

# **NSW Total Allowable Catch Setting and Review Committee**

## **Report and Determination 2017**

### **ABALONE FISHERY**

**06 December 2016**

# EXECUTIVE SUMMARY

## Preamble

The NSW Total Allowable Catch Setting and Review Committee (the Committee) has responsibility under the NSW Fisheries Act (1994) for determining the annual Total Allowable Commercial Catch (TACC) of abalone by NSW commercial fishers. This determination is for the period 1 January 2017 to 31 December 2017. The determination is based on best available information about the status of the abalone stocks, reports from managers of the fishery and compliance enforcement officers, comment from fishers, and discussions at a public forum with the Committee on November 2<sup>nd</sup> 2016.

## Determination

The Committee has determined that the total allowable catch of abalone by NSW commercial fishers during the 2017 fishing period should not exceed 130 tonnes (t). This allocation is the same as the allowable catch in the 2016 fishing period.

The determination is set given likely catches of abalone by non-commercial fishers of approximately 10 t and illegal and unreported commercial catches of up to 50 t.

## Recommendations

The Committee provides the following primary recommendations to the NSW Department of Primary Industries (the Department, DPI) and the abalone industry (Industry) in the interests of improving performance of the fishery.

**Recommendation 1:** The Department and industry develop a harvest strategy for the fishery with specific biological and economic objectives linked to target reference points.

**Recommendation 2:** The overall Legal Minimum Length (LML) for abalone harvest be increased to 120 mm, with Area-specific adjustments as specified with this Determination (Tables 6.1, A3.3) or in other Areas where recent biological information clearly indicates a lower LML is appropriate.

**Recommendation 3:** The TACC be distributed amongst Areas as recommended in Table 6.1, with appropriate regulatory or co-management measures to ensure that catch distribution.

**Recommendation 4:** The Department and Industry resolve robust and definite mechanisms for spatial-explicit management of the fishery, including an agreed set of spatial management units, spatially determined catch quotas and LMLs, efficient quota management methods, and rigorous spatially-explicit monitoring and assessment.

**Recommendation 5:** The Department develop a robust, spatially explicit bio-economic assessment model to support TACC determinations, LML settings, and strategic management of the fishery.

**Recommendation 6:** The Department and Industry develop a strategy for regular economic survey and analysis of the fishery to inform economic optimisation of the fishery.

**Recommendation 7:** The Department obtains more robust estimates of recreational catch and makes no change to recreational bag limits until rigorous recreational catch monitoring is implemented.

## Stock Status

There has been substantial improvement in the state of the stock in recent years, starting in about 2006 but particularly since about 2009. TACC reductions and increased Legal Minimum Lengths (LML) for harvest have succeeded in building accumulated stock above the LML since the mid-2000s, as evidenced by substantial increases in catch rate and mean weight of abalone. Stock increase also is indicated by the biomass estimates from the GPS logger observations and preliminary, but rudimentary, population modelling provided to the Committee in the last two years.

It is clear now also that stock rebuilding has slowed in the past 2-3 years as catches have increased. The key available indicators are plateauing, with the following implications, among others:

- Recent catches have been taking most of the surplus production from the stock in the southern half of the fishery, leaving relatively little to contribute to further rebuilding;

- The stock in the southern areas of the fishery is approximately stabilised under current catch and LML settings, and further catch increases at the current LML would be expected to decrease average commercial catch rates;
- The history of the fishery indicates that stock rebuilding to an optimal level is likely to be incomplete and optimised harvest rules would result in considerably improved production;
- Further refinement of harvest levels and LMLs for optimum productivity and economic efficiency is constrained severely by the lack of robust population modelling and monitoring of the stock, a robust harvest strategy, and specific bio-economic objectives for the fishery.

Evidence is emerging that harvest fractions (the proportion of available stock being taken by the fishery) have reached levels in several areas that will preclude further stock rebuilding, and may indicate emerging localised depletion. Other Areas appear to be being harvested below capacity. This uneven distribution of harvest intensity reflects, in part, the lack of appropriate spatial control of catch that allows control of harvest at the relatively local scales appropriate to an abalone fishery. It is clear now that recent approaches to voluntary mechanisms to regulate the spatial distribution of effort and catch within an overall Total Allowable Commercial Catch (TACC) have not been reliable.

These features of the fishery and the stock in the context of a single, overall TACC, militate in favour of conservative TACC setting to limit risks of serial stock depletion. This is an inefficient approach that does not allow the fishery to reach its biological and economic potential, especially when TACC Determinations do not encompass setting LMLs to optimise harvest. This complex situation requires greater information support than would be the case for many other fisheries to balance continued recovery with appropriate catch levels and inform management reform.

The Committee considers two management settings in particular to be important for increasing confidence in future TACC setting, securing the future stock status, and optimising the fishery.

- ***Finer scale monitoring, assessment and management.*** The electronic logger program introduced by Industry has augmented the DPI logbook program and considerably improved the ability to monitor abalone stock, catch, and fishing effort at finer space scales. Finer scale management of catches is improving but still is not adequate to deliver the spatial distribution of catches appropriate to a stock of this type. More formal methods, potentially including robust co-management arrangements, to control catches from Areas are needed, linked to formal catch caps by Area and Spatial Management Unit (SMU).
- ***Appropriate size limits.*** Spatial variability of abalone life history means that maximising yield while protecting spawning stock is likely to require different LMLs in different areas, supported by spatially explicit monitoring and biological information. Even moderate TACCs can result in both growth and recruitment overfishing in areas for which a LML is too small, while yield is foregone in areas for which a LML is too large. The Committee previously has argued for higher overall LMLs, augmented by Area-specific LMLs where biological data clearly indicate faster or slower growing local populations. The Committee again finds that available evidence indicates benefits to the stock and fishery from increasing the overall LML.

## Economic Considerations

The economic value of the abalone fishery appears to have stabilised, with little change in real gross value of production of the fishery since 2011–12. Total catches have increased slightly since 2011–12 but prices have declined in both real and nominal terms, offsetting the value of catch increases.

Productivity, in terms of CPUE, has increased substantially, most likely as a result of lower TACCs and higher biomass in most parts of the fishery. CPUE (kg/hr) has increased by roughly 25% since 2011–12, although only a modest increase was seen between 2015 and 2016. Average weight of abalone also increased in most Areas. The higher catch rates of larger animals resulted in a decrease in the total number of days fished with fewer abalone being removed to take the quota. The reduced fishing time to take the catch should have improved short term economic performance of the industry.

Share trading declined slightly between 2014–15 and 2015–16 despite indications of increased short term profitability. This indicates a slightly pessimistic medium to longer term economic outlook for the fishery. Quota trading price information, an indicator of short term economic performance is unavailable.

Market pressure from the increasing supply of cultured abalone nationally and internationally is likely to affect adversely prices for wild product in the coming years. The current size of NSW product still is within the size range produced through aquaculture, despite increases in LMLs over recent years.

Industry notes that new overseas markets, particularly in China, are being explored with the expectation of higher prices. The dominance of China as an abalone aquaculture producer, however, may mean that wild abalone premiums may not be substantial for smaller animals. Larger size wild-caught product may be required to differentiate it from cultured product and potentially receive higher prices, indicating an economic argument to increase the LML above current levels. *The Committee suggests that Industry undertake a marketing study of size preferences for abalone on overseas markets and size–price relationships for abalone on these markets.*

There is a trade-off between average size of the abalone (and its market price) and the quantity that can be removed on a sustainable basis. There is also a trade-off in terms of how rapidly any increase in LML is implemented; a gradual increase may result in greater lost profitability over time during the adjustment phase than a shorter but greater size increase (or vice versa). The Committee recommends that bio-economic modelling be done to assess these trade-offs and inform future TACC determinations.

The Committee had little economic information to inform TACC setting. The only economic performance study of the industry (i.e. costs and earnings) related to the 2011–12 financial year, and likely bares little relevance to the current economic performance. Quota trading prices also are unavailable. The Committee again recommends that Industry and the Department resolve a strategy for economic monitoring of the operating costs and product prices for the fishery, including for share and quota trading. Absence of such information continues to constrain setting economically optimised TACCs.

The Committee again notes that current economic indicators and triggers for the fishery lack specificity or clear management responses. Economic data for the fishery relating to long-term profitability are required to inform operational objectives, performance indicators, and target reference levels in a harvest strategy for the fishery.

## Management Considerations

The NSW abalone fishery has been on an improving trajectory, albeit with considerable uncertainty about the status of the stocks, their prognosis, and the ecologically and economically appropriate TACC.

The abalone fishery lacks an appropriate management plan, long-term objectives, meaningful indicators and reference points. This is now materially impacting TACC decisions as there are no stated objectives against which to maximise the benefit from the fishery in the medium to long term. This also means that there is no basis on which to make decisions about the appropriate level of investment in either the fishery's management or fishing businesses. The Committee again recommends that existing management arrangements be reviewed and a harvest strategy be developed as a priority. Investment needs to be made in expert fisheries management resources to lead this work.

Steps have been taken to develop the finer scale management system for the fishery, in common with other abalone jurisdictions, and the data logger program implemented by Industry underpins that direction. Further work is required, however, before the information is collected, presented, and used to a standard that can inform TACC decisions reliably and consistently

TACC setting intrinsically is related to the size limits for harvest in the context of stock structure and status. The Committee reinforces its previous recommendations to increase LMLs and formalise a spatial management system that allows adjustments to optimise harvest from areas of the fishery with different underlying population dynamics.

The Committee's experience in setting this TACC again has reinforced the need for a harvest strategy that outlines the objectives the fishery is working toward, how performance will be measured, how data will be collected and analysed to inform decision-making, and how decisions will be made. More consistency and transparency is required of the data monitoring and stock assessment program to build on recent improvements. The level of investment in these programs needs to be revisited as the fishery has reached the point where under-investment is compromising efficient TACC decisions.

Advice available to the Committee about non-commercial catch (Aboriginal, recreational, and illegal) suggests the low estimates assumed in recent years continue to be appropriate. Information presented in relation to compliance provides confidence that the quota system has integrity, and the information from it is reliable, and that estimates of declining illegal harvest are appropriate.

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## 1. INTRODUCTION

The Total Allowable Catch Setting and Review Committee (the Committee) is established by Division 4 (S26-34) of the *Fisheries Management Act 1994*. The committee in 2016 was:

- Dr Bruce Mapstone – Chair
- Dr Keith Sainsbury – fisheries science
- Dr Sean Pascoe – natural resources economics
- Ms Kelly Crosthwaite – fisheries management

The Committee is required to determine the Total Allowable Commercial Catch (TACC) for the commercial sector of the abalone fishery and, in doing so, to give effect to the objectives of the *Fisheries Management Act 1994*, as amended where relevant by *Fisheries Management Amendment Acts (1997, 2004, 2006, 2010, 2015)*. The Committee is not subject to control or direction of the Minister but in reaching its decision is required to have regards to:

- All relevant scientific, industry, community, social and economic factors;
- The need to ensure that the abalone resources are exploited in a manner that will conserve stocks in the long term;
- The impact of fishing on other species and the environment; and
- The precautionary principle as set out in Section 30(2)(c) of the Act.

The Committee also may be consulted out of session on a range of management issues.

The Committee produces a stand-alone report each year in support of the TACC determination. The report also sometimes includes recommendations for management of the fishery related to setting TACCs, based on the experience and background of the Committee members and reports received by the Committee. Constructive dialogue between the Committee and the Department and Industry on a range of issues related to the fishery, including recommendations from the Committee, is an important and valuable part of the Committee's deliberations in reaching a TACC determination. It is important to note, however, that the Committee makes a determination on the TACC and, potentially, matters it is required to regard that affect directly the TACC. The degree to which the Committee's suggestions or recommendations beyond that scope are accepted is a matter entirely for the Department. The Committee holds the position, however, that the abalone Determination is linked inextricably to selectivity (size limits for harvest) and spatial dynamics considerations and that its recommendations regarding these intrinsic components of the TACC should not be discretionary.

The Committee must consider the full extent of abalone exploitation to meet its statutory obligations. Total removals from the NSW abalone stock are made up of:

- The quota allocated to commercial fishers;
- The total legal catch by recreational and Aboriginal fishers; and
- Catches by commercial, recreational, or Aboriginal fishers not sanctioned by the Regulations controlling the fishery and not recorded in catch statistics (illegal catches).

The legal and illegal components of the non-commercial fishery currently are estimated as a single figure based on historical evidence, compliance information, and judgements from the Department and Industry.

The Act defines, in Section 30(2)(c), how the Committee should apply the precautionary principle, specifically:

*'... if there are threats of serious irreversible damage to fish stocks, lack of scientific certainty should not be used as a reason for postponing measures to prevent that damage.'*

The Committee interprets 'threat' in this context to mean an 'indication of probable harm to come'. The Committee therefore must respond to evidence before it that indicates probable future harm to the fishery or the stocks and not postpone action to prevent that harm occurring even if there is uncertainty surrounding such evidence. Similarly, the Committee should not take pre-emptive decisions on issues such as increasing the TACC when there is insufficient verifiable information on which to base such decisions. The abalone fishery is an instance where the Committee currently takes a precautionary approach.

## 2. PROCEDURES

### 2.1 Public Consultation by Committee

The Committee, through the Department, called for public submission on the appropriate total allowable commercial catch under the requirements of Section 31 Division 4 of the *Fisheries Management Act* 1994. Abalone fishers, relevant industry and community bodies, and the community were invited to make submissions on the total allowable commercial catch. The consultative process is set out in Appendix 1 and main points from submissions summarised in Appendix 2.

The Committee obtained input from participants in the Total Allowable Catch Committee Open Forum meeting in Sydney on November 2<sup>nd</sup> 2016 and received written reports from:

- NSW Department Primary Industries (DPI) Fisheries Research and Abalone Council<sup>1</sup>;
- NSW Department Primary Industries Commercial Fisheries Management;
- NSW Department Primary Industries Fisheries Compliance;
- The Abalone Association NSW; and
- Participants in the commercial abalone fishery.

Public submissions and presentations to the Committee were invited in the Open Forum meeting. Confidential submissions were not discussed publicly. The Committee also was able to call for *in-camera* discussions, where appropriate. No *in-camera* discussions were requested at the 2016 meeting.

### 2.2 Matters considered

The Committee considered the following matters before reaching its determination:

- Documentation available on the fishery and submissions received for this year;
- Management objectives set out in the management plan;
- The current state of the fishery;
- Advice on the status of management of the fishery provided by the Department;
- Advice on the economic status of the fishery by the Department and Industry representatives;
- Advice on compliance with regulations from the Department and Industry representatives;
- The data and assessment report for abalone stocks provided by the Abalone Council of NSW under contract to the Department;
- The spatial nature of the fishery; and
- Submissions, commentary, and presentations provided at the Open Forum.

The Committee notes again that the timeliness of reports from the Department was poor in some areas and again emphasises the importance of delivering reports to the Committee no later than 2 weeks prior to meetings to enable appropriate consideration of information by the committee.

### 2.3 Format of the Report

This report covers the three key areas affecting management of the fishery and setting the TACC:

- Status of the abalone stocks;
- Economic considerations; and
- Management considerations.

The key considerations for each of these areas are presented in the following sections 3, 4, and 5. Greater details, together with relevant historical context, for each topic are presented in Appendix 3 (Stock), Appendix 4 (Economics), and Appendix 5 (Management) for interested readers. General background information about the fishery is provided in Appendix 6.

The Committee has made several recommendations with the Determination to clarify the position of the Committee on a number of issues related to the TACC. The primary recommendations are included in the Executive Summary and all recommendations appear as relevant in sections 3, 4, and 5 and Appendices A3, A4, and A5.

The Determination of the Committee is to be published by the Minister. The Minister is required to review the regulations and any other instruments under the Act in the light of the Determination. The Determination is to be implemented in accordance with the Management Plan.

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<sup>1</sup> The research report titled Assessment of abalone stocks in NSW was prepared by the Abalone Council of NSW under contract to the NSW Department of Primary Industries and submitted to the Committee as a Department endorsed (draft) report.

## 3. STATE OF THE STOCKS

### 3.1 Introduction

There has been substantial improvement in the state of the stock in recent years, starting in about 2006 but particularly since about 2009. Reductions in Total Allowable Catch (TAC) and increases in Legal Minimum Length (LML) for harvest have succeeded in providing additional accumulated stock above the LML since the mid-2000s when those management interventions began. The stock has shown considerable rebuilding, as evidenced by the substantial increases in catch rate and mean weight of abalone for all Spatial Management Units (SMUs). This increase also is mirrored in density and biomass estimates from GPS logger observations that, while preliminary, indicate an about doubling of exploitable biomass since 2009.

The overall trend toward recovery in the past 10 years is very clear, but it also now clear that stock rebuilding has slowed considerably during the past 3-4 years in SMUs 2, 3, and 4 as the catches there have increased. Rebuilding continues in SMU 1 under very low catches. The key catch rate, mean weight, population density, and biomass indicators in SMUs 3 and 4 have plateaued and they are plateauing in SMU 2. The plateauing of these indicators was first recognised in a few Areas in 2013, was more widespread in 2014, and now is seen in almost all significantly fished Areas of the fishery.

These results also are consistent with the relatively high harvest fractions estimated for SMUs 3 and 4 from the logger observations in recent years. It can be concluded from recent trends in these SMUs that harvest fractions above about 12-15% allow little scope for stock rebuilding. SMU 2, where some slowed recovery continues, has had harvest fractions recently of about 7-10%. The harvest fraction in SMU 1 is less than 5% and steady stock rebuilding continues there.

Some implications of this plateauing of stock recovery are:

- Recent catches in SMUs 2, 3 and 4 have been taking most of the surplus production, leaving relatively little to contribute to further stock rebuilding;
- The stock in these SMUs is approximately stabilised under current catch and LML settings, and further catch increases at the current LML would be expected to decrease the average commercial catch rate;
- Stock rebuilding to the optimal level is likely to be very incomplete because the fishery catch history suggests that surplus production from the fully recovered population would be considerably larger than current catches. The implications of this would be understood far better if a population model was used to characterise surplus production, the current status of the stock, and the effects of changing LMLs.

Comparison of the commercial catch rate (Kg/hr) with the GPS logger estimates of abalone density (Kg/Ha) can detect situations where the catch rate becomes hyper-stable because operational changes in fishing strategy compensate for decreasing density. Such situations can indicate increased fishing pressure on local stocks and the start of localised depletion. Catch rate and density trends are similar in most Areas examined, indicating that hyper-stability and the associated change in fishing operations is not occurring. There are mild indications of some hyper-stability since about 2013 in Areas 13, 15, 16 and 17 (i.e. most of SMU 3), so catch rate data from these areas should be treated with caution. Much stronger patterns of hyper-stability are evident in Areas 14 and 19, however, and these are of greater concern. *It is concluded that the stocks in both these Areas are stressed by recent catches and that future catches should be reduced.*

The Committee previously has supported the implementation of catch caps at local space scales to spread the catch, help manage the risk of localised depletion, and avoid the sequential localised depletion experienced in the history of this fishery. These local catch distributions are within the regulated fishery-wide TACC and recently they have been recommended at the scale of Areas. There is ongoing failure to achieve the intended catch distribution at this finer space scale. Many Areas are persistently providing catch above or below the recommended level. In particular, the catch from SMU 1 is much lower than that recommended with the 'missing catch' taken in the southern SMUs so that catches there exceed the recommendations. The inability to manage effectively the spatial distribution of the catch risks sequential localised depletion, and that risk increases as the overall TACC increases because large catches could be taken from unintendedly small areas. This is a significant impediment to confident recovery of the fishery.

*The Committee **recommends** that arrangements be developed between industry and government to improve management of the spatial distribution of the TACC.*

Now, as in recent years, the Committee has very limited information and analysis for its decisions. There consequently is a high level of uncertainty about the true status of the stocks and their responses to recent changes in the TACC and LML. The imperative previously was to stop further stock decline and begin recovery and that could be addressed (albeit inefficiently) with relatively little information. The challenge now is balancing continued recovery with appropriate catch levels whilst also implementing management reform to prevent a return to overfishing and localised depletion. There are limitations and risks in achieving this objective with the few stock status indicators available, poor knowledge of current stock status in relation to full recovery, and the time needed to learn from previous management changes before taking next steps.

The fishery now is being limited significantly by under-investment in analysis of the monitoring data and modelling of population dynamics. The future is likely to be one of continued uncertainty and ongoing need for considerable precaution whilst such under-investment persists. The Committee notes that management changes and stock rebuilding during the past about 10 years has resulted in potentially very informative trends in the key stock indicators and recommends that formal population modelling be reinstated as a core component of advice for management planning and TACC determination. The primary aim of such modelling, however, should not be tactical stock assessment specifically for TACC setting year-to-year. Rather it should be to provide strategically focused guidance for management in the next few years toward setting sensible reference points related to productivity thresholds such as achieving optimum economic yield and avoiding recruitment overfishing. An aspect of such modelling necessarily would be consideration of the optimum LML at appropriate spatial scales, probably by Area.

The Committee has been concerned to identify past management settings that allowed overfishing to occur as well as taking measures to enable stock rebuilding. Rectification of poor previous settings is central to controlling risks that overfishing and stock collapse could recur. The Committee considers that two features of the management settings are particularly important.

- **Finer scale monitoring, assessment and management.** The electronic logger program introduced by Industry has augmented the DPI logbook program and considerably improved the ability to monitor abalone stocks, catches, and fishing effort at finer space scales. Finer scale management of catches is improving but still is not adequate to deliver the spatial distribution of catches appropriate to a stock of this type. More formal methods to control catches from Areas, potentially including robust co-management arrangements, are needed, linked to formal catch caps and targets by Area and Spatial Management Unit (SMU).
- **Appropriate size limits.** The spatial variability of abalone life history parameters means that maximising yield while protecting spawning stock is likely to require different LMLs in different areas, supported by spatially explicit monitoring and biological information. Even moderate TACCs can result in both growth and recruitment overfishing in areas for which a LML is too small, while yield is foregone in areas for which a LML is set too large. The Committee previously has argued for higher overall LMLs that are adequate to optimise the fishery in the areas of fast growth that provide most of the catch, augmented by complementary specific LML arrangements for harvest from slower growing areas. The absence of adequately spatially tailored LMLs means that stock protection needs to be provided by a low overall TACC, but this is an inefficient approach that does not allow the fishery to reach its biological and economic potential. The Committee again finds that the available evidence indicates benefits to the stock and fishery from an increase in the overall LML with selected areas subject to specifically tailored LMLs based on contemporary biological information.

