

# **NSW Total Allowable Fishing Committee**

## **Report and Determination for the 2020 Fishing Period**

### **SEA URCHIN AND TURBAN SHELL RESTRICTED FISHERY: Red Sea Urchin**

**04 November 2019**

# EXECUTIVE SUMMARY

## Preamble

The NSW Total Allowable Fishing Committee (the Committee) has responsibility under the NSW Fisheries Act (1994, No. 38) to determine the Total Allowable Commercial Catch (TACC) of red urchin (*Heliocidaris tuberculata*) by NSW commercial fishers holding endorsements for the Sea Urchin and Turban Shell (SUTS) Restricted Fishery. This determination is for the period 1 January to 31 December 2020. The determination is based on information available about the red urchin stocks, reports from fishery managers, comments from fishers, and input at a public forum in Sydney on October 9<sup>th</sup> 2019.

The red urchin fishery is part of the SUTS multi-species restricted fishery that is managed by a combination of input controls (endorsements to take all species) and individual quotas for red urchin. A TACC and annually distributed individual transferable quotas (ITQs) are applied only to red urchin. There have been 37 SUTS endorsement holders since 2002. Each endorsement has received an annual allocation of red urchin quota of 1,622 kg, being an equal share of the overall 60 t TACC. The TACC has not changed since 2002. The red urchin ITQ is not divisible nor separable from the SUTS endorsement and ownership cannot be transferred amongst endorsed fishers but quota can be leased within years.

## Determination

Current management arrangements for the SUTS fishery are not well-suited to effective operation of a TACC-ITQ system, in which commercial transfer of ITQs is expected to optimise fishery operations within the limits of a TACC. Annual uniform distribution of the TACC among endorsed fishers and operational obstacles to permanent transfer of ownership of red urchin “ITQs” mean the Committee is faced with setting TACCs that are economically fair whilst also limiting harvests to biologically acceptable levels. Current management arrangements for the SUTS fishery in general, and the red urchin harvest in particular, mean these two criteria lead to misaligned conclusions.

The biologically preferred TACC under current management arrangements is significantly less than the 60 t that was set in 2001. The allocation of the TACC evenly among SUTS licence holders and limited opportunity for quota transfer, however, means that a reduced TACC will constrain disproportionately the most active fishers, who cannot acquire additional quota other than through annually repeated (and so inefficient) leasing arrangements. Changes in TACC will have no impact on those fishers that do not take red urchin but will continue to hold (unused) quota, effectively meaning that a significant proportion of quota sits in latent holdings. The association of biologically-based Regional Catch Limits with a notional TACC does allow regulation of total harvest of red urchins whilst balancing economic fairness, albeit via a sub-optimal combination of regulatory instruments.

The Committee accordingly has determined that:

1. The notional Total Allowable Commercial Catch of red urchin by NSW commercial fishers during the 2020 fishing period should not exceed 60 tonnes (t);
2. Regional Catch Limits (RCLs) be applied that do not exceed 22.5 t in aggregate, with catches from Regions 1–5 capped at 2.5, 7.5, 6.5, 6.0, and 0 t respectively.

The notional TACC will preserve economically viable access to the fishery by those businesses dependent on harvesting red urchin, whilst the RCLs will ensure the landed catch will not exceed that considered biologically prudent given available information. Both the TACC and the RCLs are above most annual total catches reported since 2002, implying little prospect of material constraint on fishing activities similar to recent history. The determination is set on advice that unreported commercial catches, catches by aboriginal fishers, and recreational catches likely are less than 5 t.

## Recommendations

The Committee provides the following recommendations to the Minister, the Department of Primary Industries (the Department), and the SUTS fishery industry (Industry), in addition to the above Determination components, towards improving performance of the fishery.

**Recommendation 1:** The existing Legal Minimum Size limit for commercial harvest of red urchins be revised from 115 mm test diameter to 100 mm test diameter for the 2020 fishing period.

**Recommendation 2:** The Department and Industry commission research to assess the appropriateness of the Minimum Legal Size (MLS) limit, with particular attention to its effect on marketable catches and its level of protection of individuals for some time at maturity before entering the fishery.

**Recommendation 3:** The Department and Industry resolve a strategy for permanent transfer of red urchin quota independently of SUTS endorsements to allow optimisation of the red urchin fishery by real operation of Individual Transferable Quotas (ITQs) within the TACC and RCLs.

**Recommendation 4:** The Department and Industry continue to seek improved mechanisms to facilitate efficient lease of quota within fishing periods, specifically making it easier for endorsement holders to identify and contact each other to explore lease options.

**Recommendation 5:** The Department and Industry explore options for efficient implementation of Region-specific quotas such that each endorsement holder has some quota available for each Region and that leased or owned quota can be used only in the Region to which it was allocated.

**Recommendation 6:** The Department and Industry complete rigorous targeted surveys of red urchins in areas historically closed and open to fishing to estimate current population densities of harvested and protected populations in each Region and investigate the feasibility, costs, and potential benefits of rotational fishery closures, which potentially could support higher sustainable catches.

**Recommendation 7:** The Department extend application of the Legal Minimum Size limit for harvest of red urchins to recreational and Indigenous harvest.

**Recommendation 8:** The Department and industry develop a harvest strategy for the red urchin fishery with specific biological and economic objectives linked to target reference points and an associated code of conduct to guide Industry best practice in the red urchin fishery.

## Stock Status

There is little recent information from which to infer the current state of the red urchin stock, though improved assessment analyses provided this year have clarified several uncertainties in assessing stock status. The commercial catch rate now is expected to be a more reliable indicator of stock abundance than previously inferred because of these improved analyses.

Previous research demonstrated that severe depletion of stocks could occur quickly (months) under heavy fishing. Recent analyses suggest the history of red urchin catches and catch rates are consistent with that work and that peaks in harvest are followed quickly by reduced catch rates, and probably stocks, to relatively low levels. There is no definite information about the rates at which depleted populations rebuild but available indirect information suggests rebuilding is slow in the face of even low rates of harvest. Anecdotal evidence from divers suggests that population densities in fished areas remain perhaps at 50–25% of those in closed areas, indicating that even the low level of red urchin harvest since 2002 has kept local populations at levels well below unfished stocks.

It is reasonable to infer that about 2/3 of the red urchin stock has been outside closed areas. The persistent closure to urchin harvest of about 1/3 of the NSW coast will have protected mature, largely unfished, populations of red urchins in each Region and those protected populations likely provide some replenishment of depleted populations in fished areas. This conclusion relies on research suggesting that larval dispersal is widespread and that there is very limited movement of post-settlement urchins.

The Committee previously concluded that a TACC of 15–40 t is appropriate biologically for the currently accessible stock. The recent analyses provided to the Committee suggest a TACC nearer the lower end of that range (15–25 t) would be prudent, notwithstanding introduction of a Minimum Legal Size (MLS) limit for harvest. Limiting commercial harvest to this order accounts for apparent reductions in stocks in fished areas by low-level harvest during 2002–15 and somewhat higher catches since 2016.

Red urchin biomass varies among Regions in the fishery and the catch history indicates likely variation in productivity among Regions. Regions 3 and 4 perhaps are able to sustain higher harvest rates than other Regions. It will be important to implement a limit on red urchin catches that distributes harvest among regions appropriately, based on historical estimates of biomass and indicated productivity.

An appropriate and properly managed rotational harvesting strategy likely would increase the sustainable harvest of red urchins but would need to be implemented carefully with robust, evidence-based criteria for opening and closing areas to yield sustainably increased harvest.

## Economic Considerations

Few fishers are SUTS-only fishers, with most SUTS endorsement holders also holding quota for the abalone fishery. Activity in the SUTS fishery by many of the latter is incidental to taking abalone. Less than one third of endorsed fishers have harvested red urchin in most years since 2002, although the

proportion of fishers engaged in the red urchin fishery is increasing. There therefore is substantial latent capacity in the red urchin fishery, and increasing prices are likely to result in increased fishery activity.

Unit prices for red urchin are high compared to prices for other SUTS species but the relative abundance of the species is low, access to the stock is especially weather dependent, and many fishers focus more on the more accessible and abundant purple urchin. Harvest of red urchin mostly is seasonal, with most harvest in winter when purple urchin generally have poor quality roe.

There are few economic data for the SUTS fishery or the red urchin harvest but available estimates indicate that red urchin sales now comprise approximately 47–55% of the Gross Value of Production (GVP) from the SUTS fishery. Relationships between price and catch of red urchin suggest that catch responds to, rather than drives, market price, which seems largely determined by external factors. Continuing increases in price therefore likely will result in increased activity in the fishery.

A fundamental requirement for an effective ITQ system is divisibility and a well-functioning quota market. Neither exist in the red urchin fishery, impeding severely optimisation of the fishery and realisation of the TACC or RCLs. Changes in the red urchin TACC without these conditions will impede fleet rationalisation and autonomous fishery adjustment. This will mean that economic impacts of TACC adjustment will fall disproportionately on the small sub-set of businesses for which harvesting red urchin is an important source of income, with little or no efficiency gain to the fishery.

The Committee recommends that Industry and the Department resolve a strategy for permanent quota transfer independently of SUTS endorsements and implement an effective quota trading facility.

## Management Considerations

There is no management plan or formal objectives for the SUTS fishery or red urchin harvest to guide decision-making. The TAC Committee in making its decision in 2001 (for 2002) reported that managers then articulated the following fishery objectives:

- To develop the fishery in a controlled manner;
- To prevent localised over-fishing; and
- To develop an understanding of the resource.

The red urchin TACC is divided equally between all licence holders in the SUTS Fishery and the resulting individual quotas are allocated at the beginning of each fishing period. Sixteen of the 37 fishing businesses with SUTS endorsements reported SUTS catch in 2018, 12 of which landed red urchin.

