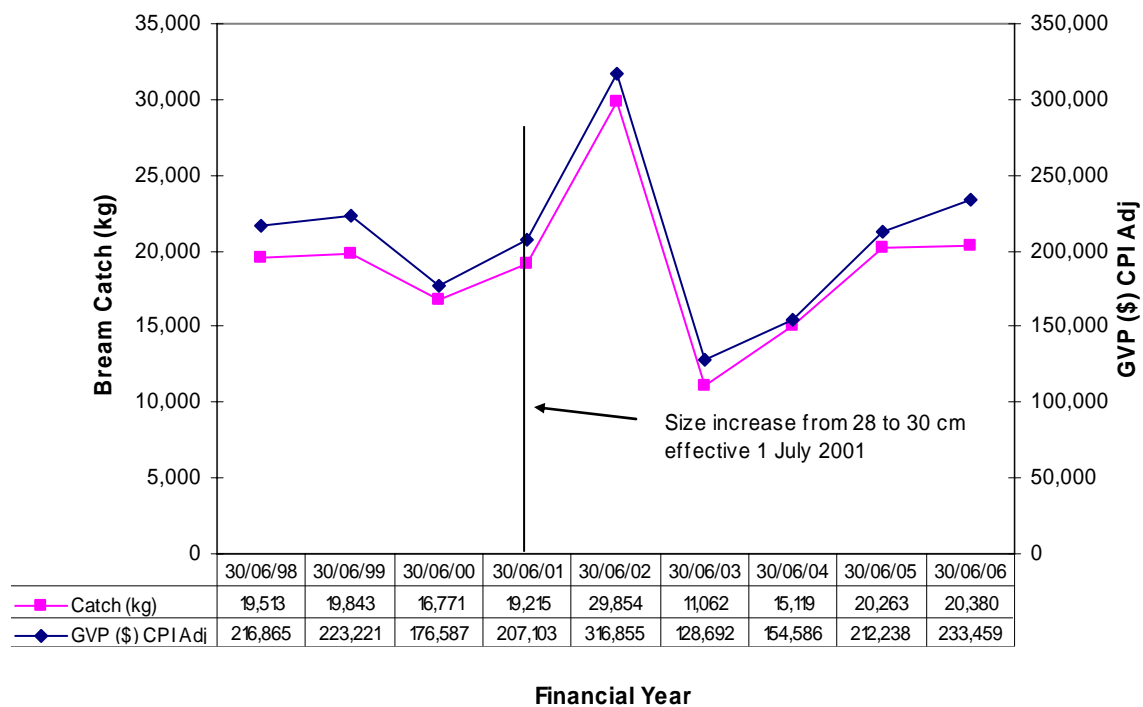
The GVP trends for leatherjackets are also positive (Figure 18 and Appendix 3, Chart 9): After adjusting for inflation, the GVP increased by 7.4% in the year following the size limit increase. Over the nine years of record, the GVP increased by 56%.



**Figure 18:** Catch and GVP for leatherjacket.

4.6.2. *Bream*

For fish trappers catching bream, total catch increased by 55% in the year following the snapper size limit increase; total catch increased by 4% over the nine years of record (Figure 19 and Appendix 3, Chart 10). There was a large decline in catch between 2001/02 and 2002/03.



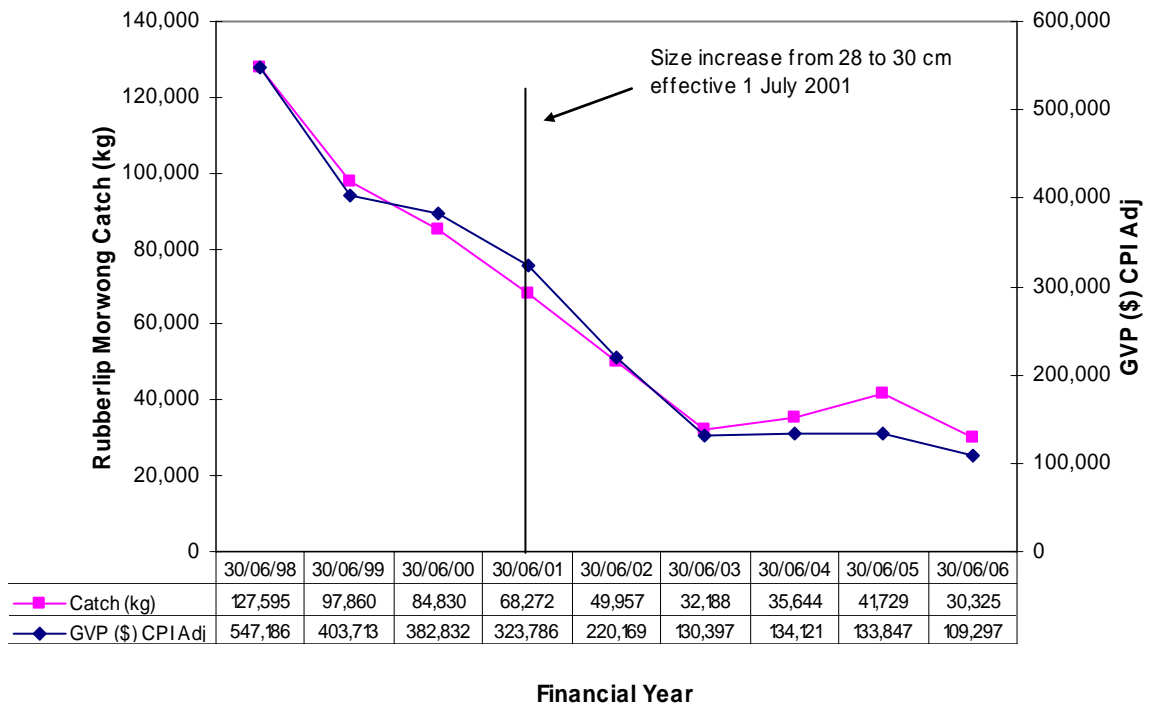
**Figure 19:** Catch and GVP for bream.

The GVP trends for bream increased by 53% in the year following the size limit increase and by 7.7% over the nine years of record (Figure 19 and Appendix 3, Chart 10).



4.6.3. Rubberlip morwong

For fish trappers catching rubberlip morwong, total catch decreased by 27% in the year following the snapper size limit increase. This is part of a longer-standing decline in catch. Over the nine years of record, total catch decreased by 76% (Figure 20 and Appendix 3, Chart 11). Between 2002/03 and 2005/06, catch appears to stabilise.



