Australian Government
Department of Climate Change, Energy, the Environment and Water

Tasmanian Government

National Recovery Team for the Maugean Skate

Meeting 6: Agenda

18 February 2025, Teams meeting (online only)

Item	Time	Topic	Lead	Paper attached
	10:00	Acknowledgement of Country Welcome and opening statements • Apologies and introductions (proxies/new members/observers) • Conflict of Interest register • Endorsement of previous meeting minutes [20 mins]	Jarrod Edwards Chair	
	10:20	Update: Terms of Reference (ToR) [15 mins]	NRE Tas	
	10:35	IMAS report: 2014-2024 Macquarie Harbour Maugean skate population status and monitoring report [20 mins]	IMAS	
	10:55	EPA Presentation: Metals in the water column [20 mins]	EPA	
	11:15	Update: Development of a Captive Breeding management strategy: progress to date and next steps [45 mins]	NRE Tas, DCCEEW, IMAS and CCA	
	12:00	Lunch break (30 mins)		
	12:30	Update: Monitoring Technical Working Group and next steps [30 mins]	DCCEEW	Minutes of the TMWG
	13:00	Member updates and general discussion [30-45 mins]	All	

Item	Time	Topic	Lead	Paper attached
	13:45	Status of actions from previous meeting [20–30 mins]	All members as required	
	14:10	Closing administration • Communique process • Next meeting date • Concluding remarks [15 mins as needed]	Chair	
MEETING CLOSE				

Australian Government
Department of Climate Change, Energy, the Environment and Water

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CONFLICT OF INTEREST REGISTER

NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

Date of conflict of interest declaration	Name of Recovery Team member	Declared conflicts (Y/N)	Description of conflict of interest (if applicable)	Summary of management strategy for conflict of interest
14/09/2023	Toby Patterson	N	NA	NA
18/09/2023	Iona Flett	N	NA	NA
20/09/2023	Colin Simpfendorfer	Y	Adjunct Professor at University of Tasmania Adjunct Professor at James Cook University Current member of the national Threatened Species Scientific committee. Member of the IUCN Shark Specialist Group Has received funding from DCCEEW for population modeling of the Maugean skate population.	Potential conflicts declared

			Receives funding form DCCEEW for a variety of tasks related to shark and ray conservation. Wife (Michelle Heupel) is the Director of the Integrated Marine Observing System (IMOS) and employed at the University of Tasmania.	
21/09/2023	Laura Simmons	N	NA	NA
21/09/2023	Jayson Semmens	Y	Professor, Institute for Marine and Antarctic Studies. Organisation is known to submit research funding applications relevant to Maugean skate population recovery.	Declare conflict of interest. Take part in discussions around research needs, but be absent for any decisions around funding providers, or any other appropriate action as determined by the Chair/Deputy Chair.
22/09/2023	Darryl Cook	N	I have no conflicts of interest to declare. I have no private or personal interest or involvement in any other member organisation of the national recovery team. I acted in a role having oversight for environment policy with NRE Tas for ~8 months to May 2022.	NA
09/10/2023	David Moreno	Y	Funding applications from IMAS/UTAS	

09/10/2023	Leonardo Guida	Y	Involved in Good Fish sustainable seafood program, a component of this is farmed salmon.	
09/10/2023	Iona Flett	Y	As previously raised, CCNRM submitted the funding application noted by Maree. Not necessarily a conflict, but worth reiterating.	
10/01/2024	Matt Barrenger	N	NA	NA
10/01/2024	Jo Crisp	N	NA	NA
29/07/2024	Rachael Alderman			
29/07/2024	Ross Monash			

MINUTES – Meeting 5

12 November 2024, 9:00 am – 5:00 pm Lands Building, Hobart

ACKNOWLEDGEMENT OF COUNTRY

Jarrod Edwards opened the meeting and provided an Acknowledgement of Country.

WELCOME, OPENING STATEMENTS AND HOUSEKEEPING

The Chair thanked Recovery Team members for working with the change of venue for the meeting and noted **apologies, observers and changes to membership** (see table 1 for record of attendance).

No new conflicts of interest were declared.

Funding announcement

DCCEEW updated the team on a new Australian Government $28 million commitment over three years (two calendar years) that they will administer to fund Maugean skate conservation actions, including:

- Up to $21 million for improving and scaling up oxygenation in Macquarie Harbour, sediment remediation and research on the effects of historical mining.
- $5 million for expanding the current Maugean skate breeding program.
- $2.5 million for skate population and environmental monitoring, compliance and community engagement.

The team noted the importance of coordinating engagement activities across Marine Resources, NRMs and other organisations actively involved. DCCEEW circulated a media release announcing the new funding.

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Action item updates from the previous meeting

Relevant team members provided updates on Meeting 4 actions (see table 3). The team discussed the most efficient method for commenting on documents. Given not all members can access Teams, it was agreed that in future, documents will be shared via email, with one consolidated set of feedback to be provided per organisation.

Actions arising from this meeting

In discussing actions from the previous meeting, the following new actions were identified.

Action 1: Organisations with multiple members to provide one consolidated document when providing feedback and comments on Recovery Team documents – all members

Action 2: Recovery Team members to provide feedback on the draft Terms of Reference (ToR) by Friday 22 November 2024 – all members
Action 3: NRE Tas to work with Recovery Team members to set a date for a future meeting in Strahan – NRE Tas

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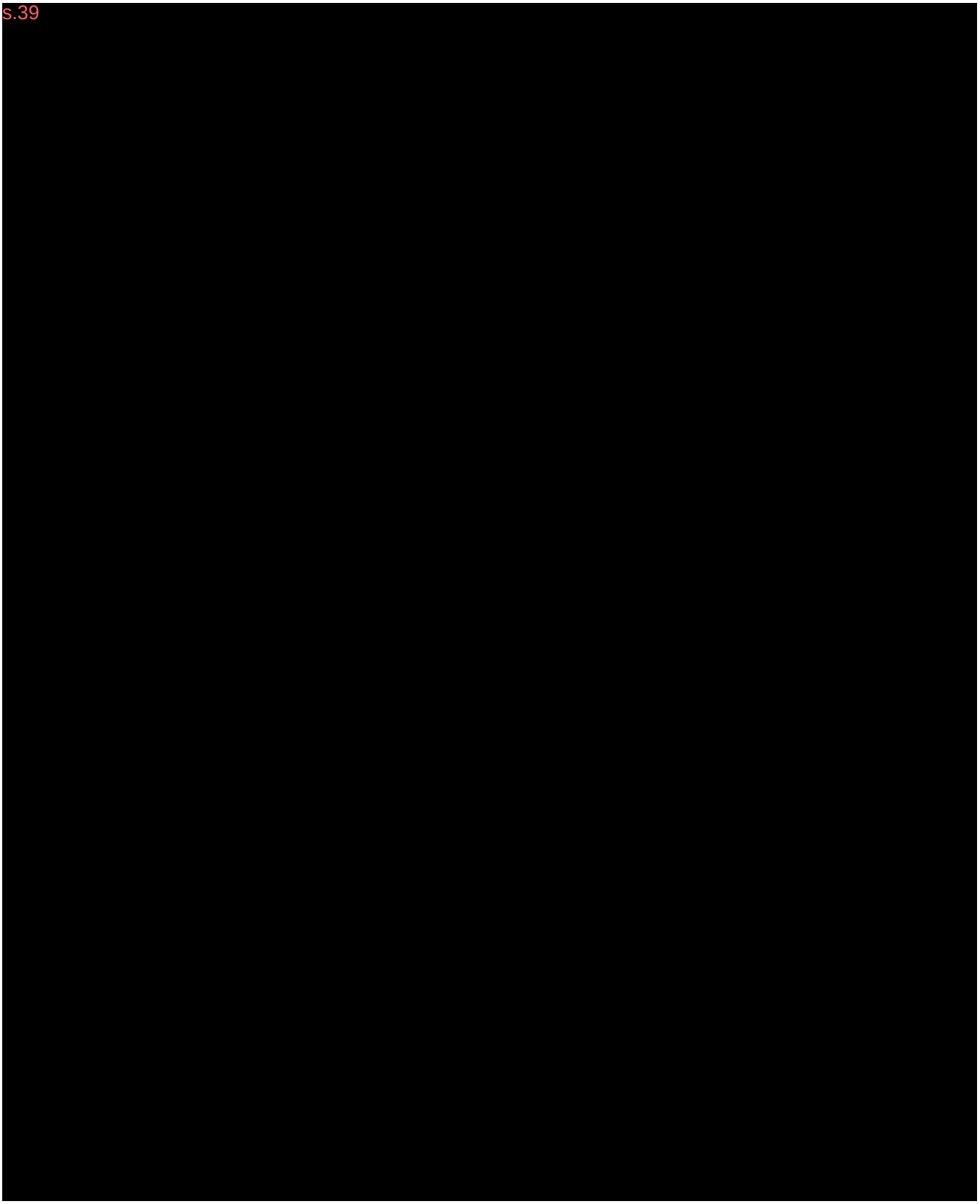

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Forward planning for 2025

The team discussed future Recovery Team meeting frequency and formats (face-to-face, online and/or some meetings in a hybrid format) and agreed that face-to-face meetings could be held biannually rather than quarterly, with online meetings in between. The frequency of working group meetings was also discussed.

Meeting frequency was updated in the draft Terms of Reference (ToR) which was circulated to the Recovery Team for review.

ACTION 12: NRE Tas to develop a framework for future NRTMS meetings to circulate to the Recovery Team – NRE Tas

Communique discussion

The team discussed topics to be included in the Communique and noted the importance of a timely dissemination.

Meeting closed.

TABLE 1: ATTENDEES AND OBSERVERS

Name	Organisation	Role
Jo Crisp	Environment, Heritage and Lands Division (EHL), Department of Natural Resources and Environment Tasmania (NRE Tas)	Recovery Team Chair
Lesley Gidding-Reeve	Ocean and Wildlife Branch; Department of Climate Change, Energy, the Environment and Water (DCCEEW)	Recovery Team Vice-Chair
Leonardo Guida	Australian Marine Conservation Society (AMCS)	Recovery Team member
Iona Flett	Cradle Coast Authority	Recovery Team member
Toby Patterson	Commonwealth Scientific and Industrial Research Organisation **(**CSIRO)	Recovery Team member

Karen Wild-Allen	CSIRO	Recovery Team member
Rachel Robbins	Ocean and Wildlife Branch; DCCEEW	Recovery Team member
Ciara Spencer	West Coast Council	Recovery Team member
Darryl Cook	Environment Protection Authority	Recovery Team member
David Ikedife	Hydro Tasmania	Recovery Team member
Colin Simpfendorfer	Commonwealth Threatened Species Scientific Committee	Recovery Team member
Jayson Semmens	Institute of Marine and Antarctic Studies University of Tasmania (IMAS)	Recovery Team member
David Moreno	IMAS	Recovery Team member
Jeff Ross	IMAS	Recovery Team member
Rachael Alderman	EHL; NRE Tas	Recovery Team member
Ross Monash	EHL; NRE Tas	Recovery Team member
Jarrod Edwards	Tasmanian Aboriginal representative, Primary Industries and Water Division; NRE Tas	Recovery Team member
David Midson	Primary Industries and Water Division; NRE Tas	Recovery Team member
Harriet Brinkhoff	Strahan Aquaculture Community Forum	Recovery Team member
Laura Simmons	Zoo & Aquarium Association	Recovery Team member
Matt Barrenger	Salmon Tasmania	Recovery Team member
Steven Rust	IMAS	Recovery Team member
Robert Butterfield	Copper Mines Tasmania	Proxy
Belinda Jago	International Environment, Reef and Oceans division, DCCEEW	Observer
Lisa Williams	Strahan Aquaculture Community Forum	Observer
Sean Tracey	Fisheries and Aquaculture Centre, IMAS	Observer
Ben Waining	Department of State Growth	Observer
Fox Ransom	CCA	Observer

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NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

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APOLOGIES

Clint Mayes, Copper Mines Tasmania, proxy Robert Butterfield

NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

MONITORING TECHNICAL WORKING GROUP MEETING MINUTES

MEETING DETAILS

- **Date**: 13 November 2024
- **Time**: 9:00 – 13:00
- **Location**: Lands Building, Hobart

ATTENDANCE LIST

- **Chair:** Lesley Gidding-Reeve, Department of Climate Change, Energy, the Environment and Water (DCCEEW)
- **Members:**
    - Jo Crisp, Department of Natural Resources and Environment Tasmania (NRE Tas)
    - Rachael Alderman, NRE Tas
    - Ross Monash, NRE Tas
    - Cloe Cummings, NRE Tas
    - Belinda Jago, DCCEEW
    - Rachel Robbins, DCCEEW
    - Darryl Cook, EPA Tasmania
    - Raymond Bannister, EPA Tasmania
    - Toby Patterson, CSIRO
    - Colin Simpfendorfer, Commonwealth Threatened Species Scientific Committee
    - Leonardo Guida, Australian Marine Conservation Society (AMCS)
    - Sean Tracey, Institute of Marine and Antarctic Studies (IMAS)
    - Jayson Semmens, IMAS
    - David Moreno, IMAS
    - Jeff Ross, IMAS
    - Steven Rust, IMAS
    - Matt Barrenger, Salmon Tasmania (10:15am onwards)
    - David Ikedife, Hydro Tasmania
- **Apologies**: Karen Wild-Allen, CSIRO

1. Welcome and Acknowledgement of Country

Chair provided an Acknowledgement of Country and an outline of the background to, and objectives of, the meeting. Participants agreed the agenda.

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ATTACHMENT A - MAUGEAN SKATE POPULATION MONITORING ACTIVITIES

[To be added once finalised by the working group]

MINUTES – Meeting 6

18 February 2025, 10:00 am – 2:40 pm Teams (Online meeting)

ACKNOWLEDGEMENT OF COUNTRY

Jarrod Edwards opened the meeting and provided an Acknowledgement of Country.

WELCOME, OPENING STATEMENTS AND HOUSEKEEPING

The Chair thanked Recovery Team members for providing written updates to assist with construction of the Communique and noted **apologies, observers and changes to membership** (see Table 1 for record of attendance).

Conflict of Interest

It was noted that not all previously declared conflict of interests were listed on the most recent register circulated to team members. It was discussed that the intention is to keep the register up to date and only list standing conflicts, and that NRE Tas have recently updated the register accordingly. No new conflicts of interest were declared.

Endorsement of previous meeting minutes

The team endorsed the minutes from meeting 5.

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CLOSING ADMINISTRATION

The Chair noted that information provided via member updates and discussions during the meeting will be used to construct the Communique.

Meeting closed.

TABLE 1: ATTENDEES AND OBSERVERS

Name	Organisation	Role
Jo Crisp	Environment, Heritage and Lands Division (EHL), Department of Natural Resources and Environment Tasmania (NRE Tas)	Recovery Team Chair
Lesley Gidding-Reeve	Ocean and Wildlife Branch; Department of Climate Change, Energy, the Environment and Water (DCCEEW)	Recovery Team Vice-Chair
Rachael Alderman	EHL; NRE Tas	Recovery Team member
Ross Monash	EHL; NRE Tas	Recovery Team member
David Midson	Primary Industries and Water Division; NRE Tas	Recovery Team member
Rachel Robbins	Ocean and Wildlife Branch; DCCEEW	Recovery Team member
Leonardo Guida	Australian Marine Conservation Society	Recovery Team member
Toby Patterson	Commonwealth Scientific and Industrial Research Organisation	Recovery Team member
Colin Simpfendorfer	Commonwealth Threatened Species Scientific Committee	Recovery Team member
Iona Flett	Cradle Coast Authority	Recovery Team member
Darryl Cook	Environment Protection Authority	Recovery Team member
David Ikedife	Hydro Tasmania	Recovery Team member
David Moreno	Institute of Marine and Antarctic Studies University of Tasmania (IMAS)	Recovery Team member
Jeff Ross	IMAS	Recovery Team member
Steven Rust	IMAS	Recovery Team member
Jayson Semmens	IMAS	Recovery Team member
Jarrod Edwards	Melaythenner Teeackana Warrana Aboriginal Corporation	Recovery Team member

Matt Barrenger	Salmon Tasmania	Recovery Team member
Lisa Williams	Strahan Aquaculture Community Forum	Recovery Team member
Laura Simmons	Zoo & Aquarium Association	Recovery Team member
Leiden Hunter	Department of Agriculture, Fisheries and Forestry	Observer
Ben Waining	Department of State Growth	Observer
Josh Fielding	Fisheries Research and Development Corporation	Observer
Sean Tracey	Fisheries and Aquaculture Centre; IMAS	Observer
Belinda Jago	Ocean and Wildlife Branch; DCCEEW	Observer
Rebecca Gee	Ocean and Wildlife Branch; DCCEEW	Observer

APOLOGIES

Karen Wild-Allen, no proxy nominated.

CHANGES TO MEMBERSHIP

Ciara Spencer has left the West Coast Council. There is not currently a representative for the West Coast Council on the Recovery Team.