Quotas are not unitised and are not transferable separately from the SUTS licence. This dependency represents a material constraint on the consolidation of red urchin quota since endorsement holders taking other SUTS species are unlikely to transfer the entire endorsement to transfer red urchin quota.

The commercial fishery is divided into Regions, Zones and Sub-zones. The Committee in 2001 allocated the TACC to the five fishery Regions in proportion to the estimated biomass at the time: Region 1, 8 t; Region 2, 28 t; Region 3, 13 t; Region 4, 11 t; Region 5, nil. Catch has never reached Regional catch limits or the TACC.

A number of spatial fishing closures apply to the fishery, including marine parks, aquatic reserves and Intertidal Protected Areas (IPA). Many sub-zones have been closed to urchin fishing since 1994, and the entire southernmost Region (Region 5) effectively has been closed since the 0 t TACC was set in 2002.

The Committee also recommended that a system of rotational spatial closures of fished sub-zones be set within each Region to protect the stock from over-harvest. Three closures were implemented in 2002 and opened about 2007 but no other rotational closures have been applied.

Compliance rates in the SUTS fishery have increased over the past 4 years to 61.5% in 2018, and Compliance Officers advised that red urchin fishing does not represent a material compliance risk.

The commercial red urchin fishery is limited by a number of factors:

- Red urchins generally occur in shallow waters of <6m depth and are difficult to harvest;
- Management arrangements are inflexible and inhibit adjustment within the fishery; and
- There is no easily accessible market or mechanism for trading quota, meaning a lack of incentive to invest in market development.

Red urchin is a major source of income for relatively few fishers, with divers reporting an average of 25.6 days fished in 2018. Some fishers have expressed a desire to develop the fishery but frustration at the difficulty in acquiring additional quota either through annual leasing or permanent purchase. Quota leasing recently has been made easier and more efficient through online tools, resulting in 9.7t of quota

being leased in 2018 — the highest amount leased in a single year yet. Nonetheless, the lack of a public register of quota holders remains a limitation on more efficient quota leasing. It is desirable that quota rights to the fishery consolidate to a smaller number of licence holders who regularly target red urchin. Optimisation is impeded severely by existing management arrangements that obstruct trading of red urchin quota independently of SUTS endorsements.

Significant increases in the market price of red urchin and some additional development in the domestic market have resulted in increased targeting and catch of red urchin by SUTS fishers over the last 4 years. The high level of latent quota currently in the SUTS fishery means there is a risk that targeting and catch of red urchin will continue to increase, further eroding the available biomass.

The Committee commends the Department for their recent introduction of enforceable Regional Catch Limits (RCLs) and a Legal Minimum Size (MLS) Limit for urchins. These two mechanisms provide important protections to prevent spatial depletion within regions, and to protect the smaller red urchins through to spawning. Industry reports, however, that the implemented MLS is constraining harvest severely and the only known relevant research publication indicates that the MLS legitimately could be reduced from the 115 mm set last year to 100 mm test diameter, pending further verification.

Issues with the equal quota allocations fixed to SUTS endorsements remain, however, despite these improvements. The Committee therefore recommends that management arrangements for the fishery be reviewed. Consideration should be given to making red urchin quota transferable separately from the SUTS licence to which it is attached to enable rationalisation of the red urchin catch to a smaller number of entitlement holders. It is recognised that transitioning to share management takes time and is costly, which may be difficult to justify for such a small fishery. Other potential reform mechanisms also should be considered, therefore, to allow improved economic and biological outcomes in the red urchin fishery.

## Conclusion

A TACC-ITQ system will operate optimally and equitably only if individual quota can be traded efficiently both within fishing periods (via lease) and in the long term through transfer of quota ownership. Each of these options are constrained in the SUTS fishery. A low TACC under the current management regime would precipitate significant reduction in quota allocations per endorsement. There currently are material procedural or regulatory impediments to efficient quota trading by which active fishers could redress such a cut so it is likely TACC reductions will affect active red urchin fishers disproportionately and inequitably.

The Committee nevertheless is concerned to secure red urchin populations for on-going harvest, with particular reference to the Regional distribution of biomass and history of exploitation.

A strategy that balances the need to regulate harvest of the fishable stock prudently whilst protecting against inequitable economic effects is to:

1. Retain the current notional TACC (60 t) to secure reasonable initial quota allocations to active red urchin fishers; and
2. Set Regional Catch Limits to biologically appropriate levels (22.5 t in total, below) to ensure total harvest is within likely appropriate biological limits, given available information.

These determination components are considered required and inseparable for the 2020 fishing period.

### Regional Catch Limits for red urchin during the 2020 fishing year.

Region	2020 Regional Catch Limit (t)
1	2.5
2	7.5
3	6.5
4	6.0
5	0
<b>Total</b>	<b>22.5</b>

The Committee recognises that the above Determination has the sum of Regional Catch Limits being less than the TACC. That unusual strategy has been set to balance economic fairness and biological sustainability criteria for the fishery in the short term given the unusual, and constraining, management arrangements in place. This should be seen as an interim strategy whilst management of the fishery is amended to enable efficient internal adjustment of quota holdings through efficient quota trading such that the fishery is enabled to adjust efficiently to future TACCs that set biologically sustainable harvests.

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## 1. INTRODUCTION

The Total Allowable Catch Setting and Review Committee was established by Division 4 (S26–34) of the *Fisheries Management Act 1994*. It was renamed the Total Allowable Fishing Committee (the Committee) and given broader responsibilities in a 2018 amendment to the Act (Part 2A S40) following structural reform of management arrangements for most NSW commercial fisheries. The committee in 2019 was:

- Dr Bruce Mapstone – Chair;
- Ms Alice McDonald – fisheries management;
- Dr Sean Pascoe – natural resources economics; and
- Dr Keith Sainsbury – fisheries science

The Committee is required to determine the Total Allowable Commercial Catch (TACC) of red sea urchins (red urchin) for the commercial sector of the Sea Urchin and Turban Shell (SUTS) Restricted Fishery, giving effect to relevant objectives of the *Fisheries Management Act 1994*, and as since amended (1997, 2004, 2006, 2010, 2015, 2018). The Committee is not subject to control or direction from the Minister but in reaching its decision is required to consider:

- All relevant scientific, industry, community, social, and economic factors;
- The need to ensure that the red urchin 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 TACC for red urchin was set first in 2001 at 60 t for 2002, and has not changed since. The Committee in 2001 also set Regional Catch Limits by which the TACC should be realised spatially, given regional stock abundances, but those regional limits were never implemented.

This Committee first reviewed the red urchin TACC and management arrangements in 2018 and made a Determination and recommendations for the 2019 fishing period. This stand-alone report has been prepared in support of the TACC determination for 2020. The report also 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, the Department, and Industry on fishery-related issues, including recommendations from the Committee, is an important and valuable part of the Committee's deliberations.

The Committee makes a determination on the TACC and matters it is required to regard that affect directly that TACC. The Committee this year has set a notional TACC for red urchins that is contingent on adoption also of revised Regional Catch Limits in order to balance biological, economic, and fairness considerations within the constraints of current management provisions for the SUTS fishery. These two instruments are intrinsic components of setting an appropriate commercial catch and should not be considered discretionary or separable. The degree to which the Committee's other suggestions or recommendations are accepted is a matter entirely for the Minister and the Department.

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

- The quota allocated to commercial fishers or allowed via regional catch limits, whichever is less;
- 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).

There currently are no data from which to estimate the legal or illegal components of the non-commercial fishery but both are inferred to be minor (less than 5 t annually) based on historical evidence, compliance information, and judgments from the Department and Industry.

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

*'... 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 proves 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.

## 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. SUTS fishers, relevant industry and stakeholder bodies, and the community were invited to make submissions on the Total Allowable Commercial Catch of red urchin. The consultative process is set out in Appendix 1. No written non-government submissions were received during this process.

The Committee obtained input from participants in the Total Allowable Fishing Committee Open Forum meeting in Sydney on October 9<sup>th</sup> 2019 and received written reports from:

- NSW Department Primary Industries (DPI) Fisheries Research; and
- NSW Department Primary Industries Commercial Fisheries Management.

Public verbal submissions and presentations to the Committee were invited during the Open Forum. The Committee also was able to call for *in-camera* discussions, where appropriate. In-camera discussions with Department officials were requested following the 2019 forum to clarify legislative and regulatory matters and request additional economic and fishery information.

### 2.2 Matters considered

The Committee considered the following matters before reaching its determination:

- The original TACC Determination (2001), fishery objectives referred to therein, and research information available to the Committee at that time;
- 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 red urchin stocks provided by the Department;
- The spatial nature of the fishery; and
- Submissions, commentary, and presentations provided at the Open Forum.

### 2.3 Format of the Report

This report covers the three key areas affecting management of the fishery and setting the allowable commercial catch:

- Status of the red urchin stocks;
- Economic considerations; and
- Management considerations.

The key considerations for each of these areas are presented in the following sections 3, 4, and 5. The Committee's conclusions in view of these considerations are presented in section 6, together with the details of this year's Determination. Appendix 3 contains a technical econometric analysis of the fishery.

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.

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 Act.



## 3. STATE OF THE STOCKS

### 3.1 Introduction

The red urchin fishery is part of the SUTS multi-species fishery managed through a combination of input controls (endorsements to take all species) and individual quotas for red urchin. Three species of sea urchin (purple urchin *Centrostephanus rodgersii*, red urchin *Heliocidaris tuberculata*, green urchin *H. erithrogramma*) and three species of turban shell (Sydney turban shell *Turbo torquatus*, military turban shell *T. Militaris*, green turban shell *T. undulatus*) can be taken under a SUTS endorsement. A TACC and individual quotas are applied only to red urchin. There have been 37 SUTS endorsements since 2002 each receiving an annually renewed red urchin quota of 1622 kg, being an equal share of the 60 t TACC. The TACC has not changed since 2002.