**Figure 20:** Catch and GVP for rubberlip morwong.

After adjusting for inflation, the GVP trends for rubberlip morwong decreased by 32% in the year following the snapper size limit increase, consistent with declines since 1997/98. Over the nine-year period, the GVP decreased by 80%. GVP stabilised between 2002/03 and 2005/06.

4.6.4. Silver trevally

For fish trappers catching silver trevally, total catch decreased by 12% in the year following the snapper size limit increase, following a drop in catch from the previous year. Over the nine years of record, total catch decreased by 52% though the rate of decline slowed significantly between 2002/03 and 2005/06 (Figure 21 and Appendix 3, Chart 12).

The GVP declined by 27% in the year after the size limit increase, following a decline in the previous year. Over the nine years of record, the GVP decreased by 52% though, as with the catch above, the rate of decline slowed significantly between 2002/03 and 2005/06 (Figure 21 and Appendix 3, Chart 12).

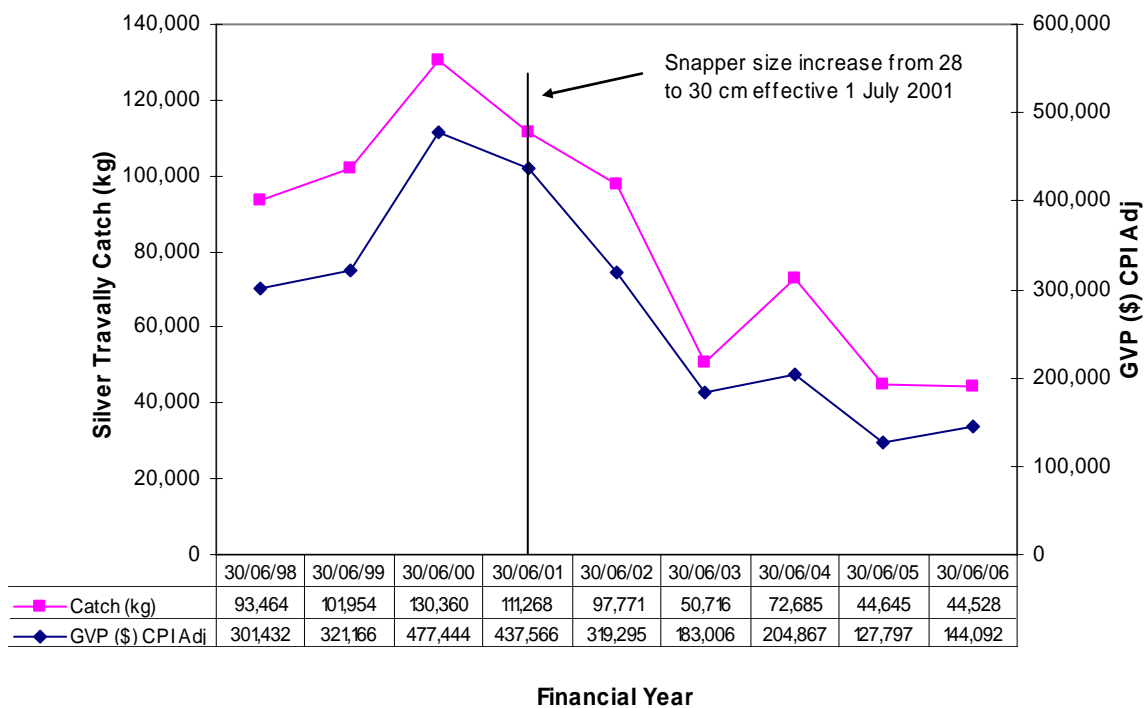


Figure 21: Catch and GVP for silver trevally.

## **5. DISCUSSION**

The assessment of biological, catch and economic impacts of the 2 cm increase in Minimum Legal Length leads to a discussion of key points about the Department of Primary Industries' 2001 MLL change. In addition, a decision on a further change to a MLL of 32 cm as originally recommended by departmental fisheries scientists as early as 1999 requires consideration.

### **5.1. The size limit change: Increasing the MLL by 2 cm from 28 to 30 cm**

Discussion of the results is grouped according to biological, catch and economic issues.

#### *5.1.1. Biological issues*

The shift in size composition of landed snapper is consistent with previous expectations about the impacts of the 2 cm increase. There is some evidence that larger fish have contributed more to landings in each year following the size limit change with fish between 28 and 30 cm FL (~33 to 36 cm TL) being relatively more abundant between 2001 and 2003 and fish between 30 and 35 cm FL (~36 to 41 TL) being relatively more abundant since 2003. This suggests that the snapper protected by the new size limit have grown and are now contributing to the fishery at these larger sizes and increasing the average weight of fish caught.

There has been an increase in the proportion of 3- and 4-year-old snapper in landings since the MLL change. This is a very desirable shift because it reduces the risk of the fishery collapsing following years of poor recruitment. However, the age composition of the fishery is still typical of a heavily fished stock, with more than 65% of the catch between 2002/03 and 2003/04 being 2- and 3-year-old fish. The snapper stock and its fishery would likely benefit from a further reduction in reliance on 2- and 3-year-old fish.

The analyses of trends in snapper catch per day trapping indicate that the abundance of snapper available to commercial fishers (i.e., those greater than the MLL) has increased markedly since the change in MLL. There was a decline in catch rates immediately following the increase in MLL (on average a decrease of 20%); however, catch rates have steadily increased in every area along the NSW coast and are now, on average, 15% greater than the year immediately prior to the MLL change (see Figure 4, Section 4.1). The year immediately prior to the MLL change was a productive year when compared to the previous three years.

#### *5.1.2. Catch issues*

The total volume of commercial catch of snapper has declined markedly since the early 1990s. This overall decline is part of a long-term trend (even prior to the years discussed in this report) and is associated with a corresponding decline in the numbers of fishers. The long-term decline in commercial fishers (and therefore snapper landings) is not the result of any one management change.

Even with the declines in snapper landings, individual fishers are each currently catching a greater weight of snapper than prior to the increase in MLL. This is evident for all snapper fishers and for those who account for 90% of the catch – both categories increase by 39% (Figure 6).

On a regional basis dedicated snapper fishers (i.e., those that account for 90% of the catch) are currently catching 70% more snapper (by weight) per person in the Northern area, 40% more in the Central area, and 14% more in the Mid-North, compared to 1997/98 (Figure 9 and Appendix 1 – Chart 4). They are catching 7% less in the South. These increases in catch per fisher exceed the expected benefits predicted following the increase in MLL and may be associated with naturally productive years in those areas. Nevertheless, the increase in MLL has almost certainly contributed

to commercial snapper fishers catching significantly more kilograms of snapper per person in recent years.