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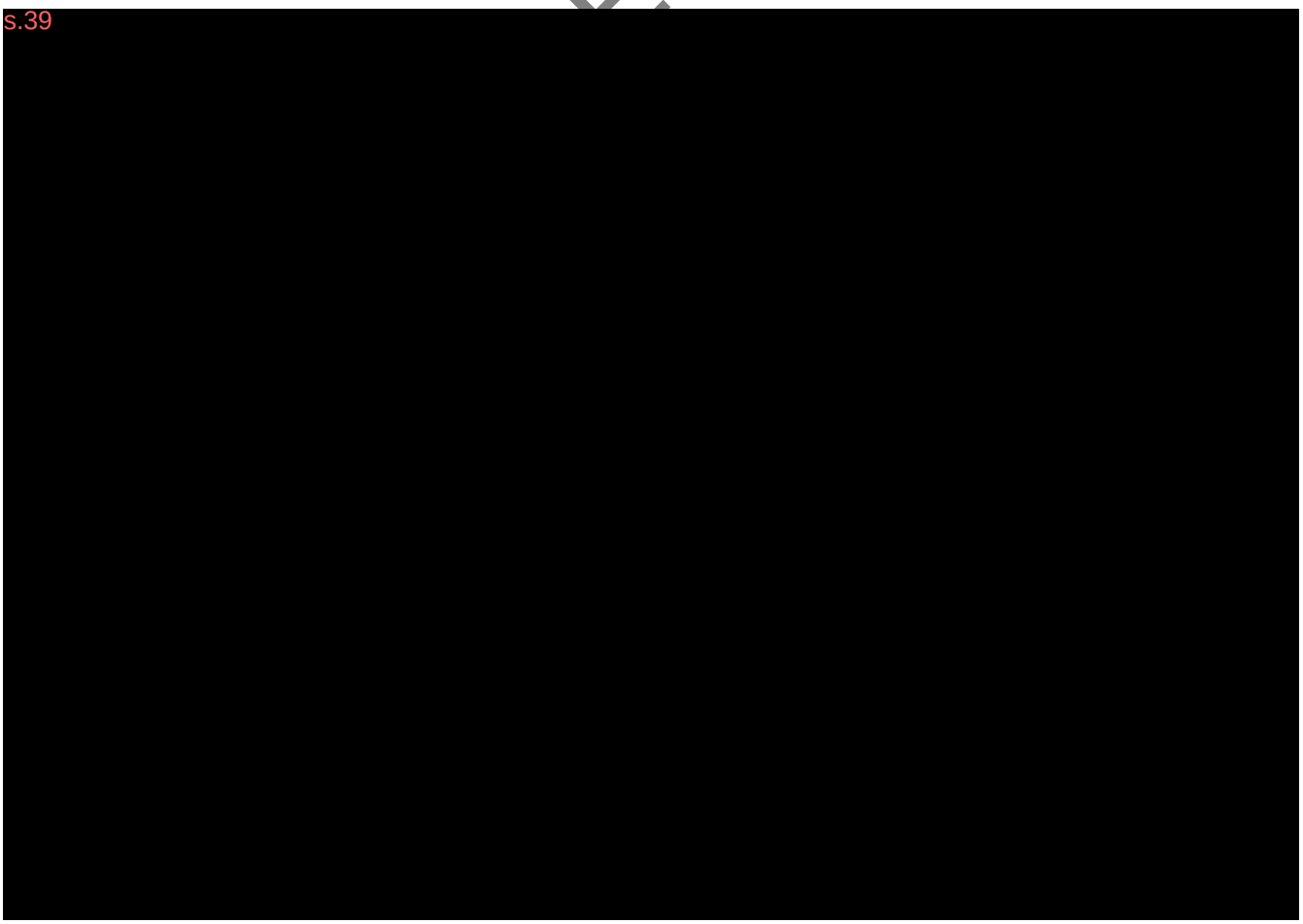

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Australian Government

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National Recovery Team for the Maugean Skate

Meeting 7: Agenda

28 July 2025, 10.00 AM – 3.45 PM

Teams meeting (online only)

Agenda item	Time	Topic	Lead	Paper attached
1	10:00	Acknowledgement of Country Welcome and opening statements • Apologies and introductions (proxies/new members/observers) • Conflict of Interest register • Endorsement of previous meeting minutes [20 mins]	Jarrod Edwards Jo Crisp	 NRTMS Meeting 6 minutes
2	10:20	Presentation: Oxygen demand Update: Hydrodynamic and oxygen process modelling scenarios [40 min]	Jeff Ross NRE Tas ESBU/ David Midson/ Darren Engwirda	
3	11:00	Working Group reporting • Skate monitoring • Environmental monitoring • Captive program • Update on the Captive Management Strategy [40 min]	DCCEEW/ NRE Tas	Monitoring WG Minutes Environmental Monitoring Data Table Skate Monitoring Table (NRE) Captive Breeding WG minutes Captive Management Strategy

Agenda item	Time	Topic	Lead	Paper attached
4	11:40	Discussion: Annual Reporting requirements [20 mins] • Process for input and finalisation	DCCEEW	Draft Annual Report
5	12:00	Discussion: Terms of Reference and Recovery Team structure [45 min]	NRE Tas/ DCCEEW	Draft updated ToR
6	12:45	Action: Voting for Chair and Vice-Chair [15 min]	Jo Crisp	
		Break		
7	1:30	Presentation: Commonwealth Funding [30 min]	DCCEEW	
8	2:00	Member updates and general discussion [60 min]	All members	
9	3:00	November Recovery Team meeting [10 min]	NRE Tas	
10	3:10	Status of actions from previous meetings [20 mins]	All members as required	
11	3:30	Closing administration • Meeting review and general discussion • Timeframe and process for meeting minutes and communique • Concluding remarks [15 mins]	Jo Crisp	

NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

MONITORING TECHNICAL WORKING GROUP MEETING MINUTES

MEETING DETAILS

- **Date**: 21 May 2025
- **Time**: 13:00 – 16:00
- **Location**: Microsoft Teams

ATTENDANCE LIST

Chair: Lesley Gidding-Reeve, Department of Climate Change, Energy, the Environment and Water (DCCEEW)

Participants:

- Lesley Gidding-Reeve, DCCEEW
- Rachel Robbins, DCCEEW
- Rebecca Gee, DCCEEW
- Ross McMillan, DCCEEW
- Deb Vidal, DCCEEW
- Rachael Alderman, Department of Natural Resources Tasmania (NRE Tas)
- Ross Monash, NRE Tas
- Darryl Cook, EPA Tasmania
- Raymond Bannister, Environment Protection Authority Tasmania (EPA Tas)
- Jayson Semmens, Institute Marine and Antarctic Studies (IMAS)
- Jeff Ross, IMAS
- Sean Tracey, IMAS
- David Moreno, IMAS
- Steven Rust, IMAS
- Colin Simpfendorfer, Threatened Species Scientific Committee (TSSC)
- Darren Engwirda, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Karen Wild-Allen, CSIRO
- David Ikedife, Hydro Tasmania
- Leo Guida, Australian Marine Conservation Society
- Clint Mayes, Copper Mines Tasmania
- Laura Simmons, SeaLife
- Scribe: Lisa Meilak, DCCEEW

Objective: The Monitoring Technical Working Group will provide guidance on monitoring priorities and data sharing relevant to the Maugean skate subpopulation, as well as broader ecological and biological processes in Macquarie Harbour. It will also advise on monitoring requirements to assess the efficacy and impacts of environmental remediation solutions.

NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

1. Welcome and Acknowledgement of Country

Lead - Lesley Gidding-Reeve

Chair provided an Acknowledgement of Country and introductions.

Chair provided welcome and opening statements including apologies.

- Apologies:
  - Belinda Jago, DCCEEW
  - Jo Crisp, NRE TAS
  - Toby Patterson, CSIRO
  - Matt Barrenger, Salmon Tasmania
  - Jarrod Edwards, MTWAC
  - Josh Fielding, FRDC
- Review of minutes from last meeting (Nov 2024)
  - The two separate meetings have occurred, one for each of the two sub-groups confirmed in last Monitoring Technical WG meeting – environmental monitoring and skate monitoring sub-groups; and this meeting is to discuss/agree on the outcomes of those deliberations.
- Agree today's Agenda
  - Agenda was broadly introduced as:
    - Discussion of sub-group findings, specifically monitoring data tables
    - Identification of key priorities and knowledge gaps and whether they are funded or should seeking funding be considered
  - All present agreed on the agenda items.

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National Recovery Team for the Maugean Skate: Environmental Monitoring Data

This form should be used assist the Recovery Team in cataloguing environmental monitoring and research data in Macquarie Harbour.

Background: A large amount of environmental monitoring data is collected and analysed by different stakeholder groups. The purpose of this document is to consolidate understanding of data collected to date, optimise monitoring effort and ensure that data collected is fit-for-purpose to inform decision-making.

Program	Data collected[1]	Years that sampling has occurred	Method of data collection (including equipment used)	Frequency of sampling	Location of sampling (including depths)	Which models are using these data?	Data ownership and contact name	Funded?
Real time Sensor Network	DO, salinity, temperature	2015 to current	Real time Sensor Network Probes	Real time - continuous	Table Head Lease, Strahan Lease and Franklin lease	CSIRO (model validation)	Industry/ IMAS (Jeff Ross)	Ongoing (MHOP/ Salmon industry)
EPA DO logger	DO, temp, salinity	2014-2022	Logger string data at 10m, 25m and 35m depths	Continuous	Boundary of WHA	CSIRO (model validation)	EPA (Raymond Bannister)	n/a
EPA DO logger	DO, temp, salinity	2023 - current	Installed logger	Continuous	Various sites including skate habitat areas	CSIRO (model validation)	EPA (Raymond Bannister)	EPA (ongoing)
EPA Quarterly monitoring	DO, salinity, temperature, Water samples are taken for nutrient and metals analysis.	1993 - current	Quarterly profile sampling throughout the water column (field based samples)	Quarterly	15 sites	CSIRO (model validation)	EPA (Raymond Bannister)	EPA (ongoing)
Macquarie Harbour Broadscale Environmental Monitoring Program (MHBEMP)	DO, salinity, temperature, turbidity. Total and dissolved nutrients at surface, middle and bottom, Chla	2011 - current	Water samples, handheld probes, GPS etc. Collected by environmental consultants coordinated by Salmon Tasmania	Monthly	17 sites harbour wide	CSIRO (model validation, in particular MH10 and MH15)	EPA (Raymond Bannister)	Industry (ongoing)

Program	Data collected[1]	Years that sampling has occurred	Method of data collection (including equipment used)	Frequency of sampling	Location of sampling (including depths)	Which models are using these data?	Data ownership and contact name	Funded?
(industry licence requirement)	integrated and or surface.							
Benthic video surveys (external)	Benthic video surveys	2016 – current (but some historical data of different frequency and locations available from 1990s)	Video surveys at 35m compliance points (plus extent dives if req) assessed against end points set in environmental licences e.g. Beggiatoa mats	4 monthly	All finfish leases and control sites (broadscale) around whole system	n/a – but opportunity to use in future	EPA (Raymond Bannister)	Industry (ongoing)
Benthic video surveys (internal)	Benthic video surveys	2016 – current (some historical data as above)	Video survey assessed against end points set in environmental licences e.g. spontaneous bubbling	Annual and prior to restocking of fallowed pens	All finfish leases	n/a – but opportunity to use in future	EPA (Raymond Bannister)	Industry (ongoing)
Salmon Industry (individual companies)	Various parameters	Many	Real time, profilers, probes, physical sampling, algae etc. (methodology dependent on company).	Daily, continuous, as required etc.	In and around marine lease areas. Very localised data so not necessarily representative of harbour conditions.	Some data used by CSIRO	Salmon companies (not centralised through Salmon Tasmania)	Industry (ongoing)
MHOP Wombat Sensor Array	DO, Temp, salinity, depth	18 months Jan 2024 – Jul 2025 (MHOP)	Real time Sensor Network Probes	Real time - continuous	Over main basin around Wombat barge	CSIRO passive tracers/oxygen plume	IMAS to July 2025	Jul 2025 TBC post-MHOP

Program	Data collected[1]	Years that sampling has occurred	Method of data collection (including equipment used)	Frequency of sampling	Location of sampling (including depths)	Which models are using these data?	Data ownership and contact name	Funded?
		TBC post-MHOP				Will be useful in future models (localised, calibration and validation)		
IMAS	Benthic infauna and sediment physico-chemical status	2015 - 2025	Benthic grabs, ROVs	Quarterly to annual	21 broadscale sites and 4 lease-scale transects (c. 12 sites each)	n/a Potential in species-distribution prediction modelling	IMAS (Jeff Ross)	EPA funding in 2025 (Jan-March due to historical dataset). No commitment to continue
CSIRO Coastal Environmental Modelling	DO, Temp, salinity, Chl florescence, pigment florescence and current velocities	Aug 2016 – Nov 2020 May 2024 – present	Profile mooring	Continuous	2016 – 2017: Centre of harbour (main basin) 2017: Moved to northern end of harbour (King River basin)	Coastal environmental modelling Model validation	CSIRO (Karen Wild-Allen)	Funded by NRE until end of 2029
Hydro Tasmania	Lower Gordon flows	Various - present	Actual and forecast river flows based on catchment models and hydrometric sites	Continuous (15 minute, note Gordon below Franklin is currently not telemetered)	Franklin @ Fincham Gordon PS tailrace Gordon above Denison compliance Gordon below Franklin (new Dec 24)	HT Lower Gordon DRIP model CSIRO oxygen process CSIRO salinity	Hydro Tasmania (David Ikedife)	Hydro (ongoing)
Hydro Tasmania	Lower King flows	Various - present	Actual and forecast river flows based on catchment models and hydrometric sites	Continuous (15 minute)	King River below John Butters PS Andrew River above Kelly Basin Rd	HT Lower King DRIP model CSIRO oxygen process	Hydro Tasmania (David Ikedife)	Hydro (ongoing)

Program	Data collected[1]	Years that sampling has occurred	Method of data collection (including equipment used)	Frequency of sampling	Location of sampling (including depths)	Which models are using these data?	Data ownership and contact name	Funded?
						CSIRO salinity		
Hydro Tasmania	Lower Gordon King rain forecast	Various - present	Merged observed and forecast rainfall	15-minute rainfall	Franklin @ Fincham Strathgordon Burbury Pluvio Gordon above Denison compliance King William Creek Narcissus Howards Plains Darwin Dam Strahan Airport	CSIRO oxygen process CSIRO salinity	Hydro Tasmania (David Ikedife) Bureau of Meteorology	Hydro (ongoing)
Salmon Tasmania tidal gauge	Tides	From 2012 – some gaps 2024 – present	Tidal gauge	Continuous	T-Hub (aquaculture hub at Macquarie Heads at Tassal Wharf)		Salmon Tasmania (Matt B)	Industry (ongoing)
Tasmanian Tide Monitoring Project	Tidal heights throughout the harbour	2020 - 2022	Tidal gauge	Continuous	Sarah Island, Macquarie Heads and Strahan		UTAS (Karen Palmer)	Not currently funded
NRM Coastal Mapping	Bathymetry and habitats (e.g. sediment distribution)	2008	Boat surveys with single beam sonar	Once off	Whole harbour		UTAS (Vanessa Lucieer)	Not currently funded
Sewage treatment plant (Tas Water) (industry licence requirement)	BOD, TSS, pH, thermotolerant coliforms and enterococci. Nutrients, some metals (annual). Average daily	Started 1988, parameters added 2008, 2012	Effluent sampling	Monthly	Just outside Strahan on headland	CSIRO input to data	EPA (required under permits) / Tas Water	Tas Water (ongoing)

Program	Data collected[1]	Years that sampling has occurred	Method of data collection (including equipment used)	Frequency of sampling	Location of sampling (including depths)	Which models are using these data?	Data ownership and contact name	Funded?
	inlet flow for month.							
Skate prey surveys	Distribution of crabs and crustaceans	2018-2019	Trapping	Seasonal	Transects throughout harbour		IMAS (Jayson Semmens)	Not currently funded
Mount Lyell Remediation and Demonstration Program	Metals, fauna, water quality	1996	Various		Broad harbour		??	n/a
BOM Wave Buoy	Wave height, period and direction	1998 (?) – present		Continuous (hourly)	10km west of Cape Sorrell (outside the harbour)		BOM	BOM (ongoing)
Glider Mission	Temp, salinity, DO, marine optics, nitrates and Chlorophyll	Planned for every year for next 4 years	Autonomous underwater vehicle (glider)	A month at a time, one mission per year	West coast of Tasmania	Define forcing for model (boundary conditions)	CSIRO IMOS (only hotspots for marine heatwave)	Funded by NRE Tas until 2029

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NATIONAL RECOVERY TEAM FOR THE MAUGEAN SKATE

Maugean Skate National Recovery Team Captive Breeding Technical Working Group meeting- MINUTES

MEETING DETAILS

- **Date:** 13 May 2025
- **Time:** 15:00- 17:00
- **Location:** Microsoft Teams

ATTENDANCE LIST

- Chair: Lesley Gidding-Reeve, Department of Climate Change, Energy, the Environment and Water (DCCEEW)
- **Members:**
  - Belinda Jago, DCCEEW
  - Lesley Gidding-Reeve, DCCEEW
  - Rachel Robbins, DCCEEW
  - Rebecca Gee, DCCEEW
  - Deb Vidal, DCCEEW
  - Billy Dunlop, DCCEEW
  - Rachael Alderman, Department of Natural Resources and Environment Tasmania (NRE Tas)
  - Darryl Cook, EPA Tas
  - Sean Tracey, Institute of Marine and Antarctic Studies (IMAS)
  - Jayson Semmens, IMAS
  - David Moreno, IMAS
  - Iona Flett, Cradle Coast Authority (CCA)
  - David Ikedife, Hydro Tasmania
  - Lisa Williams, Strahan community representative
  - Steven Rust, , IMAS
  - Leo Guida, Australian Marine Conservation Society (AMCS)
  - Clint Mayes, Copper Mines Tasmania
  - Karen Wild-Allen, CSIRO
- **Apologies:**
  - Jo Crisp, NRE Tas
  - Ross Monash, NRE Tas

1. **Welcome and Acknowledgement of Country**

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Captive Management Strategy for Maugean Skate (*Zearaja maugeana*)

UNIVERSITY of TASMANIA

IMAS
INSTITUTE FOR MARINE & ANTARCTIC STUDIES

Australian Government
Department of Climate Change, Energy, the Environment and Water

Cover: Maugean skate juvenile hatched in captivity (photo: David Moreno)

Endorsed by: Maugean Skate Captive Breeding Steering Committee, 17 February 2025

PREFACE

This document is designed to outline the general principles in managing the Maugean skate captive population to support the conservation and recovery of the species. The Maugean Skate Captive Breeding Program began as an emergency intervention action to mitigate the risk of extinction for the species. This is the first time that the species has been kept in long-term captivity. While best efforts were made to collect as much relevant information as possible prior to the beginning of the project, several key knowledge gaps remain. This should be considered a working document, and the outlined strategies are subject to revision as new information becomes available, improved husbandry practices are developed, and management objectives change.

The initial phases of this work will have a strong focus on research and development of best practices to ensure that the species can thrive in captivity. The strategy presented in this document will cover the initial two phases of captive management (3-5 years). A full revision will be undertaken when the Program moves to subsequent phases or sooner if identified triggers are met or significant new information become available.

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1. PROGRAM RATIONALE

1.1. Context

The Maugean skate (*Zearaja maugeana*) is currently listed as Endangered under both Tasmania's *Threatened Species Protection Act 1995* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It is a micro endemic species currently found only in a single estuarine system (Macquarie Harbour) in Western Tasmania. The Maugean skate is thought to have a naturally low population size resulting from its very restricted geographic range.

