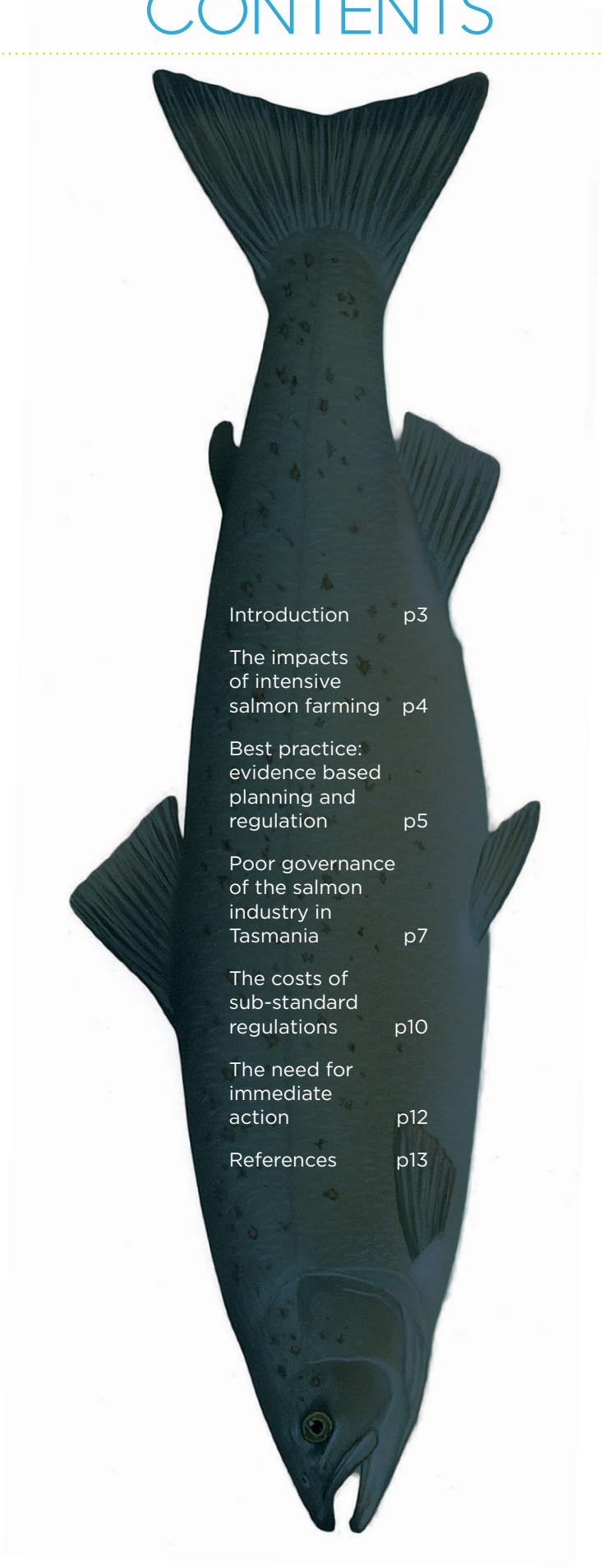
CLEANING UP TASMANIAN SALMON

How the Tasmanian Government can restore social license and secure jobs in Tasmania's salmon industry

ENVIRONMENT TASMANIA

CONTENTS



INTRODUCTION

Tasmania's salmon industry is the largest fisheries sector in Australia. Valued at $625.9 million, salmon farming makes a substantial contribution to Tasmania's economy. Starting with a commercial harvest of just 53 tonnes in 1986, the industry now produces 40,000 tonnes a year and has plans to double production by 2030.[1]

Unfortunately, regulation of Tasmania's salmon industry has not kept pace with its rapid expansion. Tasmania's salmon farm planning and regulations are twenty years old, leaving them twenty years behind global best practice. Internationally, the evidence is in on the damage done to coastal environments by inshore salmon farming. Scientific research shows that sheltered bays and harbours cannot support the amount of pollution introduced by intensive farming, or provide optimal conditions for fish health and growth.

In Tasmania, evidence is mounting of the damage done by intensive inshore farming. Scientists are describing Macquarie Harbour, with its plummeting dissolved oxygen levels, mass fish kills and threats to endangered species, as 'a biological system under stress'. And yet the Tasmanian Government continues to approve intensive inshore farms. Some of Tasmania's current zoning laws, such as the North Bruny Island Marine Farm Development Plan, have been written by the industry, rather than by the Tasmanian government, raising questions about the level of government independence in regulation of the industry.

Concerns about outdated laws and a lack of independence in government regulations, has resulted in growing community unrest about salmon industry expansion. Tasmania is seeing an increase in conflict between big salmon companies and other coastal users – like recreational fishers and boaters, the tourism industry, the wild-catch fisheries sector and local communities impacted by salmon farm pollution. The proposed expansion by Tassal, Australia's largest salmon company, onto the state's near-pristine Sapphire Coast, has become a focal point of concern.

