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DRAFT Aquatic Resource Management Strategy for the *Pinctada maxima* Managed Aquatic Resource

February 2023

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Important disclaimer

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List of acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AHL	Allowable Harvest Level
ARMA	<i>Aquatic Resources Management Act 2016</i>
ARMS	Aquatic Resource Management Strategy
ARUP	Aquatic Resource Use Plan
BMSY	Biomass that enables a fish stock to deliver the maximum sustainable yield
CEO	Chief Executive Officer
CPUE	Catch Per Unit Effort
DPIRD	Department of Primary Industries and Regional Development
EBFM	Ecosystem Based Fisheries Management
ERA	Ecological Risk Assessment
ESD	Ecologically Sustainable Development
ETP	Endangered, Threatened and Protected
HCR	Harvest Control Rules
MAR	Managed Aquatic Resource
MOP	Mother-of-Pearl
MSC	Marine Stewardship Council
PRI	Point of recruitment impairment
SCPUE	Standardised Commercial Catch Per Unit Effort
SL	Shell Length
TAC	Total Allowable Catch
TACC	Total Allowable Commercial Catch
TARC	Total Allowable Recreational Catch
WA	Western Australia

1.0 Introduction

Pursuant to section 14(1) of the *Aquatic Resources Management Act 2016* (ARMA), on 25 November 2022 the Minister for Fisheries (Minister) declared aquatic organisms of the species *Pinctada maxima* under Western Australian (WA) jurisdiction as a Managed Aquatic Resource (MAR).

Under section 17 of ARMA, declaration of a MAR triggers the requirement for an Aquatic Resource Management Strategy (ARMS) to be developed for the MAR as soon as practicable.

Section 16 of ARMA specifies the required content of an ARMS. Consistent with this, and the draft ARMA-Based Harvest Strategy Policy (DPIRD, 2022a), this ARMS covers four principal management category areas, being:

1. Resource description.
2. Management objectives, sectoral allocations and commercial access.
3. Harvest Strategy for the resource, including the measures used to assess performance and the method for setting the Allowable Harvest Level (AHL) and Total Allowable Catch (TAC) for each fishing period.
4. Consultation on the Aquatic Resource Use Plan (ARUP) that will operationalise aspects of this ARMS.

The ARMS includes full descriptions and rationale for each of the ARMA requirements in section 16 covered within these four category areas. These requirements are also presented in a summarised form within Appendix 1.

This ARMS is operationalised by a commercial ARUP and Regulations made under ARMA (see Figure 1).

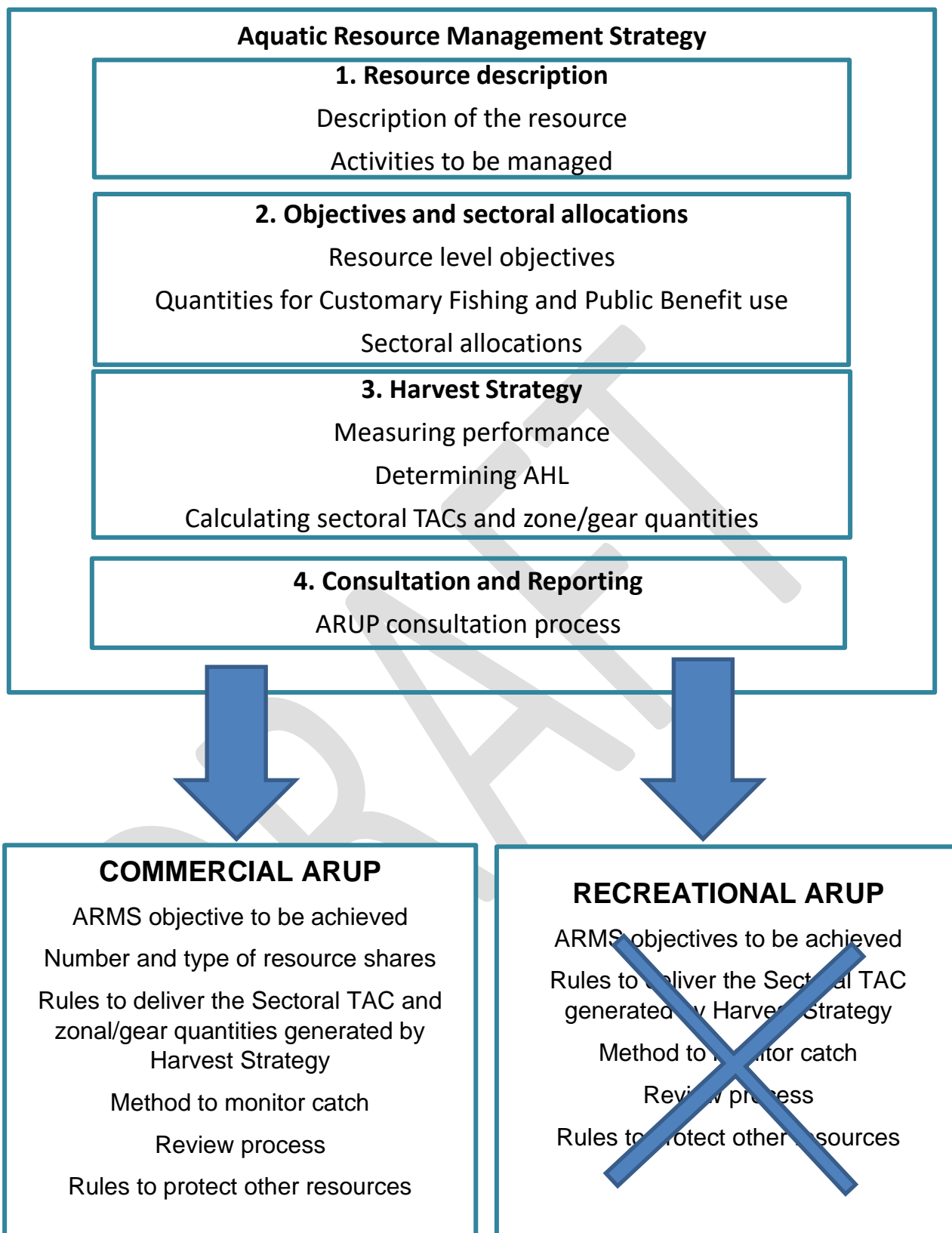


Figure 1: Standard outline of the four key components required within the ARMS and the relationship with the sectoral level ARUPs designed to deliver the ARMS. *Note*, the crossed-out box reflects that a recreational ARUP is not required for the Pearl Oyster resource; Regulations will be used to manage this sector’s marginal use allocation.

2.0 Resource Description

2.1 Aquatic Resource to be Managed - Section 16 (1) (a)

This ARMS applies to *aquatic organisms of the species Pinctada maxima (Pearl oyster)* within all WA managed waters as defined under the offshore constitutional settlement arrangements (Department of Fisheries, 1995).

Pearl oysters are a filter-feeding bivalve mollusc found in coastal WA waters north of Exmouth across northern Australia to Cooktown, Queensland (Southgate and Lucas, 2008).

Pearl oysters are a protandrous hermaphrodite, meaning that they mature first as males at approximately three to four years of age (110 to 120 mm shell length (SL)) after which they start to undergo a sex change and become females, with this change completed by eight years of age (170 to 190 mm SL). This has implications for the management of the resource because separate assessments of the male and female components of the stock are required to determine overall stock sustainability status.

Spawning occurs between September and May each year, with a peak from October to December. Annual variation in recruitment of juveniles appears to be driven primarily by environmental conditions including sea surface temperature, rainfall and wind conditions (Hart et al, 2011). Pearl oysters have been utilised for decoration and cultural purposes, meat and, more recently, the production of pearls.

2.2 History of Resource Use

The customary use of Pearl oysters (including shelled species other than *P. maxima*) has an important cultural significance to the indigenous people of Australia and have been harvested for at least 20 000 years (Yu et al, 2011). Aboriginal Australians of the West Kimberley harvested Pearl oyster shells from shallow waters and established traditional trading networks that extended throughout Australia (Akerman and Stanton, 1994). The Pearl oyster meat was consumed and the shell used for decoration and other cultural purposes (**Figure 2**). There are still Pearl oyster carvers in the Kimberley region, with Pearl oysters continuing to be significant in cultural traditions (Department of Fisheries, 2016a; Yu et al, 2011).

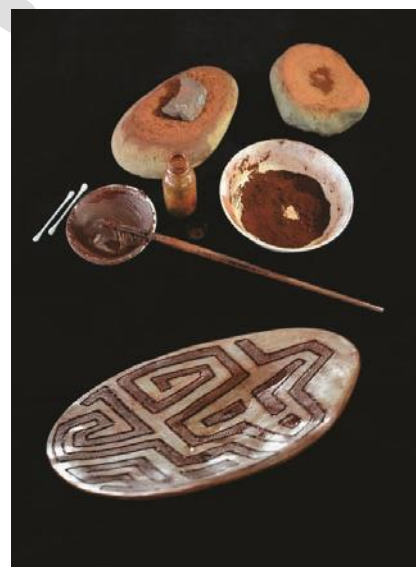


Figure 2: Indigenous carving on Pearl Oyster shell (personal-Patrick Baker © Western Australian Museum).

Commercial fishing for Pearl oysters in WA began in the 1860s in south Pilbara, around Cossack and Flying Foam Passage. By the 1890s Pearl oysters were also commercially fished at Eighty Mile Beach and throughout the Kimberley. The introduction of the *Pearl Fishing Act 1886* and the *Pearling Act 1912* established the first statutory management framework for the WA commercial Pearl oyster fishery (Southgate and Lucas, 2008; Malone et al, 1988).

Initially, the commercial industry harvested Pearl oysters of all sizes but favoured the larger Pearl oysters which were used to produce Mother of Pearl (MOP) for buttons and inlays in furniture and watches. By 1910 there were nearly 400 luggers and 3500 people in the pearling industry (**Figure 3**). At its peak, approximately 2 million Pearl oysters were harvested annually, supplying up to 75 % of global MOP production (Southgate and Lucas, 2008; Malone et al, 1988).

In the late 1950s the pearl culture phase of the commercial industry began to develop in Australia. By the end of the 1970s, most of the commercial industry had moved into cultured pearl production. This shift towards pearl culture saw a gradual decrease in the number of Pearl oyster fishing boats.

Entry into the commercial Pearl oyster fishery and access to fishing zones has been limited with industry having operated under a detailed and sophisticated management regime since the early 1980s, when quotas were first introduced. Since this time, the total annual catch has ranged between 330 000 and >839 000 Pearl oysters. The average annual catch over the past 13 years is approximately 803,800 Pearl oysters (which includes larger shell utilised for MOP).



Figure 3: “Hard- hat” diver (ca. 1915)

Since the early 1990s, the commercial pearling industry has also developed hatchery technologies for breeding Pearl oysters.

