



Fisheries New Zealand

Tini a Tangaroa

Best practices and technologies available to minimise and mitigate the interactions between finfish open ocean aquaculture and marine mammals

New Zealand Aquatic Environment and Biodiversity Report No. 273

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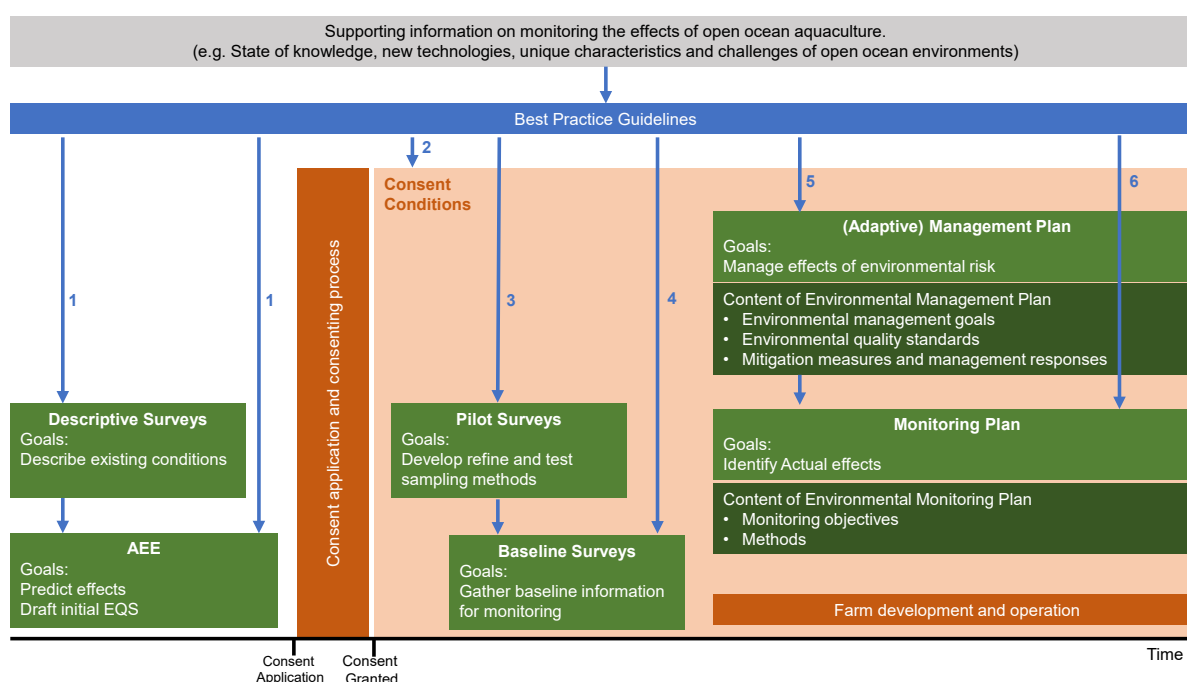
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PREAMBLE

At Fisheries New Zealand we work to ensure New Zealand has world leading finfish farming practices which are environmentally, economically, socially, and culturally sustainable. The Government's Aquaculture Strategy has a goal of \$3b in annual sales by 2035 and development of an open ocean finfish aquaculture industry is a key priority. Towards this goal of supporting sustainable open ocean finfish aquaculture, best practice guidelines for managing the effects of open ocean finfish farming on marine mammals, seabirds, water quality, and the benthic environment have been developed.

The guidelines for open ocean finfish farming ('the Guidelines') have been created to assist in the preparation of consent applications as well as inform consent conditions and decisions that will mitigate adverse environmental effects. The diagram below sets out the role of these guidelines in supporting OOA management under the Resource Management Act 1991.