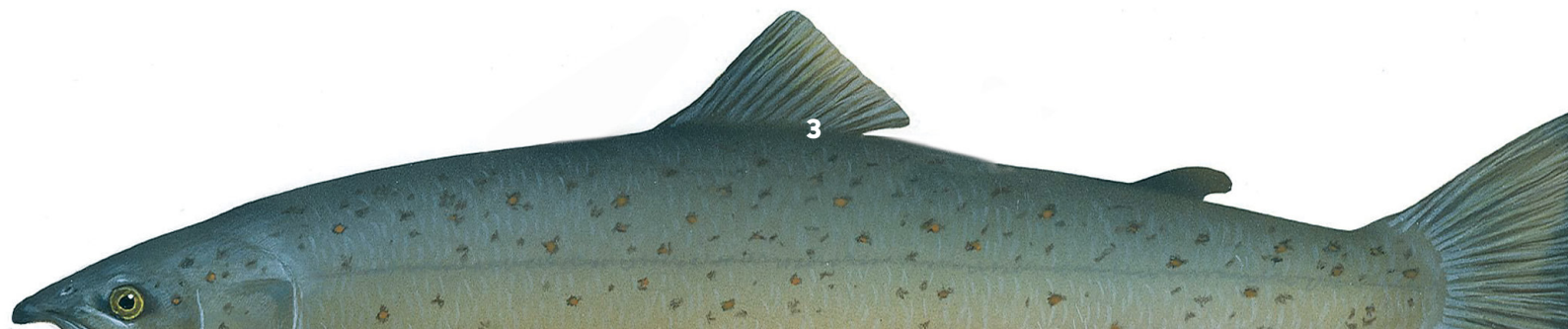
Climate modelling from the CSIRO weather station at Maria Island strongly suggests that waters on Tasmania's east coast will soon be too warm for farming Atlantic salmon (sp. *Salmo salar*). Many Tasmanians are questioning the sustainability of Tassal's expansion plans and what licence the company has to expand into high conservation value coastal areas which other industries and the community depend on.

To resolve community conflicts and support stable growth in the Tasmanian salmon industry, it is critical that the Tasmanian Government cleans up Tasmania's marine farm planning and regulations. This will require investment in high quality bioregional planning and the creation of clear minimum operating standards for the industry, which are based on the current scientific research on fish farm impacts. To allay community concerns about the increasing industrialisation of Tasmania's coastline, this process needs to be open and transparent. The decision-making criteria and the scientific data on which planning and monitoring decisions are based needs to be made publicly available.

This paper presents the latest research on the impacts of inshore salmon farming. It demonstrates how Tasmania's current regulations fail to reflect this contemporary scientific discovery, and how this has allowed aquaculture developments to proceed in coastal areas with no capacity to assimilate the tonnes of pollution created by intensive salmon farming.

Based on the evidence in this paper, Environment Tasmania calls on the Tasmanian Government to place a moratorium on approval of further ocean-based salmon farming until an open, evidence-based review of Tasmania's aquaculture planning and regulation has taken place. The solutions which would support sustainable growth of the industry are clear and are already being implemented in some areas.

- With the rapid warming of Tasmania's coastal waters, there is an obvious need to invest in developing land-based salmon farming operations. Tasmania should follow Norway's lead and offer financial incentives for investment in land-based, closed containment water recirculating aquaculture systems technology (LBCC-RAS).
- For operations within the marine environment, there is a clear need to update regulations to reflect scientific evidence which demonstrates that farming in shallow, warm, and poorly flushed bays and harbours damages the marine environment.
- Regulation of marine based operations should be guided by bioregional plans produced and updated through an independent governance process. These plans should be based on current scientific evidence on best practice salmon farm siting and operation. Regulations should stipulate maximum waste emission standards, maximum water temperatures, minimum water depth and minimum current speeds and flushing capacity for marine-based salmon farming.



THE IMPACTS OF INTENSIVE SALMON FARMING

There is consensus in scientific literature: intensive fish farming in open pens damages the marine environment, with the level of damage dependent on the intensity of production and the sites capacity to assimilate pollution.[2] Some level of damage is inevitable in open-pen systems, because they provide no way of capturing the tonnes of waste produced by farming – the waste is simply released into the ocean.

Waste produced by salmon farming includes uneaten fish food, fish faeces, urine and organic matter from net-cleaning.[3] The major components of solid and dissolved waste are various forms of carbon, nitrogen and phosphorous.[4]

This waste settles on the seabed and enters the water column. A build-up of organic matter in sediments on the seabed produces major changes in sediment chemistry. Changes typically associated with a severe build-up of organic matter are a reduction in sediment oxygen levels and the subsequent production and release of methane and toxic hydrogen sulphide.[5] Low dissolved oxygen concentrations can harm benthic invertebrates, fish and other organisms. This can lead to anoxic and hypoxic events, where sediment flora and fauna do not have sufficient oxygen to survive.

In the water column, soluble nutrients can alter the species composition and density of phytoplankton, increasing the risk of toxic algal blooms. [6]

The extent and nature of the damage caused by open-pen, ocean-based fish farming depends on the intensity of production and site location.[7] Appropriate farm siting, guided by robust, evidence-based spatial planning, can minimise some of the harm caused to the marine environment.