Over the last 30 years, in addition to maintaining resource sustainability, a focus for management of the pearling industry has been regulation of south sea pearl production. In this regard, pearl production has been limited through controls on first operation Pearl oyster seeding since 1993.

Today’s commercial pearling industry has an integrated structure across the wild capture, hatchery, seeding and culture activities with the 2021 annual value of products estimated to be \$64.5 million.

The commercial Pearl oyster fishery was awarded Marine Stewardship Council (MSC) accreditation in 2017 and has been reassessed in 2022. This is the first jewel-based fishery in the world to achieve this accreditation which includes pearl production and fishery activities.

With respect to recreational uses, under the *Pearling Act 1990*, a pearling licence or permit was required to collect Pearl oysters in WA waters. While no recreational fishing applications were made under this legislation, it is understood that small quantities of Pearl oysters have been occasionally collected by the WA community.

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3.0 Management Objectives and Regulated Activities

3.1 ARMA Objectives

Development of the main management objective (and any associated operational objectives) contained in the ARMS must be consistent with the overarching objects of ARMA which are -

- (a) *to ensure the ecological sustainability of the State's aquatic resources and aquatic ecosystems for the benefit of present and future generations; and*
- (b) *to ensure that the State's aquatic resources are managed, developed and used having regard to the economic, social and other benefits that the aquatic resource may provide.*

3.2 Main Objective for Managing the Pearl oyster Resource- Section 16 (1) (b)

For the past 150 years, Pearl oysters have primarily been taken for commercial purposes, initially for MOP and more recently to produce high-quality round pearls.

While recognising the ongoing take of Pearl oysters for customary purposes and incidental take by the wider community, the optimum return to WA from the use of Pearl Oysters will be achieved by continuing to support the commercial pearling industry.

This currently involves the collection and use of Pearl oysters for (a) direct seeding for pearls, (b) sale as MOP, (c) sale of pearl meat, (d) broodstock for hatchery operations.

Based on these uses, the main objective to be achieved by managing the Pearl Oyster resource is:

To optimise the economic return to the WA community through the production of high-quality pearls and associated Pearl oyster-based products.

Operational objectives based on this main objective are provided in Section 5.2 and the overarching objectives of ARMA (Section 3.1) are detailed in the Harvest Strategy (Section 5.0).

3.3 Regulated Activities - Section 16 (1) (d)

This ARMS, associated subsidiary legislation (Regulations), commercial ARUP, and administrative guidelines will regulate all fishing activities for Pearl oysters in WA.

The regulation of hatchery operations and pearl production will be managed under aquaculture provisions of ARMA.

3.4 Fishing Period - Section 16 (1) (e)

The fishing period specified within this ARMS recognises that the annual commercial licensing period has historically been 1 January – 31 December, but that ARMA's full implementation will occur on 1 November 2023. Consequently, ***the first fishing period under this ARMS will operate from 1 November 2023 until 31 December 2023. Thereafter, from 1 January 2024, the annual fishing period shall be from 1 January until 31 December.***

3.5 Role of Hatchery Production of Pearl oysters

Commercial pearling is an integrated pearl production operation that uses wild harvest and hatchery produced Pearl oysters to culture pearls and produce MOP and meat.

The operational objectives associated with the production, grow-out and seeding of hatchery produced Pearl oysters are to:

1. Increase industry resilience by providing a second source of Pearl oysters, thereby reducing risks to the long-term sustainability of the wildstock resource.
2. Manage hatchery activities to minimise the risk of:
 - a. serious or irreversible harm to the genetic diversity of the wildstock population.
 - b. disease introduction to the wildstock population.

As outlined above, these aspects will be managed through the aquaculture provisions under ARMA.

4.0 Sectoral Access and Allocations

4.1 Customary Fishing and Public Benefit Use Priority Allocations - Section 16 (1) (f)

ARMA establishes priority access to quantities of an aquatic resource for customary fishing and public benefit use.

ARMA defines customary fishing as “fishing by an Aboriginal person that is in accordance with the Aboriginal customary law and tradition of the area being fished; and is for the purpose of satisfying personal, domestic, ceremonial, educational or other non-commercial communal needs.” A customary fishing allocation provides material quantities to enable collection for continued/re-commenced customary use.

Public benefit use is for activities such as research or education purposes which for Pearl oysters may include collections for stock assessment, disease testing, and biosecurity activities. It does not include take for recreational fishing or commercial activities. It is also not a tradeable right. To access this public benefit allocation, formal permission through the grant of an exemption or authorisation under the Regulations will be required.

The priority quantity for customary fishing and public benefit use is a fixed amount that is deducted from the Allowable Harvest Level (AHL) each fishing season to generate the Total Allowable Catch (TAC). See the Harvest Strategy (Section 5.0) for calculation of the AHL.

A priority allocation of 25,000 live Pearl oysters will be made available in each fishing period for customary fishing and public benefit uses.

4.2 Commercial Sector Allocation - Section 16 (1) (i) (i)

Consistent with the main objective for managing the Pearl Oyster resource, **99.9% of the TAC has been allocated to commercial fishing for each fishing period.** This take will be formally managed by a dedicated Pearl oyster resource ARUP. Pearl oysters used for aquaculture broodstock purposes are included in the commercial fishing allocation.

4.3 Commercial Fishing Resource Shares - Section 16 (1) (j); (ja)

Commercial fishing access to the Pearl oyster resource will be managed within three zones (**Figure 4**) (previously four zones; see map and coordinates in Hart et al, 2016). Coordinates used to define the zones are provided in Appendix 2. Access will be conferred through the following two types of resource shares, which will give rise to separate annual catch entitlements for 100 mm to 175 mm shell length (SL) pearl oysters and >175 mm SL pearl oysters within each zone:

- ***Zone 1 – there are 115 resource shares which confer access to Zone 1.***
- ***Zone 2 (previously Zone 2/3) – there are 457 resource shares which confer access to Zone 2.***

No commercial fishing is allowed within:

- the Kimberley Development Zone (previously Zone 4), and

- all other WA managed waters outside of Zone 1 and Zone 2;

therefore no commercial resource shares are granted for these areas.

The method for allocating resource shares is contained in the commercial ARUP for this resource.

Figure 4 also includes the Zone1/2 buffer area documented in the *Pearling (Declaration of Zones) Amendment Notice 1997*, Gazetted on 28 November 1997. Zone 1 and Zone 2 licensees are permitted to fish for wildstock within the Zone1/2 buffer area.

4.4 Incidental Take by Commercial Fishing Activities for Other Resources - Section 16 (1) (i) (ii)

As there is no incidental capture of Pearl oysters during commercial fishing for other aquatic resources, ***the proportion of TAC available for incidental take whilst commercially fishing for other aquatic resources is 0%.***

4.5 Recreational Sector Allocation (Marginal Use Only) - Section 16 (1) (h)

While recreational fishing for *P. maxima* has not been recognised historically (refer to Section 2.2), it is understood that Pearl oysters are occasionally taken by members of the community as either whole live oysters or as dead shells collected from the shore.

Consistent with the common-property nature of all aquatic resources in WA and the marginal use policy outlined in the draft *Objective Setting and Allocations for Aquatic Resources Under ARMA: Policy, principles and processes* (Allocation Policy) (DPIRD, 2022b), take of Pearl oysters will be recognised through a marginal use Total Allowable Recreational Catch (TARC) allocation.

A marginal use TARC allocation for the recreational take of Pearl oysters of this resource is calculated as 0.1% of the TAC.

The marginal use TARC will be formally managed under Regulations with no recreational ARUP required for this resource. Monitoring of recreational take is summarised in Section 5.4.3 and recreational control rules are summarised in Section 5.6.4.

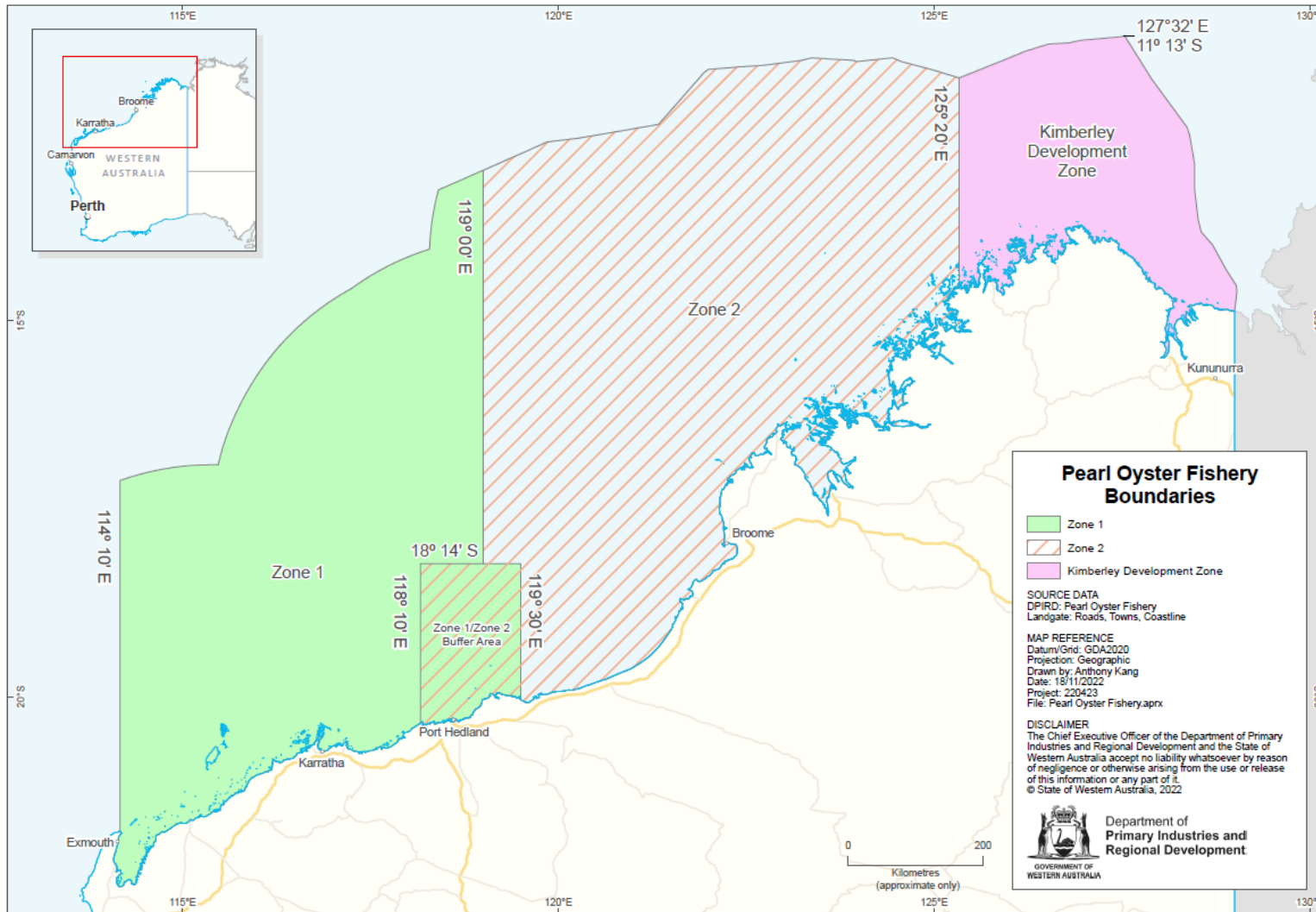


Figure 4: Map of Pearl Oyster Fishery zones.

