BIOSECURITY ASSESSMENT OF PROPOSED WAIKATO WEST COAST MUSSEL NURSERY

COAST & CATCHMENT

ENVIRONMENTAL CONSULTANTS

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August 2022

Client report for North Western Mussels Ltd

Report Number: 2022-19

Reviewed by: Shane Kelly

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EXECUTIVE SUMMARY

North Western Mussels Ltd (NWML) are applying for consent for a new 700 ha spat catching and spat holding farm (hereafter referred to as a nursery farm) 3 km off the coast of Raglan/Whāingaroa that will be divided into four well-separated blocks. The applicant is also considering using the proposed farm in the future to on-grow wild spat from 90 Mile Beach or hatchery spat (hereafter referred to as a grow-out farm). The proposed sites are situated in an exposed, high-energy environment. The substrate is fine sand and the macrofauna community is dominated by mobile taxa common to exposed sandy areas. No sensitive habitats or epifauna were observed at the site.

This report provides an assessment of the marine biosecurity risk posed by the proposed farm.

Biosecurity risks are posed by various harmful organisms, including non-indigenous pests, diseases, and harmful algae. Currently very few harmful organisms are known to be present at the proposed site. The only marine pest known to occur along Waikato's West Coast is the Asian date mussel, which inhabits sheltered inshore locations. No marine pests are known to occur offshore of Raglan. The only disease known to cause significant mortality in New Zealand mussels is digestive epithelial virosis, which was associated with 50–100% spat mortality in 1994. The virus is likely to be ubiquitous in scallops, but is typically only found sporadically in mussels at low infection levels. Harmful algal blooms occasionally occur at 90 Mile Beach and around Raglan.

There are four main sources of biosecurity risk that are associated with the proposed farm. These are risks associated with:

1. **Farm placement and its structures**—mussel farms may act as reservoirs for pests and diseases, with farms facilitating their persistence in the environment and increasing their abundance and spread to new areas. Biofouling of the proposed farm by pests is expected to be minimal due to the lack of known pests in the area and the exposed, offshore location of the farm. All the diseases known to adversely affect mussels are ubiquitous to New Zealand's marine environment and are likely to be able to survive in the area without the presence of the farm. The biosecurity risk of the proposed farm acting as a reservoir for pests and diseases is assessed as less than minor, as long as no new pests or diseases are introduced into the area that are able to survive on the farm.
2. **Transfer of stock**—the translocation of aquaculture stock is considered to be one of the most important transmission pathways for harmful organisms. The biosecurity risks of the proposed farm associated with the transfer of aquaculture stock depends on whether the farm is used as a nursery farm only, or as a grow-out farm. If the proposed farm is used:
    a. As a nursery farm only, then there is no chance of introducing harmful organisms to the Raglan area via stock movements as no stock will be moved onto the farm.

   b. For on-growing hatchery spat, then the biosecurity risk is expected to be less than minor due to hatchery spat being produced in a controlled environment with appropriate water treatment and biosecurity procedures in place.
   c. For on-growing Kaitaia spat, then there is a more than minor risk that harmful algae or pests are transferred to the Raglan area with Kaitaia spat material as this material is not routinely treated or screened for harmful organisms.

3. **Transfer of equipment**—farm equipment that is transported and redeployed in another location without cleaning and disinfection may facilitate the introduction and spread of pests and diseases. In particular, untreated used spat rope that is redeployed on the spat farm poses a high risk of introducing harmful organisms to the site. The likelihood of introducing new pests or diseases to the area via submerged equipment can be minimised by:
   a. using new equipment; or,
   b. cleaning and disinfecting used impermeable equipment such as floats prior to use on the spat farm;
   c. cleaning used rope and storing on land for at least 12 weeks before use on the spat farm.

   Provided that used equipment is treated as recommended above, the risk of introducing pests to the Raglan area via farm equipment is assessed as minor.

4. **The movement of farm vessels**—service vessels used by the aquaculture industry can transfer pests and diseases via hull fouling, or water or sediment discharged from decks, bilges, and other contained spaces. The biosecurity risks associated vessel and vehicle movements can be mitigated by:
   a. regular cleaning and antifouling of the vessel's hull and niche areas;
   b. washing down decks and equipment, and flushing or emptying contained water once the vessel has left a farm and prior to arriving at its destination, and vice versa;
   c. washing down trailer vessels and vehicles, and emptying any contained water before moving between operational zones, management areas or distant locations.

   Given the lack of pests in the Raglan area and the limited normal movements of the farm vessels, the biosecurity risks associated with farm vessel movements are assessed as minor, provided that the recommended mitigation methods are implemented.

In summary, the overall biosecurity risk of the proposed farm is **no more than minor** as long as the farm is only used as a nursery farm only or for on-growing hatchery spat, and the recommended mitigation methods are implemented, including a 12-week drying time for used rope. The transfer of Kaitaia spat onto the farm poses the greatest biosecurity risk, and the overall biosecurity risk is assessed as **more than minor** if the proposed farm is used to on-grow Kaitaia spat.