1. The Guidelines inform the preparation of the Assessment of Environmental Effects (AEEs) by: (a) describing potential effects and (b) Outlining the specific information required for designing monitoring plans.
2. The Guidelines support the development of consent conditions by (a) Recognising that monitoring and management aspects may need to be adapted over time. (b) Promoting the development of Management Plans that enable the necessary flexibility in data collection and analysis.
3. The Guidelines provide assistance for planning pilot surveys to test sampling approaches.
4. The Guidelines inform the development of baseline surveys and monitoring programmes. Baseline information can be derived from descriptive surveys or existing reliable information sources.
5. The Guidelines support the development of Management Plans by (a) Identifying the content required to link monitoring to effects management: and (b) Providing considerations for the development of Environmental Quality Standards (EQSs).
6. The Guidelines support the development of Monitoring Plans (EMOPs) by providing technical guidance for monitoring effects and advice on how this can be implemented.

For seabirds and marine mammals, the Guidelines focus on mitigation of interactions through site selection, design, and operation of farm infrastructure. For benthic and water quality, mitigation of impacts is driven by the need for careful site selection and adaptive management practices that maintain acceptable environmental conditions within consented boundaries.

Because open ocean aquaculture is at an early development stage in New Zealand, carefully designed monitoring programmes will be required to assess the effectiveness of mitigation measures. The Guidelines therefore consider the range of monitoring options that may be appropriate in open ocean environments.

Effective monitoring will inform structural or operational improvements that deliver better environmental outcomes over time. The flexibility to evolve both monitoring and farming practices will be essential given the lack of New Zealand and international experience with open ocean aquaculture (OOA).

Guideline development process:

- Literature reviews were commissioned on the effects of open ocean aquaculture on **seabirds and marine mammals**. These provided a starting point for developing best practice guidelines. Following this, the Aquatic Environment Working Group and the Aquaculture Working Group (chaired by Fisheries New Zealand) provided peer review of the first and second drafts of this document.
- Fisheries New Zealand commissioned a report focused mainly on benthic effects of open ocean aquaculture overseas. This included several case studies from Norway regarding water quality effects. A technical working group was formed to discuss issues and develop guidelines for **benthic and water column effects** given the range of options available for monitoring and management of these effects.
- **Guidelines will be reviewed as needed** based on growing knowledge, so they can be improved. Considering this is the early days of open ocean aquaculture in New Zealand (and elsewhere), it is envisaged the initial review cycles will be relatively short with a backstop of 5 years from the development of the farms, or as required (e.g., if monitoring data and results are significantly different from anticipated).
- **Further research** is required into the effects of open ocean aquaculture upon the marine environment. In addition to known information gaps, research needs will be identified and documented as part of the guideline development and review process. These can then input to any ongoing or future Fisheries New Zealand research planning or prioritisation processes such as the proposed Aquaculture Innovation Plan and the proposed Aquaculture Strategy and Investment Roadmap, currently under development.

Factors to consider when reading and applying the Guidelines:

- Fisheries New Zealand is leading (with input from other government agencies) a process of considering options **for a future regulatory framework for open ocean aquaculture**. This future **open ocean aquaculture regulatory framework will take into consideration** concurrent regulatory change including the Biosecurity Act review, marine protected areas reform, and particularly the review of the Resource Management Act with a new Natural and Built Environment Act and Strategic Planning Act.
- While this regulatory framework may lead to recommended changes for any new farms proposed, **these guidelines are expected to remain relevant under any future regulatory framework**. The guideline review process can be used to manage required adaptations. Although we describe these guidelines within a Resource Management Act context, they are technical guidelines that will remain relevant under any regulatory framework.
- For the purpose of developing guidelines, **open ocean aquaculture is defined as “aquaculture outside of semi-enclosed bays and harbours or other sheltered locations around mainland New Zealand and larger offshore islands”**. This definition

includes the existing applications^{1,2,3} at the time of publication of this document. Future applications are likely to be for areas that are at least as exposed as those in the existing applications. The process of considering different options for management frameworks for open ocean aquaculture may lead to a more precise definition of open ocean aquaculture. If so, that definition will be evaluated for adoption into these guidelines. Furthermore, although ‘open ocean’ is likely to contain areas considered non-dispersive (e.g., weak hydrodynamic regimes) (Bennett et al. 2020), we have assumed that only dispersive open ocean environments will be targeted for finfish farming and, thus, the guidance focuses on these environments.