In response to a suspected high extinction risk in 2023 (Moreno and Semmens 2023) , the **National Recovery Team for the Maugean Skate** (hereafter Recovery Team) identified a critical need for ex-situ intervention (hereafter Maugean Skate Captive Breeding Program (**the Program**)) alongside in-situ habitat remediation work to ensure the persistence of the species. Initial work was led by IMAS, with Phase 1 initiated in December 2023 to establish an initial founder population of Maugean skate.

The Program is in 3 phases:

- **Phase 1 (1 year)**: A captive population of Maugean skate is established in a Tasmanian facility and researchers are successfully holding and maintaining a number of healthy adults and eggs/juveniles.
    a. Establish captive population maximising genetic diversity, while minimising risk to the wild population (as per strategies outlined in the PVA).
    b. Begin building breeding population to support Phases 2 and 3.
    c. Development of egg rearing, juvenile holding, adult holding, transport, and collection Standard Operating Procedures (SOPs).
    d. Maximise hatching success probability of eggs by collecting them prior to exposure to adverse conditions predicted in summer 2023/24.
- **Phases 2 (3-5 years)**: Maintenance of the captive population of Maugean skates that include healthy adult and juvenile skates of both sexes in at least one (1) suitable facility in Tasmania to ensure a viable captive breeding program. Deliverables include:
    a. By 30 June 2026, an ex-situ population of Maugean skates is established in at least one (1) suitable facility in Tasmania to ensure a viable captive management program.
    b. By 30 June 2028, an ex-situ population of Maugean skates is being successfully maintained in at least one (1) facility in Tasmania, with sufficient redundancy for possible adverse events.
- **Phase 3**: Support the wild population through re-introduction (and/or translocation); ongoing maintenance and monitoring. This Phase can occur at any time so long as other objectives are not compromised or, if varied, are evidence-based.

1.2. Objectives

The overall goal of the Program is to establish a breeding population of Maugean skate in captivity to guard against species extinction and to provide a source of animals for release to the wild.

The specific objectives of the Program for the first two phases of work are:

Goals	Action	Measures of success (and timelines where relevant)
Objective 1: Establish a captive population of Maugean skate		
1a. Collect animals from the wild to establish a captive population	Collect adults and eggs from the wild and house in facility at Taroona	Collection of individuals from the wild with stable health after a reasonable adjustment period
1b. Establish and refine captive husbandry protocols for the species	Develop husbandry SOPs and detailed record keeping by captive holders to increase productivity, reduce morbidity and mortality and further improve current techniques	Husbandry SOPs are developed (complete) and updated when required. Review when required (e.g. after substantial updates) with input from the Maugean Skate Captive Breeding Program Steering Committee (the Steering Committee).
1c. Maintain high standards of husbandry to ensure a healthy, disease-free captive population	Provide optimal conditions to maximise individual fitness with consideration of maximising individual welfare.	The captive environment provides appropriate conditions to maintain best possible health and welfare outcomes for each individual
	Focus husbandry research to encourage survival of individuals (across all life-stages).	Successful breeding, growth, and survival of individuals at each stage of the species' life cycle
	Conduct annual health assessments and population reviews to track genetic diversity, breeding success, and overall health of the captive population.	Regular health check-ups indicate no significant health issues or population decline, and the genetic diversity is within acceptable thresholds for the species' survival (ongoing).
Objective 2: Strive towards a demographically stable population with a structure that promotes reliable reproduction (and possible surplus reproduction for a reintroduction program).		
2a. Develop a system to ensure accurate identification of individual animals.	Develop and maintain individual identification system and records that contain pertinent data on parentage, age, health records, weights/ measurements, transfers,	Individual animal records are updated regularly and appropriate for the Program

Goals	Action	Measures of success (and timelines where relevant)
	reproductive history and progeny etc.	
2b. Determine the number of animals needed to achieve a demographically stable population	Calculate the target population size and number of hatches to secure a balanced and genetically diverse population in captivity.	Population maintained at target size.
2c. Ensure there is sufficient capacity in appropriate facilities to house required population size.	Identify and add at least one additional facility independent of the Taroona site	Achieve a network of at least 2 separate facilities before the current facilities reach capacity (facilities identified by June 2025). Population is maintained below the maximum carrying capacity of all facilities throughout the Program.
	Develop a facility translocation plan (including consideration of the distribution of genetic representation) for the movement of animals between facilities	An agreed translocation plan is in place by June 2025
	Ensure that the breeding population is as equally distributed and genetically represented across facilities as possible to reduce the risk of catastrophic loss at any one location.	Facility distribution of animals is diversified, ensuring no facility holds a disproportionate number of individuals (Dec 2025).
2d. Achieve successful breeding and survivorship of offspring	Informed by the studbook, breed from captive stock, achieving maximum conservation of genetic variability	Studbook is up to date and informing genetic and demographic management (ongoing) Breeding is reliable and consistent. Aim for hatching rates to match or exceed 40% Juvenile mortality to remain below 10%
2e. Prevent agonistic behaviour and inbreeding in group housing configurations.	Develop a behavioural ethogram and observe group housed animals to reassess and inform appropriate housing configurations (# of animals, size and maturity	Ethogram is developed. Group housed animals are not demonstrating enduring agonistic behaviour.

Goals	Action	Measures of success (and timelines where relevant)
	classes, and sex ratios per tank)	Inbred animals are not knowingly produced.
2f. Improve hatch rate/determine aetiology of failing eggs if mortality rates fall below agreed aims	Undertake necropsy of failed eggs	Aetiology determined. Recommendations developed to reduce failed hatches.
Objective 3: Genetics - Maximise retention of genetic diversity and minimise inbreeding in the descendant captive population.		
3a. Gene diversity is maintained and inbreeding is avoided through the careful selection of breeding individuals	Assess the genetic diversity of the captive population and determine pedigrees.	Genetic diversity (GD) and pedigrees of captive population known
	Prevent unwanted pairings through careful management	No unwanted pairings occur
	Maintain inbreeding below f = 0.25 and GD at least 90% of the wild population	Inbreeding coefficient is maintained below 0.25. GD is ≥ 90% of the wild population
	If additional stock is needed to boost genetic diversity in the captive population, develop a proposal to collect from wild populations	Future collection plan in place (by Dec 2025)
Objective 4: Supplement the wild population with animals from the captive management program (to be informed by Tasmanian Flora and Fauna Translocation Policy (under development) or under guidance from the Tasmanian Translocation Technical Assessment Panel)		
4a. Develop and implement a translocation/reintroduction strategy to be informed by the Tasmanian Flora and Fauna Translocation Policy and IUCN guidelines for species translocation.	Identify triggers for commencement of translocations/ reintroductions in the wild. If triggers are met, implement the translocation strategy.	An agreed translocation and reintroduction plan is in place Timeframe: Prior to the development of any translocation proposals
4b. Provide minimum health standards for translocation/ reintroduction	Seek approval and guidance from Biosecurity Tasmania for standards to be applied to release to the wild.	Biosecurity Tasmania guidance and approval sought. Timeframe: Prior to release to the wild
4c. Reintroduce the full complement of genetic diversity present in the captive population to the wild population	Identify captive animals suitable for reintroduction and determine appropriate demographics of cohorts.	Animals suitable for reintroduction are identified.
4d. Manage animals identified for reintroduction in a manner conducive to the survival of	Research to determine raising conditions and/or acclimation conditions needed to maximise survival of animals	Skate destined for release are robust and acclimated to maximise survival upon release.

Goals	Action	Measures of success (and timelines where relevant)
animals upon release to the natural environment.	upon release ('Harbour-ready skate'). Adapt captive conditions at appropriate life stages to reflect findings of research. Note: this may require trial releases to the wild.	
4e. Provide fit, healthy animals for release that are capable of surviving in the wild (once threats have been sufficiently reduced)	Monitor the fate of captive-reared animals released into the wild and modify protocols based on new understanding of post-release survival to maximise survivorship.	Survival rates of animals released into the wild are in line with translocation/ reintroduction strategy Timeframe: Once Objectives 1 and 2 are achieved, within the term of this Plan.

2. PROGRAM GOVERNANCE AND SCOPE

2.1. Governance

Scope of managed population	The species is primarily managed to support formal state and federally endorsed recovery activities for the species in situ; and to enable research and ex-situ management, consistent with these conservation actions
EPBC Act Status	Endangered Listed as *Zearaja maugeana* under the Environment *Protection and Biodiversity Conservation Act 1999*. Last assessed in 2004. Under threatened listing assessment, due 30-Oct-2025.
Tasmanian state listing	Endangered. Listed as *Zearaja maugeana* under the *Threatened Species Protection Act 1995*. Last assessed in 2022
Other relevant legislation	○ *Living Marine Resources Management Act 1995* (TAS) ○ Threatened Species Protection Regulations 2016 (TAS) ○ *Tasmanian Biosecurity Act 2019* (TAS) ○ *Nature Conservation Act 2002* (TAS) ○ *Animal Welfare Act 1993* (TAS) ○ Other state and territory legislation will apply if animals are moved interstate
Ability to recruit from the wild	The need for further wild individual collection (founders) will be informed by demographic and genetic analysis; and will follow UTAS Animal Ethics, Biosecurity Tasmania and legislative permits approvals.
Ability to move between facilities and/or interstate if required	To be determined as part of the facility translocation plan
Ownership	In accordance with the *Tasmanian Animal Welfare Act,1993*, *Threatened Species Protection Act 1995*, and *Living Marine Resources Management Act, 1995* and associated policies, all Maugean skate (wild caught and captive hatched) are managed under the authority of the Tasmanian legislative framework. Accordingly, any decisions regarding captive animals, including those pertaining to maintenance, husbandry, welfare, population management and research, will be guided by this framework. Movement from/to the wild, or between facilities, will also include further legislative guidance under the *Tasmanian Biosecurity Act 2019*.
Permits and authority for captive individuals	All individuals in the captive population are currently housed at the IMAS Taroona research facility. Individuals are in the charge of IMAS as stipulated by State Legislation (*Living Marine Resources Management Act 1995*, section 14); *Threatened Species Protection Regulations 2016*, regulation 4 (3) (a)). In accordance with the permit conditions, IMAS can collect, keep, and breed Maugean skate as per the stipulations in the project plan submitted as part of the permit applications and subject to approval from the University of Tasmania Animal Ethics committee.

	Permitting and ethics regulations/requirements state that the holders of the animals have responsibility for the captive animals and can make decisions regarding the development and implementation of husbandry and holding protocols for the species, everyday care and animal welfare as consistent with the project plan submitted under the permit application. Expert advice will be sought from the Program Steering Committee when required. Animals holders should consult with funding partners, NRE and DCCEEW on decisions regarding use of specimens (including research use), surplus animal management, population management (including movement of animals between facilities) and overarching project design.
Maugean Skate Captive Breeding Program Steering Committee	The function of the Steering Committee is to advise the Maugean Skate Captive Breeding Program (the Program) on the work conducted under DCCEEW funding including: ○ Delivery and achievement of outcomes of Phase 1 of the Program ○ Recommendations for updates to, or development of, Standard Operating Procedures ○ Skate husbandry and veterinary care, and other captive breeding matters ○ Risk assessment and mitigation ○ Design and development of Phase 2 of the Program The Steering Committee has no executive powers, supervisory functions or decision-making authority in relation to the Program. It functions in an expert oversight and review role and therefore provides advice, endorsement or recommendations rather than approvals. Membership in the Steering Committee may change as work progresses to ensure that experts relevant to the specific Program needs are engaged.

2.2. Program administration

PROGRAM ADMINITSRATION	
Studbook Keeper	Jayson Semmens, IMAS
Software for Analysis	**Studbooks**: ZIMS for Studbooks/PMx Currently there are no studbook data available for the Maugean skate captive population. One will be developed as part of this project based on molecular data. Studbooks will be implemented and managed by the IMAS team (see Captive population management section for more details). A studbook for all captive animals will be established (ZIMS studbook management software). The studbook will be used to track captive and released individuals, and PMx will be used to import the founder empirical kinships and then analyse the studbook to develop breeding recommendations. Studbook Keeper will seek advice from relevant parties, for example Species360 and experts in studbook management. **Sequencing Platform:** Recent work (IMAS in prep) has shown that sequencing can be achieved rapidly and cost effectively using DArTseq. This sequencing method has been used successfully for Maugean skate producing 25,000 single nucleotide polymorphism (SNP) markers from deep sequencing of 5 million sequence reads per individual. Based on this, a selected marker set can be used to develop target genotyping.

	Available genetic resources include: • DArTseq data for ~200 wild individuals sampled from 2012 -2024. • A reference quality whole genome sequenced using Pacific Bio (Pac Bio). • Whole mitogenomes from an individual collected in Macquarie Harbour and an individual from Bathurst Harbour (sequenced from archival samples). • A species transcriptome (multiple tissues) and whole genome sequenced using Hi-C sequencing are currently being developed. These will aid in scaffolding, assembly and annotation of genomic resources for the species **Population genetics analysis** using the DartR library in the R statistical environment. Additional analysis will be conducted using COLONY and COANCESTRY software
Project Team	○ Institute for Marine and Antarctic Studies (IMAS), University of Tasmania (UTAS) ○ Phase 1: Laura Simmons (husbandry expert) ○ Phase 2: TBC **Veterinary support** ○ The Aquarium Vet ○ UTAS Animal Ethics Committee (AEC) veterinary team
Program funding partner(s)	○ Department of Climate Change, Energy, the Environment and Water (DCCEEW) ○ Cradle Coast Authority (CCA) - Funds provided by DCCEEW are managed by CCA. ○ Department of Natural Resources and Environment Tasmania (NRE Tas) ○ Institute for Marine and Antarctic Studies (IMAS), University of Tasmania (UTAS)
Funding arrangements	Initial funding support for Phase 1 was provided by IMAS, NRE Tas and DCCEEW. This covered facility set up and expansion costs, genetic analysis, daily program upkeep and maintenance, and animal collection. Funding to build an expanded holding facility for the Program has been provided by NRE Tas, with construction of the new facility estimated to conclude by the second quarter of 2025. As of November 2024, funding agreements are being finalised with state and federal government partners to cover the operating costs for the IMAS through to June 2026. NHT funding via the Cradle Coast Authority has been contracted to 30 June 2028 and further funding for the current facility has been secured. Work is ongoing to ensure appropriate arrangements are in place for 1 July 2025. Investigations into a second facility are continuing.
Frequency of reporting	**Steering Committee**: Annually. An annual population status report should be provided to the Steering Committee that details progress/outcomes against the

	demographic and genetic goals. This will allow discussion of mitigation actions if goals are not being met. **Recovery Team:** Updates on the captive breeding program are provided at each Recovery Team meeting (currently quarterly)
Implementation Period	10 years, with a comprehensive review after 5 years. The scope of this document covers the first 5 years of operation. An annual review of the Program will be undertaken in line with the relevant objectives, goals and triggers outlined in the document, including sections: 1.2 Objectives, 6.1 Captive Management Goals, 7. Translocation and 8. Exit Strategy as well as consideration of progress in addressing key knowledge gaps. The estimated total length of the Program is up to 10 years (based on evolving conservation goals, this may change in the future depending on development of alternate supplementation strategies, increased knowledge, mitigation of threats in the wild, status of the species in the wild and success of the Program).

2.2.1. Data collection for plan development

Data sources that will be used to inform and refine this captive management strategy will include:

- Molecular and demographic data from the captive population, with ongoing demographic modelling.
- Health and husbandry records from the captive population
- Physiology and release research program (planned, not yet funded)
- Molecular data and demographic data from the wild population (collected in the population monitoring program)
- Environmental in-situ data to inform release strategies (collected in the environmental monitoring and remediation programs)
- ZIMS (Species360) Studbook software and data

2.2.2. Record Keeping

Record keeping is crucial for population management and reporting. Records that will be kept include:

- Daily system checks and maintenance
- Daily animal welfare, feeding and behaviour records
- Daily water quality parameters
- Individual identification records and housing enclosure history, including enclosure-mates

- Current census, demographics, mortalities, births, behaviour (including agonistic behaviour), reproductive behaviour (including mating, egg laying) and parentage information
- Medical treatment, growth data, and monitoring of embryonic development and sexual maturation.

2.2.3. Reporting

Current versions of all documents and procedures developed as part of the project are available on request through cloud storage to the funding partners and Steering Committee. A curated population summary is also available with information updated daily. Other regular reports include:

- Bimonthly milestone progress reports to NRE Tas and Cradle Coast Authority (and shared with DCCEEW) during Phase 1.
- Quarterly milestone reports to Cradle Coast Authority (and shared with DCCEEW through the MERIT system) during Phase 2.
- Quarterly progress updates in the form of written updates (and presentations during meetings where relevant) to all project partners.
- Monthly short activity reports to the UTAS Animal Ethics Committee (AEC) veterinary staff once a month as part of UTAS AEC requirements.
- Annual progress report to the UTAS AEC for the duration of the Program, as well as a final report at the conclusion of work.
- Final report to the NRE Tas at the conclusion of each Animal Holding Permit period prior to its renewal (yearly).
- Progress updates to the Recovery Team at regular meetings (currently quarterly).
- Annual population status report provided to the Steering Committee that details progress/outcomes against the demographic and genetic goals.

3. USE OF SPECIMENS AND SURPLUS ANIMAL MANAGEMENT

3.1. Use of specimens

- **Commercial**: No
- **Display/education**: Not currently
- **Research**: Yes

All individuals in the current population have been designated for use in the captive conservation efforts for Maugean skate. As such, under current permit conditions, individuals cannot be used for commercial, display or education purposes.

During Phase 1 of the Program, use of individuals for research has been centred round the development of husbandry and holding procedures.

