

# National Recovery Team for the Maugean Skate

## Roadmap of Agreed Actions

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

The National Recovery Team for the Maugean Skate was formed in July 2023. This Roadmap of Agreed Actions has been developed by the Recovery Team following a series of Recovery Team and technical Working Group meetings which included national and international experts and local practitioners to identify and prioritise the immediate and short-term actions required to achieve the primary objective of the Recovery Team: *to prevent the extinction of the Maugean skate and maximise its recovery in the wild, while simultaneously minimising the impact of conservation actions on local communities and industries.*

Given the diversity of expertise and views within the Recovery Team and its Working Groups, consensus was not reached on all actions outlined, however the Recovery Team has agreed to include all technically valid options within its Roadmap of Agreed Actions.

The Roadmap of Agreed Actions has been informed by the Maugean Skate Structured Decision-Making Workshop, subsequent Recovery Team technical Working Group and Recovery Team meetings, the Commonwealth Conservation Advice for the Maugean Skate, Tasmanian Maugean Skate Listing Statement and Maugean Skate Conservation Action Plan, and relevant scientific and technical papers.

The Roadmap of Agreed Actions will be updated, if required, as more information becomes available to guide the Recovery Team's efforts.

The Recovery Team notes the available predictions of the impact of climate change and possible marine heatwaves in south-eastern Australian and Tasmanian waters. It is likely these changing conditions will have an impact on the Maugean skate and its habitat, including further exacerbating the low dissolved oxygen conditions in Macquarie Harbour.

The Roadmap of Agreed Actions is structured under key strategies designed to achieve the Recovery Team's overarching objective. These strategies are:

1. Coordinate Recovery Team actions.
2. Engage with local community to collaboratively enable the recovery of the Maugean skate.
3. Develop and initiate a Maugean skate captive breeding program.
4. Remediate and restore habitat.
5. Systems modelling to inform habitat remediation and conservation actions.
6. Identification and monitoring of Maugean skate habitat and populations.

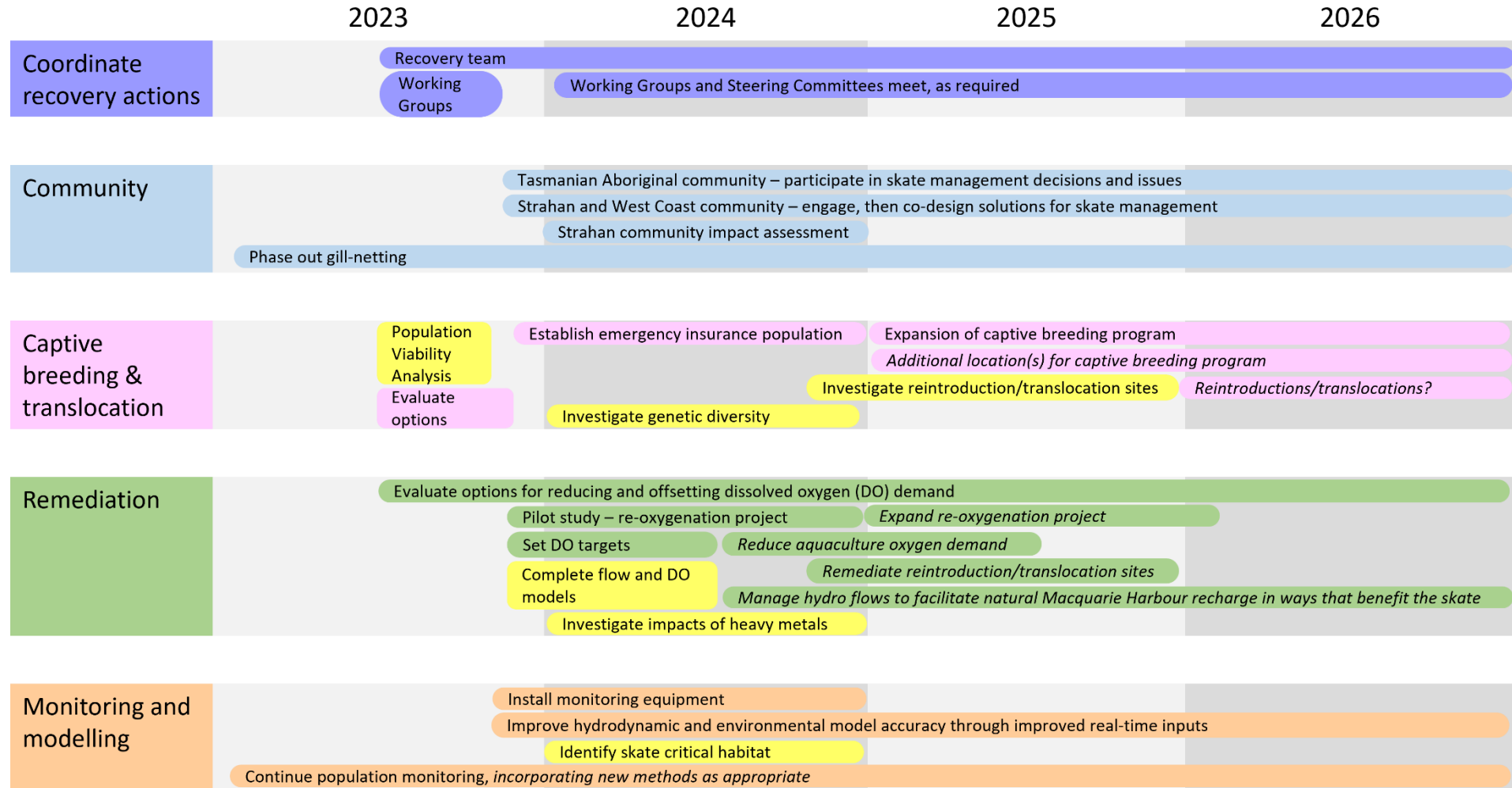
In the following, partners with primary responsibility for leading the progression and implementation of each action have been **bolded**.