Further guideline development will occur, for example:

- An approach to comprehensive biosecurity management for aquaculture is in the process of being developed. Officials advised Ministers in mid-2021 on recommendations to improve the management of aquaculture biosecurity, both marine (including open ocean) and land based.
- **Navigation issues** will continue to be considered under future regulatory frameworks. Fisheries New Zealand will continue to engage with Maritime New Zealand to ensure we meet our national and international obligations to provide for safe navigation.
- **Engineering guidelines** have been identified as a lower priority for government. This may be revised in the future.
- The development of guidelines for managing **shark or any other environmental interactions** with open ocean aquaculture has been identified as a lower priority for government. This may be revised in the future.

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¹ Blue Endeavour, New Zealand King Salmon.

² Hananui, Ngāi Tahu, and Project South, Sanford.

³ Project East, Sanford.

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EXECUTIVE SUMMARY

Clement, D.⁴; Milardi, M.⁵; Cumming, S.⁵ (2021). Best practices and technologies available to minimise and mitigate the interactions between finfish open ocean aquaculture and marine mammals.

New Zealand Aquatic Environment and Biodiversity Report No. 273. 12 p.

At Fisheries New Zealand, we work to ensure New Zealand has world-leading finfish farming practices which are environmentally, economically, socially, and culturally sustainable. The Government's Aquaculture Strategy has a goal of \$3b in annual sales by 2035, and development of an open ocean finfish aquaculture industry is a key priority.

Within these guidelines, open ocean aquaculture (OOA) is defined as “aquaculture outside of semi-enclosed bays and harbours or other sheltered locations around mainland New Zealand and larger offshore islands”. We have assumed that only dispersive open ocean environments will be targeted by industry, and the guidance is focused on these areas.

The purpose of these guidelines is to inform the sustainable development of open ocean finfish farming in New Zealand by providing robust and practical guidance for minimising and mitigating effects on marine mammals. These guidelines are intended to inform the development of Environmental Management Plans (EMOPs) and related processes under the Resource Management Act 1991 (RMA) to ensure that minimising and mitigating effects on marine mammals is well integrated into the consent management framework. Associated RMA processes include the design of baseline surveys, assessments of environmental effects (AEE) preparation, writing or review of consent conditions, and design of adaptive management processes.

These guidelines focus on mitigation of interactions through site selection, design, and operation of farm infrastructure. Because open ocean aquaculture is at an early development stage in New Zealand, carefully designed monitoring programmes will be required to assess the effectiveness of mitigation measures.

The main effects that need to be addressed include:

- **attraction or avoidance**, because marine farm structures represent a new physical, visual, or acoustic obstruction that marine mammals may choose to ignore, investigate, or avoid. Attraction might alter natural foraging and passage patterns, potentially lead to interactions and also to incidents.
- **interactions** with farm structures, defined as events when a marine mammal makes physical contact with the farm structure, which may lead to
- **incidents** that cause injury (e.g., rope cut, abrasion), entrapment, or entanglement (live or fatal) of a marine mammal.

Mitigation options include:

- Discourage activities that could attract marine mammals to the farm.

⁴ Cawthron Institute.

⁵ Fisheries New Zealand.

- Minimise artificial lighting, where and when possible, to reduce attraction of prey fish and predators.
- Avoid un-tensioned and/or loose ropes, lines, or nets on farms at all times.
- Consider the use of predator-resistant materials in the construction of farms.
- Minimise predator exclusion nets, or design nets to minimise the likelihood of entrapment.

Undoubtedly there is possibility for negative interactions between marine mammals and open ocean aquaculture facilities. Such interactions are occasionally recorded for inshore aquaculture in New Zealand. Avoiding these effects for the threatened, endangered, and protected species in particular is critical. This document provides recommendations for management and mitigation actions that will greatly reduce the potential for OOA to impact on marine mammals.

1. INTRODUCTION

New Zealand territorial waters have one of the most diverse assemblages of marine mammal species in the world. With a growth of the aquaculture industry, including out into the open ocean, there is greater potential for finfish farms to be sited in or near the migration and movement pathways of large whale species, as well as increased interactions with larger pods of dolphins (> 100 animals) and pinnipeds.