Research use

- Specimens will only be removed from the Program in accordance with the Program's objectives;
- Specimens should not be moved between facilities or out of the Program, in a way that is detrimental to other conservation programs or activities
- Research must align with the goals and objectives of the Program.
- Any research involving genetically valuable individuals or animals suitable for future release should receive advice from the Steering Committee.
    - Non-invasive research (e.g., record-keeping, behavioural observations, and routine husbandry practices) is considered business as usual (BAU) and does not require advice from the Steering Committee.
- Animals should only be considered for use in invasive research (e.g. involving direct interaction, biological sampling, in-situ research using captive animals) if they are not needed for conservation purposes and if their use is either approved by or exempt from assessment by an Animal Ethics Committee, and undertaken under appropriate permit.
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3.2. Surplus animal management

3.2.1. Challenges

In a captive breeding program, surplus animals can present a variety of challenges, especially when they arise unexpectedly due to factors like overproduction. For example, the adult female has produced an unanticipated number of eggs while in captivity, with a clutch of 2 eggs being laid approximately every 4 days. Issues include:

- **Genetic overrepresentation and inbreeding risk** - When a breeding female is genetically overrepresented in the population, the resulting surplus animals may exacerbate the problem of overrepresentation of a single genetic line and prevent a program with limited capacity from optimising genetics.
- **Overcrowding** - Surplus animals require additional space, food, and care. If not managed properly, this can lead to overcrowding, potentially affecting the overall health and breeding success of the population.
- **Financial and logistical implications** - Managing surplus animals requires additional financial and logistical resources, including staff time, veterinary care, and facility space, and may divert resources away from other important aspects of the breeding program.
- **Ethical and welfare concerns** – the management of surplus animals raises ethical concerns which can impact the public perception and credibility of the breeding program.

3.2.2. Decision-making

Managing surplus animals requires balancing genetic health, animal welfare, and the overall goals of the breeding program.

Any decisions regarding the management of surplus animals, including the annexing of animals out of the breeding program, must be made in line with legislative requirements (see 2. Governance) and in consultation with funding partners (with Steering Committee advice if appropriate), ensuring that all actions align with the overall conservation goals and ethical standards of the Program:

- The process must thoroughly evaluate the scientific justification for the management option being considered, the welfare of the animals, and the potential impact on the breeding program's objectives, including conservation efforts and genetic diversity.
- Specimens are removed from the Program only in accordance with the Program's objectives, and that specimens are not moved between facilities within the Program, or out of the Program, in a way that is detrimental to other conservation programs or activities.
- This decision-making process will be ongoing, continuing even after animals are placed into other facilities.
- Management of animals must also follow appropriate government and facility policies and guidelines.

3.2.3. Strategies to reduce the production of surplus animals

Several strategies should be deployed in the Program to help prevent the issue of surplus animals from arising:

- **Capacity planning:** Assess the capacity of the facility to care for offspring before commencing further breeding. Considerations includes space, availability of suitable

enclosures, and enough resources to maintain their welfare. Facilities should have clear guidelines on the maximum number of animals they can sustainably house and care for.

- **Animal holding management**: Ensuring that males and females are housed separately wherever possible without compromising their health or welfare, except when paired for targeted breeding.
- **Careful pairing decisions:** Guided by the studbook, breeding pairs should be selected based on genetic compatibility and the long-term goals of the Program to prevent excessive breeding from genetically similar individuals.
- **Egg management:** Eggs/embryos/hatchlings that show poor genetic health, low viability, or genetic defects may be considered for removed (dependent on permits and Tasmanian Government legislation), reducing the risk of producing animals that may not thrive or be genetically redundant.
- **Expansion of number of facilities**: Collaboration with other facilities with a shared, region-wide breeding plan can help in dispersing surplus animals without overcrowding individual facilities.
- **Regulation of egg laying**: Research to determine if there are mechanisms to regulate the number of eggs laid by females.

3.2.4. Management options

Options for surplus animal management include:

Option	Description	Considerations
Transfer to other facilities for breeding	Transferred to facilities that are part of the same breeding program or studbook. Helps maintain species population stability across different locations.	Transfers must be managed carefully depending on proposed use in new facility (e.g. headstarting, breeding)
Transfer to other facilities – non-breeding	Surplus animals that are not needed for breeding can be kept in non-breeding populations for public display. Ensures long-term care for animals that cannot be reintroduced or transferred and can provide opportunities for public education and outreach.	Animals should be housed in appropriate environments to maximise health and welfare, and to avoid inadvertent breeding. Subject to the Tasmanian Government's translocation policy and permit approvals to move animals out of Tasmania.
Reintroduction to the wild	If surplus animals are of sufficient genetic value and health, they may be candidates for reintroduction if suitable conditions exist in Macquarie Harbour (see 0 RELEASE STRATEGY)	Depending on life stage, reintroduction requires careful planning, including habitat suitability, health checks, and potentially acclimation techniques.
Research	Used for research programs that align with the goals and objectives of the	Ethical, animal welfare and public perception considerations. The Program and funding

	Program, and with the overall conservation goals for the species (for example, determining conditions needed to maximise survivorship upon release).	partners should be provided with justification for research need, details of animals to be used (including genetic value to the Program) and a clear and specific research proposal. The fate of animals once research is completed should be clearly articulated.
Gene Banking (Cryopreservation)	Surplus animals can contribute to genetic diversity through, cryopreservation of germ cells which can be stored for future use in breeding programs, helping to prevent genetic bottlenecks or inbreeding in future generations.	Requires investment in technology and expertise. Only suitable for animals that are genetically valuable but not suitable for breeding or reintroduction.
Humane destruction of eggs and euthanasia	Generally considered a last resort for healthy thriving animals when other management options are not viable.	[Significant ethical and legislative considerations and not an option for the program at this time]. The current policy for captive breeding in Tasmania is that eggs with embryos at any stage of development, cannot be destroyed for population management purposes.

4. SPECIES SUMMARY

Common name(s)	Maugean skate, Port Davey skate
Scientific name	*Zearaja maugeana* (formerly *Dipturus maugeanus,* Raja sp.)
Conservation Status	EPBC Act: Endangered (Date effective 04-Mar-2004) TAS: Endangered (*Threatened Species Protection Act 1995 (Tasmania)*: August 2024 list) IUCN: Listed as Endangered (as *Dipturus maugeanus)* under criteria B1ab(i,ii,iii,iv)+2ab(i,ii,iii,iv). Last assessed in 2015 (Last et al, 2016)
Description	Maugean skates possess a long snout with a narrow disc and head, and a smooth dorsal surface. Individuals have a dark brown dorsal coloration with lighter small spots. Ventral coloration is lighter grey-white with a variety of darker spots.
Size	Mature males will reach a maximum of 70 cm in total length, and females will reach a maximum of 84 cm in total length. Disc width more than 1 m (Last et al. 2008)
Distribution	The Maugean skate is only known from two remote estuaries in western Tasmania - Macquarie Harbour and Bathurst Harbour. It is the only species of skate in the world known to mostly inhabit brackish waters (Treloar et al., 2017). The species is now thought to exist only in Macquarie Harbour, resulting in the most limited distribution of any shark or ray globally.
Diet	The skates have a restricted diet mostly consisting of small epibenthic crustaceans, including crab and shrimp, although some small teleosts (ray-finned fish) have been reported as minor dietary items (Weltz et al., 2019).
Longevity	10-13 years of age with adults maturing early (5 – 6 years) (Awruch et al., 2020).
Reproduction	Fertilisation is internal, with oviparous (egg laying) development. In Macquarie Harbour, egg capsules are found across different depths and habitats, suggesting that there are no dedicated egg nurseries (Moreno et al., 2020).
Observed Breeding Season	Asynchronous and discontinuous reproductive cycle in which only a proportion of females are reproductively active at any given time (Awruch et al., 2020).
Sex ratio	1:1 male:female sex ratio.
Mating behaviours	Mating behaviour in the species is poorly understood, however, early captive observations suggest that the Maugean skate females displays similar pre-copulatory behaviours as described in other rajids (Luer et al, 1985). This Maugean skate was observed attempting to mate with an adult male in captivity, although it is not yet known if the attempt was successful (to be confirmed using molecular techniques). No agonistic or competitive behaviours were observed when the animals were housed together. The observed mating attempt occurred two months after the pair was introduced to the same habitat. Holding conditions during this time were set to approximate marine conditions in Macquarie Harbour following an oceanic recharge event (DO 100%, salinity 34%). Long term acoustic tracking and fisheries independent catch data showed no evidence of sex or size specific segregation. Network analysis of tagged adults found no evidence of social structuring or group affinity. However, further work is needed to understand social structure in the species, particularly across juvenile age classes.

Incubation (embryonic development) period	7 months with eclosion (the respiratory channels in the egg case becoming unblocked) halfway through development
Clutch size	Eggs are deposited in pairs at intervals between 2 and 21 days (average 4 days based on captive observations). The duration of the resting period between cycles is unknown. It was estimated to potentially be between 10 and 26 eggs based on ovarian fecundity (assessed nonlethally using ultrasonography). However, limited observations in captivity suggest that the potential individual reproductive output of the species might be much higher in a captive environment.
Egg viability	Estimated at 40% (Moreno et al, 2020), although a recent egg collection survey of eggs laid in situ suggests that current rates could be as low as 10-20% (Moreno et al, 2024). Based on early ex-situ observations, viability rates of eggs in captive conditions appear to be higher when rearing in a controlled environment (52-80%).
Juvenile and adult mortality	Population declines and acute mortality events have been documented for the wild population (Moreno and Semmens 2023; Moreno et al. 2024). Survey data may be consistent with changes to the demographic structure of the population and low recruitment levels. However, natural juvenile and adult mortality rates for the species are not well understood.
Growth rates/ages	○ Neonates: 9-12 months, birth to 20cm TW ○ Juvenile stage 1: ~2 years, 20-30cm TW ○ Juveniles stage 2: ~3 years, 30-48cm TW ○ Adult: 4 – 5 years, >48cm TW
Other comments	Preliminary molecular assessment of captive laid eggs suggests that like other elasmobranchs, Maugean skate are capable of sperm storage and multiple paternity. However, further work is needed to better understand rates of multiple paternity, duration of sperm storage, female cryptic choice mechanisms and incidence of parthenogenesis in the species. Parthenogenesis is widely observed in elasmobranchs, especially in captive oviparous species. Parthenotes have been identified in elasmobranchs using microsatellites with high polymorphism. However, that is not an option for this species, as not enough microsats are available (Weltz et al, 2018) so the Program will use the Single Nucleotide Polymorphism markers. Genomic assessments of parthenogenesis are computationally intensive, but there are new tools that allow the use of large genomic datasets for parthenogenesis determination.

5. HUSBANDRY AND FACILITIES

5.1. Captive history

Prior to 2023, Maugean skate had only been held in captive conditions for a short time in purpose-built field facilities (Morash et al, 2018, Moreno et al, 2020). Further, one pair of eggs laid during a physiology experiment was successfully reared to hatching in captivity at the IMAS Taroona facility (Moreno et al, 2020).

The current captive population is comprised of:

Life stage	Role	Comments
Adults collected from the wild	Husbandry and breeding pathfinding	In December 2023 and following the recommendations in the PVA, 4 adults (2.2) were collected from Macquarie Harbour and transported to IMAS Taroona. Two adults (1.1) died shortly after transfer to Taroona. A postmortem showed that the male succumbed to bacterial infections of both the skin on the rostrum and the gills, which caused damage to both structures and were significant enough to explain the mortality. The female was underweight for its size and had a small liver with these conditions likely pre-existing given the short holding time. Histopathology showed no obvious cause of death, although, mortality occurred post freshwater bath treatment. The remaining 2 adults have adapted well to captivity and remain in the population.
Hatchlings from eggs collected from wild	Establishment of captive population	Based on known hatching success rates for the species, a total of 50 eggs were collected with the intended goal of producing 20 hatchlings. Eggs were collected in various stages of development, and by July 2024 all eggs had either hatched successfully or failed. Egg viability was higher than anticipated (26 individuals or 52%, compared with 40% estimated for the wild population (Moreno et al, 2020)). Four individuals have died since hatching (one animal jumped out of the tank prior to lids being installed; one likely from blunt force trauma; one animal from not thriving; and one animal from a likely gastrointestinal blockage
Captive-laid eggs from adult female	Augmenting the captive population and research (planned)	The adult female was examined using ultrasound after capture and determined to have egg cases in the lower oviduct. She laid a pair of eggs the day after introduction to the Taroona facility and has continued to lay eggs at approximately 4-day intervals for the duration of the Program.
Hatchlings from captive-laid eggs from adult female	Augmenting the captive population and research (planned)	Captive laid eggs that have hatched successfully.

5.2. Husbandry goals

Given that Maugean skate have not been previously held in long term captivity, the development and refinement of husbandry SOPs is a fundamental goal of this Program. Therefore, it is expected that husbandry protocols and goals will be continually developed and updated as knowledge of the species grows.

SOPs have been developed by the project team for this Program. All SOPs were reviewed by the Steering Committee, and various useful contributions and suggestions were incorporated.

- Egg collection
- Adult collection
- Strahan temporary holding facility
- Skate transportation
- Adult holding
- Juvenile holding
- Egg rearing
- Maugean skate husbandry
- Life support system and backup facilities
- Acclimation and introduction
- Biosecurity

For a detailed description of current husbandry and holding practices see the individual SOPs.

Transitioning to welfare-based conditions

Initial holding conditions were designed to provide optimal conditions to maximise individual survival and fitness. As such, bare environments, high oxygen concentrations and high-quality nutrition were prioritised.

As the Program progresses, there will be a progressive shift towards the development of a holding strategy that emulates the skate's suitable natural habitat and maximises individual welfare (based on the Five Domains of Animal Welfare best-practice framework). Providing appropriate nutrition, fostering natural behaviours, and maintaining high standards of health and environmental care will improve welfare outcomes and prepare them for eventual reintroduction to the wild or life in a more naturalistic captive environment.

SOPs relevant to animal welfare will be developed in Phase Two of the Program.

This strategy is currently under development and will include the following considerations:

Trigger for implementation	Commencement of Phase 2: Animals are in good physical health, eating regularly, and show no signs of stress.
Timing	Gradual transitions are preferable to minimise the risk of stress-related issues.
Five Domains	
Nutrition	Provide a diet that matches their natural food sources Encourage foraging (including provision of substrates for digging) Monitor health and weight

Environment	Gradual introduction of substrates Water parameters in a range similar to their natural habitat if appropriate
Health	Ongoing health monitoring (especially during transition phases) Preventative care Avoid sudden changes in water conditions, lighting, substrates etc Development of species appropriate formulary
Behaviour	Encourage natural behaviours (burrowing in substrates, foraging etc) Ensure appropriate social conditions without overcrowding Movement is unrestricted - environment should allow for active swimming and natural movement
Mental state	Maximise opportunities for positive experiences, promote positive behaviours and minimise stress through gradual introduction of new conditions Cognitive stimulation through environmental, sensory, and social enrichment, if appropriate

5.3. Facilities

5.3.1. Current

Currently the only facility approved to hold Maugean skate is the research laboratories at IMAS Taroona with another area in Taroona to be online in 2025. These two areas will be serviced by the same staff.

Given the acknowledged risks in holding all animals at one site, one of the Program goals is to identify secondary facilities. Mitigation measures in place to prevent total loss at the Taroona facility are detailed in the SOPs, and summarised below:

- There are a total of four independent Life Support Systems (LSS) in the Maugean skate facility: two systems for the adults and two systems for the eggs/juveniles.
- The sump tanks, flow, salinity and heat chill units (that regulate temperature) are alarmed.
- If one of the adult or egg/juvenile LSS's fails, the second adult LSS can be used as short term back up facility as the systems are independent (see Life Support System and Back Up Facilities SOP).
- If both adult or egg/juvenile LSS's fail or all system's fail, replicas of the Strahan temporary holding facility (see Strahan Temporary Holding Facility SOP) will be set up until the issue can be fixed.
- Biosecurity measures are in place including foot baths, handwashing stations and equipment disinfection (see Biosecurity SOP).

One of the ongoing aims of the project is the identification and development of additional facilities.

Facility	Role	Number of tanks	Maximum capacity	Comments
IMAS Taroona				
Research laboratory (current)	Long-term holding, captive breeding, research, all age classes	2 adult holding tanks @ 3000L, 2.5 m diameter fibreglass round tanks 2 large rectangle 1200 L holding tanks 16 medium holding tanks 8 x small egg tanks/hatchling tanks 2x Flow through round black tanks	12 adults, 320 eggs, 80 neonates OR 84 juveniles stage 1 OR 20 juveniles stage 2	This facility has 4 redundant system feeding tanks of various sizes. For details on stocking densities, tank sizes and system design for this facility see the egg, juvenile and adult holding SOPs.
New skate facility	Long-term holding, captive breeding, research, all age classes, short-term holding and head starting for reintroduction (for future consideration).	2 large holding tanks 2 medium holding tanks 2 large rectangle 1200 L holding tanks 16 medium holding tanks 8 x small egg tanks/hatchling tanks 2x Flow through round black tank	22 adults, 180 eggs, 60 neonates and 60 juveniles	Under construction and expected to be completed by the second quarter of 2025. For details on the maximum holding capacity of this site across various configurations see Appendix A. A separate building with the capacity to house skate is also under construction at the Taroona campus and is expected to be online by 2026.

5.3.2. Future facilities

Holding all animals at a single facility poses significant risks for several reasons. Equipment failure, fires, disease outbreaks and environmental changes can cause a loss of the entire captive population. Further, distributing animals across multiple facilities helps spread risk to ensure a more sustainable breeding program. Partnerships and coordination between facilities involved in captive breeding should be carefully managed, along with input from a studbook coordinator to ensure the genetic health and long-term viability of the species across the entire metapopulation.

As the captive population grows it is essential to proactively plan for future facility requirements to ensure sufficient capacity and effective population management. With robust biological and

demographic data available, it is possible to project population growth over the next 5 to 10 years to provide critical insights into capacity limits, space requirements, and the potential need for additional facilities. By anticipating future needs, facility expansion can be strategically aligned with population growth, ensuring that infrastructure supports both animal welfare and the long-term objectives of the captive breeding program.

Maugean skate is a micro-endemic species only found within Tasmanian state waters. Accordingly, the captive conservation work for the species is conducted within Tasmania if possible. Movement of individuals to interstate facilities will be subject to legislative approvals and will be informed by the Tasmanian Flora and Fauna Translocation Policy.