A table of acronyms is available at the end of this document.

## MAUGEAN SKATE ROADMAP TO RECOVERY SUMMARY

*Italics indicate planned actions, to be confirmed if evidence supports*

Yellow boxes indicate research actions



**STRATEGY I: COORDINATE RECOVERY TEAM ACTIONS**

<b>Action no.</b>	<b>Description</b>	<b>Responsible partners</b>	<b>Indicative timeframe</b>	<b>Anticipated outcomes</b>
I.1	Convene Recovery Team meetings at least quarterly, more often as required.	<b>NRE-Tas, DCCEEW, Recovery Team</b>	Ongoing	Effective co-ordination and communication of recovery actions.
I.2	Assess recovery progress, including review of implementation and currency of Roadmap and Actions biannually or more often as required.	<b>NRE-Tas, DCCEEW, Recovery Team</b>	Ongoing	Adaptive and improved management understanding and recovery success.
I.3	Establish independent Expert Steering Committees for: <ul style="list-style-type: none"> <li>• Captive Breeding</li> <li>• Environmental remediation</li> <li>• Monitoring</li> </ul>	<b>DCCEEW, NRE-Tas, Recovery Team</b>	2023 onwards	Build public confidence in the independence of the science/results, and ensure best possible outcomes of projects/trials.

