



Tasmanian Government Submission

Marine Farming Expansion, Macquarie Harbour, Tasmania and the *Environment Protection and Biodiversity Conservation Act 1999* - not controlled action if undertaken in a particular manner referral decision (EPBC 2012/6406)

February 2024

Acknowledgement: Front cover photograph courtesy of the West Coast Council / Ollie Khedun

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EXECUTIVE SUMMARY

This submission provides the Government's detailed comments in relation to three requests made to the Minister for the Environment and Water, the Hon Tanya Plibersek MP, to reconsider the decision in 2012 (EPBC 2012/6406) under section 75(1) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that the action – proposed Marine Farming Expansion, Macquarie Harbour, Tasmania – is not a controlled action if undertaken in a particular manner (NCA-PM).

The particular manner specified in the 2012 decision is that the action must be undertaken in accordance with the Macquarie Harbour Marine Farming Development Plan, inclusive of particular identified measures. In summary, these requirements include a comprehensive monitoring program and, if substantial changes are detected, targeted management responses must be undertaken to ensure the significant impacts are avoided. This formalised the Adaptive Management Framework (AMF) designed to monitor and sustainably manage the (then proposed) gradual salmonid production increase and any impacts over time, and evolving knowledge in relation to threats to the Maugean skate and the Tasmanian Wilderness World Heritage Area (TWWHA).

The Tasmanian Government's position is that the 2012 decision should not be revoked and not substituted with a new decision. The primary grounds on which a reconsideration is not warranted are that:

- While as was expected through the AMF, there has been a continual stream of refined data and information generated over time – developing a continuously improving knowledge base and driving management responses – there is no “substantial new information” about the impacts that the action has, or is likely to have, on the Maugean skate and the TWWHA; and
- There has been no “substantial change in circumstances that was not foreseen” at the time of the 2012 decision relating to the impact the action has or will have, or is likely to have. The 2012 decision specifically acknowledged the *foreseen* potential impacts through the measures of the particular manner (the manner in which proposed action must be taken), which are specifically designed to effectively manage impacts to the benthic environment (benthic visual, physiochemical or biological changes) and water quality (ammonia, nitrate and dissolved oxygen (DO)).

This submission provides comprehensive evidence to support this position and specifically addresses the claims made in the reconsideration requests. The evidence clearly demonstrates that there is no new substantial information, and no unforeseen circumstances related to the impacts of the action. The submission also provides evidence that the AMF described in the original 2012 decision is ensuring appropriate monitoring and management responses to the research and monitoring program, and management of risks associated with the previous, current and ongoing action of marine farming in Macquarie Harbour.

As part of the AMF's legislative and regulatory changes, marine farms are now regulated by both Marine Licences and Environmental Licences, the latter being managed by the independent Environment Protection Authority Tasmania (EPA Tas). New comprehensive *Environmental Standards for Tasmanian Marine Finfish Farming* were released in 2023. A suite of Technical Standards specifying methodology and process requirements are currently being developed to implement the Environmental Standards, further strengthening the protection and management of environmental values and the ecological character of Macquarie Harbour.

The comprehensive regulatory and legislative framework now also requires DO mitigation plans and water quality monitoring programs; a wide range of research, monitoring and compliance programs as well as management responses including changes to biomass caps and, more recently, feed inputs. The Broadscale Environmental Monitoring Program will be revised in line with the Environmental Standards to take into account recommendations from IMAS and the Scottish Association of Marine Sciences, who independently reviewed the Program.

A detailed description of the comprehensive AMF is presented in Section 4 of this submission.

Significant changes to marine farm operations have been implemented over time and are demonstrating the effective application of the AMF through targeted management responses. Details of these responses are provided in Section 4, but examples include the following changes:

- Production levels, which peaked in January 2015 with a peak biomass of 20,735 tonnes, resulting in a reported harvest for 2015 of 15,477 tonnes of head on, gilled and gutted fish (HOGG), reducing to the current levels of peak biomass around 10,915 tonnes, with a reported production harvest of fish of 8,549 tonnes (HOGG) (in 2023), which are less than the biomass levels in January 2012 (12,964 tonnes), prior to the 2012 decision; and
- Nitrogen inputs for salmonid farming being capped at a total of 500.1 tonnes per annum through current Environmental Licences. This is a reduction of 50% from 2014-15 (1,000 tonnes) and a reduction of 30% from 2011 (750 tonnes).

It is important to note the difference between production levels presented as biomass and production as a quantity of fish harvested as they are not the same, and the relationship between them is not directly calculable. Biomass is the estimate of the amount of fish in the water at any point in time and references to biomass in this document are taken to be the peak biomass for the year referenced, which will typically be the summer months. Biomass calculations are based on modelled growth of fish based on feed inputs and growth rates of fish, and are generated from industry feed data. The amount of fish harvested in any year will be different and reflects the actual growing strategies, the levels of mortality and the rate of growth of the fish.

Unless otherwise noted in this submission, references to production levels refer to peak biomass information rather than harvest information.

As a direct result of the effective application of the particular manner and the broader AMF, marine farming activities that are now being conducted in the Harbour are:

- at lower production levels which are now close to the existing marine farming activity that was in place prior to the 2012 decision;

- over a marine farming lease area that is 61% larger than the marine farming lease area footprint in production prior to 2012, thus enabling the industry to have a less intensive impact on the benthic and pelagic environment;
- in areas of the Harbour that are not considered to be preferred (verified and unverified) habitat for the Maugean skate;
- improved as a result of comprehensive new aquaculture regulation requirements, which have strengthened the environmental management standards for the industry, when compared to the standards that were in place for the marine farming activity in 2012; and
- Undertaken within a comprehensive and transparent policy and regulatory framework which was developed after extensive community, industry and expert consultation during development of the 2017 and 2023 Salmon Plans.

There has been ongoing compliance with the particular manner. A compliance inspection by the former Australian Government Department of Environment and Energy in 2017 found that marine farming operations were being undertaken in accordance with the particular manner. Evidence of compliance with each of the requirements specified in the particular manner since the 2017 compliance inspection is summarised in Section 3.3 and details are provided in Section 10.

A detailed risk assessment focusing on the risks identified in the 2012 referral, but informed by 12 years of monitoring data and broader research findings generated through the AMF, is provided in Section 5. The findings indicate that ongoing marine farming operations will not, or are not likely to have, a significant impact nor have they contributed to significant cumulative impacts on critical foraging or breeding habitat cycles for the species, nor will they reduce the area of occupancy or quality of habitat available for the species. As such, there is no evidence to indicate a current direct causal linkage between marine farming and the population decline of the species.

However, it should be noted that there is a number of other potential, known and unknown threats to the Maugean skate, that are unrelated to marine farming. These include incidental bycatch from gillnetting associated with commercial and recreational fishing, habitat degradation due to climate change, warming waters and the occurrence of extreme weather events, predation and depredation (eg, by seals, sea lice, crabs). Further, the Maugean skate population has declined to almost undetectable levels in Bathurst Harbour where there are no identified anthropogenic inputs that impact the potential habitat for that species.

To address the range of risks to the species, the Tasmanian and Australian Governments have been working collaboratively with key stakeholders to explore a suite of conservation actions for the Maugean skate, beginning with proactive and precautionary measures to address known threats, while simultaneously planning a consultative and coordinated strategy for the protection and recovery of the population. To guide this work a Maugean Skate National Recovery Team has been formed.

On 17 January 2024 the Tasmanian Government released a comprehensive Conservation Action Plan (CAP) for the Maugean Skate. The purpose of the CAP is to provide a comprehensive and coordinated approach to identifying resources to implement priority activities, critical research and management actions across the range of risks to the species.

As part of the CAP, the Tasmanian Government has committed \$2.1 million for a captive breeding program which is being undertaken by the University of Tasmania's Institute for Marine and Antarctic Studies (IMAS). It has also committed to bring forward the planned ban of gillnetting in Macquarie Harbor to reduce the potential for skate mortality and actions to supplement oxygen levels and minimise impacts of river flows on DO levels in the Harbour.

In concluding, the rigorous and continually evolving AMF for the ecologically sustainable marine farming in Macquarie Harbour, in combination with the comprehensive CAP and other work, will ensure that marine farming in the Harbour can continue in accordance with the 2012 decision without significant adverse impacts on the Maugean skate, while wide-ranging actions to support the conservation of the species are implemented.

PART A – TASMANIAN GOVERNMENT POSITION ON RECONSIDERATION DECISION

1. SCOPE AND CONTEXT

1.1 2012 EPBC Decision – Marine Farming Expansion in Macquarie Harbour

In May 2012, the then Tasmanian Government Department of Primary Industries, Parks, Water and Environment (DPIPWE), referred an action for the proposed Marine Farming Expansion to the then Australian Government Department of Sustainability, Environment, Water, Population and Communities for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The proposed action stated the following:

The expansion of marine farming operations, that will occur consistent with the 2012 amendment to the Macquarie Harbour Marine Farming Development Plan, which will include the following activities:

- *the arrangement and securing of sea pens for fish farming;*
- *the construction of associated water based infrastructure;*
- *the operation of fish farms including:*
 - *Servicing and maintenance of sea pens and associated water and land based infrastructure;*
 - *Feeding and managing the health, waste, processing and predators of fish in the farms;*
 - *Transportation of fish to and from the farms across water and land.*

On 3 October 2012, the then Commonwealth Minister responsible for the EPBC Act, the Hon Tony Burke, determined, under sections 75 and 77a of the EPBC Act that the expansion of marine farming operations in Macquarie Harbour, on the west coast of Tasmania [as described in EPBC Act referral 2012/6406] was not a controlled action if undertaken in a particular manner.

1.2 Requests for reconsideration of 2012 decision

On 30 November 2023, the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) wrote to the Tasmanian Minister for Environment and Climate Change, the Hon Roger Jaensch MP, advising that the Commonwealth Minister for the Environment and Water, the Hon Tanya Plibersek MP, had received three requests under section 78A of the EPBC Act for the Minister to reconsider the 2012 decision (EPBC 2012/6406). On behalf of Minister Plibersek, DCCEEW invited Minister Jaensch to provide comments on whether or not the 2012 decision should be revoked and substituted with a new decision, and if so, whether a matter referred to in paragraphs 78(1)(a) to (ca) of the EPBC Act and any other information considered relevant to the reconsideration.

The power to vary or substitute decisions under the EPBC Act is limited to where the Minister is satisfied that revocation and substitution is warranted by the following three criteria:

- the availability of substantial new information about the impacts that the action has or will have, or is likely to have on a protected matter (section 78(1)(a)); OR
- a substantial change in circumstance that was not foreseen at the time of the first decision and relates to the impacts of the action has or will have, or is likely to have on a protected matter (section 78(1)(aa)); OR
- the action is not being, or will not be, taken in the manner identified in the 2012 decision notice (section 78(1)(b)).

1.3 This submission

This submission provides the Tasmanian Government's response to the invitation to comment and outlines its position on the reconsideration decision.

Part A of the submission specifically addresses the three criteria outlined in section 1.2 for varying or substituting a decision under the EPBC Act and provides clear and detailed evidence to support that position.

Part B of the submission provides a range of important background information that provides context to the evidence provided in Part A.

2. RECONSIDERATION DECISION - TASMANIAN GOVERNMENT POSITION

The Tasmanian Government rejects the claims made in the requests for reconsideration of the 2012 decision that “substantial new information” about impacts of the action is available and there has been a “substantial change in circumstances” that was not foreseen at the time of the decision. Any inference of non-compliance with the particular manner specified in the 2012 decision is also refuted.

2.1 No new substantial information nor unforeseen change in circumstances

There is no substantial new information about the impacts that the action has, or is likely to have on the Maugean skate and the TWWHA. There is, however, a very large and ongoing program of monitoring and independent research¹ collected through the AMF for marine farming in Macquarie Harbour that has provided detailed insights into the ecohydrology, water quality and benthic environment of the Harbour, and which has informed marine farming regulation and the management of other potential threats to the Maugean skate, including recreational and commercial fishing, hydroelectric generation and mining.

In addition, although there is an increased understanding of Harbour hydrodynamics, habitat availability and functioning, along with skate behaviour and physiology, there has not been a substantial change in circumstances that was not foreseen at the time of the 2012 decision. The 2012 decision specifically acknowledged *foreseen* potential impacts to the Maugean skate and the TWWHA, through the required measures of the particular manner which are designed to manage the benthic environment and water quality. It specifically requires targeted management responses, which must be undertaken:

- “if substantial benthic visual, physio-chemical or biological impacts are detected as a result of benthic video assessment”; and
- “if the water quality monitoring program identifies that the rolling annual median value for any water quality indicators ammonia, nitrate and dissolved oxygen within the compliance region exceed the identified limits”.

As such, the particular manner clearly links these measures to new and emerging information from required data monitoring and research relating to foreseen potential impacts.

A detailed discussion of the three reconsiderations requests is provided in Section 3.

¹ A comprehensive summary of salmon research undertaken by IMAS (and in conjunction with other institutions) is available in their submission to the [Tasmanian Legislative Council Finfish Inquiry](#) and at the [IMAS Aquaculture Environment Research site](#) (Aquaculture Environment Program - Institute for Marine and Antarctic Studies | University of Tasmania (utas.edu.au))

2.2 Other supporting information

The particular manner in the 2012 decision is summarised as follows “...the person taking the action must undertake the action in accordance with the Macquarie Harbour Marine Farm Development Plan”, with a number of specific measures identified for particular attention. The definitions in the decision make it clear that future prescriptions will be as “prescribed in marine farm licence conditions”. In addition, the total biomass levels across all lease areas is further identified as a maximum, and must not exceed “any such altered levels as may be identified later by the Tasmanian Government.”

Through these provisions, and explicitly linking targeted management responses to new and emerging information from data monitoring and research, the particular manner clearly describes and acknowledges adaptive management as the appropriate approach for managing ecologically sustainable marine farming in the Harbour. The comprehensive and structured AMF, including a range of supporting monitoring and research programs, was formalised through the 2012 decision and has been effectively applied and adapted continuously over time, as intended.

Detailed evidence of the effective application of the AMF, formally through targeted management responses – as required in 2012 decision, is provided in Section 4 of this submission.

Further, the comprehensive risk assessment detailed in Section 5, based on the best available scientific evidence at this time, demonstrates that the action undertaken in accordance with the AMF will not have a significant impact nor will it contribute to cumulative impacts on Maugean skate that could lead to a significant impact on the species.

3. CLAIMS MADE IN THE RECONSIDERATION REQUESTS – DISCUSSION

The Tasmanian Government understands that the Minister for the Environment and Water has received requests from three parties – the Australia Institute, Fitzgerald and Browne Lawyers on behalf of the Bob Brown Foundation Inc, and the Environmental Defenders Office on behalf of the Australian Marine Conservation Society and Humane Society International Australia – to reconsider the decision taken in 2012 that the proposed Marine Farming Expansion, Macquarie Harbour, Tasmania (EPBC 2012/6406) was not a controlled action if undertaken in a particular manner.

The requests claim that substantial new information is available relating to impacts of the action on the Maugean skate and the TWWHA.

The requests also claim that there has been a substantial change in circumstances that were not foreseen at the time of the first decision.

The request submitted by the Environmental Defenders Office also questions – without presenting any evidence – ‘whether the requirements of the particular manner have been complied with’.

3.1 Availability of substantial new information

The three requests selectively refer to findings of the following five reports to support their claims:

1. *Moreno and Semmens, Interim report – Macquarie Harbour Maugean skate population status and monitoring* (2023)
2. *Moreno et al., “Vulnerability of the endangered Maugean Skate population to degraded environmental conditions in Macquarie Harbour”* (2020)
3. *Wild-Allen et al., “Macquarie Harbour Oxygen Process model (FRDC 2016-067)”* (2020)
4. *Ross et al., “Understanding the Ecology of Dorvilleid Polychaetes in Macquarie Harbour”* (2016)
5. *Ross & MacLeod, “Environmental Research in Macquarie Harbour Interim Synopsis of Benthic and Water Column Conditions”* (2017) – enabled processes to be understood in the Harbour which informed management decisions to be made.

All five of these reports were commissioned to inform the ongoing implementation of the AMF for marine farming in Macquarie Harbour. Indeed, all of the reports referred to have informed important and specific management responses described in this submission and form a part of a much longer-term suite of research and monitoring programs in Macquarie Harbour (Attachment 2).

Ross *et al* (2016) was commissioned when impacts to the benthic environment within Macquarie Harbour were identified by the Benthic Monitoring Program (BMP). As a result of this work, increased monitoring effort occurred and the standing biomass was subsequently reduced in the Harbour. However, the Tasmanian Government notes that Ross *et al* (2016) has since been superseded by more recent research – eg, Ross *et al* 2020 and Ross *et al* (2022)– which presents monitoring data that now clearly indicates that benthic conditions across the Harbour are returning to conditions documented prior to marine farming expansion activities.

The purpose of the AMF is to monitor for change or impacts and implement management responses to ameliorate these impacts, and continue to monitor to ensure that the management responses have been effective at rectifying the impacts. The results outlined in these more recent Ross *et al* reports indicate that the AMF has been effective at identifying impacts within the benthic environment and initiating management responses that have effectively reversed these impacts.

Likewise, progress reports in Ross and Macleod (2017) have also been updated by more recent analyses of long-term data (eg, Ross *et al* (2022)). This current research has improved the understanding of physio-chemical and hydrometric processes within Macquarie Harbour and informed management responses including the introduction of a Total Permissible Dissolved Nitrogen Output (TPDNO) cap. Research into skate behaviour and netting impacts (eg, Bell *et al* (2016) and Moreno and Semmens (2023)) has also informed priority actions within the Tasmanian Government's CAP for the Maugean skate (discussed in more detail in Section 11) – for example, that recreational gillnetting will be banned in the Harbour.

The Ross and Macleod (2017) study outlined the known low DO levels across Macquarie Harbour at the time, but as evidenced later in this submission, DO levels are on a trajectory of improvement and are no longer at the low levels documented in Ross's and Macleod's 2017 study.

Wild-Allen *et al* (2020) was a key research project commissioned to inform a whole of Harbour understanding of the oxygen budget for Macquarie Harbour. The project identified key drivers for oxygen recharge and draw-down. The data inputs for this model are continually evolving and improving under the monitoring program for the AMF, with an additional three continuous DO data loggers recently added. However, as discussed in Section 4, the report is outdated as marine farming production and inputs are now substantially lower than the scenarios considered by the project.

When the action was referred in 2012, it was known that the Maugean skate inhabited shallow channels and had physiological adaptation enabling the species to survive in brackish water and low DO levels. Research and monitoring of the species since 2011 through the AMF is providing more granular information on the species habitat and physiology. Importantly, this research has confirmed the preferred and critical habitat for the species as being the shallow channels of 5 m to 15 m within the Harbour.