The change to a 30 cm MLL would account for a proportion of the impact on fishers choosing not to continue fishing snapper or to continue at a lower level. Other factors such as natural variation in biological production or buy-outs of fishing entitlements may contribute to lower levels of catch. While year-to-year variations make it difficult to distinguish other factors from the effectiveness of the size limit increase, the analysis of trends within data sets, combined with the comparison of means, immediate impacts, and overall trends, leads to a favourable view of the MLL change.

### *5.1.3. Economic issues*

The estimated GVP of all catch from the OTL fishery was already in decline before the MLL change for snapper and this decline has been at a faster rate than the decline in GVP from snapper. For example, OTL GVP declined by 38% over the nine years of record. Over the same period, snapper GVP declined by 32%. This means that factors other than the change of increasing the MLL for snapper account for the declining GVP of the OTL fishery.

While the estimated GVP from snapper declined in absolute terms, income per fisher catching any snapper increased by 30% between 1997/98 and 2005/06 (from \$8,043 to \$10,455) (Figure 12 and Appendix 2 – Chart 6).

Over the nine years of record, after adjusting for inflation, average income from snapper per OTL fisher contributing to any snapper catch increased in the following three areas (Figure 13 and Appendix 2 – Chart 7):

- by 53% in the North (from \$8,533 to \$13,054);
- by 17% in the Mid-North (from \$8,462 to \$9,890); and
- by 44% in the Central area (\$9,063 to \$13,042).
- It decreased by 6% in the South (from \$3,984 to \$3,743).

While the estimated GVP from snapper declined in absolute terms, income per fisher taking 90% of the snapper catch increased by 40% between 1997/98 and 2005/06 (from \$24,493 to \$34,277) (Figure 12 and Appendix 2 – Chart 6).

For OTL fishers that contributed to catching 90% of the total snapper catch (after adjusting for inflation), income increased in three of the four areas as follows (Figure 14 and Appendix 2 – Chart 8):

- by 64% in the North (from \$27,246 to \$44,758);
- by 10% in the Mid-North (from \$25,361 to \$27,785); and
- by 35% in the Central area (from \$26,499 to \$35,569).
- It decreased by 11% in the South area (from \$12,850 to \$11,479).

Over the five years of record after the MLL change, there is an 11% increase in the price of snapper per kilogram compared to the period before the size limit increase (Table 11). After accounting for inflation, there is a 7% increase in the price of snapper in the period after the size limit increase compared to the period before.

There were increased catches of leatherjackets and bream in the year immediately following the MLL change. Although average incomes from snapper fishing declined 18.9% for OTL snapper fishers contributing to 90% of the total snapper catch in the year following the change, for many of these snapper fishers the increase in catch of leatherjackets and bream offset short-term losses in income from snapper. In other words, large increases in landings of leatherjackets and bream by fishers since 2000/01 may have offset the short-term losses from not catching snapper under 30 cm

in length. After adjusting for inflation, the GVP of the OTL fishery – already in decline – decreased slightly from 2000/01 to 2001/02, suggesting that the change to snapper MLL did not have a significant overall impact on the OTL fishery as a whole.

Average prices by size grade of snapper sold through the Sydney Fish Market during 2005/06 indicate that ‘small’ fish (<34 cm) on average achieve a price premium of 14.6% and 20.5%, compared to medium and large size snapper, respectively (Table 6). There do not appear to be any adverse implications for size grade and price.

## **5.2. The next step: A proposal to increase the MLL by 2 cm from 30 to 32 cm**

In summary, analyses of biological information indicate that the increase in MLL has been successful in achieving both increases in snapper catch per fisher and the available biomass of larger fish. Associated with these benefits are increases in the spawning biomass and egg production and therefore probable increases in recruitment. Previous scientific analyses indicate that further benefits would occur by increasing the MLL to 32 cm TL and beyond.

Implementing the 2 cm increase from 28 to 30 cm in 2001 was the first part of a planned 4 cm increase, with the second increase originally anticipated to take place in 2003/04 or 2004/05. Because the age-composition of landings remains indicative of a heavily fished stock, there is still too much fishing mortality on 2- and 3-year-old fish. Not all 2-year-old snapper are sexually mature and a further increase in MLL would protect a greater proportion of 2-year-old snapper. Protection of more juvenile snapper should result in increases in spawning biomass and egg production. It is important to note that snapper in NSW are growth overfished and that reducing fishing mortality of juvenile fish will assist in reducing the risk of recruitment overfishing.

The original MLL change from 28 to 30 cm was associated with immediately excluding approximately 30% of the fish landed (Figure 1). The immediate impact was a 20% decline in CPUE in 2001/02; the CPUE subsequently increased each year to be currently approximately 15% higher than pre-MLL change levels. Fisheries scientists predict that a further increase in MLL to 32 cm would cause a similar decline in catch rates in the year immediately following the change, but that increases in yield to levels greater than those currently reported would follow.

A 30 cm snapper grows at an average rate of 4 cm per year. Harvesting at this size does not take into account the rapid growth of such fish. The MLLs for commercial snapper in other jurisdictions is 35 cm in Queensland, 38 cm in South Australia and 41 cm in most regions of Western Australia. In Victoria, where snapper stocks are not believed to be overfished, the size limit was increased on 1 October 2007 from 27 to 28 cm.

Regarding anticipated economic impacts, although the catch and GVP in the OTL continued to decline in the five years after the MLL change, this is not by itself a sufficient reason to postpone a necessary biological adjustment to a 32 cm MLL to promote a sustainable and hence viable commercial fishery for snapper.

Adjusting for inflation, the 7% higher price per kilogram fishers received on average compared to the price before the MLL change indicates that the price has increased in real terms. Higher incomes per fisher contributing to catching 90% of landed snapper arise through greater weights of snapper caught. In the first year of a new MLL change, fishers may be able to adjust their effort to other trap species. This may offset a short-term decrease in income from snapper in whole or part for the longer-term benefit of the stock and future fishing opportunities through an increase in yield. Given the need for a biological adjustment to enhance the sustainability of the snapper stock, and given that sustainable fisheries is a fundamental goal, there are no compelling economic reasons to object to an additional 2 cm increase in MLL to 32 cm.

Notwithstanding the above points, there is still a need to address bycatch issues, which might arise given a further increase in MLL for snapper. The promised implementation of the smallest-sized escape panel mesh in fish traps will do little to reduce the by-catch of undersized snapper and nothing to prevent the catching and discarding of 30 and 31 cm snapper. The survival of discarded snapper, especially those caught at depth, requires further study.