Scientific literature shows that high intensity production in inshore locations, such as sheltered bays and harbours, creates a high risk of waste accumulating under pens and damaging the marine environment. This is because shallow sites with low current speeds and poor flushing capacity, and sites in close proximity to other land-based sources of nitrogen pollution, have less capacity to assimilate the pollution introduced by fish farming.[8] [9]

Farm sites that have low current speeds have been shown to have higher concentrations of hydrogen sulfide under farms, decreased fish growth and higher mortality rates[10]. Anoxic and hypoxic conditions (oxygen levels below that required to sustain life) and damaging levels of hydrogen sulfide production are most commonly associated with intensively-used shallow sites that have low current velocities.

Like any farms, finfish aquaculture requires farming equipment. In the past, toxic copper antifoulants were used to keep pens clean, but subsequently leached into the open seas and groundwater around Tasmania. Tasmanian companies have recently stopped the use of these virulent chemicals and switched to a robot vacuum system (known as MICs). Unfortunately, these MIC vacuum net cleaning system are currently used in situ to remove biofouling organisms from salmon pens. The result is that industrial quantities of biofouling organisms are currently being released into Tasmania's marine environment.

The main biofouling organisms found in Tasmanian salmon farms are hydroids of the genera *Ectopleura, Plumularia, Obelia and Sarsia*.[11] Like all cnidarians, hydroids and anemones possess millions of harpoon-like stinging cells (nematocysts) that contain neurotoxins or cardiotoxins and are used to capture and immobilise prey.[12]

Recent trials in Ireland suggest that 'shredded' fragments of *E. larynx* arising during net cleaning might have the ability to cause pathological levels of gill irritation and damage in farmed Atlantic salmon[13]. In addition to being potential agents of gill and skin disorder, biofouling organisms can also act as hosts for aquatic pathogens. Depending on local current regimes, cleaning waste from fish farms may become transported, and pose disease risks to adjacent aquaculture operations.[14]

Damage or fragmentation of these biofouling organisms during cleaning may also result in the release of viable gametes (eggs and sperm) if the organisms have time to mature between cleaning intervals. This may facilitate the spread of invasive biofouling species through high-density farming regions – a particular risk if farming regions are adjacent to high conservation value areas or marine reserves.[15]

There has been very limited investigation of the biofouling drift rate and its impacts in Tasmania. In 2015, Dover Bay Mussels presented evidence to a Senate Inquiry, which showed a correlation between declined mussel growth and in situ net cleaning at Tassal's salmon farm 150 meters directly down current. Dover Bay Mussels has now gone out of business.[16]

BEST PRACTICE: EVIDENCE BASED PLANNING AND REGULATION

Given what we now know about the impacts of intensive farming, it is possible to regulate industry operations to minimise damage to coastal environments. Best practice regulations include minimum thresholds for water depth, current flow and water temperature.

Scientific research analysing a best-practice approach to siting farms has been published since the late 1980s. Depth, water temperature and water flow conditions at pen sites are critical variables to ensure delivery of oxygen to wild and introduced species and dispersal of the waste feed and effluent introduced into the marine environment by finfish farming.[17] Water temperature of 13° Celsius produces the most efficient growth rate for salmon[18] and water temperatures over 17° Celsius results in sub-lethal stresses.[19]

To meet these conditions, there is a global trend towards moving salmon farms out of sheltered bays and harbours, to deeper, offshore locations with stronger water current velocities.[20] In Norway, fish farms have relocated from shallow (<50 m deep) sheltered embayments with low current velocities to deeper (>100 m deep), more exposed areas with higher current velocities.

As early as 1987 the Norwegian Government led a national assessment of the suitability of its coastal zone and rivers for aquaculture. The planning process considered the environment's capacity to assimilate pollution, impacts on wild salmon species and nature reserves and impacts on other coastal users, including the tourism industry. This approach to planning found that 19 per cent of the coast was appropriate for salmon farming.

The First Principle of Scotland's aquaculture planning scheme is an assessment of an environment's carrying capacity, followed by an assessment of site sensitivity, to identify areas inappropriate for development.[21] In Scotland there is a continuing presumption against further marine finfish farm developments on the north and east coasts, to safeguard migratory fish species.

In Tasmania, Huon Aquaculture has made a commitment to transition to offshore farming and move into deeper water with higher wave energy. To facilitate this, Huon has invested in the development of fortress pens, which create more space for the fish and higher oxygen availability.

As well as limiting the environmental damage caused by siting finfish farms in inshore locations, moving farms further from the coastline also alleviates some of the tensions between the aquaculture industry and other coastal waters users, including the tourism industry.

In Greece, Staresinic and Popovi (2004) compared the relative contributions of tourism and mariculture to the economy of Greece, which has the greatest production of maricultured fish of all Mediterranean countries and a substantial mussel industry. While mariculture was responsible for more than 6000 jobs in 2002, the 14.2 million foreign tourists who visited Greece in 2002 generated 293,000 jobs.[22] Where such a discrepancy in the overall value of the industries to the economy exists, tourism, as the stronger competing force, may well dictate access to coastal space.