Cawthron Institute (Cawthron) produced the first draft of the Marine Mammal Guidelines ('the Guidelines') using a recent literature review on the interactions of marine mammals with open ocean aquaculture by Würsig (in prep.), as well as current information from New Zealand inshore aquaculture and overseas open ocean experiences. The guidelines focus on the following components:

- planning and siting guidance driven by spatial risk assessments, when and where feasible, to recognise important habitats or threatened species/populations and minimise interactions;
- management guidance to minimise adverse effects;
- guidance for monitoring / reporting interactions and any adverse effects.

Undoubtedly there is possibility for negative interactions between marine mammals and open ocean aquaculture facilities. Such interactions are occasionally recorded for inshore aquaculture in New Zealand. Avoiding these effects for our threatened, endangered, and protected species in particular is critical. However, by following the recommendations for management and mitigation actions discussed below, the risk of offshore aquaculture in New Zealand impacting marine mammals can be greatly reduced.

2. MARINE MAMMAL GUIDELINES

The Guidelines are focused on reducing the likelihood of marine mammals being attracted to finfish open ocean aquaculture structures, thus minimising interactions, while not hampering migration of marine mammals near or through open ocean farms. The Guidelines are also designed to mitigate the possible consequences of any interaction by reducing the significance of any resulting effects.

The Seabird Guidelines (Gaskin et al. 2021) for open ocean aquaculture were developed alongside the Marine Mammal Guidelines. Within these two sets of guidelines there are some examples of tensions: e.g., in the Seabird Guidelines it is recommended that operators "reduce the extent of structures above water in the farm design, to minimise seabird attraction, wherever possible", whereas in the Marine Mammal Guidelines it is recommended that any predator exclusion nets should "where practicable, extend 2–3 m above the sea surface (e.g., jump fences) around any surface pens". Any tension between guidelines will need to be resolved on a case-by-case basis in management plans. The Guidelines are not absolute, operators will have to ascertain, when preparing an assessment of effects, which effect should take precedence and draft their management plans accordingly. This is expected to vary on a site-by-site basis, based on the species present in the area (e.g., seabirds might be of more concern than marine mammals in a given area or for a type of farming, and thus lead to a different prioritisation of management).

2.1 Types of effects that require management / monitoring

The potential effects of aquaculture (especially finfish aquaculture) on marine mammals have been reviewed and summarised by Würsig (in prep.) and Bennett et al. (2020), but uncertainty remains on how these would translate to the open ocean environment.

These reviews concluded that the main effects that need to be addressed include:

- **attraction or avoidance**—marine farm structures represent a new physical, visual, or acoustic obstruction that marine mammals may choose to ignore, investigate, or avoid. Attraction might alter natural foraging and passage patterns and, potentially, lead to interactions and also to incidents.

Attraction may increase the risk of interaction with the structure, whereas avoidance may exclude mammals from part of their habitat. Some factors such as lighting, the presence of dead fish, or underwater noise have been identified as potentially attracting marine mammals to farm structures and increasing risk of interaction, and the Guidelines aim to minimise and mitigate these factors. Avoidance of farm structures can disrupt migration patterns or foraging, but criteria around farm siting can minimise this.

- **interactions** with farm structures—interactions occur when a marine mammal makes physical contact with the farm structure, which may lead to **incidents** that cause injury (e.g., rope cut, abrasion), entrapment, or entanglement (live or fatal) of a marine mammal. These terms are used throughout the document and in the tables of guidelines below.

A marine mammal can be trapped when unable to move away from a farm structure. If the entrapment happens underwater the animal might not be able to reach the surface to breathe. Loose ropes or nets have been identified as the main factors that increase injury and entanglement risk for marine mammals. The Guidelines aim to minimise this risk, e.g., by ensuring ropes are taut in the water or properly stowed away when not in use. Rope or net entanglements lead to abrasion injuries to flippers and tails, and these injuries sometimes impair the animal's ability to move. In some interactions, entanglements can also result in drowning of marine mammals, when they are not able to reach the surface to breathe.

The Guidelines are designed to:

- minimise or mitigate the attraction (or avoidance) of marine mammals to open ocean finfish farms, e.g., investigation of structures;
- minimise or mitigate interactions between the farm structures and marine mammals, e.g., rubbing against the structures;
- minimise or mitigate incidents, e.g., entanglements in ropes or nets.