BACKGROUND

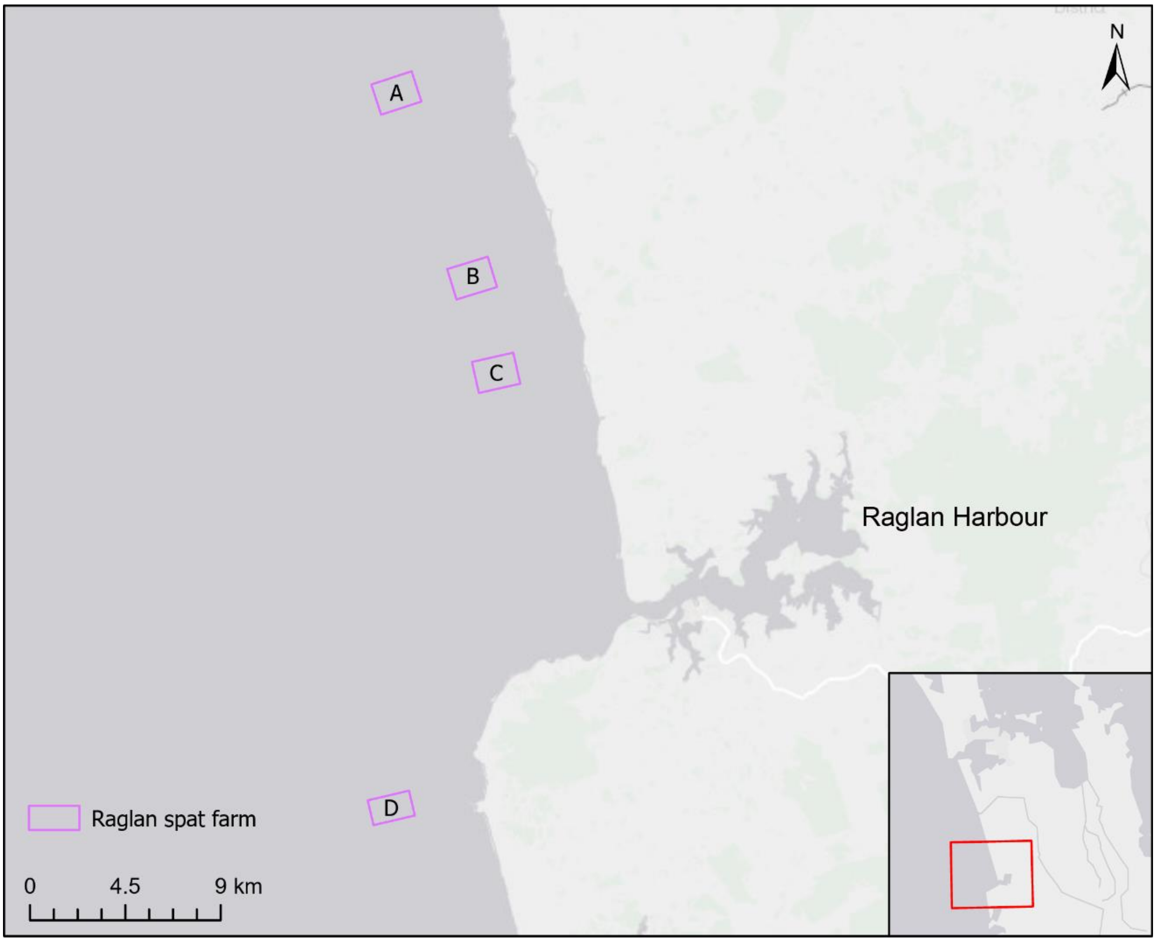
North Western Mussels Ltd (NWML) are applying for consent for a new 700 ha spat catching and spat holding farm ('nursery farm') off the coast of Raglan/Whāingaroa. The farm will consist of four, well-separated blocks that are located approximately 3 km offshore in waters ≥20 m deep (Figure 1). Blocks A–C are each 180 ha in size, while Block D is 160 ha in size. Each block will be approximately 2 km × 1.5 km in size. Spat caught on the farm will be held there until they are up to 90 mm in length. Depending on the mussel size, they will be transported over land to Waikato East Coast farms either still attached to the spat rope, or as single seed. North Western Mussels are also considering using the proposed farm as a 'grow-out farm' to on-grow wild spat from 90 Mile Beach or hatchery spat in the future. It is acknowledged that a Plan Change will be necessary for the farm to be used for holding spat beyond 20 mm in length, or for on-growing hatchery or Kaitaia spat.

Coast and Catchment were contracted to provide a desktop biosecurity assessment of the proposed farm to inform the consent application. The objectives of the biosecurity assessment are to:

- collate background information on the marine environment and habitats of the sites;
- identify and characterise key marine pests and diseases of concern for the area, including the known distribution of marine pests and diseases of concern around Raglan and the surrounding area;
- provide an assessment of the marine biosecurity risk posed by using the site for:
    - spat catching and holding to 90 mm;
    - on-growing wild spat collected from 90 Mile Beach (Kaitaia spat);
    - on-growing hatchery spat;
- provide high-level recommendations for possible mitigation and monitoring options.

We understand that the proposed farm operator, Gulf Mussels Ltd, is a member of the A+ Greenshell™ biosecurity standards programme, and therefore the biosecurity risk of the proposed farm is assessed assuming that the requirements of the A+ Greenshell™ biosecurity standards (AQNZ, 2021) will be implemented.

Figure 1. Location of the proposed farm blocks A–D off the coast of Raglan. Inset map shows the location of the farm off the west coast of the North Island.



Eagle Technology, Land Information New Zealand, Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

METHODS

A desktop review was carried out using available information from the scientific literature, grey literature, and the internet. The review:

- collated background information on the marine environment and habitats of the sites; and,
- identified and characterised key marine pests and diseases of concern for the area.

This information was used to inform an assessment of the marine biosecurity risk posed by the proposed development.

BENTHIC HABITATS AND COMMUNITIES AROUND THE RAGLAN COAST

Raglan, Aotea and Kawhia Harbours, and Gannet Rock (18 km offshore of Aotea Harbour) are all designated Areas of Significant Conservation Value in the Waikato Regional Coastal Plan (Figure 2). Significant ecological features present in these areas are given in Table 1 below.