Land-based innovations

As well as regulating to ensure intensive salmon farming does not take place in sheltered bays and harbours, leading producing nations are also investing in land-based aquaculture solutions. Land-based, closed containment, water recirculating aquaculture systems technology (LBCC-RAS), prevents the release of pollution into the environment and offers industry the ability to fully control the rearing environment. Recently, with technology improvements, freshwater aquaculture of Atlantic salmon from eggs to a harvestable size of 4–5 kg in land-based closed containment water recirculating aquaculture systems has been demonstrated as a viable production technology.[23]

LBCC-RAS farms are being planned, built and put into production in Europe, North America, China, and Norway.[24] In Norway, the negative impacts of intensive, marine based salmon farming, including sea lice and escapes, have led the Ministry of Fisheries to halt further expansion in marine farming. In 2012, planned production increases were cancelled in all locations except for Troms and Finmark. New licence allocation was limited to so-called 'Green licences', with much stricter operating conditions.[25]

To encourage investment in LBCC-RAS, the Norwegian Government has created a subsidy for land-based farming in the form of an exemption to license fees and quotas. There is currently strong competition for new net pen licenses, which can cost NOK 60 million (about US$10 million) per license. This subsidy is bringing the capital costs of land- and ocean-based farming systems closer to parity. Production costs are already at parity, according to analysts at Deloitte.[26] Their detailed calculations show an estimated production cost per kilo at NOK 26.50 for marine production regimes and NOK 26.75 per kilo for land production.

> *With these figures in mind, prepare for an increase in the world's salmon production, not at sea but on land.* **Anders Milde Gjendemsjø, PhD. Head of Seafood, Deloitte AS.**

Tasmanian finfish farms currently grow their juvenile salmon in land-based hatcheries, but there is currently no commercial scale investment in land-based, closed containment water recirculating aquaculture systems in Tasmania. This is despite the fact that the optimum temperature for growing salmon is 13° Celsius, and currents along the east coast of Australia are warming at 2 to 3 times faster than the global mean.[27]

POOR GOVERNANCE OF THE SALMON INDUSTRY IN TASMANIA

So how does regulation of salmon farming in Tasmania compare to global best practice? While leading producer nations invest in land-based innovations, Tasmania offers no incentive for investment in land-based systems.

And, unfortunately, our planning and regulatory system for salmon farming in the marine environment is 20 years behind global best-practise.

Zoning laws written by industry

Our current Marine Farm Development Plans – plans that we rely on to guide the rapid expansion of the industry – were written two decades ago. Alarmingly, some were written by industry proponents, at the time of applying for licences to farm salmon in these areas. The *Storm Bay off Trumpeter Bay – North Bruny Island Marine Farm Development Plan*, for example, was written by Nortas Pty Ltd, an aquaculture company acquired by Tassal in 2003.

> *No previous Marine Farming Development Plan had been prepared for Trumpeter Bay and this Plan was commissioned by Nortas Pty Ltd in order to facilitate the approval process for establishing an offshore marine farming operation.*
> **Marine Farm Development Plan, Storm Bay off Trumpeter Bay North Bruny Island, 1998.**[28]

While many wouldn't raise an eyebrow at industry proponents informing licence conditions, it is highly unconventional for industry proponents to write the planning and zoning laws that guide licence applications.

No independent review or oversight

Industry expansion plans are currently reviewed by the Marine Farm Planning Review Panel, which was established by the Tasmanian Government in 1995 in an effort to ensure a range of industry and community voices are heard on marine farm planning proposals.

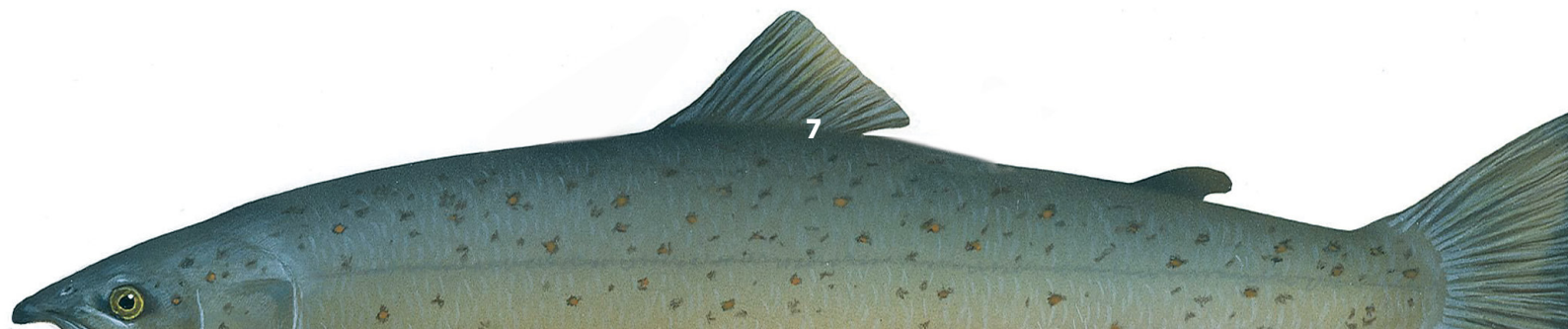
While Government representatives regularly refer to the Panel as providing independent oversight of industry expansion, the Panel was stripped of its independent powers in 2011. This occurred after the Panel refused an industry application for an expansion at Soldiers Point. In December 2011, Dr Lois Koehnken, the scientist on the Panel who was integral to the decision to prevent expansion at Soldiers Point, was asked not to reapply for her position.