The research has also added substantial information on estimates of the skate population. At the time of the 2012 decision, the combined skate population for Macquarie Harbour and Bathurst Harbour was estimated to be around 1,000. In 2016 the Macquarie Harbour population was estimated to be 3,177 individuals (within a 95% prediction interval of 1,827-6,247). Moreno and

Semmens (2023) reported a potential decline in the relative abundance of the Maugean skate population in Macquarie Harbour of 47%, and Moreno *et al* (2022) also note that Maugean skate within Bathurst Harbour is in extremely low numbers or no longer present. The report did not discuss what may have led to the decline of the population in Bathurst Harbour. However, it should be noted that there are no identified anthropogenic inputs that impact potential habitat for the species in that Harbour.

It is important to note that the requests for reconsideration draw on a report by Moreno and Semmens (2023) to attribute the potential recent decline to anthropogenic input and, specifically, to marine farming – for example:

“The report identifies the key parameter as dissolved oxygen and attributes the decline in dissolved oxygen levels to ‘anthropogenic inputs’. The principal input is, of course, the large-scale development of salmonid aquaculture. The report also refers to river flows and environmental events (which may be increasing in frequency due to climate change).”

This is a misrepresentation of that report, which specifically links mortalities in Maugean skate to two high impact natural environmental events that may have been exacerbated by low deep water DO levels and other compounding stressors such as salinity and temperature:

“Based on animal-borne environmental sensors and high-resolution environmental monitoring data of the system, Moreno et al. (2020) observed that Maugean skate mortalities were linked to two environmental events. The first occurred during summer (Jan-Feb 2019) when bottom water (<15 m) DO levels were extremely low (<25%), coinciding with high freshwater volumes that deepened the halocline and very high surface water temperatures (up to 22 °C). The second event occurred in April 2019 when a large westerly system forced a large volume of marine water into the system, causing a rapid displacement of the low DO water mass at the bottom of the harbour into shallow depths”; and

“Therefore, the observed declines in relative abundance presented herein, are likely the result of high impact environmental events, and longer-term demographic effects resulting from changes in the size structure of the population and apparent decline in recruitment.”

The report outlined that the low DO is a result of many current and historical anthropogenic inputs, not just salmon farming. Low DO events are not a recent phenomenon and are not new information for Macquarie Harbour. Durand *et al* (2021) outline that large deoxygenation events occurred roughly 400 years ago and progressed to its maximum around 200 years ago before subsiding. Given that Maugean skate were present in the estuary during this event, it can be postulated that the species has the capacity to survive these environmental events.

Moreno and Semmens (2023) suggest several potential explanations for the observed declines in population, including high impact environmental events and longer-term demographic effects resulting from changes in the population size structure, and an apparent decline in recruitment.

They note that:

“Results presented here cover only the first year (2021) and a small facet of a multi-year (2021-2023) assessment of the population. Further work is needed to understand long term trends in absolute population size, as well as the demographic consequences of the observed changes in size composition.”

The Tasmanian Government supports the findings of Moreno *et al* (2020) that more work is required to understand the population dynamics of the species within the Harbour. This research has informed the development of the CAP for the species and will continue to inform the AMF.

3.2 Substantial unforeseen change in circumstances

Two of the submissions cite Moreno and Semmens (2023) Interim report – “*Macquarie Harbour Maugean skate population status and monitoring*” in their claims that the potential 47% decline in relative abundance of the species in the Harbour was not foreseen at the time of the 2012 decision.

Moreno and Semmens (2023) identify a potential decline in skate abundance and potential changes in population structure. The report outlines that further research is required to confirm trends in population abundance, recruitment, and distribution and to determine factors contributing to population declines over time. As outlined in Section 3.1, population monitoring of the species in the Harbour has produced wide-ranging population estimates. Further monitoring and research into the population status of the Maugean skate is required to understand abundance, trends and age structure, including the long-term trend in absolute population size. This research is underway. Independent population monitoring and related research activities in Macquarie Harbour have been undertaken over the past decade as a key component of the AMF.

The 2012 referral identifies potential impacts to the Maugean skate and concludes that the action would not have a significant impact in areas inhabited by the species (at the time, specified as shallows less than 10 m). Bell *et al* (2016) subsequently confirmed that the skate’s preferred depth range of 5 m to 15 m. Long-term monitoring data across a range of sources indicates that DO levels for the species’ preferred habitat within the Harbour have varied, but have not changed substantially. That is, average DO levels remain at around 50% saturation in the preferred habitat range, which is considered highly suitable for the skate.

The detailed risk assessment in Section 5 demonstrates that the ongoing salmon operations within Macquarie Harbour will not have, and are unlikely to have, a significant impact or a cumulative impact on critical foraging or breeding habitat for the species, nor will it reduce the area of occupancy nor quality of habitat available for the species to the extent that would contribute to the decline of the species. As such, there is no current direct causal linkage between salmon farming and the decline of the species. Importantly, recent reports outlined in this submission indicate that the current management regime and AMF in place for salmon farming is effectively managing impacts to the environment within Macquarie Harbour and the newly developed CAP provides a comprehensive framework to address cumulative impacts of all Harbour uses on the Maugean skate.

While Moreno and Semmens (2023) identify a relative decline in Maugean skate abundance and note changes in population structure, historical and the most recent data and research gathered through the AMF does not support the claims in the reconsideration that this potential decline has been directly caused by marine farming operations within the Harbour.

3.3 Compliance with the existing NCA-PM decision

In 2017, the Compliance and Enforcement Branch within the Australian Government's former Department of Environment and Energy conducted an inspection of the marine farming operations in Macquarie Harbour to determine compliance with the 2012 NCA-PM (not controlled action if undertaken in a particular manner) decision. The outcome of this inspection was that the marine farming operations were being undertaken in accordance with the particular manners described within the notice. Importantly, no areas of non-compliance were recorded at that time.

Since the formal compliance inspection in 2017, all monitoring and required responses outlined in the 2012 decision have continued to be implemented, demonstrating compliance with the particular manner requirements. Importantly, many of the measures prescribed in the particular manner have been complemented by expanded research, monitoring and other management responses under the AMF. Further details demonstrating compliance with the particular manner can be found at Section 4.4.

4. ADAPTIVE MANAGEMENT FRAMEWORK – DISCUSSION

4.1 Overview

Fundamental to the existing 2012 decision and the ongoing operation of sustainable levels of salmonid farming in Macquarie Harbour is the AMF, which includes the Marine Farming Development Plan (MFDP) Management Controls and Environmental Licences, along with the recently released *Environmental Standards for Tasmanian Marine Finfish Farming* that are designed to monitor and minimise water quality and benthic impacts. Importantly, the AMF has an emphasis on transparency with regulatory settings and performance reported quarterly on the Salmon Portal². Independent research commissioned to both respond to and inform the AMF for Macquarie Harbour is also reported on the IMAS³ and Fisheries Research and Development Corporation (FRDC)⁴ websites.

Adaptive management is a structured and iterative approach to environmental management with an aim to reducing uncertainty over time via systematic monitoring and learning. In this way, decision making simultaneously addresses objectives and accrues information needed to inform and improve future management. The AMF for ecologically sustainable management of salmon farming in Macquarie Harbour comprises the following elements:

1. **Regulatory and legislative framework** – establishes the regulatory environment through an overarching statutory Macquarie Harbour MFDP (with associated management controls), which is also nested within the larger statewide regulatory and policy framework, with farming operations also regulated in accordance with Marine Farming Licences and Environmental Licences. New comprehensive *Environmental Standards for Tasmanian Marine Finfish Farming* were released in 2023 and a suite of Technical Standards specifying methodology and process requirements are currently being developed to further strengthen the protection and management of environmental values and the ecological character of Macquarie Harbour.
2. **Research, Monitoring and Compliance Program** – establishes data monitoring programs that enable environmental conditions to be monitored at a Harbour and lease level to determine compliance with agreed indicator limits and identification of causal impacts to water quality of the benthic environment. Ongoing independent research is also being commissioned in response to new and emerging data and knowledge and to inform the AMF and specific management actions.

² [Home | Salmon Farming Data Portal \(nre.tas.gov.au\)](https://nre.tas.gov.au)

³ salmoninteractionsteam.org

⁴ [Fisheries Research and Development Corporation | FRDC](https://www.frdc.gov.au)

3. **Management responses** – include changes to biomass caps, feed inputs or environmental management actions at lease level to respond to and mitigate any impacts detected via monitoring and compliance activities. Management responses can inform changes to Marine Farming and/or Environmental Licences. Management responses additional to those outlined in the Macquarie Harbour MFDP may be introduced through amendments to the MFDP via legislative process under the *Marine Farming Planning Act 1995* (MFPA) and the provisions of EMPCA.

These elements were designed to address the risks associated with the proposed expansion of marine farming within Macquarie Harbour to the wider aquatic environment and farmed fish as production progressively increased. When formalised through the 2012 decision, the ultimate aim of the AMF was to monitor and sustainably manage the anticipated gradual production increase, and to increase knowledge in relation to the sustainability and feasibility of the proposed expansion.

The very nature of an AMF is that it evolves as it is informed by data, research and management responses. Accordingly, the AMF for Macquarie Harbour has not remained static and has effectively evolved to incorporate monitoring and research findings – and contemporary international environmental standards, to be implemented through a suite of technical standards over the next 12-18 months – to mitigate risks associated with marine farming.

The AMF for salmonid farming in Macquarie Harbour is summarised in Figure 1.

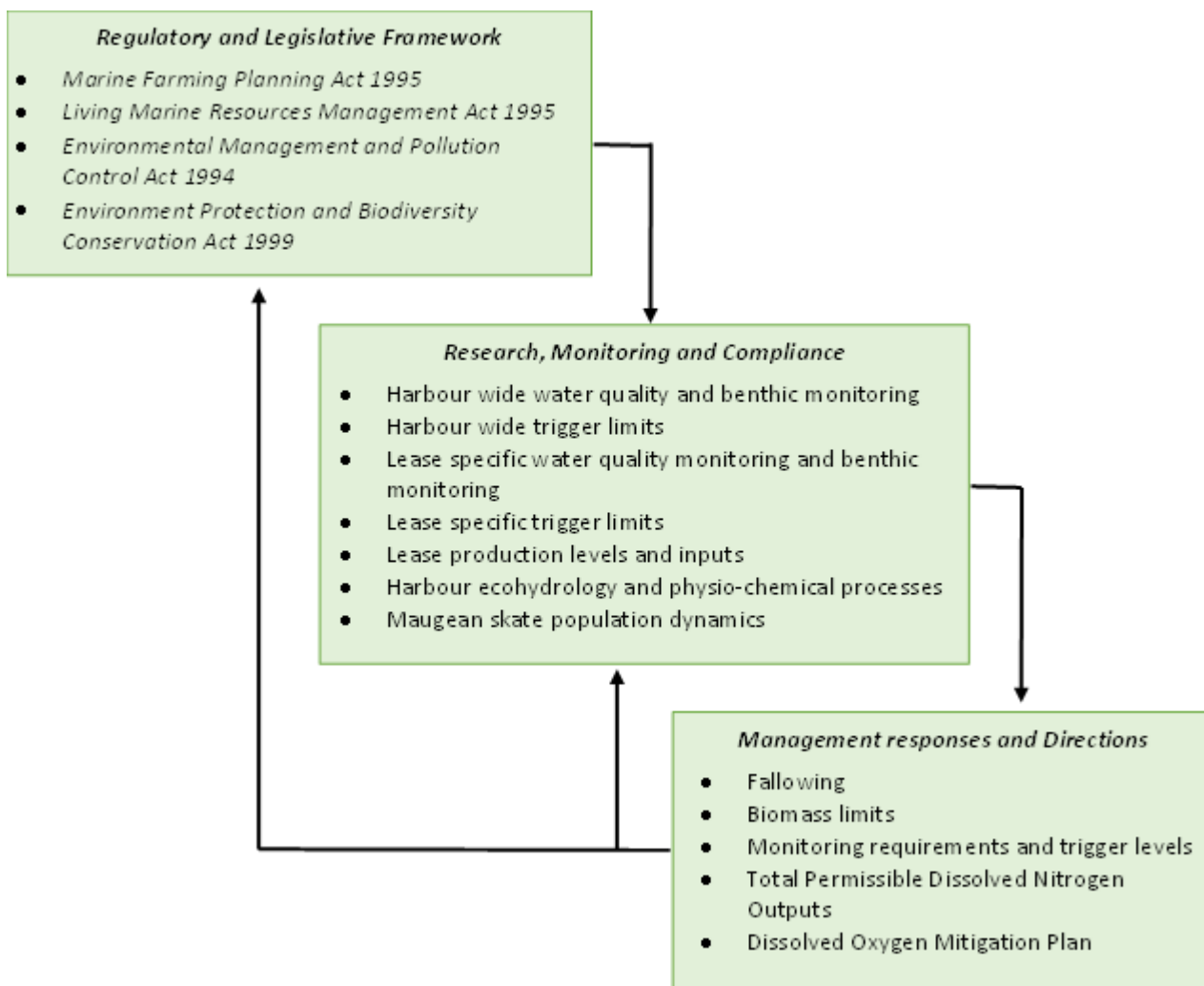


Figure 1: Adaptive Management Framework

4.2 Legislative and Regulatory Framework

The Tasmanian marine farming industry is subject to a comprehensive regulatory framework⁵. The industry is primarily regulated by the Department of Natural Resources and Environment Tasmania (NRE Tas) under the MFPA and the *Living Marine Resources Management Act 1995* (LMRMA), and by EPA Tas under EMPCA.

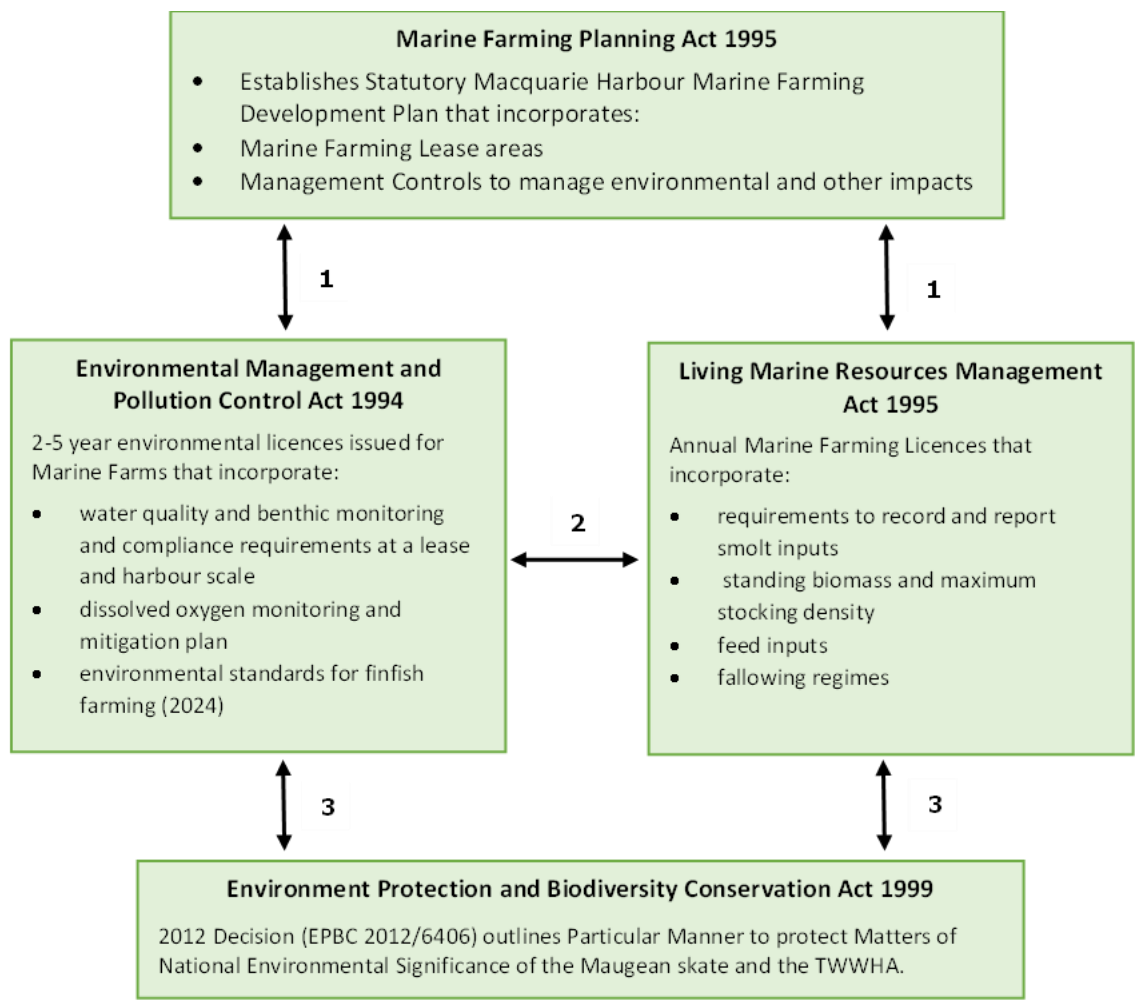
The Macquarie Harbour MFDP includes Management Controls that relate to all Marine Farming Zones within the Harbour, including that Lessees must comply with the MFPA and with any other Act or regulations that may affect the lease area or the marine farming operations in that lease area.

⁵ [Tasmanian Regulatory Framework for Finfish Aquaculture](#)

NRE Tas is responsible for regulating the non-environmental aspects of marine finfish marine farming in Tasmania and ensuring compliance with conditions of Marine Farming Licences the MFPA and MFDP management controls.

EPA Tas is responsible for regulating the environmental aspects of marine finfish farming and ensuring compliance with the conditions of Environmental Licences and the recently released *Environmental Standards for Tasmanian Marine Finfish Farming*.

Compliance information gathered during these processes also documents compliance against the 2012 decision. Figure 2 provides an overview of the current Legislative and Regulatory framework that applies to marine finfish farming in Macquarie Harbour.



1. Management Controls in the Macquarie Harbour Marine Farming Development Plan inform Environmental Licence and Marine Farm Licence conditions. Compliance reporting of Environmental Licence and Marine Farm Licence conditions can inform amendments to the Macquarie Harbour Marine Farming Development Plan.
2. Compliance reporting of Environmental Licence conditions informs the renewal process for Marine Farm Licences. Compliance reporting of Marine Farming Licence conditions informs the renewal of Environmental Licences.
3. Compliance reporting of Environmental Licence and Marine Farming Licence conditions demonstrate compliance with Particular Manner requirements.

Figure 2: Legislative and regulatory framework for salmon farming in Macquarie Harbour

Since the action to expand marine farming in Macquarie Harbour commenced, the AMF has informed changes to the Legislative and Regulatory framework and associated settings.

These changes can be considered as four phases:

Phase 1 (2012 - 2016): Marine farming activities were the sole responsibility of the then DPIPWE (now NRE Tas). Environmental management obligations consistent with the Macquarie Harbour MFDP were imposed via annual marine farming licences and legal decisions and management directions were made by the Secretary of the Department.

Phase 2 (2016 - 2021): Responsibility for the environmental regulation of marine farming transitioned to EPA Tas with Environmental Licences introduced. The Director EPA Tas acted under the delegation of the Secretary. Annual Marine Farming Licence conditions mirrored the environmental conditions contained within the Environmental Licences. In November 2018, Annual Marine Farming Licences were varied to remove environmental monitoring and compliance conditions but maintained requirements to collect a range of data.