*The Committee **recommends** some changes in the previously recommended distribution of catches among Areas to provide increased protection in Areas 14 and 19 and to reiterate the desirability of taking increased catches from SMU 1 with commensurately decreased catches in the more southern SMUs.*

The Committee provides suggested area-specific catch caps and LMLs together with the TACC Determination in Section 6. LML suggestions are the same as made last year for SMUs 2, 3 and 4 but it is suggested now that the default LML in most of SMU 1 be 120mm, rather than 117mm, with scope to decrease it in specific Areas through agreement between the Department and Industry. This suggestion is made because: (i) SMU 1 has had a long period of very low catches and so the size distribution of the stock can be expected to have rebuilt substantially; (ii) the structured fishing program in SMU 1 in 2007 found that the median length of abalone then was greater than 120mm; (iii) the mean weight observations from most Areas in SMU 1 suggest that they contain relatively large abalone (with Area 6 being a possible exception); and (iv) a larger LML will provide greater protection of the mature stock if the stocks have not recovered as significantly as expected, noting that the recent data are from relatively small catches so may not be representative of the wider populations.

## 4. ECONOMIC CONSIDERATIONS

### 4.1 Introduction

Economic information available for considering economic implications of different quota alternatives included estimates of gross value of production from the fishery, estimated beach prices, and share trading prices. Indirect productivity measures were available in the form of average catch rates for the fishery as a whole as well as by fishing area.

The absence of relevant contemporary data on fishing costs means that it is not possible to make a complete analysis of the economic performance of the NSW abalone industry. Focussing on gross returns alone means that the economic implications of different alternative quota scenarios cannot be assessed fully. The constraints of limited economic information have been highlighted in several previous determination reports and are further discussed below.

### 4.2 Gross value of the fishery and abalone prices

The economic value of the abalone fishery appears to have stabilised over recent years, with little change in the real gross value of production (GVP) of the fishery since 2011–12. The estimated GVP of the fishery in 2016 is \$3.73m, up slightly from 2015 but roughly equivalent to the average over the period 2011–12 to 2016 in real terms (\$3.79m).

Abalone prices have decline in both real and nominal terms<sup>2</sup> since 2011–12 and offset the potential value of Total Allowable Commercial Catch (TACC) increases from 110 tonnes (t) to 130 t over the same period. Beach prices have declined in real terms by 14% from \$33.42 in 2011–12 to \$28.71 in 2016. A substantially greater decrease in beach price has been seen since 2000, with prices in 2016 being less than a third of their 2000 level in real terms.

This substantial price decrease largely corresponds with the expansion of farmed abalone both within Australia and globally. Production of Australian farmed abalone more than doubled between 2010 and 2015 from 456 t to 965 t (Cook 2014<sup>3</sup>). Farmed abalone production increased globally from 8,700 t in 2002 to 130,000 t in 2015, while wild caught product declined from 10,000 t to 6,500 t over the same period (Cook 2016<sup>4</sup>).

Pressure from the increasing supply of cultured abalone is likely to continue to affect adversely prices for wild product in the coming years. Studies of the Japanese market, the current main destination for NSW abalone, found that consumers do not differentiate abalone based on their origin (Hoshino *et al.* 2015<sup>5</sup>), so “wild caught” may not be sufficient alone to attract a price premium if the animals are of similar size to cultured abalone. The current size of NSW product remains within the size range produced through aquaculture despite increases in NSW LMLs over recent years, meaning that NSW product is competing directly with cultured product rather than targeting alternative markets based on preferred size. Prices for wild-caught product are likely to decline further whilst ever such direct competition occurs, resulting in further downward pressure on the GVP of the NSW fishery.

There is an economic argument to increase the LML above the current levels to differentiate NSW abalone from cultured product and potentially receive higher prices by targeting markets with preference for larger size product. Industry notes that new overseas markets, particularly in China, are being explored with the expectation that supplying new markets will lead to higher prices. “Wild abalone” premiums may not be substantial for smaller animals in China, however, given the dominance of China as an abalone aquaculture producer. A price premium for larger abalone has been observed on the Chinese market (Cook 2016<sup>4</sup>).

*The Committee suggests that Industry undertake a marketing study of size preferences for abalone on overseas markets and size–price relationships for abalone on these markets.*

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<sup>2</sup> Nominal values are the actual or ‘raw’ transaction values recorded at given times, without any adjustment for inflation from previous or later times. Real values are the transaction values at each time adjusted for inflation between the time of transactions and some standard reference period. Comparison of real values over time are more sensible because the effects of inflation have been removed. The Consumer Price Index (CPI) often is applied for this adjustment since it reflects changes in the costs of living, and so inflation, over time.

<sup>3</sup> Cook, P.A. (2014). The worldwide abalone industry, *Modern Economy* 5, 1181.

<sup>4</sup> Cook, P.A. (2016). Recent Trends in Worldwide Abalone Production, *Journal of Shellfish Research* 35, 581-583.

<sup>5</sup> Hoshino, E., Gardner, C., Jennings, S. and Hartmann, K. (2015). Examining the Long-Run Relationship between the Prices of Imported Abalone in Japan, *Marine Resource Economics* 30, 179-192

### 4.3 Fishery economic performance and quota trading prices

Productivity, in terms of CPUE, has increased substantially in the fishery, most likely as a result of lower TACCs and higher biomass levels in most parts of the fishery. CPUE (kg/hr) has increased by roughly 25% since 2011–12, although only a modest increase was seen between the 2015 and 2016 fishing periods. Average weight of abalone in most area also has increased, resulting in fewer numbers of abalone being removed to realise quotas. The higher catch rates of larger animals has resulted in relatively small changes in the total numbers of days fished to take higher quotas, suggesting that the cost per unit of catch would have declined. This would have resulted in an improvement in economic performance of the fishery, all else being equal.

Share trading prices have largely stabilised between 2014-15 and 2015-16, despite anecdotal evidence of a potential for an increase in short term profitability due to improved productivity. Price reductions appear to have offset likely cost reductions, resulting in no real change in the economic status of the fishery and a slightly pessimistic economic outlook for the fishery in the medium to longer term, as price and cost conditions are not expected to improve. Quota trading price information — a good indicator of short term economic performance — is unavailable.

### 4.4 Economic targets for the fishery

The Committee noted that there is no formal (or informal) economic objective for the fishery, nor an economically-based target level of biomass and catch. The economic performance of the fishery may be enhanced longer term, nevertheless, through a higher LML, particularly if a larger LML is sufficient to differentiate the wild caught from farmed product in the marketplace.

There is a trade-off between average size of the abalone (and its subsequent price) and the quantity that can be removed on a sustainable basis. There is also a trade-off in terms of how rapidly any increase in LML is implemented; a gradual increase may result in greater lost profitability over time during the adjustment phase than a shorter but larger size increase. The Committee suggests that bio-economic modelling analysis be undertaken to assess these trade-offs to help inform future TACC determinations.

### 4.5 Future economic information needs

The Committee had very little economic information to inform its TACC setting consideration. The only economic performance study of the industry, including costs and earnings, related to fishing in the 2011-12 financial year and likely bears little relevance to current economic performance. Quota trading prices also are unavailable. Absence of such information increasingly will constrain the setting of economically optimal TACCs.

The Committee again notes that current economic indicators and triggers for the fishery lack specificity or clear management responses. Economic data for the fishery relating to long-term profitability are required to inform operational objectives, performance indicators and target reference levels in a harvest strategy for the fishery.

*The Committee again **recommends** that Industry and the Department resolve a strategy for economic monitoring of the operating costs and product prices for the fishery, including for share and quota trading.*

## 5. MANAGEMENT CONSIDERATIONS

### 5.1 Decision-making framework

This fishery has sound fundamental management systems in place to manage abalone – individual transferable quotas, size limits, and an independent TACC-setting process. This system has been implemented over the last ten to fifteen years to rebuild the fishery from an over-fished condition and low TACC of 75 tonnes (t) to the current TACC of 130 t through annual review of TACCs and adjusting size limits. The fishery is now at a point where a more sophisticated standard of data and analysis than previously available is required to determine confidently the extent of stock recovery and monitor indicators of future status. More sophisticated management systems also are required now to optimise economic returns from the fishery and prevent repeating the serial depletion that over-fished the fishery in the past.

A harvest strategy is required to enable optimisation of the fishery. This has been highlighted in Determination reports as a priority for some years now, with some initial progress by the Department in early 2015 which has since stalled. A harvest strategy would provide a decision-making framework to articulate the objectives of the fishery, identify the information necessary to inform management, guide TACC-setting through decision rules, and guide other management interventions. The absence of a robust harvest strategy means the Committee must set catch limits with less information than desirable and therefore take a more precautionary approach than would be feasible with a well-informed harvest strategy in place.

### 5.2 Spatial management

Some prerequisites of a finer-scale spatial management regime for the fishery have been implemented over the last five years, with the collection of data from loggers and associated reporting and analysis at the finer “Area” scale. The Committee has used this information to recommend catch limits for each Area and to set TACCs for the whole fishery based on these Area-specific limits. Recent TACC increases therefore have been predicated on the Committee’s expectation that more formal spatial management arrangements will be put in place to ensure that these recommendations are implemented and enforced. The Committee in the past has stated that the TACC increases have been intended to be spread across the fishery and that increased catches should not be concentrated on Areas in the south that have higher catch rates, are easily accessible, and are closer to wholesale buyers. No management arrangements have been put in place, however, and increased catches have been taken in the south of the fishery despite the Committee’s recommendations.

The Department this year again indicated a willingness to implement a ‘northern quota’ to enforce a minimum spatial distribution of the TACC. There are significant implementation issues that are yet to be resolved, however, (e.g., separate quota zones or overlapping quota zones, reporting and quota transfer arrangements for spatially explicit quota, and the degree to which subdivision of quota would be a determination or recommendation from the Committee) and the Committee is not confident that a spatially divided quota could be, or would be, implemented from the start of the 2016 quota period. The Committee therefore is setting the TACC based on the existing single quota zone, accompanied by strong recommendations for Area-specific catch caps. We strongly support more formalised spatial management of the fishery, either by regulation or through robust co-management arrangements, that would ensure a spatially-specific Determination could be and would be applied and enforced. Any increase in TACC under the current quota system, however, is likely to be taken in the south of the fishery where increased catches are not recommended.

*The Committee **recommends** that the Department implement a system to regulate spatially explicit quotas prior to the next Determination and verify that spatial-explicit TACCs are required to be set by the Committee and will be enforceable.*

### 5.3. Legal Minimum Length

Previous reports have discussed at length the close relationship between Legal Minimum size Limits for harvest (LMLs) and catch limits in managing abalone fisheries and have recommended increases in LMLs in the NSW fishery. The Committee reiterates its advice that LMLs in the fishery should be reviewed in light of more spatially-specific information about stock dynamics and the need now to develop a harvest strategy to optimise the fishery economically and biologically. An overall increase in LML is expected to improve production from the fishery, provide consistency that will improve

compliance, and underpin market differentiation of wild caught product from smaller aquaculture product in international markets.

*The Committee **recommends** again that the underlying LML for all of the fishery be set at 120 mm with specific variations for Areas 19, 20 and 21 south of Wonboyn (123 mm) and other Areas where recent biological information indicates a lower LML is appropriate to productivity in those areas.*

#### 5.4 Compliance

The compliance performance of the fishery is important to TAC-setting as it provides the confidence that catch limits are being adhered to, and that the information on which decisions are based is accurate and reliable. The current management plan for the fishery establishes basic benchmarks about 'compliance rate' but this can be misleading because improvements in the targeting of compliance effort can lead to more offences being detected, which can appear as higher levels of non-compliance when reported statistically together with other data. Use of an intelligence-led and risk-based approach should lead to a higher rate of detections and therefore lower rates of compliance, at least initially. It is difficult to draw conclusions from crude 'compliance rate' information, therefore, without supporting explanations and it is suggested that the Department consider mechanisms for reporting metrics from targeted, intelligence-based enforcement operations separately from routine compliance rates derived from random inspections. The focus of revised reporting should be to provide insights about the efficiency of targeted compliance activity *versus* actual changes in illegal activity.

The Committee was provided this year with aggregated compliance information, judgements of the Department's compliance staff, and anecdotal information and commentary by industry representatives. Industry representatives highlighted a concern that there may be illegal commercial activity by a small group of Aboriginal fishers claiming native title rights, which apparently complicates prosecutions. The Committee is satisfied, based on this input, that compliance overall in the fishery is satisfactory and that the decreasing 'compliance rates' reflect improved enforcement practices rather than a growth in illegal activity. The Committee therefore is comfortable relying on the existing estimates of illegal catch for the purposes of the TAC.

#### 5.5 Fees

Licence fees for cost recovery for 2017 have not been set at the time of writing this report. The Committee is of the view, consistent with previous years, that investment is required in several areas of the abalone fishery to secure the sustainability and optimise the benefits from the fishery. Fisheries management expertise and legal or legislative clarity is required to implement the recommended spatial management arrangements. Analysis of optimum size limits is required to inform optimal harvest settings. A harvest strategy set within a clear policy framework is required to guide future TACC Determinations and any review of recreational harvest. Targeted investment in science is required to collect and analyse commercial and recreational harvest data at relevant spatial scales and implement an appropriate assessment model to inform strategic and tactical decision-making. Sustained investment in compliance monitoring and enforcement is required to ensure illegal harvest continues to decline. There are obvious gaps in the existing funding structure, particularly in the short term, in relation to fisheries management expertise to get a robust framework in place for the ongoing management of the fishery.

*The Committee **recommends** that consideration be given to making these investments and that these strategic issues be considered through cost recovery discussions between the Department and with Industry, which might include consideration of direct investment by Industry in the fishery's management.*

## 6. CONCLUSION

### 6.1 Summary

The abalone stock and fishery metrics have shown significant improvement over the last decade and are showing signs of plateauing in most areas. This is a solid position from which to seek more secure and optimised harvest arrangements for the fishery.

The Committee was impressed by the positive engagement of shareholders attending the public forum and notes industry's advice that shareholders favour a cautious approach to stock rebuilding. Persistent uncertainties about the true status of stocks in the context of a legislative requirement to adopt a precautionary approach also mean caution is required to protect improvements made over recent years.

The Committee continues to be concerned about the low level of research and monitoring investment in the fishery, the absence of a sufficient assessment model to inform tactical or strategic decisions, and the lack of a well-developed harvest strategy with clear resource and economic objectives. There also are basic economic data needed to inform future TACC setting if quotas are to be set for economically as well as biologically optimal results. Recreational harvest of abalone continues to be very uncertain.

*The Committee **recommends** that no changes to recreational bag limits be considered without robust monitoring to quantify recreational harvest and the consequences of any change to bag limit.*

Abalone life history renders them extremely vulnerable to serial depletion despite seemingly stable fishery metrics. The scarcity of monitoring and biological assessment information makes it very difficult to detect serial depletion, notwithstanding the commendable development of detailed diver and catch logging data across the fishery. Absence of effective spatially-specific management arrangements to implement spatially-explicit allowable catches and size limits also means the fishery remains vulnerable to serial localised stock depletion such as apparently depleted the stock historically.

A revised management plan with specific fishery objectives and a formal harvest strategy are needed urgently to facilitate further development of this fishery. Such a strategy should include formal limits and targets that incorporate economic as well as biological considerations to guide future setting of TACCs and review of LMLs, which should be determined together. The lack of such a harvest framework, and robust monitoring and assessment information to support it, will constrain materially future TACC Determinations given the requirement to act within a precautionary approach.

### 6.2 Total Allowable Commercial Catch for 2017

The Committee was presented with a detailed Research Report provided by the Abalone Council of NSW under contract to the Department that summarised available fishery-dependant information and provided a rudimentary (generic and total biomass based) model assessment of the stock. The report was endorsed by the Department, the Abalone Council, and the Abalone Association of NSW and the Committee accordingly interprets the report to be a joint Industry and Departmental report. Management and compliance reports also were provided, together with a *draft* Harvest Strategy dated May 18 2015.

The key factors in arriving at the Total Allowable Commercial Catch for 2017 were:

- Catch rates of abalone continue to be strong but appear to be plateauing in most Areas;
- Sizes of abalone landed appear to be increasing in most Areas, albeit at a slowing rate;
- There are some circumstantial signals of localised depletion in some Areas but generally sound catch rate to stock density ratios from logger data in most Areas;
- There remains an absence of clear objectives or a coherent harvest strategy to which TACC settings can be referred;
- There continues to be insufficient biological or economic monitoring data or any robust bio-economic assessment information to inform tactical or strategic TACC settings for the fishery;
- Current management arrangements are not sufficient to implement reliably Committee determined or recommended spatially allocated quotas;
- Consistent advice is that compliance in the fishery is improving, notwithstanding the (potentially misleading) statistics from successful targeted enforcement activities; and
- Industry opinion favours a cautious approach to TACC setting to consolidate recent gains whilst the status of abalone stock remains uncertain.

The Committee has decided that the TACC remain at 130 t for the 2017 quota year on this basis.

The Committee has reached this conclusion after taking into account requests to set separate or additional quota for the northern Areas of the fishery, the still nascent use of high-resolution logger data to inform us about the status of stocks, the ongoing uncertainty about the true status of the stock and the absence of any credible formal stock assessment, and uncertainty that any spatially specified quota can or will be implemented. The Committee therefore has taken a precautionary approach in the interests of preserving improvements in the fishery and stock realised by previous decisions.

The Committee's determination for 2017 is influenced heavily by the persistent uncertainties in many aspects of the fishery that could be improved materially by strategic reinvestment in robust bio-economic assessment and development of a credible harvest strategy. These same shortcomings likely also will similarly constrain future Determinations.

### 6.3 The Determination

The Total Allowable Catch Setting and Review Committee, pursuant to Division 4 of Part 2 of the Fisheries Management Act 1994, determines that the Total Allowable Commercial Catch of abalone that may be taken in the NSW Abalone Fishery during the period 1 January 2017 to 31 December 2017 should be **130 tonnes**.

*The Committee also **recommends** a spatial distribution of that catch by Area and associated Area-specific increases in Minimum Legal Lengths for harvest as provided in Table 6.1.*

The Committee expects that the Department, in consultation with industry, will manage the fishery to achieve the recommended spatial distribution of catch in support of the above Determination.

**Table 6.1.** Recommended catch limits and Legal Minimum Lengths (LML) by Area\* for the 2017 TACC.

Area	Catch (t)	LML (mm)
1	1.0	120
2	1.0	120
3	2.0	120
4	1.0	120
5	5.0	120
6	1.0	120
7	2.0	120
8	5.0	120
9	8.5	120
10	11.0	120
11	10.0	120
12	9.5	120
13	5.0	120
14	8.0	120
15	9.0	120
16	10.0	120
17	7.0	120
18	4.0	120
19	5.0	123
20	9.0	123
21	16.0	123
<b>Total</b>	<b>130.0</b>	

\* Subject to review where recent biological information indicates a lower LML is appropriate to growth and productivity in a particular Area.



Bruce Mapstone, Chair



Kelly Crosthwaite, Fisheries Management



Sean Pascoe, Natural Resource Economist



Keith Sainsbury, Fisheries Scientist

## APPENDIX 1. DETAILS OF PUBLIC CONSULTATION

Public consultation steps taken by the Committee, with support from the Department, are summarised in the table below. These steps effected the consultation requirements stipulated in the *Fisheries Management Act 1994, Division 4 S31*.

Date	Fisheries Management Act Reference	Consultation Stages
07.09.2016	Section 31(1)	Committee called for public submissions on the appropriate level of the annual TACC for Abalone for 2015 fishing period.
07.09.2016	Section 284 (1b)	The advertisement was placed in the Sydney Morning Herald and the Daily Telegraph.
15.09.2016	Section 284 (1b)	Individual calls for submissions sent to particular interest groups who the Committee considered might wish to provide collective submissions either due to their direct involvement in the abalone fishery or their interest in related issues. These groups included: <ul style="list-style-type: none"> <li>■ All NSW Abalone Shareholders;</li> <li>■ Nominated Divers;</li> <li>■ Abalone Processors.</li> </ul>
12.10.2016	Section 284 (1b)	Closing date after at least 28 days for public consultation.
21.10.2016 – 21.11.201	Section 31 (2)	The Committee received the following collated submissions: <ul style="list-style-type: none"> <li>■ NSW DPI – Commercial Fisheries Management Report;</li> <li>■ NSW DPI &amp; Abalone Council NSW Research Report;</li> <li>■ NSW DPI Compliance Report;</li> <li>■ The Abalone Association of NSW; and</li> <li>■ 3 NSW abalone fishery shareholders*.</li> </ul>
02.11.2016		The Committee considered submissions and heard formal presentations and opinions at the Total Allowable Catch Committee Open Forum meeting in Sydney on 02 November 2016. The following made presentations or provided information to the Committee: <ul style="list-style-type: none"> <li>■ Dr. D. Worthington (The Abalone Council of NSW, contracted provider of stock status report to DPI NSW);</li> <li>■ The Abalone Association of NSW (presented by Mr John Smyth);</li> <li>■ Mr Mick Arentz</li> <li>■ Mr Gunther Pfrengle</li> <li>■ Mr Greg Rzy</li> <li>■ Mr John Smythe;</li> <li>■ Ms Fiona McKinnon, NSW DPI (Management);</li> <li>■ Dr Rowan Chick, NSW DPI (Research);</li> <li>■ Mr Joshua Foster, NSW DPI (Management);</li> <li>■ Mr Nick Schroder, NSW DPI (Compliance).</li> </ul>

\* *These submissions were considered 'Confidential'. Identification of the authors has been withheld from the Report and Determination.*

## APPENDIX 2. SUMMARY OF SUBMISSIONS

Submission provided by	Issue(s) Raised
Abalone Association of NSW (AANSW)	<p>The submission provided background information about the AANSW and made several comments about the fishery.</p> <ul style="list-style-type: none"> <li>➤ Members of AANSW concerned by "... DPI's inaction on a range of issues raised by industry at workshops and at TAC meetings ...", including: <ul style="list-style-type: none"> <li>• A review of all data relevant to the size of abalone in view of the TAC Committee's recommendations for an increased size limit for some areas of the fishery;</li> <li>• An abalone fishery harvest strategy;</li> <li>• Hanging abalone by numbers to facilitate fishing in harder to service areas of the fishery."</li> </ul> </li> <li>➤ AANSW supports the use of data loggers by divers.</li> <li>➤ Common reports from divers of increased stocks, including pre-recruits, "on the bottom", increased CPUE, and increased average weight of abalone landed;</li> <li>➤ "Biomass increases since the early 2000s are clearly evident", which was "attributed to the conservative TACs set, small increases in size limits, and a reduction in illegal activity".</li> <li>➤ Noted severe storm affected sections of coast in June 2016, with little short-term consequence for CPUE.</li> <li>➤ Noted that similar storm in 1970s followed by improved catches and catch rates in following months and considerable improvement in habitat following removal of urchins by storm.</li> <li>➤ Noted move of some effort to southern Areas and supply of abalone to Mallacoota processor, with strong catch rates in those areas compared to eastern Victoria.</li> <li>➤ Suggested allocation of specifically 'Northern quota' as incentive to 'spread catch' and reduce concentration in southern Areas.</li> <li>➤ Provided comment on price and market conditions;</li> <li>➤ Advised diverse opinions RE future quota, ranging from 'no change' to 'small increase' and desire to move effort (and quota) from southern to northern Areas.</li> </ul>
Shareholder 1*	<p>Provided raw data showing increases in size of abalone landed over recent years, as evidence of success of increased LMLs.</p>
Shareholder 2*	<ul style="list-style-type: none"> <li>➤ Need to consider increasing LML in conjunction with TACC.</li> <li>➤ Argued strongly for increase in LML.</li> <li>➤ Presented examples of evidence that previous increases in LML were followed by improved catches and catch rates.</li> <li>➤ Argued evidence demonstrated that notion of "stunted growth" in some areas was incorrect and that abalone in all areas exceeded increased LMLs shortly after changes implemented, contrary to expectation under 'stunted growth' idea.</li> <li>➤ Suggested any areas where evidence supported truly stunted growth should be closed to harvest.</li> <li>➤ Suggested zero or small increase in quota for southern regions and small increase in northern regions.</li> <li>➤ Called for more field research and compulsory provision of data from industry for research and management.</li> </ul>
Shareholder 3*	<ul style="list-style-type: none"> <li>➤ Expressed concern that the June storm would have long-lasting negative effects, contending 1974 storm affected stocks (negatively) for up to 7 years.</li> <li>➤ Concerned small group of Aboriginals claiming land rights protection for harvests but selling product illegally.</li> <li>➤ Opposed to increasing quota, especially in northern region(s).</li> </ul>

\* *These submissions were considered confidential. Identification of the authors have been withheld from the Report and Determination.*

## APPENDIX 3. STATE OF THE STOCKS — DETAILS

### A3.1 Introduction

The timely flow of information for assessment has continued to improve in the last 2-3y, which is a marked improvement over earlier years. The stock assessment report this year was produced by the Abalone Council of NSW and was endorsed by both NSW DPI and the Abalone Association of NSW. It was provided in October 2016 and included fishery-based data summaries to August 2016. Additional and more recent data also are available through the NSW Abalone Council website (<http://acnsw.ambrad.com.au/>). The report contained some population assessment modelling of the abalone stocks and further improved description of analysis and interpretations.