## STRATEGY 2: ENGAGE WITH LOCAL COMMUNITY TO COLLABORATIVELY ENABLE THE RECOVERY OF THE MAUGEAN SKATE

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
2.1	Invite Aboriginal representative/s familiar with the west coast of Tasmania to join the Recovery Team.	<b>NRE-Tas</b>	2023 onwards	Improved Recovery Team representation; active engagement of the Tasmanian Aboriginal community in Maugean skate recovery decisions and activities; increased capacity and capability for engagement of Tasmanian Aboriginal community in longer-term recovery activities.
2.2	Engagement with local Aboriginal community to understand and, with permission, incorporate their knowledge and perspectives to inform recovery efforts for the Maugean skate.	<b>NRE Tas, CCA, DCCEEW, Council, SAF, UTAS, ZAA</b>	2023 onwards	Active engagement of the Tasmanian Aboriginal community in Maugean skate recovery decisions and activities; increased capacity and capability for engagement of Tasmanian Aboriginal community in longer-term recovery activities.
2.3	Engagement with the Strahan community, focused on a collaborative approach to decision making related to conservation of Maugean skate. Focus on building social licence in working through: <ul style="list-style-type: none"> <li>Understanding and managing fishing practices in Macquarie Harbour (including options for redirecting displaced fishing effort, compliance, education, signage).</li> <li>Captive breeding options and their implications for Aboriginal land and sea Country (hereafter, 'Country'), and community.</li> <li>Understanding impacts on and needs of community from (potential) changes to industry, and other recovery activities.</li> <li>Explore opportunities to encourage and utilise citizen science and local knowledge.</li> </ul>	<b>NRE Tas, CCA, DCCEEW, Council, SAF, UTAS</b>	2023 onwards	Increased local community support for Maugean skate conservation actions; improved conservation management of Maugean skate, incorporating local knowledge.
2.4	Early communication to the Tasmanian Aboriginal community of planned urgent extraction of animals from Macquarie Harbour for captive breeding. Invite representatives to participate in animal collection and consult on next steps. Incorporate Tasmanian Aboriginal community perspectives into the captive breeding program, where possible.	<b>CCA, UTAS, NRE Tas, DCCEEW</b>	November/ December 2023	Increased Aboriginal understanding, support for, and engagement in captive breeding program

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Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
2.5	Undertake community impact assessments for relevant recovery activities.	<b>CCA, UTAS, SAF, NRE Tas,</b> Council, explore other collaborators	2024	Improved understanding of the impact on the local community of any proposed Maugean skate conservation actions. Potential modification to proposed actions to minimise community impact.
2.6	<p>Consistent with Tasmania-wide action, continue the planned phase out of gill netting in Macquarie Harbour.</p> <ul style="list-style-type: none"> <li>Engagement with the Strahan community and local gillnetters (recreational and commercial) to explore alternatives to gillnetting, with a focus on maintaining positive community activities while implementing progressive gill netting restrictions.</li> <li>Engagement with the Strahan community to explore compliance options for supporting gill netting restrictions.</li> </ul>	<b>NRE Tas,</b> Council, <b>CCA,</b> SAF, marine compliance officers, explore other collaborators	2022 – 2030	Increased local community support for Maugean skate conservation actions; reduction in impact of gillnetting on skates, identification of substitute activities.

**STRATEGY 3: DEVELOP AND INITIATE MAUGEAN SKATE CAPTIVE BREEDING PROGRAM**

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
3.1	<p>Establish and maintain a captive breeding program to ensure an insurance population, with accompanying research to support best-practice protocols, as per captive breeding workshop findings.</p> <p>Considerations:</p> <ul style="list-style-type: none"> <li>• Informed by the Population Viability Analysis (PVA), which will guide numbers of eggs and adults which can be taken from the wild without significantly increasing extinction risk.</li> <li>• Develop standard operating procedures (SOPs) based on international expert elicitation, extensive husbandry and aquarium holding experience in the team and species-specific knowledge.</li> <li>• Prioritise permit approvals for extraction of individual animals and eggs.</li> <li>• Convene a program Steering Committee (including relevant Recovery Team members and international experts) to review SOPs and project progress, and assist with technical complexities as required.</li> </ul>	<p><b>UTAS, ZAA</b>, CSIRO, CCA, Tasmanian Aboriginal representatives, NRE Tas, DCCEEW, others as required</p>	2023 onwards	Emergency captive population established.
3.2	Investigate genetic diversity of wild populations and captive-bred animals.	<b>CSIRO</b> , UTAS, ZAA, NRE Tas, DCCEEW	2024 onwards	Improved understanding of Maugean skate genetic diversity, including for population modelling.