Phase 3 (2021 - 23): EPA Tas was established as an independent authority with the Director, EPA Tas having direct authority to issue management directions. Environmental Licences were renewed for a period of two years in 2023 and for the first time included requirements to: (a) develop and implement DO mitigation plans to reduce or offset oxygen consumption in the Harbour; and (b) develop and implement a water quality monitoring program to measure success of the mitigation compared against the published interim Default Guideline Values for DO.

Annual Marine Farming Licences contain requirements to monitor production levels and inputs, and no longer contain environmental monitoring and compliance conditions. With the introduction of the *Tasmanian Salmon Industry Plan* in 2023, there also a broad range of regulatory, policy and engagement reforms being implemented.

Phase 4 (2024) – Environmental Licences will be varied to impose conditions set out in Part 4 of the *Environmental Standards for Tasmanian Marine Finfish Farming*. The Broadscale Environmental Monitoring Program (BEMP) will also be re-specified in line with the *Environmental Standards for Tasmanian Marine Finfish Farming*, taking into account the recommendations of IMAS and the independent advice from the Scottish Association of Marine Sciences (SAMS). Trigger Levels for DO will be put in place at appropriate depths to better address middle and deep water oxygen issues. Comprehensive compliance and reporting will be required, to demonstrate compliance with environmental conditions and the Environmental Standards.

4.3 Monitoring Framework

At the core of the AMF for marine farming in Macquarie Harbour is a detailed and targeted environmental monitoring program to detect impacts at both 'Harbour-wide ecosystem' and 'lease scales' (Figure 3).

Macquarie Harbour Monitoring Program

The Macquarie Harbour Monitoring program has been in place since 2011 and includes water quality and benthic monitoring at both harbour and marine farm lease scale.

Harbour-wide Monitoring*

To determine if there are any causal impacts from salmon farming on the broader habitat. Results are assessed against trigger limits and Default Guidelines Values for Macquarie Harbour.

Lease scale environmental monitoring

No significant visual, physio-chemical or biological impacts at or extending 35 metres from the boundary of the Lease Area.

Broadscale Environmental Monitoring

- Water Quality program implemented by salmon companies
- Monthly sampling at 17 (11 compliance 6 industry led) representative sites across the harbour
- Parameters monitored at different depths within the water column:
 - Nutrients (ammonia, nitrate and TKN)
 - DO, temperature, salinity, oxygen saturation, turbidity
 - Chlorophyll a and phytoplankton
- Continuous real time data at 3 sites for DO, salinity and temperature at depths of 10, 25 and 35 metres.

Water Quality Monitoring

- Continuous DO monitoring at representative depths within each Lease Area boundary
- Other water quality monitoring as defined in the Water Quality Monitoring Plan

Benthic Monitoring

Under pens

- Pre-stocking visual surveys to ensure no extensive bacterial mats, excessive feed, or gas bubbling is present.
- Annual benthic video surveys to identify excessive feed dumping, extensive bacterial mats, spontaneous gas bubbling.

Compliance and recovery sites

- Quarterly video surveys at compliance and recovery sites to document biological health of sediments and macrofauna, including ongoing visual observations for pellets, bacterial mats, gas bubbling and polychaetes.

EPA Tasmania Water Quality Monitoring

- Quarterly sampling at 15 sites at various depths of the water column
- Parameters monitored:
 - Nutrients (ammonia, nitrate and TKN)
 - DO, temperature, salinity, oxygen saturation, turbidity
 - Chlorophyll a and Phytoplankton
- Continuous real time data for DO at 5 sites at depths of 10, 25 and 35 metres.

Lease scale production monitoring

Marine farming licence holders must provide a quarterly report that includes:

- monthly biomass, smolt and feed inputs, standing biomass, stocking density
- biofouling management
- Forecast data of feed inputs and derived nitrogen values, fallowing regimes, smolt inputs and biomass.

Benthic Monitoring

- Video surveys at 28 compliance sites outside of marine farming lease area, including the baseline survey control sites.
- Visual assessment of the biological performance of the sediments and macrofaunal communities.

Macquarie Harbour Model

- Hydrodynamic and biogeochemical model developed by CSIRO to predict oxygen concentrations and demand.

* All the components of the Harbour Wide Monitoring will be reviewed and amalgamated into a Macquarie Harbour Broadscale Environmental Monitoring Program in 2024-2025.

Figure 3: Current Environmental Monitoring Framework for Macquarie Harbour Harbour-wide (ecosystem) environmental monitoring

In addition, NRE Tas and EPA Tas manage a comprehensive independent research program to complement and use data generated by the monitoring program. The research outcomes produced by this program continue to inform management responses to protect the Maugean skate and to improve and maintain environmental conditions within the Harbour. A list of key research commissioned by industry, NRE Tas and EPA Tas is summarised in Attachment 2.

The purpose of the 'Harbour-wide' monitoring program is to determine if there are any causal impacts from salmon farming on the broader habitat and values within Macquarie Harbour. The current components of the 'Harbour-wide' monitoring are:

1. Broadscale Environmental Monitoring;
2. EPA Tas Water Quality Monitoring;
3. CSIRO Macquarie Harbour predictive model; and
4. Benthic Monitoring.

1. Broadscale Environmental Monitoring (BEM)

Environmental Licences for marine farms in Macquarie Harbour require industry to monitor water quality at 11 sites on a monthly basis (Figure 4). Monitoring data, management responses and research reviews over the past ten years have informed the ongoing design of the BEM. In December 2013 an additional six sites were included in the program. Most of these sites were added to better understand the influence of river and ocean inputs on carbon and nitrogen loads in the system, and thus, their influence relative to aquaculture on oxygen levels. Since 2014 monthly monitoring has been conducted at 17 sites across the Harbour.



Figure 4: Location of BEM sites within Macquarie Harbour

Parameters monitored at different depths within the water column include: nutrients (ammonia, nitrate and Total Kjeldhal Nitrogen (TKN), DO, temperature, salinity, oxygen saturation, turbidity chlorophyll a and phytoplankton. Data collected for ammonia, nitrate and DO under the BEM is used to demonstrate compliance with the water quality limits for ammonia (2 m and 20 m), nitrate (2 m), and oxygen (2 m).

In 2016, industry installed data loggers at three sites adjacent to the marine farming lease area which collect continuous real time data for DO, salinity and temperature at increments of 2.5 m to 10 m and every 5 m after that to the seabed. The data collected from these sites is combined with the other water quality data collected across the Harbour to inform management responses.

From December 2023, the water quality monitoring is being assessed against the Interim Default Guideline Values for Aquatic Ecosystems⁶ that were published by EPA Tas in November 2023.

2. EPA Tas Water Quality Monitoring

EPA Tas has routinely undertaken quarterly water quality monitoring at 15 sites within Macquarie Harbour since 1993, which represents the longest time series available for this estuarine system. The monitoring has included physio-chemical parameters, nutrients, and metals. Samples are taken near the surface and at 1 m intervals to approximately 1 m above the bottom. EPA Tas has also recently re-established its continuous data logger and installed four new loggers for DO at depths of 10 m, 25 m and 35 m from the surface. EPA Tas intends to install additional loggers in 2024. (Figure 5)

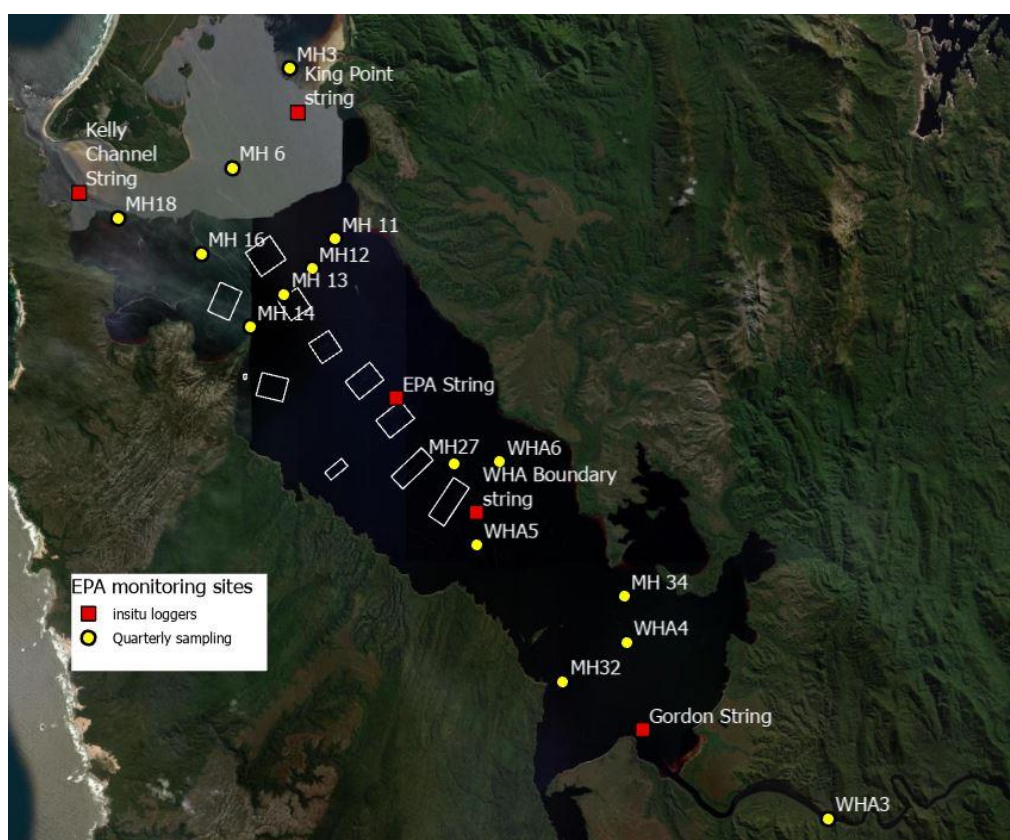


Figure 5: EPA Tas monitoring sites within Macquarie Harbour

⁶ [Interim Default Guideline Values for Aquatic Ecosystems Macquarie Harbour - Segment 119.pdf \(EPA Tasmania Tasmania.tas.gov.au\)](#); [Interim Default Guideline Values for Aquatic Ecosystems Macquarie Harbour - Segment 120.pdf \(EPA Tasmania Tasmania.tas.gov.au\)](#); [Interim Default Guideline Values for Aquatic Ecosystems Macquarie Harbour - Segment 121.pdf \(EPA Tasmania Tasmania.tas.gov.au\)](#)

3. CSIRO Macquarie Harbour predictive model

The CSIRO has developed and implemented a biochemical and water quality model for Macquarie Harbour. The model reproduces the hydrodynamics, biochemical cycling and DO conditions in the Harbour. It is calibrated and validated using data collected from a CSIRO profiling water quality mooring, EPA Tas's continuous DO data sets and industry logger strings. The model is used to predict oxygen concentration and demand across the Harbour.

4. Benthic Monitoring

The Environmental Licence conditions for marine farms in Macquarie Harbour require industry to conduct quarterly benthic video surveys at a total of 28 baseline and survey control sites (Figure 6). This survey enables a visual assessment of the biological health of the sediments and macrofaunal communities within the Harbour to be monitored, which enables any impacts to be detected. In addition to these control sites, compliance monitoring also occurs around the lease boundary of each of the leases every four months. However, the exact number and location of these compliance sites varies based on the farm husbandry practices employed on each of the leases.

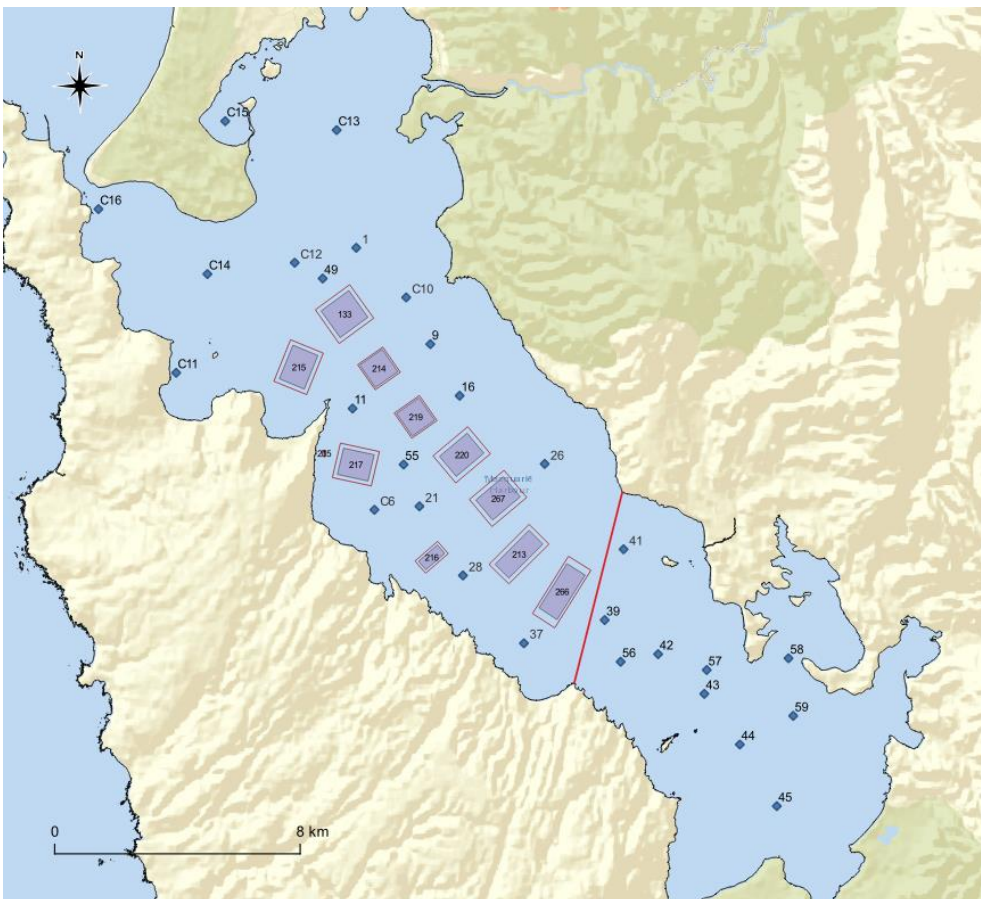


Figure 6: Current benthic monitoring sites within Macquarie Harbour

Review of the Harbour-wide (ecosystem) monitoring

Collectively all four of the elements of the 'Harbour-wide' monitoring program described above form a BEMP. EPA Tas commissioned two reviews (Ross *et al.* (2022) and Black *et al.* (2022)) of the BEMP in Macquarie Harbour to evaluate the suitability and efficacy of the existing program to detect environmental impacts of finfish farming at regional scales. The reviews concluded that:

- The number and location of monitoring sites should be rationalised to ensure detection of broad-scale ecosystem effects while increasing the frequency of some parameters being monitored including DO for bottom and mid waters.
- Existing benthic monitoring methods should be expanded to include routine sampling of physio-chemical and biological parameters of soft sediment habitats and other key water quality sampling parameters.
- Low density monitoring of seagrass and seaweed communities should be undertaken.
- Macquarie Harbour BEMP and its distinct role amongst the other monitoring and research programs in Macquarie Harbour should be identified.
- An integrated annual report to summarise monitoring data and increase accessibility for the public should be developed.

EPA Tas supported the outcomes of the reviews and has incorporated the requirement for increased DO monitoring into Environmental Licences for marine farms in Macquarie Harbour. EPA Tas will consult with industry and key scientific experts at IMAS, CSIRO, SAMS and Analytical Services Tasmania to develop the revised broadscale environmental monitoring program for Macquarie Harbour. The revised BEMP is being prioritised for implementation.

During 2024, the independently reviewed BEMP will be re-specified to meet the criteria of a BEMP as described in Division 4 of the *Environmental Standards for Tasmanian Marine Finfish Farming 2023*.

Lease Scale Environmental Monitoring

The purpose of the 'lease scale' monitoring program is to ensure that each marine farm lease is being managed in accordance with regulatory requirements to ensure that there are no significant visual, physio-chemical, or biological impacts at or extending 35 m from the boundary of each Lease Area. This includes:

1. Water Quality Monitoring;
2. Benthic Monitoring; and
3. Lease scale production reporting.

Water Quality Monitoring

In November 2023 requirements for industry to conduct continuous DO monitoring at representative depths within each Lease Area boundary were added to Environmental Licences for marine farms in Macquarie Harbour. The DO monitoring requirements are to be included in a Water Quality Monitoring Plan approved by EPA Tas. The purpose of the monitoring is to determine if mitigative actions to increase DO across the Harbour are effective.

Benthic Monitoring

To enable a visual assessment of the biological performance of the sediments and macrofaunal communities within the marine farming lease area, the environmental licence conditions for marine farms in Macquarie Harbour stipulate that industry is required to undertake the following benthic monitoring:

- Pre-stocking visual surveys of pen bays to ensure no extensive bacterial mats, excessive feed, or gas bubbling are present prior to restocking of individual pen bays;
- Annual benthic video surveys of pen bays to identify excessive feed dumping, extensive bacterial mats and spontaneous gas bubbling; and
- Four monthly video surveys at compliance and recovery sites 35 m from the lease boundary to document biological health of sediments and macrofauna.

Lease Scale Production Reporting

Under Environmental and Marine Farming Licences industry is required to provide quarterly reports that contain:

- monthly biomass and production data including smolt inputs, standing biomass, stocking density;
- biofouling management data;
- monthly quantity of feed for each pen bay; and
- forecast data of feed inputs and derived nitrogen values, fallowing regimes, smolt inputs and biomass.

Lease scale production data enables assembly of core data for reporting and benchmarking purposes. These data provide valuable contributions to the broader salmon regulatory framework by providing insights into the performance of policy settings and to assist in identifying areas of further research or monitoring priority.

4.4 Adaptive Management Framework remains appropriate and effective

Through the AMF the Tasmanian Government, industry and the research community have been able to obtain and analyse accurate and timely information – including baseline and trigger limits – for water quality and benthic conditions in Macquarie Harbour.

This information has enabled impacts to water quality and benthic habitat within Macquarie Harbour to be detected, and informed management responses implemented by industry, to ameliorate the potential and identified environmental impacts from salmon farming on the environment within Macquarie Harbour.

The comprehensive monitoring program, which has been peer reviewed by independent Tasmanian and international scientists, has enabled the effectiveness of regulatory and management responses implemented to be measured. The monitoring and research programs will continue to evolve over time in response to data and information gathered, ensuring that marine farming in Macquarie Harbour will continue to operate under current best practice environmental management.

Table 1 below demonstrates the AMF in action through the management responses to limit biomass levels and nitrogen inputs and introduce new monitoring and operational activities to manage low levels of DO in Macquarie Harbour.