5.0 Harvest Strategy

5.1 Overview

The Harvest Strategy section of an ARMS includes the rules and processes used to adjust the catch levels each season in a predictable manner to achieve acceptable performance in relation to the objectives established for the resource. Each of these steps and the various inputs involved in this process are outlined in **Figure 5**.

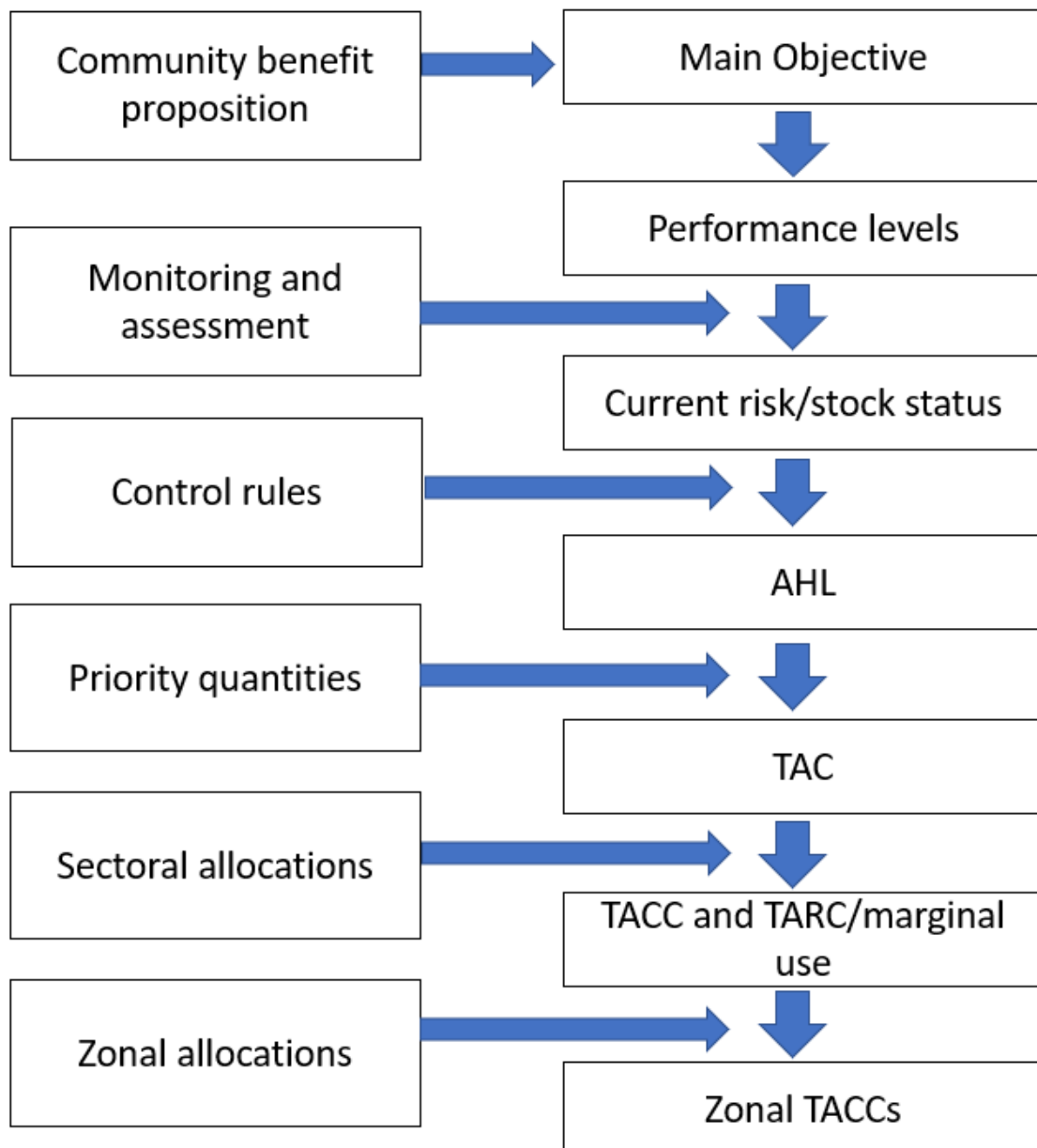


Figure 5: Outline of the Harvest Strategy processes and inputs used to develop the AHL, TAC, TACCs and TARC (marginal use) for each fishing period for this resource.

The Harvest Strategy essentially delivers on the Section 16 (1) (g) requirement for an ARMS to set out the method that will be used for calculating the AHL, TAC, Total Allowable Commercial Catch (TACC) and TARC for each fishing season. This calculation is based on achieving the outcomes specified within the main objective and applying the defined sectoral allocations.

The first step for developing the Harvest Strategy requires translating the main objective and relevant ARMA objects into operational objectives for the resource. From these, explicit performance measures (indicators and reference levels) are established using the best available scientific parameters. The associated monitoring systems required to measure stock status against the reference levels and any sectoral allocations are also documented. The final component of the Harvest Strategy requires specifying the Harvest Control Rules (HCRs) that describe how the AHL (and other management arrangements) will be adjusted each season to achieve acceptable performance based on the current stock status.

Where relevant, the Harvest Strategy can also consider the impacts of fishing activities on bycatch¹, endangered, threatened and protected (ETP) species, benthic habitats, and broader ecosystem processes. Depending upon the resource and fishing operations, dealing with these risks may require adjusting the overall catch levels and/or the types of fishing methods and/or the areas permitted to access the managed resource.

The Pearl Oyster Harvest Strategy documented below and summarised in **Appendix 3** is based on the extensive documentation and knowledge of the Pearl Oyster resource contained within previous reports completed to meet Ecologically Sustainable Development (ESD) (Fletcher et al., 2005) and Ecosystem Based Fisheries Management (EBFM) requirements (Fletcher, et al., 2010, 2012; Cochrane et al, 2014; Fletcher 2015); MSC certification (Hart et al, 2016) plus previous Harvest Strategies (Department of Fisheries, 2016b; DPIRD, 2022c). Key elements are largely refinements of the annual Pearl Oyster TAC setting processes used over the last few decades.

5.2 Operational Objectives

To assist in achieving the overall objects of ARMA and the main objective for the Pearl Oyster resource and associated fishing activities, the following ESD-based operational objectives will be used to guide the development of management arrangements (**Table 1**).

¹ Bycatch in this context is the part of the catch returned to the sea (usually referred to as non-retained or discarded) either because it has no commercial value or because legislative requirements preclude it being retained.

Table 1: ESD-based operational objectives for managing the Pearl oyster resource.

ESD Component	Operational Objective
Target species sustainability	To maintain ecological sustainability, keep the spawning stock (spawning potential) of the Pearl oyster resource at levels where future recruitment is only affected by environmental variability, not the current stock size.
Economic and social outcomes	To provide optimal economic opportunities for industry participants and ongoing customary fishing activities by maintaining Pearl oyster stocks near catch rate-based target levels.
Climate change	To have management systems that can identify and adapt to climate change-based effects to promote the long-term productivity of the resource.
Bycatch (non-ETP) species	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to bycatch species populations.
ETP species	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to ETP species populations.
Habitats	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to habitat structure and function.
Ecosystem	That the overall effects of fishing do not result in an unacceptable risk of serious irreversible harm to ecological processes.

Based on Ecological Risk Assessment (ERAs) results for this resource (e.g., Hart et al., 2014, Travaille et al, 2016, Smith et al., 2022) the operational objectives directly relevant for determining the annual AHLs for the Pearl oyster stock are:

- Target species and ecosystem sustainability.
- Economic and social outcomes.
- Climate change.

The following sections outline the performance levels and their underlying scientific parameters that will be used to assess the status of the Pearl oyster stock in relation to meeting the objectives.

In addition, **Appendix 3** outlines Harvest Strategy performance indicators, reference levels, control rules for associated ecological assets that may be impacted by fishing activities for the Pearl Oyster resource.

5.3 Performance Levels - Section 16 (1) (c) (k).

Based on the relevant operational objectives for the Pearl oyster stock, clear performance indicators and reference levels that define acceptable from unacceptable

stock performance in determining each season's allowable catch levels (**Figure 6**) need to be established, whereby:

- Target level is where the pearl stock indicators should be to best meet the economic and social outcomes.
- Threshold level is where you review your position in relation to meeting the desired outcomes and the potential impacts of climate shifts.
- Limit level is where you do not want the stock indicator to be, as it is not meeting the target species and ecosystem sustainability objectives.

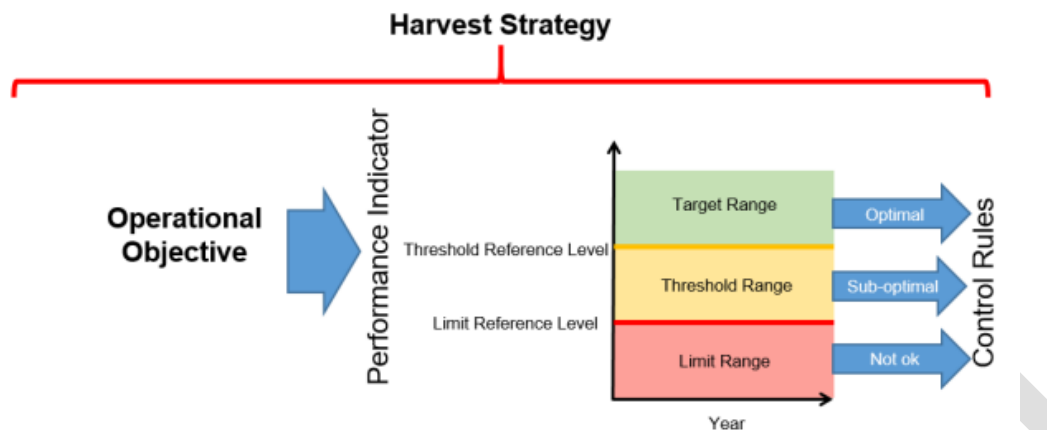


Figure 6: The relationship between Operational Objectives, Performance Indicators, Reference levels and Control Rules.

5.3.1 Performance Indicators for Stock Status

There are two size classes of Pearl oysters that can be taken by the commercial Pearl oyster fishery:

- 100 to 175 mm SL Pearl oysters (previously referred to as 'culture shell' and these are mostly male).
- >175 mm SL Pearl oysters (previously referred to as 'MOP' shell and these are females).