Recreational fishing constitutes another consideration. A survey of recreational fishing in New South Wales for 2000/01 estimated the recreational catch of NSW snapper at 117 tonnes (Henry and Lyle, 2003). This was about 43% of the 273 tonnes of commercial catch, yielding a combined catch of about 390 tonnes. The high proportion of recreationally caught snapper provides an additional factor in favour of a 32 cm size limit because it provides additional protection to a proportion of the snapper that would otherwise be caught without the increase in size limit.

## **6. CONCLUSIONS AND RECOMMENDATIONS**

The 2 cm MLL change has increased the yield of snapper as expected. A further 2 cm increase in the MLL to 32 cm will likely lead to greater biological benefits such as promoting sustainability by shifting catch to a larger proportion of 3- to 6-year-old fish. The benefits also include a reduced risk of stock collapse, reduced yearly variations in landings due to variable recruitment, and increased egg production.

The MLL policy is part of other policy changes (including buy outs for Marine Protected Areas and Recreational Fishing Havens) that have taken place in NSW fisheries. While no one policy change explains the current catch and income figures for OTL fishers catching snapper, there is clearly no basis for arguing that the 2 cm increase has had an adverse impact on fishers continuing in the industry. From an economic perspective, increased catches by weight have improved the viability of fishers contributing to catching 90% of landed snapper catch.

The conclusions lead to the following recommendation:

**Recommendation:** That the Department of Primary Industries increase the MLL by 2 cm from 30 to 32 cm.

## **7. REFERENCES**

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## Appendix 1: Catch Assessment

The catch assessment of fishers catching snapper in New South Wales covers research findings for OTL snapper catch, regional OTL snapper catch and regional OTL snapper catch per snapper fisher. In reviewing the data, there are two separate matters to consider. The first is the MLL change from 28 to 30 cm on 1 July 2001. The second is that the buy out of fishing business that took place in 2002 will have also influenced changes in average catches and incomes.

### OTL snapper catch

Four categories guide the assessment of the data in Chart 1 and subsequent charts:

- The first category concerns trends within each data set, that is, trends ‘before-and-after’ 1 July 2001 when the new MLL came into effect (columns 2 and 3, denoted C2 and C3, respectively);
- The second category is about mean values since the differences, if any, are important because year-to-year variations can be independent of the management decision to introduce a 30 cm MLL:
  - The mean values for the two data sets are reported (C4 and C5);
  - The difference between the mean value of the first data set (before 1 July 2001) and the mean value of the second data set (after 1 July 2001) is recorded (C6);
  - The percentage change in the mean values between the two periods is noted (C7);
- The third category of data details the impact of the change the year after the size limit increase (C8);
- The fourth category reports the percentage change over nine years of record (C9).

**Chart 1: Pre- and post-MLL changes to average annual snapper catch (kg/fisher).**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Catch (kg/fisher) pre-MLL 1997/98 to 2000/01	Mean Catch (kg/fisher) post-MLL 2001/02 to 2005/06	Difference between means (kg/fisher)	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Any catch	27.3	46.1	837	834	-3	-0.4	-25.5	38.5
Taking 90%	15.5	50.2	2,580	2,540	-40	-1.6	-20.1	38.7

For fishers catching any snapper, the trends are as follows (Figure 6 and Chart 1):

- Catch increased by 27% before 1 July 2001 from 731 kg/fisher in 1997/98 to 931 kg/fisher in 2000/01. After 1 July 2001, catch increased 46% from 693 kg/fisher to 1,013 kg/fisher;
- There is a slight difference between the mean catch of 837 kg/fisher before 1 July 2001 and the mean catch of 834 kg/fisher afterwards;
- Catch per fisher dropped by 25.5% in the year following the size limit increase;
- Over the nine years of record, the catch in kg/fisher increased by 38.5%.

For fishers taking 90% of snapper catch, the following trends are noted (Figure 6 and Chart 1):

- Catch increased by 15.5% before 1 July 2001 from 2,395 kg/fisher in 1997/98 to 2,766 kg/fisher in 2000/01. After 1 July 2001, catch increased by 50.2% from 2,211 kg/fisher to 3,321 kg/fisher;
- There is little difference between the mean catch of 2,580 kg/fisher before 1 July 2001 and 2,540 kg/fisher afterwards;



- Catch per fisher dropped by 20.1% in the year following the size limit increase;
- Over the nine years of record, the catch in kg/fisher increased by 38.7%.

### Regional catch

Catch records are available on a regional basis (Figure 7). The overall decline in catch between 1997/98 and 2005/06 for the North, Mid-North, Central and South Areas is 23%, 35%, 23% and 27%, respectively, (Chart 2) (rounded to the nearest integer).

Data for the North area, the most productive area, as reported in Chart 2, indicates that:

- Catch decreased by 14% over the four years before 1 July 2001 (C2): it increased by 22% over the five years following 1 July 2001 (C3);
- The mean catch before and after 1 July 2001 decreased by 37.4% (C7);
- Catch decreased by 26.1% in the year following the size limit increase (C8);
- Over the nine years of record, catch decreased by 22.6% (C9).

For the Mid-North area, the following points are noted (Chart 2):

- Catch increased by 8.9% over the four years before 1 July 2001 (C2): it increased by just 0.3% over the five years following 1 July 2001 (C3);
- The mean catch before and after 1 July 2001 change decreased by 38.4% (C7);
- Catch decreased by 40.8% in the year following the size limit increase (C8);
- Over the nine years of record, catch decreased by 35.4% (C9).

**Chart 2: Pre- and post-MLL changes to average annual snapper catch by area.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Catch (t) pre-MLL 1997/98 to 2000/01	Mean Catch (t) post-MLL 2001/02 to 2005/06	Difference between means (t)	Percentage change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	Percentage change over 9 years of record
North	-14.0	22	122,347	76,609	-45,737	-37.4	-26.1	-22.6
Mid-North	8.9	0.3	87,975	54,235	-33,740	-38.4	-40.8	-35.4
Central	42.7	-28.1	57,726	44,561	-13,165	-22.8	-25.1	-23.2
South	-23.1	13.2	14,717	14,133	-584	-4.0	-15.8	-26.7

For the Central area, the following points are noted (Chart 2):

- Catch increased by 42.7% over the four years before 1 July 2001 became effective (C2): it decreased by 28.1% over the five years following 1 July 2001 (C3);
- The mean catch before and after 1 July 2001 decreased by 22.8% (C7);
- Catch decreased by 25.1% in the year following the size limit increase (C8);
- Over the nine years of record, catch decreased by 23.2% (C9).