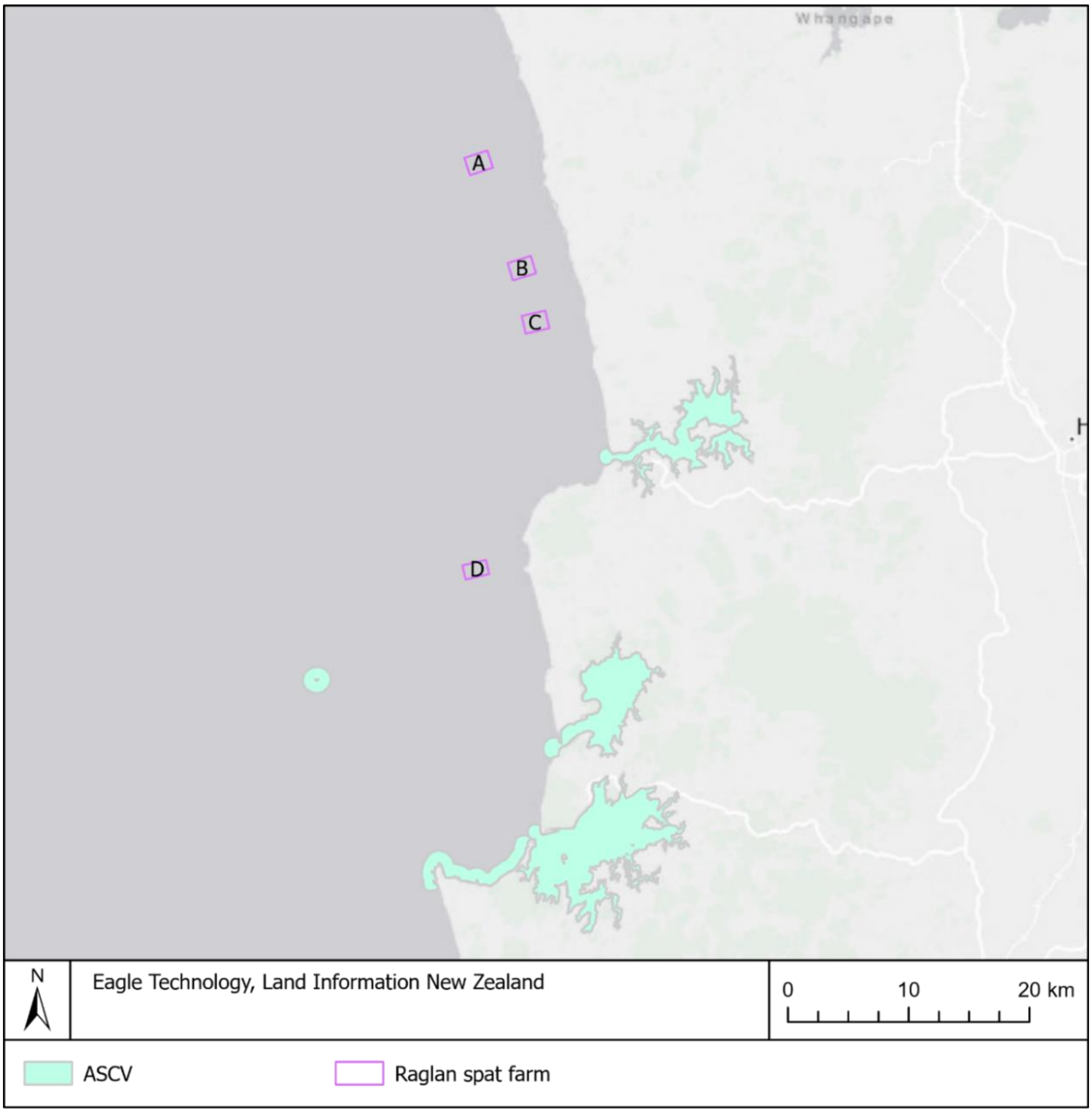
The three harbours are shallow with large areas of intertidal flats. Saltmarsh habitats are present in the inner areas of the harbours, and small areas of mangrove habitat are present in the northern arms of Raglan Harbour. Extensive areas of seagrass are present in the intertidal areas of Aotea and Kawhia Harbours (Graeme, 2012; 2014b; 2014a). Shellfish beds (mainly cockles (*Austrovenus stutchburyi*), pipis (*Paphies australis*) and wedge shells (*Macomona liliana*)) are present in several areas within the three harbours (Hillock & Rohan, 2011; Ryer *et al.*, 2016; Berkenbuisch & Neubauer, 2020). Estuary monitoring in Raglan Harbour indicates that there is a health gradient within the harbour, with inner harbour sites being muddy with poor health indices, while outer sides are less muddy and have good health indices (Jones, 2021).

Rocky reefs are present outside Raglan and Aotea Harbours, and Gannet Rock (Figure 3). Dive surveys have been conducted around the Raglan reef and Gannet Rock. Waters around the Raglan reef were very turbid and macroalgae were sparse, apart from small amounts of *Carpophyllum maschalocarpum* interspersed with red foliose algae in shallow waters. Sponges, bryozoans, mussels *(Perna canaliculus* and *Xenostrobus pulex)* and the starfish *Stichaster australis* were commonly found on the reef. Waters around Gannet Rock were clearer and a dense band of *C. maschalocarpum* was present in shallow waters. Kina (*Evechinus chloroticus*) were extremely abundant and the gastropods *Cookia sulcata* and *Dicathais orbita* were commonly found (Shears & Babcock, 2007).

Table 1. Significant ecological features of Raglan, Aotea and Kawhia Harbours, and Gannet Rock identified in the Waikato Regional Coastal Plan.

Area of Significant Conservation Value	Ecological features
Raglan Harbour	▪ habitat for rare and threatened wading and coastal birds ▪ Hector's dolphin area ▪ southern limit of mangroves
Kawhia Harbour	▪ outstanding habitat for wildlife, wading, shore and wetland birds, including rare and threatened species ▪ extensive seagrass communities ▪ presence of Hector's dolphins
Aotea Harbour	▪ extensive sandspit and sand dune system ▪ extensive seagrass communities ▪ habitat for rare and threatened wading and coastal birds ▪ Hector's dolphin area
Gannet Rock	▪ island wildlife sanctuary ▪ haul out area for New Zealand fur seal ▪ Australian gannet major breeding site

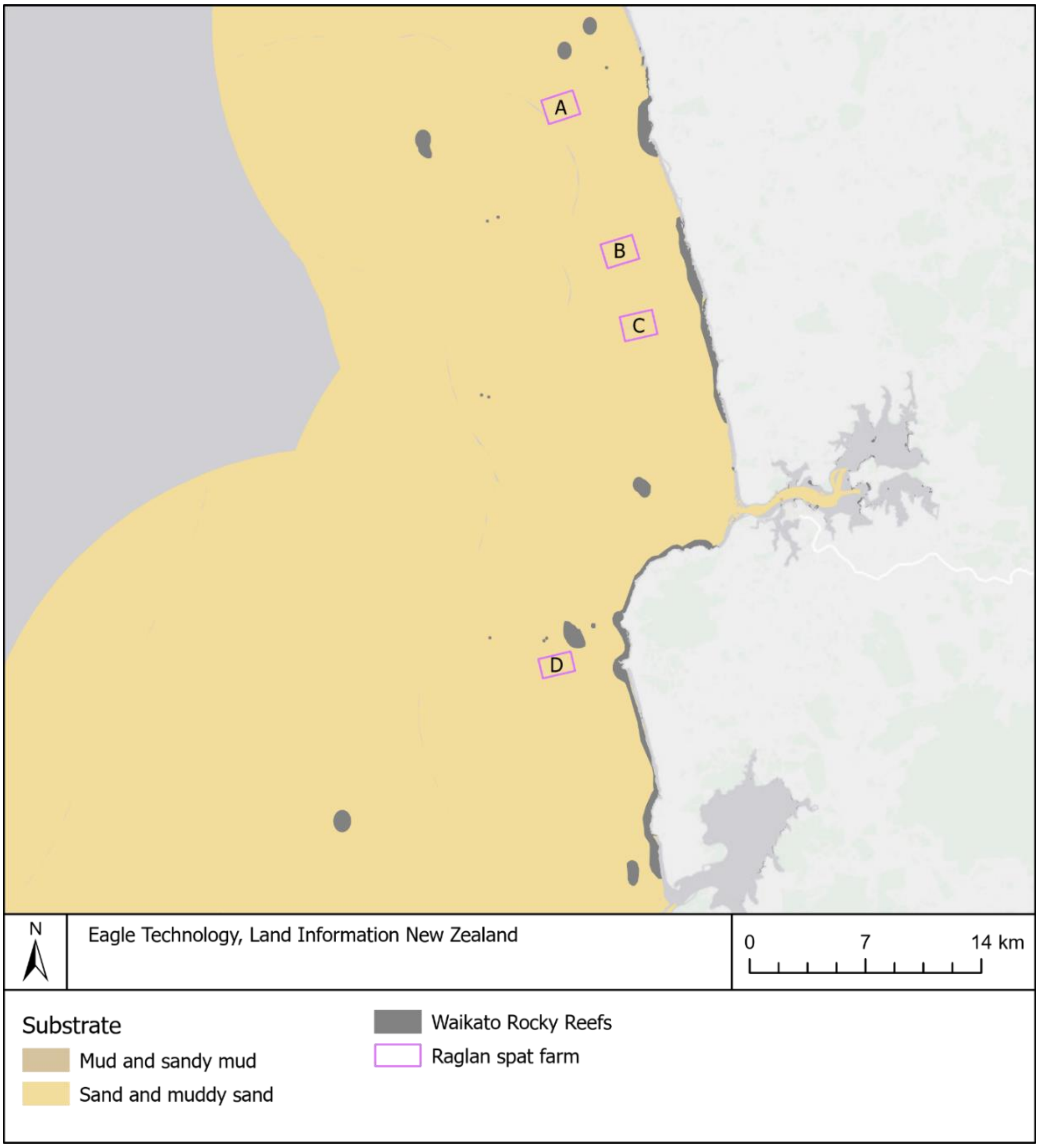
Figure 2. Areas of Significant Conservation Value (ASCV) around the Raglan coast.