5.4. Reproductive and behavioural management

Planned housing arrangements	There is a large number of individuals in the captive population due to the unanticipated number of hatchlings from fertile eggs laid by the female since she has been in captivity. Accordingly, group housing is the only existing choice as there is insufficient space to allow individual housing. To help avoid unwanted mating, adults and individuals nearing maturity will be housed in single sex enclosures. Mixed sex individuals will only be held together for breeding purposes. See Demographic management strategy for further detail.
Reproductive challenge/s identified	Given the difficulty of managing female sperm storage and parthenogenesis, molecular monitoring will be conducted for all new hatchlings in the Program as a secondary control to ensure that parthenotes are not recruited to the captive adult breeding population. Females will lay eggs with or without males and any eggs laid should be monitored for development.
Single sex groups can be housed together without significant welfare concerns	To be determined. Based on observations to date (and not including a single bite observed during mating behaviours), there are no agonistic or competitive dynamics between individuals housed together] regardless of sex or size. Therefore, new hatchlings are currently housed in mixed sex groups with similar aged individuals. This may change with maturity. Facility set up allows for multiple combinations of animals to be achieved in the event of agonistic behaviours being observed. Housing of single-sex groups of adults was attempted when animals were first brought into the Program but has not been possible since given the deaths of 1:1 in December 2023.

See demographic and genetic management sections for further detail.

5.5. Health management

- Health assessments of all individuals are conducted routinely at various intervals (see egg, adult, and juvenile holding SOPs for details).
- Behaviour is assessed three times a day for each individual. Body condition is assessed and recorded regularly.
- All life support systems (existing and planned) have flow through tanks where individuals can be isolated or quarantined for an indefinite period if needed.

- If there are any abnormal observations, the animal(s) is moved to an isolation tank and the veterinary team is contacted to make an assessment.
- Individuals are kept separate during treatment and recovery.
- A detailed written and electronic record of all interventions is kept.

6. CAPTIVE POPULATION MANAGEMENT

6.1. Captive management goals

Given that Maugean skate are new to captivity, targets presented here assume a scenario where: "Species is not yet capable of self-sustaining in captivity" (Ballou et al, 2010).

The primary goal during the first phase of the Program was to build a strong knowledge base on the husbandry, genetic structure, and demographics of the Maugean skate in captivity. As knowledge of the species progresses, the objectives and methods will be adjusted to meet the Program goals. If reliable breeding can be established, management will instead assume a scenario where: "Rare species being propagated for release into natural habitat" (pending development of a release strategy).

6.1.1. Genetic goals and management thresholds

Genetic Diversity (GD)	Represent > 90% of existing wild genetic diversity in the captive population (for the wild population, current heterozygosity= 0.27 and allele richness=1.94). Observed (0.27) and expected (0.29) heterozygosity is not statistically distinct. Maintain at least 95% of wild-sourced genetic diversity (heterozygosity and allele richness) over the 10-year duration of the Program (Ballou et al, 2010)
Mean inbreeding coefficient	Maintain population inbreeding coefficients below 0.125 (values over 0.125 are considered highly inbred populations) and individual inbreeding coefficients below 0.2.

6.1.2. Demographic goals and management thresholds

Demographic Goals	• Establish and maintain a demographically viable, stable captive population at the size required without generating unwanted surplus. • Maintain a balanced population structure. i.e. balanced sex ratio. Initially the population's age structure will be biased towards younger individuals due to the primary collection strategy relying on eggs. As the project progresses and breeding pairs are established, a shift towards a more common triangular age distribution is anticipated. • Identify captive animals suitable for re-introduction, the criteria for this will be determined at a later date once research has been undertaken on the best translocation methods to use.
Population size	Sustain at target size to maintain demographic and genetic goals, as determined once demographic and genetic analysis has been completed.

Juvenile mortality	Aim for below 10% (AEC A29717) (Ballou et al, 2010).
Natural hatching success rates for wild collected eggs	Aim to match or exceed 40% (Moreno et al, 2020)
Natural hatching success rates for captive laid eggs	Aim to match or exceed 40% (Moreno et al, 2020)
Collection of additional founders	This will be determined based on demographic analysis, genetic analysis, delineation of a release strategy, and facility increases (either in the capacity of current facilities, and/or additional of new facilities).
Number of eggs allowed to hatch from a single female	The current Tasmanian Government position is that the destruction of eggs with confirmed viable embryos cannot be used as the default method of population management unless all other reasonable strategies have been explored. The Australian Code for the Care and Use of Animals for Scientific Purposes (2013) states that '*As a guide, when embryos, fetuses and larval forms have progressed beyond half the gestation or incubation period of the relevant species, or they become capable of independent feeding, the potential for them to experience pain and distress should be taken into account*'.
Size of stock for release	To be informed by a translocation/ release strategy.
Number of individuals and number, frequency and timing of releases	To be informed by release strategy.
Number of breeding recommendations per year	This will be determined based on demographic analysis and genetic analysis, total program capacity, and the number, frequency and timing of releases.

6.2. Current demographic and genetic summary of captive population

Current captive population (as of 9 February 2025)	○ 1 adult female collected from the wild (~7 yo) ○ 1 adult male collected from the wild (~6 yo) ○ 22 juveniles hatched from wild collected eggs (M=13, F=9, ages = 6-13 months) ○ 207 eggs laid in captivity ○ 46 juveniles hatched from captive laid eggs (M=21, F=25, ages= <4 months) ○ 118 unhatched eggs (93 confirmed fertilised, 16 wind eggs, 13 not developing, 8 damaged).
Sex ratio	1:1 (M:F)
Fertility (based on one single female)	○ % fertile eggs (including non-hatched) = 70%* ○ % of hatched eggs = 25% (as of February 2025) ○ Number of eggs produced by female = 207 (cycle ongoing)

	*as at 9/2/25, does not include potential parthenotes
Wild and captive inbreeding coefficients (FH)	Analysis is ongoing using reduced representation data (DArTseq). Raw sequence data is stored with IMAS. Current estimates of wild population inbreeding F_H=0.04-0.07
Relatedness within captive population	In-progress
Captive population Ho, Ne, and individual inbreeding coefficients	In-progress
Representation of founders of wild genetics	In-progress
Genomic based pedigree	In-progress
Average MK	Pending studbook development
GD	Pending studbook development
FGE	Pending studbook development
Observed heterozygosity of founders	Pending integration of molecular relatedness of founders
Average MK of founders	Pending integration of molecular relatedness of founders
Inbreeding of founders (FH)	Pending integration of molecular relatedness of founders
GD wild source represented in descendant breeding population	Pending integration of molecular relatedness of founders
Genetic Management	A suitable strategy will be selected once more information is available regarding the reproductive characteristics of the species and potential ontogenetic changes in behaviours that might affect housing groupings.
Primary Genetic Management Strategy	**MK - Pair animals with similar and low Mean Kinship** This approach relies on the estimation of relatedness between all individuals as well as individual genome uniqueness. These metrics can be used to derive the genetic value of individuals and inform breeding recommendations (Ballou et al. 2010). This is typically used for one-to-one pairings or in group situations where parents can be allocated using genetic pedigrees. This is the preferred approach for the Program. OR **MAI - Maximum avoidance of inbreeding** This approach permits generational breeding in a group housed scenario (Wright 1981). This may be particularly useful if a rotational breeding scheme is implemented (see below).

6.3. Ability to collect individuals from the wild

While there are no immediate plans to collect further Maugean skate individuals from the wild, there are various reasons why the project team may decide to do so in the future to help reach

the demographic and genetic targets of the captive management program (see 6.1 Captive management goals). These may include:

Reason for additional collection	Trigger point(s)
Collection of additional potential founders (determination pending final analysis of the current genetic structure of the captive population).	Insufficient genetic diversity in the captive population Insufficient breeding aged animals in the captive population to maintain program objectives A loss or sudden decline in the captive population due to catastrophic or deleterious events Population structure does not provide assurance of viable breeding program in the event of a catastrophic event in wild population
Collection of adult individuals for rotational breeding schemes.	If agreed to be a suitable strategy for the Program
Captive rearing of wild eggs and head starting (whereby eggs or juveniles are collected from the wild, raised in captivity and subsequently released into the wild).	If agreed to be a suitable strategy for the Program High egg/juvenile mortality in the wild limiting natural recruitment
Research, including assisting with monitoring of post release survivorship and genetic effects of introduced captive individuals on the wild population.	Insufficient number of captive animals to allow necessary research to achieve program objectives Removal of captive animals for research would disrupt breeding plans or reduce genetic diversity Captive animals not representative of wild counterparts for specific research needs (e.g. disease prevalence, natural behaviours, effectiveness of reintroduction strategies).

Any further collections will continue to be informed by demographic analysis and follow UTAS Animal Ethics, Biosecurity Tasmania, legislative permit approvals and updated SOPs incorporating learnings from previous collections. To this end, a demographic model of the population will continue to be updated using information from the ongoing population monitoring program, as well as any updated research on the species life-history and biology.

6.4. Genetic management strategy

- Pedigree-based strategies are most effective for managing captive breeding. The underpinning assumption of pedigree-based management is that all founders are unrelated which is not possible in micro-endemic endangered species that have experienced significant population declines in a short period of time. To combat this, molecular genetic data can be used to provide relationships of founding individuals that

can under-write the pedigree-based strategy for a captive management program (Hogg et al 2019; Galla et al 2019). Early results suggest that there are 15 unique family groups represented in the potential founders. Analysis is ongoing with next steps focusing on constructing a studbook and calculating a kinship matrix.

- Animals currently held in captivity that were hatched from wild collected eggs will be used in captive breeding along with additional founding individuals required to maintain the genetic diversity target.
- Breeding recommendations based on MK strategy will be generated using PMx. The number of breeding recommendations and size of stock for release to be determined after delineation of a release strategy.

6.5. Demographic management strategy

Individual identification	Currently identification is undertaken manually using photos of body patterns taken throughout the holding period. This manual process will eventually be replaced by computer assisted pattern recognition (I3S Classic and pattern image recognition software) (in development). There is also genetic analysis of tissue samples (implemented).
Stocking density	Holding conditions (including stocking density and enclosure design) aim to maintain individual welfare and enable/manage breeding. All enclosures and facilities are subject to the thresholds set by animal ethics and permitting conditions.
Housing	Juveniles will be housed and managed by cohorts to ensure that animals were housed with others of similar sizes to help mitigate potential detrimental social interactions, with a different strategy considered if adverse behavioural observations warrant a safer or more appropriate configuration (see Reproduction and behavioural management section for details). To help avoid unwanted mating pairings, adults and individuals nearing maturity will be housed in single sex enclosures. Sexually mature males and females will only be held together for breeding purposes. In the wild, males mature at 4-5 years old and females 5-6 years old. Hormone production and development of secondary sexual characteristics is expected to begin a few months before so animals would be moved to single-sex housing halfway through their third year, before the males begin puberty. If signs of accelerated maturity are observed, the timeline will be adjusted accordingly. Assisted reproduction techniques such as artificial insemination (AI) are being developed as part of this project and may be used as an additional way to manage breeding. Early growth rates will be combined with historical age and growth data (Awruch et al, 2021) to model projected growth rates and manage ongoing housing as individuals develop.
Housing of mated females	Once mating has been confirmed, females will be housed separately to ensure parentage of developing embryos can be determined.
Reproductive challenge/s identified	Given the difficulty of managing female sperm storage and parthenogenesis, molecular monitoring will be conducted for all new hatchlings (currently at 2 months post hatching) in the Program as a secondary control to ensure

	parthenotes or genetically overrepresented offspring are not included in captive breeding activities. Genetic analysis will inform an individual's role in the Program, so sampling as early as possible is desirable.
Single sex groups can be housed together without significant welfare concerns	To be determined. Based on observations of a very limited number of life stages to date, there are no agonistic or competitive dynamics between individuals housed together regardless of sex or size. Therefore, new hatchlings are currently housed in mixed sex groups with similar aged individuals. Housing of single-sex groups of adults has not yet been attempted for more than several weeks.
Assessment of reproductive status of individuals	Maugean skate in the wild reach sexual maturity at 5-6 years of age. However, in captivity some elasmobranchs may reach maturity faster than in the wild. Assessment of the reproductive status of the species can be accurately accomplished by monitoring secondary sexual characteristics (claspers and ovaries) (Bell et al., 2016). As such, although the current juvenile population is not expected to reach maturity for some years, maturation is being carefully monitored and recorded.
Disease load	Veterinary screening of individuals coming into the captive population to determine baseline disease load of the wild population.

6.5.1. Potential alternate captive management strategies

If genetic monitoring of the captive population shows that the Program's genetic and demographic targets are not being met (to be determined and discussed by the Steering Committee in consideration of the annual program report), alternative strategies may be considered where possible (see below). This plan should be fully re-evaluated after 5 years (December 2028), and reviewed annually or sooner if triggers are met or new information becomes available.

Additional strategies to support breeding management will be developed alongside the measures outlined above, including germ cell cryo-banking, assisted reproduction, and surrogacy. This may be in conjunction with future relevant in-situ work. Considering the learnings of Phase 1 of the Program, various strategies have been identified that could be implemented in isolation or in combination to increase the effectiveness of the Program (all require further development and research):

- **Cryo- aided life conservation schemes** - Cryo-preserving genetic material (semen (short-term only) and germ cells) from all founding and first-generation animals can function as a redundancy in case of catastrophic loss. In combination with artificial insemination, stored material can be integrated into the mating structure. If genetic drift or genetic depression occurs, the original preserved material can be used to relieve the inbreeding or select against specific undesired traits. IMAS have successfully developed protocols for sperm and germ cell cryobanking and are working to develop protocols for AI.
- **Headstarting** (collecting eggs from the wild, raising them in captivity, and then releasing them) - Considering the high vulnerability of eggs to variable environmental conditions in Macquarie Harbour and the apparent lack of recruitment seen over the past 10 years,

captive rearing of wild collected eggs to be released after hatching could be a viable strategy to improve recruitment. In many egg laying species, early developmental stages (including eggs) tend to have a much higher mortality rate (Loktionov et al, 2023) so providing protection during these critical phases may improve survivorship of reintroduced animals. Given that eggs have modest space requirements, this could be a cost-effective way to reinforce recruitment in the wild population through a head starting program.

- **Rotational breeding schemes** - Captive fecundity rates for the species appear to be higher than in the wild. During a cycle, females in captivity appear to be able to lay a pair of eggs in short succession (2-7 days) for a prolonged period. While avoiding over-representing the genetic contribution of a single individual, by temporarily holding a small number of females and rotating them, it may be possible to establish a consistent influx of eggs for captive rearing or release in a cost-effective way. This strategy could be used as an interim strategy to supplement the wild population while the captive population reaches sexual maturity and becomes self-sustaining.
- **Broodstock surrogacy** - This developing technique can be adapted to applications for ex-situ threatened species conservation. Fundamentally, undifferentiated germ cells from an endangered species are transplanted into a closely related surrogate species, enabling the production of viable gametes (and offspring). Early work by IMAS has demonstrated the ability to isolate, cryopreserve and xenotransplant primordial germ cells (pGCs) successfully in skate including Maugean skate pGCs transplanted into surrogate species. IMAS is currently working on verifying gametogenesis in transplanted cells. Further development of this technology can help improve captive management program effectiveness by reducing the risk to the wild population, reduce the effective generation interval, and support conservation of genetic resources. Additionally, this technique can act as and insurance against catastrophic declines in the wild population. Behara (2024) provides further information on this technique.
    - Full assessment of the applicability, benefits and risks of this approach would be required before this technique would be considered as part of the captive management strategy.

7. RELEASE STRATEGY

[**NB:** The following is still in development and represents a future phase in the Program but requires consideration for preparing skate for release. It will be updated accordingly in line with Tasmanian Translocation Policy or under advice from the Tasmanian translocation Technical Assessment Panel]

The fundamental goal of the Program is to use the captive population to supplement recovery of Maugean skate in the wild. However, there are significant knowledge gaps to address before a release strategy can be formulated, including those identified in 9. Knowledge gaps. The release strategy will be developed in accordance with the Tasmanian Flora and Fauna Translocation Policy and the IUCN Guidelines for Re-introductions and Other Conservation Translocations (IUCN, 2013).

Reintroduction/translocation will be contingent on the Tasmanian Flora and Fauna Translocation Policy, and regulatory and biosecurity approval from relevant Tasmanian authorities. Permits will be required under the *Nature Conservation Act 2002* and the *Threatened Species Protection Act 1995* for all translocation activities.

Table: Triggers/thresholds for translocation planning and implementation

Target wild population characteristics before releases start	**To be determined**
Mitigation of threats in the wild	Recent declines in the wild population have coincided with degradation of environmental conditions in Macquarie Harbour. These have also been highlighted as a likely driver of reduced recruitment. Therefore, it is crucial that environmental remediation work be conducted alongside building of the captive managed population. Measures to mitigate threatening processes are outlined in the Conservation Advice (Commonwealth) and Conservation Action Plan (Tasmania). Prior to release, environmental thresholds for reintroduction should be defined and observed. Ongoing monitoring will be necessary to ensure that conditions remain within these thresholds through the life of the project. Research into environmental thresholds and metrics is needed to assess appropriate conditions in Macquarie Harbour for release.
Preparation of 'harbour-ready skate'	**To be determined**. Research is required to understand how holding and rearing conditions will affect the ability of released individuals to cope with natural conditions in Macquarie Harbour (low dissolved oxygen, variable salinity, limited prey availability). A veterinary screening strategy prior to release is also required to minimise risk of disease spread to wild population should also be developed.
Release locations	**Macquarie Harbour -** Maugean skate in Macquarie Harbour constitute the only known extant population of the species. Therefore, reintroduction into this critical habitat should be the primary focus of any strategies. **Other locations -** Suitability of other locations to be determined. Translocation to alternate sites may be possible and could help increase the

	species' resilience to localised environmental impacts. However, a significant amount of research would be required to assess the suitability of Bathurst Harbour or any other potential sites. As such, this research should be considered as a concurrent objective and release to alternate sites should not be seen as an alternative to, but rather adjunct to, Macquarie Harbour.
Number of animals in cohort for release	**To be determined.**
Sex ratio and age distribution of release cohort	**To be determined.** It will be important to determine what the optimal stage of development, number of individuals, and demographic characteristics of a release stock will be. Pilot release trials could be conducted to gain an understanding of post release survivorship.
Monitoring strategy	**To be developed.** These should be reliable, low cost and viable at various time scales. Solutions will likely include acoustic tracking, genetic monitoring and tag recapture studies. The effects of released individuals on the wild population will have to be monitored and modelled to design an appropriate release schedule and manage long term demographic and genetic impacts (Willoughby et al, 2018).
Measures of success	Short- and long-term metrics of success will have to be outlined to manage the release strategy.
Adaptive management framework	The final strategy should have an adaptive framework that can incorporate various strategies
Releases to support research activities	As key research is identified, consideration is to be given to potential benefits of the research against the benefits of maintaining animals in captivity – advice should be sought from the Captive Breeding Steering Committee and the Recovery Team, but final decisions remain with the legislative authority.