For the South area (Chart 2):

- Catch decreased by 23.1% over the four years before 1 July 2001 (C2): it increased by 13.2% over the five years following 1 July 2001 (C3);
- The mean catch before and after 1 July 2001 decreased by 4% (C7);
- Catch decreased by 15.8% in the year following the size limit increase (C8);
- Over the nine years of record, catch decreased by 26.7% (C9).

### Regional catch per fisher catching any snapper

Catch can also be analysed according to a regional catch per fisher catching any snapper (Figure 8). The overall trend in catch between 1997/98 and 2005/06 shows an increase of 63% for the North,

and 25%, 54% and less than 1% for the Mid-North, Central and South Areas, respectively (Chart 3) (rounded to the nearest integer).

Data for the North area as reported in Chart 3 indicates that:

- Catch/fisher increased by 8% over the four years before 1 July 2001 (C2): it increased by 96.2% over the five years following 1 July 2001 (C3);
- There was no difference between the mean catch/fisher before the size limit change and the mean catch afterwards (C7);
- Catch/fisher decreased by 22.9% in the year following the size limit increase (C8);
- Over the nine years of record, catch/fisher increased by 63.4% (C9).

**Chart 3: Pre- and post-MLL trends – regional catch per snapper fisher, any snapper.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Catch (t) pre-MLL 1997/98 to 2000/01	Mean Catch (t) post-MLL 2001/02 to 2005/06	Difference between means (t)	Percentage change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	Percentage change over 9 years of record
North	8.0	96.2	882	886	4	0.4	-22.9	63.4
Mid-North	46.0	39.4	887	820	-67	-7.6	-38.7	24.8
Central	67.8	0.7	1,069	1,379	310	29.0	-9.0	53.7
South	-17.9	30.5	292	294	2	0.7	-6.3	0.3

For the Mid-North area, the following points are noted:

- Catch/fisher increased by 46% over the four years before 1 July 2001 (C2): it increased 39.4% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and after 1 July 2001 decreased by 7.6% (C7);
- Catch/fisher decreased by 38.7% in the year following the size limit increase (C8);
- Over the nine years of record, catch increased by 24.8% (C9).

Data for the Central area, the most productive area, as reported in Chart 3, indicates that:

- Catch/fisher increased by 67.8% over the four years before 1 July 2001 (C2): it increased by 0.7% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and after 1 July 2001 increased by 29% (C7);
- Catch/fisher decreased by 9% in the year following the size limit increase (C8);
- Over the nine years of record, catch increased by 53.7% (C9).

For the South, the following points are noted:

- Catch/fisher decreased by 17.9% over the four years before 1 July 2001 (C2): it increased 30.5% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and after 1 July 2001 increased by 0.7% (C7);
- Catch/fisher decreased by 6.3% in the year following the size limit increase (C8);
- At the end of nine years of record, catch increased by 0.3% (C9).

### Regional catch per fisher catching 90% snapper

The regional catch per fisher taking 90% of snapper shows some similar trends to those fishers catching any snapper (Figure 9). The overall trend in catch/fisher between 1997/98 and 2005/06 shows an increase of 70% in the North, 14% in the Mid-North, 40% in the Central area and a decrease of 7% in the South (Chart 4 – rounded to the nearest integer).

Data for the North area, as reported in Chart 4, indicates that:

- Catch/fisher taking 90% decreased by 5.8% over the four years before 1 July 2001 (C2) and increased by 126.2% over the five years following 1 July 2001 (C3);
- There was a 4.2% decrease in the mean catch/fisher taking 90% of snapper before 1 July 2001 and the mean catch afterwards (C7), from 2,673 to 2,561 kg;
- Catch/fisher decreased by 20.4% in the year after the size limit increase (C8);
- Over the nine year period, catch/fisher taking 90% increased by 69.5% (C9).

For the Mid-North area, the following points are noted:

- Catch/fisher taking 90% increased by 11.9% over the four years before 1 July 2001 (C2): it increased 28.9% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and after 1 July 2001 increased by 1.5% (C7) from 2,351 kg to 2,387 kg;
- Catch/fisher decreased by 21.1% in the year after the size limit increase (C8);
- Over the nine years of record, catch/fisher taking 90% increased by 13.8% (C9).

Data for the Central area indicates that:

- Catch/fisher taking 90% increased by 58.5% over the four years before 1 July 2001 (C2) and decreased by 15% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and 1 July 2001 increased by 12.7% (C7) from 3,144 to 3,544 kg/fisher;
- Catch/fisher increased by 3.7% in the year following the size limit increase (C8);
- Over the nine years of record, catch/fisher taking 90% increased by 39.7% (C9).

**Chart 4: Pre- and post-MLL trends – regional catch/snapper fisher, 90% snapper.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Catch (kg) pre-MLL 1997/98 to 2000/01	Mean Catch (kg) post-MLL 2001/02 to 2005/06	Difference between means (kg)	Percentage change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	Percentage change over 9 years of record
North	-5.8	126.2	2,673	2,561	-112	-4.2	-20.4	69.5
Mid-North	11.9	28.9	2,351	2,387	36	1.5	-21.1	13.8
Central	58.5	-15.0	3,144	3,544	400	12.7	3.7	39.7
South	-14.1	35.9	968	869	-99	-10.3	-20.1	-7.2

For the South, the following points are noted:

- Catch/fisher taking 90% decreased by 14.1% over the four years before 1 July 2001 (C2) and increased 35.9% over the five years following 1 July 2001 (C3);
- The mean catch/fisher before and after 1 July 2001 decreased by 10.3% (C7);
- Catch/fisher decreased by 20.1% in the year following the size limit increase (C8);
- Over the nine years of record, catch/fisher taking 90% decreased by 7.2% (C9).

## Appendix 2: Economic Assessment – OTL and Snapper Component

The Gross Value of Production (GVP) is a calculation of catch multiplied by price from Sydney Fish Market records. The nominal GVP of all species caught in the OTL was approximately \$11.5m in 1997/98 (Figure 10). In 2005/06, the GVP was about \$8.5m, a 26% decline.<sup>8</sup> For snapper, the GVP was approximately \$2.5m in 1997/98 and \$2m in 2005/06, equating to a 20% decline. Snapper GVP as a proportion of total OTL GVP ranged between 16% and 25%.