The Marine Farm Planning Review Panel can now only make recommendations to the Minister for Fisheries regarding industry expansion plans. The Minister retains full decision making power, and also appoints six of the eight positions on the Marine Farm Planning Review Panel.

No general rights of appeal

Despite this lack of independent oversight, there are currently limited rights of appeal for stakeholders negatively impacted by aquaculture developments. Once a Marine Farm Development Plan has been certified, there is no further public involvement in the lease allocation, licencing or development processes.[29]

This stands in contrast to applications assessed under the *Land Use Planning and Approvals Act 1993* (Tas) (LUPAA). Under LUPAA, any person who made a representation in relation to a proposed development has a right to appeal to the Resource Management and Planning Appeal Tribunal (RMPAT). In stark contrast, appeals under Tasmania's *Marine Farming Planning Act 1995* are limited to appeals against a refusal to consider an amendment or to grant a lease, or appeals on the grounds that the proposal will adversely affect other marine farming operations. Put simply, the aquaculture industry has a right of appeal, the public and other affected stakeholders don't.



No clear standards for assessing site suitability

Tasmanian aquaculture planning and regulation contains none of the minimum thresholds for site suitability recommended by the scientific literature. This creates significant risks to the environment, other industries, coastal communities and, ultimately, the salmon industry's social licence to operate.

Below is a list of best practice planning criteria, which Tasmania's current marine farm planning policy, legislation and regulation, does not include.

- Criteria to guide an area-based approach to planning that considers the carrying capacity of marine farming zones.
- Nutrient budgets for marine farming zones that inform considerations of the amount of nitrogen that can be discharged by farms.
- Minimum site depths.
- Minimum current velocity.
- Minimum flushing capacity.
- Maximum water temperatures.
- Maximum release of toxic sulphides.
- Maximum release of biofouling organisms during in situ net cleaning.
- Minimum distance from other fisheries.
- Minimum distance from high conservation value and heritage areas.
- Minimum distance from areas of cultural importance to traditional owners.
- Minimum distance from popular boating and recreational fishing areas.
- Minimum distance from popular tourism areas and public beaches.

An unlimited amount of faeces

Tasmania's aquaculture regulations currently allow salmon companies to release an unlimited amount of waste into Tasmania's coastal waters. According to the David Suzuki Foundation, the excreta from an average salmon farm are estimated to equal the sewage from a city of 7500 people.

> *To get a sense of how much nutrient loading comes from salmon farms we can compare it to other man-made sources such as untreated human sewage. The average person excretes 4 kilograms N and 1.1 kilogram P per year. Typically, for every tonne of farmed salmon produced, 55 kilograms of N and 4.8 kilograms of P are excreted into the marine environment. The 49,600 tonnes of farmed salmon produced in BC in 2000 contributed as much nitrogen as the untreated sewage from 682,000 people or as much phosphorous as the sewage from 216,000 people.*
> **David Suzuki Foundation, (2002)**[30]

According to the Australian Government's Emissions Estimation Technique Manual, 52.8 kg N/t is discharged each year for every tonne of salmon farmed. **Based on the industry's current production, the salmon farming industry is using 48,000,000 tonnes of feed and discharging at least 2,112,000 kg N/t into Tasmania's coastal waters each year.**

The Tasmanian Government's Department of Primary Industries, Parks, Water and Environment has recognised since 1997 that the introduction of soluble nutrients into the water column by salmon farming can alter the species composition and density of phytoplankton, increasing the risk of toxic algal blooms[31]. In 2009, Volkman et al. recommended the introduction of a nitrogen cap for salmon farms in the Huon Estuary and D'Entrecasteaux Channel, after their research discovered a clear connection between salmon farming in the area and the increased frequency and density of algal blooms between 1996 to 2005.[32]

> *Our measurements and modelling indicate that the salmonoid industry is a significant contributor of nutrients to this region and that these have led to measurable increases in phytoplankton abundance.*[33]

Given recent algal blooms on Tasmania's east coast, which continue to threaten our commercial fisheries and consumer health, it is imperative that the Tasmanian Government introduce regulations which prevent salmon farming in areas which are sensitive to toxic algal blooms and limit the amount of pollution that salmon farms can discharge into coastal waters.

Toxic dinoflagellate algae. Tasmania suffered its first outbreak in 2012.

Poor quality monitoring of impacts

The current monitoring regime for fish farms requires operators to conduct just one underwater video survey per year to assess for visual impacts up to 35 metres beyond the farming lease area. Previous monitoring requirements were more comprehensive. From 1998 to 2004, regulations required six-monthly video surveys to be supplemented by sampling every two years, to assess benthic fauna diversity and sediment chemistry within the farm and at designated compliance points.