The stock assessment report was prepared by Dr Duncan Worthington, Executive Officer of the Abalone Council of NSW, under contract to the Department and co-badged by the NSW DPI and the Abalone Association of NSW. It was not clear what if any independent scientific input was provided by NSW DPI but it was confirmed that the report was to be read as the Department's endorsed assessment input to the TACC-setting process. It would be preferable for the DPI scientific assessment to be provided separately from the industry and management inputs to the Committee. See management section for a recommendation on this issue.

There continues to be inconsistency and complexity in the spatial scale of reporting. There now are multiple spatial scales being used (Table A3.1). Regions, Zones and Sub-Zones were used historically with Areas introduced recently through industry workshops, but Area boundaries were not aligned with previous Region, Zone, or Sub-zone boundaries. Spatial Management Units (SMU) also were introduced recently, also by Industry, and this year the boundary between SMU 1 and 2 was changed in the assessment report to subdivide Area 7 but align with the previous boundary between Region 1 and Region 2 (Table A3.1). It was not clear whether the management report used the same definitions of SMU 1 and 2 as the assessment report; differences in the data reported in each suggested the SMUs were not defined the same way.

**Table A3.1.** Summary of some of the spatial categorisations used reports for the fishery. Key: Z – Zone, A-Z; sub-Z – sub-Zone (1-32, various numbers within each Zone); SMU – Spatial Management Unit (1–4).

Area	Area Name	Z & sub-Z	Region	(SMU) in previous reports	SMU in 2016 assessment
1	Tweed	A-E	1 north	1	1
2	Pt Stephens	F-J	1 south	1	1
3	Kiama	K-M	1S (K-L) 2 (M)	1	1
4	Ulladulla	N	2	1	1
5	South Brush	P	2	1	1
6	Batemans	Q	2	1	1
7	Moruya	R	2	1	1
7	Moruya	S	3	1	2
8	Narooma	T	3	1	2
9	Bermagui	U1-U3	3	1	2
10	Bunga	U4-V2	3 (U4) 4 (V1-2)	1 2	2
11	Moon Bay	V3-W1	4	2	2
12	Turingal	W2-X1	4	2	2
13	Long Beach	X2	4	2	2
14	Eden	Y11-Y21	5	3	3
15	Saltwater	Y22-Y23	5	3	3
16	Bittangabee	Y24	5	3	3
17	Green Cape	Y31	6	3	3
18	City Rock	Y32	6	3	3
19	Wonboyn	Z1-Z3	6	4	4
20	Saltlake	Z4	6	4	4
21	Howe	Z5	6	4	4

This year there was reporting by most of the various spatial categories, though some were reported from 1982, some from 1999, and others from 2000. The Committee understands that the Department remains committed to Region, Zone, and Sub-zone reporting rather than Area or SMU structures but Industry and the contracted assessment scientist clearly favour Areas and SMUs. It is appropriate and useful to have a small number of relatively large spatial units for overall assessment, reporting and coarse catch allocation and either Regions or SMUs could meet that need. It also is useful to have finer scale units for assessment and local catch management and either Zones or Areas could meet that need. The use of both schemes, however, is overly complex and confuses the connection between reporting and management and, when used inconsistently, makes sensible comparison of results from successive reports difficult or impossible. The multiplicity of scales is a barrier to developing sensible spatially-explicit management structures for the fishery.

*The Committee **recommends** that a single system of spatial categorisation for reporting and management be selected and used consistently, and that full historical data are presented by those categories. The chosen scales should be aligned with management instruments such as spatially-explicit quota allocations, including co-management based local catch caps and minimum size limits.*

In making its determination, the Committee considers the current and likely future status of the stock. There are two main features that provide a background and context for this year's consideration – previous conclusions about the status of the stocks and changes in the information available for assessment.

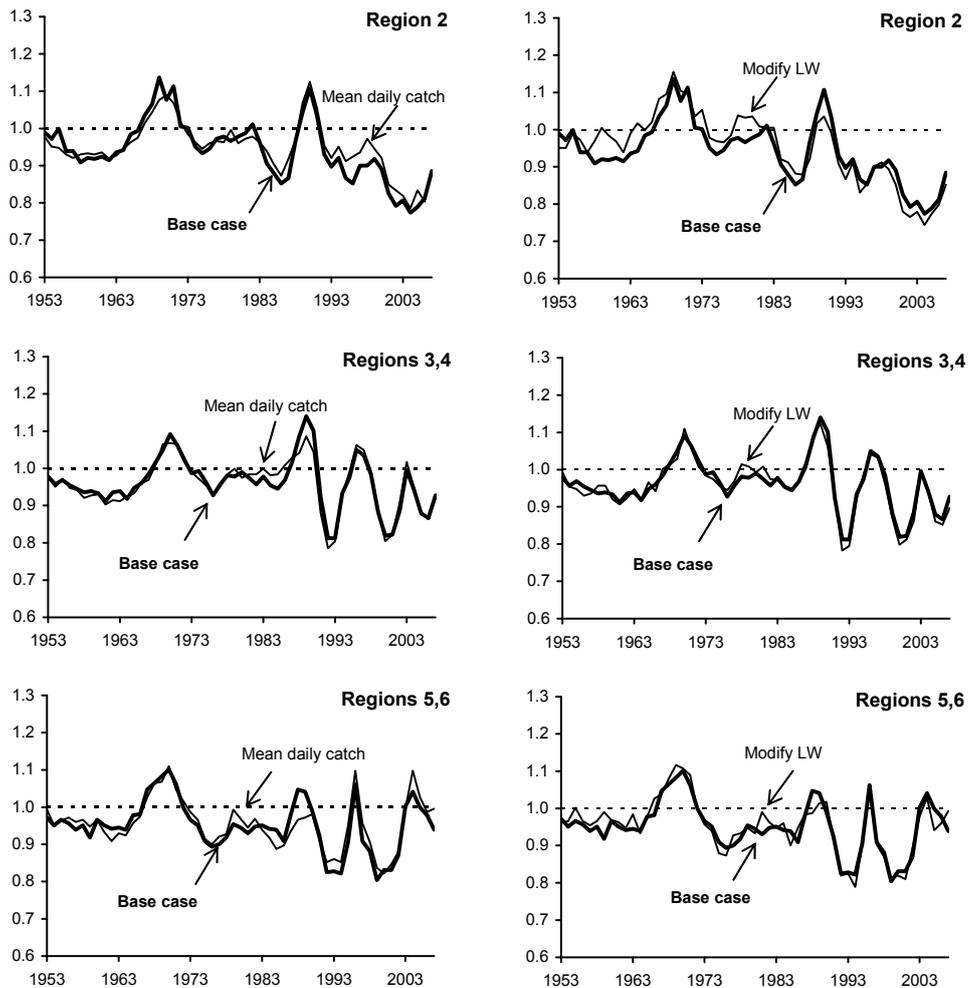
## A3.2 Background and context

### A3.2.1 Previous conclusions about the status of the stocks

The previous status of the stocks provides a key context for the current interpretations and recommendations. The NSW abalone stocks historically suffered from significant over-fishing and over-depletion. The actions of the Committee since the early 2000s have been a response to this situation, with the aim of recovering the stocks and preventing repetition of the previous over-exploitation.

The stock showed significant evidence of over-depletion in the 1990s and early 2000s including:

- Serial depletion starting in the north of NSW in Region 1, exacerbated in the north by mortality from a severe outbreak of *Perkinsus* in the late 1990s, and progressing south;
- Recruitment overfishing (i.e., breeding stocks depleted sufficiently to reduce the number of young produced) in Region 2 from the early to mid-1990s;
- Onset of recruitment overfishing in Regions 3 and 4 starting in about the 1990s;
- All the well monitored Regions (2-6) showed increasingly 'spiky' patterns in catch rates and estimated recruitment, including progressively lower lows between the spikes with briefer and (in most Regions) progressively lower highs (Figure A3.1); and
- The fishery became highly dependent on abalone that grew over the Legal Minimum Length (LML) for harvest each year.
- Overall this information indicated a very high fishing mortality on abalone above the LML, a population that has lost most of its age structure and resilience, and a population with greatly reduced breeding potential because the high fishing mortality was applied with a LML that was relatively close to the size at reproductive maturity.



**Figure A3.1.** The pattern of recruitment estimated from the fitted population model in 2008 (the last year of its application) for a base case interpretation and various alternatives to test sensitivity of the analysis. Recruitment was not sensitive to these alternatives. There has been a decreasing trend in recruitment in Region 2 since about 1990. The average recruitment in Regions 3, 4 and 5 and 6 since about 1990 is lower than in the earlier period, with an increasingly 'spiky' pattern of recruitment through time, with different Regions showing different mixtures of lower and more persistent lows and briefer highs.

There have been additional specific issues within this overall context and analyses relating to the status of stocks in the northern part of NSW (Regions 1 and 2).

*Region 1 North (north of Port Stephens, Zones A-E)*

There was very little information available to assess the status of stocks in Region 1 north of Port Stephens. There was no Fishery Independent Survey in this area and there has been very little commercial fishing at any time since 1987, even when there were no regulated restrictions on fishing there. It is not known whether, or to what extent, the stocks there were affected by the disease *Perkinsus* that significantly reduced stocks in the southern portion of Region 1. Commercially targeted fishing was stopped in Region 1 North in 2002 but special catch allocations were made to allow structured collection of data to determine the extent of *Perkinsus* impacts, to support an initial assessment of the stocks, and to estimate a sustainable catch. Region 1 North was re-opened to targeted commercial fishing in 2010.

*Region 1 South (south of Port Stephens, Zones F-L)*

This area suffered a severe outbreak of *Perkinsus* in the late 1990s. There were relatively few Fishery Independent Survey sites in the southern portion of Region 1 but they all showed the death of 50-75% of abalone of all sizes. Some areas were closed to commercial fishing in 1996 and the whole of Region 1 South was closed in 2002. The Fishery Independent Surveys after total closure

showed continued low abundance and no recovery of the small or medium sized abalone. They showed an accumulation over time of increasingly large abalone, interpreted to be the survivors of the outbreak augmented by low recruitment. Fishery Independent Survey sites in Region 1 South were clustered in three areas - Port Stephens, Sydney, and Kiama (Zones F, J and K), so there was concern about how representative these sites were of the whole region.

Trial fishing in Region 1 South during 2004 showed that it was possible to take large abalone at high catch rates from targeted sites, as was expected from the Fishery Independent Surveys, but that fishing did not help assess the status of the stock or the extent of any recovery.

A more structured program of trial fishing was conducted in 2007 to test the change in status of the stock at pre-identified sites that were recognised as being productive historically. This program allowed comparison of the proportion of previously productive sites that remained productive, of the change in catch rate at those sites compared to catch rates in 1994, 1987 and 1982-85, and of the current catch rates at historically productive sites compared to sites chosen by divers as being productive in 2007. The general conclusions were:

- i) About 36% of historically productive sites were still as productive as they were previously;
- ii) 70-80% of historically productive sites had catch rates that were lower than those recorded at the same sites in 1994 or 1987;
- iii) The northern Zones, between Pt Stephens and Sydney (i.e. Zones F, G and H, which comprise the northern part of Area 2) had very low abalone abundance and a major loss of historically productive sites;
- iv) The southern Zones, between Sydney and Wreck Bay (Zones J, K and L, which comprise the southern part of Area 2 and the northern part of Area 3) had considerably higher abalone abundance and had lost fewer historically productive sites than the northern sub-Regions, and slightly more than half of all sites fished in these southern sub-Regions had catch rates greater than was recorded at the same sites in 1994;
- v) The median length of abalone taken was greater than 120mm for almost all sites (i.e. more than 50% of abalone were larger than 120mm length); and
- vi) The diver selected sites provided slightly higher catch rates than the pre-identified historically productive sites but did not materially change the overall results or conclusions.

These conclusions overall were consistent with the Fishery Independent Survey data in indicating that Region 1 South in the late 2000s supported some dense aggregations of large and abalone, but that many historically productive sites still did not support dense abalone aggregations or significant numbers of small abalone, despite several years of protection from fishing. The stock of legal sized abalone in the northern Zones (F, G and H) remained very depleted in 2007, while the stock of legal sized abalone in the more southern Zones (J, K and L) had recovered to 1994 levels at more than half of the sites fished.

The south Zones (Sydney to Wreck Bay) were re-opened to commercial fishing in 2010 and the northern Zones (Pt Stephens to Sydney) were reopened in 2012.

### *Region 2*

Region 2 was closed to commercial fishing in 2006 because of evidence of recruitment overfishing there (Fig. A3.1). Average recruitment in Region 2 started decreasing in about 1995, including a decrease in the strength of recruitment in the 'pulse years'. The 1995-96 and 2001-02 pulses of increased recruitment and productivity were estimated to be very much weaker in Region 2 than in the more southern regions in those years and were considerably weaker than was seen in Region 2 in the 1988-89 pulse. Special catch allocations were made each year following the closure of Region 2 in 2002 to allow collection of data that would support an improved assessment of the stocks there, especially in relation to interpretation of recruitment overfishing. Region 2 was re-opened to commercial fishing in 2010.

#### **3.2.2 The information available for recent assessments**

The information available to the Committee to assess the status of the stock has changed considerably in recent years.

- The fishery assessments until 2008 were based on: (i) Fishery Independent Surveys of the relative abundance of different size categories of abalone, including abalone smaller than the minimum legal size in the fishery that provided a 'leading indicator' of recruitment to the fishery; (ii) catch rate and weight composition from commercial fishing; (iii) integrated analysis of this information through a length-based population model to estimate population size and

recruitment; and (iv) prediction of the expected future trends in the status of the stocks under different potential levels of harvest.

- There has been no formal scientific stock assessment or prediction of future stock condition in the period 2009–16 inclusive.
- Collection of fine scale data on fishing effort and catch, through the use of GPS-linked data loggers, started in 2008. Coverage of the fishery has increased as more, and more reliable, data loggers have been provided to divers. Logger-based estimates of catch per unit area searched have been shown to provide a useful indicator of relative population size. They also provide an estimate the exploitable biomass and harvest fraction, which are additional indicators for TACC selection, although reference points for these corresponding to desired or undesired outcomes for the fishery have not been developed and linked to fishery objectives.

The information available to assess the status of stocks is in a transition from the previous methods based on Fishery Independent Surveys, coarse scale data from commercial fishing, and population modelling to future methods that are hoped to be better and cheaper based on fine scale data reporting and analysis. The previous methods were stopped, however, before the new methods were developed and shown to be adequate. This has resulted in a period of very limited information on the state of the stocks, increased uncertainty about the state of the stock, and increased uncertainty about the consequences of different catch levels. Robust and meaningful indicators of stock status or fishery performance appropriate to the new, higher-resolution data also have yet to be developed and tested, limiting severely their utility in stock and fishery assessments and TACC setting.

There now is heavy reliance on commercial catch information for the indicators of stock abundance. Assessment and management of recovery is now based mainly on trends in commercial catch rate and the average weight of abalone in the catch. This reliance on commercial catch data has well-known problems, especially (but not only) for animals like abalone with spatially highly fragmented populations.

- The management intent in a fishery managed by individually tradable quotas is for industry to innovate and change fishing practices to optimise economic returns in a dynamic cost and market environment. These innovations and changed fishing practices can be expected to affect directly the indicators used for assessment, including the catch rate and mean weight of abalone caught. There is anecdotal information suggesting that operational and market conditions have had such effects but those effects have not been quantified.
- Commercial catch rate, particularly for large aggregated areas and times, is notoriously 'hyper-stable' for abalone fisheries. That is, high catch rates can be maintained for a time by targeting concentrations of abalone in known patches of preferred habitat or searching faster even if the overall population is declining. Hyper-stable catch rates have been seen in the history of the NSW abalone fishery at both the Region and Sub-Region scales. Logger-based estimates of catch per unit area searched account for some of the operational changes that result in catch rate being hyperstable (e.g. faster swims), but not all.
- Commercial catch rate and mean weight in the catch are 'trailing indicators' that reflect what has happened, rather than 'leading indicators' that inform what will happen. They contain no information about numbers of sub-legal sized abalone that provide future harvestable stock.

The current lack of size or age-based population analysis also precludes scientific examination of the LML that both optimises catch and provides adequate protection of the breeding stock. This consequently is being explored empirically by applying small changes in allowable catch or LML and monitoring the results. This is inefficient because it does not make use of well-established scientific methods, slow because monitoring and measuring the consequences of each change before the next change can confidently be made takes time (years), and risky to the stock and to fishery yields because mistakes are recognised only after their effects have occurred.

The substantial reductions in TACC and recommendations for increased LMLs from 2000 to 2010 were to rebuild the stock, with the main indicators available after 2008 being commercial catch rate and mean weight of abalone in the catch. The lower catches during 2005–6 and 2009–10 coincided with the period when, based on previous patterns, a pulse of relatively good recruitment was expected to enter the population and help stock rebuilding. Conversely, a period of relatively low productivity was expected during 2011–13, and a critical success indicator was continued stock recovery during this period.

Substantial increases in catch rate and mean abalone weight were seen clearly from about the mid-2000s in all Areas where there was sufficient fishing to provide reasonable measurements, and they were maintained through to 2011–13.

A key issue in managing the population to recovery and preventing repeated overfishing when it is recovered is understanding and addressing what was wrong with the previous management settings. Recognising and correcting these factors is necessary to avoid a repetition of the failures of the past and to achieve the full potential benefits from the resource. The Committee considers three issues whole are very important to achieving this goal, in addition to setting an appropriate TAC for the fishery.

- i) **Finer-scale management.** Use of finer scale monitoring, assessment and management to better address the fine scale variability of abalone biology and the risk of serial localised depletion. There are ongoing and broadly successful efforts to gather finer scale data from the fishery using GPS-linked data loggers. The analysis and interpretation of these finer scale data for stock assessment continues to improve, most notably through the calculation of abalone biomass and catch per area searched. Attempts to limit catch at finer space scale (e.g. SMUs and Areas), to prevent overly concentrated fishing and localised depletion, have had limited success. This remains an important challenge to sustainable recovery of the fishery.
- ii) **Minimum Legal Lengths.** The Committee and many in industry have questioned the appropriateness of the LMLs used in the fishery. The fishery has a history of a relatively small LMLs compared to those used in other fisheries on the same species. The LML in NSW was 100mm in the 1970s, 108mm for most of the 1980s, 115mm for the 1990s and most of the 2000s, and 117mm from 2008. The LML for harvest from the most southern areas of Region 6 was increased to 120mm in 2010 and then to 123mm in 2012. Some in shareholders voluntarily also have fished successfully to a 120mm size limit in more northern areas.

The Committee has recommended for several years that a larger size limit be applied to the overall fishery in NSW, complemented with various locally specific arrangements applied to those areas where abalone growth appears unusually either higher or lower. There are several advantages of a higher 'default LML' which can be selectively altered as appropriate rather than low LMLs everywhere. It protects against localised overfishing abalone sub-populations that grow quickly, have a large size at first maturity, and reach large maximum size. Such fast growing abalone are highly productive if managed appropriately but are vulnerable to overfishing if fished at too low a LML.

A major element in the argument against increase in the overall LML has been the view that NSW has many areas of abalone with stunted growth, a view supported by some early research results. Responses of the fishery to changes in LMLs, however, made it clear by 2010 that the population is not dominated by stunted stocks and that the earlier research results were not representative of the majority overall stock or the current situation. The observed rapid increase in the individual weight of abalone caught and the very rapid recovery of catch rate following the recent increases in LML simply would have been impossible if the population was dominated by stunted stocks.

- iii) **Management Objectives.** The Committee has commented often that the benchmarks and reference levels used in the Share Management Plan and the Fishery Management Strategy were set at levels that did not protect adequately the sustainability and productivity of the stock. Revision of these benchmarks and reference levels is necessary and should be grounded in scientific assessment of the biological productivity of the stock.

There are serious weakness in the current management situation. Key uncertainties relate to the robustness of the recent stock improvements, the limited ability to detect faltering recovery if that eventuates, the lack of benchmarks for current indicators relating to overfishing and optimal fishing, and unknown management settings for optimal fishing, including spatial management of LML and catch caps. It is not appropriate or possible with the limited information and analysis currently available for management measures to be based on detection and tracking of detailed nuances of population change in response to natural variability, harvest, or the effects of previous management interventions. Precautionary management measures, as required by the Act, therefore must be simple, robust and conservative.