2.2 Approach to guideline development and legislative framework

The Guidelines are focused on the main effects discussed above and are intended to define best practices and technologies to minimise and mitigate adverse effects of open ocean finfish aquaculture on marine mammals. Several of these guidelines are intentionally general, particularly for aspects where little or no knowledge exists to suggest how marine mammals will react to aquaculture structures, gear, and technology in an open ocean environment. New Zealand has not yet implemented a marine mammal monitoring framework to assist in developing evidence-based mitigation actions and/or guidelines for open ocean finfish aquaculture, so these guidelines are mainly a product of current scientific literature and expert knowledge. It is expected that further development of the guidelines might be needed when new evidence becomes available.

As a result, these marine mammal guidelines for open ocean farms reflect New Zealand's current inshore practices and experiences (Clement 2013), augmented by a collection of best management practices implemented over time across the aquaculture industries in Australia, New Zealand, and internationally. Several of these best practices also align with the international certification

requirements of the Aquaculture Stewardship Council⁶ (ASC 2019a, ASC 2019b) and the Best Aquaculture Practices⁷ (BAP 2016) certification processes, as well as Aquaculture New Zealand's recent Sustainable Management Framework initiatives for both the shellfish (AQNZ 2015a) and salmon industries⁸ (AQNZ 2015b). Guidance is also intended to be consistent with the Seafood Watch⁹ Aquaculture standards.

There are two statutes that specifically manage impacts on marine mammals in New Zealand, including both its territorial waters (12 nautical miles from the coast) and the exclusive economic zone (EEZ, out to 200 nautical miles). The Marine Mammals Protection Act 1978¹⁰ provides for the conservation, protection, and management of all marine mammals. Under this Act, all marine mammals are considered protected species and it is an offence to 'take' (which includes, among others, disturb, harass, injure, or kill) a marine mammal without a permit. It also gives defence for accidental or incidental injury or death (e.g., while fishing or carrying out other activities) provided all such events are reported to the Department of Conservation (DOC).

The Marine Mammals Protection Regulations 1992¹¹ establish a permit regime for commercial marine mammal tourism. These regulations also prescribe operating rules for all boats (and aircraft) in the vicinity of marine mammals. The Minister of Conservation also has the authority to create marine mammal sanctuaries for area-specific protection measures for marine mammals. Additionally, non-statutory 'threat management plans' may be used by DOC and Fisheries New Zealand to help address species- or population-specific threats to marine mammals. These guidelines are intended to help ensure the statutes protection is met.

Most other regulatory requirements fall under national resource management legislation, including the Resource Management Act 1991 (RMA), the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (and associated regulations), and the New Zealand Coastal Policy Statement 2010. Regional coastal plans and regional policy statements established under the RMA may also have provisions relevant to marine mammal populations and/or their habitats.

2.3 Interaction between the Guidelines and the Resource Management Act 1991

Practitioners, i.e., regional councils, can use the Guidelines to assist processes under the RMA in one of three ways:

- Information generated because of implementing the planning and siting guidelines (Table 1) may be suitable for subsequent inclusion in regional coastal plans, such as known marine mammal migration or movement routes. These types of areas could, for example, be shown on plan maps and require any applicant to carefully consider how they would avoid, remedy, or mitigate risk of entanglement.
- The Guidelines provide a source of guidance for councils in processing and making decisions on consent applications for open ocean aquaculture. For example, if a proposed aquaculture site

⁶ The Aquaculture Stewardship Council is an independent non-profit organisation and labelling organisation that establishes protocols for farmed seafood while ensuring sustainable aquaculture.

⁷ Best Aquaculture Practices is a seafood specific certification programme that addresses the four key areas of sustainability—environmental, social, food safety, and animal health & welfare—at each step of the aquaculture production chain.

⁸ Aquaculture New Zealand's A+ is a world class sustainable management framework which enables the New Zealand aquaculture industry to better engage with our communities and continuously improve our environmental practices while strengthening global demand for our seafood.

⁹ Monterey Bay Aquarium's Seafood Watch programme evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace (e.g., Seafood Watch 2020).