Worthington and Blount<sup>1</sup> completed surveys of red urchins along the NSW coast in early 2000 from which they estimated the total biomass of red urchins, including in areas closed to fishing, to be 1,195 t, with 154 t, 517 t, 265 t, 252 t, and 7 t in Regions 1–5 respectively. Standard errors were about 50% of the estimate in most Regions. Those surveys coincided with the peak harvests of red urchin of 85.5 t in 2000 (over 90% taken by just 3–8 divers, 59 t from Region 3) and so likely were affected by at least part of that exceptional harvest. That harvest had been preceded by annual harvests of 2–5 t up to 1998 and 15.6 t in 1999 and has been followed by annual harvests of approximately 50 t in 2001 and less than 20 t since.

Worthington and Blount recorded significant fishing-induced depletion of red urchins in sub-zones of Regions 3 and 4 opened to fishing in 1999 and 2000. Average sub-zone depletions were estimated at 45% and 49% in Regions 3 and 4 respectively during less than a year of fishing, with extreme depletions to 12–15% of previous biomass. Some declines in closed areas also occurred, attributed in part to (illegal) fishing, and some sub-zones had increased abundances. Total biomass over all fished and closed areas was estimated to be reduced by 53% and 12% for Regions 3 and 4 respectively. Some changes might have been due to factors other than fishing but the data indicated that local populations of red urchins were vulnerable to very rapid depletion through fishing and suggested material risk of serial depletion. There are no data about rebuilding of depleted populations after fishing pressure diminished from 2002.

The 2001 determination of 60 t TACC for 2002 largely was based on data from Worthington and Blount and application of a yield equation with instantaneous natural mortality of 0.2 and analysis of sensitivity to alternative assumptions. The 2001 Committee cited a total biomass of "... *approximately 940 t of red urchin, with 380 t in the areas that are currently open to fishing*", which they considered likely to be close to the unfished biomass. Reasons for the discrepancy between the biomass estimates by Worthington & Blount (1,195 t) and the Committee (940 t) are unclear but may reflect the Committee combining biomass estimates from 3 regions based on one method with those from the other 2 regions based on a different method. The Committee nevertheless presumed that "... *the remaining biomass will be open to fishing (not only that in the currently open areas) ...*" because scaling the TACC to just the fishable areas "... *is not yet possible as the Department gave no clear indication of which areas would remain open or which areas would be closed in future ...*". The Committee also recognised that a TACC should be based on the fishery-available rather than total stock, notwithstanding its use of the latter for the TACC determination.

Regional Catch Limits (caps) also were recommended to distribute the TACC roughly in proportion to the biomasses provided by Worthington and Blount. The Committee recommended some areas remain closed to the fishery and rotational closures of other fished areas to reduce the risk of serial depletion.

### 3.2 Stock Status and Trends

There is little recent information from which to infer the current state of the red urchin stock, with all information since about 2002 coming from fishery reporting. There has been no research on the stock since 2002 and there is little published biological research on the species. Information provided by the Department to the Committee this year, however, was analysed in greater detail than previously and provided important insights to interpretation of the fishery-dependent data.

The Committee last year speculated that catch and catch rate data were likely to be poor indicators of stock status because it was suggested at the public forum that most fishers landed red urchin as incidental catch whilst targeting either other SUTS species or abalone. The recent analyses, however, demonstrated that: (i) very little red urchin was taken by fishers reporting catches of abalone on the same days; and (ii) substantial proportions of red urchin catches were taken on days when no other SUTS species were landed. There also was a reasonable correlation between patterns of catches and catch

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<sup>1</sup> D.G. Worthington DG and C Blount, 2003. *Research to develop and manage the sea urchin fisheries of NSW and eastern Victoria*. FRDC Project No. 1999/128. NSW Fisheries Final Report Series No. 56. ISSN 1440-3544

rates from days when only red urchin was landed and those when red urchin was landed with other SUTS species. These results thus remove two material uncertainties in interpreting signals from catch rates of red urchin. The assessment this year consistently separated catch, effort, and catch rate between those days from which only red urchin was landed and those when red urchin was landed with other species.

Red urchin catch history shows three periods of substantially increased catches (2000–01, 2007–08, 2016–19) with corresponding higher catch rates (~60–100 kg/hr), separated by several years of low but relatively stable catches and catch rates (~30–50 kg/hr). The highest catch rates in the record were during peak catches of 2001 and 2007. The overall pattern reflected different patterns in different regions, however, with peak catches in 2000–01 taken from Regions 3 and 4, those in 2007–08 driven from Regions 1 and 2, and the most recent peak reflecting catches in all regions. Two notable features of these catch histories are that: (1) periods of peak catches tend to be characterised by increases in the proportion of days on which red urchin was landed when no other SUTS species were landed; and (2) initial years of peak catches and catch rates were followed by fairly steep declines in hourly catch rates over subsequent years, including since 2016 in most regions (notwithstanding maintenance of relatively high total catches). Data from several sub-zones within Regions show similar patterns to regional or overall patterns, though sparse data from most sub-zones render inferences very uncertain at that scale.

Worthington and Blount suggested material depletion of stocks in Regions 3 and 4 by heavy fishing during 1999–2001 but there is no information about rebuilding of affected populations since. Anecdotal evidence from divers, however, indicates that population densities in fished areas remain considerably below, perhaps at 50–25% of, those in closed areas. Such a pattern would indicate that even the mostly low level of red urchin harvest since 2002 has kept local populations at levels well below unfished stocks.

Increased targeting of red urchin by SUTS fishers in years of higher catches possibly reflects changes in demand or prices for various SUTS species. Prices received by fishers for red urchin in recent years have increased by approximately 40% from \$7.50 in 2015 to \$10.50 in 2019, with catch increasing from 7.5 t in 2015 to 18.1 t, 19.0 t, 19.7 t, and 13.5 in 2016, 2017, 2018, and up to August 2019 respectively. Declines in catch rates are expected to follow periods of relatively high exploitation but tend to diminish concerns that catch rates might be hyper-stable in this fishery and poorly related to stock abundance or availability. The latter, given sharp declines in catch rates, supports concerns that the red urchin stock may be vulnerable to rapid depletion after only short periods of elevated exploitation, possibly with long periods of relatively slow rebuilding under low exploitation. Such concerns suggest caution in response to the relatively elevated harvests and market prices of red urchin since 2016 in most regions.

Persistent closure to red urchin harvest of about 1/3 of the NSW coast will have protected mature, largely unfished, populations in each Region. Urchins produce buoyant planktonic larvae that probably disperse moderate–long distances, whilst post-settlement red urchins have limited dispersal. The combination of extensive larval exchange with limited post-settlement movement means that unfished areas can provide resilience for the population as a whole but areas open to fishing are vulnerable to localised depletion. There are several biological and economic consequences of local depletion of the fishery-accessible areas, but the overall stock condition is likely to be well protected by the current closed areas.

It is unknown whether red urchin habitat is distributed roughly uniformly among closed and open areas. It is parsimonious to assume that to be the case and infer that the fraction of unfished biomass outside closed areas when they were declared was about 2/3. That would mean roughly 627–797 t of the 940–1,195 t of total biomass estimated by the TAC Committee or Worthington and Blount respectively in 2001 was available to the fishery. Those estimates would mean the 60 t TACC, if taken, would be a harvest fraction of about 5–6.4% of the total (relatively unfished) stock and 7.5–9.6% of the fishery-available stock. Average catches during 2002–17 (9.5 t pa) would be approximately 1.2–1.5% of unfished biomass in open areas under the same assumptions, with harvest fractions in 2016–18 at 2.3–3.1%. These would be considered moderate (5–9.6%) or low (1.2–3.1%) harvest fractions for an urchin species.

Anecdotal information from industry divers about relative population densities in open and closed areas implies that the catch from these open areas is about, or perhaps somewhat more than, the MSY for fishery-available stock and that the fished populations were being maintained at relatively low levels. A more rigorous measure of the relative density in open or closed areas, perhaps by 'structured fishing' or similar, would provide cost-effective information for managing the fishery, including TACC determinations. The Committee again recommends that the Department and Industry complete a rigorous, properly designed survey of red urchins in areas closed and open to fishing in each Region to estimate current densities of populations subject to fishing and those protected from fishing.

The Committee last year recommended that a minimum legal size (MLS) for harvest of red urchin be set at 115 mm test diameter. That recommendation was implemented from October 11 2019. That LMS was based on discussion with fishers about approximate sizes at which red urchin had 'quality' roe and so was

inferred to be a size likely to protect at least some urchins for some period of spawning before being vulnerable to harvest. A published paper<sup>2</sup> has come to hand since then that indicates that red urchin likely mature around 55–60 mm test diameter, although it remains unclear what proportion of individuals likely mature by that size. A MLS is intended to constrain harvest appropriately but recent feedback from industry suggests 115 mm may be unreasonably limiting. Those concerns appear supported by the (limited) information in Laegdsgaard et al. (1991) but should be reviewed with reference to better information about size at maturity and marketable sizes of red urchin (the marketable product being mature roe) when that is available. The LMS has not been applied to harvest of red urchins by recreational or indigenous fishers but the Committee recommends that extension be implemented.