Changes in price over time can vary with inflation or deflation of the currency unit used for measurement, as well as changing market conditions of supply and demand. Nominal value is not adjusted for inflation. Real value removes the effect of inflation such that only the change in market conditions is considered.

Taking adjustments for inflation into account yields a slightly more pronounced trend (Figure 11). The real GVP of all species caught in the OTL was approximately \$14.2m in 1997/98 compared to \$8.8m in 2005/06, a 40% decline. This calculation includes a consumer price index adjustment to 30 June 2006. For snapper, the GVP was approximately \$3.1m in 1997/98 and \$2.1m in 2005/06, equating to a 36% decline over the nine years of record. Snapper GVP as a percentage of total OTL GVP ranged between 16% and 24%.

The data from the OTL fishery (reported in Chart 5) indicates that:

- Real GVP decreased by 9.5% over the four years preceding 1 July 2001 (C2) and decreased by 28.4% over the five years following 1 July 2001 (C3);
- The mean GVP before and after 1 July 2001 decreased by 24.9% (C7);
- Real GVP decreased by 4.4% in the year following the size limit increase (C8);
- Over the nine years of record, real GVP decreased by 38% (C9).

The data for the snapper component of the OTL fishery (Chart 5) indicates that:

- Real GVP decreased by 2.8% over the four years preceding 1 July 2001 (C2) and increased by 2.5% over the five years following 1 July 2001 (C3);
- The mean GVP before and after 1 July 2001 decreased by 35.6% (C7);
- Real GVP decreased by 31.4% in the year following the size limit increase (C8);
- Over the nine years of record, real GVP decreased by 31.6% (C9).

**Chart 5: Pre- and post-MLL GVP of the OTL fishery and snapper component (CPI adjusted).**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value (\$) pre-MLL 1997/98 to 2000/01	Mean Value (\$) post-MLL 2001/02 to 2005/06	Difference between means (\$)	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
OTL (\$m) CPI Adj	-9.5	-28.4	\$13,341,948	\$10,021,271	-\$3,320,677	-24.9	-4.4	-38.0
Snapper (\$m) CPI Adj	-2.8	2.5	\$3,005,570	\$1,935,989	-\$1,069,580	-35.6	-31.4	-31.6

Given the foregoing, it is apparent that there has been a much sharper decline in the GVP of the OTL fishery compared to the snapper component of this fishery. This means that factors other than the decision to increase the MLL for snapper also account for the declining GVP for the OTL fishery.

<sup>8</sup> The basis of this calculation is landed-weight in kilograms.

### Income per fisher

Real income per fisher trends are reported according to snapper fishers catching any snapper and snapper fishers contributing to catching 90% of landed snapper catch (Figure 14).

A comparison of pre- and post-MLL incomes reveals a number of differences (Chart 6):

- Real income increased by 20.8% over the four years preceding 1 July 2001 (C2): it increased by 47.1% over the five years following 1 July 2001 (C3);
- There is a 3.6% decline in the mean real income between the two periods (C7) from \$8,792 to \$8,478;
- Real income decreased by 26.8% in the year after the size limit increase (C8);
- Over the nine years of record, real income increased by 30% (C9).

**Chart 6: Pre- and post-MLL changes in real income of snapper fishers.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value (\$) pre-MLL 1997/98 to 2000/01	Mean Value (\$) post-MLL 2001/02 to 2005/06	Difference between means (\$)	% change in mean income	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Any catch	20.8	47.1	\$8,792	\$8,478	-\$314	-3.6	-26.8	30.0
Taking 90%	0.9	71.0	\$24,150	23,250	-\$900	-3.7	-18.9	39.9

A comparison of pre- and post-MLL incomes of fishers contributing to catching 90% of landed snapper catch shows a number of differences (Chart 6):

- Real income increased by 0.9% over the four years preceding 1 July 2001 (C2): it increased by 71% over the five years following 1 July 2001 (C3);
- There is a 3.7% decline in the mean real income between the two periods (C7) from \$24,150 to \$23,250;
- Real income decreased by 18.9% in the year following the size limit increase (C8);
- Over the nine years of record, real income increased by 39.9% (C9).

### Income per fisher by area

Real average snapper income for fishers reporting any snapper catch (that is, catching snapper on at least one occasion) from the OTL fishery varies by area (Figure 14).

Examining differences in the trends before and after the size increase reveals the following results (Chart 7):

*For the North area:*

- Real income from fishers catching any snapper increased by 2.1% over the four years preceding 1 July 2001 (C2) and increased by 96.2% over the five years following 1 July 2001 (C3);
- The mean real income before and after 1 July 2001 decreased by 2.9% (C7) from \$9,267 to \$9,000;
- Real income decreased by 23.6% in the year following the size limit increase (C8);
- Over the nine years of record, real income increased by 53% (C9).

**Chart 7: Pre- and post-MLL changes to average real income from snapper – any catch.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Income (\$) pre-MLL 1997/98 to 2000/01	Mean Income (\$) post-MLL 2001/02 to 2005/06	Difference between means (\$)	% change in mean income	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
North	2.1	96.2	9,267	9,000	-266	-2.9	-23.6	53.0
Mid-North	38.0	39.4	9,320	8,344	-976	-10.5	-39.3	16.9
Central	58.7	0.7	11,211	14,011	2,801	25.0	-9.9	43.9
South	-22.4	30.5	3,087	2,994	-92	-3.0	-7.2	-6.0

*For the Mid-North area:*

- Real income from fishers catching any snapper increased by 38% over the four years preceding 1 July 2001 (C2): it increased by 39.4% over the five years following 1 July 2001 (C3);
- The mean real income before and after 1 July 2001 decreased by 10.5% (C7) from \$9,320 to \$8,344;
- Real income decreased by 39.3% following the size limit increase (C8);
- Over the nine years of record, real income increased by 16.9% (C9).

*For the Central area:*

- Real income from fishers catching any snapper increased by 58.7% over the four years preceding 1 July 2001 (C2) and increased by 0.7% over the five years following 1 July 2001 (C3);
- The mean real income before and after 1 July 2001 increased by 25% (C7) from \$11,211 to \$14,011;
- Real income decreased by 9.9% following the size limit increase (C8);
- Over the nine years of record, real income increased by 43.9% (C9).

*For the South area:*

- Real income from fishers catching any snapper decreased by 22.4% over the four years preceding 1 July 2001 (C2) and increased by 30.5% over the five years following 1 July 2001 (C3);
- The mean real income before and after 1 July 2001 decreased by 3% (C7) from \$3,087 to \$2,994;
- Real income decreased by 7.2% following the size limit increase (C8);
- Over the nine years of record, real income decreased by 6% (C9).