The main performance indicators used to measure stock levels for each of these two size classes are Standardised Commercial Catch Per Unit Effort (SCPUE) obtained from Zone 2.

- The SCPUE for 100 to 175 mm SL Pearl oysters is generated from commercial catch data.
- The SCPUE for the >175 mm SL Pearl oysters comes from an independent survey.

The SCPUE measures the number of Pearl oysters collected per diver hour that has been corrected for differing environmental conditions, sizes targeted and other factors that may have affected the divers catching efficiency. The specific size range of Pearl oysters used to calculate the SCPUE can therefore vary among seasons based on shifts in the targeting practices of the fishing operations.

Within Zone 1, nominal commercial catch rate data for the two size classes will be assessed against historical trends plus periodic fishery independent surveys will provide additional indices of stock abundance.

Zone 1 and 2 performance indicators are summarised in **Table 2**.

Table 2: Pearl oyster resource Zone 1 and 2 performance indicators

Zone	Performance indicator
1	<p>Given the relatively low and variable level of annual take within this zone, Zone 2 SCPUE performance indicators will be used to assess the current stock status for the entire Pearl oyster resource including those within Zone 1.</p> <p>The commercial catch rate for Zone 1 size class 100 to 175 mm SL Pearl oysters can be independently assessed against recent CPUE trends obtained within this zone. Nominal catch rate assessments for >175 mm shell will be undertaken when there are sufficient data to generate a robust trend.</p> <p>Periodic fishery independent surveys are also planned for this zone.</p>
2	<p>Separate formal analyses on stock status are completed for 100 to 175 mm SL Pearl oysters and >175 mm SL Pearl oysters within this zone based on the outputs from separate prediction models that estimate future SCPUE for these two size classes.</p> <p>The SCPUE for 100 to 175 mm SL Pearl oysters from commercial catches and >175 mm SL Pearl oysters from an independent survey using the mean annual number of each of the size classes of Pearl oysters caught per hour.</p> <p>These SCPUE models need to be adjusted each year to account for changes in targeting practices and minimum size.</p>

5.3.2 Reference Levels Targets, Thresholds and Limits

Establishing the limit level reference levels for this resource meets the requirement of the ARMS including **S. 16(1)(c)** which is to specify the *minimum quantity of the aquatic resource that is considered necessary to be maintained for the resource to be ecologically sustainable*.

Establishing the threshold and target levels fulfils the requirement of **S. 16 (1) (k)** to *specify the scientific parameters that will be used to assess how effectively the resource is being managed*.

Based on the catch history and data available to assess the Pearl oyster resource, reference levels for Zone 2 will be used. Given there are two size classes of Pearl oysters captured in Zone 2, two reference levels and associated scientific parameters are required to assess the overall stock status of the Pearl oyster resource, outlined below.

Zone 2 (100 to 175 mm SL Pearl oysters) - The SCPUE is the standardised mean number of Pearl oysters for this size class caught per hour within Zone 2 each season. The three SCPUE reference levels (limit, threshold and target) have been set based on

the reference period from 2003 to 2021. The three reference level types for 100 to 175 mm SL Pearl oysters are described in **Table 3**.

Table 3: Reference Levels for 100 to 175 mm SL Pearl oysters in Zone 2.

Reference level	Predicted SCPUE 100 to 175 mm SL	Justification
Limit	15 Pearl oysters per hour.	This level is close to the lowest value recorded in 1981 of 16 Pearl oysters per hour. The ongoing sustainability of the stock over the last 40 years indicates that this limit reference level is set above the level where there is a substantial risk of recruitment impairment.
Threshold	20 Pearl oysters per hour.	This level is 33 % above the limit reference level and approximates BMSY. It is used to provide an early warning that stock abundance is declining and/or there may be a shift in recruitment due to climate shifts, enabling management action to be taken to reduce exploitation before the limit reference level is reached
Target	25 Pearl oysters per hour.	This level has been set well-above the limit and threshold reference levels, with the intention of maintaining the stock at levels of production consistent with BMEY. When the indicator is above the target level, a predictive model is used to adjust the sustainable catch levels (see HCRs).

Zone 2 (>175 mm SL Pearl oysters) – The performance indicator for implementing this HCR is the annual fishery independent SCPUE of >175 mm SL Pearl oysters in Zone 2. Reference levels have been set based on the reference period from 2007 to 2021. This is when routine monitoring of >175 mm SL Pearl oysters commenced and is a period when the stock is known to have been above the point of recruitment impairment (PRI). The three reference level types for >175 mm SL Pearl oysters are described in **Table 4**.

Table 4: Reference Levels for >175 mm SL Pearl oysters in Zone 2.

Reference level	Predicted SCPUE > 175 mm SL	Justification
Limit	5 Pearl oysters per hour.	The limit reference point is slightly below the lowest SCPUE of 6.6 Pearl oysters per hour observed during the reference period (Hart et al. 2014b; Figure A-4). Densities of >175 mm SL Pearl Oysters rapidly increased from this low SCPUE of 6.6, and hence PRI was proved to be below 6. These rapid increases would not have occurred if PRI had been reached. Selecting a value of 5 to represent the PRI was therefore deemed appropriate.
Threshold	10 Pearl oysters per hour.	This level is 100% above the limit reference level and is used to provide an early warning that stock abundance is declining, enabling management action to be taken to reduce exploitation before the limit reference level is reached.
Target	15 Pearl oysters per hour.	This level has been set well-above the limit and threshold reference levels, with the intention of maintaining the stock at levels of production consistent with BMEY. If above target level utilise predictive model outcomes to adjust the sustainable catch levels (see control rules).

Zone 1 - The reference levels and performance indicator outcomes from Zone 2 will be applied to Zone 1. In addition, catch and effort levels within the zone are used to assess whether the abundance of Pearl oysters in this zone is consistent with the predicted levels of stock abundance generated from the Zone 2 models. The nominal catch rate of 100 to 175 mm SL Pearl oyster caught per hour within Zone 1 with a limit reference level having been set based on the reference period from 1980 to 2021.

Limit – 15 Pearl oysters 100 to 175 mm SL per hour. This limit reference level indicates the lower 20% range of the nominal catch rate during the reference period.

The use of data from the periodic independent surveys may be used to supplement these analyses.

5.3.3 Tolerance Levels (Zone 2 only)

The Zone 2 Pearl oyster fishery tolerance levels are the 95% confidence limits for the future predictions of abundance, up to three years in advance. Where observed abundance falls outside the predicted range, a review of contributing factors is initiated and may require the model to be updated as this may be evidence of climate change impacts.

In addition, if the SCPUE model for either size class results in predictions that are more than 30% different to starting values, a review will be undertaken

5.4 Monitoring Procedures and Assessments

5.4.1 Pearl oyster Resource

Performance indicators and monitoring procedures for the Pearl oyster resource presented in **Table 5**, assess each operational objective presented in **Table 1**. The series of indices generated by the monitoring activities outlined within **Table 5** enable robust predictions of Pearl oyster abundance up to four years into the future from which predictions of future allowable catch levels can be made up to three years in advance (see Appendix 4).

Table 5: Pearl oyster Performance Indicators and Monitoring Procedures.

Component	Performance indicator and monitoring procedure
Recruitment:	A unique “piggyback” spat index, derived by counting juvenile spat that settle onto adult oysters as part of the commercial monitoring program, is used to calculate recruitment abundance of 0+ and 1+ Pearl oysters each year. The unit of abundance is “density per 1000 adult oysters”.
Stock Levels (100 to 175 mm SL Pearl oysters):	SCPUE for the 100 to 175 mm SL Pearl oyster size class derived from statutory records of daily catch and effort in 10 x 10 nautical mile statistical reporting blocks are used as an index of current Pearl oyster abundance (for this size).
Spawning Potential (>175 mm SL Pearl oysters):	SCPUE of breeding Pearl oysters >175 mm SL. The abundance index is derived from population surveys of Pearl oyster stocks coordinated by DPIRD staff, but undertaken by commercial divers
Zone 1 catch and effort:	A constant catch exploitation rate of Pearl oysters per annum (nominal catch rate of 100 to 175 mm SL Pearl oysters).

5.4.2 Target Species Assessments

WA Pearl oyster stocks are assessed each year using a weight of evidence approach that examines the series of annual indices of actual and predicted catch rates within Zone 2 and compares these to the specified reference levels, plus the other available lines of evidence.

The indices of catch rate are standardised using generalised linear regression models to account for effects of a range of factors. In addition, a relationship between SCPUE and previous recruitment is used to predict future commercial catch rates (abundance).

These indices have been used to develop predictive relationships between:

1. Spat abundance and 100 to 175 mm SL Pearl oyster SCPUE four years into the future.
2. The current season’s allowable harvest level and 100 to 175 mm SL Pearl oyster SCPUE. As the catch of 100 to 175 mm SL Pearl oysters is comprised mainly of two age classes (4+ and 5+ Pearl oysters), these relationships allow recommendations on a AHL to be made up to three years in advance based on the spat settlement surveys (see Appendix 4).
3. This predictive approach to harvesting has been extended to Pearl oysters >175 mm SL which combines the spat settlement surveys with a fishery-independent

index of abundance, and utilises fishery efficiency and ecological parameters, such as area of Pearl oyster stocks, to estimate allowable harvest level for this size class.

These indices provide an early warning system allowing pre-emptive management to prevent stock depletion or take advantage of predicted high abundance.

Additional support for this assessment is provided by catch length frequency and population length frequency surveys to verify the spatial pattern of the exploited populations. Full details of the assessment methodology are provided in Hart et al., 2016 and these predictive models will be updated at regular intervals.

Given the low levels of catch in Zone 1, the outcomes for the assessments of changes in Pearl oyster abundance determined for Zone 2 each season are used as the basis for the assessment of the entire stock. Catch and effort in Zone 1 will also be assessed independently to determine if there is variation in stock status between the two zones, with nominal catch rates of 100 to 175 mm SL Pearl oyster used as the index.

5.4.3 Recreational Monitoring

Recreational take of live Pearl Oysters will be monitored through the state-wide recreational fishing survey. The year-long survey is run every two to three years and combines the data from the following sources to accurately estimate WA's boat-based recreational fishing participation, effort and catch:

1. Off-site phone-diary survey information.
2. On-site access point boat ramp interviews.
3. Boat ramp camera footage.

The purpose of the survey is to provide up-to-date information on boat-based recreational fishing to inform management and ensure WA's recreational fisheries remain sustainable. The survey will be used to monitor the recreational take of live Pearl Oysters by boat-based fishers.

5.4.4 Non-Target Species Assessments

Periodic ERAs are completed to assess potential risks of Fishery operations on other ecological components (marine environment, including target species, bycatch, ETP species, habitats and ecosystem). ERAs use a risk-based resource management framework based on the global standard for risk assessment and risk management (AS/NZS ISO 31000), adopted for use in a fisheries context (see Fletcher et al. 2002a, 2002b, Fletcher 2005, 2015).