The removal of requirements for benthic sampling went ahead despite advice from scientific experts that video surveys alone were insufficient to assess fish farm impacts. Limitations of video surveys included an inability to detect moderate site impacts and an inability to monitor key indicators, such as whether benthic macrofauna under cages were alive or dead.[34]

> *However, it proved extremely difficult to distinguish live molluscs from dead ones on the video footage.*[35]

More stringent monitoring requirements have been introduced for salmon farms in Macquarie Harbour and Huon and the Channel, but only in response to evidence that farms were having significant environmental impacts. And even the more rigorous approach to monitoring in these areas is lax when compared with best practice. This was clearly stated by the Cawthron Institute, which the Government commissioned to review the adequacy of their monitoring program in Macquarie Harbour in 2015.

> *So in the broadest context of the Department's first question the answer is no - the monitoring is not '...likely to be effective in detecting harbourwide effects related to salmonid farming.*
> **Macquarie Harbour Environmental and Fish Health Monitoring Review, August 2015.** [36]

An analysis of Government-commissioned reviews of the impacts of fish farming in the Huon Estuary and D'Entrecasteaux Channel raises similar concerns. There are significant limitations to the data collected by the Broadscale Environmental Monitoring Program (BEMP) for the area. The authors of the 2013 review of BEMP data point to a lack of baseline data and problems with control sites, preventing any meaningful comparison between pre- and post-farming impacts.

> *Unfortunately a lack of comparable ammonium and oxygen data pre-BEMP in the Channel obfuscates meaningful assessment in the Channel.*[37]

> *However, it is worth noting that the environmental conditions at the current control location (Recherche Bay) would appear to be quite different from the other sites sampled. The sedimentary environment at this site is inconsistent with other sites in the Huon/Channel and therefore both the natural biological community and the potential response to changes in environmental condition will be quite different ... the potential for comparison and translation of such changes to the Huon and Channel ecosystems would be limited.*[38]

THE COSTS OF SUB-STANDARD REGULATIONS

Regulations allowing salmon farming in near coastal locations have permitted significant harm to some of Tasmania's most valuable coastal areas.

Case study: Macquarie Harbour

In 2012, the Tasmanian Government approved a 360 per cent expansion in finfish farm production in Macquarie Harbour, from 8000 tonnes to 29,500 tonnes. This occurred despite warnings from ex-fish farmers, scientists and conservation groups that Macquarie Harbour was not an appropriate site for fish farm production, because of its shallow waters, poor flushing rates and naturally low levels of dissolved oxygen. After the first year of increased production, there were signs of serious changes to water quality in Macquarie Harbour.

Salmon companies have denied that the tonnes of pollution introduced by farming was the cause of plummeting rates of dissolved oxygen in the harbour. They pointed to changes to Hydro Tasmania's dam releases and one-off storm events as the cause of dramatic decreases in water quality. There is, however, a direct correlation between plunging dissolved oxygen rates and increased salmon tonnage in the harbour.

Image credit: CSIRO
Pictured, amoebic gill disease. Companies pushed into Macquarie Harbour because of an absence of the disease. Unfortunately, a rare new disease developed which has been linked to degraded environmental conditions in the Harbour.

A timeline of the ecological crisis in Macquarie Harbour

2012

MAY

Government approves an increase in salmon production in Macquarie Harbour from 8000 tonnes to 29,500 tonnes.

2013

Industry data shows a significant increase in production in the Harbour is accompanied by plummeting dissolved oxygen (DO) levels, with median DO levels dropping from 20–40% in 2010–11 to 5% in 2013–14.

2014

FEBRUARY

The industry body the Tasmanian Salmonoid Growers Association establishes an industry-led inquiry into plummeting dissolved oxygen levels in the harbour – the Macquarie Harbour Dissolved Oxygen Working Group.

2015

MARCH

An industry insider leaks parts of the industry working group's report to the media. The leaked report documents that licence conditions have been breached at all fish farms across Macquarie Harbour. Feed waste and faecal matter has built up to become clearly visible at all lease sites. Two species of dorvilleids – a worm that feeds off faeces and is used as an indicator of serious pollution – are present at the majority of lease sites and up to 150 metres from lease sites. Bacteria mats have formed at two lease sites. A degraded environment has led to increased incidences of fish disease. [39]

MARCH

Industry sources leak an email from Huon Aquaculture and Petuna Seafoods CEOs to Premier Will Hodgman. The email describes serious environmental and fish health warning signs, and urges the Premier not to approve Tassal's request for an increase in production in the harbour.

APRIL

The Government commissions the Cawthron Institute in New Zealand to review the data on Macquarie Harbour and assess whether 'current water quality and benthic monitoring regimes are likely to be effective in detecting harbour wide effects related to salmonid farming'.[40]

MAY

85,000 fish are suffocated in Macquarie Harbour. Petuna blames a one-off storm event which 'pushed up' lower levels of water with low dissolved oxygen. The company fails to acknowledge the impacts of fish farming in creating low dissolved oxygen at 20 metres.

AUGUST

The Cawthron Institute submits its report. It documents 'a biological system under stress', with serious impacts up to 7.5 kms from fish farm sites. It concludes that there is a correlation between increased fish farming and the damage seen in Macquarie Harbour, and that current government regulations are not sufficient to monitor these impacts.