For OTL fishers catching 90% of the snapper catch, there is also a regional variation in the record for average annual real income (Figure 16 and Chart 8).

*For the North area:*

- Real income for fishers taking 90% of the snapper catch decreased by 13.2% over the four years preceding 1 July 2001 (C2) and increased by 150% over the five years following 1 July 2001 (C3);
- The mean real income/fisher before and after 1 July 2001 decreased by 7.6% (C7) from \$27,026 to \$24,978;
- Real income/fisher decreased by 24.5% in the year following the size limit increase (C8);

- Over the nine years of record, real income/fisher increased by 64.3% (C9).

*For the Mid-North area:*

- Real income for fishers taking 90% of the snapper catch increased by 2.5% over the four years preceding 1 July 2001 (C2): it increased by 42.1% over the five years following 1 July 2001 (C3);
- The mean real income/fisher before and after 1 July 2001 at 0.6% barely changed (C7) from \$23,795 to \$23,947;
- Real income/fisher decreased by 24.8% in the year following the size limit increase (C8);
- Over the nine years of record, real income/fisher increased by 9.6% (C9).

**Chart 8: Pre- and post-MLL change to regional average real income – fishers contributing to catching 90% of landed snapper catch.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value (\$) pre-MLL 1997/98 to 2000/01	Mean Value (\$) post-MLL 2001/02 to 2005/06	Difference between means (\$)	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
North	-13.2	150.5	\$27,026	24,978	-2,048	-7.6	-24.5	64.3
Mid-North	2.5	42.1	\$23,795	23,947	152	0.6	-24.8	9.6
Central	45.2	-5.9	\$31,670	34,160	2,490	7.9	-1.6	34.5
South	-21.3	50.5	\$9,842	8,416	-1,426	-14.5	-24.6	-10.7

*For the Central area:*

- Real income for fishers taking 90% of the snapper catch increased by 45.2% over the four years preceding 1 July 2001 (C2): it decreased by 5.9% over the five years following 1 July 2001 (C3);
- The mean real income/fisher before and after 1 July 2001 increased by 7.9% (C7) from \$31,670 to \$34,160;
- Real income/fisher decreased by 1.6% in the year after the size limit increase (C8);
- Over the nine-year period, real income/fisher increased 34.5% (C9).

*For the South area:*

- Real income for fishers taking 90% of the snapper catch decreased by 21.3% over the four years preceding 1 July 2001 (C2): it increased by 50.5% over the five years following 1 July 2001 (C3);
- The mean real income/fisher before and after 1 July 2001 decreased by 14.5% (C7) from \$9,842 to \$8,146;
- Real income/fisher decreased by 24.6% in the year after the size limit increase (C8);
- Over the nine-year period, real income/fisher decreased 10.7% (C9).

## Appendix 3: Economic Assessment of Other OTL Catch

### Leatherjacket

Of the two dominant categories for the reporting of leatherjackets, unspecified and Chinaman, the majority are reported in the former but are comprised of the latter. Combined, the two categories account for more than 80% of the leatherjacket catch in the OTL fishery (Figure 18).

For fishers catching leatherjackets, the trends are as follows (Figure 18 and Chart 9):

- Total catch decreased by 14.6% before 1 July 2001 and increased 40.6% afterwards;
- There is a 100.8% change between the mean total catch of 101,741 kg before 1 July 2001 and the mean total catch of 202,264 kg afterwards;
- Total catch increased by 80.2% in the year following the size limit increase;
- Over the nine years of record, total catch increased by 116.4%.

After adjusting for inflation, the GVP trends for leatherjackets are as follows (Figure 18 and Chart 9):

- Real GVP increased by 14.6% in the four years before 1 July 2001 and by a further 27.1% in the five years afterwards;
- There is a 42.6% change between the mean GVP of \$399,727 before 1 July 2001 and the mean GVP of \$570,161 afterwards;
- Real GVP increased by 7.4% in the year following the size limit increase;
- Over the nine years of record, real GVP increased by 56.4%.

**Chart 9: Before-and-after comparison in leatherjackets catch and real GVP.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value pre-MLL 1997/98 to 2000/01	Mean Value post-MLL 2001/02 to 2005/06	Difference between means	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Catch (kg)	-14.6	40.6	100,741	202,264	101,523	100.8	80.2	116.4
GVP (\$) CPI	14.6	27.1	\$399,727	\$570,161	\$170,433	42.6	7.4	56.4

The snapper size change may have had a considerable impact on fishing for leatherjacket. There was an 80.2% increase in catch and a 7.4% increase in value in the year following 1 July 2001.

### Bream

For fishers catching bream, the trends are as follows (Figure 19 and Chart 10):

- Total catch decreased by 1.5% before 1 July 2001 (C2); catch declined by 31.7% in the post change period (C3);
- There is a 2.7% increase in the mean total catch before 1 July 2001 and the mean total catch afterwards;
- Total catch increased by 55.4% in the year following the size limit increase;
- Over the nine years of record, total catch increased by 4.4%.

Real GVP trends for bream are as follows (Figure 19 and Chart 10):

- Real GVP decreased by 4.5% in the period before 1 July 2001 (C2) and decreased 26.3% afterwards (C3);



- There is a 1.6% increase between the mean GVP of \$205,944 before 1 July 2001 and the mean GVP of \$209,166 afterwards;
- Real GVP increased by 53% in the year following the size limit increase;
- Over the nine years of record, real GVP increased by 7.7%.

**Chart 10: Before-and-after comparison of bream catch and real GVP.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value pre-MLL 1997/98 to 2000/01	Mean Value post-MLL 2001/02 to 2005/06	Difference between means	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Catch (kg)	-1.5	-31.7	18,836	19,336	500	2.7	55.4	4.4
GVP (\$) CPI Adj	-4.5	-26.3	\$205,944	\$209,166	\$3,222	1.6	53.0	7.7

### Rubberlip morwong

For fishers catching rubberlip morwong, the trends are as follows (Figure 20 and Chart 11):

- Total catch decreased by 46.5% over the four years before 1 July 2001 and declined again by 39.3% in the five years afterwards;
- There is a 59.9% change between the mean total catch before 1 July 2001 and the mean total catch afterwards;
- Total catch decreased by 26.8% in the year following the size limit increase;
- Over the nine years of record, total catch decreased by 76.2%.