### 3.3 Biologically Appropriate Allowable Catches

The above alternative approaches to inferring exploitation rates (i.e., pro-rate original biomass estimates to infer that accessible to fishing or use fisher statements that populations in fished areas are 50-25% of those in open areas) suggest a TACC of around 15–40 t is appropriate for the currently accessible stock. The regional distribution of biomass reported by Worthington and Blount applied to TACCs of 15, 20, 25, 30, or 40 t gives Regional Catch Limits in Table 3.1. The regional allocation of the 2002 TACC (also in Table 3.1) differed very slightly from the biomass distribution reported by Worthington and Blount for unknown reasons. We have applied the Worthington and Blount proportions here but accepted the 2001 Committee’s proposition that no catch should be taken from Region 5 given the very low biomass there. It was noted at the public forum this year that there may be pockets of very abundant red urchins in Region 5, but there remains no clear basis from which to set an appropriate catch limit for that Region.

**Table 3.1.** Regional distribution of biomass (Worthington and Blount) and Regional Catch Limits (RCLs) from the 2001 TACC (Top), RCLs consistent with the biomass distribution under alternative TACC settings (upper middle), minimum, maximum, and average annual catches from each Region during 2002–18 (lower middle) and annual Regional catches since 2016 (Bottom).

Worthington & Blount	Regional Biomass Estimates (t, proportion)				
	Region 1	Region 2	Region 3	Region 4	Region 5
Biomass (SE) t	154 (118)	517 (174)	265 (153)	252 (119)	7 (5)
P <sup>n</sup> of Total	0.129	0.433	0.221	0.211	0.006
2002-18 TACC	Regional Catch Limits (t, proportion)				
	Region 1	Region 2	Region 3	Region 4	Region 5
TACC = 60 t	8.0	28.0	13.0	11.0	0
P <sup>n</sup> of TACC	0.133	0.467	0.217	0.183	0
Prospective TACCs and RCLs (t)					
15	2.0	6.5	3.3	3.2	0
20	2.7	9.3	4.3	3.7	0
25	3.3	11.7	5.4	4.6	0
30	4.0	13.0	6.6	6.4	0
40	5.2	17.4	8.9	8.5	0
Reported Catches 2002–18 (t)					
Minimum	0.4	1.1	0.0	0.4	0.00
Maximum	6.0	10.6	7.4	6.7	0.15
Mean	1.9	4.1	1.4	2.1	0.01
Reported Catches 2016–19* (t)					
2016	2.6	5.9	4.7	4.9	0.00
2017	2.8	5.5	3.9	6.7	0.04
2018	2.4	4.6	7.4	5.4	0.00
2019*	0.6	4.3	6.1	2.4	0.12

\* 2019 catches January–August only.

The persistent increase in catches of red urchin since 2016, together with steadily increasing market prices, increased participation from SUTS endorsement holders, and indications of material vulnerability of the red urchin stock to even moderate increases in harvest leave the Committee concerned that the biologically prudent limit on red urchin harvest may be less than that recommended in last year’s report. The Committee thus considers that reduced RCLs to cap total red urchin harvest nearer 20 t is advisable.

<sup>2</sup> Laegdsgaard P, M Byrne, DT Anderson. 1991. Reproduction of sympatric populations of *Heliocidaris erythrogramma* and *H. tuberculata* (Echinoidea) in New South Wales. *Marine Biology* 110, 359–374.

Reducing the existing TACC of 60 t to values of the order given in Table 3.1 is due to accounting for the suggested reductions in stocks through persistent harvest over the last 17 years and for the reduced area accessible to the fishery through what effectively are indefinitely closed areas rather than a system of rotational harvesting closures envisaged by the Committee in 2001. The catch giving 50-75% depletion in open compared to closed areas broadly supports the original basis (MSY) for TACC determination. There is some component of this reduction due to introduction of MPAs and other non-fishery closures since 2001, which is a permanent reduction in the area accessible to the fishery.

A properly managed rotational harvesting strategy might increase the sustainable harvest available to the fishery by allowing more of the resource to be harvested over time. Rotating closures would hinge on establishing robust, evidence-based criteria for opening and closing areas to yield sustainable harvest. Such a scheme needs to maintain good stock abundance on average across the rotation zones and rotational harvesting should not be attempted without proper development of such criteria and appropriate catch and stock monitoring. Widespread use rotational harvesting in the absence rigorous design and monitoring could erode quickly the protection offered by the current indefinite area closures.

### 3.4 Management Implications

It is desirable to have a TACC aligned with what is biologically sustainable from the fishery accessible red urchin resource. That outcome, however, will mean considerably lower TACCs (15–40 t) than that in place for the last 17 years (60 t). A low TACC under current management, with red urchin quota reallocated uniformly annually among endorsement holders within the multi-species SUTS fishery, would flow into low allocations for each endorsement holder. TACCs of 40 t or 15 t would deliver individual quota allocations to each fishing business of 1.08 t or 0.41 t respectively. Both are material reductions from the current ITQ of 1.622 t. Permanent quota transfers currently can occur only via SUTS endorsement sales and there currently is concern about the efficiency of quota leasing arrangements within fishing periods, so it is unlikely that trading could be effective for active operators to obtain quota from the majority of SUTS businesses that don't harvest red urchin. These conditions mean TACC reductions likely will affect active red urchin fishers disproportionately and arguably inequitably.

The Committee last year therefore recommended a two-tiered TACC regulating process in which the notional TACC for annual allocation purposes was retained at 60 t but annual catch was limited to what was considered closer to biologically appropriate levels by imposition of Regional Catch Limits (RCLs). This approach has been implemented, though RCLs were effective only from October 11 2019. The tension between economic and equity implications of a low TACC and the biological risks of a higher TACC remain and so the two-tiered approach remains important, especially given the implications of the more refined analyses of fishery data presented to the Committee this year.

The above issues, and those elaborated in the following sections, indicate that a need remains to effect significant management changes to enable a TACC and ITQ system to operate effectively, equitably, and efficiently in the red urchin fishery. The changes implemented in response to some of the Committees recommendations last year are important interim steps but enabling an effective mechanism for permanent transfer of red urchin individual quotas without the need to transfer entire SUTS endorsements remains the most important management step required for operation of ITQ principles.

### 3.5 Conclusions

The implemented Regional Catch Limits (RCLs) now are the effective controls to limit the harvest of red urchin, despite the higher TACC retained for economic and equity reasons. There now is sufficient evidence, however, for the Committee to hold concerns that the existing RCLs may be insufficient to limit red urchin catch to biologically prudent or sustainable levels, if realised. The current TACC and the RCLs are much greater than what will be biologically sustainable if they are realised from just the areas open to fishing. A key risk of these settings is that there is no obstacle to excessive, potentially serial, depletion in the open areas if the market or other factors encourage endorsed businesses to attempt to take the current TACC of 30 t RCLs. Such a situation is unlikely to threaten the presence of red urchins in NSW because of the populations protected in closed areas but certainly would render continued fishing unviable and unsustainable, with serious economic and social consequences for fishers.

There might be longer-term scope to increase red urchin harvest sustainably from that strictly appropriate for the currently fishable stock if a reliable system of rotational harvesting could be introduced. That will not happen quickly, however, and should not be done precipitously. Implementation failure in such a scheme would pose biological risks that could unfold very quickly and affect the entire NSW stock.

## 4. ECONOMIC CONSIDERATIONS

### 4.1 Introduction

The SUTS fishery is managed through a combination of input controls for all species and individual quotas for red urchin (only). Thirty seven SUTS endorsement holders each have received a red urchin quota allocation of 1622 kg (equal share of 60 t TACC) each year since 2002. The quota is not separable from the SUTS licence, so transfer of quota requires purchase of the full fishery entitlement. Temporary quota transfer (via leasing) is permitted within fishing periods and is divisible (i.e., part of the full individual quota can be leased).

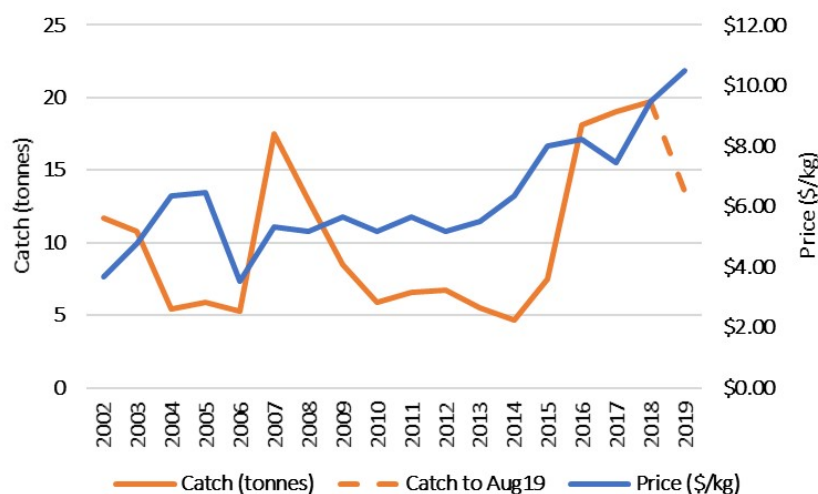
Catches in the SUTS fishery are dominated by purple urchin (*Centrostephanus rodgersii*), which are managed through limited entry only. Most of the fishing activity for purple urchin takes place during warmer months, with red urchin targeted mainly in cooler months. Fishers advise that purple urchins are of lower value (\$/kg) than red urchins, although the higher abundance and broader distribution over greater depths make it more attractive to target and market. Red urchins occur mainly in very shallow near-shore waters, making fishing more difficult and weather-dependent. Many SUTS endorsement holders also operate in the abalone fishery and do not depend materially on red urchin harvest.