¹⁰ <http://www.legislation.govt.nz/act/public/1978/0080/latest/DLM25111.html>.

¹¹ <https://www.legislation.govt.nz/regulation/public/1992/0322/latest/DLM168286.html>.

is near known marine mammal migration or movement routes, then reasoning for selecting that location and an appropriate management plan should be provided for a consent application.

- The Guidelines for management and monitoring (Tables 2 and 3) could inform the development of proposals that outline potential consent conditions, and then be used by applicants and councils during the consent process as a basis for discussion of conditions. Management of effects of activities under the RMA is typically approached through a combination of consent conditions and management and monitoring plans. Consent conditions need to be both certain and enforceable. A balance should therefore be drawn in using the guidelines between those that might be suitable to include as consent conditions, those that could inform or form part of management plans, and those that sit outside the resource consent process. Consent applicants should consider these guidelines while preparing consent applications and discuss particulars of specific sites and approaches with councils during the application development process. Discussions between councils and applicants should continue throughout the processing of an application.

Table 1: Planning and siting guidelines to minimise and mitigate the risk of interactions between marine mammals and open ocean finfish aquaculture in New Zealand.

Principle	Guidelines
Minimise location overlap	<p>Optimise site selection to minimise overlap with threatened / at-risk¹² species.</p> <p>Farm siting should strive to minimise spatial overlap with marine mammal breeding and foraging habitats and/or migration routes.</p>
Minimise interaction risk through farm design	<p>Minimise overlap or crossing of underwater warp lines on farms.</p> <p>Dissuade animals from entering farms by placing multiple structures / pens in as close proximity to each other as practical, and set parallel to migration pathways, where possible.</p> <p>Prevent the ‘channelling’ of mammals within or between farms into dead ends or maze-like configurations through farm layout.</p> <p>Reduce the extent of structures above water in the farm design, to minimise seal attraction, where practical.</p>

¹² At-risk species aren’t considered threatened, but they could quickly become so if declines continue, or if a new threat arises.

Table 2: Management guidelines to minimise and mitigate the risk of adverse effects on marine mammals from open ocean finfish aquaculture in New Zealand. [Continued over the page]

Principle	Guidelines
Management plan	Develop customised marine mammal management plans addressing protocols to minimise interactions with the species likely to be in each area, defining monitoring and reporting requirements, and providing for entanglement response actions. Plans should include an appropriate review period (e.g., three years).
Minimise attraction to farms	<p>The amount of feed and dead fish that are accessible outside the nets is limited by:</p> <ul style="list-style-type: none"> • utilising strategies for feed rates and feeding systems, to minimise attraction of predators and their prey; • removing dead fish from pens as soon as reasonably practical and storing them in a manner that does not attract predators. <p>Discourage activities that could attract marine mammals to the farm (e.g., fishing).</p> <p>Minimise the use of any pinniped or dolphin acoustic deterrent devices. Other deterrent devices may be considered:</p> <ul style="list-style-type: none"> • as technology develops, or • for discrete activities (e.g., shark repellent devices on divers). <p>Minimise artificial lighting, where and when possible, to reduce attraction of prey fish and predators by:</p> <ul style="list-style-type: none"> • using downward pointing, shaded light sources within fish pens as part of fish husbandry; • reducing the use of lights on farm structures to the minimum required for health and safety of farm workers and navigation, where practical; • minimising the need for service vessels to be active in the area at night, where practical. <p>Minimise above-water and underwater operational noise generation by:</p> <ul style="list-style-type: none"> • regularly maintaining all equipment and vessels (e.g., lubrication and repair of winches, generators); • ensuring that all noise suppression equipment, such as mufflers and ventilation baffles, are maintained in good working order.
Minimise and mitigate entanglement / entrapment risk	<p>Maintain anchor warps under sufficient tension in all tidal conditions</p> <p>Avoid un-tensioned and/or loose ropes/lines on farms at all times.</p> <p>Consider predator-resistant materials in the construction of farms (e.g., semi-rigid or core stiffened nets resistant to chewing / tearing).</p> <p>Minimise predator exclusion nets, if possible. If predator or external nets are considered necessary, design should minimise the likelihood of entrapment. For example, predator / external nets if fitted should:</p> <ul style="list-style-type: none"> • completely enclose all structures to be protected; • be spaced from pen nets by a distance sufficient to avoid entrapment and designed so that fish pen and predator net gear do not touch in all tidal and sea conditions as practicable;