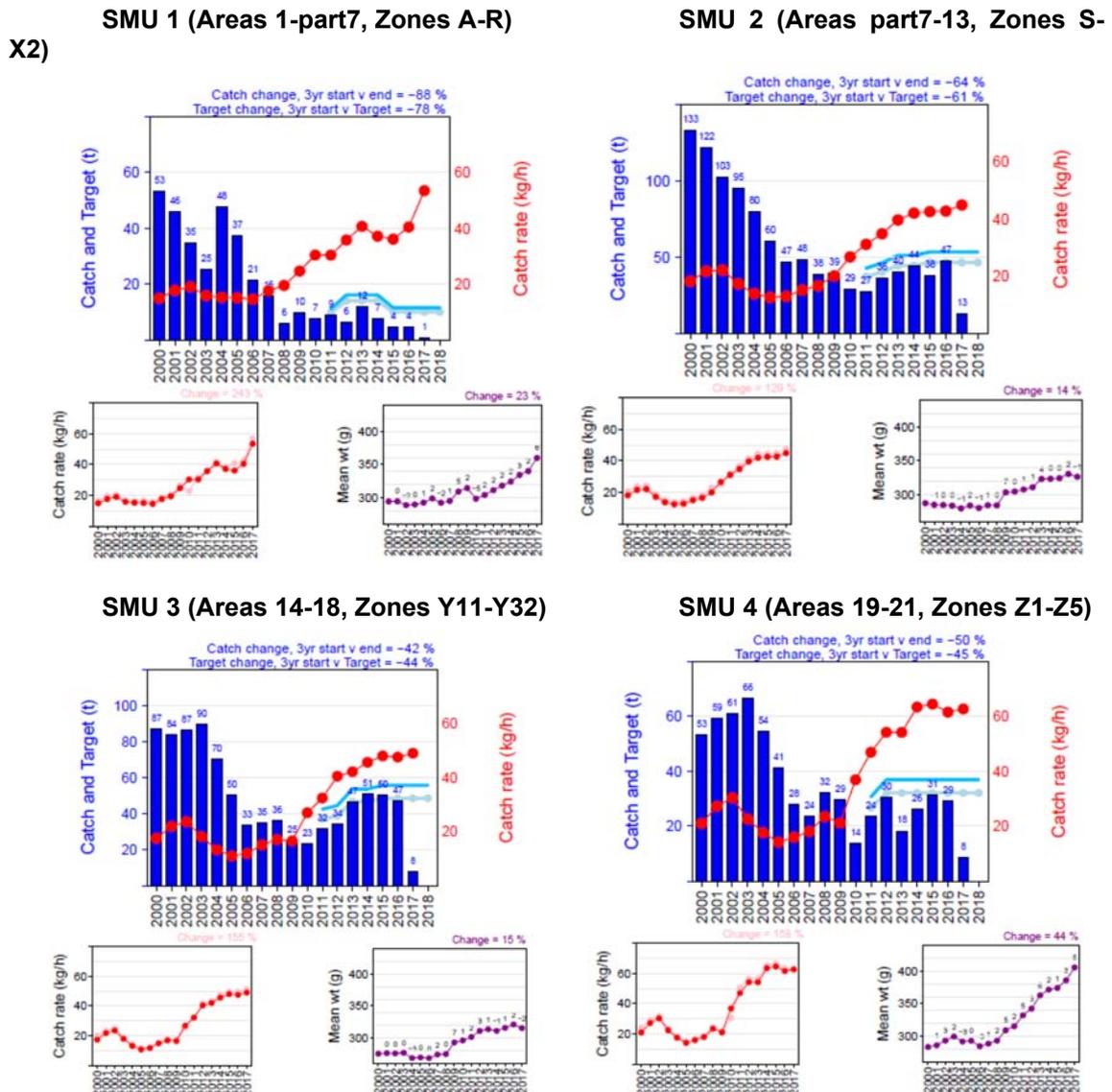
### A3.3 Information and analysis available for the current 2016 assessment

There are two primary sources of information available: (1) logbook and related information from commercial fishing, including catch, catch rate, and mean weight of individuals in the catch, aggregated variously by Regions, Zones, Sub-Zones, Areas or Spatial Management Units (SMUs); and (2) the fine-scale GPS data-logger information.

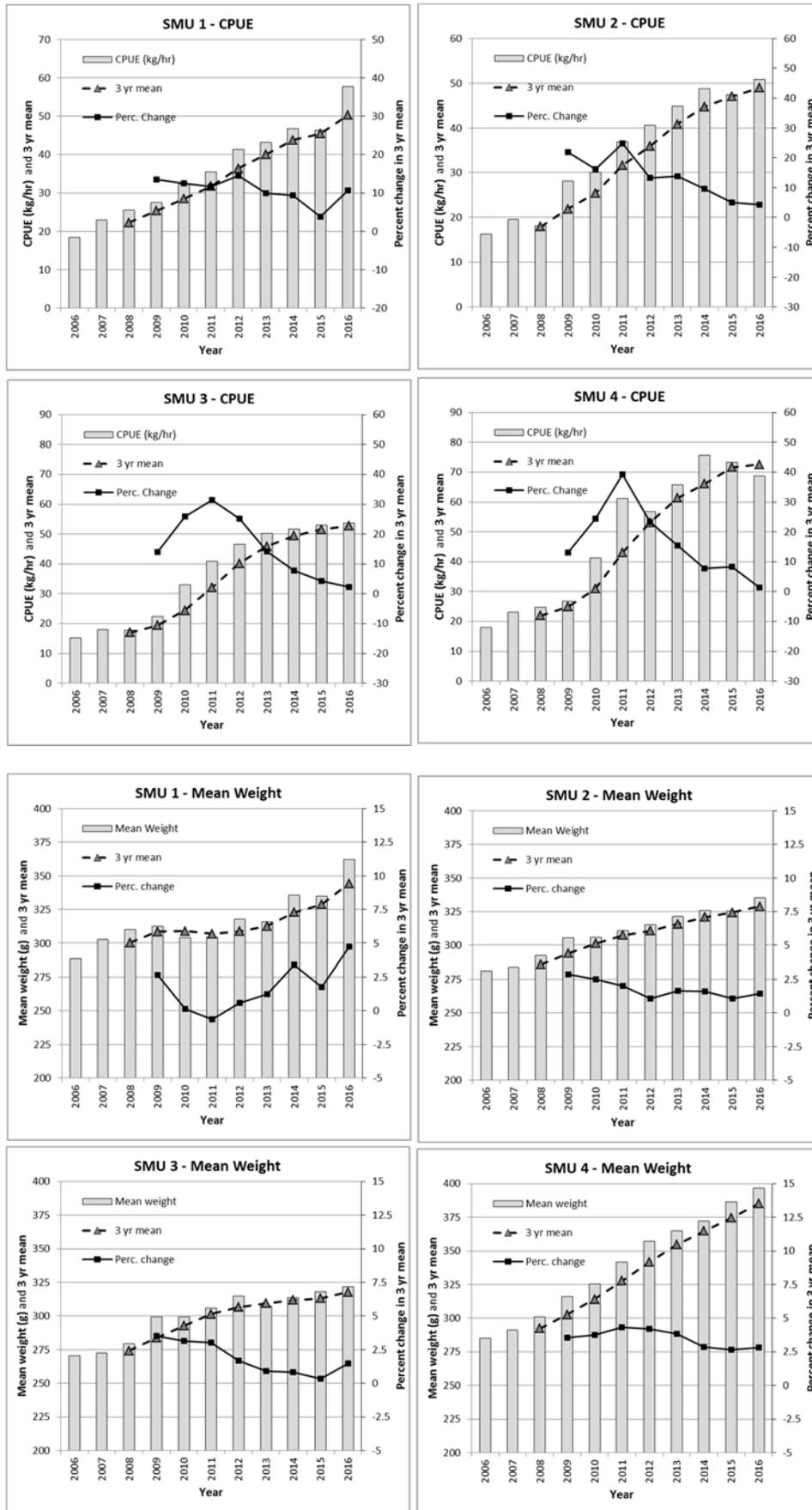
### A3.3.1 Aggregate catches, catch rates, and mean weight

The annual commercial catch, catch rate (CPUE), and mean weight of abalone in the catch is shown for each Spatial Management Unit (SMU) in Figure A3.2. Figure A3.3 shows recent trends in catch rate and mean weight for each SMU and their percentage change.

There is a consistent pattern across all SMUs. Annual catch rates and mean weight increased rapidly from about 2008 through to 2013–2014, after which the rate of increase began to reduce and is now substantially lower. The catch rate has now plateaued in SMU 3 and 4, is very close to plateauing in SMU 2, and continues to increase with very small catches in SMU 1. The mean weight of landed abalone has plateaued in SMU 2 and 3. Mean weight continues to increase in SMU 4, which is interpreted as further recovery of the population size structure following LML increases there, and continues to increase under very small catches in SMU 1.

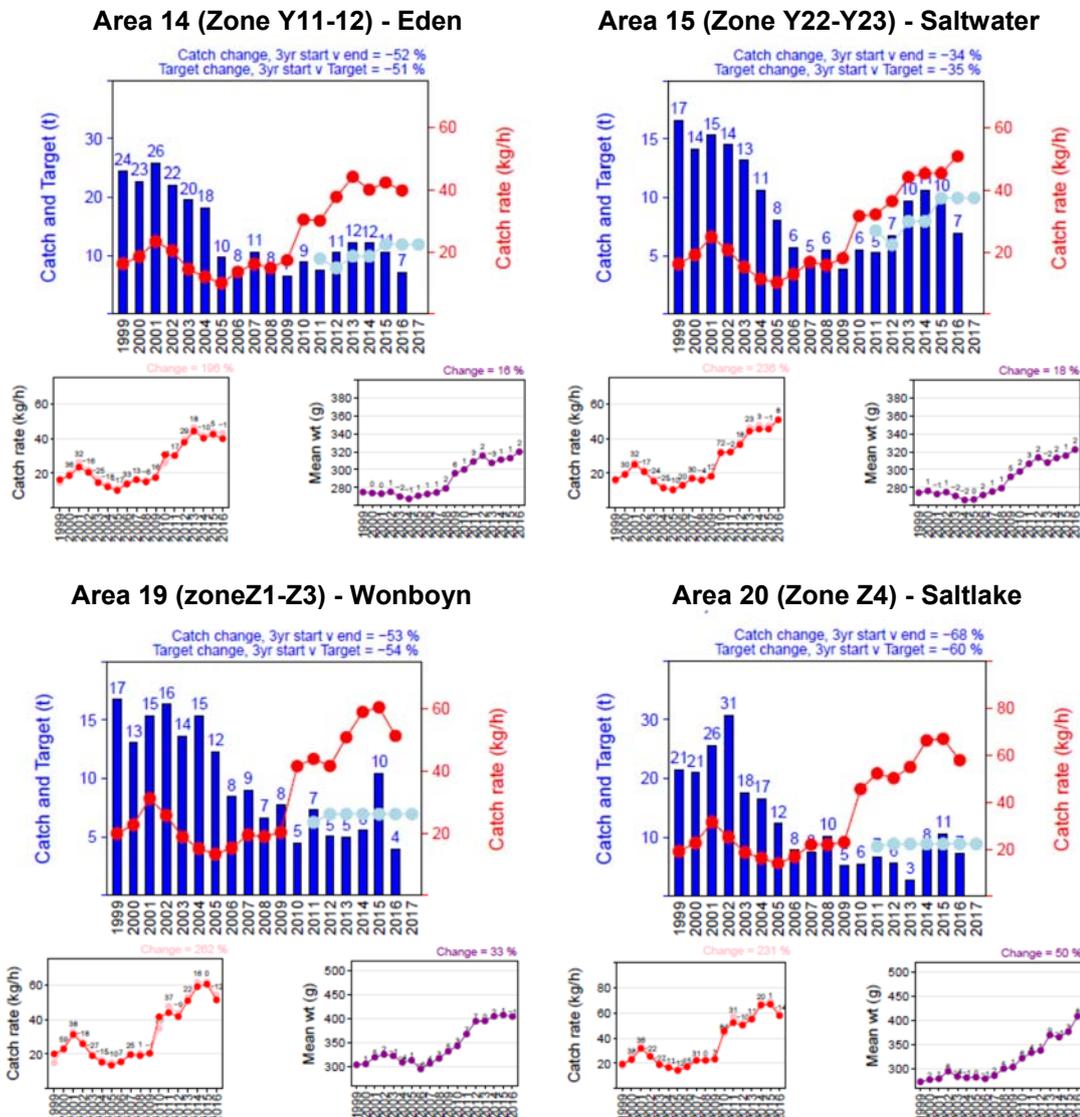


**Figure A3.2.** Annual catch (blue histograms), CPUE (red lines) and mean weight (purple lines) of abalone in the catch for each Spatial Management Unit (SMU) as given in the assessment report. SMU 1 and SMU 2 are defined differently to last year, and possibly from the definitions used in the management report (Fig A3.3). The LML was increased from 115mm to 117mm in late 2008. The LML was further increased in SMU 4 from 117mm to 120mm in late 2010, and from 120mm to 123mm in late 2012.



**Figure A3.3.** Recent trends and the rate of change for the commercial catch rate (CPUE, top 4 panels) and mean weight of caught abalone (bottom 4 panels) by SMU, as given in the management report.

These patterns also are seen at the Area spatial scale (see examples in Figure A3.4). The Committee has pointed out in the last two years that catch rates and mean weights were plateauing in most Areas, and that is now widespread in Areas within SMUs 2, 3 and 4. The pattern is more ambiguous across Areas in SMU 1 where catch rate and mean weight generally show slow increase in the more northern Areas (1-3) and stabilisation in the more southern Areas (4-7) despite the very low recent catches in all Areas in SMU 1. The SMU 1 data may not be fully representative of the stock there because it is based on such low catches but taken at face value it implies low recent productivity.

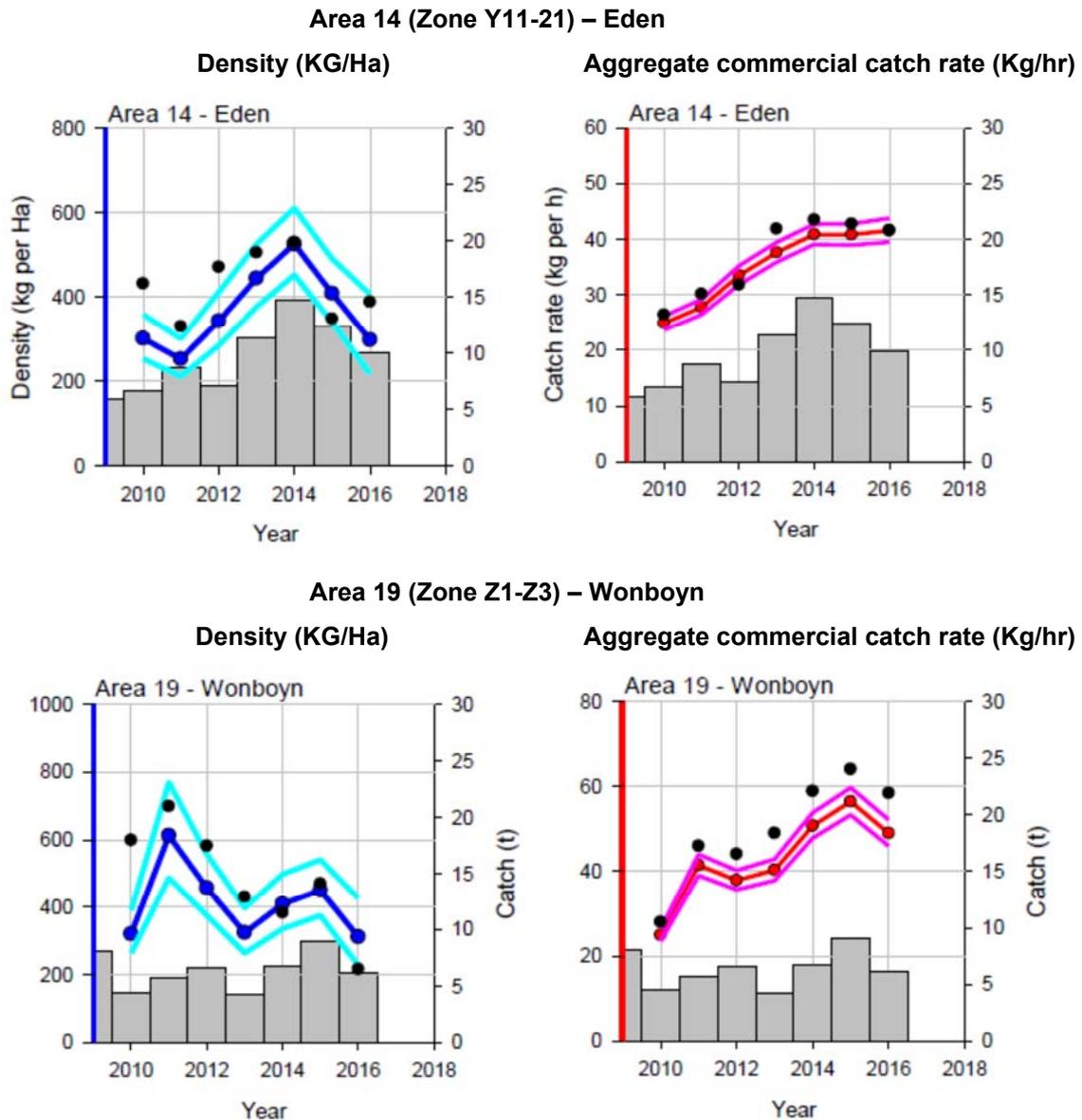


**Figure A3.4.** Examples of the patterns of change in catch rates and mean weights at the scale of Areas. Areas 14 and 15 are in SMU 3 where the SMU-wide pattern is plateaued catch rate and mean weight. Areas 19 and 20 are in SMU 4 where the SMU-wide pattern is plateaued catch rate but still increasing mean weight.

The aggregate catch rate (Kg/hour) is used as an indicator of relative stock density in these interpretations but it is known that catch rate in this fishery can be hyper-stable because operational fishing strategies can compensate for the effects of stock reduction. It has been shown in previous assessment reports that abalone density (Kg/Ha) estimated from logger data potentially can be used to detect and correct for some of these changes in operational fishing strategy (e.g. correct for changes in the speed of searching), but not for other effects (such as choice of spatial effort allocation). Comparison of the time series of commercial catch rate with logger-based density estimates show that for most Areas the two indicators are well correlated, giving increased confidence in catch rate as an indicator of stock abundance for those Areas.

There are two Areas, however, where the two indicators are not well correlated (Areas 14 and 19, Figure A3.5). The implications are that in these two Areas operational changes are occurring that have resulted

in hyper-stability of the catch rate, that the catch rate should not be accepted as a reliable indicator of abalone density, and that the local stock may be under sustainability pressure. The correlation between the catch rate and density is reasonable for other Areas, though there are indications of some hyper-stability since about 2013 in Areas 13, 15, 16 and 17 so catch rate data from these areas also should be treated with caution.



**Figure A3.5.** Aggregate commercial catch rate (Kg/hr) from logbook returns and density (Kg/Ha) from GPS data-loggers for Areas 14 and 19 where these indicators are not well correlated. For these Areas operational fishing patterns are compensating for changes in abalone density to result in hyper-stability of the commercial catch rate. For these Areas the commercial catch rate is not a good indicator of abalone abundance and it is likely that the local stock is under significant fishing pressure. The correlation between the catch rate and density is reasonable for other Areas, though there are indications of some hyper-stability since about 2013 in Areas 13, 15, 16 and 17.

This widespread plateauing of CPUE, logger-estimated density, and mean weight indicates that the population is stabilising under the current catch and LML settings. This is consistent with the Committee’s comments last year that most of the net population productivity of the resource is being harvested. Consequently, there is relatively little scope for further substantial stock rebuilding under these management settings, though some further slow rebuilding of the population age structure is to be expected given the growth and mortality rates typical of abalone. Two implications of this stabilisation are that any increased catch is likely to result in decreased CPUE and that further rebuilding to an

optimal fishery is expected to involve change in the LML. Put another way, the fishery is experiencing a 'soft landing' under the current management settings, the new stock and fishery conditions are very much improved, but it is not known how the current management settings (LML, total catch and spatial distribution of catch) relate to what would be the optimal settings for this fishery.

The catch rates in all regions increased steadily through the introduction of the 117mm LML in 2008 and they continue to increase steadily in SMU 4 following the increased LML to 120mm in 2010 and 123mm in 2012. Catch rates decreased for a few months after each increase in LML but then quickly recovered and increased thereafter. Such rapid recovery of the catch rate following increases in the LML implies that in aggregate, across whatever local variation there is in growth rates at fine spatial scale, the stocks are on the steep and non-optimal part of the yield per recruit curve. The available data and analysis indicate that it is not possible to determine the optimum LML at this stage, just that it is larger than the current LML and that the current LML is not optimal. Hence the Committee continues to recommend increased minimum legal size limits.

Arrangements to set and implement sub-Regional catch targets and limits, intended to spread the catch spatially and avoid localised depletion, are an important aspect of management to avoid repetition of localised and sequential depletions that depleted the fishery historically. Catch targets and limits are identified by Area but it is apparent from comparison of the targets and actual catches in recent years that management of catches within the intended area-specific ranges is successful in at least some Areas. Considerably more catch than intended again has been taken from some Areas, especially in SMU 2 and SMU 3, while considerably less catch than intended has been taken from most Areas in SMU 1. This inability to control fishing effort and catch at local space scales is not expected to have major stock consequences at low TACCs but it is clear that finer scale management arrangements are not yet sufficiently robust to prevent serial depletion at higher TACCs, possibly including the current TACC. The ability to set and enforce appropriate local catch caps is necessary to prevent a repeat of sequential depletion if TACCs are increased as the stock recovers. Confidence in the ability to control catches at this finer scale is a key consideration in management of this recovering stock and, accordingly, when setting precautionary TACCs. There are proposals for a catch allocation specifically to SMU 1 though the details of this are still being developed. Such SMU-specific catch allocations, if enforced, could be a very effective part of the spatial management of catch but there will remain the need for finer scale (e.g. Area) control of catches.