Four aspects are considered for the assessment: ecological sustainability, community wellbeing, external factors and governance. ERA results are used to prioritise research, data collection and monitoring needs, as well as sustainable and efficient management actions for the Fishery.

In addition to periodic ERAs (held every three to five years) additional risk assessments can also be triggered if significant changes in fishing operations, management activities and/or controls occur, which may change

current risk levels.

ERA outcomes are considered against reference levels within the Harvest Strategy. Comparisons can be used to assess if additional management actions are required to sustainably and efficiently manage the resource to meet the main objective and minimise fishing impacts on the marine environment. Additional actions on fishing operations would be addressed within the ARUP.

Independent audits of these assessments and impacts also occur through the MSC accreditation and Commonwealth export approvals processes.

5.5 Harvesting Approach

5.5.1 Zone 1

Given the intermittent fishing in this zone, the Pearl oyster harvesting approach is a constant catch allocation when the stock assessment for the entire resource is above the target level. In Zone 1, the baseline catch for 100 to 175 mm SL Pearl oysters is 54,970 and 10,000 for >175 mm SL Pearl oysters annually.

5.5.2 Zone 2

The Harvest Strategy for both Pearl oyster size classes in Zone 2 is a constant exploitation approach whereby the same proportion of the stock is harvested each year. This approach has been operationalised through annual TACCs which are set in proportion to overall stock abundance.

5.6 Pearl Oyster Harvest Control Rules

5.6.1 Zone 1

The HCR used for Zone 2 (described below) is applied to Zone 1, should the Zone 2 performance indicators be below the target level. If the Zone 2 performance indicators are above the target level, then baseline catches for Zone 1 are applied.

If the catch and effort indicator (nominal catch rate of 100 to 175 mm SL Pearl oysters per hour) for this zone is below the limit, the zone is closed for the season. This is applied for both the 100 to 175 mm SL and >175mm SL Pearl oyster stocks.

5.6.2 Zone 2 (100 to 175 mm SL Pearl oysters)

When 100 to 175 mm SL Pearl oyster stock is predicted to be below target levels, HCRs adjust the total seasonal catch for this segment of the resource against the Zone 2 baseline of 457,000 Pearl oysters 100 to 175 mm SL. This is the lowest value since 2003 when the SCPUE index began.

A range of fixed and variable reductions to the baseline are made to reduce exploitation as stock abundance decreases and the limit reference level is approached.

When the stock is predicted to be at or above target levels, the HCR calculates the Zone 2 100 to 175 mm SL Pearl oyster allowable catch for the season as a function of stock abundance, using a linear regression model that is updated annually (Fig A4.1).

5.6.3 Zone 2 (>175 mm SL Pearl oysters)

When >175 mm SL Pearl oyster stock is predicted to be below target levels, HCRs adjust the TAC for this size class for the season against the Zone 2 baseline of 37,100 Pearl oysters >175 mm SL. A range of fixed and variable reductions to the baseline are made to reduce exploitation as stock abundance decreases and the limit reference level is approached.

When the stock is predicted to be at or above target levels, the HCR calculates the >175 mm SL Pearl oyster allowable catch as a function of stock abundance, using a linear regression model that is updated annually (Fig. A42)

5.6.4 Recreational Control Rule

Quantities of Pearl oysters taken recreationally will be monitored through state-wide recreational fishing surveys (described in Section 5.4.3) and assessed against the 0.1% of the TAC marginal use allowance for the year the recreational survey was taken. Where recreational take exceeds 0.1% of the TAC (the limit), the recreational take HCR (provided in **Table A2-1** in **Appendix 3**) requires that a review is conducted to investigate reasons for the limit exceedance. Management action, appropriate to the findings of the investigation, will be implemented to reduce take to below the limit.

5.6.5 Control Rules for other Ecological Assets

ERA (described in Section 5.4.4) results are used to determine when additional management actions may be required for other ecological assets such as bycatch, ETP species, habitats and ecosystem processes.

Reference levels for these assets differentiate acceptable fishery impacts (low/moderate levels) from unacceptable fishery impacts (high/significant levels) according to the calculated risk levels as defined in Fletcher (2015). The description of risk levels specific for the Pearl oyster resource is available in Smith et al., 2022.

Changes to these risk levels are expected to only potentially affect the activities associated with the collection of Pearl oyster shells, not the allowable catch levels which will be reflected in changes to the ARUP.

5.7 Calculation of AHL, TAC and Zonal TACCs Section 16 (1) (g)

Figure 7 summarises the AHL and TAC calculation process, displaying 2022 data in red as an example. The following sections describe how each figure presented in the example in **Figure 7** is calculated.

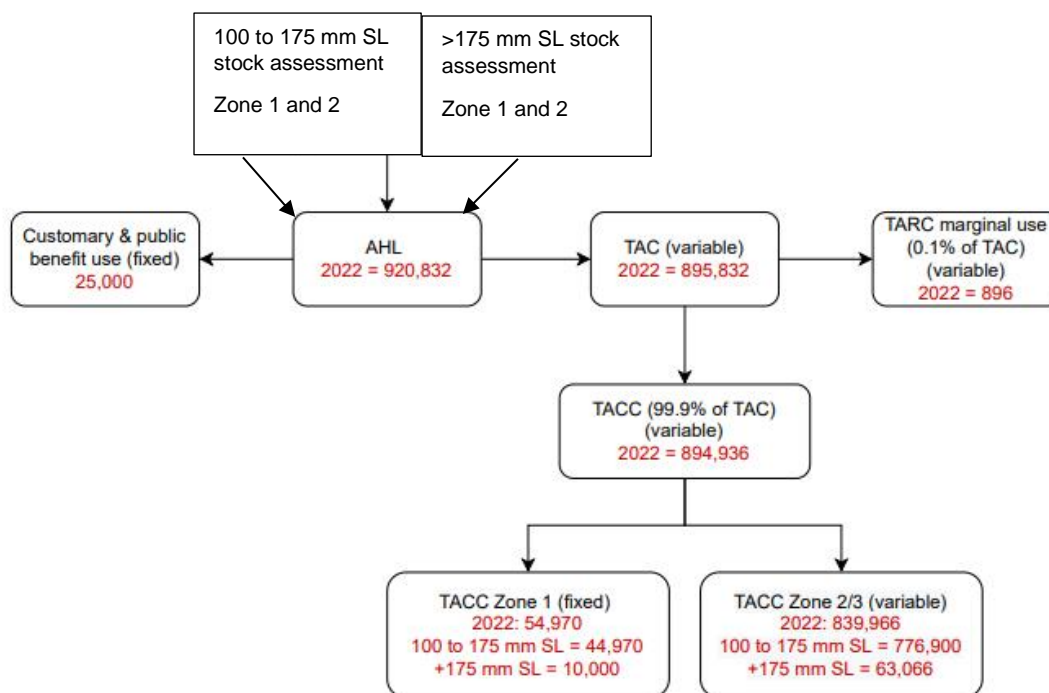


Figure 7: Pearl oyster fishery AHL, TAC, Zonal TACC and marginal use calculation processes, with 2022 values in red provided as an example.

5.7.1 Allowable Harvest Level

Each season, the AHL for the Pearl oyster resource is calculated by adding the acceptable catch levels generated from the stock assessments and HCR processes for both size classes of Pearl oysters for Zone 1 and Zone 2.

5.7.2 TAC (S. 16. (1) g (i))

The TAC for the season is determined by removing the fixed quantity of 25,000 shell allocated for customary and public benefit purposes from the AHL.

5.7.3 TARC Marginal use (S 16. (1) h).

Each season, the marginal use allocation for recreational fishing is calculated as 0.1% of the TAC.

5.7.4 TACC (S. 16 (1) (i) (i))

Each season, the TACC is calculated as 99.9% of TAC.

5.7.5 Zonal TACCs for each size class (S.16. (1) g (ii))

The TACC is then split into Zone 1 and Zone 2 quota allocations. The Zone 1 TACC is a fixed amount of 54,970 Pearl oysters per annum, except where performance indicators for Zone 2 are below the target level as per section 5.6.1 above. The remainder of the TACC is then allocated to Zone 2.

Following this, the TACC for Zone 1 and Zone 2 are split into quota amounts for the two Pearl Oyster size classes. Again, as the TACC for Zone 1 is fixed, the distribution between the two size classes is also fixed, namely 44,970 Pearl oysters 100 to 175 mm SL and 10,000 Pearl oysters >175 mm SL (unless performance indicators for Zone 2 fall below the target). The annual distribution of the Zone 2 TACC between the two size classes is determined on a proportional basis given their relative proportions within the AHL and as a function of stock abundance using a predictive linear regression model that is updated annually in accordance with the HCRs.

5.8 Determination and publication of TAC and Sectoral Catch entitlements S 33.

In accordance with section 33 of ARMA, the CEO must annually determine and publish a notice that sets out the TAC for the resource, calculated in accordance with this ARMS, and the allocations to sectors and zones as outlined above, at least 30 days prior to the start of the fishing period.

6.0 Consultation and Reporting

6.1 Consultation on ARUP - Section 16 (1) (I)

A commercial ARUP will operationalise management of commercial wildstock pearling operations regulated under the relevant MAR declaration. Prior to approval of the ARUP by the Minister, a draft must be made available for public comment for a period of no less than four weeks. This will enable interested parties to understand and provide feedback on the entire wildstock management system, noting the statutory consultation requirements that apply to this ARMS.

Prior to any subsequent amendments to, or revocation of the ARUP, all holders of resource shares must be consulted, except where the amendment is:

1. Required urgently - Where the Minister forms the view that an amendment to the ARUP is required urgently, consultation with all holders of shares in the resource must occur as soon as practicable after the amendment is made; or
2. Of a minor nature - Where the Minister is of the view that the amendment is minor in nature, consultation is not required.

This process for consulting on amendment and revocation of the ARUP recognises that this instrument will materially impact on only commercial pearling operators. Where change to management of this sector is so significant as to require revocation of the ARUP, consultation requirements in relation to making a new ARUP will enable the broader community to provide comment on the potential impacts of management changes in the commercial sector on the overall management system.

6.2 Reporting on resource performance against objectives

Public reporting of the status of the Pearl oyster resource against the management objectives is done through:

- State of the Fisheries Report (published by the Department of Primary Industries and Regional Development);
- Australian fisheries and aquaculture production statistics (published by Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), and
- Status of Australian Fish Stocks Report (published by Fisheries Research and Development Corporation).

Reported information includes the value of pearl production and other products including pearl meat and mother of pearl shells, value of the wildstock fishing component, sustainability status of the stock, catch levels, estimated number of people employed in the industry, and number of vessels involved in the industry.

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Appendix 1: Summary of Ministerial decisions, under Section 16(1) of ARMA.