The exposed, high-energy shoreline of the Raglan coastline mainly consists of sandy beaches and steep cliffs. Very little ecological information is available for open coastline habitats (Ryer *et al.*, 2016). The substrate in subtidal, offshore areas is fine sand. The macrofaunal subtidal community offshore from the entrance to Raglan Harbour (11–20 m depth) was found to have a low diversity (46 taxa) and was numerically dominated by polychaete worms (particularly *Armandia maculata*), amphipods, hermit crabs *Pagurus* sp., turret shells *Maoricolpus roseus,* and the small bivalve *Linucula hartvigiana* (Hayward *et al.*, 2002).

A benthic survey of the proposed farm sites found that the substrate in Blocks A–C was predominantly sand, with a small percentage of mud (~10%). Block D contained a larger percentage of mud (~20–30%). No sensitive habitats or epifauna were observed at the site. Infaunal communities were dominated by small, common mobile taxa e.g., polychaetes, amphipods, cumaceans, the decapod *Ogyrides delli*, and the bivalves *Dosinia* sp. and *Mactra ordinaria*, which are widespread around the New Zealand coast in exposed, sandy areas (Grange, 2017).

Figure 3. Predicted substrates around the Raglan coast (substrate data from Gardiner and Jones (2020) and reef data from WRC (2017)).



KEY MARINE PESTS OF CONCERN

Mussel farmers regard any species that adversely impacts on their business as a 'pest', regardless of their origin. These include both native and non-indigenous fouling organisms (ascidians, sponges, macroalgae, barnacles, polychaetes, and blue mussels (*Mytilus planulatus*)) that grow on the mussel lines and farm equipment, harmful algae, and the parasitic pea crab (*Nepinnotheres novaezelandiae*) (Sim-Smith *et al.*, 2016). However, this assessment focuses on non-indigenous pest species that pose significant risks to New Zealand marine environments, mussel parasites and pathogens, and harmful algae. Collectively, these organisms are referred to as 'harmful organisms'.

PESTS IN THE RAGLAN AREA

Waikato Regional Council conduct biosecurity surveys on Waikato's west coast (within Raglan, Kawhia and Aotea Harbours) approximately every three years. The last survey was conducted in 2019. The dive surveys focus on unwanted organisms and marine pests listed in the New Zealand Marine Pest ID Guide (MPI, 2019). None of these pests have been found in the three harbours (D. Kruger, WRC, pers. comm.).

ACUATULA SENHOUSIA

The only marine pest known to occur along Waikato's west coast is the Asian date mussel (*Arcuatula senhousia*). This pest has been recorded from sheltered locations throughout much of the upper North Island including Kawhia, Aotea and Raglan Harbours (Figure 4; Hillock & Rohan, 2011; iNaturalistNZ, no date).

The Asian date mussel is a small (20–30 mm), suspension-feeding bivalve that was accidentally introduced into New Zealand in the late 1970s and is now established in upper half of North Island. The mussel lives in sheltered, inshore locations where it occupies the lower intertidal shore and subtidal regions to around 20 m (Bernard *et al.*, 1993).

Asian date mussels typically forms dense beds in soft sediments, though it has also been found attached to macroalgae, eel grass and hard substrates (Morton, 1974; Carlton, 1979; Sim, 1999). The mussels weave byssal cocoons around themselves, which attaches them to the substrate and to adjacent mussels. Bed densities usually range from 500–10,000 individuals/m^2 though a maximum of 200,000 individuals/m^{-2} has been reported from San Diego (Crooks, 1996). The tightly interwoven byssal nests trap fine sediments, organic matter and faeces, which changes the composition of the underlying sediment and can create anoxic conditions underneath the mats (Morton, 1974). Sediment underneath mussel mats was found to have a significantly smaller grain size and 4.5 times higher sulphide concentrations compared to the surrounding bare sediment (Ito & Kajihara, 1981; Futian *et al.*, 1989; Crooks, 1998).

Asian date mussel beds have been found to change the infaunal community composition. Densities of large filter-feeding bivalves, such as pipis (*Paphies australis*), cockles (*Austrovenus stutchburyi*), and black mussels (*Xenostrobus pulex*), were found to be lower within the mussel beds, which is likely due to the smothering effect of the mussel beds and competition for food (Uchida, 1965; Creese *et al.*, 1997; Crooks, 2001; Mistri *et al.*, 2004). Conversely, overall infaunal diversity and abundance was typically higher within the mussel bed than outside it (Crooks, 1998; Hayward *et al.*, 1999; Mistri, 2002; Mistri *et al.*, 2004). In particular, densities of deposit feeders, such as polychaetes, small crustaceans (isopods, amphipods and tanaids), the sea cucumber *Taeniogyrus dendyi*, and the bivalve *Linucula hartvigiana* were higher within the mussel beds, which is likely due to the higher concentrations of nutrients and organic matter within the beds (Crooks, 1998; Hayward *et al.*, 1999; Mistri *et al.*, 2004).