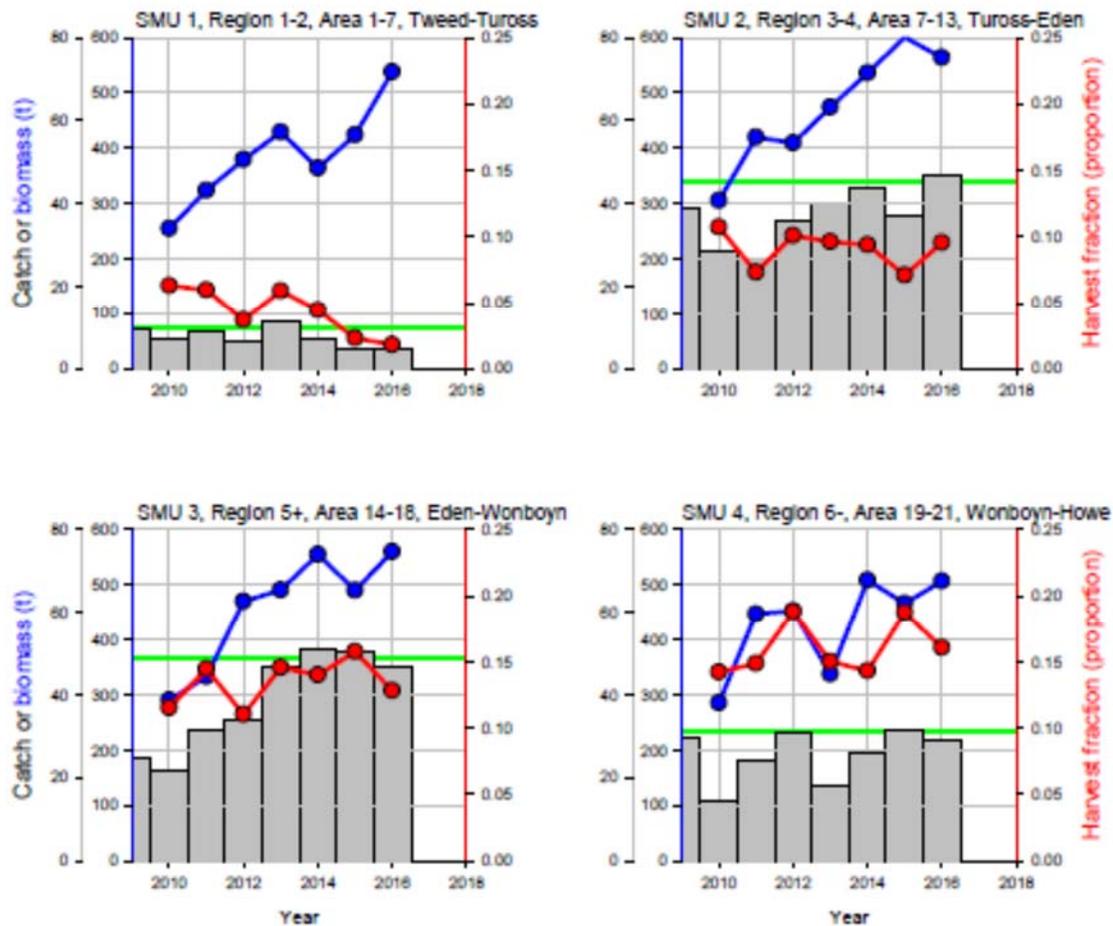
*The Committee **recommends** that local catch targets and limits for Areas be established and implemented to provide reasonable operational flexibility to the fishery and to protect local stock status. It should not be accepted that particular Areas are persistently over or under the catch.*

### **A3.3.2. Fine scale data and interpretations**

All divers in the fishery have access to GPS data-loggers though not all divers operate them on all fishing days and there are occasional equipment failures. The analysis provided for 2015–16 covered 50–60% of diver days. There was reasonable coverage in 2009 and 2010, with good coverage for the five years 2011–16. The data-logger information increasingly is critical to assessment, both for detecting and correcting some of the sources of hyper-stability in commercial catch rates and in providing the new indicators of exploitable biomass and harvest fraction that will be necessary for spatially-explicit management. The continuation and further improvement of the data logger program is strongly supported by the Committee with particular attention to developing meaningful stock and fishery performance indicators to inform management decisions.

Anecdotal observations from industry are unanimous in reporting numerous undersized abalone in the population. All fishers report significant improvement in the stock during the last few years but there are different views about the robustness and stage of the recovery so far.

The density of abalone (Kg/Ha) for all SMUs and for most Areas in the period 2010-16 was calculated from the GPS logger data, and provides a very useful cross-check on the trends from CPUE (e.g. Figure A3.5). The GPS data logger information was also used to estimate the area of productive reef, which was used in combination with the density to estimate the biomass of exploitable abalone and harvest fraction for each SMU (Figure A3.6, Table A3.2). This is a new and evolving and very promising method but its reliability is not yet clear and it should be further tested against proven scientific survey methods. The trends in relative measures such as biomass and harvest fraction are likely to be more reliable than absolute estimates.



**Figure A3.6.** The catch (grey bars), standardised biomass density (blue lines), that is proportional to exploitable biomass under the assumption of a constant habitat area, and the implied Harvest Fraction resulting from the catches in recent years (red line).

The estimated Harvest Fractions in Figure A3.6 show the gradient of low to high harvest fraction for SMUs north to south. The harvest fraction in SMU 1 is less than 5% and has been decreasing in recent years as the exploitable biomass increased under a low catch. The harvest fraction in SMU 2 has been consistently between about 7-10%, which has allowed some ongoing stock rebuilding. The harvest fraction in SMU 3 has been consistently about 12–15% and there has been little or no ongoing stock rebuilding. The harvest fraction in SMU 4 has been consistently about 14–18% and there also has been little or no ongoing stock rebuilding.

The harvest fraction giving common fishery management reference points (e.g. maximum sustainable yield) has not been calculated for NSW abalone. A value of 15%, however, is considered relatively high for a stock that is being rebuilt after overfishing, based on Victorian experience. The recent NSW observations indicate that harvest fractions near 15% or larger allow little scope for stock rebuilding.

The estimates in Table A3.2 indicate an about doubling of the exploitable biomass in each of the SMUs since 2009–10. They indicate an approximate stabilisation of the biomass in SMUs 3 and 4 in the past about 4 years, while the biomass in SMUs 1 and 2 continues to increase (although more slowly in SMU 2).

The estimated biomass in SMU 1 (Regions 1 and 2) is large, and it is perhaps a minimal estimate, but the reliability of these estimates is unclear because they are based on relatively low catches and the density estimates by Area were not reported. Future analysis in SMU 1 should relate the spatial coverage and densities from the data loggers with the earlier scientific monitoring locations and the experimental fishing sites in Region 1 (south) in 2007, so potentially providing a verification of the recovery and harvest potential there.

**Table A3.2.** The biomass of legal sized abalone estimated from GPS logger data from commercial fishing operations each year since 2009–10. Density (Kg/Ha) estimates are provided for two standardisations, the lower one related to an average diver and the upper one (used for 'best' biomass estimation) calibrated to match scientific surveys in some southern reefs in 2013. Three estimates of the productive area are provided: the cumulative area fished in 2009-2016; the cumulative area fished in the past 3 years (used for 'best' biomass estimation); and the area fished in 2015–16. The 'best' biomass estimate is given with a range in brackets – the low value from the average diver density combined with the productive area from the past 3 years fishing and the high value from the calibrated density combined with the productive area from all years fishing.

	SMU 1	SMU 2	SMU 3	SMU 4
	Region 1-2	Region 3-4	Region 5+	Region 6-
	Area 1-7	Area 7-13	Area 14-18	Area 19-21
	Subzone A-R	Subzone S-X	Subzone Y1-Y3	Subzone Z
Year				
	Density (kg/Ha)			
2009-10	201 - 255	242 - 306	229 - 290	226 - 285
2010-11	256 - 324	332 - 420	263 - 333	354 - 447
2011-12	300 - 379	324 - 410	372 - 470	358 - 453
2012-13	339 - 429	375 - 474	388 - 491	267 - 337
2013-14	288 - 364	424 - 536	439 - 556	402 - 509
2014-15	335 - 424	475 - 601	388 - 490	369 - 467
2015-16	425 - 538	446 - 564	443 - 560	401 - 507
	Area (Ha)			
All years	687-763	1107-1228	665-728	364-405
Last 3 years	461	873	654	349
2015-16	95	510	283	145
	Biomass (t)			
2009-10	117 (93 - 284)	267 (211 - 389)	190 (150 - 215)	102 (81 - 116)
2010-11	149 (118 - 361)	367 (290 - 535)	218 (172 - 246)	161 (127 - 182)
2011-12	175 (138 - 423)	358 (283 - 521)	308 (243 - 348)	163 (129 - 184)
2012-13	198 (156 - 478)	414 (327 - 604)	321 (254 - 363)	121 (96 - 137)
2013-14	168 (133 - 406)	468 (370 - 682)	363 (287 - 411)	183 (144 - 207)
2014-15	195 (154 - 473)	524 (414 - 765)	321 (253 - 362)	168 (132 - 190)
2015-16	248 (196 - 600)	492 (389 - 718)	367 (290 - 414)	182 (144 - 206)

The biomass estimates, CPUE, and mean weights broadly are consistent. The abalone population has plateaued under recent catches in SMUs 3 and 4, exhibits some further but slowing population growth in SMU 2, and continues to increase at a steady rate in SMU 1 where harvest fractions are lower.

This preliminary analysis and data illustrates the high potential value of the fine scale data and analysis. There are few years or data available for comparison and the methods for interpretation are not yet well developed, tested, or standardised from year to year, but it is already allowing exploration of some of the key questions of stock recovery and sustainability at scales appropriate to abalone. The estimation of biomass from logger data is very promising but the approach needs further development and testing, and especially testing against direct surveys of biomass.

The Committee strongly supports the use of finer scale information for assessment and management of the fishery and encourages development of verified, robust indicators for routine application.

### A3.3.3. Population modeling

The results of fitting an aggregate biomass stock-production model to the NSW abalone was available this year. This was an initial and exploratory analysis using the 'catch maximum sustainable yield' (CMSY) method that allows model fitting with just catch data and some assumptions about the level of depletion at various times, but also fitting to indicators such as catch rate. Both methods of model fitting were applied. This simple model structure gave very similar historical biomass trajectories to the earlier NSW age structured model when fitted to the commercial catch rate data. Variations of model fitting to explore the more recent stock dynamics, and specifically the history since 1990 and CPUE increases since about 2006, implied different historical trajectories so there is some complexity to understand that requires further work.

This preliminary modelling is not at the stage where robust conclusions can be drawn about stock status or to inform TACC setting, but it is encouraging to see population modelling being used to explore the integration of different data, overall population trends, and reference points related to maximum

sustainable yield. The Committee encourages this development, including the use of data from the stock rebuilding period in recent years which should be very informative. Aggregate biomass models cannot address LML or spatial catch allocation questions, however, both of which are important in this fishery. Nor can these simple models make use of all available indicators (e.g., mean animal weight) and it is suggested that more structured population models are explored and developed for the abalone fishery.

#### A3.3.4. Illegal, unreported, and non-commercial fishing catches

The level of illegal, unreported and non-commercial (recreational and Aboriginal) catch, and trends during the history of the fishery, remain very uncertain. The Committee was informed that recent recreational catch was likely to be unchanged and less than 10 t. An aggregate catch for Aboriginal fishing was not provided specifically but it was advised that legal harvest by Aboriginal fishers was estimated to be very low. The recent implementation of Aboriginal cultural fishing permits is not considered to have caused a significant increase in Aboriginal legal catch.

The illegal and unreported catch in previous years has been assumed to be 40% of the legal and reported catch in 1987, equating to 102t from Regions 2-6. General impressions from compliance officers and Industry are that the illegal catch probably was about 100t per year in the past, that it was likely to have been below 100t but above 50t in 2008, to be about 20-40t per year through to about 2013, and now is in the lower part of that range and trending down. There are no reliable data from which to test these impressions empirically.

### A3.4 Conclusions

There has been substantial improvement in the state of the stock in recent years, starting in about 2006 but particularly since about 2009. The reductions in TAC and increased LML have succeeded in providing additional accumulated stock above the LML since the mid-2000s when those management interventions began. The stock has shown considerable rebuilding, as evidenced by the substantial increases in catch rate and mean weight of abalone for all SMUs. This increase also is mirrored in the density and biomass estimates from the GPS logger observations that, while preliminary, indicate an about doubling of exploitable biomass since 2009.

The overall trend toward recovery in the past 10 years is very clear but it also now is clear that stock rebuilding has slowed considerably during the past 3-4 years in SMUs 2, 3, and 4 as the catches there have increased. Rebuilding continues in SMU 1 under very low catches. The key catch rate, mean weight, population density, and biomass indicators in SMUs 3 and 4 have plateaued and they are plateauing in SMU 2. The plateauing of these indicators was recognised first in a few Areas in 2013, was more widespread in 2014, and now is seen in almost all significantly fished Areas of the fishery.

These results also are consistent with the relatively high harvest fractions estimated for SMUs 3 and 4 from the logger observations in recent years. It can be concluded from recent trends that harvest fractions above about 12-15% allow little scope for further stock rebuilding in these SMUs. SMU 2, where some slowed recovery continues, has recently had harvest fractions of about 7-10%. The harvest fraction in SMU 1 is less than 5% and steady stock rebuilding continues there.

Some implications of this plateauing of stock recovery in are:

- Recent catches in SMUs 2, 3, and 4 have been taking most of the surplus production, leaving relatively little to contribute to further stock rebuilding;
- The stock in these SMUs is approximately stabilised under current catch and LML settings, and further catch increases at the current LML is expected to decrease average commercial catch rates;
- Stock rebuilding to the optimal level is likely to be very incomplete because the fishery catch history suggests that surplus production from the fully recovered population would be considerably larger than current catches, an implication that would be understood far better if a population model was used to characterise surplus production, the current status of the stock, and the effects of changes to LML.

Comparison of the commercial catch rate (Kg/hr) with the GPS logger estimates of abalone density (Kg/Ha) can detect situations where the catch rate becomes hyper-stable because operational changes in fishing strategy compensate for decreasing population density. Such situations can indicate increased fishing pressure on local stocks and the start of localised depletion. The catch rate and density trends have been similar for most Areas examined, indicating that hyper-stability and the associated change in fishing operations is not occurring. There are mild indications of some hyper-stability since about 2013 in Areas 13, 15, 16 and 17 (i.e. most of SMU 3), however, so catch rate data from these areas should

also be treated with caution. A much stronger pattern of hyper-stability seen in Areas 14 and 19 is of greater concern. It is concluded that the stocks in both Areas are stressed by recent catches and that future catches from those areas should be reduced.

The Committee previously has supported the implementation of catch caps at local space scales to spread the catch, help manage the risk of localised depletion, and avoid the sequential localised depletion experienced in the history of this fishery. These local catch distributions are within the regulated fishery-wide TACC and recently they have been recommended at the scale of Areas. There is ongoing failure to achieve the intended catch distribution at this finer space scale. Many Areas persistently are providing catch above or below the recommended level. Catches from SMU 1 in particular have been much lower than those recommended, with the 'missing catch' taken from the more southern SMUs. The inability to manage effectively the spatial distribution of the catch risks sequential localised depletion and that risk increases as the overall TAC increases because large catches could be taken from unintendedly small areas. This is a significant impediment to confident recovery of the fishery.

*The Committee **recommends** that arrangements be developed between industry and government to improve management of the spatial distribution of the TACC.*

Now, as in recent years, the Committee has very limited information and analysis for its decisions. There consequently is a high level of uncertainty about the true status of the stocks and their responses to recent changes in the TACC and LML. The imperative previously was to stop further stock decline and begin recovery and that could be addressed, albeit inefficiently, with relatively little information. The challenge now is balancing continued recovery with appropriate catch levels whilst also implementing management reform to prevent a return to serial localised depletion and resultant overfishing. There are limitations and risks from the few stock status indicators available, poor knowledge of current stock status in relation to full recovery, and the time needed to learn from previous management changes before taking next steps.

The fishery now is being limited significantly by under-investment in analysis of the monitoring data and modelling of population dynamics. The future is likely to be one of continued uncertainty and the need for considerable precaution without improvements to this investment. The Committee notes that management changes and stock rebuilding during the past about 10 years has resulted in potentially very informative trends in the key stock indicators and recommends that formal population modelling be reinstated as a core component of advice for management planning and TACC determination. The primary aim of such modelling, however, should not be tactical stock assessment specifically for TACC setting year-to-year but to provide strategically focused guidance for management in the next few years toward setting sensible reference points related to productivity thresholds such as achieving optimum economic yield and avoiding recruitment overfishing. An aspect of such modelling necessarily would be consideration of the optimum LML.

The Committee has been concerned to identify past management settings that allowed overfishing to occur as well as taking measures to enable stock rebuilding. Rectification of poor previous setting is central to controlling risks that overfishing and stock collapse could recur. The Committee considers that two features of the management settings particularly are important.

- **Finer scale monitoring, assessment, and management.** The electronic logger program introduced by Industry has augmented the DPI logbook program and considerably improved the ability to monitor abalone stocks, catches, and fishing effort at finer space scales. Finer scale management of catches is improving but still is not adequate to deliver the spatial distribution of catches appropriate to a stock of this type. More formal methods to control catches from Areas are needed, linked to formal catch caps and targets by Area and Spatial Management Unit (SMU).
- **Appropriate size limits.** The spatial variability of abalone life history parameters means that maximising yield while protecting spawning stock is likely to require different LMLs in different areas, supported by spatially explicit monitoring and biological information. Even moderate TACCs can result in both growth and recruitment overfishing in areas for which a LML is too small, while yield is foregone in areas for which a LML is too large. The Committee previously has argued for higher overall LMLs that are adequate to optimise the fishery in the areas of fast growth that provide most of the catch, augmented by complementary specific LML arrangements for harvest from slower or faster growing areas where appropriate. Inadequate LML protection of spawning stock in fast growing portions of the stock means protection must be provided by a low overall TACC, but this is an inefficient approach that does not allow the

fishery to reach its biological and economic potential. The Committee again finds that the available evidence indicates benefits to the stock and fishery from an increase in overall LML.

*The Committee **recommends** that urgent consideration be given to an increase in the overall LML to increase benefits to both the stock and the fishery.*

The Committee has concluded that the TACC for 2017 should remain unchanged. The Committee recommends some changes in the distribution of catches among Areas (Table A3.3) to provide increased protection in Areas 14 and 19, and to reiterate the desirability of taking increased catches from SMU 1, with commensurate decreased catches in the more southern SMUs. The Committee also provides suggested area-specific LMLs (Table A3.3). These are the same LML suggestions as made last year for SMUs 2, 3 and 4 but it is suggested now that the default LML in SMU 1 should be 120mm, with scope to decrease it in specific Areas where warranted through agreement of DPI and industry. This suggestion is made because: (i) SMU 1 has had a long period of very low catches and so the size distribution of the stock can be expected to have rebuilt substantially; (ii) the structured fishing program in SMU 1 in 2007 found that the median length of abalone then was greater than 120mm; (iii) the mean weight observations from most Areas in SMU 1 suggest that those Areas, with Area 6 being a possible exception, contain relatively large abalone; and (iv) a larger LML will provide greater protection of the mature stock if the stocks have not recovered as significantly as expected, noting that recent data are from relatively small catches and so might not be representative of the wider populations,.

**Table A3.3:** Recommended catch targets and LML by area

Area	Catch (t)	LML (mm)
1	1.0	120
2	1.0	120
3	2.0	120
4	1.0	120
5	5.0	120
6	1.0	120*
7	2.0	120*
8	5.0	120
9	8.5	120
10	11.0	120
11	10.0	120
12	9.5	120
13	5.0	120
14	8.0	120*
15	9.0	120
16	10.0	120
17	7.0	120
18	4.0	120
19	5.0	123
20	9.0	123
21	16.0	123
<b>Total</b>	<b>130.0</b>	

\* A lower LML had been suggested previously for these areas based on assertions that growth rates and productivity in them were lower than elsewhere. Recent sizes of abalone in catches suggest those assertions might no longer apply. The Department and industry should garner or review recent information about abalone growth in those areas to assess whether lower LMLs should be retained for them.

# APPENDIX 4. ECONOMIC CONSIDERATIONS — DETAILS

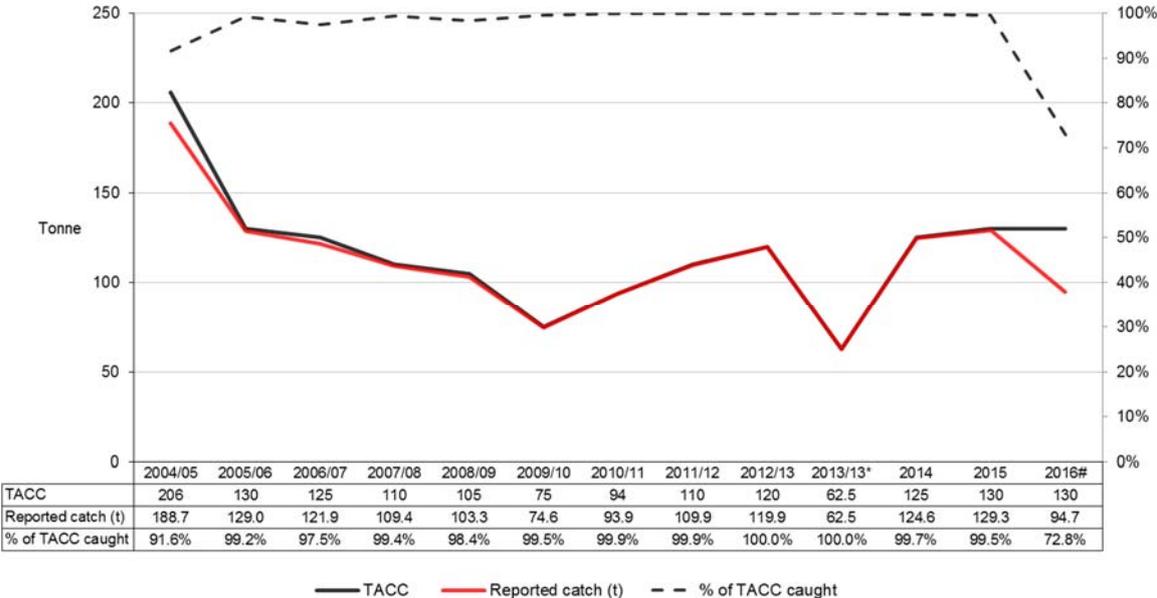
## A4.1 Introduction

The economic status of the NSW abalone industry is described in this section, consistent with the requirement that the Committee have regard to economic and social issues in making its determination.

Discussion is provided of the data affecting the economic performance of the abalone fishery, including gross revenue, export prices, and catch per unit effort. Much of the information provided in this section is derived from the Management Report provided by NSW Department of Primary Industries (McKinnon 2016)<sup>6</sup> and is reproduced in this report for completeness. This section also follows a similar format to economic background information sections in previous determination reports, for consistency.