	<ul style="list-style-type: none"> • where practicable, extend 2–3 m above the sea surface (e.g., jump fences) around any surface pens; • be maintained under tension and taut; • have a mesh size that minimises a predator’s ability to penetrate the net with its head, flippers, or tail (note a potential conflict with Seabird Guidelines); • be kept well-maintained (e.g., holes repaired as soon as possible).
Appropriate maintenance and replacement schedules	<p>Perform inspection and maintenance of all fish pen nets and predator exclusion nets, including tensioning systems, on a regular basis.</p> <p>Minimise potential for loss of rubbish or structural and gear debris from farms through a waste management plan that could include, for example:</p> <ul style="list-style-type: none"> • collecting or retrieving waste, and retaining it in secure storage (especially in higher wind conditions); • mitigating the loss of debris through service vessel scuppers; • maintaining farm infrastructure regularly, to minimise breakages or loss of equipment overboard. <p>Follow standard and regular maintenance inspections and replacement schedules, particularly after any significant storm events, to ensure:</p> <ul style="list-style-type: none"> • no marine wildlife is entangled in or has entered the farm, • nets/pens and lines are well maintained (e.g., holes are repaired as soon as feasible) and kept taut. <p>Utilise remote sensing autonomous equipment to enable underwater survey of pens, barges, and other farm structures, where feasible.</p> <p>Consider whether marine mammals are likely to be in the area and review the management procedures accordingly, before undertaking major operational installations, removals, and / or maintenance of structures.</p>
Entrapment / entanglement emergency response plan	<p>Develop emergency entanglement response action plans and protocols in conjunction with marine mammal experts, including:</p> <ul style="list-style-type: none"> • disentanglement protocols and procedures developed in consultation with the Department of Conservation (DOC)—for large whales, these should be aligned with DOC’s national large whale disentanglement programme; • training of staff in the removal of entrapped / entangled animals from pens or nets; • separate procedures for whales, dolphins, and pinnipeds as well as live and dead individuals (including appropriate tikanga of that region).
Review of management practices, protocols, and procedures	<p>Run regular external reviews of the effectiveness of the management plan in managing and mitigating the adverse effects on marine mammals, through the life of the consent.</p> <p>With each review, consider integrating newly available best international practices and technologies.</p>

Table 3: Monitoring guidelines to minimise and mitigate the risk of adverse effects on marine mammals from open ocean finfish aquaculture in New Zealand.

Principle	Guidelines
National monitoring framework	Make data available to any future government-led national database, with standardised reporting requirements, across the open ocean aquaculture sector to collectively gather and make use of New Zealand-wide marine mammal monitoring data and record all incidents in open ocean aquaculture.
Baseline and farm construction monitoring (Level 1)	<p>Develop a baseline monitoring programme lasting for at least a year, to understand presence and density of marine mammals in the proposed area prior to and during farm development. Multiple surveys at different times of the year might be required, depending on species breeding and migration times.</p> <p>Establish and collect standard parameters, regardless of methods used, to model potential interaction rates (e.g., number of marine mammal individuals adjusted for observation effort within a particular area).</p>
Farm monitoring (Level 2)	<p>Develop monitoring and reporting protocols using existing farm management processes and equipment (e.g., video monitoring or passive acoustic systems) to monitor marine mammal interactions and incidents, once the farm is operating. This should last for the first year of operation and cover all seasons.</p> <p>Report interactions and incidents to DOC, including:</p> <ul style="list-style-type: none"> • detailed observations of time marine mammals spent under or around farm structure, where available; • recorded, categorised, and quantified interactions/incidents for the first year of operation; • footage and/or photographs where available; • reporting on marine mammal injuries and mortalities under Section 16(2) of the Marine Mammals Protection Act 1978. <p>Target monitoring of marine mammal interactions during periods potentially at higher risk of interaction (e.g., overlap between species presence/activity and farm operations) and during each stage of farm development.</p>
Solution Monitoring (Level 3)	<p>If level 2 monitoring identifies a significant interaction or increased risk, increase monitoring effort (e.g., use real-time farm monitoring systems, passive acoustics, etc.), to assess:</p> <ul style="list-style-type: none"> • marine mammal behaviour around farms; • cause and duration of attraction; • type and outcomes of interactions. <p>Investigate attraction factors and identify mitigation solutions if marine mammal interactions are commonplace and/or result in entanglement(s).</p>