Table 1: Management responses implemented in Macquarie Harbour

Date	Impacts identified	Management Response
Feb 2017 – June 2017	<p>Benthic monitoring identified an increase in the bacteria <i>Beggiatoa</i> and a decline in faunal abundance in the vicinity of leases, leading to a significant deterioration in the level of compliance with benthic indicators monitored through the regulatory video survey monitoring for the periods May 2016, September 2016, and January 2017. The September 2016 benthic surveys determined that 21% of compliance sites across four lease areas were non-compliant with <i>Beggiatoa</i>. The January 2017 benthic surveys determined 36% of compliance sites across six lease areas were non-compliant with <i>Beggiatoa</i> trigger limits.</p> <p>Ongoing benthic surveys in Macquarie Harbour highlighted deterioration in conditions under and around the farms, a significant decline in the total abundance and number of benthic fauna species collected from the leases assessed and provides significant concerns regarding the potential for sediment “souring”.</p> <p>In April 2017, monitoring reported in late 2016, identified DO conditions in the middle and bottom waters were extremely low, before a replenishment of oxygen was seen in the deep bottom waters in early 2017. It was unclear to what extent individual farms were contributing to the low DO water body (bodies) in the broader Harbour.</p>	<p>The Director EPA Tas, under Delegation of the Secretary, made a determination to reduce biomass in Macquarie Harbour from 21,500 tonnes (established by the Secretary in April 2016) to 14,000 tonnes.⁷</p>

⁷ [EPA Tasmania Statement of Reasons May 2017](#)

Date	Impacts identified	Management Response
June 2017 – June 2018	As above.	The biomass determination reduced biomass in Macquarie Harbour from 14,000 tonnes to 12,000 tonnes.
June 2018 – May 2020	<p>The Harbour wide and lease scale monitoring program indicated that while the benthic community in the Harbour was showing signs of recovery in May 2017, there was a return to very low oxygen levels in spring 2017 and a subsequent infaunal decline at lease sites in the October 2017 survey.</p> <p>Monitoring results suggested that until DO levels recover and stabilise over the longer term, it would be difficult to see a sustained benthic recovery.</p> <p>Benthic infauna results from the January 2018 survey indicated that since May 2017, there was a decline through October 2017 and January 2018 at lease sites indicative of the effects of the low bottom water DO concentrations. A reduction in species diversity and abundance since the October 2017 surveys was evident at some locations in January 2018.</p> <p>Water quality monitoring for bottom and mid-water DO levels in the Harbour over spring/summer 2017/2018 showed a recharge in DO in the bottom waters in November, following the very low levels of early spring 2017. Subsequent improvement was also observed in the mid-water range, although to a lesser degree. Increases in DO levels also occurred over summer and again in late March 2018. However, the oxygen levels in the water column continued to vary.</p> <p>Sub-surface DO conditions in the Harbour remained low in comparison with historical levels, reflecting the need for sustained, broad-scale</p>	<p>A biomass determination was made by the Director EPA, under Delegation of the Secretary of DPIPW.</p> <p>The biomass determination reduced biomass in Macquarie Harbour from 12,000 tonnes to 9,500 tonnes⁸.</p>

⁸ [EPA Tasmania Statement of Reasons May 2018](#)

Date	Impacts identified	Management Response
	recovery of oxygen levels in the bottom and mid-waters of the Harbour.	
June 2020 – May 2022	<p>The Harbour wide and lease scale program indicates that the ecological conditions in Macquarie Harbour showed an improvement in some key environmental parameters both on and off lease in comparison with Spring/Summer 2016/2017.</p> <p>The results from the June 2019 monitoring survey indicate improved sediment conditions including an increase in the number and abundance of benthic species and reduced <i>Beggiatoa</i> bacterial mats on most of the survey sites. However, DO levels in the mid and bottom waters in November 2019 were still lower than levels observed historically.</p> <p><i>Beggiatoa</i> compliance surveys: EPA Tas review of January 2020 survey results found 13 non-compliant survey points for <i>Beggiatoa</i> detected across three leases. Eleven of these non-compliances were recorded at the southernmost leases. Surveys indicated that areas of <i>Beggiatoa</i> across the wider Harbour decreased and improvements in the benthic habitat were documented.</p> <p>Monitoring indicates compliance with water quality limits and rolling annual median indicators for monthly ammonia, nitrate and DO data collected for sites located across Macquarie Harbour. Median values for ammonia and nitrate at 20 m represent amongst the lowest concentrations since 2011. DO concentrations at 20 m, while remaining below the long-term modelled 20th percentile value, showed limited improvement when compared to other 12-month periods to April over the last three years. Long term EPA Tas monitoring of DO in Macquarie Harbour continues to indicate that levels are significantly below historical levels (4-6 mg/L) pre 2010 for mid</p>	The Director EPA Tas, under Delegation of the Secretary of DPIPWE made a determination to retain biomass at 9,500 tonnes. ⁹

⁹ [EPA Tasmania Statement of Reasons June 2020](#)

Date	Impacts identified	Management Response
	and bottom waters with levels below hypoxic conditions.	
June 2022 – Aug 2022	Environmental monitoring indicates that DO in mid waters remains low.	The Acting Secretary of NRE Tas made a determination to retain biomass at 9,500 tonnes. ¹⁰
Sept 2022 - Aug 2027	<p>EPA Assessment of the Macquarie Harbour EMP data from 2011-2020 outlines the ecological condition of the Harbour during that period. This report shows that there has been an improvement in some key environmental parameters both on and off lease since the maximum permissible biomass was reduced from early 2017.</p> <p>The DO levels in Macquarie Harbour fluctuate considerably as they are influenced by complex riverine and oceanic inputs and other environmental conditions. The mid-water depth DO levels, which continue to remain lower than those observed historically. While DO levels in the Harbour vary due to the circulation pattern hydrodynamics, which are influenced by riverine and marine inputs, the DO drawdown due to finfish aquaculture in the middle and bottom water is significant.</p> <p>Production data submitted to NRE Tas under the Marine Farm Licences indicates that since 2018, annual feed inputs have gradually been increasing. This has occurred while complying with the peak standing biomass limit of 9,500 tonnes and appears to be due to a change in harvesting strategies and an increase in total annual production.</p>	The Director EPA replaces the biomass limit with a limit of 500.1 tonnes per annum of TPDNO for a period of five years across the marine farming lease area limiting the amount of nitrogen which can be released to the environment via feed inputs ¹¹ .
Nov 2023 – Nov 2025	Despite signs of improving, a review of the long-term monitoring data indicates that the DO in the deeper layers in the Harbour continues to be significantly below pre-2010. While DO levels in	The Director EPA approves Environmental Licences for marine

¹⁰ [Acting Secretary NRE Tas Statement of Reasons June 2022](#)

¹¹ [EPA Tasmania Statement of Reasons for TPDNO determination August 2022](#)

Date	Impacts identified	Management Response
	<p>the Harbour vary due to the circulation pattern hydrodynamics, which are influenced by riverine and marine inputs, the DO drawdown due to finfish aquaculture in the middle and bottom water is significant¹². Monitoring indicates that reduced freshwater flow through the Harbour is allowing tidal incursions of marine waters to displace bottom (recorded at 35 m) waters upwards into the mid-depth (recorded at 25 m) and subsequently surface (recorded at 10 m) depths. DO values in bottom and mid-depth water have also declined over this period with bottom waters between 1 mg/L and 2 mg/L, compared to the long-term average ~4.2 mg/L, and mid-depth water in the vicinity of 1 mg/L, compared to a long-term average ~4 mg/L.</p> <p>DO at 2 m depth has remained steadily above the limit, indicating well oxygenated surface waters with DO levels in the range of 8 to 10 mg/L. Following an improvement in DO levels at 20 m depth in 2021, concentrations in 2022 returned to lower levels, similar to those observed in 2016-17. More recent datasets however indicate improved DO concentrations at this depth. The last two assessment periods have shown levels around 2.7 mg/L.</p> <p>Marine farm lease areas' median rolling annual values for each specified parameter and water depth are compared against the relevant limits. Median values for ammonia and nitrate have remained stable in recent years and have continued to show improvement compared to earlier reporting periods (e.g. 2016). All values remain well within the respective limits.</p>	<p>farms in Macquarie Harbour that include condition to determine the overall DO demand resulting from finfish activities; implementation of a Dissolved Oxygen Mitigation Plan to substantially offset or reduce DO demand from each lease; and Implementation of an approved Water Quality Monitoring Plan to measure the success of the DO mitigation measures against the interim default guideline values set by EPA Tas.¹³</p>

¹³ [EPA Tasmania Environmental Licence renewals for Macquarie Harbour](#)

Ross *et al* (2021) illustrates Macquarie Harbour has a complex oxygen budget with many factors influencing draw down and recharge. As Figure 7 illustrates, DO levels and benthic conditions vary considerably from year-to-year. Long-term oxygen budget monitoring indicates that despite seasonal and annual variability, the total tonnage of oxygen below 15 m has increased from 2014 to 2023.

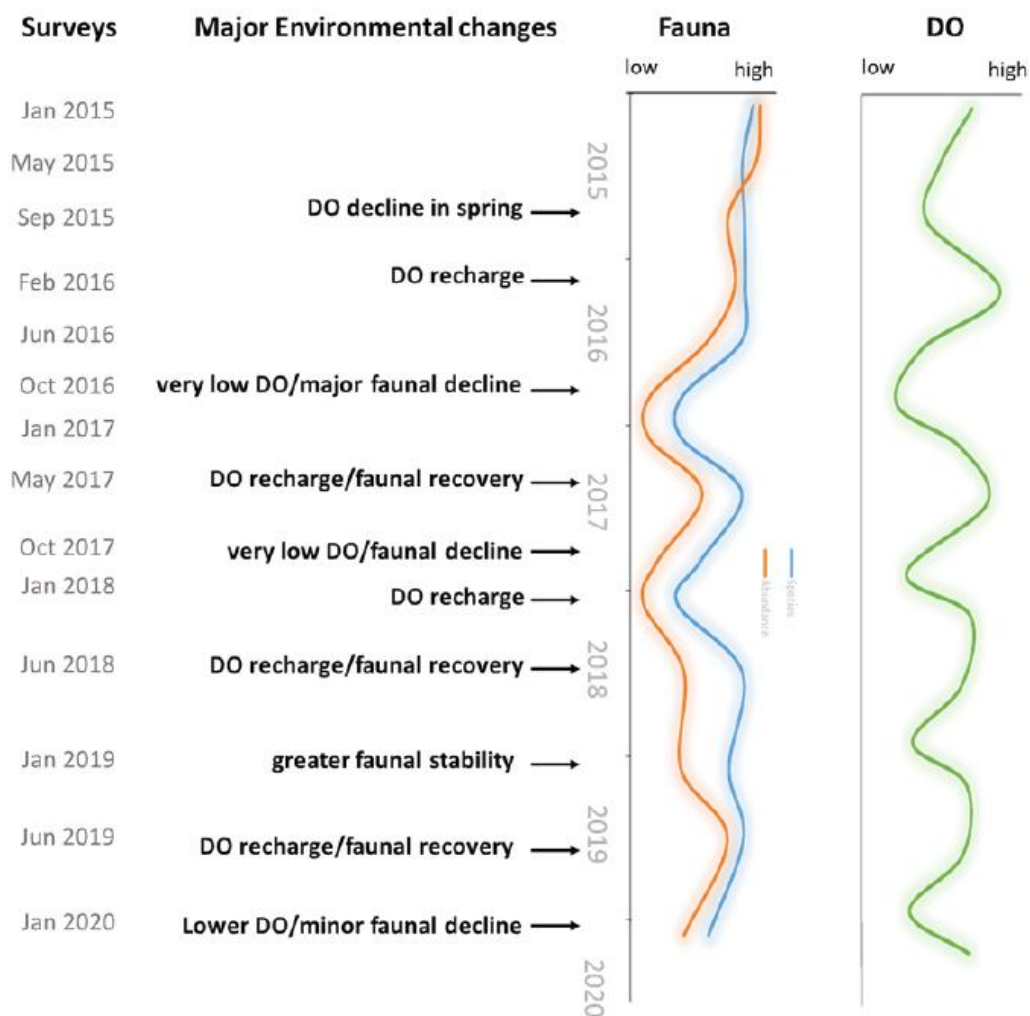


Figure 7: Changes in Benthic Fauna and Environment in Macquarie Harbour 2015-2020 (Ross *et al* 2021)

The data generated by the ‘Harbour wide’ and ‘lease scale’ monitoring program up to mid-2020 was reviewed by IMAS (Ross *et al* 2022) and demonstrated that the management responses implemented have led to improvements in some key environmental parameters, both on and off lease, since the maximum permissible biomass was reduced from early 2017.

Between 2018 and 2021, nutrient concentrations across the Harbour declined from previous elevated levels. Monitoring of various forms of nitrogen, including the observed trends in TKN in bottom waters, suggests that there had been an increase in the organic nitrogen pool within the system that is now beginning to decline (Ross *et al.* (2020)). This is an important indicator as

excess nutrients in the system lead to additional oxygen drawdown. Activities by Hydro Tasmania to improve flow regimes of the Gordon River entering the Harbour and the TPDNO cap of 500.1 tonnes will continue to ensure that nitrogen levels within the Harbour decline. However, it is also important to note, as was observed by Ross *et al* (2021) the pivotal role played by weather, both direct and indirectly (wind, river flow, etc.) in influencing the magnitude and extent of seasonal DO decline.

As indicated by Ross *et al* (2022) benthic surveys show overall improved sediment conditions, including an increase in the diversity and abundance of benthic species across the Harbour. Notably, at the majority of both lease and external sites faunal abundance and the number of species have returned to or are closely approaching the range observed prior to the decline in spring 2016-early 2017 (Ross *et al*. 2020). In the period between May 2021 to May 2023, non-compliance for benthic surveys at compliance sites situated 35 m from the lease boundary for all marine finfish farming leases in Macquarie Harbour sat within the range of 0% - 2.9%. When compared to the non-compliance rates of 36.2% in January 2017, this indicates that the environmental management controls being enforced through the Environmental Licences are effectively managing benthic impacts across Macquarie Harbour (Attachment 3).

Long-term data for DO shows a relatively consistent trend from 1993 through until 2009. From 2008-09 to 2013-14 there was a notable decline in DO at depths >20 m. The DO of surface waters (0 m to 5 m) has remained high (>90% saturation) and relatively stable. At 5 m to 10 m depth, DO is variable between 70% – 90%, with monitoring data indicating a slightly declining trend. At 10 m to 15 m the trend is similar to 5 m to 10 m, but DO is typically ~50% saturation. The depth categories from 15 m to 20 m through to 30 m to 35 m declined from late 2011 through until mid-2014 when concentrations were in the 10 – 20% range, then increased due to a recharge of deep waters that occurred in late July 2014 when concentrations increased to >30% in most instances. Since 2014, as Ross *et al* (2022) indicated, DO monitoring has shown a slow upwards trend due to periodic recharges, particularly in summer, and periods of decline through winter and spring.

5. RISK ASSESSMENT – ONGOING SALMON FARM OPERATIONS IN MACQUARIE HARBOUR

5.1 Background

A detailed risk assessment of ongoing salmon farming operations in Macquarie Harbour has been undertaken based on the Australian Government's *Matters of National Environmental Significance – Significant Impact Guidelines* which describes a significant impact as:

“An impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.”

The risk assessment has been completed utilising comprehensive monitoring data and research findings generated by the AMF over 12 years and focuses on those risks identified in the 2012 referral.

5.2 Risk Assessment – findings

The overall outcome of the risk assessment (Attachment 3) is that the ongoing marine finfish farming operations undertaken under the AMF within Macquarie Harbour will not, or are not likely to have, a significant impact nor have they contributed to significant cumulative impacts on critical foraging or breeding habitat of cycles for the Maugean skate, nor will they reduce the area of occupancy or quality of habitat available for the species.

In particular, there is no evidence to indicate a current direct causal link between salmon farming and the population decline of the skate. There is a growing understanding of the synergistic nature of threats to the species from multiple sources which are being addressed as part of the CAP.

Further, the risk assessment indicates that the current management regime in place for salmonid production is effectively managing the range of potential impacts to the environment within Macquarie Harbour.

Sensitivity of the environment

Macquarie Harbour is a shallow estuarine environment that experiences persistent thermal and salinity stratification which constrains fluctuations in water properties over seasonal scales, whilst event scale storms and floods can strongly influence the environment in any season. Monthly mean surface temperature ranges from around 20°C in summer to around 8°C in winter, modulated by river inflow and seasonal atmospheric heat flux; at 20 m depth temperature remains at around 15°C all year. Monthly mean surface salinity ranges from around 20 practical salinity units (PSU) in summer/autumn to less than 5 PSU in winter and spring modulated by river flow; at depth, salinity remains at about 30 PSU all year (Wild-Allen *et al* (2020)).

DO concentrations in the Harbour have a complex history, as described by Durand *et al* (2001). They note that a large deoxygenation event occurred roughly 400 years ago and progressed to its maximum around 200 years ago before subsiding. They also note that the impact of mining waste over the past 150 years has complicated interpretation of oxygen levels since this time, until the past 30 years when more detailed monitoring began.

Over the past 30 years much has been learnt about seasonal variation in, and environmental and anthropogenic influences on, DO in Macquarie Harbour. Surface waters are generally high in DO, while concentrations at depth are depleted, primarily due to stratification and slow flushing of deep water in the Harbour. DO levels at depth can, however, recharge quickly, as was noted by Bell *et al* (2016), in which they noted that a single July 2014 storm event recharged DO concentration at 17m from 12.8% to 72.4% over a 10.5 hour period.

Modelling undertaken by Wild Allen *et al* (2020) indicates that the Harbour oxygen budget is very close to balanced. They note however, the oxygen budget for the Harbour can be strongly influenced by the balance of river flows and oceanic water entering the Harbour. Lower river flows potentially lead to higher marine influx, which enables oxygen recharge at depth in the Harbour to occur.

The benthic environment within the Harbour is considered to be naturally depauperate with unique benthic fauna that has arisen due to sediments enriched with large amounts of terrestrial organic carbon, low oxygen levels and historical heavy metal pollution (Ross *et al.* (2020)).

The Maugean skate has a strong preference for shallow channels between 5 m and 15 m (Moreno *et al* (2020)) with water that generally has relatively stable temperatures (12–15 °C) and salinity (18–27 parts per thousand (ppt)), and naturally low-moderate DO concentrations (30–80% DO) (Bell *et al* (2016); Morash *et al* (2020)).

Timing, duration and frequency of the action and its impacts

The action under re-consideration is the expansion of salmonid farming in Macquarie. Salmon farming has occurred in Macquarie Harbour since 1986 and the ten current marine farming leases, currently expire between 2029 and 2043, as indicated in the Table 2 below.