## A4.2 Volume and value of production

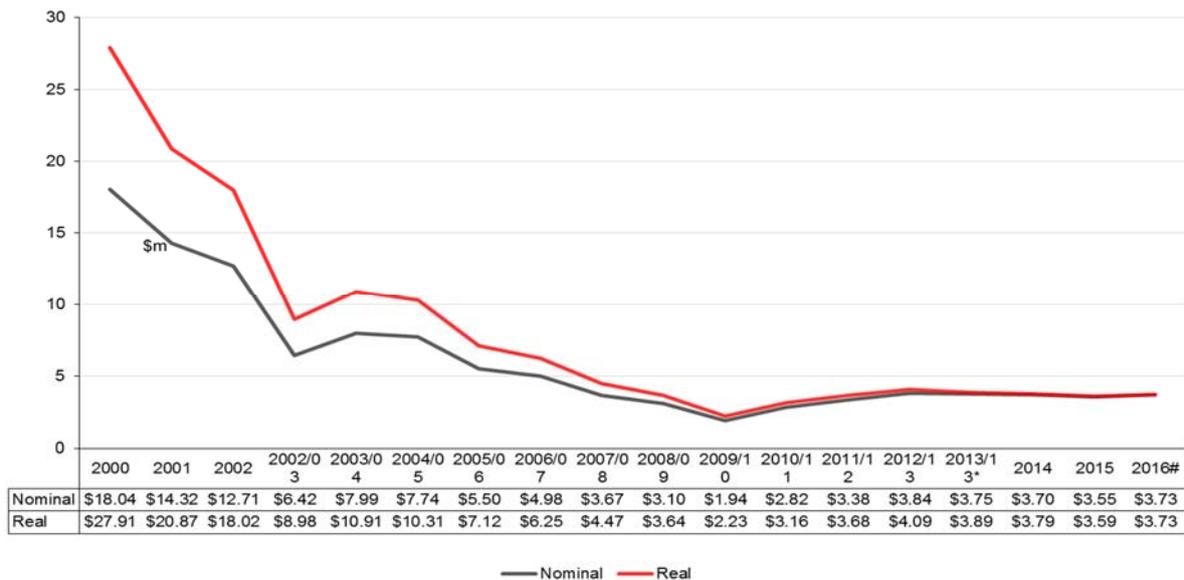
The volume of reported catch of abalone in 2015 was 129.3 tonne (t) and is expected to come close to the 130 t TACC for 2016. Data to 31 August 2016 has the reported catch at 73% of the TACC. The proportion of TACC caught has remained above 97% since 2005–06 and has been over 99% of the TACC since 2008–09 (Figure A4.1).



**Figure A4.1.** TACC (t), total reported commercial catch (t), and proportion of TACC caught (%) for each fishing period from 2001 to end August 2016 (note \*6 month fishing period 2013; # incomplete year 2016).

The gross value of reported catch of abalone has remained relatively constant since 2011–12 in real terms despite the changes in TACCs over this period. Real values are CPI adjusted values using RBA “all groups” CPI data up to 2016. The 2016 gross value of production (GVP) is expected to be \$3.73 million, assuming the TACC is reached (Figure A4.2). Current values are low compared to those in 2000 when the gross value of the fishery was \$27.9 million in real terms due to both higher catches and higher prices. It is noted, however, that that the high levels of catch at that time were not biologically sustainable and that the price of abalone was unusually high.

<sup>6</sup> McKinnon, F. (2016). Management Report – NSW Abalone Fishery 2017 Fishing Period, *OUT16/39583*. NSW Department of Primary Industries, Sydney.



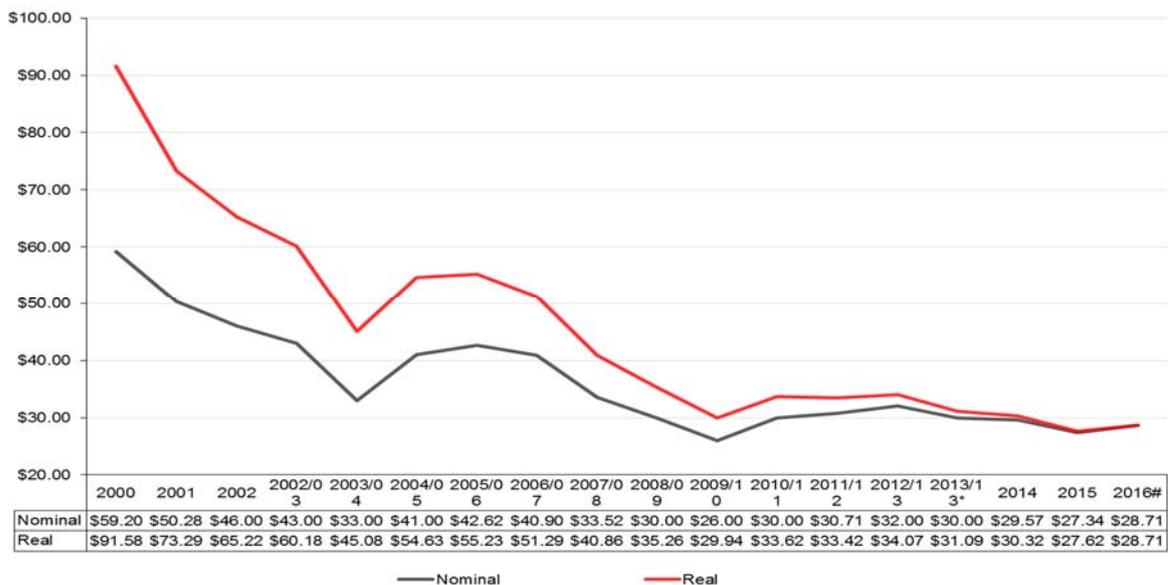
**Figure A4.2.** Estimated nominal and real gross value of production in the fishery (\$m) for each fishing period from 2000 to the end of August 2016. \*2013–13 catch figures applied to a six-month adjusted reporting period and have been doubled to represent 12-month equivalent gross value of production. # 2016 value assumes the 130 t TACC is reached.

### A4.3 Abalone markets and prices

The NSW abalone industry is predominantly export-oriented. Prices received for NSW abalone therefore are subject to economic conditions and exchange rate fluctuations in the main export markets, and competition from exports from other abalone exporters. Another significant factor affecting prices is increasing competition from cultured product.

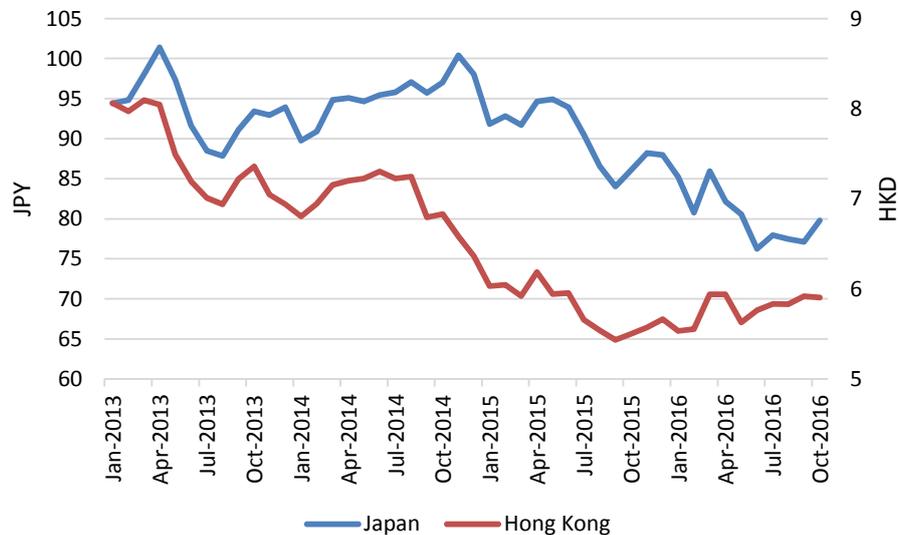
The main export markets for Australian abalone are China, Hong Kong, and Japan. The main market for NSW abalone in 2015 was Japan, for which the main product was live abalone. China is seen as a potential new market for NSW abalone, with industry reporting high prices on the market for Tasmanian abalone in particular.

Beach prices for abalone are estimated from data abalone processors provide to the Department. Real terms prices declined rapidly from around \$86/kg in 2000 to \$29.94/kg in 2009–10 (Figure A4.3). Prices have continued to decline since then but at a lower rate. Prices have declined gradually recently from \$34.07/kg in 2012–13 to \$28.71/kg in real terms over the first eight months of 2016 (Figure A4.3).



**Figure A4.3.** Estimated nominal and real beach prices (\$/kg) for each fishing period from 2000 to the end of August 2016.

Part of the earlier decline in prices may be related to the increasing strength of the Australian dollar against the Japanese Yen and US dollar but beach prices have continued to fall despite a depreciating Australian dollar over more recent years. The Australian dollar has depreciated roughly 20% against the Japanese Yen and 25% against the Hong Kong Dollar since 2013 (Figure A4.4). The continuing decline in prices largely can be attributed to the rapid expansion of cultured abalone production.



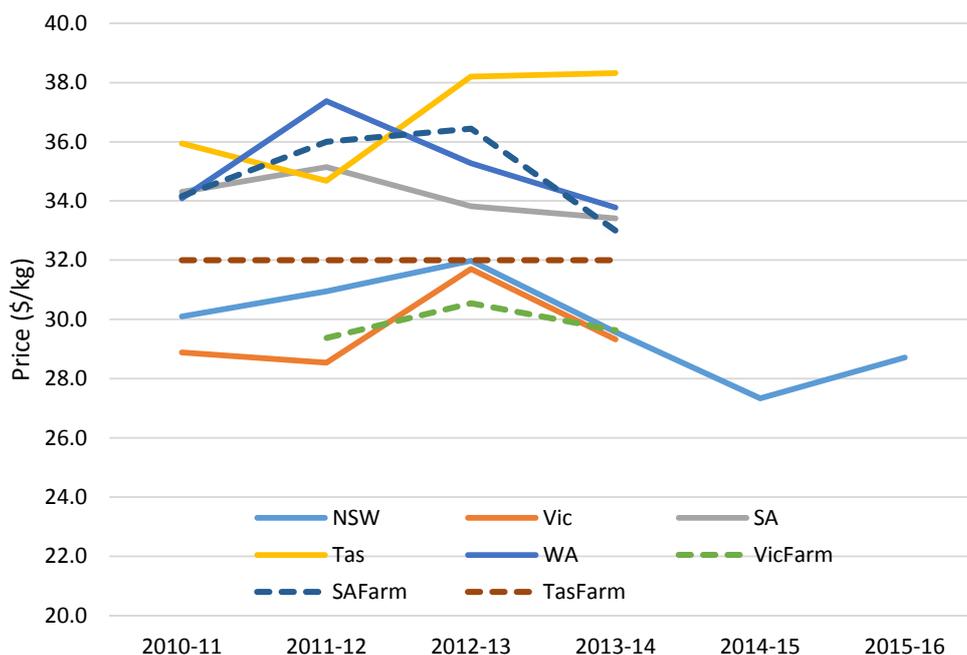
**Figure A4.4.** Exchange rates AUD:JP¥ and AU\$:HK\$ 2013 to the end of October 2016.

This substantial price decrease largely corresponds with the expansion of farmed abalone both within Australia and globally. Australian farmed abalone has more than doubled between 2010 and 2015 from 456 t to 965 t (Cook 2014). Farmed abalone has increased globally from 8,700 t in 2002 to 130,000 t in 2015, while wild caught product has declined from 10,000 t to 6,500 t over the same period (Cook 2016). China and Korea are the two largest producers of farmed abalone with production levels in 2015 of 115,397 and 9,400 t respectively (Cook 2016). Costs associated with producing cultured abalone are continuing to fall both in Australia and, more significantly, China and Korea. This is resulting in lower prices for cultured abalone, undercutting those for wild caught product, particularly of smaller sizes.

The challenges from decreasing prices facing NSW abalone producers also are being felt by other Australian abalone producers to varying degrees. Beach prices for NSW and Victorian abalone have been close to prices of farmed product over recent years, while prices for Tasmanian, Western Australian, and South Australian product generally have been higher (Figure A4.5). These high-price States have variable LMLs with many areas subject to LMLs >130mm. Anecdotal evidence provided by Industry suggests that Tasmanian prices have increased in recent years particularly for larger abalone, attracting a premium on the international markets (particularly China).

NSW abalone is sold through registered fish receivers, two main processing plants along the NSW coast, and a processing plant in Mallacoota, Victoria. The capacity of the two main NSW processing plants to take abalone was identified as a key constraint by many divers interviewed through a previous survey of the fishery. This also was raised by an industry representative at the TACC Committee public forum this year, who noted that trip limits often were imposed on fishers supplying to the processors. Preferences expressed by processing plants affected significantly decisions on days to fish, where to fish, and the size of abalone to target, aside from effects of weather or availability of quota.

The relatively small size of the NSW industry and irregularity in demand from overseas were identified as key reasons for the processors' caps on abalone intake. Shareholders and divers continue to sell increasing shares of abalone through 'AFCOL' in Mallacoota. The absence of daily catch limits to abalone landed at Mallacoota and willingness from that processor to travel as far north as Tathra to collect product means there is likely to be increasing interest in landing NSW catch through Mallacoota, possibly accompanied by movement of effort toward the southern boundary of the NSW fishery. The location of processors to a large extent dictates where divers fish, as processors are not willing to travel long distances to pick up from a single diver. This may be particularly relevant to the northern areas of the fishery that have been fished below their recommended level in recent years and also contribute to the increasing harvest from southern areas. The Department should continue to keep a watching brief on movement in fishing effort towards the southern Areas of the fishery.



**Figure A4.5.** Estimated beach prices (\$/kg) by State, 2010-11 to 2015-16 (nominal values). The solid lines represent wild caught produce and the dashed lines represent farmed product. Data for 2014-15 and 2015-16 for NSW prices were provided as noted above. Prices for other years and States were derived from ABARES (2015)<sup>7</sup>.

One Victorian processor indicated that the size preference for abalone sold through AFCOL in Mallacoota may differ from processors in NSW. AFCOL cans abalone, rather than selling live product, and is happy to buy a range of sizes of abalone. The strongest demand, and highest prices, elsewhere in Victoria, however, is for smaller sized (250g in the shell) live abalone, which the NSW industry can supply. A NSW shareholder, in contrast, maintained that the main processor in NSW, Pacific Shoji, preferred larger abalone to supply live to Japan. The strongest demand, and highest price, was for abalone over 130mm. The other main supplier of live abalone, Southern Ocean Seafood, sells a range of sizes, with a preference for larger animals.

Evidence provided to the Committee at previous industry meetings indicated that tastes and preferences in overseas markets were changing away from product that can be supplied easily by NSW abalone fishers. It was stated that the niche market that NSW abalone previously held in Japan in particular was shrinking due to competition from cultured product and that a separate Japanese market was emerging for larger size abalone due to a recent change in consumer preferences. Hoshino et al. (2015) found that Japanese consumers did not differentiate between wild and farmed abalone on the market, and that any “wild premium” instead would result through size based differentiation in which a preference for larger abalone would be met by wild-caught product but not by farmed product, given the costs associated with the additional time it would take to grow farmed abalone to larger sizes.

The indicators above, including strong demand for abalone within current legal sizes in NSW for canning, potentially strong demand for live product larger than NSW can supply currently, and potentially strong demand for live abalone at sizes above the current NSW LML, indicate that it is more important than ever to investigate tastes and preferences for abalone on overseas markets, and size–price relationships for abalone on these markets. An appropriate TACC and size limit(s) for maximum economic yield can be assessed only with such information and a well-founded harvest strategy with specific economic goals.

*The Committee suggests that Industry investigate size preferences for abalone on overseas markets and size–price relationships for abalone on those markets.*

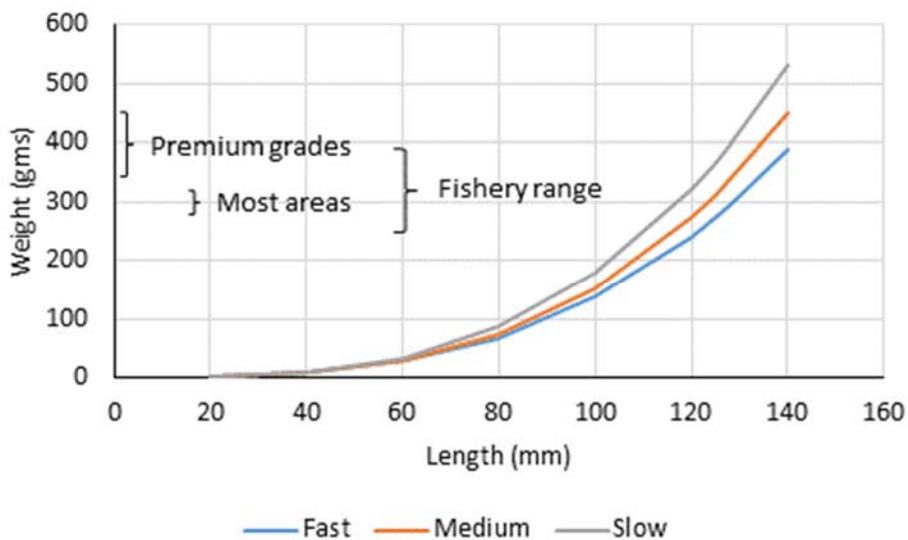
<sup>7</sup> ABARES (2015). Australian fisheries and aquaculture statistics 2014. ABARES, Canberra.

#### A4.4 Catch per unit effort and average size

The fishery has been in a rebuilding stage over the last decade with TACCs reduced to help rebuild stock abundance. There are well known risks in relying on overall catch per unit effort (CPUE) as an indicator of stock abundance of abalone but it does provide an indication of changes in the availability of abalone to the fishery. It also reflects changes in the cost of catching the quota, as will be discussed later.

CPUE has doubled since 2008–09 from 19.6kg/hr to an average of 49.26 kg/hr in the first eight months of 2016 and increased by roughly 25% since 2011–12, although only a modest increase was seen between the 2015 and 2016 fishing periods. These increases most likely resulted from stock growth under lower TACCs and higher size limits. Higher size limits and significantly reduced numbers of fish being taken than earlier in the decade continue to put the fishery in a much better position to improve productivity and consolidate recruitment events. This is a positive sign of likely improved returns from fishing in the future, subject to the extent of current and future recruitment.

The average size of abalone in the fishery catch has risen continuously from 280g in 2005–06 to 343g in the first eight months of 2016. The average size in the different areas in the first eight months of 2016 averaged 290g–410g (Figure A4.6), with most (16 of the 21 areas) averaging between 290g and 325g. The current premium market grades<sup>8</sup>, in contrast, appear to be in the range 340g–450g, which corresponds to average lengths of 130mm–140mm. This is currently above the size range being harvested from most of the fishery but the fact that five of the areas averaged within this range suggests that it is not beyond what the fishery can achieve.



**Figure A4.6.** Relationship between length and weight of NSW abalone, premium market grades and performance of the fishery in 2016. Length-Weight derived from Worthington and Andrew (1998)<sup>9</sup>. ‘Fast’ refers to animals showing rapid growth in length; ‘Slow’ refers to animals with relatively slow growth in length.

It remains the opinion of the Committee therefore that a further increase in LML in many areas of the fishery may be appropriate and economically advantageous. There is a trade-off, however, between LML and allowable catch, and the benefits of increasing LML to achieve higher prices need to be assessed against the potential overall reduction in catch. Building the stock further to increase the proportion of larger animals also will take time and there are trade-offs between the speed at which it rebuilds and the longer term benefits against the short term costs to the industry. Previous increases in LML, however, indicate that reductions in catch have been relatively short-lived (less than 1 year) compared to the long-term improvement in CPUE and, likely, economic efficiency.

<sup>8</sup> Based on information on the Southern Oceans Seafood webpage.

<sup>9</sup> Worthington, D. and Andrew, N. (1998). Small-scale variation in demography and its implications for an alternative size limit in the fishery for blacklip abalone (*Haliotis rubra*) in New South Wales, Australia, *Canadian Special Publication of Fisheries and Aquatic Sciences* 341-348.

The Committee **recommends** that bio-economic modelling analysis be undertaken to assess short-term vs long-term harvest and economic trade-offs associated with further increases in LML to inform future TACC determinations.

#### A4.5 Economic performance indicators

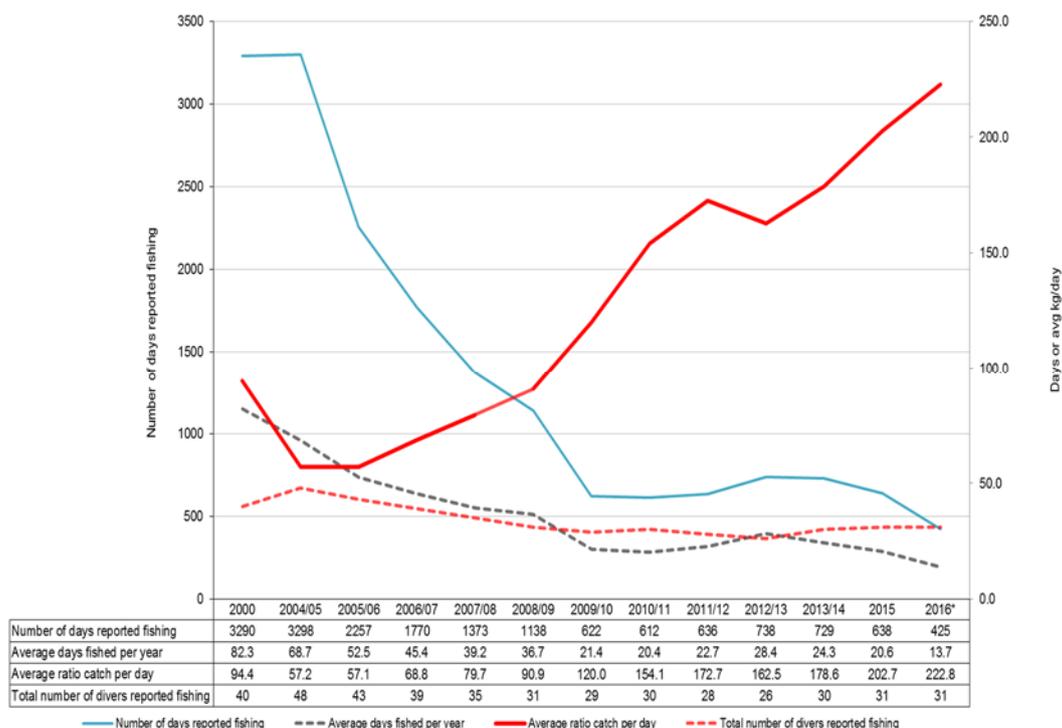
Economic data for the fishery is not routinely collected so assessments of economic performance rely on imperfect indicators such as changes in CPUE and quota trading amounts or prices.

The Committee notes that the only available direct information on the economic performance of the NSW Abalone Fishery relates to the 2011–12 fishing period. Price, productivity, and cost conditions have changed considerably since then so these data are likely to have materially diminished relevance as indicators of current performance. The Committee would like to see analogous surveys run more regularly (every 1–2 years) to capture structural economic dynamics of the fishery.