8. EXIT STRATEGY

The ultimate conservation goal is that no augmentation to the wild population is required to maintain a healthy population of Maugean skate. Any expansion of the captive program needs to be staged, orderly based on clear measurable triggers and reversable.

This program has already established that Maugean skate can be housed in captivity. Phase 2 will help understand if ex situ management options can be reliably used to aid in the conservation of the species. The conclusion of this phase of work marks a natural point to re-evaluate the viability and direction of the Program.

If this Program is successful, and based on the life history of the species, conservation goals and characteristics of the population, it is expected that this Program would have a 10-year duration, although the life of the Program may be extended or shortened depending on the status of the wild population. Funds to continue this work to the completion of the Program have not yet been identified.

The fate of individuals in the captive population at the end of the Program will be determined under the authority of the Tasmanian legislative framework and in consultation with funding partners. The decision to upscale or downscale the Program must be based on a careful assessment of the species' conservation needs and available resources.

A number of triggers may initiate management strategies to upscale or downscale/end the Program. The below are initial :

Trigger point	Action
Upscaling	
The current captive population becomes genetically at risk (e.g., GD thresholds not met, inbreeding depression or genetic bottlenecks) and requires more individuals to restore diversity.	Introduce more breeding pairs to the Program, ensuring that genetic diversity is maintained or improved. Identify underrepresented genetic lines and prioritize breeding from those lines to prevent inbreeding. Identify and implement strategies to reduce breeding of descendants from over-represented genetic lines.
Improvement in wild habitat results in opportunity to release a significant number of animals into the wild, requiring more animals to be bred and prepared for release.	Increase the number of offspring to be raised and prepared for release or translocation. Prepare animals for reintroduction (e.g., soft release techniques, conditioning, acclimation).
The wild population of the species experiences a significant decline or crash	If the wild population is unlikely to recover in the short term, continued reliance on the captive breeding program may be necessary to maintain a genetically viable population and to support future reintroductions or supplementation. Focus on preventing genetic bottlenecks in the captive population by increasing genetic diversity through new breeding pairings

	If necessary, employ assisted reproductive technologies to optimize breeding success and preserve genetic diversity in the captive population. Conduct rapid assessments of wild habitat to determine whether captive animals can be safety reintroduced, including a determination of the capacity of Macquarie Harbour. Continue to prioritise habitat restoration as part of the overall recovery strategy.
Downscaling	
Significant improvements in the species' population status in the wild, or in their habitat reducing the need for captive breeding	Gradually reduce the number of breeding pairs and individuals, focusing only on essential maintenance of genetic diversity or care for individuals that are not suitable for release. Shift focus to monitoring the wild population, including tracking survival rates, reproduction and capacity. If the wild population is stable and self-sustaining, consider gradually phasing out the breeding program entirely.
Insufficient space and infrastructure	Temporarily or permanently halt breeding to stop the production of surplus offspring. Relocate animals or downscale the breeding program to fit within current infrastructure. Prioritise the maintenance of a core breeding group with optimal genetic diversity, phasing out animals that are not essential to the breeding program.
Population becomes genetically unhealthy due to inbreeding or a limited gene pool, leading to health concerns and reduced fertility.	If certain genetic lines are overrepresented, reduce or end breeding from those lines to prevent further inbreeding. Slow down breeding efforts and shift focus to the health and genetic viability of the current population.
Loss or reduction of funding	Focus on essential activities, such as maintaining genetic diversity and animal welfare, and cut non-essential activities. Actively pursue other funding sources to support the Program's core needs.

9. KEY KNOWLEDGE GAPS

Several key knowledge gaps and areas for future research have been identified, noting that multiple approaches may be needed to address these gaps and further discussions required. This list will be regularly reviewed, updated and prioritised with advice from the Steering Committee and/or Recovery team if appropriate.

- Re-introduction potential of the species. There is a critical need for research (e.g. physiology, population genetics, transcriptomics) to optimise husbandry conditions for acclimation/re-introduction and understand what the ideal points in the life history of individuals are to ensure successful introduction to a wild habitat.
- Integrate genomics and demographic data to model recovery potential of the species and inform long term ex situ goals using stochastic individual based simulations. There is a growing body of work showing that small populations in long term isolation and historically low population sizes have unique mechanisms that allow them to purge very detrimental alleles despite low genetic diversity. If population size is increased too much through supplementation, models suggest that this could have unintended detrimental consequences that may hinder recovery (Robinson et al. 2022). Given that Maugean skate have genetic and demographic characteristics that are consistent with those traits, this type of modelling may be helpful for understanding risk and long term recovery. The parameterisation of this model, its structure will need to be carefully constructed and reviewed.
- Post release survival and reproduction
- Environmental thresholds and metrics to assess conditions in Macquarie Harbour for release.
- Patterns of multiple paternity, fertility, hatchability and parthenogenesis in the species.
- Natural mortality rates of developing embryos (e.g. via predation), juveniles and adults in the wild. For juveniles, this may be achieved through mark recapture studies. Close Kin Mark Recapture studies currently underway may provide adult mortality rates.
- Post release mortality rates for captive-reared animals released through the captive management program. Effectiveness of other in-situ actions that may reduce or negate the need for supplementing the wild population.

10. PROGRAM RISKS

In addition to the risks identified in 8.

EXIT STRATEGY section, broader risks to the Program will be identified in a standalone Risk Assessment and Mitigation Report.

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Glossary

Breeding pathfinding –Establishing if captive breeding in the species is possible and, if so, research and development of the conditions (holding, social, environmental) that may enable reliable breeding.

Current Gene Diversity (GD) – The proportional gene diversity (as a proportion of the source population) is the probability that two alleles from the same locus sampled at random from the population will not be identical by descent. Gene diversity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating, and if the population were in Hardy-Weinberg equilibrium.

Founder – Wild-caught individual that contributes genetically to the captive population.

Founder Genome Equivalents (FGE) – Number of equally contributing founders that would have produced the same genetic diversity found in an existing captive population if there had been no random loss of founder alleles. The gene diversity of a population is 1 - 1 / (2 * FGE).

Heterozygosity - Average proportion of loci that are heterozygous (have two different alleles in an individual) in a population.

Inbreeding Coefficient (F) – Probability that the two alleles at a genetic locus are identical by descent from an ancestor common to both parents. The mean inbreeding coefficient of a population will be the proportional decrease in observed heterozygosity relative to the expected heterozygosity of the founder population.

Mean Kinship (MK) – The mean kinship coefficient between an animal and all animals (including itself) in the living, captive-hatched population. The mean kinship of a population is equal to the proportional loss of gene diversity of the descendant (captive-hatched) population relative to the founders and is also the mean inbreeding coefficient of progeny produced by random mating. Mean kinship is also the reciprocal of two times the founder genome equivalents: MK = 1 / (2 * FGE). MK = 1 - GD.

Maximum Avoidance of Inbreeding Strategy – A strategy under which individuals with a group are treated as genetically indistinguishable. Founding groups are treated as genetically unique. Single sex migration is managed between groups.

Reintroduction - Releasing individuals of a species into an area where that species no longer occurs in an effort to reestablish a wild population. Reintroduced individuals may be captured from a healthy wild population in another area or may be derived from a captive population if there are no healthy wild populations remaining.

Studbook - List of all the living and dead individuals in a captive population that contains information on the mother, father, date of birth, location, and other topics for each individual.

Translocation - the deliberate movement and release of plants, animals or fungi into the wild for conservation purposes.

Appendix A: Stocking density plan for Taroona existing and planned facilities

Maugean skate population stocking plan

Projected individual growth

Adult growth rates in the wild (modelled)

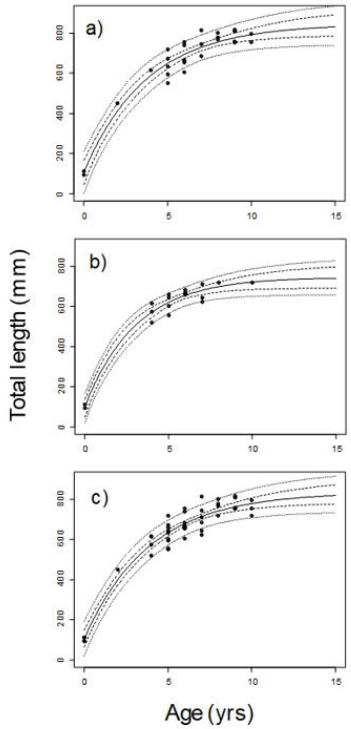
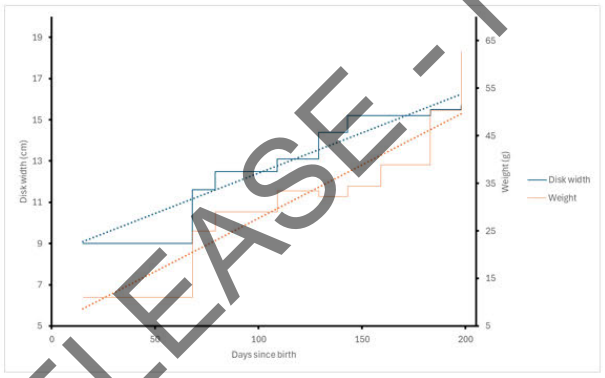


Fig. 1. Estimated growth for observed data based on vertebral age estimates of (a) female, (b) male and (c) pooled female and male Maugean skate (*Zearaja maugeana*). Model shown is the best ranked for each dataset (-) 95% confidence intervals (- -) and prediction intervals (···)

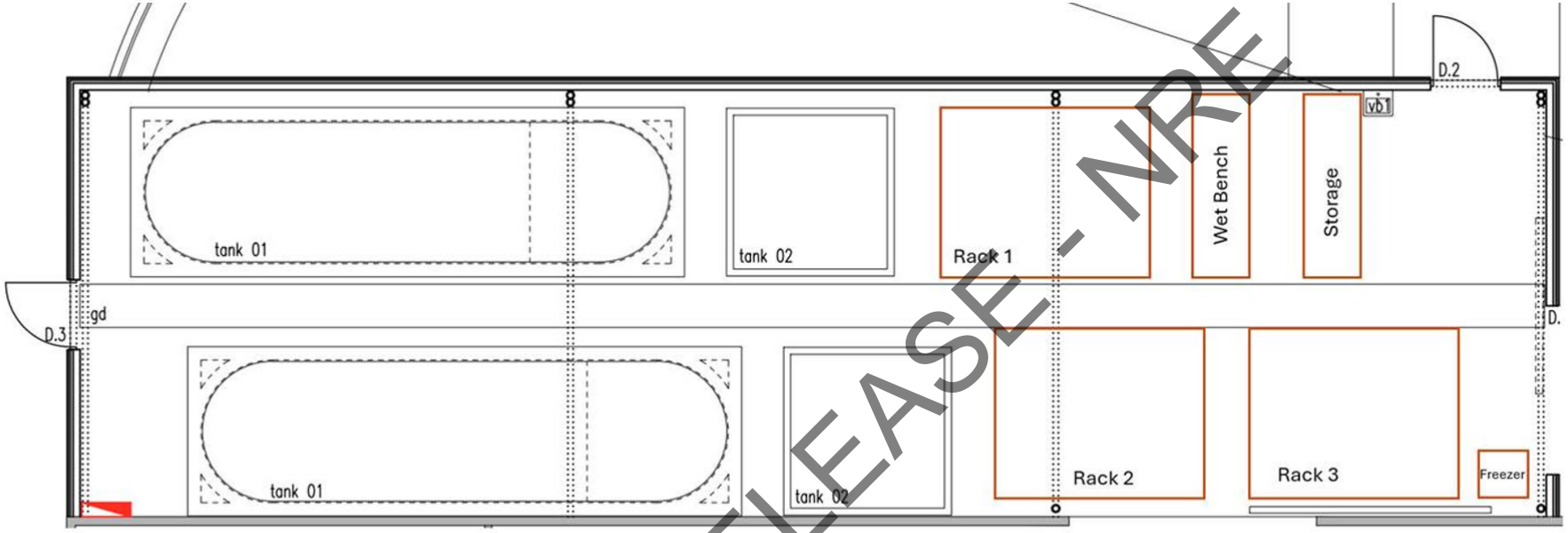
Juvenile growth in captivity (observed)



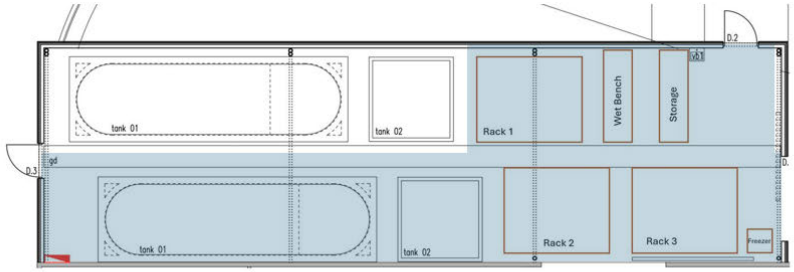
	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

New facility

Maugean skate ex-situ facility IMAS Taroona



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

Large system (X2)

- Config 1 (Adult holding):
  - 1 Large holding tank
  - 1 Isolation / Quarantine tank

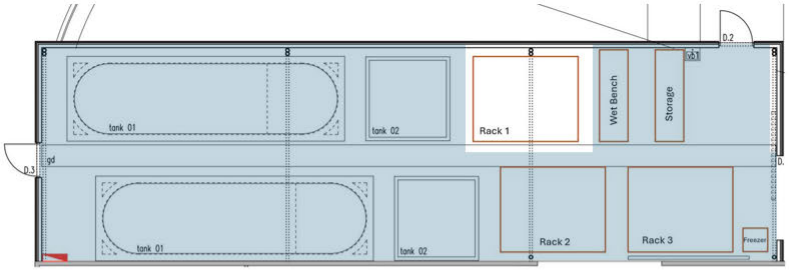
Captive breeding, long term adult holding

	Eggs	
	Neonates	
	Juvenile stage 1	
	Juvenile stage 2	
	Adult	10+1

- Config 2 (Adult / Juvenile mixed holding):
  - 1 Large holding tank divided in 3
  - 1 Medium holding tank

Long term juvenile holding, acclimation for reintroduction

	Eggs	
	Neonates	
	Juvenile stage 1	Up to 40
	Juvenile stage 2	Up to 20
	Adult	Up to 11



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

Modular rack systems (X3)

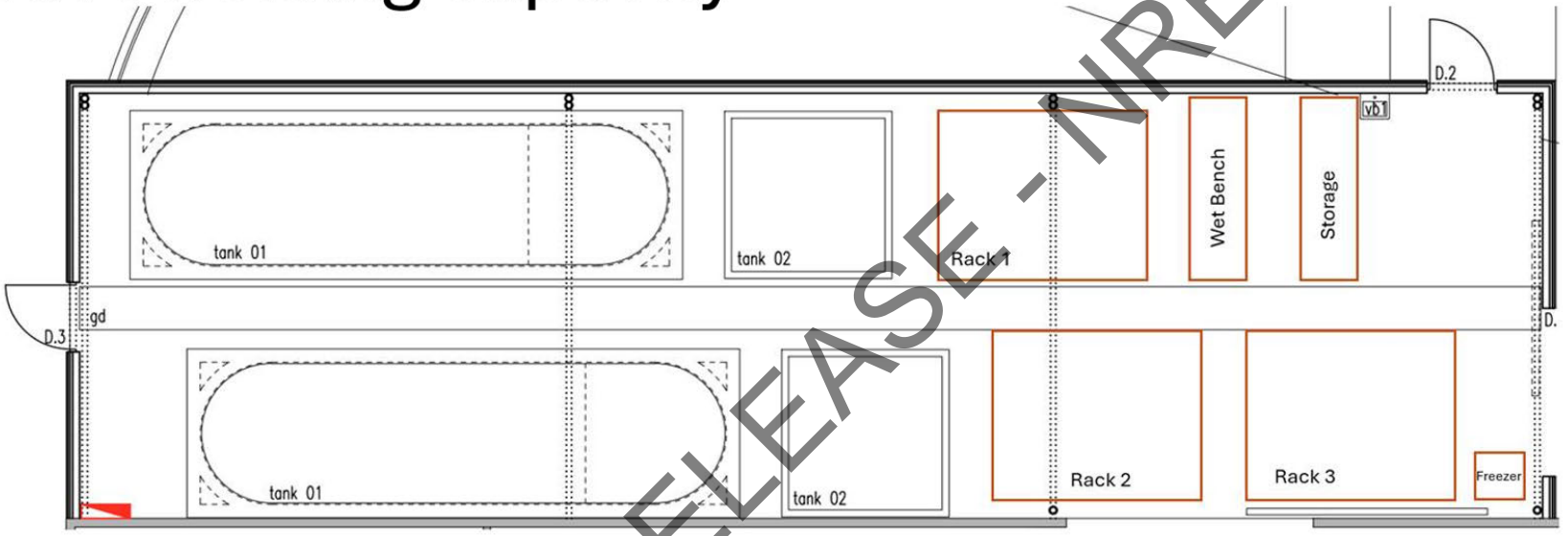
- Base configuration (Mixed age holding):
  - 8 small egg tanks
  - 4 neonate tanks
  - 4 stage 1 tanks
  - 2 stage 2 tanks

Long-term holding for insurance population
Acclimation / conditioning for reintroduction

** Tank configuration can be adapted to account for growth and demographic changes in the insurance population*

	Eggs	Up to 60
	Neonates	Up to 20
	Juvenile stage 1	Up to 20
	Juvenile stage 2	Up to 10
	Adult	