Based on regulatory and other monitoring data presented in reports and synthesis documents (i.e. MHDOWG 2104; Aquadynamic Solutions 2015), it appears there is correlative evidence that finfish farming is affecting the water quality of the harbour environment and is contributing to benthic DO reductions in the system. [41]
So in the broadest context of the Department's first question the answer is no – the monitoring is not "...likely to be effective in detecting harbourwide effects related to salmonid farming".[42]

AUGUST

A rare chronic disease called mycobacteriosis, that can cause mortality in fish, is found in farmed salmon in Macquarie Harbour. A Department of Primary Industries internal discussion paper, obtained by the ABC through Right to Information laws, reveals than an increased rate of the disease was recorded in 2014 and is linked to degraded environmental conditions in the harbour.

SEPTEMBER

The Tasmanian Government responds to the Cawthron Institute Report. There are no penalties for fish farm companies. None of the improvements to impact monitoring that were recommended by Cawthron are adopted. The government responds by commissioning 'further research'.

2016

APRIL

The Tasmanian Government responds to a continued build up of evidence of pollution indicator species found up to 7.5 kilometers from fish farm sites in Macquarie Harbour not by issuing fines, but by removing regulations on pollution indicator species pending the outcome of 'further research'.

... [T]he Department has determined that presence of this indicator alone at or beyond 35 metre compliance sites will not constitute a significant visual impact.[43]

APRIL

The Government approves an increase in salmon production in Macquarie Harbour, from 20,000 to 21,500 tonnes a year.

OCTOBER

New research by Melbourne University shows that the conditions in Macquarie Harbour in the summer of 2015 consistently breached the maximum temperature and minimum oxygen supply that salmon can withstand before they stop eating and develop skin lesions. Researchers found that salmon were crushing into the small areas of pens with sufficient oxygen, effectively increasing stocking density 3–4 times beyond the limits set by regulations.[44]

OCTOBER

Research requested by the Government to determine whether pollution indicator species (dorvillieds) are an accurate indicator of salmon farm pollution in Macquarie Harbour finds that dorvillieds are an accurate indicator of salmon farm pollution in Macquarie Harbour. The Government does not reintroduce licence conditions relating to dorvillieds.[45]

THE NEED FOR IMMEDIATE ACTION

This report has provided a detailed, well-referenced account of how Tasmania's planning and regulation of salmon farming lags behind global best practice. It has described a failure of governance which has allowed industry proponents to write zoning laws, and seen government introduce monitoring requirements for the industry which Tasmanian and international researchers have described as ineffective in monitoring the impacts of salmon farming.

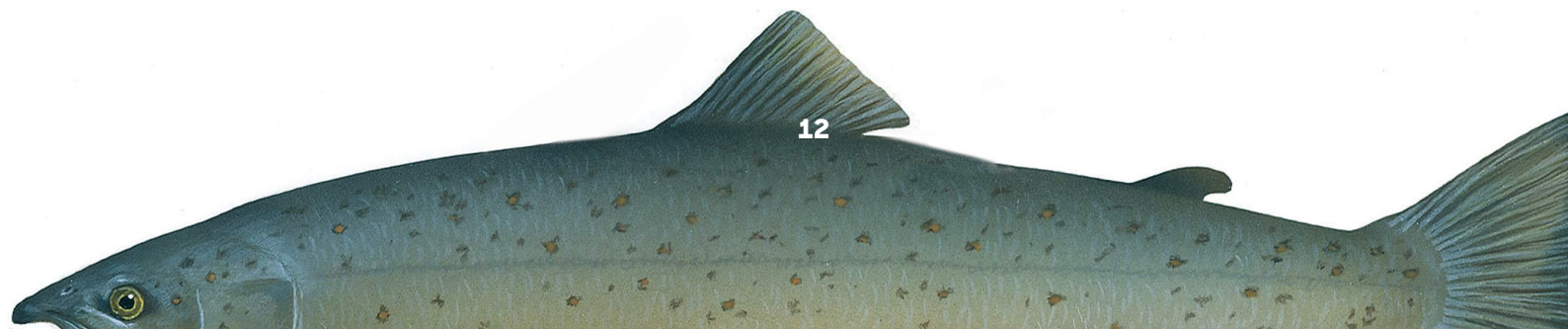
Poor governance of such a large and expanding industry creates risk for our marine environment, investors, and the industries and communities that rely on sustainable management of Tasmania's coasts.

Environment Tasmania calls on the Tasmanian Government to place a moratorium on approval of further ocean-based salmon farming, until an open, evidence-based review of Tasmania's aquaculture planning and regulations has taken place.

The solutions which would support sustainable industry growth are clearly documented in the scientific literature presented in this paper. They are already being implemented overseas.

The immediate solutions

- With the rapid warming of Tasmania's coastal waters, there is a clear need to invest in developing land-based salmon farming operations. Tasmania should follow Norway's lead and offer financial incentives for investment in land-based, closed containment water recirculating aquaculture systems technology.
- For operations within the marine environment, there is a clear need to update regulations to reflect scientific evidence which demonstrates that farming in shallow, warm and poorly flushed bays and harbours damages the marine environment.
- Regulation of marine-based operations should be guided by bioregional plans produced and updated through an independent governance process. These plans should be based on current scientific evidence on best practice salmon farm siting and operation. Regulations should stipulate maximum waste emission standards, maximum water temperatures, minimum water depth and minimum current speeds for marine-based salmon farming.