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
3.3	<p>Determine suitable conditions for reintroduction/translocation to Macquarie Harbour, and other locations, by considering:</p> <ul style="list-style-type: none"> <li>• Habitat suitability at time of release.</li> <li>• Likely effect on any in-situ and ex-situ population.</li> <li>• Optimal stage of release and requirements for ensuring captive bred individuals are equipped for wild release (e.g., demonstrate ability to forage effectively).</li> <li>• Development of methods to monitor survival of released individuals.</li> <li>• Following appropriate methods for reintroduction (e.g., IUCN captive release guidelines).</li> <li>• Genetic diversity of captive bred individuals.</li> <li>• Modelling of the interaction between the ex-situ and any wild populations.</li> </ul>	<b>UTAS, CSIRO, CCA</b>	2024 onwards	Improved understanding of possible captive breeding release/translocation sites; improved well-being and survival of translocated or released animals; increased size of the wild population of skates.
3.4	<p>Expansion of captive breeding program utilising UTAS, ZAA and/or other facilities at various locations in Australia.</p> <p>Considerations:</p> <ul style="list-style-type: none"> <li>• Any outcomes of Actions 3.1, 3.2, and 3.3.</li> <li>• Any further collection of individuals or eggs from the wild will be informed by an updated PVA to ensure no significant impact on extinction risk of wild population.</li> <li>• If possible, prioritise retention of captive individuals within Tasmania. Any removal from Country/Tasmania is pending consultation with Tasmanian Aboriginal people, local community and Tasmanian Government (Actions 3.1 and 3.5).</li> <li>• Captive breeding program to ensure spreading of risk (use multiple holding sites and following best-practice husbandry, animal welfare, disease mitigation, etc).</li> </ul>	<b>UTAS, ZAA, CSIRO, CCA, Tasmanian Aboriginal representatives, NRE Tas, DCCEEW</b> , others as required	2025 onwards	Captive breeding population maintained and capable of reproducing for wild release.



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Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
3.5	<p>Investigate and, if feasible, develop ex-situ facility in Strahan.</p> <p>Considerations:</p> <ul style="list-style-type: none"> <li>• Long-term funding requirements.</li> <li>• Need to adopt best-practice animal husbandry and access specialist veterinary support.</li> <li>• Facility could also be used for public engagement and communication.</li> </ul>	<p>UTAS, ZAA, Salmon Tasmania, Council, CCA, Tasmanian Aboriginal representatives, <b>NRE Tas, DCCEEW</b>.</p>	2025 onwards	<p>Captive breeding population maintained and capable of reproducing for wild release; community support for Maugean skate conservation increased; facility provides tourism income stream; skates are retained in local area.</p>
3.6	<p>Informed by the outcomes of Action 3.3, reintroduce captive-bred animals to Macquarie Harbour. Pending further detailed investigations, potentially translocate into other locations that have been determined to be suitable for such (e.g., Bathurst Harbour, New River Lagoon and Pieman River).</p> <p>Ensure all release is undertaken in consultation with relevant Tasmanian Aboriginal communities.</p>	<p><b>UTAS, ZAA</b>, Tasmanian Aboriginal representatives, NRE Tas, DCCEEW, others as required.</p>	2026 onwards	<p>Wild populations of Maugean skate are supplemented with captive-bred animals.</p>