Captive holding capacity

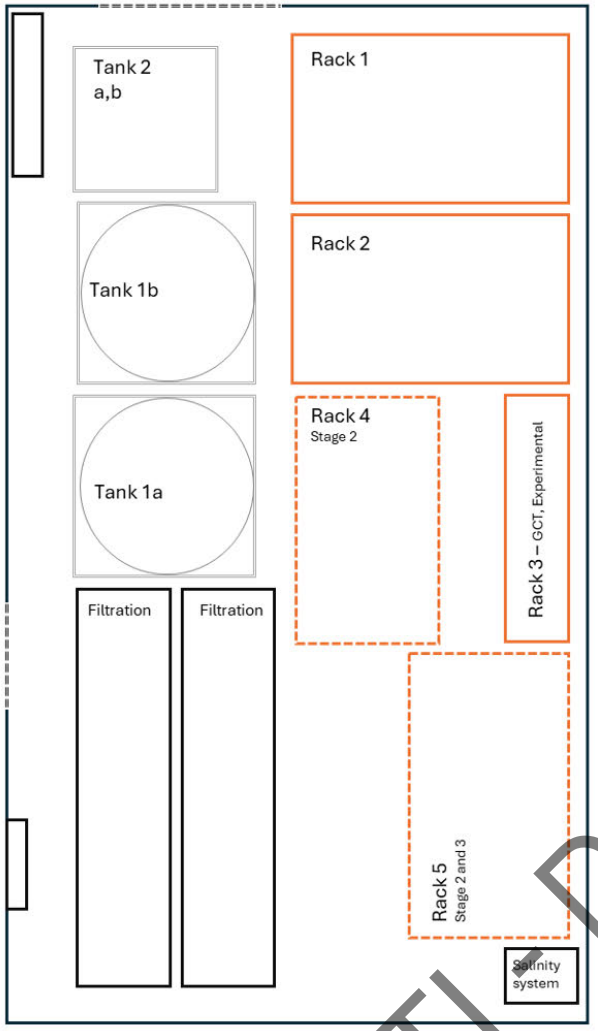


	Eggs		7 month gestation	180
	Neonates	Birth – 20 cm TW	9 – 12 months	60
	Juvenile stage 1	20cm-30 cm TW	~2 years	30
	Juvenile stage 2	30cm-48 cm TW	~3 years	30
	Adult	>48 cm TW	4 – 5 years	22

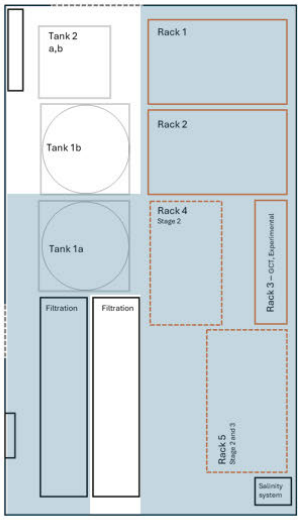
** Max occupancy of base configuration for long-term holding. Tank configuration can be adapted to account for growth and demographic changes in the insurance population*

Current facility

Eco-physiology laboratory IMAS Taroona



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

Large system (X2)

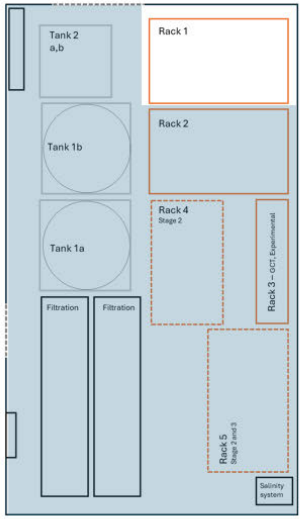
- Config 1 (Adult holding):
  - 1 large round tank
  - 1 quarantine tank (flowthrough)

Captive breeding, long term adult holding

	Eggs		
	Neonates	Birth – 20 cm TW	
	Juvenile stage 1	20cm-30 cm TW	
	Juvenile stage 2	30cm-48 cm TW	
	Adult	>48 cm TW	5+1

- Config 2 (Adult/ juvenile mixed holding)
  - 1 large round tank
  - 1 large juvenile holding tank

	Eggs		
	Neonates	Birth – 20 cm TW	
	Juvenile stage 1	20cm-30 cm TW	up to 10
	Juvenile stage 2	30cm-48 cm TW	or up to 5
	Adult	>48 cm TW	+ 5



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

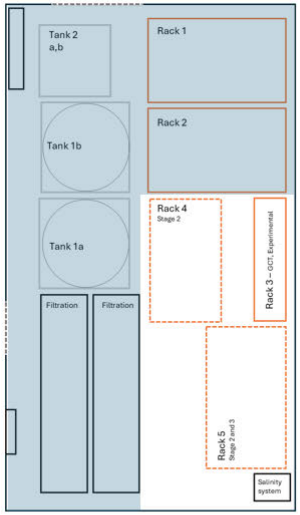
Modular rack systems (X2)

- Base configuration (Mixed age holding):
  - 8 small egg tanks
  - 4 medium tanks

Long-term holding for insurance population
Acclimation / conditioning for reintroduction

	Eggs		Up to 80
	Neonates	Birth – 20 cm TW	+Up to 20 …
	Juvenile stage 1	20cm-30 cm TW	Or up to 12
	Juvenile stage 2	30cm-48 cm TW	
	Adult	>48 cm TW	

** Tank configuration can be adapted to account for growth and demographic changes in the insurance population*



	Eggs		7 month gestation
	Neonates	Birth – 20 cm TW	9 – 12 months
	Juvenile stage 1	20cm-30 cm TW	~2 years
	Juvenile stage 2	30cm-48 cm TW	~3 years
	Adult	>48 cm TW	4 – 5 years

Modular rack systems – GCT/ experimental (X1)

- Base configuration (Mixed age holding):
  - 2 medium tanks

Long-term holding or experimental acclimation / conditioning for reintroduction

	Eggs		Up to 40
	Neonates	Birth – 20 cm TW	Up to 10
	Juvenile stage 1	20cm-30 cm TW	
	Juvenile stage 2	30cm-48 cm TW	
	Adult	>48 cm TW	

Modular rack systems – stage 2 (X1) *(under construction)*

- Base configuration (Mixed age holding):
  - 4 medium tanks

Long-term holding

	Eggs		Up to 80 …
	Neonates	Birth – 20 cm TW	or up to 20
	Juvenile stage 1	20cm-30 cm TW	or up to 12
	Juvenile stage 2	30cm-48 cm TW	
	Adult	>48 cm TW	

Modular rack systems – stage 2/3 (X1) *(under construction)*

- Base configuration (Mixed age holding):
  - 2 large tanks

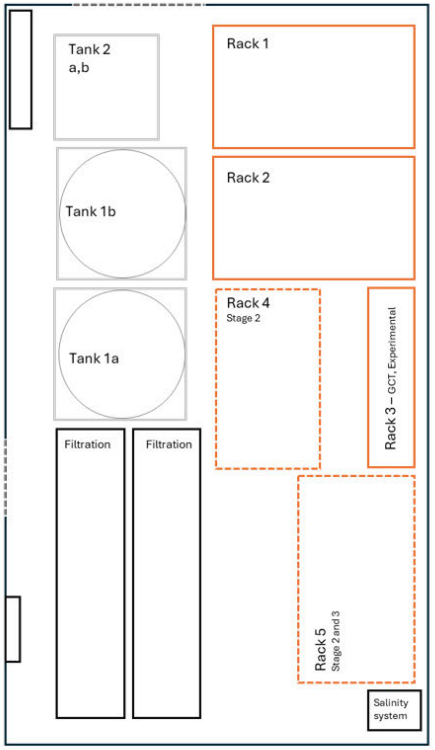
Long-term holding

	Eggs		
	Neonates	Birth – 20 cm TW	
	Juvenile stage 1	20cm-30 cm TW	up to 20 …
	Juvenile stage 2	30cm-48 cm TW	or up to 10
	Adult	>48 cm TW	

** Tank configuration can be adapted to account for growth and demographic changes in the insurance population*

Captive holding capacity

(Max occupancy of base configuration for long-term holding. Tank configuration can be adapted to account for growth and demographic changes in the insurance population)



Existing infrastructure

	Eggs		7 month gestation	160
	Neonates*	Birth – 20 cm TW	9 – 12 months	40
	Juvenile stage 1*	20cm-30 cm TW	~2 years	Or 44
	Juvenile stage 2*	30cm-48 cm TW	~3 years	Or 10
	Adult	>48 cm TW	4 – 5 years	10

Planned additional capacity

	Eggs		7 month gestation	160
	Neonates*	Birth – 20 cm TW	9 – 12 months	40
	Juvenile stage 1*	20cm-30 cm TW	~2 years	Or 40
	Juvenile stage 2*	30cm-48 cm TW	~3 years	Or 10
	Adult	>48 cm TW	4 – 5 years	2

** These life stages use the same space, so the number of each stage is dependant on the number of the other two life stages*

Background notes for the Recovery Team

As a registered Recovery Team, we are required to provide an annual report on progress to DCCEEW. To assist with this, we have prepared a draft version of the report. We have taken on board Recovery Team member comments during previous discussion on this item and used a template that has been used successfully by others. You will note the traffic light systems of reporting—we have moved away from the traditional traffic light system and instead adopted a five-grade scale. This approach is informed by recent examples from other Recovery Teams and is designed to provide a more nuanced and transparent view of progress.

Note: this is a partially populated draft developed by DCCEEW and NRE Tas and using information from past communiqués and meeting minutes. Please note that while some progress has been captured, additional updates may not yet be reflected, and several sections remain incomplete.

To ensure the report accurately represents the full scope of our work, we're seeking input from all members. Your contributions will help us fill in the gaps and confirm that the content is correct and up to date.

Please make suggestions, additions in tracked changes or add a comment. Once complete, please email your comments to rachel.robbins@dcceew.gov.au (cc lesley.gidding-reeve@dcceew.gov.au).

National Recovery Team for the Maugean Skate

Annual Progress Report 2025

Contents

Acknowledgements

The format of this progress report has been adapted from the Recovery team annual progress report (draft), Commonwealth of Australia 2017.

Image credit

Front cover: Maugean skate © Jane Ruckert

List of abbreviations

ARIS	Adaptive Resolution Imaging Sonar
Bureau	Bureau of Meteorology
CCA	Cradle Coast Authority
CKMR	Close kin mark recapture
Council	West Coast Council
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DO	Dissolved oxygen
DCCEEW	Australian Government Department of Climate Change, Energy, Environment and Water
EPA	Tasmanian Government Environment Protection Authority
FRDC	Fisheries Research and Development Corporation
Hydro Tas	Hydro Tasmania
IMAS	University of Tasmania's Institute of Marine and Antarctic Science
MH	Macquarie Harbour
NGOs	Environmental non-government organisations, represented by the Australian Marine Conservation Society within the National Recovery Team for the Maugean Skate
NRE Tas	Tasmanian Government Department of Natural Resources and Environment
Recovery Team	National Recovery Team for the Maugean Skate
ROVs	Remotely Operated Vehicle
SAF	Strahan Community Aquaculture Forum
SOPs	Standard Operating Procedures
TSSC	Commonwealth Threatened Species Scientific Committee
ZAA	Zoo and Aquarium Association

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National Recovery Team for the Maugean Skate Terms of Reference

Maugean skate *Zearaja maugeana*. *Copyright Jane Ruckert/IMAS*

Contents

1. BACKGROUND

The Tasmanian endemic Maugean skate (*Zearaja maugeana)* is only known from two remote estuaries in western Tasmania – Macquarie Harbour and Bathurst Harbour. There have been no confirmed sightings of the species in Bathurst Harbour since 1992 and environmental DNA surveys conducted in 2020 indicate that the species now does not exist in any significant number in this location. Macquarie Harbour is now considered to hold the sole remaining viable population of the species, but there is a lack of understanding on population size and trend, with various environmental and skate monitoring and research programs raising substantial concerns about the conservation status of the species.

The Maugean skate is listed as Endangered under both Tasmania's *Threatened Species Protection Act 1995* (TSPA) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species has been included as a priority threatened species under the National Threatened Species Action Plan (2022-2032).

In response to new information on the status of the Maugean skate population within Bathurst Harbour and Macquarie Harbour, the Department of Natural Resources and Environment Tasmania (NRE Tas) and the Australian Government's Department of Climate Change, Energy, the Environment and Water (DCCEEW) have been exploring a suite of conservation actions, beginning with proactive and precautionary measures to address known threats to the species, identify and address priority knowledge gaps, while simultaneously planning a consultative and coordinated strategy for the longer-term stabilisation and recovery of the population.

In 2022, NRE Tas and DCCEEW held a series of workshops and discussions with key stakeholders centred around thematic areas of relevance, including environmental remediation, ex-situ conservation management, population monitoring, and the potential impacts of predation and depredation to identify and prioritise conservation, research, and management strategies to support the recovery of the species. The outcomes of the discussions informed a structured decision-making workshop that was conducted to assist with the prioritisation of management and conservation strategies to prevent extinction of the Maugean skate population and support recovery of the species into the future. The outcomes of the structured decision-making workshop informed the Conservation Action Plan (NRE Tas) and the updated Commonwealth Conservation Advice for the species (DCCEEW).

The National Recovery Team for the Maugean Skate (Recovery Team) was formed in July 2023.

2. ROLE OF RECOVERY TEAM

The Recovery Team serves as an advisory body that provides high-level advice on recovery actions for the Maugean skate to a range of stakeholders, including the Australian and Tasmanian Governments.

The Recovery Team's role is to guide, review and monitor the effective and adaptive implementation of the Tasmanian *Conservation Action Plan* and *Commonwealth Conservation Advice* for the species in a range of ways, including but not limited to the following key functions:

- Providing a forum to share information and expertise; report and review past and ongoing recovery activities; and consider, recommend and coordinate future recovery activities;
- Facilitating engagement of key individuals and groups/organisations to support Maugean skate recovery;

- Providing a point of coordination between organisations involved in *in situ* and *ex situ* conservation efforts to progress recovery activities;
- Seeking funding to support implementation of the Conservation Action Plan and Conservation Advice;
- Reviewing and report on progress towards achieving Conservation Action Plan and Conservation Advice objectives, including the development and endorsement of an annual report; and
- Identifying areas of recommended improvement and/or adaptive management.

In identifying the Recovery Team's areas of responsibilities, it is also important to identify those roles which sit outside of a recovery team's Terms of Reference. For example:

- It is not the role of the Recovery Team to make decisions on policy issues.
- The Recovery Team's responsibilities do not entail broader public engagement under the Recovery Team's name on issues beyond those agreed by the Recovery Team. This does not preclude members publicly raising and discussing other matters separately through and under their respective organisation's names.

3. STRUCTURE

The recovery team structure incorporates a core Recovery Team group and numerous technical subgroups. This structure has been designed to best support the implementation of recovery actions based on Recovery team governance best practice guidelines.

3.1. Recovery Team

The recovery team group is the primary advisory and coordination body and consists of representatives from many stakeholder groups and technical specialists.

3.2. Technical subgroups

Technical subgroups work on specific aspects of conservation plans or on other issues that the Recovery Team deems appropriate. Subgroups may be dynamic and can be established as temporary or permanent structures to service specific functions of the Recovery Team.

Subgroups will:

- be led and coordinated by an appointed Recovery Team member.
- meet as required, independent of the broader Recovery Team meetings.
- comprise Recovery Team members identified for their relevant areas of technical or specialist expertise. Other Recovery Team members may opt-in subject to interest and capacity.
- where relevant, include additional experts who are not members of the core Recovery Team.
- coordinate meetings, prepare minutes of subgroup meetings and provide regular reports to the Recovery Team.

4. RECOVERY TEAM MEMBERSHIP

The Recovery Team comprises an appropriate mix of representative stakeholders to coordinate implementation of the Conservation Action Plan and Conservation Advice for the species. These include federal and state government departments, industry, environmental non-government organisations, experts and researchers, accredited zoological institutions, and community members or groups. New members and partner organisations may join through an invitation from the Chair or through a direct request from a member to the Chair. The Recovery Team will decide to accept new members and stakeholder organisations (see Section 6 'Decision Making').

Existing members representing stakeholder organisations may transfer their membership to another person within their organisation. Typically, such a transfer of membership does not require the approval of the Recovery Team. Members must inform the Chair of any changes in membership within an organisation as soon as practicable. Where a member cannot attend a meeting, a proxy from their organisation can attend. The Chair must be informed of any such arrangements before the meeting.

Current membership is provided in Appendix 1.

5. ROLES AND RESPONSIBILITIES OF RECOVERY TEAM MEMBERS

Terms of appointment are for two years; following an initial 2-year appointment, the position of Chair and Vice-Chair will be assigned according to voting at a Recovery Team meeting, with more than 50% of votes required for appointment to occur. Membership of the Recovery Team will be reviewed annually, along with the Terms of Reference.

The roles and responsibilities of Recovery Team members are outlined in Table 2 below.

Table 2. Roles and responsibilities of Recovery Team members

Position	Responsibilities (examples)
Chair	• Lead the Recovery Team to help achieve its objectives for species recovery • Act as a spokesperson • Answer queries from stakeholders and the public • Seek advice on matters, sometimes at short notice, from the Recovery Team • Approve Recovery Team agendas • Lead meetings and decision-making processes • Ensure reporting obligations are met • Assist members to seek funding opportunities • Manage member conflicts and ensure compliance with the ToR following agreed processes
Vice-Chair	• Assist the Chair in their duties as required • Act as Chair in the absence of the Chair • Act as Chair when the Chair has Conflicts of Interest

Commented [RR1]: For RT discussion - Chair and Vice-Chair roles should be held by State or Commonwealth government members

Commented [RR2]: For RT discussion - process to review membership

Position	Responsibilities (examples)
Coordinator	• Organise Recovery Team meetings and prepare meeting agendas • Take minutes and record agreed actions from Recovery Team meetings • Maintain currency and follow-up on actions • Keep members regularly informed of Recovery Team matters • Coordinate Terms of Reference and membership review
Sub-group Chairs	• Report to the Recovery Team on group activities as required • Manage group following these Terms of Reference and the agreed timeline and scope of the sub-group • Request decision-making support where required

All members	• Work with Recovery Team to help it achieve objectives for species recovery
	• Contribute their skills, knowledge and experience
	• Regularly attend and participate in meetings
	• Prepare meeting reports and agenda papers as required
	• Endeavour to align and coordinate the work of their organisation with the Conservation Action Plan and Conservation Advice
	• Share with their organisation the progress of implementation of the Conservation Action Plan and Conservation Advice, and broader relevant Maugean Skate issues
	• Identify gaps in knowledge relevant to the Conservation Action Plan and Conservation Advice
	• Seek to make available relevant information held by the organisations they represent to assist the conservation and management process.
	• Respect requests to contain information/data/reports within the Recovery Team and direct outside requests for information/data/reports to the organisation that owns these things
	• Behave in a manner that is conducive to constructive collaboration including:
	  ○ Respecting all organisations and individuals involved in the team and the safety and wellbeing of all team member;
	  ○ Respecting the perspectives of others;
	  ○ Avoiding public criticism of the contribution of other members; and
	  ○ Respecting the confidentiality, conflict of interest, and communications principles outlined in these Terms of Reference.
	• Lead sub-groups (where required)

6. OBSERVERS

Observers may attend meetings on a case-by-case basis. Requests to invite an observer must be made through the Chair and may be subject to broader Recovery Team approval. When making a request to invite an observer, members should demonstrate that:

- the observer has skills, knowledge and/or experience pertinent to the agenda or a specific agenda item that are not adequately represented among Recovery Team members; and/or
- the observer represents an important stakeholder or organisation to which an update (through the observer) is beneficial to Recovery Team outputs and activities; and/or
- The observer has been nominated by a member organisation to replace an existing member of the Recovery Team at the meeting as their proxy.