Dense beds of Asian date mussels have also been found to negatively affect eelgrass (*Zostera marina*) in San Diego (Reusch & Williams, 1998). Mussel coverage of greater than 50% of the seabed was found to decease the growth of eelgrass, but effects were not significant at lower mussel densities (Reusch, 1996).

Asian date mussels are a very short-lived species, with a lifespan of one to two years (Morton, 1974; Tanaka & Kikuchi, 1978; Creese *et al.*, 1997). Beds are ephemeral and are typically dominated by a single cohort (Creese *et al.*, 1997; Sim, 1999). Once a bed dies the environmental can quickly return to normal. Physical recovery of the seabed can occur in a matter of weeks (Morton, 1974), while recovery of the infaunal community back to baseline conditions has been shown to take 2–3 years (Hayward *et al.*, 1999).

Given the mussel's preference for sheltered, inshore habitats, it is highly unlikely that the Asian date mussel will be able to survive on the seabed at the proposed farm given the exposed, high-energy conditions at the site.

PESTS IN THE HAURAKI GULF & FAR NORTH ASSOCIATED WITH MARINE FARMING ACTIVITIES

Non-indigenous marine pests known to occur around 90 Mile Beach and in the Hauraki Gulf[1] that pose significant risks to New Zealand marine environments that may be associated with marine farming activities include the: Japanese kelp (*Undaria pinnatifida*), clubbed tunicate (*Styela clava*) and the Mediterranean fan worm (*S. spallanzanii*), the Australian droplet tunicate *(Eudistoma elogantum),* light bulb ascidians (*Clavelina oblonga* and *C. lepadiformis*), and the sea squirt *Pyura doppelgangera*[2] (MPI, 2019; Biosecurity NZ & NIWA, no date). The first three species are designated as unwanted organisms under the Biosecurity Act 1993, and the latter four species are species under sustained control programmes in the Auckland and/or Northland Regional Pest Management Plans. The biology and potential impacts of these species are discussed below.

UNDARIA PINNATIFIDA

Undaria pinnatifida originates from temperate regions of Japan, China and Korea, where it is farmed as a food crop (commonly known as wakame). This invasive seaweed was first discovered in Wellington Harbour in 1987 and is now present down the length of New Zealand (Russell *et al.*, 2008a; Biosecurity NZ & NIWA, no date). The seaweed rapidly colonises bare space, grows quickly, and forms a dense canopy that prevents other seaweeds from gaining a foothold (Stuart, 2004; James, 2016). *Undaria pinnatifida* can colonise areas where other macroalgae are present, but it does not appear to dominate these established algal communities or displace native species (Schiel & Thompson, 2012; James & Shears, 2013; De Leij *et al.*, 2017; South *et al.*, 2017).

Undaria pinnatifida is easily spread by human activities and is difficult to eradicate due to a very hardy microscopic stage (gametophyte) that can survive for years, early maturity, and large reproductive output (Stuart, 2004; James & Shears, 2016). The natural rate of spread of gametophytes is between hundreds of metres to a few kilometres per year (Brown, 1999; Sinner *et al.*, 2000), but drifting sporophytes (adult plants) can be transported tens of kilometres (Sliwa *et al.*, 2006). The rapid spread of this species around New Zealand is thought to have been facilitated by vessels (fouled hulls and/or ballast water) and the

[1] South of Cape Colville

[2] Previously identified as *P. praepetualis* in New Zealand

transfers of aquaculture equipment and stock (Hay, 1990; Stuart, 1997; Sinner *et al.*, 2000; Russell *et al.*, 2008b).

Undaria pinnatifida flourishes on artificial substrates such as wharves, marinas and marine farms, from the low intertidal to subtidal zones (Stuart, 2004; James, 2016). It can tolerate a wide range of environmental conditions, but may be limited by excessive wave action, and is largely absent from the exposed west coast of New Zealand (Figure 4; South *et al.*, 2017; Biosecurity NZ & NIWA, no date). *Undaria pinnatifida* is widespread on mussel farms in western Coromandel and present at low densities in north-eastern Coromandel (James & Shears, 2013; 2016; Sim-Smith *et al.*, 2016; Skelton & Jeffs, 2019). Coromandel farmers report that the seaweed can form huge rafts in the top 3 m of the water column, but these rafts usually break off the mussel lines once they grow too large. Low abundances of *U. pinnatifida* have been found on rocky coastlines adjacent to mussel farms in the Coromandel, which suggests that mussel farms may act as 'stepping stones', facilitating the spread of *U. pinnatifida* to nearby coastal areas (James & Shears, 2016).

Although still designated as an unwanted organism, farming of *U. pinnatifida* is now permitted in heavily infested areas (Wellington, Marlborough, Lyttelton and Bank's Peninsula), and commercial harvest is permitted from artificial surfaces or when cast ashore (Biosecurity NZ, 2019).

SABELLA SPALLANZANII

Sabella spallanzanii is a large (up to 80 cm in length) tube-building polychaete. Mediterranean fan worms usually grow on hard surfaces in subtidal habitats such as artificial structures (e.g., vessel hulls, wharves, marine farms), rock and shell, though they are also commonly found in soft sediment habitats attached to small pieces of rock or shell (Fletcher, 2014a). *Sabella spallanzanii* was first discovered in Lyttelton Harbour in 2008, though it is thought that it previously arrived in the country on a heavily fouled barge from Australia to Auckland (Read *et al.*, 2011; Fletcher, 2014a). The fan worm is now commonly found in most of the major ports in New Zealand and on marine farms in the Hauraki Gulf, where it can occur at high densities (Figure 4; James & Shears, 2013; Skelton & Jeffs, 2019).

Sabella spallanzanii larvae have a two to three week planktonic stage (Giangrande *et al.*, 2000), resulting in a large natural dispersal range (10–20 km) (Parry *et al.*, 1996; Knight, 2013 in Fletcher, 2014a). The fan worm can reach densities of 13 individuals/m^2 over large soft-sediment areas (50 m^2), and up to 300 individuals/m^2 in small patches (< 1 m^2) (Parry *et al.*, 1996). Densities on artificial substrates are often higher, with densities of up to 1000 individuals/m^2 recorded (A. Pande, MPI, pers. comm. in Fletcher, 2014a). The fan worm has remarkable regenerative capabilities, and cut fragments from the anterior, middle and posterior of the worm have been found to have high survival and regeneration rates (Licciano *et al.*, 2012; Brand & Jeffs, 2022).