The low quantities of red urchin landed makes processing for export unviable, despite a strong international market for urchin roe and the fishery having export trade approval. The Japanese market is considered very competitive and also has good quality local product available, making prices in Japan generally not worth the processing and transportation costs from Australia. The fishery therefore almost exclusively supplies domestic markets either through direct sales to restaurants or sales through the Sydney Fish Market (SFM). The quantities sold through each outlet are not available.

### 4.2 Volume and Value of Production

The nominal Gross Value of Production (GVP) of the SUTS fishery overall was estimated to be \$294,219, \$280,511, and \$335,208 (in 2016, 2017, and 2018 respectively, based on catch and price data provided to the Committee. The corresponding nominal values of red urchin catches were estimated to have been \$138,646 (2016), \$139,460 (2017), and \$183,801 (2018), indicating that red urchin accounted for 13.6–22.3% of the total catch and 47.1–54.8% of the total value of the SUTS fishery over those years. The value of the red urchin up to September 2019 was estimated to be \$142,950.

Catch of red urchin has fluctuated between 5 t and 19 t since the 60 t TACC was introduced in 2002 (Figure 4.1). Real prices over the same period (in 2019 dollars) has tended to increase, reflecting an increase in the demand for the product on the domestic market.



**Figure 4.1.** Catches and real prices for red urchin 2002–2019.

The relationship between quantity supplied and price (Figure 4.1) suggests that catch responds to price rather than price responding to catch. This is consistent in areas where the price is driven by other factors, such as availability of competing products and exogenous shifts in demand (such as introduction of a new processor and growing restaurant demand).



A simple econometric estimate of this relationship is presented in Appendix 3 to this report. The results suggest that fishers are responsive to price changes, with a proportional response in the short term (i.e. a 1% change in price leads to a 1% change in catch), and a greater than proportional change in subsequent years (i.e. a 1% change in price also leads to a 1.7% change in catch over the coming years, all other things being equal). This suggests that the recent (and continuing) price rises have not only attracted more fishing effort into the fishery, but will continue to attract additional effort in the coming years. The model estimates that prices have been increasing since 2002 on average about 4% a year, notwithstanding more rapid increases in recent years, suggesting that regional catch limits are likely to be reached in the coming years, provided the biomass is also able to support these catch increases.

### 4.3 Fishing Activity

Activity in the fishery (number of endorsements landing red urchin and total fishing effort targeted at red urchin) has varied since quotas were introduced in 2002 (Table 4.2), again consistent with an opportunistic fishery. Catch rates where only red urchin was caught and the total red urchin catch can be used to derive an equivalent targeted effort [Equivalent red urchin effort = Total Catch/CPUE(RU only)]. That calculation indicates that the proportion of fishing effort directed at red urchin (from those reporting red urchin landings) tended to decline over the first decade after quotas were introduced but has increased substantially in recent years. Nearly all SUTS effort when red urchin was landed in 2018 and 2019 (year to date) largely has been directed towards red urchin, even when other species were landed. Both the number of operators involved with harvesting red urchin and the overall level of their targeted fishing effort have increased since 2015, consistent with a supply response to the price increases noted above.

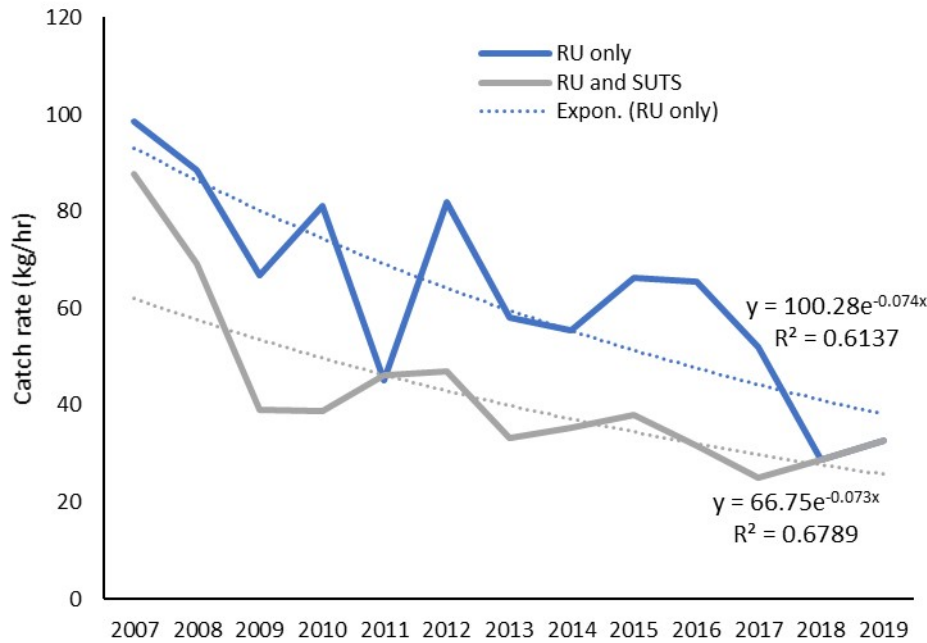
**Table 4.1.** Fishing activity for red urchin 2002 to 2019

Year	Catch (t)	Catch rate (kg/hr)	Catch rate RU only (kg/hr)	Effort (hrs)	Equiv. RU effort (hrs)	% Total hours	N <sup>o</sup> . of businesses	% endorsements	Hours / endorsement
2002	11.7	40	41.4	282	283	100%	6	15%	47.0
2003	10.8	24.7	39	427	277	65%	9	23%	47.4
2004	5.4	25.8	30.4	207	179	86%	11	28%	18.8
2005	5.9	26.6	30.6	217	192	89%	14	36%	15.5
2006	5.3	37	42.6	142	124	88%	9	23%	15.8
2007	17.5	87.7	98.5	194	177	91%	8	21%	24.3
2008	12.9	69.3	88.6	185	146	79%	8	21%	23.1
2009	8.5	39	66.9	217	127	58%	12	31%	18.1
2010	5.9	38.7	81.2	153	73	48%	9	23%	17.0
2011	6.6	46.2	45.1	141	145	103%	9	23%	15.7
2012	6.7	47	82	142	82	58%	8	21%	17.8
2013	5.5	33.1	58.2	165	95	58%	9	23%	18.3
2014	4.7	35.3	55.5	130	85	65%	8	21%	16.3
2015	7.5	37.9	66.2	184	114	62%	9	23%	20.4
2016	18.1	31.6	65.5	564	276	49%	11	28%	51.3
2017	19	25.1	52	667	365	55%	16	41%	41.7
2018	19.7	28.8	28.6	709	689	97%	13	33%	54.5
2019	13.5	32.8	32.8	414	412	99%	15	38%	27.6

<sup>a</sup> to the end of August 2019

This increased targeting has persisted despite declining catch rates. Catch rates peaked in 2007 and generally have declined since by an average of 7% a year since then (Figure 4.2).





**Figure 4.2.** Catch rates (kg/hr) for targeted and non-targeted red urchin fishing 2007–2019.

#### 4.4 Economic Targets and Performance Indicators for the Fishery

There are no independent economic targets or performance indicators for the fishery. The initial TACC was set on the basis of the estimated maximum sustainable yield, notwithstanding that a substantial area of the fishery has been closed to fishing since that determination.

Quota leasing has ranged from 1.6 t to 8.2 t over the period 2009–2018, although the lease price is unavailable. 9.7 t was leased between January and August 2019, reflecting increased activity in the fishery as prices increased.

Permanent transfers of red urchin quota are not possible except through transfer of the full SUTS endorsement. The only information on transfer prices is from 2017, when the average value of a transferred endorsement was \$12,500, although this reflects the value of the full SUTS endorsement, not just the red urchin component. Three endorsements were traded in 2018 and two in 2019 but the transfer prices were not reported.

#### 4.5 Management Cost Recovery and Community Contribution

Cost recovery charges relate to the full endorsement, not just the red urchin component. An amount of \$1,184 per participant in the SUTS Fishery has been levied for the 2019–20 financial year, the maximum permissible under the current regulations. There is no community contribution from the fishery.

#### 4.6 Conclusion

The red urchin fishery is a subset of the larger SUTS fishery. Red urchin harvest, as a result, at least partly depends on activities in the broader fishery. The fishery seems to be highly responsive to price, with catch increasing as price increases. Price, in turn, largely seems driven by external factors, with a general upward trend of around 4% a year since 2002 and greater annual increases since 2015.

The quota fishery has not been able to adjust as well as it might due to the lack of divisibility and transfer of the red urchin quota independently of the SUTS endorsements. Fishers who are not interested in catching red urchin are not able to transfer just that component of the endorsement to other fishers who may be better placed to take the quota. Leasing within fishing periods is permitted – and actively undertaken in the fishery – but the lack of permanent transferability limits the ability of fishers to adjust their business models (i.e. increase activity in the red urchin component) without also paying

unnecessarily<sup>3</sup> for redundant 'additional' access to other SUTS species. The few fishers who depend materially on red urchin need to purchase an entire endorsement to increase their harvest potential permanently, effectively buying out an entire fisher even though only the red urchin quota is needed.

Leasing red urchin quota each fishing period is an option, and does occur, but this does not allow full adjustment in the fishery and is difficult because there is no public market mechanism by which to identify and access unused quota. The SUTS fishery is a restricted fishery and so has no share register and privacy provisions restrict access to information about who holds endorsements, so limiting access to quota that might be available for lease. Industry members at the meeting highlighted the difficulty in identifying and contacting fishers who could potentially lease quota (or transfer their full endorsement).