Table A1-1: Summary of Ministerial decisions under S.16(1) of ARMA

Section 16 (1)		Section of ARMS	Summary of text within ARMS			
(a)	<i>a description of the aquatic resource that is to be managed;</i>	2.1	WA aquatic organisms of the species <i>Pinctada maxima</i> (Pearl oyster), as declared by the Minister on 25 November 2022 under s.14 of ARMA.			
(b)	<i>the main objective to be achieved by managing the aquatic resource;</i>	3.2	To optimise the economic return to the WA community through the production of high-quality pearls and associated Pearl oyster-based products.			
(c)	<i>the minimum quantity of the aquatic resource that is considered necessary to be maintained for the resource to be ecologically sustainable;</i>	5.3	The limit level reference levels for this resource, summarise below, specifies the minimum quantity of the aquatic resource that is considered necessary to be maintained for the resource to be ecologically sustainable.			
			<p>Table 6: Reference Levels for 100 to 175 mm SL Pearl oysters in Zone 2</p> <table border="1"> <thead> <tr> <th>Reference level</th> <th>Predicted SCPUE</th> <th>Justification</th> </tr> </thead> <tbody> <tr> <td>Limit</td> <td>15 Pearl oysters 100 to 175 mm SL per hour.</td> <td>This level is close to the lowest value recorded in 1981 of 16 Pearl oysters per hour. The ongoing sustainability of the stock over the last 40 years indicates that this limit reference level is set above the level where there is a substantial risk of recruitment impairment.</td> </tr> </tbody> </table>	Reference level	Predicted SCPUE	Justification
Reference level	Predicted SCPUE	Justification				
Limit	15 Pearl oysters 100 to 175 mm SL per hour.	This level is close to the lowest value recorded in 1981 of 16 Pearl oysters per hour. The ongoing sustainability of the stock over the last 40 years indicates that this limit reference level is set above the level where there is a substantial risk of recruitment impairment.				

Section 16 (1)	Section of ARMS	Summary of text within ARMS						
		<p>Table 7: Reference Levels for >175 mm SL Pearl oysters in Zone 2</p> <table border="1"> <thead> <tr> <th data-bbox="891 316 1064 395">Reference level</th> <th data-bbox="1064 316 1265 395">Predicted SCPUE</th> <th data-bbox="1265 316 2078 395">Justification</th> </tr> </thead> <tbody> <tr> <td data-bbox="891 395 1064 646">Limit</td> <td data-bbox="1064 395 1265 646">5 Pearl Oysters >175 mm SL per hour.</td> <td data-bbox="1265 395 2078 646">The limit reference point is slightly below the lowest SCPUE of 6.6 Pearl oysters per hour observed during the reference period (Hart et al. 2014b; Figure A-4). Densities of >175 mm SL Pearl oysters rapidly increased from this low SCPUE of 6.6, and hence PRI was proved to be below 6. These rapid increases would not have occurred if PRI had been reached. Selecting a value of 5 to represent the PRI was therefore deemed appropriate.</td> </tr> </tbody> </table>	Reference level	Predicted SCPUE	Justification	Limit	5 Pearl Oysters >175 mm SL per hour.	The limit reference point is slightly below the lowest SCPUE of 6.6 Pearl oysters per hour observed during the reference period (Hart et al. 2014b; Figure A-4). Densities of >175 mm SL Pearl oysters rapidly increased from this low SCPUE of 6.6, and hence PRI was proved to be below 6. These rapid increases would not have occurred if PRI had been reached. Selecting a value of 5 to represent the PRI was therefore deemed appropriate.
Reference level	Predicted SCPUE	Justification						
Limit	5 Pearl Oysters >175 mm SL per hour.	The limit reference point is slightly below the lowest SCPUE of 6.6 Pearl oysters per hour observed during the reference period (Hart et al. 2014b; Figure A-4). Densities of >175 mm SL Pearl oysters rapidly increased from this low SCPUE of 6.6, and hence PRI was proved to be below 6. These rapid increases would not have occurred if PRI had been reached. Selecting a value of 5 to represent the PRI was therefore deemed appropriate.						
(d)	<i>the activities that should be regulated in respect of the aquatic resource;</i>	<p>3.3 This ARMS, associated subsidiary legislation (Regulations), ARUP, and administrative guidelines will regulate all fishing activities for Pearl oysters in WA.</p> <p>The regulation of hatchery operations and pearl production will be managed under aquaculture provisions of ARMA.</p>						
(e)	<i>the details of each period for which activities in respect of the aquatic resource are to be regulated (fishing period);</i>	<p>3.4 The first fishing period under this ARMS will operate from 1 November 2023 until 31 December 2023. Thereafter, from 1 January 2024, the annual fishing period shall be from 1 January until 31 December.</p>						
(f)	<i>the quantity of the aquatic resource that is to be available in a fishing period for customary fishing and public benefit uses;</i>	<p>4.1 A priority allocation of 25,000 live Pearl oysters will be made available in each fishing period for customary fishing and public benefit uses.</p>						
(g)	<i>the method to be used in calculating the total allowable catch (TAC) for the aquatic resource;</i>	<p>5.7</p> <ul style="list-style-type: none"> • Allowable Harvest Level - Each season, the AHL for the Pearl oyster resource is calculated by adding the acceptable catch levels generated from the stock assessments and HCR processes for both size classes of Pearl oysters for Zone 1 and Zone 2. • TAC (S. 16. (1) g i) - The TAC for the season is determined by removing the fixed quantity of 25,000 shell allocated for customary and public benefit purposes from the AHL. • TARC Marginal use (S 16. (1) h) - Each season, the marginal use allocation for recreational fishing is calculated as 0.1% of the TAC. 						

Section 16 (1)		Section of ARMS	Summary of text within ARMS
			<ul style="list-style-type: none"> • TACC (S. 16 (1) g i) - Each season, the TACC is calculated as 99.9% of TAC. • Zonal TACCs for each size class (S.16. (1) g ii) - The TACC is then split into Zone 1 and Zone 2 quota allocations. The Zone 1 TACC is a fixed amount of 54,970 Pearl oysters per annum, except where performance indicators for Zone 2 are below the target level, as described in section 5.6.1 above. The remainder of the TACC is then allocated to Zone 2. <p>Following this, the TACC for Zone 1 and Zone 2 are split into quota amounts for the two Pearl Oyster size classes. Again, as the TACC for Zone 1 is fixed, the distribution between the two size classes is also fixed, namely 44,970 Pearl oysters 100 to 175 mm SL and 10,000 Pearl oysters >175 mm SL (unless performance indicators for Zone 2 fall below the target).</p> <p>The annual distribution of the Zone 2 TACC between the two size classes is determined on a proportional basis given their relative proportions within the AHL and as a function of stock abundance using predictive linear regression model that is updated annually in accordance with the HCRs.</p>
	(h)	the proportion of the TAC that is to be available for recreational fishing for the resource;	4.5 A marginal use allocation for the recreational take of both live and dead Pearl oysters is calculated as 0.1% of the TAC.
(i)	(i)	the proportion of the TAC that is to be available for commercial purposes, including- the proportion of the TAC that is to be available for commercial fishing for the resource; and	4.2 99.9% of the TAC has been allocated to commercial fishing for each fishing period.
	(ii)	the proportion of the TAC that is to be available for taking incidentally in the course of commercial fishing for other aquatic resources;	4.4 The proportion of TAC available for incidental take whilst commercially fishing for other aquatic resources is 0%.

Section 16 (1)		Section of ARMS	Summary of text within ARMS
(j)	<i>The type or types of resource shares in the aquatic resource that are to be available to the commercial sector;</i>	4.3	<ul style="list-style-type: none"> • Zone 1 – there are 115 shares which confer access to Zone 1. • Zone 2 – there are 457 resource shares which confer access to Zone 2. <p>Further information including resource share ownership by zone is provided in the ARUP.</p>
(ja)	<i>the number of a type of resource share in the aquatic resource that is to be available to the commercial sector;</i>		
(k)	<i>the scientific parameters to be used to assess how effectively the aquatic resource is being managed;</i>	5.3	<p>Zone 1:</p> <p>Given the relatively low and variable level of annual take within this zone, Zone 2 SCPUE performance indicators will be used to assess the current stock status for the entire Pearl oyster resource including those within Zone 1</p> <p>The commercial catch rate for Zone 1 size class 100 to 175 mm SL Pearl oyster can be independently assessed against recent CPUE trends obtained within this zone. Nominal catch rate assessments for >175 mm shell will be undertaken when there are sufficient data to generate a robust trend.</p> <p>Periodic fishery independent surveys are also planned for this zone.</p> <p>Zone 2:</p> <p>The main performance indicators used to measure stock levels for each of these two size classes are Standardised Commercial Catch Per Unit Effort (SCPUE) obtained from Zone 2.</p> <ul style="list-style-type: none"> • The SCPUE for 100 to 175 mm SL Pearl oysters is generated from commercial catch data. • The SCPUE for the >175 mm SL Pearl oysters comes from an independent survey. <p>The SCPUE measures the number of pearl oysters collected per diver hour that has been corrected for differing environmental conditions, sizes targeted and other factors that may have affected the divers catching efficiency. The specific size range of pearl oysters used to calculate the SCPUE can therefore vary among seasons based on shifts in the targeting practices of the fishing operations.</p>

The reference level types for 100 to 175 mm SL Pearl oysters are described in the following table.

Table 8: Reference Levels for 100 to 175 mm SL Pearl oysters in Zone 2

Reference level	Predicted SCPUE	Justification
Threshold	20 Pearl oysters 100 to 175 mm SL per hour.	This level is 33 % above the limit reference level and is used to provide an early warning that stock abundance is declining, enabling management action to be taken to reduce exploitation before the limit reference level is reached approximating BMSY.
Target	25 Pearl oysters 100 to 175 mm SL per hour.	This level has been set well-above the limit and threshold reference levels, with the intention of maintaining the stock at levels of production consistent with BMEY. If above target level utilise predictive model outcomes to adjust the sustainable catch levels (see control rules).

Zone 2 (>175 mm SL Pearl oysters) – The performance indicator for implementing this HCR is the annual fishery independent SCPUE of >175 mm SL Pearl oysters in Zone 2. Reference levels have been set based on the reference period from 2007 to 2021. This is when routine monitoring of >175 mm SL Pearl oysters commenced and is a period when the stock is known to have been above the point of recruitment impairment (PRI). The reference level types for >175 mm SL Pearl oysters are described in the following table.