REFERENCES

1 http://www.tsga.com.au/

2 Price et al. 2015, Marine cage culture and the environment: effects on water quality and primary production. Journal of Aquaculture Environment Interactions, Vol. 6.

3 Impact of Aquaculture (2001), Commonwealth Environment Department, https://www.environment.gov.au/resource/impact-aquaculture.

4 Ibid.

5 Price et al. (2015). Hargrave (2010) Empirical relationships describing benthic impacts of salmon aquaculture. Journal of Aquaculture Environment Interactions. Vol. 1.

6 Impact of Aquaculture (2001). Commonwealth Environment Department, https://www.environment.gov.au/resource/impact-aquaculture citing DPIF, 1997.

7 Levings et al. 1995; Hargrave 2003; Belle and Nash 2008; Scott 2010; Bergheim 2012; Kutti et al. 2007a; Black et al. 1996; Preece, 2012a.

8 Bergheim 2010, http://www.scielo.cl/pdf/lajar/v40nSpecIssue/art26.pdf.

9

10 Black et al. 1996.

11 Floerl et al. 2016. Aquacult Environ Interact. Vol. 8: 407–417, 2016

12 Ibid, citing Sher & Zlotkin 2009; Frazão et al. 2012; Cegolon et al. 2013.

13 Baxter et al. 2012

14 Floerl et al. 2016. Aquacult Environ Interact. Vol. 8: 407–417, 2016.

15 Ibid.

16 Dover Bay Mussels Submission to the Senate Inquiry into the Regulation of the Fin-fish Industry in Tasmania. Accessed online at aph.gov.au/documentstore, September 2016.

17 Levings et al. 1995; Hargrave 2003; Belle and Nash 2008; Scott 2010; Bergheim 2012; Kutti et al. 2007a; Black et al. 1996; Preece 2012a.

18 Ernst M Hevrøy et al., 2013.

19 Brett et al. 1982.

20 Bergheim 2010, http://www.scielo.cl/pdf/lajar/v40nSpecIssue/art26.pdf.

21 Scotland's National Marine Plan, http://www.gov.scot/Publications/2015/03/6517.

22 WTTC 2003.

23 Y. Liu et al., *Aquacultural Engineering* 71 (2016) 1–12.

24 Summerfelt, S., Christianson, L., 2014. Fish farming in land-based closed-containment systems. *World Aquacult*, March, 18–22

25 http://link.springer.com/article/10.1186/s40152-015-0034-9.

26 http://www.akvagroup.com/news/future-growth-in-salmon-farming

27 Lenton et al. *Australian Meteorological and Oceanographic Journal,* 2015, 65:1 citing Wu et al. 2012.

28 http://dpipwe.tas.gov.au/Documents/CurrentStormBayTrumpeterBay.pdf, accessed 22/09/2016, page 5.

29 http://www.edotas.org.au/wp-content/uploads/2014/01/Improving-Tasmanias-Marine-Farming-Framework.pdf

30 Ocean Pollution from Salmon Farming (webpage).

31 DPIF, 1997.

32 Volkman et al. 2009, *A whole-of-ecosystem assessment of environmental issues for salmonoid aquaculture*, Page 81,83, 173.

33 Ibid. Page 3.

34 Crawford, C. M., Mitchell, I. M., and Macleod, C. K. A. 2001. 'Video assessment of environmental impacts of salmon farms', *ICES Journal of Marine Science*, 58:445–452.

35 Ibid, page 113.

36 Knight, Forest, Johnstone (2015) 'Macquarie Harbour Environmental and Fish Health Monitoring Review.'

37 Ibid. Page 5.

38 Ibid. Page 6.

39 http://www.tasmaniantimes.com.au/index.php/article/New-call-for-Government-to-come-clean#sthash.iD2fl0Gk.dpuf. http://www.openaustralia.org.au/senate/?id=2015-03-02.169.1

40 http://dpipwe.tas.gov.au/sea-fishing-aquaculture/marine-farming-aquaculture/macquarie-harbour-environmental-and-fish-health-monitoring-review

41 http://dpipwe.tas.gov.au/Documents/Report%20Cawthron%20Review.pdf, Page 43.

42 http://dpipwe.tas.gov.au/Documents/Report%20Cawthron%20Review.pdf, Page 15.

43 Macquarie Harbour Status Report 2016.

44 Dempster et al. *Identifying the nature, extent and duration of critical production periods for Atlantic salmon in Macquarie Harbour, Tasmania, during summer, June 2016*, http://frdc.com.au/research/Final_reports/2016-229-DLD.pdf.

45 Ross et al. 'Understanding the ecology of dorvillied polychaetes in Macquarie Harbour', IMAS, 2016.

ENVIRONMENT
TASMANIA

For more information, contact Laura Kelly, Strategy Director, Environment Tasmania. (03) 6281 5100.