The Committee noted in the 2018 Determination that this quota market inflexibility potentially has severe economic consequences for the current sub-set of fishers who are engaged in harvesting red urchin. A red urchin TACC reduction would apply to all endorsement owners equally but have very different consequences for those who harvest red urchin and those who do not. There will be little or no effect of a changed TACC on the majority of SUTS endorsement holders who do not fish red urchin. A reduced TACC, however, will reduce, potentially substantially, the access of active red urchin fishers to the resource, even though the TACC might not be landed by the fishery. Those fishers would need to either buy-out other fishers' SUTS endorsements in full or discover and lease unused quota for each fishing period to maintain their current income, even within a reduced TACC. Leasing quota will be difficult in the current absence of a transparent trading mechanism and having to purchase SUTS endorsements will incur a financial burden disproportionate to the value of red urchin quota for no efficiency gain in the fishery. The prospect also arises that reducing the initial quota allocation to all SUTS endorsements that would flow from a reduced TACC would increase lease demand by active red urchin fishers and so drive-up lease prices simply as an artefact of the annually reset, uniform, quota allocation.

A fundamental requirement for an effective ITQ system is divisibility and a well-functioning quota trading market. The absence of these characteristics for the red urchin harvest means that reductions in the TACC for prudent management of the red urchin stock will result in substantial difficulties for fleet rationalisation and autonomous adjustment in the fishery.

The potential for conversion of the red urchin fishery to a share fishery was discussed at the meeting, and we encourage further consideration of this by the Department and industry, or consideration of alternative mechanisms to transfer permanently red urchin quota among endorsements.

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<sup>3</sup> Other SUTS species are not regulated by quota and so access to them is not limited other than by holding an endorsement to fish. Paying for second, third, or more endorsements in order to gain additional red urchin quota therefore has no effect on access to other species and so the marginal value of the additional access rights attached to purchased endorsements is an unnecessary cost that does not change a businesses access to resources.

## 5. MANAGEMENT CONSIDERATIONS

### 5.1 The Red Urchin Fishery

The commercial harvest of red sea urchins is managed as part of the SUTS Fishery, which also harvests long spined (purple) urchin (*Centrostephanus rodgersii*), short spined (two species, red and green) urchins (*Heliocidaris tuberculata*, *H. erithrogramma*) and three species of turban shell (Sydney turban shell (*Turbo torquatus*, military turban shell *T. Militaris*, and green turban shell *T. undulatus*). The catch of red urchins peaked at 85.5 t in 2001, immediately prior to the 2002 TACC, when some processors and a small number of fishers made a dedicated effort to establish an export market for red urchin roe. Those ventures failed, however, and catches since generally have been extremely low — limited by the lack of a market, the difficulty of physically harvesting red urchins (which are most abundant in very shallow water), and inflexible management arrangements that have limited quota trading.

The SUTS fishery landings have been dominated by catches of purple (long-spined) urchins since the high catches of red urchin in 2000 and 2001. Purple urchins constituted 75–90% of the total SUTS catch during 2002–2016. Red urchin landings since 2002 have amounted to 7.8–32.8% of the red urchin TACC.

The past three years have seen an increase in red urchin catch from around 5–8 t during 2009–2015 to 18–20 t since 2016. This increase coincides with an increase in the value of red urchin, which has almost doubled from \$5.50 per kilo in 2013 to a peak of \$10.50 in 2019. This period also has seen an increase in active fishers and effort targeted specifically at fishing for red urchin, and a decrease in the harvest volumes of purple urchins.

The harvest and management of red urchin must be considered in the context of the authorisation being part of a multi-species fishery. Shifts in the abundance or value of other SUTS species therefore can influence directly or indirectly shifts in the harvest of red urchin. The SUTS fishery has, since 2001, focussed on harvesting the purple urchin despite the value of that species remaining relatively flat at around \$1.00 per kilo for the past decade. The value of red urchin during this time has increased to a price that is now ten times higher per kilo than that of the purple urchin. A shift in targeting to red urchin is to be expected, therefore, and is likely to continue until the value or availability of red urchins declines, or conversely (but less likely) the value of purple urchin dramatically increases.

### 5.2 Current Management Arrangements

#### **Commercial Fishing**

The SUTS Fishery is a declared restricted fishery under Division 1 of Part 9 of the Fisheries Management (General) Regulation 2010 and pursuant to section 111 of the Fisheries Management Act 1994. Access to the SUTS Fishery is limited to fishing business owners that are eligible for an endorsement authorising the take of the three species of urchin and three species of turban shell above.

The SUTS fishery is managed by a combination of input and output controls. There is no management plan for the fishery that guides decision-making. There also is no resource allocation mechanism or policy that applies. An annual Total Allowable Commercial Catch (TACC) and Regional Catch Limits (RCLs) apply to the harvest of red urchin. No TACCs or RCLs apply to other species taken in the SUTS fishery. Urchins are harvested commercially by fishers using underwater breathing apparatus or freediving using a hook.

The objectives that fishery managers articulated for the fishery when the first TACC determination was made in 2001 were:

- To develop the fishery in a controlled manner;
- To prevent localised over-fishing; and
- To develop an understanding of the resource.

Only one person is eligible for an endorsement in respect of each fishing business but each business owner can nominate another licensed commercial fisher to operate the endorsement in a single fishing period. There currently are 37 fishing businesses with endorsements to operate in the SUTS Fishery, with 16 of those fishing businesses reporting catch in 2018 and 12 reporting landings of red urchin. This leaves significant latent effort in the fishery with more than half of the licence holders currently not fishing for SUTS species.

The TACC for red urchins has been 60 t since 2002 and divided equally among all SUTS licence holders, equating to 1,622 kg per endorsement. These quotas are not unitised, however, and are not transferable separately from the SUTS licence on which they are an endorsement. This dependency represents a

material constraint on trading quota for red urchin when an endorsement holder fishes for other SUTS species and does not want to transfer the endorsement, even though not harvesting red urchin.

### **Recreational**

Recreational fishers are subject to a bag limit of 10 sea urchins (all species combined), and bag and size limits exist for all species of molluscs (including turban shell), with a limit of 20 of any species or combination of species. The amount of sea urchins caught by recreational fishers is not known but is estimated at less than 5 t. Most recreational harvest of urchins is concentrated in Regions 1 and 2. Department officers provided anecdotal reports of a recent increase in the harvest of urchins, predominantly purple urchins, in and around high population areas (e.g. Sydney and Coffs Harbour).

### **Aboriginal**

Aboriginal fishers are subject to the same limitations as recreational fishers when taking red urchins. There are no additional possession limits for red urchins under the NSW Aboriginal Cultural Fishing Interim Access Policy. There have not been any cultural fishing permits sought to take red urchins.

## **5.3 Spatial management and Regional Catch Limits**

The commercial fishery is divided into 5 Regions and numerous Zones and Sub-zones within Regions. The Committee in 2001 allocated the 60 t TACC to the five fishery Regions in proportion to their estimated biomass: Region 1, 8 t; Region 2, 28 t; Region 3, 13 t; Region 4, 11 t; and Region 5, zero. The Committee also recommended that some of the spatial closures existing at the time be retained to protect a portion of the stock, prevent localised overfishing, and facilitate understanding of population dynamics, whilst also recommending a system of rotational closures be considered for the fishery.

The SUTS fishery has been subject to fifteen fishery spatial closures since 1994, and additional exclusions for marine parks (MPAs, 5), Aquatic Reserves (ARs, 12), and Intertidal Protected Areas (IPAs, 9) have been effected since. These closures, together with effective closure of Region 5 (under 0 t quota) exclude harvesting from about 1/3 of the NSW coast and probably a similar amount of red urchin habitat.

The Committee's 2001 Determination recommended that heavily fished areas be accessed and closed alternately on a rotational basis. Four previously closed sub-zones in Regions 3 and 4 were opened to fishing in 1999–2000 and three heavily-fished sub-zones were closed to fishing in 2002 and reopened to fishing in 2007, but no other rotations have occurred. The 1994 closures, and subsequently declared MPAs, IPAs, and ARs have remained, excluding fishing from about 1/3 of potential SUTS fishing ground.

The catch of red urchin has shifted spatially over time, with the high catches in 2000 and 2001 coming primarily from Region 3, catches in 2006–2008 focussing on Regions 1 and 2, and more recently catches being spread more broadly across Regions 1–4. Catch has been reported for the five SUTS Regions against the notional Regional Catch Limits (RCLs) since 2002 but the limits were neither reached nor enforced until 2019. The Committee reviewed the TACC in 2018 and made a two tiered Determination — to retain a 60 t notional TACC while limiting catch to 30 t across the fishery through reduced RCLs. That two-tiered approach was necessary to balance economic interests of active fishers and stock sustainability. The Department implemented fishing closures under S8 of the Act in October 2019 to enable enforcement of the reduced RCLs. Region 3 was closed to the fishery from 11 October 2019 as a result, due to the Region 3 limit of 6.6t being exceeded. This closure was being implemented at the time of writing, so no comment on the effect of the closure on industry or compliance rates can be made yet.

The Committee commends the implementation of enforceable Regional Catch Limits by the Department, allowing more robust spatial management of the fishery. The Committee continues to encourage the Department to investigate the feasibility, costs, and potential benefits of more sophisticated rotational closures, which have the potential to enable higher sustainable catches in the red urchin fishery. This should include some review of the abundance of red urchins in Region 5, which has been subject to a 0 t RCL on the basis of minimal density being detected in the 2000–01 surveys, potentially attributable to lower water temperatures. An industry member has provided anecdotal reports of increased red urchin abundance in these southern waters and the Australian Bureau of Meteorology has reported above average sea surface temperatures around south-east Australia. It may be possible, therefore, that Region 5 has become more acceptable to red urchins and could support some level of sustainable harvest.