Table 2: Lease Areas in Macquarie Harbour

No	Spatial area	Locality	Zone	Lease expiry
133	119.98	North Liberty Point	Zone 4B	31/12/2042
213	99.99	North East of Hogan Cove	Zone 1	20/05/2029
214	79.98	Liberty Point Central Harbour	Zone 7	31/03/2030
215	105.99	Table Head	Zone 3A & 3B	31/10/2043
216	29.98	North East Pelias Cove	Zone 2	30/11/2038
217	89.99	Liberty Point	Zone 4A	28/02/2038
219	80	South Central Harbour	Zone 8	28/02/2032
220	99.99	North East Double Cove	Zone 10	30/06/2043
266	119.99	North-east of Bryans Bay	Zone 9	31/01/2043
267	99.99	East of Butt of Liberty	Zone 11	31/01/2043

Salmon harvesting in the Harbour typically occurs across the months of January to April, with lesser volumes harvested in Spring and the lowest production levels observed in mid-Winter. Peak biomass typically occurs across the months of November to January.

As demonstrated in Section 8, the level of expansion outlined in the 2012 referral was not achieved over the long term by industry. Expansion was implemented in the years 2012 to 2016, with production levels peaking in 2015 with a biomass of 20,735 tonnes. Production levels (biomass levels) for salmon farming in the Harbour are now lower than levels achieved in January 2012 (ie, prior to the 2012 decision). The information is often presented on an annual basis, and this does not reflect the monthly contributions or the seasonal biomass (November to January – refer to Table 3). Importantly, nitrogen inputs for salmonid farming have been capped at a total of 500.1 tonnes per annum. This is a reduction of 50% from 2014-15, when 1,000 tonnes was applied and a reduction of 30% from 2011, when 750 tonnes was applied (Ross *et al* (2022)).

The total footprint of the marine farming leases in Macquarie Harbour is 926 ha or 3% of the total area of the Harbour. Not all of the actual area the total marine farming leases are in production on an annual basis due to fallowing and other operational requirements.

The ongoing action of salmon farming in Macquarie Harbour could have a significant impact on the estuarine environment within the Harbour and the Maugean skate if:

1. a substantial or measurable change in the hydrological regime of the Harbour occurred due to the ongoing operation of the marine farms;
2. the water quality of the Harbour was substantially changed by the ongoing operation of the marine farms leading to a reduction in the available habitat for the Maugean skate;
3. large areas of the benthic environment were destroyed/modified by the installation of pens or by the ongoing operation of the marine farms reducing foraging habitat and triggering physio-chemical processes that reduce DO within bottom layers;
4. the lifecycle of the Maugean skate was seriously affected by the ongoing operation of the marine farms; or
5. an invasive species that competes with the Maugean skate for habitat or prey or predated on juveniles or eggs was introduced or spread as a result of the ongoing operation of the marine farms.

The only *known* direct impact on the Maugean skate within Macquarie Harbour is incidental bycatch from fishing activities in Macquarie Harbour. Both recreational and commercial gillnetting occur in Macquarie Harbour. Lyle *et al* (2014) report that Maugean Skate are readily caught in gill nets. Bell *et al* (2016) note that, although they are not targeted, Maugean Skate have been caught regularly in gillnets since at least the early 1900s and reference first hand reports of occasional large captures (i.e. more than 10 in a single net). Maugean skate ecology and feeding behaviour exacerbate the risk of incidental capture by gillnets, which precipitated controls on recreational gillnet use in 2015. These were expanded and strengthened in 2022 and 2023. The CAP proposes bringing forward the cessation of commercial and recreational gillnetting in Macquarie Harbour to end this source of threat.

The main indirect impact identified for Maugean skate is changes to water quality impacting available habitat within Macquarie Harbour and skate behaviour. Changes to water quality, particularly temperature and DO, may impact the suitability of habitat utilised by the skate. Macquarie Harbour is a complex estuarine system, which is strongly influenced by river flows, oceanic influx, anthropogenic inputs (historical mining, sewerage, marine farming) and seasonal variations and climate change. All these processes have the potential to individually and collectively impact on water quality within Macquarie Harbour.

Total impact, which can be attributed to the action over the entire geographic area affected, and over time

The impacts from marine farming are considered anthropogenic inputs. The anthropogenic inputs associated with marine farming that can affect the estuarine environment within Macquarie Harbour are:

1. Excess nutrients contributed to the system via excretion and/or excess feed inputs.

Excess nutrients in the water column can cause physio-chemical processes which directly draw down oxygen from the Harbour oxygen budget. Excess nutrients in the benthic environment can create an environment for bacteria to grow, which triggers a biochemical remineralisation process in the sediment that draws down oxygen from the Harbour oxygen budget. The Macquarie Harbour Oxygen Process model has determined that 60% of the nutrient load generated from marine farming is exported to the ocean and not available within the Harbour (Wild-Allen *et al* (2020)).

2. Stocking rates or biomass levels, which affect the amount of oxygen that is drawn down from the Harbour oxygen budget by respiration.

As outlined previously, DO within the Harbour is complex and influenced by a wide range of processes. If the oxygen budget enters into deficit, then hypoxic water and sediment events can occur. The Macquarie Harbour Oxygen Process Model completed an oxygen budget analysis for 2017–18 data and found the largest influx of oxygen to the Harbour was from rivers (66%), marine input (10%) and air-sea flux (6%); while the greatest loss terms were from export to the ocean (87%), and biogeochemical remineralisation processes in the sediment (8%). Farmed fish respiration comprised (3%) (Wild-Allen *et al* (2020)).

At the time, the model considered scenarios to explore reduced anthropogenic load on Harbour water quality by omitting fish farm respiration and nutrient loads. This reduction in anthropogenic load from marine farming resulted in a 50% reduction in hypoxic water and a 40% reduction in hypoxic sediment (Wild-Allen *et al* (2020)). However, this scenario used data from 2017, when biomass levels were 16,544 tonnes and total nitrate inputs were 800 tonnes. In 2023, the harvest production level in Macquarie Harbour was, at 8,549 tonnes, or around 53% of the peak of 16,034 tonnes in 2017, and total nitrate inputs are capped at 500.1 tonnes.

Recent calculations indicate that the total tonnage of oxygen below 15 metres is currently increasing, as is shown by Figure 8.

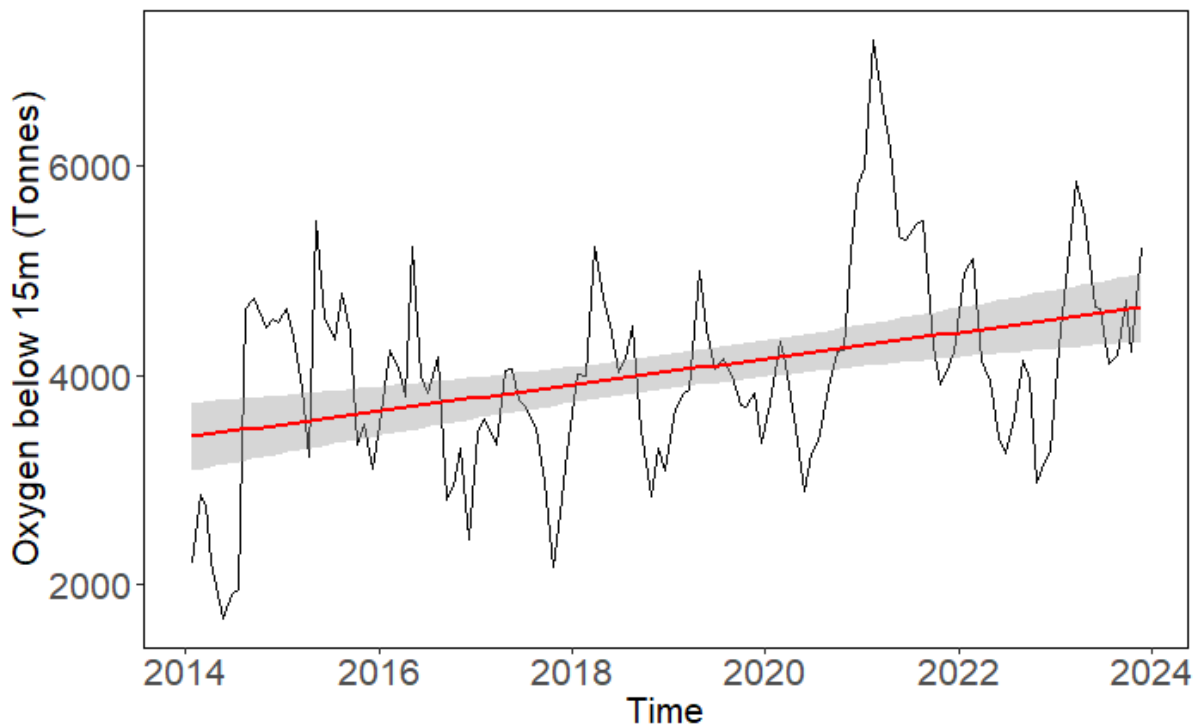


Figure 8: First order estimate of the mass (tonnes) of DO below 15 m in the Harbour from 2014 to 2023 based on monthly DO vertical profiles collected at 16 monitoring stations spread through the harbour. Each station was assigned a representative area and the DO concentrations measured at 1 m depth intervals below 15 m was multiplied by each intervals representative volume, and then summed for each area and the whole Harbour. (IMAS pers comm. Unpublished data Dec. 2023)

Scenario testing and benthic monitoring also indicates that the management responses to ameliorate impacts related to higher biomass levels, and nitrate inputs have reached a point where salmon production is not having a significant impact on the estuarine environment within the Harbour. The ongoing action of marine farming in Macquarie Harbour will not, and is unlikely to have, an impact or cumulative impact on the benthic environment or water quality within Macquarie Harbour.

Existing levels of impact from other sources

As outlined previously, gillnetting within the Harbour has a known direct impact on Maugean skate. While there is no consolidated data set for the number of skate mortalities annually, the impacts could be significant, as there are currently two commercial gillnetting licences and 250 recreational gillnetting licences held by residents within 50km² of Strahan, with a further 1,400 licences held by nearby North West Coast recreational fishers.

The Tasmanian Government instituted a range of interim controls on recreational and commercial gillnetting¹⁴ in November 2022 that were extended in November 2023. The Government is now acting to remove this current threat as part of the CAP actions, by bringing forward the cessation of commercial and recreational gillnetting in the Harbour. While the timeframe for this has not been finalised, consultation with industry and the community will be focused on the process and timeline for mitigating this activity.

The Macquarie Harbour Oxygen Process Model has determined that there is a strong relationship between river flow, marine influx of oxygen and hypoxia (Wild-Allen *et al* (2020)). The model determined that when reduced river flows occurred, there is a 20% greater influx of marine water into the deeper layers of the Harbour and a reduced number of hypoxia events. When increased river flow occurred, marine influx was suppressed by at least 20% increasing deep water residence time which, in turn, increased hypoxia within the Harbour (Wild-Allen *et al* (2020)). The Gordon River is the main contributor of freshwater flows into the Harbour and is a regulated river system managed by Hydro Tasmania. Discussions with Hydro Tasmania regarding an optimal flow regime into the Harbour that will maximise the opportunity for oxygen recharge events to occur have commenced. If an optimal flow regime for the Harbour can be implemented, it is highly likely that the frequency of natural oxygen recharge events will increase and hypoxia events will decrease. This is already clearly evidenced by a recharge event in January 2024.

Long-term monitoring data indicates that water temperature within Macquarie Harbour and sea surface temperature (SST) in the ocean adjacent to the Harbour are rising (Ross *et al* (2022)). Data indicates that there is a clear positive relationship between the SST from outside the Harbour and temperature measured inside the Harbour at all depths, but the pattern is strongest during the spring and summer months, when oceanic recharge is most common. This suggests that water temperature at depth in Macquarie Harbour is mostly influenced by oceanic recharges rather than from top-down warming and the influence of river flows on surface waters. It is unclear if the observed warming is the result of broader climate change patterns or part of natural long-term oscillations. However, these observations suggest that Macquarie Harbour has a unique dynamic that is distinct from most estuaries, where deep waters form a stable thermal environment with little seasonal variability, but are susceptible to long-term changes in external SST (Ross *et al* (2022)). Temperature can affect aerobic performance, energetic demands, fitness, other metabolic processes in organisms and importantly, oxygen solubility. If temperatures in Macquarie Harbour continue to increase, such increases are likely to have synergistic effect on all other stressors, including the oxygen dynamics of the Harbour (Ross *et al* (2022)). It is believed that the changes to SST are driven by climate change and as such there are no mitigative actions that can be implemented.

The largest input of nitrogen to the Harbour in 2017-18 was from rivers (45%), fish farms and sewerage (25%), and marine intrusions (23%) (Wild-Allen *et al* (2020)). Nitrogen inputs for marine farming have now been capped at a level 38% lower than those utilised in the 2017-18 analysis.

¹⁴ [Maugean Skate | Fishing Tasmania](#)

Degree of confidence with which the impacts of the action are known and understood

Due to the substantial water quality and benthic condition monitoring, research and analysis at both Harbour and lease scales completed over the last 12 years, the Tasmanian Government has a high degree of confidence in understanding the impacts that can occur from marine farming on water quality and benthic conditions within the Harbour. This knowledge has guided adaptive management by NRE Tas and EPA Tas to limit and ameliorate these impacts and guided development of the CAP. Water quality and benthic conditions within the Harbour continue to improve, with benthic conditions returning to conditions documented prior to expansion activities (Ross *et al* (2024)).

Moreno *et al* (2020) and Bell *et al* (2016) both outline that the preferred habitat for the skate is the shallow channels between 5 m to 15 m in depth within the Harbour. The habitat use and movement patterns determined by these studies concluded that the skate spends up to 95% of its time at this depth and has a high degree of site fidelity.

Long-term monitoring data across a range of sources for the Harbour indicates that DO levels for this habitat within the Harbour have not changed substantially, with average DO levels remaining at around 50% saturation, which is considered highly suitable for Maugean skate. This data supports the original modelling for DO and nutrients for the risk assessment within the 2012 referral that indicated the action would not result in any significant effect in areas inhabited by the species (considered, at the time, to be shallows less than 10 metres).

Earlier studies also postulated that low DO levels in deeper layers in the Harbour could be contributing to higher mortality rates of eggs and juveniles in deeper waters. However, Moreno *et al* 2020 outline that the majority of egg cases for the skate are found in the shallower preferred habitat of <10 metres, where DO levels remain stable and within the accepted range for the skate.

Moreno *et al* 2020 and 2023 note that the recent observed declines in relative abundance were linked to two high impact environmental events (in January 2019 and April 2019), and potential longer-term demographic effects resulting from changes in the size structure of the population and an apparent decline in recruitment. It is important to note, however, that there was a high degree of uncertainty associated with the estimates derived by Bell *et al* (2016), so Moreno and Semmens (2023) have relied upon use of catch per unit effort (CPUE) as a more consistent basis for estimation of relative abundance.

Moreno *et al* 2020 note that skate are subject to wide ranging fluctuations in water chemistry. For instance oxygen levels experienced ranged from normoxic (50-100%), hypoxic (20-50%) and to near anoxic (~0-20%), with individuals often experiencing substantial variation (as high as > 90%) in the range of DO levels experienced within the same day. They propose that whilst the Maugean skate has behavioural and physiological mechanisms that allow it to survive in these challenging conditions, recent changes to the environment (particularly DO levels and mixing dynamics) mean that high impact environmental events (such as occurred in 2019) pose significant metabolic/energetic risks to skate.

In these circumstances, the skate would seek refuge within the deeper or shallower layers of the Harbour until the water quality within their preferred habitat range returned to a suitable range. Given the evolutionary history and inherent variability of the complex hydrological dynamics of the Harbour, it is likely that similar events to this have occurred in the past. Indeed, Durand *et al* 2021 (in Ross *et al* 2021) have identified a low oxygen event that lasted for a period of 200 years. Moreno *et al* (2020) indicate that the deaths of tagged Maugean skate in their study corresponded with marked changes in environmental conditions, and concluded that this may have been related to stress caused by changes in environmental health of the Harbour coupled with the consequences of climate change.

As indicated earlier, the oxygen volume within the bottom layers in the Harbour has steadily increased in recent years and there has been a clear recovery in benthic community condition. It is notable that production levels are now below levels prior to the expansion action being granted. With the stronger restrictions on lease management and nitrogen cap in place, salmon farming activities in the Harbour will not decrease the availability or quality habitat within Macquarie Harbour for the Maugean skate to the extent that the species is likely to decline. Planned research and monitoring initiatives under the CAP, linked with the comprehensive monitoring program under the AMF, will both continue to provide a strong foundation for impact detection and regulatory adjustment and improve the understanding of the interplay between environmental and anthropogenic influences on the ecology of the Maugean skate within Macquarie Harbour.

The comprehensive and longstanding independent research and monitoring, the effective compliance regime, the strict regulatory settings and the innovative work underway as part of the CAP and by industry, demonstrates that the AMF is ensuring that the action will not have a significant impact on the Maugean skate.

PART B – BACKGROUND AND SUPPORTING INFORMATION

6. MACQUARIE HARBOUR

Macquarie Harbour is located on the West Coast of Tasmania and is Australia’s second largest natural harbour covering an area of 28,192 ha or 281 square kilometres (km²). Figure 9 shows that approximately one third of Macquarie Harbour is located within the boundary of the TWWHA. The remaining area is included in the Macquarie Harbour MFD. The township of Strahan and major road access to the Harbour is located on the northern shore of the Harbour. The western and southern shores are primarily accessible by boat and are incorporated into reserves including the Southwest Conservation Area and the TWWHA.