**STRATEGY 4: REMEDIATE AND RESTORE HABITAT**

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
4.1	<p>Assess and compare the ecological risk, feasibility and predicted performance of all possible immediate (1 year) and longer-term (2-4 years) options to remediate the environmental conditions within Macquarie Harbour, with priority given to improving dissolved oxygen levels.</p> <ul style="list-style-type: none"> <li>Feasibility assessment to include harbour-wide impact of option/s; revision of Maugean skate Population Viability Analysis (where appropriate); technical, social, economic, and environmental considerations.</li> </ul>	<b>Salmon Tasmania, UTAS, Hydro Tas, EPA, FRDC</b>	2023 - 2024	Understanding of options to improve levels of dissolved oxygen in Macquarie Harbour.
4.2	<p>Investigate, and where feasible, implement methods for offsetting salmon aquaculture oxygen demand on Macquarie Harbour, by implementing mechanical methods of remediation of low dissolved oxygen. Feasibility assessment as per Action 4.1.</p> <ul style="list-style-type: none"> <li>Prior to summer 2023/24 initiate remediation pilot study using artificial aeration techniques to inject and mix oxygen-rich water into oxygen-poor water layers.</li> </ul>	<b>Salmon Tasmania, UTAS, CSIRO, FRDC, EPA</b>	Pilot study to commence 2023	Improvement in levels of dissolved oxygen in Macquarie Harbour.
4.3	Finalise Dissolved Oxygen targets for Macquarie Harbour to support Maugean skate recovery and provide to Hydro Tasmania and Salmon industry, to assist with modelling management scenarios, noting climate change impacts on Dissolved Oxygen levels.	<b>EPA</b>	2023	Improved ability to monitor progress towards agreed targets.
4.4	Investigate, and where feasible, implement methods for reducing salmon aquaculture oxygen demand on Macquarie Harbour including by decreasing salmon biomass in Macquarie Harbour through mechanisms such as lifecycle-based gradual destocking, fallowing of pens, growing out on land, movement of stock to other locations. Feasibility assessment as per Action 4.1 and informed by Action 4.2.	<b>Salmon Tasmania, UTAS, CSIRO, FRDC, EPA</b>	2024	Improvement in levels of dissolved oxygen in Macquarie Harbour.
4.5	Liaise with TasWater to investigate the oxygen demand of wastewater treatment discharge on Macquarie Harbour, and if significant, implement methods for reducing/offsetting TasWater wastewater treatment discharge oxygen demand. Feasibility assessment as per Action 4.1.	<b>EPA, TasWater, UTAS, CSIRO, NRE Tas</b>	2024	Improvement in levels of dissolved oxygen in Macquarie Harbour.
4.6	Investigate residual oxygen demand of organic matter build up in the sediments of Macquarie Harbour, and if significant, implement methods for reducing/offsetting oxygen demand, where feasible. Feasibility assessment as per Action 4.1.	<b>EPA, Salmon Tasmania, UTAS, NRE Tas</b>	2024/25	Improvement in levels of dissolved oxygen in Macquarie Harbour.
4.7	Informed by the outcomes of Actions 4.1, 4.3 and 5.1, undertake modifications to releases from hydropower operations (if required and feasible) to achieve conditions for trickle oceanic recharge events to improve dissolved oxygen levels and support dissolved oxygen targets (as per Action 4.3).	<b>Hydro Tasmania, UTAS, CSIRO, EPA</b>	2024 onwards	Improvement in levels of dissolved oxygen in Macquarie Harbour.

**STRATEGY 5: SYSTEMS MODELLING TO INFORM HABITAT REMEDIATION ACTIONS**

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
5.1	<p>Undertake hydrodynamic modelling to predict dissolved oxygen dynamics under contrasting management scenarios, and facilitate data sharing with Recovery Team and community. Scenarios could incorporate (not limited to):</p> <ul style="list-style-type: none"> <li>• Changes in salmon biomass.</li> <li>• Altered river flow regimes, including power station operations (Action 5.2).</li> <li>• Different climate scenarios, (including changes in maximum dissolved oxygen given warming waters as a result of climate change).</li> <li>• Role/effects of oxygen injection trials.</li> <li>• Hydrodynamic and oxygen tracer 10-day forecasts.</li> <li>• Bureau of Meteorology model forecasts.</li> <li>• Data assimilation of near real time data sets.</li> <li>• An automated alert system to improve appropriate forecast delivery.</li> <li>• Associated assessment of change in Maugean skate habitat conditions (distribution and area) in response to management scenarios.</li> <li>• Associated assessment of change in dissolved oxygen conditions, relevant to EPA guidelines, in response to management scenarios.</li> </ul>	<b>CSIRO, UTAS, EPA, Hydro Tas</b> , Salmon Tasmania	Development of models in 2024; ongoing calibration of models	Improved knowledge of impacts on dissolved oxygen in Macquarie Harbour.
5.2	Develop and calibrate hydrological models (including outputs from Action 6.2) for the King and Gordon catchments to support the hydrodynamic model and development of scenarios for changes in flow from Hydro Tasmania to support Maugean Skate recovery.	<b>Hydro Tas</b> , Bureau, UTAS, EPA, CSIRO	Development of models in 2024; ongoing calibration of models	Improved knowledge of impact of environmental flows on dissolved oxygen in Macquarie Harbour.
5.3	Undertake modelling including incorporating remote sensing, telemetry and other data, to better characterise the impact of contrasting anthropogenic loads and hydroelectric regulation on water quality, by running additional model scenarios.	<b>CSIRO, UTAS, EPA, Hydro Tas</b> , Salmon Tasmania	2024-2026	Improved knowledge of impacts on dissolved oxygen in Macquarie Harbour.