A model of data collection that the industry may wish to consider is that of the Commonwealth Northern Prawn Fishery (NPF). The industry association collects economic information from its members which is passed to a third body for analysis. The analysed results, and de-identified data, are then available to managers and industry to assess any implications for changes in economic performance of the fishery and provide timely input into the bio-economic modelling used to determine the next year's (effort) quota. Advantages of this model include that it is relatively low cost, backing from the industry association results in relatively high participation rates, and concerns about revealing individual commercial information to government agencies are removed by having industry contract an independent analyst, with appropriate confidentiality provisions. *The Committee suggests that the Industry Association consider the NPF economic data collection and analysis model and*

The Committee **recommends** that Industry and the Department regularly update economic data for the fishery.

The higher catch rates of larger animals in recent years has resulted in relatively small changes in the total number of days fished to take the higher TACCs (Figure A4.7), with average days fished declining between 2014 and 2015 despite an increase in TACC.<sup>10</sup> This suggests that the cost per unit of catch would have declined, with an improvement in economic performance of the fishery, all else being equal.



**Figure A4.7.** Days fished (total and average per diver) and catch rates since 2000. Note data gap between 200 and 2004–05. Data to August 2016 only.

<sup>10</sup> Data for 2016 are incomplete (only to the 31 August) so a comparison with 2015 is not possible.

Share trading prices, however, stabilised between 2014–15 and 2015–16 despite anecdotal evidence of an increase in short term profitability due to improved productivity. Share prices in theory reflect longer term expectations of profitability of the fishery. There were six share transfers in the 2014–15 financial year representing a total of 254 shares with a nominal weighted average value of \$8,774 per share, based on reported values. There were 12 share transfers in 2015–16 representing a total of 400 shares with an estimated (adjusted)<sup>11</sup> nominal weighted average value per share of \$8,700. Price reductions appear to have offset the inferred reductions in cost of operation, resulting in no real change in the economic status of the fishery. This also is indicative of a slightly pessimistic economic outlook for the fishery in the medium to longer term, as price and cost conditions are not expected to improve.

Quota trading price information, a good indicator of short term economic performance, is unavailable for this fishery. Quota trading price information is supplied on a voluntary basis only and industry has generally not reported sufficient data on which to estimate trading prices reliably. It would be helpful to the Committee if the Department required the collection of quota price data and undertook such calculations in the same manner that data on share trading prices are collected. Reporting by shareholders of all information on the price of share and quota transfers would provide invaluable information for assessing the economic status of the fishery and implementing management settings, including TACCs, which favoured optimum economic performance of the fishery.

*The Committee suggests that Industry make available information on the price of share and quota transfers in the abalone fishery and that the Department and Industry work together to develop more detailed information on the structure and operation of the quota market.*

#### A4.6 Share and Quota markets

A key feature of fisheries operating with individual transferable quotas is the opportunity for fishers to adjust quota holdings to improve their individual economic performance. The potential for the economic performance in the fishery to improve is dependent on the ability for fishers to adjust their operations in response to changing stock, price, or cost conditions. This may be either long term adjustment through trade of shares in the fishery or shorter term adjustment through leasing quota on an annual basis.

The fishery has had a total of 3454 shares since 2003–04, with the quota attached to each share determined by the TACC divided by the total share. The quota per share in 2016 was 37.64kg, steadily increased since 2009–10 (Table A4.1).

**Table A4.1.** Quota per share and quota transfers 2003–04 to 2016 (to October 18<sup>th</sup>)

Fishing period	TACC (t)	Quota (kg/share)	Total quota transferred (kg)	% TACC	N° shareholders supplying quota
2003-04	281	76.90	34,937	12	25
2004-05	206	56.38	29,474	14	23
2005-06	130	35.58	23,428	18	21
2006-07	125	34.21	29,743	24	21
2007-08	110	31.85	24,590	22	20
2008-09	105	30.40	32,826	31	NA
2009-10	75	21.71	24,512	33	21
2010-11	94	27.21	29,911	32	22
2011-12	110	31.85	31,993	29	25
2012-13	120	34.74	36,703	31	21
2013-13*	125	36.19	17,472	28	21
2014	125	36.19	42,263	34	27
2015	130	37.64	37,413	29	21
2016**	130	37.64	42,334	33	24

\* 6 month fishing period.

\*\* Incomplete fishing period to 18 October 2016.

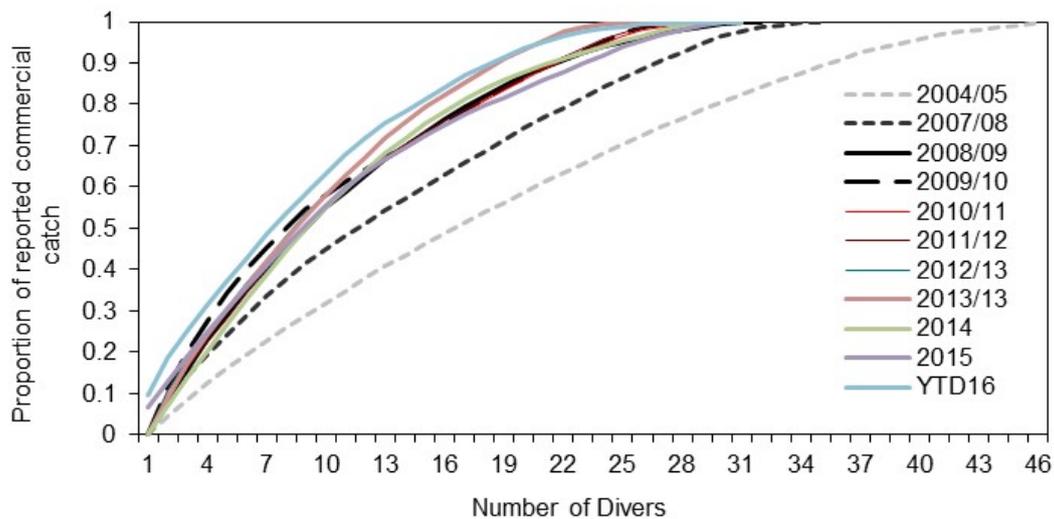
<sup>11</sup> A number of trades occurred at a substantially lower reported price but these were considered to be administrative transfer prices rather than a true reflection of the value of the share so were not included in the average price.

There were 51 shareholders in 2016, an increase from 48 in 2015, with shareholdings ranging between 10 and 150 shares. Thirty six of these shareholdings currently are eligible for an endorsement to fish, which requires a holding of  $\geq 70$  shares. The remaining 15 shareholders are able to lease their quota to active fishers. Thirty one shareholders reported fishing up to August 31<sup>st</sup> in 2016, with an additional four nominated divers operating on shareholders' behalf.

The Fisheries Management (Abalone Share Management Plan) Regulation 2000 stipulates that shares can only be traded in packages of 10. Restrictions also exist on quota trading, including that quota may be transferred only in lots of 100 kilograms (or as otherwise approved by the Director) and that a shareholder may not acquire by any quota transfer more than twice the amount of quota owned by the shareholder at the beginning of the fishing period. Previous Committees have expressed a concern that these restrictions may impede potential improvements in efficiency compared with what may arise if transfers were less restricted. Share trading occurs despite these restrictions, however, and around 7% and 12% of all shares were transferred in 2014–15 and 2015–16 financial years respectively, substantially fewer than the number transferred in 2013–14 (21%).

Around one third of the total available quota has been transferred each year since 2008–09, with the number of shareholders actively involved in trading also being fairly constant. These short term and long term transfers suggests that the share and quota markets are fairly healthy despite the current share transfer restrictions<sup>12</sup> and is not likely to be an impediment to economic performance in the fishery.

There has been little evidence of change in concentration of quota since 2008–09, with little consistent change in the proportion of catch taken by a given number of divers (noting that 2004–05 and 2007–08 as outlier years) (Figure A4.8).



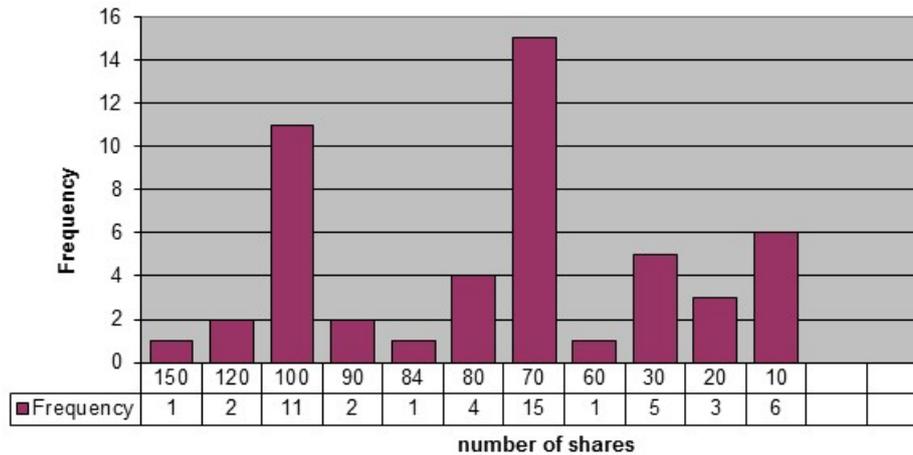
**Figure A4.8.** Cumulative distribution of quota uptake each year (proportion of total catch).

Another trading rule in the abalone fishery is the cap of 210 shares as the maximum number of shares that can be held by a single entity (person or business). This cap is aimed at preventing concentration of quota into a small number of operators with potential market power implications.

The number of shareholders owning 70 or more shares generally has declined over time, with 36 in 2016, but average shareholding size generally also is decreasing, rather than increasing. The number of non-fishing shareholders, with less than 70 shares, was 1 in 2000 and has increased to 15 in 2016 (Figure A4.9), suggesting that investors are engaging in the quota market as well as active fishers increasing their holdings. The 210 share cap could be considered unnecessarily restrictive as it is far smaller than would be necessary to prevent any near-monopoly situation. The Committee notes the Department's intention to amend the maximum shareholding to 40% of the total number of shares initially issued in the fishery, which should facilitate improved opportunity of rationalisation of the fishery.

<sup>12</sup> Newell *et al.* (2005), for example, concluded that the New Zealand quota market was operating efficiently with 5–10% of the total shares being transferred annually. Higher levels of quota leasing were observed, although this was largely from non-fishing quota owners to fishers.

Newell, R.G., Sanchirico, J.N. and Kerr, S. (2005). Fishing quota markets, *Journal of Environmental Economics and Management* 49, 437–462.



**Figure A4.9.** Distribution of shareholdings, August 2016.

### A4.7 Illegal and unreported removals

Previous reports by the Committee have discussed the loss of economic value from the fishery due to perceived high levels of illegal catch. Illegal take has been estimated previously to be as high as 40 per cent of legal take but the most recent compliance report suggests that there has been a downward trend in serious illegal abalone activity detected over the past five years.

The black market demand for abalone in NSW remains potentially high but also appears to have tapered gradually. A contributing mitigating factor affecting black market demand is the increase on the market of farmed abalone at a competitive price. The lower and more competitive prices of legally caught abalone and its availability on domestic markets also reduces the incentives for buyers to operate in the black market. Falling prices globally for abalone also reduce the incentive for illegal export operations. There appears some evidence that improved intelligence also is increasing the detection rate of illegal activity, perversely resulting in an apparent decrease in compliance rates (see Section A5.2.5). The compliance report also notes, however, that illicit buyers are becoming more attuned to fisheries compliance and new trafficking laws, which in turn is forcing the black market to be more secretive.

### A4.8 Recreational and Aboriginal catch

Recreational and cultural catch of abalone generates non-market values to the groups that participate in these activities. Studies to specifically estimate these values for abalone harvesting in NSW have not been undertaken, so it is not possible to quantify associated economic values.

Recent advice suggests that abalone are not often targets of recreational fishing *per se* but are harvested by recreational divers whilst targeting rock lobster (West *et al.* 2015)<sup>13</sup>. Recreational take of abalone is restricted to 2 animals in possession per-person. Estimates of total recreational catch in 2013–14 were 18,423 individuals (West *et al.* 2015)<sup>11</sup>, equivalent to around 5.4 tonnes assuming an average of 300g per individual. This catch was taken across three regions – Hunter, Sydney and mid-south coast, all north of Tuross Heads and hence in the “Northern” zone of the fishery. Commercial catch for 2016 in these areas was estimated to be 1.4 tonnes, substantially lower than the estimated recreational catch. The distribution of recreational fishing and the relatively low catch overall suggest that recreational fishing is unlikely to have material impact on the main areas of the commercial fishery. A better understanding of the economic value of recreational abalone fishing may help appropriate allocations to be made in those areas of higher recreational and low commercial harvest.

Aboriginal peoples’ connection to the fisheries resource was formally recognised in fisheries legislation through the introduction of a new object to the Act, distinctly from recreational and commercial fishing. The current policy makes special provisions for Aboriginal people to take twice the recreational bag limit (i.e. 4 animals in possession) with a special allowance of up to 10 abalone to provide for cultural needs where elders, the incapacitated, or other community members are unable to fish for themselves. Allowances also are made for cultural events in which greater numbers may be taken if an appropriate permit is obtained. There have been no attempts to equate an economic value to these cultural activities.

<sup>13</sup> West, L., Stark, K., Murphy, J., Lyle, J. and Ochwada-Doyle, F. (2015). Survey of Recreational Fishing in New South Wales and the ACT, 2013/14, *Fisheries Final Report Series*. NSW Trade & Investment, Sydney, pp 150.

#### A4.9 Community Contribution

The Community Contribution charge in the NSW Abalone Fishery was based on a decision by the NSW Government to return to society economic rent earned by abalone fishers. The Community Contribution for a fishing period is calculated annually and considers CPI, abalone beach price, and TACC. It is payable by each shareholder following each fishing period. The Community Contribution has been calculated at zero (\$0) since 2005–06 following declines in TACCs and average estimated beach prices.

The aim of the community contribution is to return some of the resource rent generated through fishing back to the community. Resource rent represents the economic profits being generated in the fishery once all costs, including unpaid labour and a normal return to capital, have been accounted for. The results of the earlier economic survey suggest that economic rent was being generated in the NSW Abalone Fishery in 2011–12, although that calculation excluded the costs of fisheries management. True economic rent is likely to be lower than was estimated through that survey, though it is unclear whether the actual value in 2016 would be zero. Some of this rent also is not true 'resource rent' that is a result of the natural resource being used (i.e. the abalone stock). The other types of rent — entrepreneurial rent that is attributable to the skill of the fisher and quasi-rent that is surplus that can occur for external reasons such as exchange rate fluctuations — should not be removed from the fishery.

Estimating how much of each of the different types of rent is present and, therefore, how much should be extracted from the fishery each year for Community Contribution is a complex task and has not yet been undertaken, and would not be feasible without detailed economic information on the fishery.

#### A4.10 Economic targets and performance indicators for the fishery

The Committee notes that the economic indicators and triggers in the Fishery Management Strategy for abalone lack specificity and relevance and fail to stipulate clear management responses to trigger point violations. These indicators and triggers need to be revised as a matter of urgency to make them more relevant to measuring the economic status of the industry.

The Committee notes that such indicators should be refined and expanded as a formal harvest strategy is developed and in any revised management plan for the fishery. Economic performance indicators for the fishery should relate to long-term profitability.

*The Committee **recommends** that a more meaningful set of performance indicators and economic reference points be developed as part of the proposed harvest strategy for the Abalone fishery.*

#### A4.18 Conclusion

The long-term outlook for the NSW Abalone Fishery remains uncertain in the light of increasing aquaculture production and the effect of cultured product on global prices. NSW abalone product is competing with strong market-place competition from aquaculture product nationally and internationally. Limited existing studies suggest consumers in the main export markets do not differentiate between aquaculture and wild product of the same size. Farmed product tends to be marketed at smaller sizes to avoid long grow-out periods and supply of larger individuals may be the best option for wild-harvest industries to differentiate their product from cheaper aquaculture product. There potentially are strong economic arguments, therefore, for increasing the LML for the NSW fishery.

Increasing the LML may require a trade-off of reduced TACC, at least in the short term. The committee suggests that these trade-offs be assessed through quantitative modelling to inform future TACC setting. *The Committee also suggests that industry investigates preferences for abalone on overseas markets and size–price relationships for abalone on those markets to inform future harvesting strategies.*

Quota markets appear to be functioning well, and autonomous adjustment seems to be occurring in the fishery. Information on quota trading and leasing prices would provide useful data for assessing the short term economic performance of the fishery and help inform future TACC determinations.

The Committee also notes that economic information for the fishery is lacking and recommends that steps be taken to develop a more routine economic data collection process. Analyses of such data would inform the setting of TACCs and size limits for harvest, increase or optimise returns from the fishery, and inform the risk–catch–cost trade-offs for investing in research and monitoring for the fishery.

The Committee notes that the economic indicators and triggers in the proposed Fishery Management Strategy for abalone are lacking in specificity and relevance. These indicators and triggers should be revised during development of a formal harvest strategy to make them more relevant to measuring the economic status of the industry.

## APPENDIX 5. MANAGEMENT CONSIDERATIONS — DETAILS

### A5.1. Data collection and stock assessment

#### A5.1.1 Recreational Fishing

Targeted surveys to estimate recreational abalone catch and effort would be required to provide robust estimates of total harvest, particularly if bag limits are increased (see below). Identifying an adequate sample size in small recreational dive fisheries is notoriously difficult and therefore expensive unless divers are identified through some type of registration such as a licence endorsement, as is the case in Tasmania. Experience in other jurisdictions would suggest that the costs of surveying divers would be prohibitively expensive without some way of identifying an appropriate target sampling frame. Consideration therefore should be given to licensing recreational dive fishing to enable cost-effective surveys of recreational catch and effort, or some other method of identifying divers should be implemented, such as formal endorsements or statements of intent on the existing recreational licence application forms.

The Department advises that both the former Abalone Management Advisory Committee and the Advisory Council on Recreational Fishing previously have supported an increase in the recreational bag limit for abalone from two to five. The Department has advised that it intends to consider this increase in future reviews of recreational catch limits but such a review has not occurred yet. It is noted that the Department does not intend to review other restrictions on recreational effort and that the restrictions on fishing only on weekends and adjacent public holidays in the area from Port Stephens and Wreck Bay Beach, and spatial closures around heavily populated urban areas, won't be lifted.

The Committee considers that the proposed change in bag limit may result in a significant increase in recreational harvest and in particular could cause localised depletion in areas adjacent to large population centres. This proposed change highlights the need to improve the accuracy of estimates of the recreational harvest, to assess the stock taking into account estimates of all fishing mortality, and for a decision-making framework against which to assess the risks of increased recreational catches. It also raises the possibility that recreational catch could materially affect commercial catches in some Areas. There currently is no resource sharing arrangement to manage such interactions.

The Committee considers that it would be prudent to delay any decision to increase the recreational bag limit until the current recreational harvest is known, regular monitoring of recreational catch is established, the extent of the recovery of the resource is better understood, and a management plan and harvest strategy for the fishery are in place to manage any increases in total catch and changes in relative share between the commercial and recreational sectors.

#### A5.1.2 Aboriginal Fishing

The current interim compliance policy for Aboriginal fishing allows an Aboriginal person to take up to 10 abalone to provide for cultural needs where elders, the incapacitated, or other community members are unable to fish for themselves. The arrangements apply by increasing an individual fisher's limit – it is not an accumulating limit related to the number of people for who the abalone are being provided.

Applications for Aboriginal cultural fishing permits can be made if Aboriginal people have a need to access the fisheries resource for larger cultural events. A written request to the Department outlining species and numbers proposed to be taken is required before aboriginal cultural fishing permits can be issued. Permits have been issued over recent years for:

- 3,890 abalone in 2009–10;
- 1,700 in 2010–11;
- 2,115 in 2011–12;
- 880 in 2012–13;
- 1,050 in 2013–14;
- 1,450 in 2014–15;
- 350 in 2015–16; and
- 300 in 2016–17, as at 31 August 2016.

It should be noted that permits are issued for a basket of species, not just abalone, and so it is unlikely that the full number taken will be all abalone. Advice from the fishery compliance officers is that actual take is significantly less than the amounts formally permitted, suggesting that such catch is unlikely to have a detectable impact on the resource.

There was some discussion with respect to fisheries prosecutions and native title defences that are available. These issues do not relate to setting a TACC unless the effect was that additional catch was taken that was not already accounted for under the omnibus estimate of illegal harvest, and this was not considered to be an issue at this time.

### **A5.1.3 Commercial Fishing**

Formal catch and effort information is collected through regulated logbooks and managed in a Departmental database (the quota management system). The data logger program is implemented by the Abalone Council of NSW as a service provider to the Department. Data loggers are not mandatory but are used by a majority of divers. The Abalone Council of NSW (and specifically one of its Directors, Duncan Worthington) provide scientific services under contract to the Department, using the Department's catch and effort data and the logger data.

The stock status sections of this report discuss in detail the commercial fishery data and their implications, and the shortcomings in the available data and analysis.

The Council's presentation to the Committee and subsequent provision of data on request built on the feedback from last year, with some useful simplifications in presentation. Nevertheless, it is still the case that work is needed to identify the key indicators that should be used in decision-making, to standardise and document how the data will be treated, and decide what analyses would best inform the management of the fishery. This should be done through the development and implementation of a harvest strategy.

## **A5.2 Current management arrangements for the commercial fishery**

### **A5.2.1 Quota management system, size limits and finer spatial scale management**

The core management arrangements in the commercial abalone fishery are the system of individual transferable quotas and Minimum Legal Length (LML) regulations. The history of these management tools is outlined in previous reports. These measures are relatively blunt instruments for managing an abalone fishery in the absence of explicit spatial management arrangements. Species like abalone with relatively low movement among local populations often have different recruitment, growth, and productivity characteristics in different areas and also are vulnerable to 'hyper-stability' of catch rates where catch rates can continue to appear healthy or stable as successive local populations are targeted even though the stock overall is declining. The existing management tools need to be applied differentially, at a finer spatial scale, to be more effective and appropriate to the abalone fishery.

#### ***Spatial management***

NSW has implemented some finer scale management of the commercial abalone fishery, to a small extent, with voluntary catch caps for Areas and two LMLs, 117mm for most of the fishery and 123mm from Wonboyn south. This spatially explicit management system is being developed and implemented informally, however, without penalty for non-compliance. The industry is to be commended for the progress that has been made in this environment but the system requires further work to improve its consistency, rigour, transparency and, ultimately, its effectiveness at regulating catch spatially. The last two years of fishing have demonstrated that voluntary caps have not been implemented to keep fishing levels at those recommended by the Committee for some Areas.

The proposed comprehensive management regime has been described in various reports and correspondence in recent years. Having rigour in the spatial management system is particularly important to ensure that past patterns of localised overfishing and serial depletion are not repeated as the fishery rebuilds and TACCs increase. The Department last year indicated a willingness to implement a "Northern quota" and "cap and close" arrangements at the Area level in conjunction with the TACC determination as an interim step towards full spatial management arrangements. This was considered as a way of enabling the additional TACC to be allocated with measures in place to prevent the catch being taken from Areas of uncertainty and potential stress (Areas 14-18 at the time). That was exactly what happened, however, with the additional 5t by which the TACC was increased last year being taken in the south of the fishery in Areas from which catch was intended to be diverted.