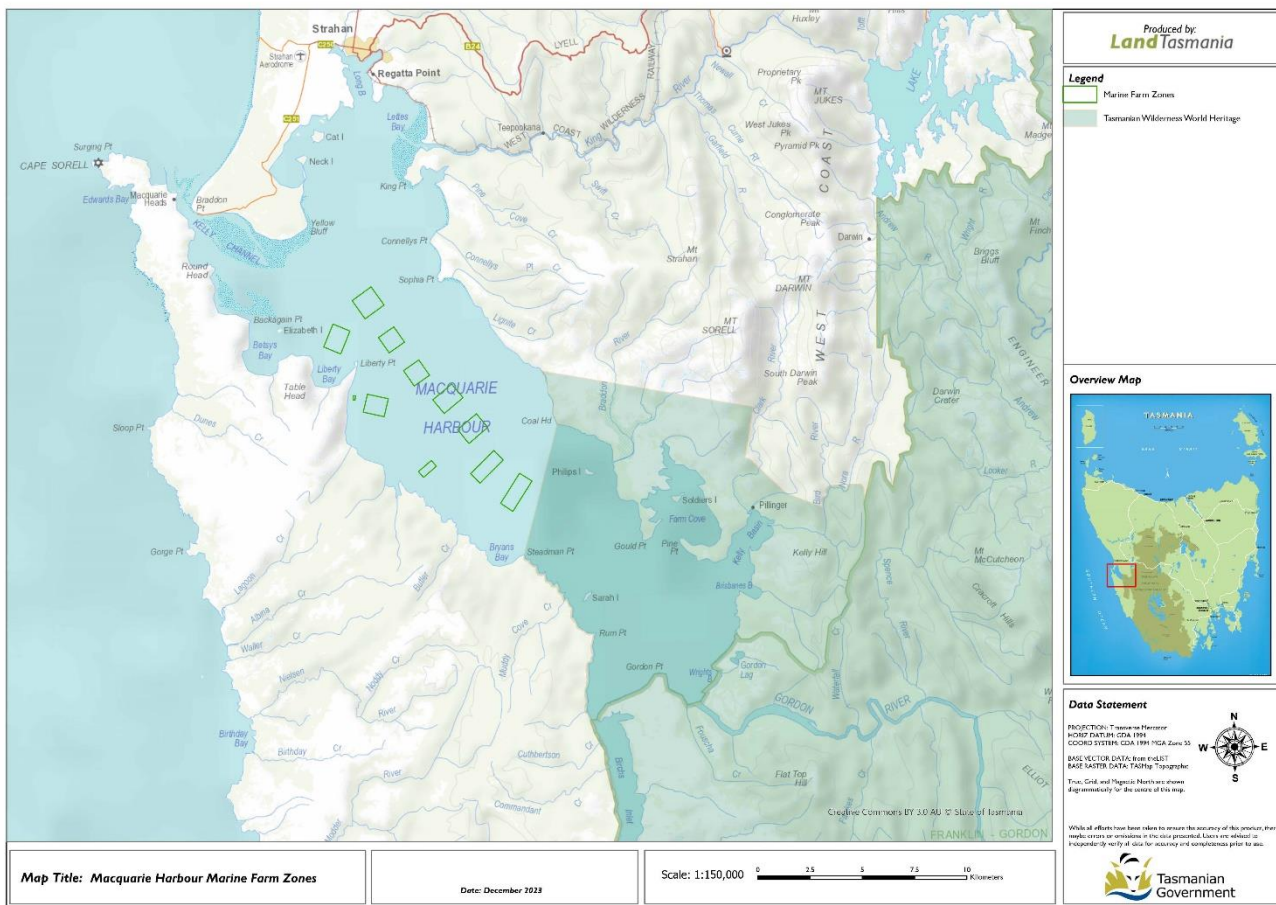


Figure 9: Macquarie Harbour, including delineation of Tasmanian Wilderness World Heritage Area and current Marine Farming leases within the Marine Farming Development Plan Area

Hydrology

Macquarie Harbour is an estuarine system with complex hydrodynamics and variable environmental conditions. The Harbour has a deep central basin with a shallow, narrow entrance to the Southern Ocean (Figure 10). While the Harbour's maximum depth is around 50 m, a shallow sill at its mouth (< 5 m) restricts exchanges with the ocean. The estuary is influenced by highly variable inflows of freshwater from the Gordon and King Rivers. Oceanic bottom waters mix with large amounts of freshwater and the water column in the Harbour is highly stratified, with a freshwater top layer, brackish mid-layer and deep waters which are close to marine salinity.

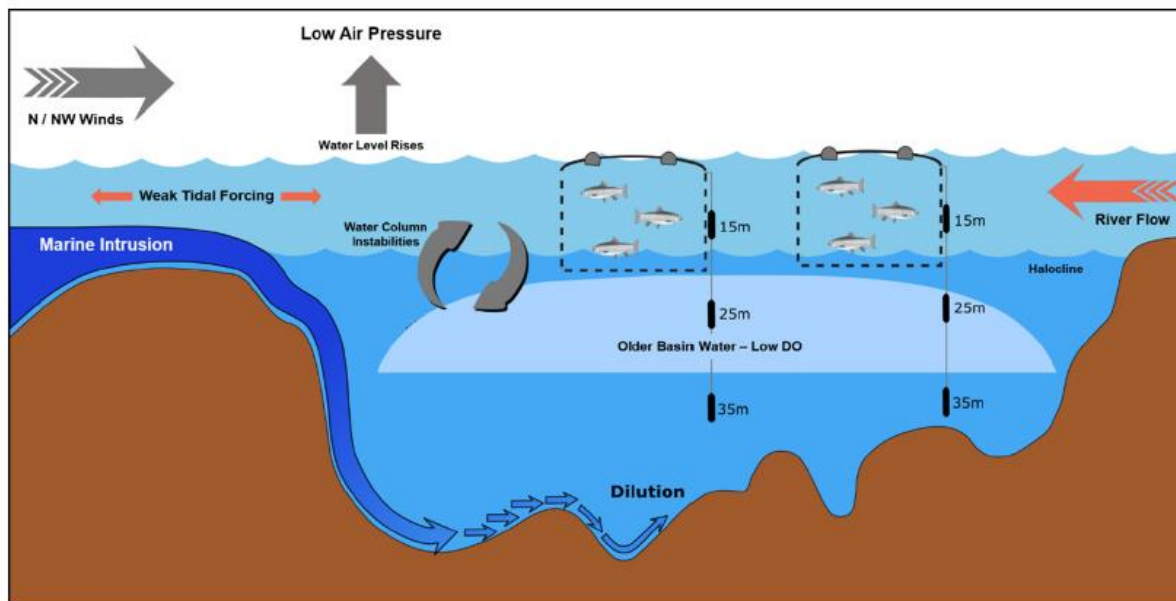


Figure 10: Conceptual model highlighting the drivers of deep water renewal in Macquarie Harbour (Hartstein *et al.* (2019))

While the hydrodynamics of the Harbour are well understood, the interactions between, and influences on, the layers within the water column are complex. The CSIRO has developed a model that simulates harbour dynamics. IMAS, in conjunction with CSIRO, is conducting ongoing research into the hydrodynamics of Harbour which will inform future management (Ross *et al* (2020)).

Water Quality

There are many factors that have influenced and continue to influence water quality in the Harbour, including historical mining runoff and legacy pollution to sediments, Hydro Tasmania freshwater pulses for power generation, ocean warming due to climate change, continual flood and drought events, aquaculture production, oceanic influences, and high exposure to predominantly westerly weather patterns. The shallow entrance to the Harbour restricts exchanges with the ocean. This isolation of deep water in the Harbour has resulted in a naturally depleted DO environment. The dark colour of the Harbour water which makes visual detection of skate

challenging is typical of waterways throughout the southwest of Tasmania and is caused by naturally occurring tannins in the water.

The *Assessment of the Macquarie Harbour BROADSCALE Environmental Monitoring Program (BEMP) data from 2011-2020*¹⁵ (Ross *et al.* (2022)) provides a detailed analysis of water quality within Macquarie Harbour. The report outlines that:

- There is evidence that nutrient concentrations have increased in Macquarie Harbour, particularly from the years 2012-2017 (nitrate, Total Kjeldhal Nitrogen (TKN) filtered and Total Nitrogen (TN) (unfiltered TKN)); however, nutrient concentrations appear to have declined since ~2018. Nutrient concentrations remain elevated, but these data (particularly ammonia) need to be treated with caution given the paucity of data from the late 1990s until the Macquarie Harbour BEMP began in 2011. The increase in TKN (filtered) and to a lesser extent TN, suggests that there was an increase in the organic Nitrogen (N) pool within the system that is now beginning to decline.
- Temperature within the surface waters (<5 m) of Macquarie Harbour demonstrate a strong seasonal pattern, with temperatures approaching 21°C in summer and 8°C in winter. The seasonal variation is also evident in waters 5 m to 10 m (~10°C–18°C). Seasonal variation deeper in the water column (>10 m) is greatly reduced, with differences of ~ 2°C between summer and winter. This is likely due to a combination of factors, including the shorter residence time of surface waters, the presence of a strong halocline at ~ 10 m, and the heavy tannin content of the riverine water. All these factors combined create an insulating layer and reduced mixing between surface and deep waters, which is responsible for the more stable temperature conditions at depth. Analysis of the longer-term EPA Tas data shows that there has been an increase of ~1.5°C-2°C in the mean temperature of deeper waters from 1993 to 2020. Conversely, long-term temperature data (single-sensor multi-satellite data from IMOS 1992-2020) measured ~ 500 m north of the Harbour entrance shows a similar mean increase of ~1.5°C-2°C in sea surface temperature since 1993. Research indicates that water temperature at depth in Macquarie Harbour is mostly influenced by oceanic recharges, rather than from top-down warming and the influence of freshwater inputs on surface waters.
- The salinity of Macquarie Harbour is highly variable with shallow waters <10 metres showing a strong seasonal pattern ranging from ~0-20 ppt at <5 m and 10-30 ppt at 5 m to 10 m. Deeper waters are far more stable, rarely fluctuating outside of 25–34 ppt, however on several occasions lower salinity water has penetrated to greater depths. For example, in 1995, waters >25 m declined to ~27 ppt, and in 2014 water at 10 m to 15 m depth declined to <10 ppt during a winter storm.
- The DO dynamics in Macquarie Harbour are complex and vary greatly with depth, but show a relatively consistent pattern throughout the Harbour. The general water column trend is for surface waters (<5 m) to remain highly oxygenated (~100%) with DO levels decreasing with

¹⁵ [IMAS Assessment of Macquarie Harbour BEMP data from 2011 to 2020, March 2022.pdf \(epa.tas.gov.au\)](#)

depth, but in waters >35 m, DO concentrations can be higher than mid-depths. This is often associated with saltwater recharge events such as has occurred in the summer of 2023/24 (Jeff Ross, pers comm. 12 January 2024).

Habitat

Surveys conducted in Macquarie Harbour in 1996 indicated that the following benthic and pelagic habitats/communities were present:

1. Seagrass (*Zostera*) in sandy sediments under marine or brackish conditions to a water depth of 2 m.
2. Macroalgal communities on intertidal and shallow subtidal rocks, possibly mainly greens (*Ulva/Enteromorpha*) because of low salinities.
3. Freshwater macrophytes (*Nitella*) in organic rich (black) river-mouth sediments.
4. Benthic macro-invertebrates in soft, sandy to muddy sediments, throughout the harbour.
5. Pelagic phytoplankton and zooplankton throughout the harbour.

Surveys of aquatic macrophyte habitats subsequently have shown that these habitats might make only a small contribution to the Macquarie Harbour ecosystem because of the Harbour's shallow euphotic zone. Crawford *et al* (2013) reported algae and seagrass at several intertidal sites from a visual survey undertaken in Spring and Autumn 2012.

The main benthic habitat(s) of importance to the Maugean skate are those of the soft sediments, including heterotrophic micro-organisms as well as the macro-invertebrate fauna. Like most estuarine systems on the West Coast of Tasmania, the macrofaunal community in Macquarie Harbour is naturally depauperate with low species diversity and abundance. The lower macrofaunal biomass on the West Coast in comparison to everywhere else in Tasmania is attributed to low concentrations of dissolved nutrients in rivers and dark tannin-stained waters, which greatly restricts algal photosynthesis and primary production (Edgar *et al* 1999b). Heavy metal pollution and acid leaching from tailing dams into the Harbour via rivers from historical mining activities may also have contributed to the depauperate nature of macrofaunal communities in Macquarie Harbour (Talman *et al* (1996)).

7. MAUGEAN SKATE

The Maugean skate, a medium-sized skate endemic to Tasmania, have evolved in the complex coastal environment of western Tasmania. The skate was first described by scientists in 1988 and has only been recorded in two isolated estuaries in South-Western Tasmania – Macquarie Harbour; and to a limited extent in Bathurst Harbour, where only four confirmed records of the species (including the type species) have been caught, with the last record from this location occurring in 1992. Recent surveys indicate that the species is now found in extremely low numbers or are no longer present in Bathurst Harbour (Moreno *et al* (2022)).

Constance *et al* (2023) note that one third of all elasmobranchs (sharks and rays) are threatened with extinction and euryhaline and estuarine generalist species (a group of 29 species globally, including the Maugean skate) are both poorly known and disproportionately threatened with some 72% at risk of extinction or data poor. In December 2023, Constance confirmed the first known modern marine fish extinction was the Java stingaree, a small ray from Indonesia.

Maugean skate is the only species in the world that is found in brackish waters with individuals showing a strong preference for shallow channels between 5 m and 15 m in depth (Moreno *et al*. (2020)), although they have been detected at 0.6 m to more than 55 m in depth (Bell *et al*. (2016)). Moreno *et al*. 2020 determined that adult Maugean skate exhibit a high level of site selectivity and site fidelity across a relatively small spatial range (<10 km²). Figure 11 depicts the preferred verified and unverified habitat for the Maugean skate within Macquarie Harbour. There is a total of 6,975 ha of potential habitat for the species within its preferred habitat of shallow channels (Bell *et al* 2016). Within this area, the current Commonwealth Conservation Advice¹⁶ states a total of 3,455 ha has been verified as habitat for the species. The total potential habitat accounts for an area of approximately 25% of the total estuarine habitat within the Harbour.

¹⁶ [Conservation Advice for *Zearaja maugeana* \(Maugean skate\) \(environment.gov.au\)](https://www.environment.gov.au/conservation/advice/zearaja-maugeana)

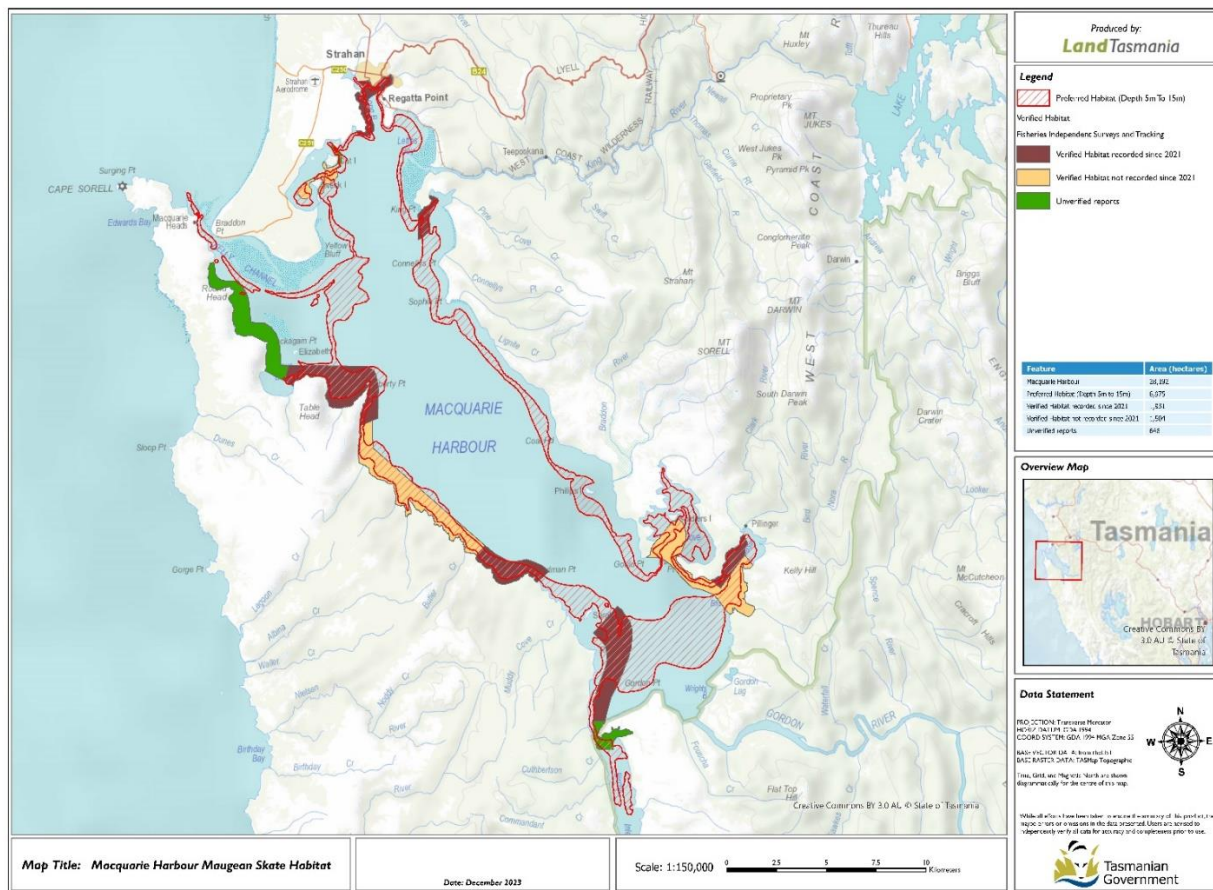


Figure 11: Preferred verified and unverified habitat for Maugean skate within Macquarie Harbour

Waters preferred by the species generally have relatively stable temperatures (12–15°C) and salinity (18–27 ppt), and naturally low-moderate DO concentrations (30–80% DO) (Bell *et al.* (2016); Morash *et al.* (2020)). The species is more active at night using a broader range of waters to forage. Egg capsules have been detected across a wide range of depths (2.5 m to 30 m), however Moreno *et al.* (2020) outlines that skate eggs are most abundant at shallow sites (<10 m).

The Maugean skate has a specialised diet, mainly consisting of small epibenthic crustaceans, including crab and shrimp.

Population

The Maugean skate has been recorded from Bathurst Harbour, but relatively little is known about the species' past presence or abundance in this location including its status during the last ice age when sea levels were ~120 m lower than present day. Only four individuals are confirmed to have been caught in Bathurst Harbour, with the species not having been recorded since 1992 (NRE Tas 2022).

Macquarie Harbour is the only confirmed location where Maugean skate currently occurs in any significant numbers and is, therefore, an important habitat for the conservation of the species. Early surveys undertaken between 1994-95 in Macquarie Harbour found only six individuals. The surveys were extensive and used a range of sampling equipment and methods (nets, droplines, diver observation) (DCCEEW 2023). The 2004 Listing Advice ¹⁷ estimated that the combined population of the Maugean skate for both estuaries was likely to be small, probably in the order of 1,000 individuals.

IMAS currently monitors population trends in Macquarie Harbour in quarterly surveys using monofilament gillnets. Survey efforts using this technique have been ongoing since 2012. Environmental DNA, remote operated vehicles, tow cameras, dive transects, and baited remote underwater video have also been used to survey the population in both Macquarie Harbour and Bathurst Harbour. However, there are considerable logistical and resourcing considerations that currently limit the feasibility of applying these techniques in routine monitoring (Moreno and Semmens 2023). Figure 12 outlines the locations where Maugean skate have been identified during 1989-2023 surveys in Macquarie Harbour.