Sabella spallanzanii has a high filtering capacity and large populations have the potential to remove significant nutrients from the ecosystem (Ross *et al.*, 2013), which may reduce the growth of native species. However, the results of field experiments are inconsistent, for example:

- densities of <2 individuals/m^2 had no detectable effect on soft sediment communities (Ross *et al.*, 2007);
- densities of 10–50 individuals/m^2 were found to cause changes in the abundance and composition of soft sediment infauna, with the largest decreases seen in small crustaceans (copepods, ostracods, amphipods and cumaceans), and increases in deposit-feeding polychaetes (O'Brien *et al.*, 2006; Atalah *et al.*, 2019);
- densities of 250 individuals/m^2 had little effect on the growth or composition of understory communities on hard surfaces (Holloway & Keough, 2002);
- clumps of *S. spallanzanii* were found to have a positive impact on soft sediment communities, increasing the biodiversity and abundance of epibiota, and having no effect on the abundance of other suspension feeders (Douglas *et al.*, 2020).

These findings suggest that that the potential impacts of this species on seabed communities depend on environmental conditions and the size of the fan worm population, and that effects are not necessarily negative. However, there is also evidence to suggest that the worm (and non-living worm mimics) can reduce the denitrification rate of the sediment, potentially leading to higher nitrate concentrations in the marine environment, though the reasons behind these results and the potential magnitude of impact are not understood (Tait *et al.*, 2020).

STYELA CLAVA

Styela clava was first discovered in Auckland's Viaduct Basin in 2005, and is now present in most of the major ports around New Zealand (Biosecurity NZ & NIWA, no date). It is thought that the sea squirt entered New Zealand attached to the hulls of vessels, and has been present in the country since at least 2002 (Kluza *et al.*, 2006; McFadden *et al.*, 2007). The widespread distribution of the sea squirt meant that complete eradication was not feasible in the Hauraki Gulf (Figure 4) (MPI, 2013). However, localised control programmes are being conducted in areas where the species is not well-established e.g., Tutukaka, Picton, Nelson, Tarakohe and Tauranga Harbour to try and stop the species becoming widespread in those regions (Wong *et al.*, 2011; Forrest, 2013; Bay of Plenty Regional Council, 2015; K. Walls, MPI, pers. comm.).

The natural dispersal range of the sea squirt is limited, with larvae only surviving for ≤24 hours (Davis *et al.*, 2007). *Styela clava* grows on both natural and artificial hard structures such as rock, shell, wharves, boats and aquaculture equipment. It is most commonly found in sheltered subtidal areas with depths of less than 25 m (Lützen, 1999). *Styela clava* is reported to reach densities of 50–100 individuals per m^2 on natural substrates (Minchin & Duggan, 1988; Lützen, 1999), while densities of up to 500–1000 individuals per m^2 have been recorded on artificial substrates (Holmes, 1976; Lützen, 1999). The sea squirt has the potential to out-compete native species for space and food, though no studies have been conducted on the ecological impacts of *S. clava* in New Zealand. Internationally, the sea squirt was found to have a negligible effect on soft sediment communities in Australia at natural densities of <2 individuals per m^2 (Ross *et al.*, 2007). *Styela clava* was assessed as posing a negligible to moderate risk to New Zealand's biodiversity and habitat shortly after its discovery in New Zealand (Kluza *et al.*, 2006).

Styela clava has caused major fouling problems for the aquaculture industry in Auckland and Waikato regions. At times, *S. clava* can reach levels of up to 20–50% of the weight of mussels lines, although adverse effects have been sporadic and localised (Forrest, 2013). In recent years, *S. clava* has been less problematic for Coromandel mussel farmers, partially because farmers have learnt to manage the sea squirt by increasing their seeding densities (Forrest, 2013; Sim-Smith *et al.*, 2016).

EUDISTOMA ELONGATUM

The droplet tunicate is a colonial ascidian that has white, cylindrical heads that are up to 1.5 m long. It was first discovered in New Zealand in 2005 but was not initially considered a pest species. In 2007–08 it was found in high densities at several Northland locations associated with oyster farms (Smith *et al.*, 2007a; Grace, 2014). The ascidian typically grows in sheltered areas on hard surfaces such as rocks and man-made structures in both intertidal and shallow subtidal areas (Morrisey *et al.*, 2009b). However, it has also been found covering large areas of the mudflats in Northland and Sandspit (Grace, 2014; K. Walls, MPI, pers. comm.). The tunicate is now present around Northland and Auckland (Figure 5; Grace, 2014; Auckland Council, 2017). Natural dispersal ability of *E. elongatum* is limited because larvae can only swim for six hours (Page *et al.*, 2011). Thus, it is likely that the spread of the tunicate around the country was facilitated by the transfer of oyster stock and vessels (Page *et al.*, 2011; Auckland Council, 2017).

Initially, it was predicted that the tunicate would not spread south of Auckland (below 37 °S) because it was thought to be unable to survive below 16°C (Smith *et al.*, 2007b). However, subsequent research has shown that the tunicate can survive and reproduce at temperatures down to 14 °C (Page *et al.*, 2011).

The ecological impacts of the droplet tunicate are unknown, though it has the potential to become a significant nuisance to intertidal marine farms in northern New Zealand. During summer it can account for up to 50% of the biofouling waste removed from oyster farms in northern New Zealand (C. Bunton, Northland Regional Council, in Dickey, 2017). In 2009, MAF Biosecurity NZ funded an investigation into potential control methods for the droplet tunicate. Concentrated acetic acid was found to be effective in killing intertidal populations of the ascidian, but no effective control method was found for subtidal populations and eradication is considered unfeasible by MPI (Morrisey *et al.*, 2009a).

CLAVELINA LEPADIFORMIS

The lightbulb ascidian, *Clavelina lepadiformis,* is a small (≤2 cm long), transparent ascidian that grows on hard substrates from the intertidal down to around 50 m (Riley, 2008). It was first detected in New Zealand in Nelson in 2009 and has since spread around most of New Zealand's ports including Auckland and Whangarei (Figure 5; Biosecurity NZ & NIWA, no date).