Table 9: Reference Levels for >175 mm SL Pearl oysters in Zone 2

Reference level	Predicted SCPUE	Justification
Threshold	10 Pearl oysters >175	This level is 100% above the limit reference level and is used to provide an early warning that stock abundance is declining,

Section 16 (1)		Section of ARMS	Summary of text within ARMS		
				mm SL per hour.	enabling management action to be taken to reduce exploitation before the limit reference level is reached.
			Target	15 Pearl oysters >175 mm SL per hour.	This level has been set well-above the limit and threshold reference levels, with the intention of maintaining the stock at levels of production consistent with BMEY. If above target level utilise predictive model outcomes to adjust the sustainable catch levels (see control rules).
(i)	<i>the consultation to be carried out in relation to the making, amendment or revocation of an aquatic resource use plan (ARUP) to implement the ARMS.</i>	6.1	<p>A commercial ARUP will operationalise management of commercial wildstock pearling operations regulated under the relevant Managed Aquatic Resource declaration. Prior to approval of the ARUP by the Minister, a draft must be made available for public comment for a period of no less than four weeks. This will enable interested parties to understand and provide feedback on the entire wildstock management system, noting the statutory consultation requirements that apply to this ARMS.</p> <p>Prior to any subsequent amendments to, or revocation of, the ARUP, all holders of resource shares in the resource must be consulted, except where the amendment is:</p> <ol style="list-style-type: none"> 3. required urgently; or 4. of a minor nature. <p>In the case where the Minister forms the view that an amendment to the ARUP is required urgently, consultation with all holders of shares in the resource must occur as soon as practicable after the amendment is made. Consultation is not required where the Minister is of the view that the amendment is minor in nature.</p> <p>This process for consulting on amendment and revocation of the ARUP recognises that this instrument will materially impact on only commercial pearling operators. Where change to management of this sector is so significant as to require revocation of the ARUP, consultation requirements in relation to making a new ARUP will enable the broader community to provide comment on the potential impacts of management changes in the commercial sector on the overall management system.</p>		

Appendix 2: Pearl oyster Fishery Zone Coordinates

Zone 1

All Western Australian waters bounded by a line commencing at the intersection of 21° 47' 30" south latitude and 114° 10' east longitude (on the mainland); then extending due north along the meridian to the intersection of the outer limit of the Exclusive Economic Zone (200 nautical mile limit) and 114° 10' east longitude; then generally north-easterly along the outer limit of the Exclusive Economic Zone (200 nautical mile limit) to its intersection with the meridian at 119° 00' east longitude; then due south along the meridian to the intersection of 18° 14' south latitude and 119° 00' east longitude; then due east along the parallel to the intersection of 18° 14' south latitude and 119° 30' east longitude; then due south along the meridian to the intersection of 20° 03' south latitude and 119° 30' east longitude (on the mainland); then generally south-easterly and then northerly along the high water mark to the commencement point.

Zone 2

All Western Australian waters bounded by a line commencing at the intersection of 20° 22' south latitude and 118° 10' east longitude (on the mainland); then extending due north along the meridian to the intersection of 18° 14' south latitude and 118° 10' east longitude; then due east along the parallel to the intersection of 18° 14' south latitude and 119° 00' east longitude; then due north along the meridian to the intersection of the outer limit of the Exclusive Economic Zone (200 nautical mile limit) and 119° 00' east longitude; then generally north-easterly along the outer limit of the Exclusive Economic Zone (200 nautical mile limit) to its intersection with the meridian at 125° 20' east longitude; then due south along the meridian to the intersection of 14° 34' south latitude and 125° 20' east longitude (on the mainland); then generally south-westerly along the high water mark to the commencement point.

Kimberly Development Zone

All Western Australian waters off the northern coast, east of 125° 20' east longitude.

Appendix 3: Pearl Oyster Fishery Harvest Strategy for target species and associated ecological assets

Table A2-1: Harvest Strategy performance indicators, reference levels, control rules for the Pearl oyster (*P. maxima*) resource.

Component	Operational objective	Resource/asset	Performance Indicators	Size class	Reference Levels	Control Rules
Target species	To maintain ecological sustainability, keep the spawning stock (spawning potential) of the Pearl oyster resource at levels where future recruitment is only affected by environmental variability, not the current stock size.	Commercial take of Pearl oyster (<i>Pinctada maxima</i>).	<p>Zone 1:</p> <p>Given the relatively low and variable level of annual take within Zone 1, Zone 2 SCPUE performance indicators (below) are used to assess the current stock status for the entire Pearl oyster resource including those within Zone 1.</p> <p>The commercial catch rate for Zone 1 100 to 175 mm SL Pearl oysters can be independently assessed against recent CPUE trends obtained within Zone 1.</p> <p>Nominal catch rate assessments for >175 mm SL Pearl oysters will be undertaken when there are sufficient data to generate a robust trend.</p>	100 to 175 mm SL Pearl oysters	Target: SCPUE is 25 pearl oysters per hour.	<p>Zone 1:</p> <p>If Zone 2 performance indicators are:</p> <ol style="list-style-type: none"> Above the target level, apply Zone 1 baseline catch of 54,970 Pearl Oysters. Below the target level, adjust total seasonal catch against Zone 1 baseline of 54,970 Pearl Oysters using HCRs below. <p>Zone 2:</p> <p>If the Zone 2 performance indicators are:</p> <ol style="list-style-type: none"> Above target levels, calculate the Zone 2 AHL as a function of stock abundance using predictive linear regression model that is updated annually.
					Threshold: SCPUE is 20 pearl oysters per hour.	
					Limit: SCPUE is 15 pearl oysters per hour.	

Component	Operational objective	Resource/asset	Performance Indicators	Size class	Reference Levels	Control Rules
			<p>Periodic fishery independent surveys are also planned for this zone.</p> <p>Zone 2:</p> <p>Separate formal analyses on stock status are completed for 100 to 175 mm SL Pearl oysters and >175 mm SL Pearl oysters within Zone 2, based on the outputs from separate prediction models that estimate future SCPUE for these two size classes.</p> <p>The SCPUE for 100 to 175 mm SL Pearl oysters from commercial catches and >175 mm SL Pearl oysters from an independent survey using the mean annual number of each of the size classes of Pearl oysters caught per hour.</p> <p>These SCPUE models are adjusted each year to account for changes in targeting practices and minimum size.</p>	100 to 175 mm SL Pearl oysters		<p>2. Below target levels, adjust total seasonal catch against Zone 2 baseline of 457,000 Pearl Oysters using HCRs below.</p> <p>HCRs:</p> <p>(a) If predicted SCPUE between target and threshold, reduce TACC by reducing baseline by 30%, which equates to:</p> <ul style="list-style-type: none"> • Zone 1 TACC = 38,479 oysters. • Zone 2 TACC = 319,900 oysters. <p>(b) If predicted SCPUE between threshold and limit, reduce TACC by reducing baseline by 40 to 50% which equates to:</p> <ul style="list-style-type: none"> • Zone 1 TACC = between 32,982 to 27,485 oysters. • Zone 2 TACC = between 274,200 to 228,500 oysters. <p>(c) If predicted SCPUE is below limit, reduce TACC by reducing baseline by 50 to 100% and close Zone 1. This equates to:</p>

Component	Operational objective	Resource/asset	Performance Indicators	Size class	Reference Levels	Control Rules
						<ul style="list-style-type: none"> • Zone 1 = closed. • Zone 2 TACC = <228,500 oysters.
				>175 mm SL Pearl oysters	Target: SCPUE is 15 pearl oysters per hour.	<u>Zone 1:</u> If Zone 2 performance indicators are: <ol style="list-style-type: none"> 1. Above the target level, apply Zone 1 baseline catch of 10,000 Pearl oysters. 2. Below the target level, adjust total seasonal catch against Zone 1 baseline of 10,000 Pearl oysters using HCRs below. <u>Zone 2:</u> If the Zone 2 performance indicators are: <ol style="list-style-type: none"> 1. Above target levels, calculate the Zone 2 AHL as a function of stock abundance using predictive linear regression model that is updated annually. 2. Below target levels, adjust total seasonal catch against Zone 2 baseline of
					Threshold: SCPUE is 10 pearl oysters per hour.	
					Limit: SCPUE is 5 pearl oysters per hour.	

Component	Operational objective	Resource/asset	Performance Indicators	Size class	Reference Levels	Control Rules
				>175 mm SL Pearl oysters		<p>37,100 Pearl Oysters using HCRs below.</p> <p>HCRs:</p> <p>(a) If predicted SCPUE between target and threshold, reduce TACC by reducing baseline by 30% which equates to:</p> <ul style="list-style-type: none"> • Zone 1 TACC = 7,000 oysters. • Zone 2 TACC = 25,970 oysters. <p>(b) If predicted SCPUE between threshold and limit, reduce TACC by reducing baseline by 40 to 50% which equates to:</p> <ul style="list-style-type: none"> • Zone 1 TACC = between 5,000 to 6,000 oysters. • Zone 2 TACC = between 22,260 to 18,550 oysters. <p>(c) If predicted SCPUE below the limit, reduce TACC by reducing the baseline by 50 to 100% and close Zone 1. This equates to:</p> <ul style="list-style-type: none"> • Zone 1 TACC = Closed.

Component	Operational objective	Resource/asset	Performance Indicators	Size class	Reference Levels	Control Rules
						<ul style="list-style-type: none"> Zone 2 TACC = <18,550 oysters.
		Recreational take of Pearl Oyster (<i>Pinctada maxima</i>).	Total quantity of live Pearl Oysters taken recreationally (per annum) recorded during state-wide recreational fishing surveys (conducted every 3-5 years).	N/A	Limit: >0.1% of the TAC.	Conduct a review to investigate the reason(s) for the limit exceedance within three months and implement appropriate management action to reduce take to ≤ 0.1% of the TAC as soon as practicable.

Table A2-2: Harvest Strategy performance indicators, reference levels, control rules for associated ecological assets that may be impacted by fishing activities for the Pearl oyster (*P. maxima*) resource.