**STRATEGY 6: IDENTIFICATION AND MONITORING OF MAUGEAN SKATE HABITAT AND POPULATIONS**

Action no.	Description	Responsible partners	Indicative timeframe	Anticipated outcomes
6.1	Provide regular updates to the Recovery Team on the forecast power station operation.	<b>Hydro Tas</b>	2023-2024 Summer	Improved prediction of environmental conditions for Maugean skate.
6.2	Install monitoring equipment where needed to refine modelling of freshwater inflows and endmember contributions to dissolved oxygen dynamics in Macquarie Harbour.	<b>Hydro Tas, CSIRO, EPA</b>	2024	Improved knowledge of impact of environmental flows on dissolved oxygen in Macquarie Harbour.
6.3	<p>Improve integration of industry, EPA, and research sampling programs that monitor dissolved oxygen in Macquarie Harbour by:</p> <ul style="list-style-type: none"> <li>• Clarifying models and data used to provide decision support to Recovery Team and actions.</li> <li>• Clarifying data gaps and limitations, relevant to each decision context.</li> <li>• Undertake a desktop study to consolidate environmental monitoring programs for the purpose of understanding the correlations between parameters; and the correlation with Maugean skate population assessments.</li> </ul>	<b>CSIRO, Bureau, Salmon Tasmania, Hydro Tas, EPA, NRE Tas, UTAS</b>	2024	Improved ability to monitor progress towards agreed targets.
6.4	<p>Investigate and identify both known and potential habitat critical to the survival of the Maugean skate in Macquarie Harbour.</p> <ul style="list-style-type: none"> <li>• Incorporate into Actions 6.5 and 6.6.</li> <li>• Characterise features and environmental conditions of known critical habitat to inform any potential relocations outside of Macquarie Harbour.</li> <li>• Undertake habitat mapping of known and predicted critical habitat.</li> </ul>	<b>UTAS, CSIRO, DCCEEW</b>	2024	Improved understanding of key habitat attributes and population locations.
6.5	Continue Maugean skate adult population monitoring using existing gillnetting methodology to provide a long-term indicator of population size, structure and distribution.	<b>UTAS, CSIRO</b>	2024-2026	Long-term estimation of relative population size and trends.
6.6	Extend population monitoring using gillnetting methodology to smaller size-classes and broader harbour-wide sampling effort.	<b>UTAS, CSIRO</b>	2024-2026	Improved estimation of relative population size and trends.
6.7	Conduct field trials on methods for improving population monitoring over time, to support evaluation of management strategies, and to identify the best candidate technology and sampling design, e.g., video sonar (ARIS), supplementary coverage by ROVs or other methodology.	<b>UTAS, CSIRO</b>	2024-2026	Improved estimation of population size and location.

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6.8	<p>Initiate close-kin mark recapture (CKMR) population analysis to examine what information can be supplied from currently available tissue samples and, if possible, refine recent population status estimates.</p> <ul style="list-style-type: none"> <li>Determine appropriate sequencing methodology to support refined CKMR assessments and support kinship assignment/genetic diversity metrics in ex-situ / release population.</li> <li>CKMR to examine what information can be supplied from currently available tissue samples to refine recent population status.</li> </ul>	CSIRO, UTAS	2024-2026	Improved estimation of population size and location.
6.9	Water quality and benthic community monitoring within Macquarie Harbour.	UTAS, CSIRO, EPA, Salmon Tas	2024-2026	Long-term understanding of the habitat health throughout Macquarie Harbour.
6.10	Investigate Citizen Science reports of Maugean skate both within and external to Macquarie Harbour (including further investigations within Bathurst Harbour) using eDNA, gillnetting, ROV methodologies.	CSIRO, UTAS	2024-2026	Improved understanding of distribution.

**ACRONYMS AND 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
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
PVA	Population Viability Analysis
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
UTAS	University of Tasmania
ZAA	Zoo and Aquarium Association