¹⁷ 2004 [Listing Advice for the Maugean skate](#):

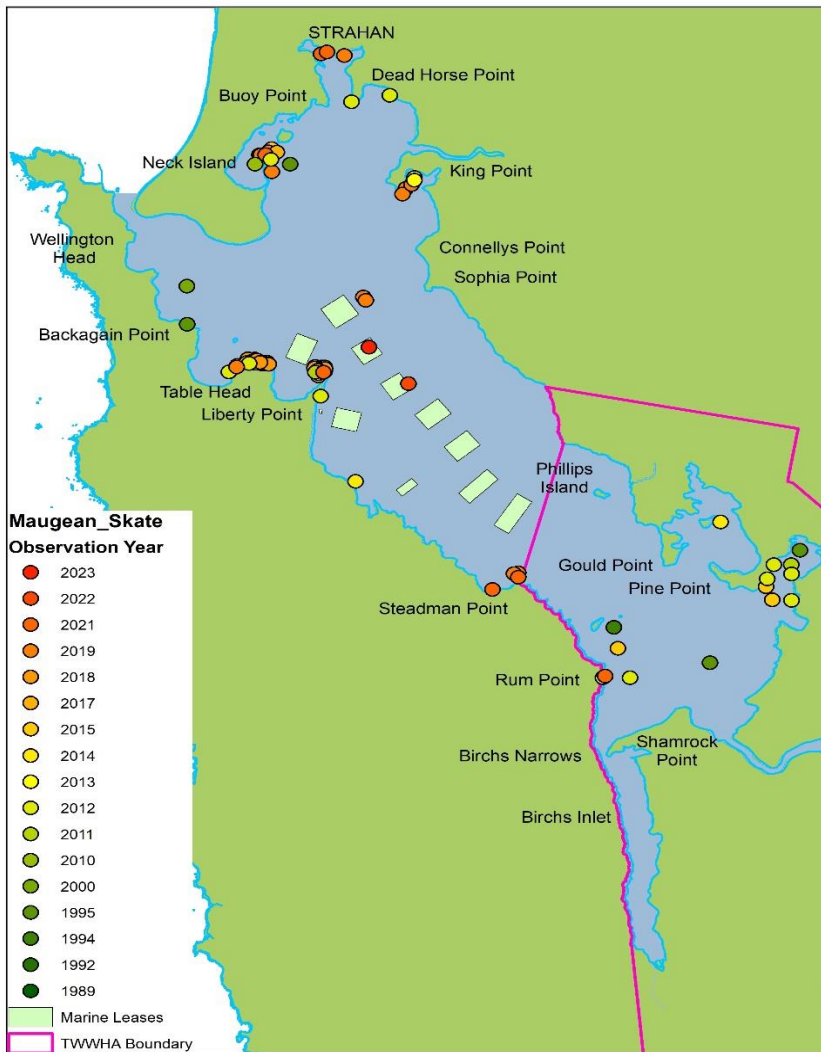


Figure 12: Locations where Maugean skate have been sampled in Macquarie Harbour (Source: CAP, NRE Tas)

In 2014, the Macquarie Harbour population was estimated to be 3,200 individuals (Bell *et al.* 2016) with a high degree of uncertainty (Moreno and Semmens, 2020). A decline in relative abundance of 47% is thought to have occurred between 2014 and 2021 (Moreno and Semmens 2023). However, both Bell *et al.* 2016 and Moreno 2020 note that this population estimate should be considered with caution and only be considered as indicative, and that a better understanding of population status is required. Further, the methodology of using monofilament gillnets has significant limitations, particularly sampling juveniles, so this cohort is potentially under-represented in the population estimate even when present (Moreno and Semmens 2023).

Due to the limited timeframe that consistent and reliable surveys have been undertaken, and the relatively limited understanding of species physiology, energetics, and habitat use, it has proven difficult to establish an accurate baseline population estimate for the Maugean skate over the past decade. This is further substantiated by the mixed effectiveness of surveys of the other skate population in Bathurst Harbour and of the technological and logistical challenges of conducting surveys in these estuaries.

8. MARINE FARMING IN MACQUARIE HARBOUR

8.1 Marine farming in Macquarie Harbour prior to 2012

Salmon farming has occurred in Macquarie Harbour since 1986. By 2011, standing biomass levels grew to 9,037 tonnes of fish being grown across 10 marine farming leases with a total footprint of 564 ha (Figure 13). Approximately 59% of the production area at the time occurred within what is now verified as preferred habitat for the Maugean skate.



Figure 13: Location of marine farming zones within Macquarie Harbour prior to 2012

The Macquarie Harbour MFDP introduced management controls in 2005, which aimed to effectively monitor, manage and mitigate negative environmental impacts within the MFDP area resulting from marine farming operations. These include:

1. *There must be no significant visual, physio-chemical or biological impacts at or extending 35m from the boundary of the lease area, as specified in the relevant marine farming licence;*
2. *Environmental parameters must be monitored within the lease area, 35 m outside the boundary of the marine farming lease area and at any control site(s) in accordance with the requirements specified in the relevant marine farming licence;*
3. *Management controls relating to nitrogen outputs;*
4. *Environmental controls relating to carrying capacity; and*
5. *Environmental controls relating to environmental Baseline Monitoring survey requirements.*

8.2 Marine farming in Macquarie Harbour 2012-2023

The salmon farming industry identified a need to expand the area available for salmonid culture to respond to projected increases in demand. Macquarie Harbour was identified as the preferred area to achieve a coordinated expansion program for the industry, involving the companies of Petuna Aquaculture, Huon Aquaculture and Tassal.

To support the proposed expansion a comprehensive Environmental Impact Study was completed and a whole of Harbour environmental predictive model was developed to determine and monitor sustainable production limits within Macquarie Harbour. The 2012 decision indicated that the maximum sustainable biomass was then modelled to be 29,500 tonnes. A conservative approach to the expansion was set that required production levels not to exceed 52.5% of the determined biomass limit before mid-2013. Following a review of the water quality arrangements in October 2013, the 52.5% biomass cap no longer applied as at September 2014.

The expansion of marine farming activities within Macquarie Harbour also revised the marine farming lease footprint, increasing it to an area of 926 ha within 10 zones (Figure 14). Importantly, the majority of marine farming leases were moved into the deeper channels of the Harbour, thereby moving them out of now verified preferred habitat of the Maugean skate.



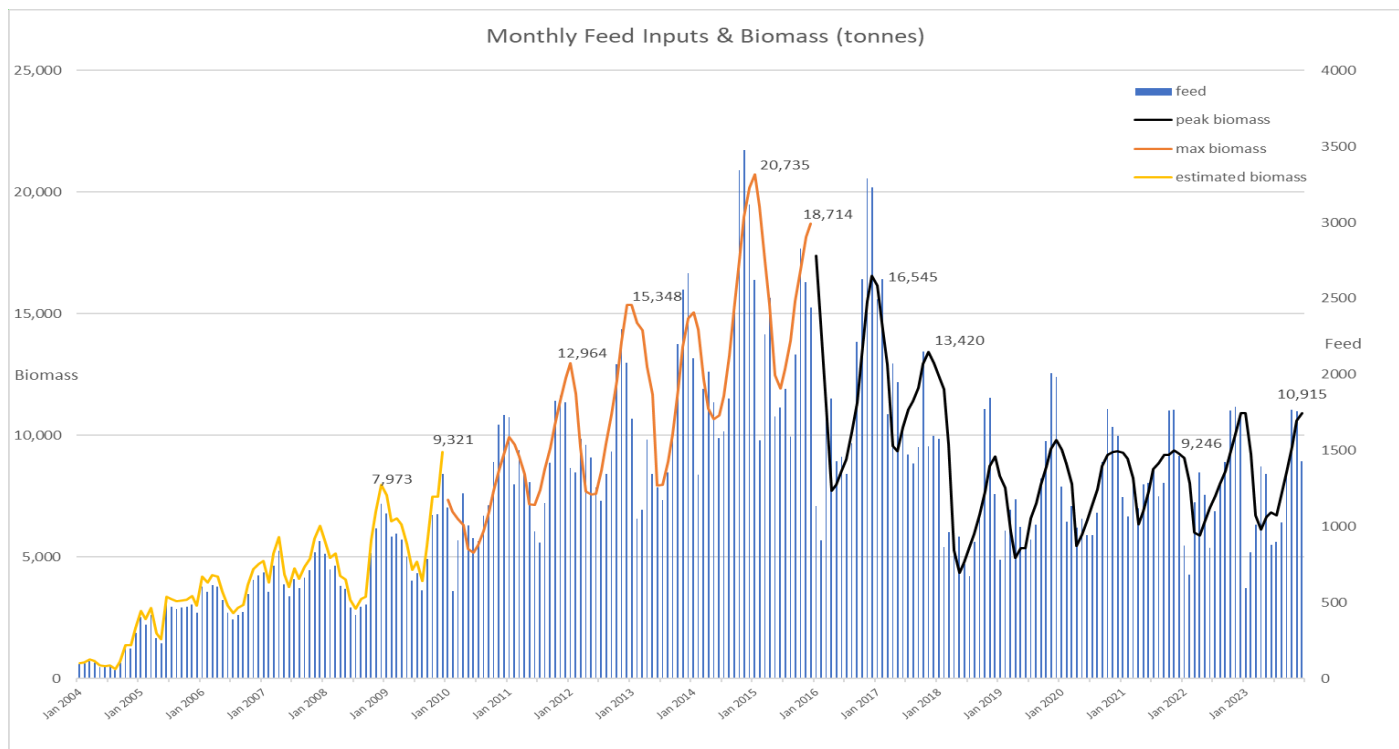
Figure 14: Existing location of marine farming zones in Macquarie Harbour

In 2012, the Macquarie Harbour MFDP was amended to incorporate the amended marine farming lease areas and introduce revised carrying capacity controls to enable the regulator to adjust biomass limits and stocking densities if required. All the environmental controls related to benthic and environmental monitoring remained in place.

Expansion of marine farming in the Harbour was implemented in the years 2012-2016, with production levels peaking in 2015 with a biomass of 20,735 tonnes. At this time, the BEMP implemented under the MFDP and Marine Farming Licences (through the AMF) identified water quality and benthic habitat declines within the Harbour. In response to new and emerging data, the then DPIPW and now EPA Tas have progressively reduced the maximum biomass levels allowed in Macquarie Harbour in response to environmental monitoring.

Macquarie Harbour has not supported the levels of expansion identified within the original whole of Harbour environmental predictive modelling undertaken to support the action.

As outlined in Figure 15, the planned expansion of marine farming activities in Macquarie Harbour described in the 2012 referral and decision was not achieved over the long term by the industry. The data outlines a graduated reduction in biomass levels since 2018, which have remained at levels equivalent to or below the annual salmon production biomass levels that were in place prior to the proposed expansion in 2011. Notably, this production is now also occurring within a footprint that has actively sought to avoid conflict with verified preferred Skate habitat.



- “Peak Biomass” Biomass across all leases in combination is at a maximum for the month.
- “Maximum Biomass” Total biomass as at the end of each month.
- “Estimated biomass” Biomass data was not collected prior to January 2010. An estimated biomass for this period was calculated by determining the ratio of feed to biomass each month from January 2010 to September 2023. An average of these ratios was then applied to pre-January 2010 feed data to produce an estimated biomass.

Figure 15: Feed and biomass levels of salmon farming in Macquarie Harbour 2004 – 2023

In 2018, Environmental Licences for Marine Farms (finfish farming) were introduced under section Part 3, Division 8 of EMPCA¹⁸.

Biomass levels within Macquarie Harbour were at 10,915 tonnes in 2023 and annual nitrogen inputs have reduced from ~1,000 tonnes in 2015 (Ross *et al* 2022) to 500.1 tonnes currently and will remain at this level for at least a period of two years, aligned with the current Environmental Licences.

It is important to note the difference between production levels presented as biomass and production as a quantity of fish harvested as they are not the same, and the relationship between them is not directly calculable. Biomass is the estimate of the amount of fish in the water at any point in time and references to biomass in this document are taken to be the peak biomass for the year referenced, which will typically be the summer months. Biomass calculations are based on modelled growth of fish based on feed inputs and growth rates of fish, and are generated from industry feed data. The amount of fish harvested in any year will be different and reflects the actual growing strategies, the levels of mortality and the rate of growth of the fish.

Unless otherwise noted in this submission, references to production levels refer to peak biomass information rather than harvest information.

The Table below provides information on peak biomass along with reported harvest by tonnes.

Table 3: Reported harvest weight and peak biomass

Year	Reported harvest (HOGG) weight (tonnes)	Month-Year of Peak biomass	Peak Biomass (tonnes)
		Jan-11	9,925.01
		Jan-12	12,964.34
2013	11,680.8	Dec-12	13,355.21
2014	11,001.3	Jan-14	15,051.13
2015	15,477.6	Jan-15	20,734.71
2016	15,043.3	Dec-15	18,714.16
2017	16,034.8	Dec-16	16,544.63
2018	10,374.4	Nov-17	13,419.68
2019	7,485.5	Dec-18	9,125.75
2020	10,225.2	Dec-19	9,809.63
2021	10,066.5	Dec-20	9,354.28

¹⁸ <https://epa.tas.gov.au/business-industry/regulation/salmon-aquaculture/marine-environmental-licence-renewals>

8.3 Marine farming in Macquarie Harbour – current situation

In 2022-23 a series of major regulatory reforms occurred, including the establishment of EPA Tas as a standalone, independent statutory authority and the release of a comprehensive new *Tasmanian Salmon Industry Plan*¹⁹(May 2023). This new Plan establishes the policy framework to support a series of new standards for finfish farming in Tasmania for biosecurity, environmental management and wildlife interactions. The *Salmonid Industry Biosecurity Program*²⁰ commenced in November 2022, the *Environmental Standards for Tasmanian Marine Finfish Farming* came into effect in October 2023 (and will be supported by a suite of Technical Standards currently being developed) and the *Wildlife Interaction Standards* are currently under development.

Macquarie Harbour still plays an important role for the industry in supplying ocean trout and salmon, particularly at times when the marine farms in other regions are not supplying salmon into the market. It is also the only site where ocean trout are grown due to the lower salinity levels.

The environmental controls related to benthic and water quality monitoring remain in place. In addition, the Environmental Licences renewed in November 2023 for a period of two years included the following requirements to address DO levels in Macquarie Harbour:

1. Provision of the overall DO demand resulting from finfish activities on their lease;
2. Implementation of a Dissolved Oxygen Mitigation Plan to substantially offset or reduce demand from each lease; and
3. Implementation of an approved Water Quality Monitoring Plan to measure the success of the DO mitigation measures against the interim default guideline values set by EPA Tas.

The current Marine Farming Licences and Environmental Licences are provided at Attachments 4 and 5.

¹⁹ [Tasmanian Salmon Industry Plan 2023 \(nre.tas.gov.au\)](https://nre.tas.gov.au)

²⁰ [Salmonid Industry Biosecurity Program | Department of Natural Resources and Environment Tasmania \(nre.tas.gov.au\)](https://nre.tas.gov.au)

9. RISK ASSESSMENT FOR THE 2012 REFERRAL

The following section provides the risk assessment content for the Maugean skate that was provided with the original referral for the action.

Macquarie Harbour is one of two small estuarine systems in Tasmania (the other being Bathurst Harbour) that the Maugean Skate (skate) is known to inhabit. The total range of the species is thought to be no more than 100 km² and the population was estimated at 1,000 individuals (TSSC 2004). The species inhabits low-nutrient brackish water, 5-7 m deep (TSSC 2004) and appears to mostly inhabit the shallower upper regions of the estuaries (IUCN 2007). The species is listed as endangered under the EPBC and the Tasmanian *Threatened Species Protection Act 1995*.

Macquarie Harbour therefore represents a critical habitat for this poorly understood species. Given the small population size and the limited distribution, any action that may result in the death of skates may be considered significant.

Actions associated with the proposal that could potentially impact on the skate include:

- physical disturbance of habitat
- changes in water quality – either through inputs (food, waste), incidental additions (oil and diesel) or the re-suspension of contaminated sediments – resulting in adverse health impacts and/or loss of suitable food species
- incidental entanglement/capture in netting used in fishing activities
- the introduction of non-indigenous marine species

Habitat Disturbance

Given that the skate has been recorded in 5-7 m water depth it is unlikely that the proposal would directly impact upon the skate. Mooring blocks utilised in the mooring systems for sea cages would cause localised disturbance to the seabed, however it is unlikely that their deployment would directly impact upon the skate or its habitat given that the proposed zones are all located in water that is greater than 20 m in depth. Similarly, it is unlikely that solid wastes from the stocked fish and waste feed would have any impact on skate habitat given the relatively restricted dispersal of solid wastes from cages. There is some potential for dredging and other actions related to shore-based activities to result in very small areas being subject to sedimentation. However, it is considered that these activities would have minimal impact on skate or its habitat.

Water Quality

The range of dispersal of soluble waste from stocked fish is likely to be greater than that of solid wastes. Modelling undertaken for DO and nutrients predicts that the proposal would result in no significant effect in areas inhabited by the species, i.e. shallows less than 10 m.

Gill Netting Entanglement

The most significant risk that the proposal poses to the skate would be through entanglement in gill netting associated with escaped salmonid capture activities conducted by the Proponent and/or recreational fishers following a mass escape event of stocked fish. Recreational and commercial

gill netting is currently permitted in Macquarie Harbour and any consideration of the relative increase in the level of impact on the skate from proponent/recreational netting (for escaped salmonids) needs to take into account the background level of recreational and commercial netting that currently occurs for species targeted in the harbour. It is highly likely that any netting efforts targeting escaped salmonids following mass escape events associated with the proposed zones would be minimal compared to the total recreational/commercial netting effort conducted annually in the harbour.

Introduced Species

It is unlikely that the proposal would result in the introduction and establishment of non-indigenous marine species in Macquarie Harbour.

10. COMPLIANCE WITH THE 2012 DECISION PARTICULAR MANNER

There has been ongoing compliance with the particular manner. A compliance inspection by the former Australian Government Department of Environment and Energy in 2017 found that marine farming operations were being undertaken in accordance with the particular manner. The following table provides detailed evidence of compliance with each of the requirements specified in the particular manner since the 2017 compliance inspection.