Real GVP trends for rubberlip morwong are as follows (Figure 20 and Chart 11):

- After adjusting for inflation, real GVP decreased by 40.8% over the four year before 1 July 2001 and declined a further 50.4% in the five years afterwards;
- There is a 64.9% decline between the mean GVP of \$414,379 before 1 July 2001 and the mean GVP of \$145,566 afterwards;
- Real GVP decreased by 32% in the year following the size limit increase;
- Over the nine years of record, real GVP decreased by 80%.

**Chart 11: Before-and-after comparison of rubberlip morwong catch and GVP.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value pre-MLL 1997/98 to 2000/01	Mean Value post-MLL 2001/02 to 2005/06	Difference between means	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Catch (kg)	-46.5	-39.3	94,639	37,968	-56,671	-59.9	-26.8	-76.2
GVP (\$)	-40.8	-50.4	\$414,379	\$145,566	-\$268,813	-64.9	-32.0	-80.0

### Silver trevally

For fishers catching silver trevally, the trends are as follows (Figure 21 and Chart 12):

- Total catch increased by 19% over the four years before 1 July 2001 and declined by 54.5% in the five years afterwards;
- There is a 43.2% decline in the mean total catch before 1 July 2001 and the mean total catch afterwards;
- Total catch decreased by 12.1% in the year following the size limit increase;
- Over the nine years of record, total catch decreased by 52.4%.

**Chart 12: Before and after comparison of silver trevally catch and real GVP.**

C1	C2	C3	C4	C5	C6	C7	C8	C9
	Pre-MLL change between 1997/98 & 2000/01 (%)	Post-MLL change between 2001/02 & 2005/06 (%)	Mean Value pre-MLL 1997/98 to 2000/01	Mean Value post-MLL 2001/02 to 2005/06	Difference between means	% change in mean catch	Yr/Yr change 2000/01 to 2001/02 when MLL effective	% change over 9 years of record
Catch (kg)	19.0	-54.5	109,262	62,069	-47,193	-43.2	-12.1	-52.4
GVP (\$) CPI	45.2	-54.9	\$384,402	\$195,812	-\$188,591	-49.1	-27.0	-52.2

Real GVP for trends for silver trevally are as follows (Figure 21 and Chart 12):

- Real GVP increased by 45.2% in the four years before 1 July 2001 and then decreased by 54.9% in the five years afterwards;
- There is a 49.1% decline between the mean GVP of \$384,402 before 1 July 2001 and the mean GVP of \$195,812 afterwards;
- Real GVP decreased by 27% in the year following the size limit increase;
- Over the nine years of record, real GVP decreased by 52.2%.

## Appendix 4: Statistical analysis

### (a) Prices – not adjusted for inflation

The statistical analysis software, ASREML, uses a linear mixed model methodology similar to ANOVA methodology (Gilmour et al., 2000). The model used for the analysis is:

$$\text{price} \sim \text{mean} + \text{change status} + \text{quarter} + \\ \text{change status} \cdot \text{quarter} + \text{linear trend over the years} + \\ \text{linear trend over the years} \cdot \text{change status}$$

All terms are fitted as fixed terms in the model, where change status is a factor with two levels (before change / after change) and the quarters are numbered 1 to 4 within a year (Q1=July to September; Q2 = October to December; Q3 = January to March; and Q4 = April to June).

Linear mixed model methodology provides a description of the data but since the randomisation and replication processes that underpin an analysis of variance cannot be followed for this data, the significance tests are not strictly valid.

The ANOVA results for average price per quarter (not adjusted for inflation) are shown in Table 1.

**Table 1: ANOVA results for OTL snapper price.**

Source	DF	DDF	F Incremental	p-value
change status	1	31.0	18.42	< 0.001
quarter	3	31.0	7.20	< 0.001

In this test, the *p*-values for change status and quarter are < 0.001. Given a significance level of < 0.05, this indicates that the two terms are highly significant (*p*-value < 0.001). The predicted values for price are noted in Tables 2 and 3.

**Table 2: Predicted price – before and after.**

Change Status	Predicted Average Price Per Quarter	Comments on Difference in Predicted Price
after	9.40 b	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)
before	8.48 a	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)

**Table 3: Predicted price – price per quarter.**

Quarter	Predicted Average Price Per Quarter	Comments on Difference in Predicted Price
1	9.07 bc	Significantly different to Q4 only ( <i>p</i> -value < 0.05)
2	8.94 b	Significantly different to Q3 & Q4 ( <i>p</i> -value < 0.05)
3	9.54 c	Significantly different to Q2 & Q4 only ( <i>p</i> -value < 0.05)
4	8.21 a	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)

**(b) Prices – inflation-adjusted prices**

The statistical analysis software, ASREML, uses a linear mixed model methodology similar to ANOVA methodology (Gilmour et al., 2000). The model used for the analysis is:

$$\text{price} \sim \text{mean} + \text{change status} + \text{quarter} + \\ \text{change status} \cdot \text{quarter} + \text{linear trend over the years} + \\ \text{linear trend over the years} \cdot \text{change status}$$

All terms are fitted as fixed terms in the model, where change status is a factor with two levels (before change / after change) and the quarters are numbered 1 to 4 within a year (Q1=July to September; Q2 = October to December; Q3 = January to March; and Q4 = April to June).

Linear mixed model methodology provides a description of the data but since the randomisation and replication processes that underpin an analysis of variance cannot be followed for this data, the significance tests are not strictly valid.

The ANOVA results for average price per quarter, CPI adjusted), are shown in Table 1.

**Table 1: ANOVA results for OTL snapper price.**

Source	DF	DDF	F Incremental	p-value
change status	1	31.0	10.54	< 0.003
quarter	3	31.0	6.38	< 0.002

In this test, the *p*-values for change status and quarter are < 0.001. Given a significance level of < 0.05, this indicates that the two terms are highly significant (*p*-value < 0.001). The predicted values for price are noted in Tables 2 and 3.

**Table 2: Predicted price – before and after.**

Change Status	Predicted Average Price Per Quarter	Comments on Difference in Predicted Price
after	10.49 b	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)
before	9.80 a	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)

**Table 3: Predicted price – price per quarter.**

Quarter	Predicted Average Price Per Quarter	Comments on Difference in Predicted Price
1	10.79 bc	Significantly different to Q4 only ( <i>p</i> -value < 0.05)
2	9.49 b	Significantly different to Q3 & Q4 ( <i>p</i> -value < 0.05)
3	10.21 c	Significantly different to Q2 & Q4 only ( <i>p</i> -value < 0.05)
4	10.10 a	Significantly different to all other predicted values ( <i>p</i> -value < 0.05)

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