Observers should contribute their skills, knowledge and experience where appropriate, and are expected to meet the same standards of professional behaviour as members. It is also expected that Observers will report back to their organisation on the progress of implementation of the recovery actions and broader relevant Maugean skate issues as appropriate and subject to any confidentiality considerations.

At the discretion of the Chair, Observers may be permitted to attend only for specific sessions and not necessarily for the entirety of the meeting. Observers must not be present for discussions relating to non-compliance, dispute resolution and matters that are highly confidential.

Observers are expected to read and abide by the Terms of Reference.

7. CONSENSUS AND DECISION MAKING

Commented [RR3]: RT meeting discussion point - worked examples of decisions that require consensus versus those that require advice

The Recovery Team and any formed sub-groups will aim to make decisions by consensus. Members are entitled to support an option, object to an option, or abstain from decision making. Where a consensus is not reached, the different views of the team or group members will be recorded. Where a consensus is not reached but a decision is required, a majority will decide the outcome with a vote of more than 50%. Organisations will have one vote each.

When decisions need to be made out of session, the Coordinator will ensure that all members are aware of the information required to make the decision and the due date of the decision making. Members that do not respond to out of session decision making before the due date will be recorded as abstaining from the decision. Decisions made by sub-groups are considered as recommendations for ultimate Recovery Team decision making.

7.1. Conflicts of Interest

Each member must declare any duality of interest in matters of concern to the Recovery Team, including verbally declare any potential non-standing conflicts of interest at the commencement of each meeting. Declared conflicts of interest will be recorded in the meeting Minutes and a register of declared conflicts of interest will be maintained by the Coordinator. Where a conflict of interest occurs during the meeting, the relevant member(s) will not take part in the relevant decision making and may be required to absent themselves from discussion of the relevant matter. The Coordinator will note the conflict of interest and relevant member(s).

A conflict of interest may arise when there is a conflict between your role as a Recovery Team Member and any other interests which could improperly influence the performance of your duties and responsibilities as a Recovery Team Member. Conflict of interest means a situation arising from a conflict between the duty to the Recovery Team and a private or personal interest. All Recovery Team Members have an obligation to immediately disclose any conflict of interest.

A conflict may be personal, financial or political. It may be actual, perceived or potential.

(i) Actual: means there is a conflict between a person's official duties and responsibilities on the Recovery Team, and their personal interest.

(ii) Perceived: means when a reasonable person, knowing the facts, would consider that a conflict of interest may exist, whether or not this is the case.

(iii) Potential: means where a person has a personal interest that could conflict with their duties in the future.

Personal Interests occur when a decision a Recovery Team Member may be required to make, either directly or indirectly affects themselves, family or associates including (but not limited to):

- Immediate and extended family and members or associates with a close personal relationship (for example, a spouse, a sibling of a member's spouse, a grandparent, a grandchild, parents, cousins, aunts, uncles and friends); or
- Organisations in which the member is actively involved, such as a sporting club or cultural organisation; or
- Business partners: a conflict of interest may arise from a business proposal for a financial benefit to a member's partner or relative, a close personal friend or a professional colleague rather than the member themselves.

Financial interests could include:

- trusts;
- multiple roles: may occur if the member has a business or financial interests such as holding a company directorship or shareholding; or
- financial investment: where the member has access to information or is able to influence decision making so that he or she may benefit directly (such as shares in a company).

Political Interests occur when a member participates in political activities or makes political comment that may relate to, or be seen to relate to, the Recovery Team.

If you become aware of any conflicts of interest during your time as a Recovery Team Member, you are required to disclose any conflicts of interest or other items of disclosure at each Recovery Team Meeting or notify the Chair out of session.

Members must then declare a conflict of interest if it is on the agenda for the meeting or should it arise throughout a meeting, i.e., where they have a vested interest in the outcome of discussions or votes that are not reflective of the Recovery Teams objectives to protect the Maugean Skate.

Once you have disclosed a conflict of interest, you should not be present or take part in any decision-making relating to any matter in which you have a direct conflict of interest unless prior approval has been granted by the Chair for your participation. If you are voting member, you must abstain from voting on any matters relating to the conflict of interest.

The obligations outlined above also apply to individuals invited to participate in any subgroups and are not full members of the Recovery Team.

8. OPERATIONAL ARRANGEMENTS

8.1. Meeting details

Recovery Team meeting

- Recovery Team meetings will be held a minimum of once per year (online via Microsoft teams and/or in-person), with online updates to be provided as required.
- Discussions and minutes of meetings are confidential and members must only share their contents with other Recovery Team members and non-Recovery Team members in the partner organisations and sub-groups (where appropriate). For particularly confidential information, the member(s) providing this information must inform the group that it is so.
- Conflicts of interest in meetings will be dealt with as described in section 6.1 above.
- Meetings will be organised by the Chair, Vice Chair and Coordinator, and an agenda provided at minimum one week prior to the meeting.

Subgroup meetings

- Subgroup meetings will be held as required (online via Microsoft Teams and/or in person).
- Discussions and minutes of meetings are confidential and members must only share their contents with other Recovery Team members and non-Recovery Team members in the partner organisations and sub-groups (where appropriate). For particularly confidential information, the member(s) providing this information must inform the subgroup that it is so.
- Conflicts of interest in meetings will be dealt with as described in section 6.1 above.
- Meetings will be led and organised by the appointed subgroup Recovery Team member. The agenda and minutes will also be prepared by the appointed subgroup member.

8.2. Records and minutes

- The Recovery Team Coordinator will take the minutes of meetings and records of all correspondence and reports will be kept by the Coordinator and be available to the Recovery Team members.
- Minutes will be circulated for comment and finalisation within four weeks of the meeting.
- The minutes of meetings may be available to non-Recovery Team members and observers on request to the Chair.
- Minutes will focus on key discussion points, actions, and outcomes of meetings and who will undertake actions.
- A communique of each Recovery Team meeting will be published online after each meeting has concluded. The communique will be a high-level summary and update of the Recovery Team's deliberations.

8.3. Quorum

- A quorum is met when a least half of the membership is present, and it must include the Chair or Vice Chair and one state and one commonwealth government representative, if they are not the Chair or Vice Chair.

8.4. Information management

- The Recovery Team will generally not collect, maintain or hold data.
- Where data are collected on behalf of the Recovery Team, specific data sharing arrangements will be identified as part of the agreement. Where possible, all data collected on behalf of the Recovery Team will be open source and freely available.
- Data collected, maintained or held by any organisation within the Recovery Team will be owned and maintained by that organisation, unless other arrangements are made.

8.5. Communication

- All communication with the media, including social media, or non-Recovery Team organisations on behalf of the Recovery Team will be referred to the Coordinator and approved by the Recovery Team Chair and the relevant state and/or Australian Government delegates. If the topic or content of a planned communication is deemed controversial, the Chair will seek to discuss the matter with the organisation preparing the material. This discussion will intend to ensure accuracy of reporting on Maugean Skate conservation and recovery activities, and due diligence in working with partners to communicate potentially controversial matters.
- All members of the Recovery Team and sub-groups when communicating with the media, including social media, or non-Recovery Team organisations, will express views on behalf of their own organisation and limit detailed discussion to projects their organisation is delivering. Exceptions to this principle are: general recovery program progress can be discussed using messaging wholly consistent with the most recent public recovery program update (prepared by the Coordinator or the Chair after Recovery Team meetings); and members may discuss projects under the responsibility of other organisations if granted permission by the organisation responsible in advance.

Commented [RR4]: For discussion at RT meeting - speaking to media on behalf of the RT versus as a organisational rep

8.6. Fees and expenses

- Sitting fees will not be paid, positions on the Recovery Team are on an honorary basis. Costs and expenses for meetings logistics (e.g. room hire, catering) will be borne by the relevant host organisation as negotiated.
- Costs associated with travel to meetings will be covered by the individual or relevant agency unless other arrangements are made.

9. REVIEW AND REPORTING

An annual progress report will be prepared by the Recovery Team facilitated by the Chair, Vice Chair and Coordinator, each July. Reporting will be consistent with guidelines developed by the Australian Government and/or other agency requirements. The report will be publicly available and published on the Department of Climate Change, Energy, the Environment and Water website.

The Recovery Team will review the structure and membership of the Recovery Team and subgroups and these Terms of Reference annually to ensure they remain the best way to implement the Conservation Action Plan and Conservation Advice. The Recovery Team is nationally registered

under the EPBC Act. The Coordinator will coordinate annual reporting requirements under the national monitoring and reporting framework.

10. NON-COMPLIANCE AND DISPUTE RESOLUTION

The below sub-sections provide guidance related to managing non-compliance and dispute resolution among and between Recovery Team members. Non-compliance and dispute resolution will be largely dealt with on a case-by-case basis with the Chair empowered to apply their discretion regarding appropriate actions.

Non-compliance

Instances of Recovery Team members non-compliance with these Terms of Reference and agreed procedures must be reported to the Chair.

Examples of non-compliance include:

- Discussing or disclosing confidential content from Recovery Team meetings with non-members outside of their organisation.
- Failing to disclose conflicts of interest.

The Chair is responsible for managing instances of non-compliance; the exact procedure will vary case-by-case. The following steps indicate possible actions:

- The Chair may meet with the involved member to determine cause and identify potential resolutions (e.g. clarification of expectations, new representative identified if member no longer most appropriate within their organisation).
- The Chair may meet with senior representatives of the involved members organisation to identify potential resolutions (e.g. align communication objectives, assess appropriateness of membership).
- The Chair may facilitate a vote among Recovery Team members if identified potential resolutions result in impacts or changes to the Recovery Team or these ToR.

Dispute resolution

Where disputes arise between Recovery Team members that are relevant to Recovery Team outputs and activities, the Chair is responsible for managing these. Depending on the severity and nature of the dispute, attempts should be made to resolve these within meetings, including the use of voting. Where a resolution is not forthcoming, or a vote is inconclusive / inappropriate, the Chair will identify actions for each party involved in the dispute to provide clarification / evidence for their position to assist with decision making and resolution.

For significant disputes, the Chair may meet with parties outside the Recovery Team meeting with senior representatives from involved organisations in attendance if appropriate.

11. NATIONAL REGISTRATION

The Recovery Team is on the Australian Government's register of recovery teams and will maintain registration through annual reporting.

12. ENDORSEMENT

These Terms of Reference have been endorsed by the Recovery Team on X Month 2024.

13. Appendix 1: Recovery Team membership

Name	Organisation	Reason for membership
Jo Crisp - Chair (Environment)	Department of Natural Resources and Environment Tasmania (NRE Tas)	State Government Agency accountable for species.
Rachael Alderman (Environment)		
Ross Monash – Coordinator (Environment)		
David Midson (Marine Resources)		
Lesley Gidding-Reeve (Vice Chair)	Ocean and Wildlife Branch; Department of Climate Change, Energy, the Environment and Water (DCCEEW)	Federal Government Agency accountable for species.
Rachel Robbins		
Darryl Cook	Environment Protection Authority	Representative of independent environmental regulator
Leonardo Guida	Australian Marine Conservation Society (AMCS)	Representative of environmental-NGO sector
Iona Flett	Cradle Coast Natural Resource Management	Representative of local NRM authority
David Ikedife	Hydro Tasmania	Representative of hydroelectric energy producer
Lisa Williams	Strahan Aquaculture Community Forum	Representative of West Coast community
Clint Mayes	Copper Mines Tasmania	Representative of local mining industry
seeking nominee – confirmation of ongoing participation	West Coast Council	Representative of Local Government Area
Jarrod Edwards	Melaythenner Teeackana Warrana Aboriginal Corporation (MTWAC)	Representative for Tasmanian Aboriginal Community

Matt Barrenger	Salmon Tasmania	Representative of aquaculture industry, with operations in Macquarie Harbour
Colin Simpfendorfer	Commonwealth Threatened Species Scientific Committee	Technical specialist on elasmobranchs
Toby Patterson	CSIRO	Technical specialist on elasmobranchs
Darren Engwirda		Technical specialist on Macquarie Harbour environmental dynamics
Jayson Semmens	Institute of Marine and Antarctic Studies (IMAS), University of Tasmania	Technical specialist on species
David Moreno		Technical specialist on species
Jeff Ross		Technical specialist on Macquarie Harbour environmental dynamics
Steven Rust		Technical specialist on marine resource economics
Laura Simmons	Zoo & Aquarium Association, SEA LIFE ANZ	Technical specialist on ex-situ conservation techniques

14. Appendix 2: Recovery Team technical subgroups

Technical subgroup	Membership	Date/still active
Captive Breeding subgroup	**Recovery Team members** ○ Lesley Gidding-Reeve, DCCEEW ○ Rachel Robbins, DCCEEW ○ Jo Crisp, NRE Tas ○ Rachael Alderman, NRE Tas ○ Ross Monash, NRE Tas ○ Darryl Cook, EPA Tas ○ Jayson Semmens, IMAS ○ David Moreno, IMAS ○ Iona Flett, Cradle Coast Authority (CCA) ○ David Ikedife, Hydro Tasmania ○ Lisa Williams, Strahan community representative ○ Steven Rust, IMAS ○ Leo Guida, AMCS ○ Clint Mayes, Copper Mines Tasmania **Additional members/experts** ○ Belinda Jago, DCCEEW ○ Rebecca Gee, DCCEEW ○ Deb Vidal, DCCEEW ○ Billy Dunlop, DCCEEW ○ Sean Tracey, IMAS	Active since September 2023
Monitoring subgroup	**Recovery Team members** ○ Lesley Gidding-Reeve, DCCEEW ○ Rachel Robbins, DCCEEW ○ Jo Crisp, NRE Tas ○ Rachael Alderman, NRE Tas ○ Ross Monash, NRE Tas ○ Darryl Cook, EPA Tas ○ Jayson Semmens, IMAS ○ David Moreno, IMAS ○ Toby Patterson, CSIRO ○ Colin Simpfendorfer, TSSC ○ Leo Guida, AMCS ○ Steven Rust, IMAS ○ Matt Barrenger, Salmon Tasmania ○ David Ikedife, Hydro Tasmania ○ Darren Engwirda,CSIRO	Active since September 2023

Commented [RR5]: Membership taken from last meeting attendees and apologies - please add if you are missing from any of these lists

	Additional members/experts o Belinda Jago, DCCEEW o Rebecca Gee, DCCEEW o Sean Tracey, IMAS o Raymond Bannister, EPA Tasmania	
Environmental Remediation Feasibility Working Group	**Recovery Team members** o Lesley Gidding-Reeve (Chair), DCCEEW o Rachel Robbins, DCCEEW o Davina Gregory-Dunsmuir, NRE Tas o Tom Duncan, NRE Tas o Darryl Cook, Tasmanian EPA o Greg Dowson, Tasmanian EPA o Jeff Ross, David Moreno & Jayson Semmens, IMAS/UTAS o Karen Wild-Allen, CSIRO o Matt Barrenger, Salmon Tasmania o Sean Riley, Tassal o Adam Smark, Huon o Depha Miedecke, Petuna o Charles Livesey, Hydro Tasmania o Jack Penny, Hydro Tasmania o David Midson, West Coast Council o Fran Smith, TasWater o Leo Guida, AMCS o Crispian Ashby & Josh Fielding, FRDC **Additional members/experts** o Thomas Aabling, Thomas Aabling Vandmiljø Environmental Engineering, Denmark o Anders Stigebrandt, Department of Marine Science, University of Gothenburg, Sweden	Inactive (last meeting August 2023) Superseded by MHOP project which included specialist working groups
Macquarie Harbour Hydrodynamics Working Group	**Recovery Team members** o Lesley Gidding-Reeve (Chair), DCCEEW o Rachel Robbins, DCCEEW o Karen Wild-Allen, CSIRO o Bec Sheldon, Hydro Tasmania o Matt Barrenger, Salmon Tasmania **Additional experts** o Mike Herzfeld, CSIRO o Emlyn Jones, CSIRO o Charles Livesey, Hydro Tasmania o Jack Penny, Hydro Tasmania	Inactive (last meeting September 2023) Superseded by MHOP group and Monitoring Technical subgroup

	○ Karl Bragana, BOM ○ Claire Spillman, BOM ○ Sean Riley, Tassal ○ Adam Smark, Huon ○ Depha Miedecke, Petuna ○ Crispian Ashby, FRDC ○ Josh Fielding, FRDC	
Dissolved Oxygen Working Group	○ Lesley Gidding-Reeve (Chair), DCCEEW ○ Rachel Robbins, DCCEEW ○ Davina Gregory-Dunsmuir, NRE Tas ○ Tom Duncan, NRE Tas ○ Darryl Cook & ○ Jeff Ross, IMAS/UTAS ○ Karen Wild-Allen, CSIRO ○ Bec Sheldon, Hydro Tasmania ○ Matt Barrenger, Salmon Tasmania **Additional experts** ○ Emlyn Jones, CSIRO ○ Greg Dowson, Tasmanian EPA ○ Sean Riley, Tassal ○ Adam Smark, Huon ○ Depha Miedecke, Petuna ○ Charles Livesey, Hydro Tasmania ○ Jack Penny, Hydro Tasmania ○ Crispian Ashby, FRDC ○ Josh Fielding, FRDC	Inactive (last meeting September 2023) Superseded by MHOP group and Monitoring Technical subgroup