Clavelina lepadiformis has a high reproductive output, fast growth rate reaching full size in two months, and is tolerant to a wide range of environmental conditions including sheltered to exposed conditions, 18–40 ppt salinity, and a wide range of temperatures (Riley, 2008). These characteristics have allowed the ascidian to successfully invade numerous countries with densities of up to 3900 zooids/m^2 recorded on artificial surfaces, but an order of magnitude lower (~700 zooids/m^2) recorded on natural surfaces (de Caralt *et al.*, 2002). Its natural dispersal ability is limited due to a very short larval duration (3 hours), therefore long-distance translocations are likely the result of transport via hull fouling (Mackenzie, 2011).

Little is known about the potential impacts of *C. lepadiformis.* It has the potential to outcompete native species due to its high growth rates and the production of toxic metabolites (Teo & Ryland, 1995; Mackenzie, 2011). Dense colonies of *C. lepadiformis* can rapidly dominate disturbed habitats (Reinhardt *et al.*, 2010).

CLAVELINA OBLONGA

Clavelina oblonga was recently discovered in Great Barrier Island in 2019 and is currently not known to occur elsewhere in New Zealand (Figure 5). Very little information is available on the biology or impacts of this species. The ascidian has a fast growth rate and high reproductive output, and introduced populations of *C. oblonga* in the Northern Hemisphere have been found to smother and kill farmed mussel spat (Ordóñez *et al.*, 2016), and to almost completely dominate disturbed habitats and settlement plates (Theuerkauf *et al.*, 2018; Christianson, 2019).

PYURA DOPPELGANGERA

Pyura doppelgangera was first detected in New Zealand in 2007 when it was initially identified as the non-indigenous *P. praepetualis* (M. Page in Hayward & Morley, 2009). However, subsequent genetic work has shown that New Zealand specimens are in fact *P. doppelgangera* (Rius & Teske, 2013). Anecdotal evidence suggests that *P. doppelgangera* has been present in the Far North since around 1970 or earlier (Atalah *et al.*, 2021). The non-indigenous status of *P. doppelgangera* was questioned by Atalah *et al.* (2021), who recommended that it should be considered a cryptogenic species due to the lack of clear evidence on its status. *Pyura doppelgangera* has now been recorded at numerous discrete locations around Northland including on oyster farms in Parengarenga Harbour and the Bay of Islands (Figure 5).

Pyura doppelgangera is thought to have a similar larval biology to *P. praepetualis*, which has a limited natural dispersal ability due to a short planktonic larval duration (~12 hours) and a preference for settling close to the parent population (Clarke *et al.*, 1999; Hayward & Morley, 2009).

Pyura doppelgangera forms dense mats on hard substrates in intertidal to shallow subtidal (<12 m) areas, particularly in areas of strong wave or tidal action. The initial assessment on the potential impacts of the ascidian by Fletcher (2014b) was based on information on the closely related *P. praepetualis*, which can: reach densities of more than 1,800 ind./m^2 (Castilla *et al.*, 2000); alter the structure and composition of native communities resulting in a substantial increase in species diversity within the mats (Castilla *et al.*, 2002; Monteiro *et al.*, 2002; Castilla *et al.*, 2004); and, outcompete or displace wild mussel beds (Castilla *et al.*, 2002; Caro *et al.*, 2011). Similarly, in New Zealand *P. doppelgangera* was found to support a significantly different macroinvertebrate community than intertidal green-lipped mussels, with the ascidian community dominated by polychaetes while the mussel community was dominated by gastropods and crustaceans (Davis *et al.*, 2018). Initial observations of *P. doppelgangera* in Northland suggested that it was also displacing intertidal mussel beds

(Hayward & Morley, 2009). However, a subsequent experimental study in New Zealand found that *P. doppelgangera* beds showed no increase in size over 1.5 years and there was no evidence of competition or overgrowth of mussels by the ascidian (Atalah *et al.*, 2021). Those results suggests that the ascidians may have more benign impacts than previously thought and may not warrant its pest status (Atalah *et al.*, 2021).

Figure 4. Occurrence of *Arcuatula senhousia, Sabella spallanzani, Styela clava* and *Undaria pinnatifida* recorded in the Marine Biosecurity Porthole (www.marinebiosecurity.org.nz) and iNaturalist (www.inaturalist.nz) to July 2022.