Table 4: Evidence and/or actions demonstrating compliance with NCA-PM referral decision

MEASURES AS SET OUT IN THE NCA-PM REFERRAL DECISION	EVIDENCE AND/OR ACTIONS
<p>To ensure there are no significant impacts to the Maugean Skate or to the Tasmanian Wilderness World Heritage Area, the person taking the action must undertake the action in accordance with the Macquarie Harbour Marine Farming Development Plan October 2005.</p>	<p>The Aquaculture Branch of NRE TAS routinely undertakes compliance inspections to ensure all salmon farming activities are being undertaken in accordance with the MFDP. This includes:</p> <ul style="list-style-type: none"> • Inspection of boundary markers • Inspection of marine equipment markings (a register is maintained to identify companies uniquely) • Inspection of lease conditions and identification of any non-compliant activities <p>These routine inspections are further supplemented by routine Tasmania Police patrols of the Harbour and by joint patrols to assess the causes and impacts of any salmon escapes. Salmon farming in Macquarie Harbour has maintained compliance in accordance with the Macquarie Harbour Marine Farming Development Plan October 2005²¹.</p>
<p>In particular, the person taking the action must undertake the following measures:</p> <p>1: To ensure there are no significant impacts to the Maugean Skate as a result of changes to the benthic environment, the person taking the action must:</p>	

²¹ [Mac-Harbour-MFDP-October-2005.pdf \(nre.tas.gov.au\)](http://nre.tas.gov.au/Mac-Harbour-MFDP-October-2005.pdf)

<p>a) Take measures to prevent the substantial benthic visual, physio-chemical or biological changes attributable to marine farming operations at, or extending beyond 35 metres from the boundary of any lease area;</p>	<p>Since 2017 the following measures have been implemented to prevent substantial benthic visual, physio-chemical or biological changes across Macquarie Harbour. This has been achieved through determinations made by the Director, EPA Tas.</p> <p>On 16 January 2017, the Director, EPA Tas issued a determination reducing the standing biomass cap for Macquarie Harbour from 21,500 tonnes to 14,000 tonnes for a period to commence from 14 February 2017 and to 30 April 2017.</p> <p>This determination was followed by another determination on 31 May 2017, and then subsequent clarifying determinations on 6 June 2017, further reducing the maximum standing biomass to 12,000 tonnes and 9,500 tonnes for the period commencing 1 June 2017 and 31 May 2018, respectively.</p> <p>The maximum standing biomass determination of 9,500 tonnes remained in place until 1 September 2022 when the Director, EPA Tas implemented a TPDNO of 500.1 tonnes for the Macquarie Harbour region. This limit was apportioned to each lessee or sub-lessee in the region based on the number of hectares of lease area and represented a 10% reduction compared to feed inputs in 2021.</p> <p>Additionally, since 2017, four monthly video surveys at compliance and recovery sites 35 m from the lease boundary to document biological health of sediments and macrofauna are required for all Harbour leases.</p> <p>These measures have resulted, in combination with other factors, in a significant reduction in the number of significant visual, physio-chemical or biological impacts attributable to marine farming operations at, or extending beyond, 35 m from the boundary of the lease areas.</p>
<p>b) Undertake a baseline environmental survey of all new lease areas and compliance sites prior to commencement of marine farming operations;</p>	<p>There have been no new lease areas established within Macquarie Harbour or changed lease boundaries since January 2017. As a result, no further baseline environmental surveys have been conducted during this period.</p> <p>All baseline environmental surveys of the current lease areas within Macquarie Harbour prior to January 2017 were conducted by the then DPIPWE prior to EPA Tas assuming responsibility for the environmental regulation of Tasmanian finfish farms in 2016.</p>
<p>c) Undertake a benthic video assessment of lease areas and compliance sites in</p>	<p>Since January 2017, assessments of benthic video surveys for a total of 2,203 external (beyond 35 m) compliance sites and approximately 1,680 internal (within) lease area sites (annual</p>

<p>accordance with marine farming licence conditions;</p>	<p>and pre-stocking surveys) have been undertaken for the ten leases located within Macquarie Harbour. EPA Tas publish these results and they demonstrate continual improvement in compliance status²².</p>
<p>d) If a substantial benthic visual, physio-chemical or biological impact is detected as a result of benthic video assessment, targeted management responses must be implemented within 10 weeks of the assessment;</p>	<p>EPA Tas continues to require targeted management responses to be implemented as soon as practicable if significant visual, physio-chemical or biological impacts are detected as a result of a survey. Targeted management responses may include, but are not limited to, extent surveys, follow-up surveys, interim surveys, fallowing of pen bays, fallowing of pen bay grids, fallowing of the entire lease, operational reviews and the provision of mitigation plans.</p> <p>Over time EPA Tas has developed a consistent approach to the type and process of escalation for management responses required of the industry. As a result, in recent years the industry has been substantially more proactive in implementing targeted management responses when significant impacts are identified. This means that often the management response (commonly fallowing) has been undertaken prior to EPA Tas receiving the surveys for assessment, well within the ten-week period required.</p>
<p>e) Following any targeted management responses undertaken in accordance with 1 (d) relating to a substantial benthic visual within a lease area, a follow up benthic video assessment must be undertaken at the lease areas prior to restocking;</p>	<p>For seven of the highest risk Macquarie Harbour leases, EPA Tas currently requires pre-stocking benthic video surveys to be conducted prior to the next production cycle regardless of previous benthic condition. This means that approval to restock must be granted by the Director, EPA Tas. This includes any lease area sites which have never been farmed or have not been recently farmed when a grid is to be laid over new sediment.</p> <p>For the remaining three lease sites, pre-stocking benthic video surveys are required, and approval to restock must be granted by the Director, EPA Tas when a significant benthic visual impact is observed at a site within a lease area. These leases are also required to conduct pre-stocking surveys for lease area sites which have never been farmed or have not been recently farmed when a grid is to be laid over new sediment.</p> <p>All leases within Macquarie Harbour that have been restocked have complied with this requirement as per their Environmental Licences.</p>
<p>f) Following any targeted management responses</p>	<p>EPA Tas requires the industry to conduct follow-up benthic video surveys for compliance sites that have been identified to</p>

²² [MH Compliance Site Summary Table.pdf \(epa.tas.gov.au\)](https://www.epa.tas.gov.au/mh-compliance-site-summary-table)

<p>undertaken in accordance with 1 (d) relating to a substantial benthic visual, physio-chemical or biological impact at a compliance site, a follow up benthic video assessment must be undertaken at the compliance site to monitor benthic recovery within four months of the targeted management responses; and</p>	<p>have a significant visual impact. For example, when <i>Beggiator</i> spp. mats are identified at 3 m compliance site, benthic video extent surveys are required at +50 m intervals.</p> <p>The follow-up survey requirement may be fulfilled during the next four monthly video survey, or in some cases, EPA Tas requires the follow-up survey to be completed sooner.</p> <p>If a follow-up survey does not demonstrate compliance, EPA Tas will then require an escalated management action such as the preparation of a mitigation plan which may involve measures such as bringing forward the harvest date of nearby pens.</p>
<p>g) 1 (e) and 1 (f) must be undertaken until the benthic video assessment identifies that a substantial benthic visual, physio-chemical or biological impact is no longer occurring.</p>	<p>EPA Tas requires the industry to continue to conduct follow-up benthic video assessments, in accordance with the requirements outlined for 1(e) and 1(f) until the significant impact is no longer occurring. EPA Tas publishes the number of surveys undertaken and compliance status for²³ benthic visual, physio-chemical or biological impact indicators.</p>
<p>2: To ensure there are no significant impacts on the Tasmanian Wilderness World Heritage Area and the Maugean Skate as a result of water quality changes, the person taking the action must:</p>	
<p>a) Undertake a water quality monitoring program for the assessment of the water quality indicators ammonia, nitrate and dissolved oxygen at the monitoring sites in accordance with marine farming licence conditions. Monitoring must occur at these monitoring sites on a monthly basis until 30 June 2013, when the number and location of monitoring sites will be reviewed;</p>	<p>Completed.</p> <p>The industry continues to be required (under Environmental Licences) to collect samples and environmental data at a number of sites, at various depths and for several parameters as part of the BEMP. These samples are collected on a monthly basis by consultants contracted by Salmon Tasmania.</p> <p>EPA Tas continues to conduct its own water quality monitoring program in Macquarie Harbour on a quarterly basis.</p>
<p>b) Take measures to prevent the rolling annual median value of quarterly water quality indicator values for ammonia, nitrate and dissolved oxygen, as</p>	<p>Monitoring results indicate that since 2012, the 12-month rolling median ammonia concentration at both 2 m and 20 m has remained below the trigger limits. Similarly, the 12-month rolling median for DO concentration at 2 m has remained above the trigger limit. However there has been a slight downward trend since winter 2012 and throughout 2016 DO</p>

²³ [MH Compliance Site Summary Table.pdf \(epa.tas.gov.au\)](http://epa.tas.gov.au)

<p>recorded within the compliance region, from exceeding the identified limit levels;</p>	<p>concentration observations were at times below the trigger limit. Nitrate concentration at 2 m has also remained within the trigger limits, however throughout 2015, when aquaculture operations were operating at the historical maximum, nitrate concentrations approached the trigger limit.</p> <p>In 2023, EPA Tas introduced new requirements via Environmental Licence conditions for the industry to determine and mitigate the levels of DO consumption that are caused by their fish farming activities. The industry is also required to develop an additional monitoring program to measure and report the success of the identified mitigation measures towards meeting the recently published Interim Macquarie Harbour Default Guideline Values for DO.</p> <p>In addition, all marine farms in Macquarie Harbour will be required to comply with the new <i>Environmental Standards for Tasmanian Marine Finfish Farming</i> with new standard conditions and new investigative trigger levels to be imposed in Environmental Licences in 2024.</p>
<p>c) If the water quality monitoring program identifies that the rolling annual median value for any of the water quality indicators ammonia, nitrate and dissolved oxygen, within the compliance region, exceed the identified limit levels and that is attributable to marine farming operations, targeted management responses must be implemented within 10 weeks of the most recent quarterly monitoring report;</p>	<p>Not breached.</p>
<p>d) Following any targeted management responses undertaken in accordance with 2 (c), a follow up monitoring assessment of the water quality indicators ammonia, nitrate and dissolved oxygen must be undertaken at the monitoring sites to monitor water quality recovery within four months</p>	<p>Monitoring for all water quality indicators has continued on a monthly basis for all monitoring sites. EPA Tas also continues to conduct its independent quarterly water quality monitoring program with the next round of samples scheduled to be collected in January 2024.</p>

of the targeted management response;	
e) 2 (c) and 2 (d) must be undertaken until the monitoring assessment of the water quality indicators ammonia, nitrate and dissolved oxygen identifies that the identified limit levels are not being exceeded; and	Monitoring for all water quality indicators has continued on a monthly basis for all monitoring sites. EPA also continues to conduct its independent quarterly water quality monitoring program with the next round of samples scheduled to be collected in January 2024.
f) The total biomass held across all lease areas must not exceed 52.5 percent of the modelled maximum sustainable biomass until limit levels are reviewed in mid-2013, and must not exceed any such altered levels as may be identified thereafter by the Tasmanian Government.	<p>At the time of referring the action a detailed Environment Impact Statement (EIS) and model to determine the maximum sustainable biomass was completed to support the expansion of marine farming in Macquarie Harbour.</p> <p>To support the proposed expansion a comprehensive Environmental Impact Study was completed and a whole of Harbour environmental predictive model was developed. 2012 decision was informed by modelling based on a proposed maximum biomass of approximately 29,500 tonnes. A conservative approach to the expansion was set that required production levels not to exceed 52.5% of the determined biomass limit before mid 2013. Following a review of the water quality arrangements in October 2013, the 52.5% biomass cap no longer applied as at September 2014.</p> <p>Since this time, the NRE Tas and the EPA Tas have reduced the maximum biomass levels in response to environmental monitoring across Macquarie Harbour as follows:</p> <ol style="list-style-type: none"> 1. February 2017 – 14,000 tonnes 2. June 2017 – 12,000 tonnes 3. June 2018 – 9,500 tonnes <p>A TPDNO of 500.1 tonnes per annum was determined from September 2022 and represented a 10% reduction compared to 2021 feed inputs. The change to the TPDNO rather than the biomass as management control is detailed by the EPA Tas in its submission, and is also available on the EPA Tas website.</p>

11. COMPREHENSIVE APPROACH TO CONSERVATION OF THE MAUGEAN SKATE

11.1 Current broader threats to the Maugean skate

The 2004 Listing Advice for the Maugean skate outlined that priority recovery and threat abatement actions required for this species were considered to be:

1. Protect species habitat in the two estuaries where it is found from direct physical disturbance; and
2. Monitor and manage the impacts of incidental fishing.

Since the listing advice was published there has been a range of research undertaken over the last 10 years into aspects of Maugean skate behaviour, physiology and habitat preferences and a new Listing Statement was published in 2022. While there are still substantial information gaps regarding the species life cycle, behaviour, energetics, and habitat preferences, the main identified threats to the species are now considered to be:

Habitat degradation and loss

The observed declines in DO as well as declines in sediment health (Ross & MacLeod (2017); Ross *et al* (2020)). As Durand *et al* (2021) observe, Macquarie Harbour is naturally low in DO and subject to significant historical variability in DO levels prior to European settlement of the West Coast. Over the past 150 years the Harbour has been impacted by historical and ongoing anthropogenic activities, including leachate from large mining operations, changes in river flows due to generation of hydroelectricity and recent aquaculture development (Ross *et al* (2021)). The potential impact of unfavourable DO is increasingly well understood in relation to skate physiology and energetics (Morash *et al* 2020).

While there has been no information published on the potential impacts of heavy metal from historical mining operations specifically on the Maugean skate, various studies (Koehnken (1996); Talman *et al* (1996)) have noted the impact of copper contamination on benthic communities which may have impacted the health and abundance of skate prey and the health of skate habitat. Such effects can, as Edgar *et al* (1999) notes, be difficult to distinguish from the ambient conditions of low primary productivity and paucity of available food.

Water temperature and salinity also affect skate habitat use and physiology, including through the reduced solubility of oxygen in water as temperature increases (Moreno *et al* (2020)).

Incidental bycatch from fishing activities in Macquarie Harbour

Both recreational and limited commercial gillnetting occur in Macquarie Harbour. Maugean skate ecology and feeding behaviour exacerbate the risk of incidental capture by gillnets in some circumstances, because Maugean skate are more likely to use shallow areas where gillnetting occurs in response to physiological stress and also appear to be more active at night when gillnets are set (Moreno *et al.* (2020)). The Maugean skate is particularly susceptible to capture in gillnets,

with mortality associated with long soak times and related depredation by whitespotted dogfish, crabs (including introduced species) and sea lice (Lyle *et al.* (2014)).

Recreational line-fishing also occurs in Macquarie Harbour and presents a potential threat to Maugean skate due to the potential for post-release mortality. However, this fishing method is considered to present a lower relative risk to the species, because it is a less effective method of capture than gillnets, and considered less likely to expose skate to depredation.

The Tasmanian Government introduced significant restrictions on net use by recreational and commercial fishers in the Harbour in 2022 and these have now been extended via recent rule changes²⁴ enacted in 2023.

Climate change and the occurrence of extreme weather events

Climate change and the occurrence of extreme weather events directly influence water quality in Macquarie Harbour, including through higher water temperatures potentially reducing DO levels), changes to freshwater flows into the Harbour (both high and low flows impact DO), and extreme weather events leading to inversion of the harbour water column and changes to DO levels at the skate's preferred depth of 5-15 m (Moreno *et al* 2020). The species' ability to tolerate environmental changes, including reduced salinity and thermal fluctuations, can be energetically costly. Long term metabolic stress could have important implications on vital processes such as growth and reproduction, and ultimately survival.

The increase in ambient water temperatures of 1.5-2 degrees over the past 30 years (Ross *et al.* 2022) potentially poses both direct and indirect threats to the skate (energetics, behaviour, etc.) and its habitat (DO levels, benthic habitat, prey availability, etc.). This increase also interacts synergistically with other threats and may be exacerbated by seasonal marine heatwaves such as were experienced in 2015-16 (Oliver *et al* 2017) and currently (Centre for Marine Socioecology, 2023).

11.2 Tasmanian Government Conservation Action Plan

The Tasmanian Government released the CAP for the Maugean skate on 17 January 2024 (Attachment 1). The purpose of the CAP is to outline interventions to minimise the extinction risk of the Maugean skate and to maximise the probability of recovery for the species in the wild. The purpose will be achieved through the five objectives listed below. These are designed to give effect to the CAP's purpose, and establish the framework for conservation action, and for tracking of the impacts and effectiveness of the Plan.

The CAP specifies five objectives:

1. Ensure that viable habitat in Macquarie Harbour is available to meet the needs of the Maugean skate;
2. Establish an ex-situ Maugean skate population for future reintroduction;

²⁴ [Scalefish Fishery Rule Changes | Fishing Tasmania](#)

3. Implement strategies to reduce threats to the Maugean skate population;
4. Actively engage key stakeholders, including the community, in Maugean skate conservation recovery actions; and
5. Maintain and strengthen the knowledge base for Maugean skate recovery.

The CAP identifies 35 Priority Conservation Actions for the recovery of the Maugean skate. There are three Priority Conservation Actions identified to manage impacts from salmon farming within Macquarie Harbour on the Maugean skate. All three of these actions are already underway:

1. Amend the Marine Farming Development Plan to refer to *Environmental Standards for Tasmanian Marine Finfish Farming*²⁵, and vary Environmental Licence conditions to incorporate these Standards to adaptively consider:
 - oxygen demand monitoring.
 - reduction of oxygen demand over time.
 - shorter licence timeframes to enable adaptive review and adjustment of conditions.
2. Investigate and trial engineering solutions in Macquarie Harbour to effectively increase the supply of DO. Steps include:
 - international scan of technology options.
 - planning and approval of pilot study to trial technology.
 - implementation of pilot study, including monitoring and assessment of effectiveness in increasing DO concentrations and any adverse impacts.
3. Implement Marine Finfish Farming Environmental and Technical Standards to protect and maintain environmental values and the ecological character of Macquarie Harbour including water quality investigative trigger values and monitoring of sensitive habitats as part of the broadscale monitoring program.

An important component of the CAP is the commitment to initiate a captive breeding trial using existing IMAS facilities. This action began in November 2023 and is collaboratively funded by the Australian and Tasmanian Governments. Maugean skate (adults and egg cases) were collected in December 2023 to commence captive breeding.

There are also priority actions underway to minimise the impacts of river flows on DO levels. This includes assessing and modelling the role of hydro-power generated flows in DO dynamic and investigating options for adjusting hydro-electric water flows in the Gordon and King Rivers to facilitate entry of high DO marine water into Macquarie Harbour (i.e., oceanic recharge).

The CAP includes actions that will increase the overall knowledge base of the population of the Maugean skate within the Harbour and remove a direct impact on the Maugean skate through the urgent cessation of commercial and recreational gillnetting within the Harbour.

²⁵ [Environmental Standards | Department of Natural Resources and Environment Tasmania \(nre.tas.gov.au\)](https://www.nre.tas.gov.au/environmental-standards)

ACRONYMS LIST

Acronym	Meaning
BEM	Broadscale Environmental Monitoring
AMF	Adaptive Management Framework
BEMP	Broadscale Environmental Monitoring Program
CAP	Conservation Action Plan for the Maugean skate
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIPWE	Department of Primary Industries, Parks, Water and Environment
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
EMPCA	<i>Environmental Management and Pollution Control Act 1994</i>
Env Tas	Environment Protection Authority Tasmania
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FHMP	Fish Health Management Plan
FRDC	<i>Fisheries and Research Development Corporation</i>
ha	hectare
HOGG	head on gill and gutted
IMAS	Institute for Marine and Antarctic Studies at the University of Tasmania
km	kilometre
km ²	square kilometres
LMRMA	<i>Living Marine Resources Management Act 1995</i>
m	metres
MFPA	<i>Marine Farming Planning Act 1995</i>

MFDP	Marine Farming Development Plan
N	Nitrogen
NCA-PM	not a controlled action if undertaken in a particular manner
NRE Tas	Department of Natural Resources and Environment Tasmania
ppt	parts per thousand
PSU	Practical Salinity Units
RLO	rickettsia like organism
SAMS	Scottish Association of Marine Science
SST	sea surface temperature
TKN	Total Kjeldhal Nitrogen
TN	Total Nitrogen (TKN unfiltered)
TPDNO	Total permissible Dissolved Nitrogen Output
TWWHA	Tasmanian Wilderness World Heritage Area

12. REFERENCES

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<https://www.dcceew.gov.au/environment/biodiversity/threatened/assessments/maugean-skate>

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14. ATTACHMENTS

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2	Research and monitoring programs in Macquarie Harbour
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4	Current Macquarie Harbour Marine Farming Licences
5	Current Macquarie Harbour Macquarie Harbour Environmental Licences



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