## **5.4 Compliance**

Compliance data are available only since 2010 and only for the SUTS fishery as a whole. The Department has reported an increase in compliance rates over the past 4 years, noting that further improvements are expected in 2019 due to the departure from the fishery of operator(s) with relatively

high rate(s) of non-compliance. The Fisheries Compliance Unit have advised that red urchins do not represent a compliance risk and that most offences for the SUTS fishery are minor reporting issues.

## 5.5 Fees

The fees that can be levied for licence holders in a restricted fishery are capped under the regulations. Each licence holder therefore has been levied the maximum amount possible, \$1184, for 2019-20.

## 5.6 Recommendations for Review of Management Arrangements

The commercial red urchin fishery is currently limited by a number of factors:

- Red urchins generally occur in shallow waters of <6 m depth and therefore are difficult to harvest;
- Management arrangements are inflexible and inhibit adjustment within the fishery; and
- There is no easily accessible market or mechanism for trading quota, meaning a lack of incentive to invest in market development.

The average number of days fished per diver in the fishery in 2018 was 25.6. A small number of fishers target the species on a part-time basis and there are a few fishers for whom the fishery is a major source of income. Some of these fishers have been involved in the fishery long term and were involved in earlier attempts to develop the fishery. Some have expressed a desire to develop the fishery in the future but also express frustration at the difficulty in acquiring additional quota either through endorsement purchase or lease. The TAC Committee in 2001 noted that the SUTS fishery was a niche fishery that was likely only ever to provide sufficient catch and income to support a small number of dedicated fishers. It is desirable therefore that the quota rights to the fishery consolidate to a much smaller number of endorsement holders who regularly target red urchin, either as a primary or important ancillary catch.

There were 21 fishing business that did not report any urchin or turban catch in 2018 and, although some of these may have leased their red urchin quota to active fishers, a large amount of the red urchin quota in the fishery apparently is not being used currently. Recent increase in the price of red urchin and a drop in purple urchin catch (possibly due to market over-supply nationally) mean there is a risk that latent red urchin quota could be reactivated, either by quota owners or through lease to other endorsement holders.

The Committee reiterates the recommendation to review the management arrangements for the fishery with a view to removing the structural obstacles to internal adjustment and allowing the TACCs to be set at biologically appropriate levels without inequitable financial consequences for active and latent fishers. Consideration should be given to making red urchin quota transferable separately to the SUTS endorsement to which it is attached to enable rationalisation of the red urchin catch to a smaller number of entitlement holders.

The Committee commends the Departments implementation of a legal minimum size limit (LML) for red urchin in the SUTS fishery in 2019. Biological information from which to establish a science-based LML was not available to the Committee when the LML recommendation was made in 2018 and it was based upon anecdotal reports from industry representatives that red urchins were mature at approximately 110–115 mm test diameter. Industry feedback since the MLS introduction, however, indicates that the 115 mm limit has had severe effects on catches. This anecdotal information in the context of the earlier mentioned published information (Section 3) leads the Committee to recommend relaxation of the MLS to 100 mm test diameter for the coming fishing period. It clearly is important that the impact of the new size limit on catches be monitored and research commissioned as a matter of urgency to verify whether this is a limit appropriate to both the reproductive biology and reasonable harvest of red urchins.

## 5.7 Total Allowable Commercial Catch

The limitations of the current management arrangements for the SUTS fishery in general and the red urchin harvest in particular mean the Committee is faced with the difficult task of setting a TACC and associated provisions that both protect the red urchin stock from over-exploitation and also ensure procedural and economic fairness for fishers within the currently constrained management arrangements.

The current catch rates in the fishery provide grounds for some concern with regards to the status of the fishery, notwithstanding that retention of closures covering approximately 1/3 of the stock provides important protection for the biological status of the entire stock. The stock status section (Section 3) of this report sets out the biological reasons for the preferred TACC to be significantly less than 60 t.

The current requirement that a TACC for red urchin is allocated evenly among licence holders, and the limited opportunity to transfer quota, means that reducing the TACC would see reduction in each and every licence holder's allocation from the current 1.622 t to as low as 0.41 t. Existing conditions mean that

such a cut would constrain disproportionately the most active fishers, who are constrained in their ability to acquire additional quota to meet their current catches, even though the current total catch is less than 20 t. This is unfair as it would reduce materially the catches of active fishers and have no impact on those that do not take red urchin but would continue to hold quota and might not wish to transfer their SUTS endorsement. Restricting those active fishers who are most likely to develop the fishery would be perverse and would create further disincentive to invest.

The Committee therefore will set this Determination with two dependent and necessary components. The first will be to maintain the TACC at 60 t to secure the fair allocation of ITQs to active fishers under the current 'flat' allocation system. The second component will require Regional Catch Limits (RCLs) that total 22.5 t and reflect the prudent total catch that should be harvested safely from each Region, and collectively over all the fishery-available stock, based on the limited data available. These two components ideally would be equal overall but in this Determination will differ because the biologically prudent setting, through RCLs, is less than the TACC required to allow fair access to the fishery in the absence of an efficient quota transfer system. The total harvest from the red urchin stock should be enforced to remain below the less of these two settings (22.5 t).



## 6. CONCLUSION

### 6.1 Summary

There is limited information from which to infer the status of the red urchin stock in NSW. Annual total catches since the TACC of 60 t was set in 2002 mostly have been below 10 t, though were nearly 20 t in each of the last three years and likely will be of similar amount in 2019. Analyses provided this year illustrated that catch rates have varied considerably with a pattern of peaking in years of (relatively) high catches followed by rapid decline to persistent rates about half of those peaks. These patterns occurred for series both when red urchin were landed alone or with other SUTS species. Those analyses also negated the assertion that red urchin often was taken as incidental catch whilst fishing for abalone. These results suggest that red urchin catch rates are not affected materially by the multi-species nature of the SUTS fishery and also that catch rates appear unlikely to be prone to hyper-stability through location-specific targeting of high-density populations, so diminishing considerably two key uncertainties in using catch rates to infer likely stock status of red urchin.

Protection from fishing of approximately 1/3 of red urchin habitat likely means that the overall stock is robust to past harvest rates (about 9.5 t pa) and potentially to the recent harvest approaching 20 t. The 60 t TACC for red urchins is not biologically appropriate in the areas available to the fishery, however, notwithstanding preservation of populations beyond the reach of the fishery. Recent increases in the market price for red urchin likely have motivated increased numbers of fishers to harvest red urchins, presenting increased risk that latency in the limits could be caught. The Committee now is concerned that the 30 t total catch limit imposed via RCLs last year also may be above what will be sustainable. A biologically more appropriate TACC under current conditions would be 15–25 t. Setting such a TACC alone, however, would have inequitable consequences for SUTS endorsement holders given existing management provisions. The Committee accordingly recommends revising the RCLs to a biologically more prudent level of 22.5 t in the coming year(s).

There is some longer-term scope to increase the sustainable harvest from that strictly appropriate for the currently fishable stock if a reliable system of rotational harvesting could be introduced. That will not happen quickly, however, and should not be done precipitously. Implementation failure in such a scheme would pose biological risks that could unfold very quickly and affect the entire NSW stock for a long time.

The harvest of red urchin as the only species with a TACC within the multi-species SUTS restricted fishery presents several challenges for TACC setting under current management arrangements. Three properties of existing management severely constrain operation of TACC-ITQ instruments for red urchin:

1. The annually renewed uniform distribution of a TACC among SUTS endorsement holders;
2. Binding the resultant individual quotas to the multi-species SUTS endorsement which prevents medium–long term rationalisation of red urchin quota without corresponding consolidation of SUTS endorsements, at inflated cost to red urchin fishers; and
3. The existence of a somewhat constrained annual quota leasing mechanism, in part precipitated by the restricted fishery conditions under which red urchin is harvested.

These conditions dictate an inherent tension between setting a TACC based primarily on stock status and productivity and economic inequities that flow from changes in TACC because of the obstacles to market optimisation of individual quotas. A TACC-ITQ system will operate optimally and equitably only if quota can be traded efficiently both within fishing periods (via lease) and in the long term through transfer of quota ownership. Constraint of these features means that TACC changes will impact disproportionately quota holders depending on red urchin catch but not affect at all those who do not harvest red urchin.

### 6.2 Total Allowable Commercial Catch for 2020

A compromise strategy was proposed in last year's Determination to balance the need to regulate harvest of the fishable stock prudently whilst protecting against inequitable economic effects of a sharply reduced TACC. That recommendation has been implemented and the Committee recommends its continuation until the obstacles to fishery optimisation through efficient ITQ behaviours are removed.

This Determination, therefore, also has two components to ensure economic and social equity through an allocated TACC and biological sustainability through effective Regional limits on harvest. The Committee determines that the regulation of the commercial catch in the 2020 fishing period should comprise:

1. A notional TACC of 60 t that secures fair and reasonable quota allocations to those who depend on red urchin harvest; and
2. Regional Catch Limits (RCLs, Table 6.1) that total 22.5 t and provide prudent biological protection to the stock if they were realised.

Harvesting of red urchin should cease in any Region when the relevant RCL is reached and the fishery should be closed if the overall total catch reaches 22.5 t, notwithstanding the 60 t notional TACC.

The mismatch between the TACC for ITQ allocation purposes and the harvest limits imposed by RCLs should be seen as an interim measure whilst management arrangements are amended to enable efficient internal adjustment of quota holdings through transparent leasing and permanent quota transfer systems.

The Committee recommends that the Legal Minimum Size (LMS) for harvest of red urchin be revised in 2020 to 100 mm test diameter, given additional information recently available to the Committee and apparently unreasonable impacts of the LMS recommended last year based on industry information. We reemphasise the urgent need to get reliable data to assess the appropriateness of this LMS.