Component	Operational objective	Resource/asset	Performance Indicators	Reference Levels	Control Rules
Bycatch (non-ETP) species	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to bycatch species populations.	All bycatch species	Assessed level of risk for each bycatch species/group from fishery activities from periodic risk assessments incorporating: <ul style="list-style-type: none"> • current management arrangements, • annual fishing effort and catch (including discards), • review of alternative measures to minimise unwanted catch, • species information, and • other available research. 	Target: Moderate or low level of risk to asset from fishing.	Maintain current management arrangements aimed at achieving objectives of managing the resource.
				Threshold: High level of risk to asset from fishing.	Conduct a review to investigate the reasons for the variation within three months. If sustainability is at risk, implement appropriate management action to reduce the risk to an acceptable level as soon as practicable.
				Limit: Severe level of risk to asset from fishing.	Implement immediate management strategies to reduce the risk to an acceptable level.
ETP species	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to ETP species populations.	All ETP species	Assessed level of risk for each ETP species/group from fishery activities from periodic risk assessments incorporating: <ul style="list-style-type: none"> • current management arrangements, • annual fishing effort and catch (including discards), 	Target: Moderate or low level of risk to asset from fishing.	Maintain current management arrangements aimed at achieving objectives of managing the resource.
				Threshold: High level of risk to asset from fishing.	Conduct a review to investigate the reasons for the variation within three months. If sustainability is at risk, implement appropriate management action to reduce the risk to an

Component	Operational objective	Resource/asset	Performance Indicators	Reference Levels	Control Rules
			<ul style="list-style-type: none"> species information and number of reported ETP species interactions, and other available research. 		acceptable level as soon as practicable.
				Limit: Severe level of risk to asset from fishing.	Implement immediate management strategies to reduce the risk to an acceptable level.
Habitats	To conduct fishing activities in a manner that does not result in an unacceptable risk of serious or irreversible harm to habitat structure and function.	Benthic habitats	<p>Assessed level of risk for benthic habitats from fishery activities from periodic risk assessments incorporating:</p> <ul style="list-style-type: none"> current management arrangements, annual fishing effort, extent of fishing area annually, and other available research. 	Target: Moderate or low level of risk to asset from fishing.	Maintain current management arrangements aimed at achieving objectives of managing the resource.
				Threshold: High level of risk to asset from fishing.	Conduct a review to investigate the reasons for the variation within three months. If sustainability is at risk, implement appropriate management action to reduce the risk to an acceptable level as soon as practicable.
				Limit: Severe level of risk to asset from fishing.	Implement immediate management strategies to reduce the risk to an acceptable level.
Ecosystem	That the overall effects of fishing do not result in an unacceptable risk of serious irreversible harm to ecological processes.	Northwest Shelf Ecosystem	<p>Assessed level of risk for ecosystem processes from fishery activities from periodic risk assessments incorporating:</p> <ul style="list-style-type: none"> current management arrangements, 	Target: Moderate or low level of risk to asset from fishing.	Maintain current management arrangements aimed at achieving objectives of managing the resource.
				Threshold: High level of risk to	Conduct a review to investigate the reasons for the variation within three months. If sustainability is at risk,

Component	Operational objective	Resource/asset	Performance Indicators	Reference Levels	Control Rules
			<ul style="list-style-type: none"> • catch levels, • number of reported ETP species interactions, • extent of fishing activities, • ecosystem information, and • other available research. 	asset from fishing.	implement appropriate management action to reduce the risk to an acceptable level as soon as practicable.
				Limit: Severe level of risk to asset from fishing.	Implement immediate management strategies to reduce the risk to an acceptable level.

Appendix 4: Pearl oyster Standardised Commercial Catch Per Unit Effort (SCPUE) data

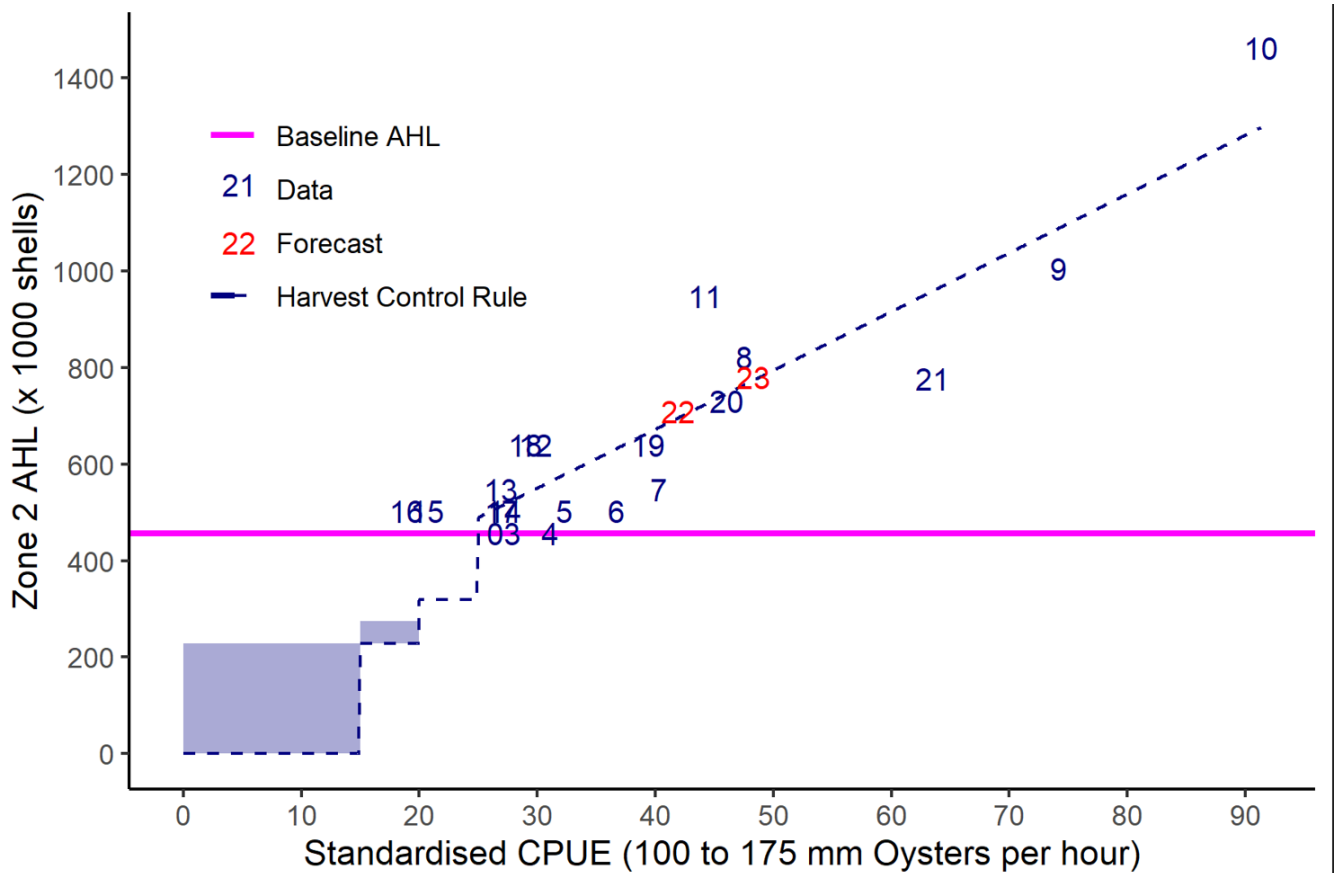


Figure A4-1: The harvest control rule used for calculating Zone 2 AHL is based on forecast values of SCPUE from multiple regression model. When forecast SCPUE is above target levels, AHL is proportional to SCPUE. Blue numbers compare AHL against the achieved SCPUE from 2003 to 2021. Red numbers are forecast values of AHL. Below target levels the reductions are made relative to a baseline AHL. Blue shaded zones indicate range of values allowed under the harvest control rules when SCPUE is below threshold and limit levels.

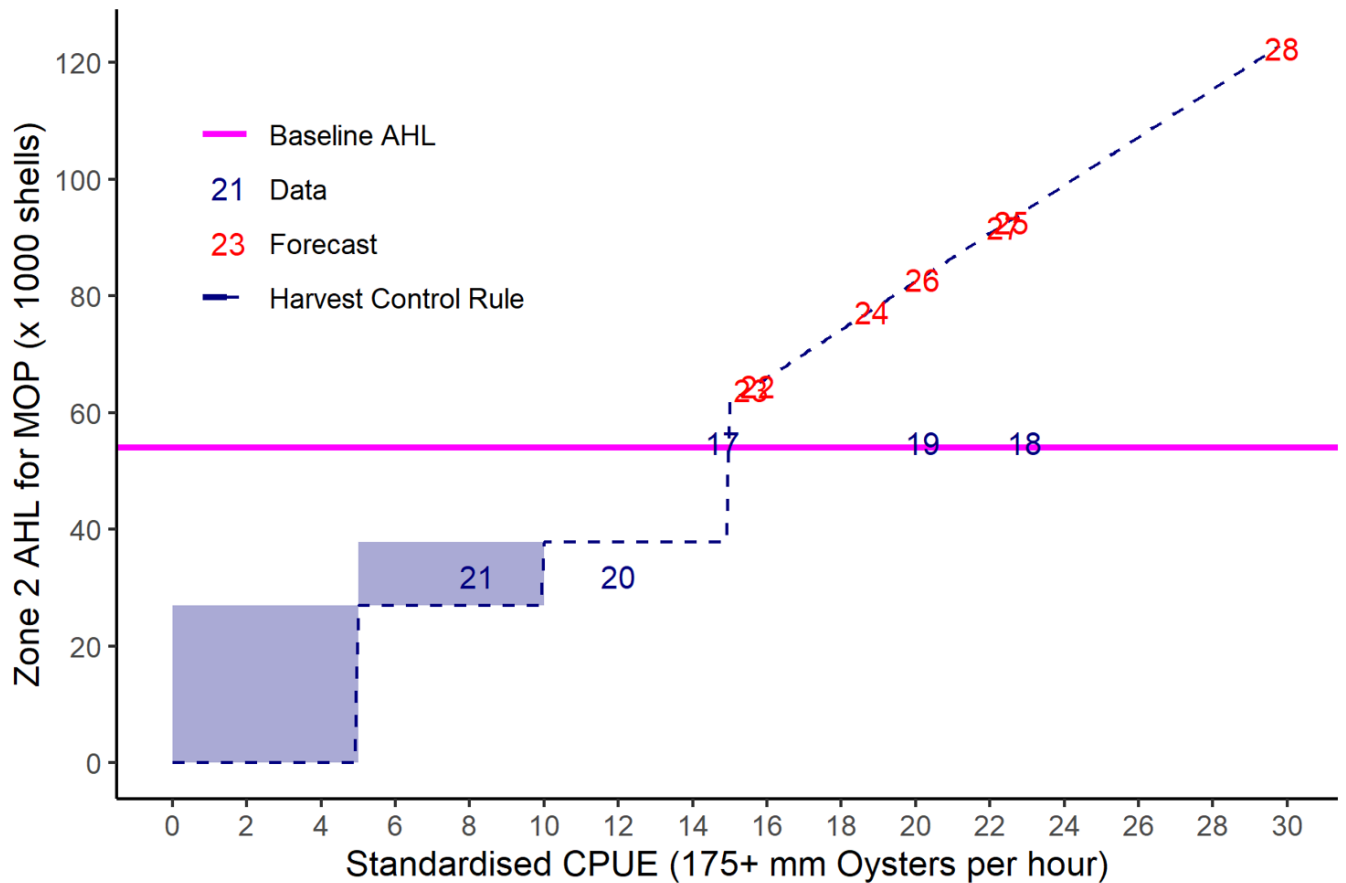


Figure A4-2: The harvest control rule used for calculating the AHL for >175 mm SL Pearl oysters in Zone 2. When forecast SCPUE is above target levels, the AHL is calculated using the SCPUE, and parameters for fishing efficiency and area of the stock. Blue numbers compare the AHL against the achieved SCPUE from 2017 to 2021, prior to a predictive capacity becoming available. Red numbers are forecast values of the AHL for >175 mm SL Pearl oysters using the new predictive model. Below target levels the reductions are made relative to a baseline AHL. Blue shaded zones indicate range of values allowed under the harvest control rules when SCPUE is below threshold and limit levels.