There have been further discussions this year about the relative merits of a Northern Zone quota. The discussions at the open meeting would suggest that there is broad industry support, although with some different understanding in whether the preferred model is two separate quota zones – north and south – or the existing statewide quota zone overlapped with a separate and additional northern quota. The Committee has a view that two distinct and not overlapping quota zones is a more direct way of limiting

catch but, irrespective of design, the priority is that a system is agreed and can, or will, be implemented as recommended with the TACC Determination, preferably as part of the Determination.

Fundamental to implementing a regime is determining the spatial scale at which caps will be set. Previous reports detail discussions about setting caps at an Area level and again this report uses Area as the unit for analysing and setting a cumulative catch limit. The Committee considers this a useful unit of management but acknowledges that there can be other workable options in terms of spatial unit. It is a priority to agree and implement a consistent spatial unit, irrespective of what it is, that will be the subject of both Departmental and Industry management and reporting and that can be used to set future TACCs.

#### **A5.2.2 Management plan and decision-making framework**

The current management plan is obsolete. It does not reflect the status of the stock, changes in monitoring and assessment, or (informal) implementation of fine scale approaches and knowledge of the resource, and it contains inappropriate targets and indicators.

The fishery has no long-term objectives, meaningful indicators, or reference points, which materially impacts TACC decisions (e.g. what rate of rebuilding is desired, what trade-offs should be made between total yield, catch rates, or range of size classes available). Defined objectives for the fishery and, in particular, the operational objectives contained in a harvest strategy would guide these decisions and inform the balance of the various risks.

The lack of a meaningful harvest strategy and management plan leaves the fishery in a very uncertain management environment. There is no structure to maximise the benefit from the fishery in the medium to long term and no basis on which to make decisions about the appropriate level of investment in either the fishery's management or fishing businesses. Lack of guidance to the decisions that can be made mean that there is no explicit choice between growing the fishery to its potential or, alternatively, to stabilise it more conservatively at some lower stock levels.

The Department's initial work to prepare a draft interim harvest strategy was seen as a significant step forward in meeting the deficiencies in the current management arrangements. That work has not progressed but, ideally, the ongoing harvest strategy will sit within a revised management plan for the fishery, which the Committee continues to recommend. The revised management plan should, among other things, formalise the co-management arrangements in place for the abalone fishery and establish appropriate governance mechanisms to ensure agreed regulatory mechanisms function as intended.

The Committee is firmly of the view that the development of a harvest strategy is a role of fisheries management. Science is fundamental to a good harvest strategy but it is not the only factor. Harvest strategy development should be led by fisheries managers skilled in bringing the players together and creating an objective-driven framework that provides structure for trade-offs and risk-weighted decisions, informed by appropriate research and monitoring.

#### **A5.2.3 Co-management**

The history of industry involvement in the management of the fishery has been documented in previous reports. The relationships between government and industry has at times been acrimonious. The industry appears to be moving to a greater level of consensus now that the stock is improving and cautious TACC setting is appropriate but the advisory and co-management processes remain relatively unstructured. Standard governance arrangements such as the use of independent chairs, Departmental oversight of industry driven research, communication protocols, peer review processes, etc., have been identified in the past for consideration.

It is important that the Department has full access to the fine scale logger information for assessment, management, and governance purposes. There have been assertions from industry previously that finer scale data are the 'property' of industry. This issue needs clarification. The Department will not be in a position to audit the quality or even understand the basis of the industry recommendations on catch levels and Area management without access to the fine scale data. The arrangements need to be sustainable beyond a particular service provider.

#### **A5.2.4 Fees**

The abalone fishery is subject to the Government's policy on cost recovery whereby shareholders must meet all identified management costs attributable to the commercial fishery, less any savings passed on to shareholders. Management charges are payable by each shareholder in proportion to shareholdings. The management charge is reviewed and re-determined on annually. The management charge for 2016–17 was not yet determined at the time of writing this report.

Abalone shareholders may be required to make an annual Community Contribution for the right of access to the fisheries resource, similarly to other share management fisheries but the community contribution for the abalone fishery has been set at \$0 since 2005–06.

The abalone fishery has declined in value over the last ten years mainly due to the increasing value of the Australian dollar and declining market prices, partly as a result of increasing competition from farmed abalone. These trends have been detailed in previous Committee reports, as have the large reductions in fees that have been made in response to the industry’s capacity to pay and the negotiated debt recovery process to mitigate the impact of large accumulated unpaid fees. The management charge for 2014–15 was \$62.81 per share and was \$68.37 for 2015–16, increasing by 8.8% between periods. This equates to industry contribution of 5.87% of the nominal estimated GVP for 2014–15 and 6.64% of the 2015–16 nominal estimated GVP, based on data available to 30 June 2016.

It is not unusual for small fisheries like the NSW abalone fishery to attract considerably larger proportional levies due to diseconomies of scale, especially during times of low economic returns from the fishery, but this is not the case for the abalone fishery at this stage.

The Committee has noted before that the decision to drastically reduce funding for research and monitoring in 2008 had over-whelming support from share-holders but also notes that that decision has left the fishery in a difficult position with respect to management decision making. The consequences of the reduction and the flow-on effects to the task of setting a TACC have been discussed extensively in previous reports and we note again here that absence of robust assessments will continue to constrain TACC setting whilst ever this low investment persists.

An immediate priority for the fishery is the development of a harvest strategy, led by an experienced person with fisheries management expertise. Insufficient resources are allocated to fisheries management currently (less than 0.5FTE) as part of the cost recovery process to lead such development. It is in the industry’s and the fishery’s interests that this work is resourced – whether that be through licence fees or some other mechanism.

**A5.2.5 Compliance**

Reporting on compliance and infringement detection rates is notoriously difficult as improvements in the targeting of compliance effort can lead to more offences being detected, which then can appear as higher levels of non-compliance when reported statistically in the same way as infringements detected from random compliance inspections. Use of an intelligence-led approach should lead to a higher rate of detections and therefore seemingly lower rates of compliance, at least initially. It is difficult to draw conclusions from crude ‘compliance rate’ information, therefore, without supporting qualitative explanations or separation of metrics from intelligence-driven targeted enforcement from more routine ‘on patrol’ compliance data. The Committee has recommended previously that the Department investigate presenting the available statistics in terms of both compliance rate and detection rate, and present the data with the relative amount of compliance effort applied each year, to allow more meaningful comparison across years. There are difficulties with this approach but the explanatory notes in the report help to explain the raw data. Compliance rates for each sector in recent years are set out in the Table A5.1.

**Table A5.1.** Compliance rates by sector.

Compliance activity type	Compliance Rate			
	2012–13	2013–14	2014–15	2015–16
Unlicensed and recreational	56%	69%	73%	63%
Licensed commercial	71%	51%	64%	52%

The licensed commercial compliance rate of 52% is consistent with a downward trend in compliance rate over the last ten years from a high of 94%. All offences reported in 2015–16 were infringement notices and the overwhelming majority of these related to the administration of the quota system and catch returns. Compliance with these rules is fundamental to managing the fishery and therefore the Department’s compliance efforts are important. Non-compliance with the administrative systems creates risks for the sustainability of the fishery and also adds to the costs of management. It is very positive, nevertheless, that none of the offending within the licensed sector relates to intentional quota fraud, breaching size limits, or other serious offences.

The Committee is satisfied that the trend in decreasing compliance rate in fact reflects improved compliance practices and the efficiencies that they bring through intelligence-led and risk-based 'policing'.

The 'unlicensed and recreational' compliance rate includes offending by fishers undertaking genuinely recreational fishing, either with or without a licence, as well as intentional illegal fishing of a commercial nature but that is unlicensed. The rate (63%) has decreased significantly compared to 2014–15 but is within with the range seen over the last ten years of 75%–56%, with average 67.9%. The most common offences in the unlicensed sector were recreational offences, including 'possess prohibited size fish' and 'exceeding possession limit'. This is similar to last year. There are fewer but still significant numbers of high-end offences including trafficking and obstructing, assaulting, or resisting a fisheries officer. This reflects the continuing specialised operations carried out by the Department and reported to the Committee (to the extent possible within the confines of confidentiality).

The compliance report notes that the Department continues to develop more efficient targeting and an added emphasis on specialised compliance teams that focus their efforts on deliberate non-compliance and recidivist offenders. This strategic approach entails a reduction of inspections on low risk divers with an added focus on inspections of higher risk divers, which is a more effective strategy but appears as low compliance rates due to the way the statistics are presented.

It is noted that interest in 'genuine' recreational abalone fishing activity remains low. The bag limit of 2 per person has seen the majority of recreational abalone activity being conducted as by-catch to other targeted fishing activity, such as snorkel divers taking their bag limit of abalone as by-catch to lobsters they are targeting during the inshore lobster season.

Aboriginal fishing levels have increased under the new arrangements but remain at relatively low levels.

Table A5.2 shows the allocation of compliance efforts in recent years. The reducing effort in the licensed commercial sector reflects the risk-based, intelligence led approach and the fact that fewer major abalone operations have required intensive compliance effort in recent

**Table A5.2.** The amount of compliance effort put into the abalone fishery in recent years.

Compliance activity type	Compliance Effort (hours)				
	2011–12	2012–13	2013–14	2014–15	2015-16
Unlicensed and recreational	4670	4790	3189	2390	2090
Licensed commercial	1478	1654	452 (37 QA inspections)	402 (33 QA inspections)	461 (27 QA inspections)

The Committee appreciates the difficulty in accurately defining the illegal catch of abalone from NSW waters. It seems clear, however, that the reduction in the recreational bag limit to two abalone per day has reduced occurrences of the "small scale" poacher who relied on taking multiple recreational bag limits of 10 (the previous daily bag limit) to make their illegal activities viable.

#### **A5.4 Total Allowable Commercial Catch (TACC) for 2017**

The Committee last year made a moderate increase to the TACC to 130 tonnes with explicit explanation of the importance of a spatial management regime to be implemented at the same time as the increase, to ensure that the additional catch was taken from the Areas of the fishery that are lightly used. The Committee noted that "... if [neither] the requisite 'northern zone quota' nor the 'cap and close' arrangements are in place for 2015, the impact of the 130t TACC on the fishery could be to further slow the rate of recovery for the fishery and in particular in some Areas. Future TACC determinations will take this into account." The continued absence of any formal spatial management arrangements means the Committee is bound to take an appropriately precautionary and conservative approach to setting future TACCs.

## APPENDIX 6. BACKGROUND INFORMATION

### A6.1. Introduction

This appendix provides a brief description of the New South Wales abalone fishery, including outlines of recreational and aboriginal sectors of the fishery and some relevant notes on the history of commercial fishing and changes in management arrangements. Reference also is included to the relevance of coastal marine parks to the fishery and the standing of the fishery as an approved exporter of a native species under the Environment Protection and Biodiversity Conservation Act (1999).

### A6.2 The stock

The NSW abalone fishery targets a single species, the blacklip abalone, *Haliotis rubra*. *H. rubra* is an Australian abalone reaching 200mm shell length and found around the southern coasts, from Fremantle in Western Australia to northern New South Wales, including around Tasmania. It is harvested commercially in South Australia, Victoria, Tasmania, and New South Wales.

Abalone generally are relatively sedentary once settled from the plankton to rocky reef habitat, typically in relatively shallow coastal waters. They have short duration larval stages with generally limited distribution between spawning and settlement. The stock(s) thus exist as meta-populations of largely discrete local sub-populations with relatively little and infrequent exchange. This characteristic makes abalone especially susceptible to localised depletion and serial over-harvest of entire stocks.

Estimates of the total biomass of *H. rubra* in NSW remain highly uncertain and there is no current formal stock assessment modelling done for harvest of the stock.

### A6.3 The Fishery

Abalone in NSW are gathered individually by hand by free-diving recreational divers or commercial divers using surface-supplied air or SCUBA. The commercial fishery is very targeted and no by-catch is taken while harvesting abalone.

NSW fisheries are managed under the *Fisheries Management Act 1994* which requires management to ensure ecologically sustainability. Abalone management provisions are specified in the *Fisheries Management (Abalone Share Management Plan) Regulation 2000*, *Fisheries Management (General) Regulation 2010*, and *Fisheries Management (Supporting Plan) Regulation 2006*.

#### A6.3.1 Commercial fishing

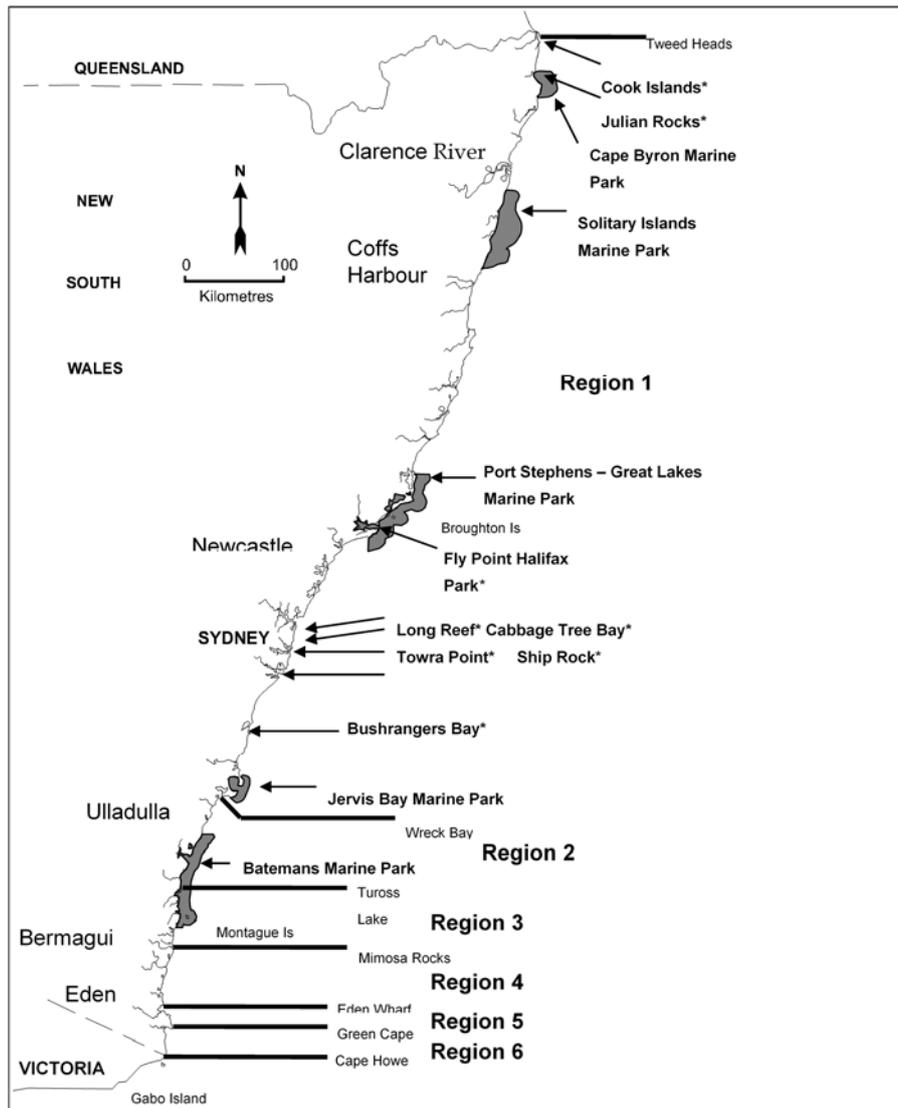
The New South Wales commercial abalone fishery was established in the early 1960s and annual production peaked at approximately 1250 tonnes in 1973. The status of the abalone stock and annual production has declined steadily since to the extent that the Total Allowable Commercial Catch (TACC) was less than 10% of peak production for several years and only recently has risen to above 10% of peak production. The NSW Abalone Fishery is currently classified as 'overfished-recovering' in the Status of Key Australian Fish Stocks Report 2014.

The fishery extends from Forster in the north to the border with Victoria in the south and is categorised into 6 main regions with many zones and sub-zones at smaller scales (Figure A6.1). The bulk of the commercial catch of abalone since 2002 has been harvested south of Jervis Bay.

The abalone fishery has seen significant change particularly in the last ten years. The fishery has moved from free fishing through the 1970s, to many years at 300 tonne total allowable commercial catch (TACC), size limit introductions, TACC reductions from 300 to 200 then around 100 t by 2007–08 and then 75 tonnes in 2009–10. The annual TACC has increased steadily since and currently is set at 130 t. A Legal Minimum Length (LML) for harvest of 117mm was introduced in July 2008 and subsequently increased (south of Wonboyn) to 120mm and then 123mm in 2010 and 2013 respectively.

The number of shareholders and divers in the fishery has decreased since the introduction of limited licensing in the late 1970's through the introduction of the share management system in 2000 and subsequent operation of that system under decreasing TACCs. There are currently around 48 shareholders with shareholdings ranging between 10 and 160. Thirty eight shareholdings currently hold sufficient shares (70) to be eligible for an endorsement to fish.

The value of the fishery has improved recently from historical lows in the mid-2000s. The industry continues to face variable and challenging circumstances and is especially vulnerable to exchange rate fluctuations and increasing competition and price pressures from aquaculture product in its primarily international markets.



**Figure A6.1.** The NSW Coast showing marine parks and regions by which the commercial abalone fishery is classified by the Department of Primary Industries. Figure courtesy NSW DPI.

### A6.3.2 Recreational fishing

There are about one million recreational fishers in New South Wales. A licence is required, although exemptions exist for many sectors of the community, such as children and retirees. The recreational sector pays approximately \$12,000,000 in licence fees for all forms of fishing.

Recreational fishing for abalone is restricted to taking by hand whilst free-diving without any assistance from SCUBA or hookah equipment. A daily bag and total possession limit of two abalone applies and recreational fishers are subject to a Minimum Legal Size limit for harvest of 117 mm throughout the state. The bag limit was reduced from 10 to 2 abalone per person per day in July 2005. This has had a profound effect on the recreational harvesting of abalone in NSW in that few recreational fishers now are believed to targeted abalone as their primary target. The lower bag limit also effectively prevented the illegal sale of frequent repeat catches taken under the guise of bona fide recreational fishing.

Estimating the number of people who target abalone and how many abalone they catch is the subject of regular and ongoing discussion, with existing estimates having very low precision. Recreational Trust funded fisher surveys are providing some data regarding the recreational harvest of abalone. Initial results from the survey confirm that recreational take of abalone is likely to be low but the estimates are statistically imprecise. The catch now is estimated to be approximately 10 tonnes. Recreational catch of abalone was estimated to be approximately 50 tonnes annually prior to the reduction of the bag limit.

Some areas previously closed to recreational harvest of abalone were opened for recreational fishing in recent years. The area between Botany Bay and Wreck Bay was opened to recreational fishing on

weekends and adjacent public holidays from August 2010 and the area between Port Stephens and Botany Bay was opened to recreational fishing under the same arrangements in March 2012. These changes permit recreational fishing for abalone in areas adjacent to large population centres and are likely to have increased the level of recreational harvest slightly, though still within the estimate of 10 t.

### A6.3.3 Aboriginal fishing

Aboriginal peoples' connection to fisheries resources was recognised formally in fisheries legislation in 2010 through the introduction of a new object to the *Fisheries Management Act 1994*. Aboriginal cultural fishing is now articulated in the Act, distinct from recreational and commercial fishing.

Section 21AA was inserted into the Act at the same time but has not commenced. That section provides regulatory powers to apply limits to the special cultural fishing provisions, including bag and possession limits or other management options. Regulations cannot be made under section 21AA without consulting the Aboriginal Fishing Advisory Council (AFAC). Consultation with AFAC and a broader cross sector working group has commenced to develop proposals to balance sustainability with the needs of Aboriginal people, recreational fishers, and the commercial industry.

An interim compliance policy is in place to capture the spirit of this yet-to-be-commenced provision of the Act. The current interim compliance policy allows an Aboriginal person to take up to 10 abalone to provide for cultural needs where elders, the incapacitated, or other community members are unable to fish for themselves, or twice the recreational bag otherwise. The arrangements apply by increasing an individual fisher's limit – it is not an accumulated limit related to the number of people for who the abalone are being provided. The interim arrangements also allow for shucking of abalone, rock lobster, and turban shell within 100 metres of the high water mark but only if the animals are consumed in that area.

The policy applies to cultural fishing in State waters, including appropriate zones of the NSW marine parks. All other fishing activity, possessions, and gear must comply with the current fisheries legislation.

An application for an Aboriginal cultural fishing authority under section 37(1)(c1) of the Act also can be made if Aboriginal people wish to access fisheries resources for larger cultural events where the amended daily bag and possession limits would be exceeded. Section 37 permits provide defences against some aspects of the fisheries laws, subject to conditions. Fisheries Officers report that the actual take under the small number of issued permits generally is less than the maximum permitted.

### A6.4 Marine Parks

Marine sanctuary zones make up less than 7% of NSW state waters and cover a range of estuarine and marine habitats including those with mud, sand, and rocky substrata (Figure A6.1). Well under half the area of sanctuary zone would include habitat suitable for abalone and these areas would cover a range of depths from the intertidal to around 80 metres, beyond the depths from which abalone are taken.

All six coastal marine parks include sanctuary zones over reef area likely to provide habitat for abalone. Abalone shares were purchased by government in amounts estimated to be proportional to catch from grounds lost to the fishery in three of these parks (246 shares in total). The TACC and management charges for commercial shareholders were adjusted accordingly.

It is likely that there would be an increase in the number and size of abalone in sanctuary zones following closure to fishing, though those increases would stabilise over time due to the effects of intraspecific competition and habitat limitations. Abalone are relatively sedentary as adults and have a relatively short larval life dispersal over generally short distances. It is unlikely therefore that spawning within sanctuary zones would materially affect populations beyond habitats close to sanctuary zone boundaries.

It is unlikely that current marine sanctuary zones have significant influences on stock assessments and TACC setting processes for abalone, given the relatively small size of the sanctuaries, the small percentage of them in depths preferred by abalone, and the localised population dynamics of abalone.

### A6.5 EPBC Act Assessment of the NSW Abalone fishery

The NSW Department of Primary Industries first gained export approval for abalone under the Federal Environment Protection and Biodiversity Conservation (EPBC) Act (1999) in 2005 and gained renewed approvals in 2008 and 2011. Export approvals have been annual since 2014 and the current approval expires in August 2017. Important factors influencing export approval include consideration of management arrangements and precautionary measures currently in place for the fishery, including annually reviewed total allowable catch limits, limited entry, recreational bag limits, minimum size limits, area closures, and fishing method restrictions.