The Committee further recommends that the Department and Industry consider mechanisms for implementing future TACCs as Region-specific allocations whilst current obstacles to autonomous industry rationalisation persist. Leasing of quota within the fishing period would need to be similarly Regionally constrained to prevent transfer of quota among regions through leasing. The Committee recognises such a system might be inefficient under current administrative arrangements and so requests further advice about such a prospect at next year's public forum.

The revised Regional Catch Limits stipulated in Table 6.1 reflect both improved analyses provided to the Committee this year and responses to elevated harvests and market prices over recent years, with declining catch rates despite more dispersed fishing than previously. We have considered the recent Regional distribution of catches, together with the likelihood of realising RCLs, in revising the RCLs. We have adjusted the distribution of catch among regions accordingly to ensure that the harvest potential for the fishery is maintained in those regions that have supported most catch historically (Regions 3 and 4) whilst avoiding curtailing severely prospective catches in any region. This strategy inherently includes an assumption that red urchin stocks are more productive or robust in Regions 3 and 4 than elsewhere. There is a risk, therefore, that continued higher catches in Regions 3 and 4 might deplete stocks there disproportionately, and necessitate future cuts, if that assumption is incorrect. The Committee considers the revised RCLs to provide sensible limits to further, and likely unsustainable, increases in harvest in all regions whilst not constraining total harvest below what has been taken in any year since 2002.

### 6.3 The Determination

The Total Allowable Fishing Committee, pursuant to Division 4 of Part 2 of the Fisheries Management Act 1994, determines that the commercial catch of red urchins in the NSW SUTS Restricted Fishery should be controlled by two essential and dependent instruments:

1. A notional Total Allowable Commercial Catch of red urchin during the period 1 January 2020 to 31 December 2020 of **60 tonnes**; and
2. Regional Catch Limits per Table 6.1 that collectively total, and should not exceed, **22.5 tonnes**.

These two instruments should be seen as required and inseparable for the 2020 fishing period.

**Table 6.1:** Regional Catch Limits for red urchin during the 2020 fishing year.

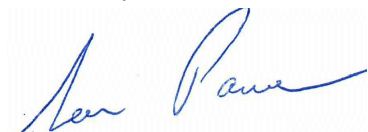
Region	2020 Regional Catch Limit (t)
1	2.5
2	7.5
3	6.5
4	6.0
5	0
<b>Total</b>	<b>22.5</b>



Bruce Mapstone, Chair



Alice McDonald, Fisheries Management



Sean Pascoe, Natural Resource Economist

Dr Keith Sainsbury was unavailable for this Determination.

## 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, *inter alia*, in the *Fisheries Management Act 1994, Part 2a, Division 2, S40*.

Date	Fisheries Management Act Reference	Consultation Stages
11.09.2019	Section 40F(1)	Committee called for public submissions on the appropriate level of the annual TACC for red urchins for the 2020 fishing period.
11.09.2019	Section 284 (2)(c)	<p>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 Sea Urchin and Turban Shell (SUTS) Restricted Fishery or their interest in related issues. These groups included:</p> <ul style="list-style-type: none"> <li>■ NSW SUTS Fishery business owners and nominated divers;</li> <li>■ NSW Department of Primary Industries Fisheries Regional Offices;</li> <li>■ NSW Department of Industry Head Office.</li> </ul>
11.09.2019	Section 284 (2)(c)	Advertisement calling for public submissions placed in the "Open for Comment" section of the Department of Primary Industries web-site.
11.10.2019	Section 284 (2)(b)	Public consultation closing date, after at least 30 days.
26.09.2019	Section 40F (2)	<p>The Committee received the following collated submissions:</p> <ul style="list-style-type: none"> <li>■ NSW DPI – Commercial Fisheries Management Report;</li> <li>■ NSW DPI Red Urchin Assessment Report;</li> </ul> <p>No submissions were received from either NSW SUTS fishery endorsement holders, or other stakeholders.</p>
09.10.2019	Section 40F (2)	<p>The Committee considered submissions and heard formal presentations and opinions at the Total Allowable Fishing Committee Open Forum meeting in Sydney on 9 October 2019.</p> <p>The following made presentations or provided information to the Committee:</p> <ul style="list-style-type: none"> <li>■ Ms Fiona McKinnon, NSW DPI — Management</li> <li>■ Mr Joshua Foster — Management Report</li> <li>■ Dr. Rowan Chick, NSW DPI Stock Status Report;</li> </ul> <p>The following also attended the public forum:</p> <ul style="list-style-type: none"> <li>■ Ms Amy Boughton</li> <li>■ Mr Travis Gumley</li> <li>■ Mr Tyler Gumley</li> <li>■ Mr Ralph Lavender</li> <li>■ Mr Jamie Newman</li> <li>■ Mr Gunther Pfrengle</li> <li>■ Mr James Mansfield (DPI)</li> <li>■ Mr James McLeod (DPI)</li> <li>■ Mr Jai Setttee (DPI)</li> </ul> <p>Apologies: Dr Keith Sainsbury, Mr Greg Finn.</p>

## APPENDIX 2. SUMMARY OF SUBMISSIONS

No submissions were received from a SUTS fishery endorsement holders or other non-government stakeholders.

Submission from	Summary

## APPENDIX 3. ECONOMETRIC ANALYSIS

The data provided in the management and stock assessment reports were used to estimate the relationship between catch, price, and catch rate (catch per unit effort, CPUE). The previous (2018) Determination Report included some preliminary modelling that suggested that catch is highly responsive to price. The inclusion in the 2019 stock assessment report of CPUE for days on which only red urchin was landed provides an opportunity to revise the model with a proxy for relative stock abundance, assuming some correlation between stock abundance and catch per unit of effort.

Data between 2002 and 2018 were used for the analysis. Earlier data were available but earlier fishing behaviour and catches may have been influenced by known unusual market conditions during 2000–01 and the prospective move to quotas in 2002. High catch levels were observed in 2000 and 2001, prior to the introduction of the 60 t TAC and catches fell to substantially lower levels (and well below the TAC) after the TAC was introduced. Data for 2019 were incomplete (i.e. available only to August–September) so were not included.

The data were time series and so their stationarity properties were established first to ensure the correct modelling framework was used. The natural logs of price (in real terms), catch, and CPUE were all found to be non-stationary in levels but stationary in first differences, indicating that a dynamic modelling framework was appropriate. An error correction approach was adopted. This allows for estimates of short term as well as longer term effects to be captured in the models.

Both demand and supply functions were estimated, with CPUE used to identify the supply function and a time variable used to identify the demand function. All variables were logged.

The model results are given in Table 4.2. The lagged price and CPUE variables were not significant in the supply model, but excluding these resulted in a worse performing model (based on the Akaike Information Criterion, AIC). Catch was not found to be significant for the demand model (as expected), and excluding the catch variables resulted in an improved model (based on the AIC).

Changes in catch responded to changes in both price and CPUE in the supply model, as expected. The short term price elasticity is close to 1, which means that a 1 per cent change in price will lead to a 1 per cent change in catch, all else being equal. The short term “biomass” elasticity was around 0.6, suggesting that catch increases by a less than proportional degree to biomass increases (assuming CPUE is proportional to biomass). The longer term impacts of both price and CPUE on catch are greater than the short term impacts. For example, a price increase this year will result in higher catches this year but also result in increased catches the following year(s), all else being equal. Similarly, changes in CPUE will have longer term impacts on catch. Both the long term price and CPUE elasticity, however, were not significant, suggesting that the actual change is still uncertain.

**Table A3.1.** Short term and long term supply and demand in the red urchin fishery (2002-2018)

	$\Delta\text{Catch}_{t,t-1}$ (supply)				$\Delta\text{Price}_{t,t-1}$ (demand)			
	Estimate	Std. Error	t value	Pr(> t )	Estimate	Std. Error	t value	Pr(> t )
Intercept	-1.624	1.578	-1.029	0.324	1.266	0.364	3.479	0.003 **
$\Delta\text{Price}_{t,t-1}$	0.972	0.410	2.368	0.036 *				
$\Delta\text{CPUE}_{t,t-1}$	0.628	0.326	1.926	0.078 +				
$\text{Price}_{t-1}$	0.699	0.424	1.647	0.125	-0.918	0.241	-3.815	0.002 **
$\text{Catch}_{t-1}$	-0.413	0.179	-2.304	0.040 *				
$\text{CPUE}_{t-1}$	0.315	0.293	1.076	0.303				
Time					0.040	0.011	3.511	0.003 **
Derived long run coefficients								
$\text{Price}_{t-1}/-\text{Catch}_{t-1}$	1.692	1.190	1.421	0.173				
$\text{CPUE}_{t-1}/-\text{Catch}_{t-1}$	0.763	0.793	0.963	0.349				
$\text{Time}/-\text{Price}_{t-1}$					0.044	0.010	4.445	0.000
$\bar{R}^2$	0.532				0.456			
F	4.867			***	8.129			**

Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘+’ 0.1 ‘.’ 1

The demand equation essentially was solely an increasing function of time, increasing by around 4% a year on average in real terms (i.e. after adjustments for inflation have been made). This reflects the influence of external factors on price and a general increase in demand over time, with the amount landed having no significant impact in the short or longer term on price received.

These results are indicative only due to the limited data and the consequent lack of statistical significance of some of the key drivers. Further, measures of CPUE have not been adjusted for changes in efficiency (fishing power) in the fishery (if any), so may provide a misleading indication of the biomass. The results are consistent with what has been observed in the fishery, however, and the comments raised by industry members. These estimates will be able to be improved as more data becomes available over time.