2.4 Structure of marine mammal monitoring guidance

Understanding and adequately mitigating adverse effects of open ocean finfish aquaculture farms will not be possible without baseline and standardised marine mammal monitoring across this industry sector. These guidelines propose three levels of monitoring that could be implemented with any new finfish farm proposal (see Table 3). Depending on the outcomes of the various levels, monitoring can be modified and tailored to best address the concerns at each site.

In the first instance (Level 1), one year of baseline monitoring is required at the proposed open ocean aquaculture site. Most level 2 and 3 monitoring is expected to be undertaken by existing remote farm operational systems, because it is assumed that a large portion of day-to-day operational monitoring on open ocean finfish farms will be undertaken remotely. It is envisaged that the monitoring approach will be developed in consultation with scientists, and that monitoring will be operated and maintained by the consent holder, as specified in the resource consent and audited by the council. These approaches are reliant upon farm operators maintaining protocols and are part of the regulatory consent compliance that can be enforced by councils.

The consent holder will also be in the unique position to assess the significance of these interactions and develop solutions more effectively, while gathering much needed data on the knowledge and research gaps identified below, which would serve to refine and develop future guidelines.

3. FUTURE RESEARCH REQUIREMENTS

This is a list of gaps and research needs, which is useful to guide future research and to underline the limitations on the currently available information that was used to develop these Guidelines. There might be issues not yet apparent at the time the Guidelines were drafted, which will require review due to the fast-changing nature of research/development of the open ocean aquaculture industry. Fisheries New Zealand will look to prioritise the delivery of these research needs as possible.

3.1 Marine mammal populations

- Home ranges or locations of important habitats for most New Zealand populations and sub-populations of marine mammal species are not well-quantified.
- Migration pathways of whales are not well known in New Zealand waters.
- In recent years, increasing numbers of humpback, southern right, and blue whales have been documented off Australia, within New Zealand's Cook Strait, and near sub-Antarctic islands as populations continue to recover from whaling effects. However, no population estimates are available for whale numbers within or passing through New Zealand waters.
- The potential biological and/or population level effects of almost all the discussed effects of aquaculture on marine mammals are unknown.
- Use of mātauranga Māori to inform our understanding of marine mammal populations.

3.2 Marine mammal interactions

- There is little to no peer-reviewed scientific documentation of New Zealand marine mammal interactions with marine farms. The main exceptions are New Zealand fur seals around inshore salmon farms and dusky dolphins within Admiralty Bay.
- More in-depth analysis to discern which protected species are most prone to harmful interactions with open ocean aquaculture and other marine structures will enhance current efforts to avoid such interactions.

- Investigation of behavioural and physical mechanisms behind entanglement and other harmful interactions will provide valuable insights into how protected species interact with marine aquaculture gear and how adverse effects could be mitigated.
- Continuation of research into the types of design, optimal layout, maintenance features, and operational procedures that minimise entanglement risk.
- Research to better understand how marine species perceive farm structures (e.g., visually, acoustically, and physically) with the objective to develop strategies to reduce interactions and incidents.
- Research into methods to increase species' awareness of marine farms without introducing additional anthropogenic noise (e.g., vibrations or reflectors rather than acoustic deterrent devices) and to make lines/farms easier to detect in the water column (e.g., type, colour, texture, reflectivity).
- Continuation of research into feeding systems and different light colours (other than white) used at night that may reduce attraction of predators and their prey.
- Investigation of fixed, tensioned, weighted or negatively buoyant lines, hard structures, and/or methods to stiffen lines with rigid or semi-rigid cores, that do not diminish the primary function of these lines while reducing incidents.

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