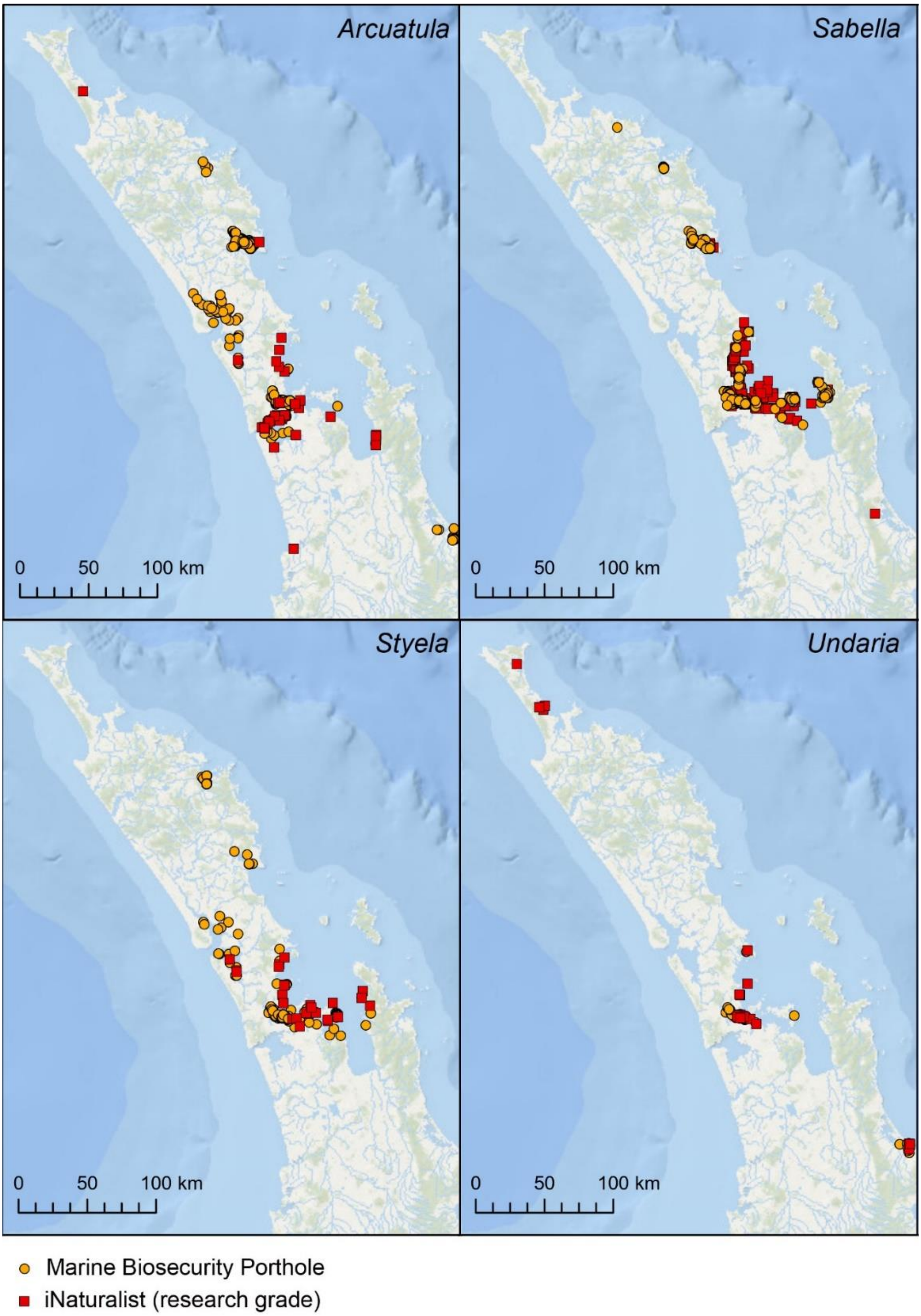
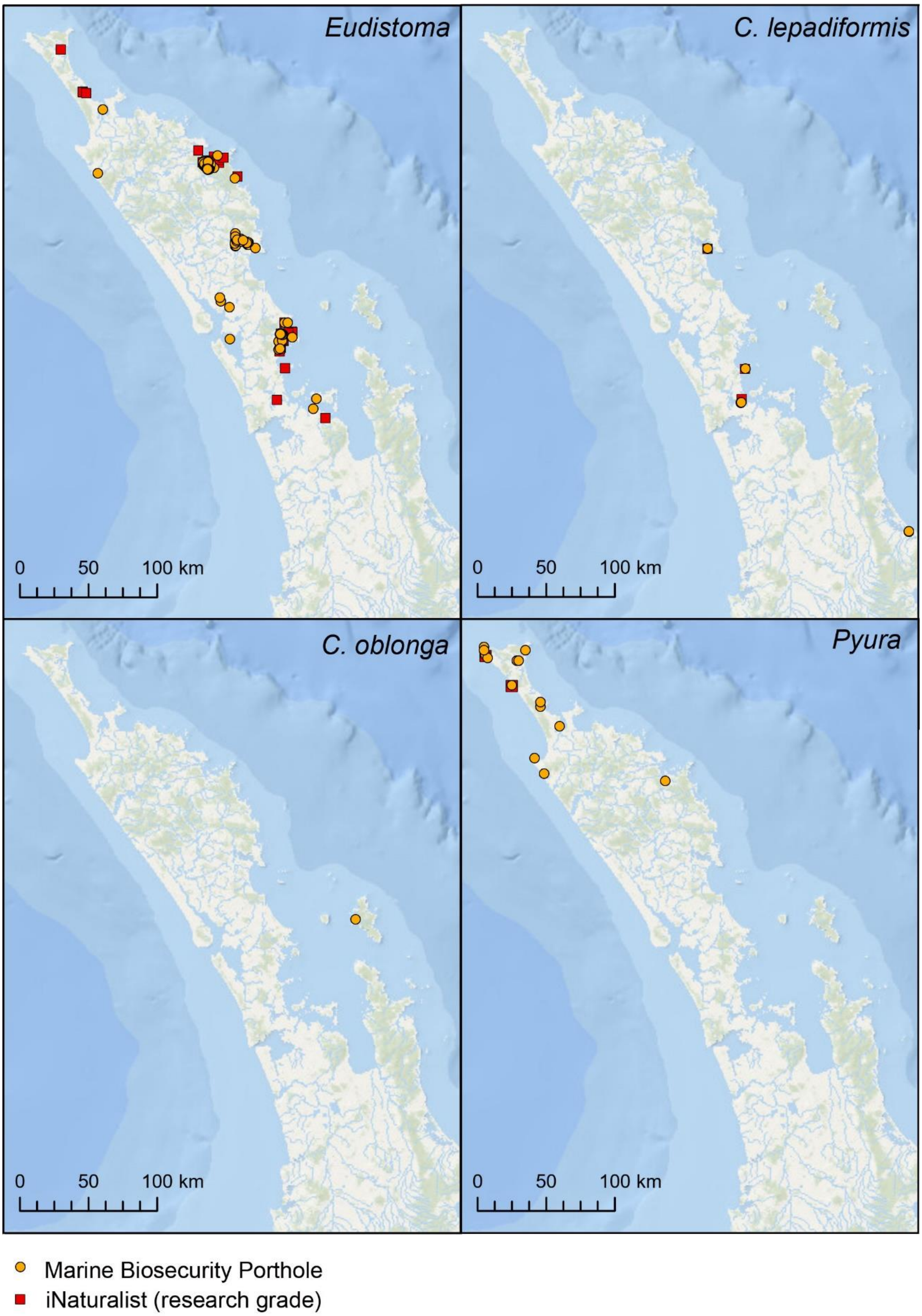


Figure 5. Occurrence of *Eudistoma elongatum, Clavelina lepadiformis, C. oblonga* and *Pyura doppelgangera* recorded in the Marine Biosecurity Porthole (www.marinebiosecurity.org.nz) and iNaturalist (www.inaturalist.nz) to July 2022.



KEY DISEASES OF CONCERN

There have been few reports of disease that cause high mortalities in mussels (*Perna canaliculus* and *Mytilus planulatus*[3]) in New Zealand (Castinel *et al.*, 2019). Reports of high spat losses are common, but it is not known whether this is due to disease, predation, poor spat condition, or poor retention (Hayden, 1994a; 1994b; Sim-Smith & Jeffs, 2011; South *et al.*, 2021). The only disease known to cause significant mortality in New Zealand mussels is digestive epithelial virosis. High *P. canaliculus* spat mortalities of 50–100% and low adult mortalities of 2–5% in 1994 were associated with digestive epithelial virosis, which is cause by a group of unenveloped RNA viruses. The viruses were also found in *M. planulatus*. The viruses are likely to be ubiquitous in scallops, but only high levels of the virus appear to cause the disease in scallops (Jones *et al.*, 1996; Bower, 2001; Diggles *et al.*, 2002). Subsequent surveys have only found sporadic occurrences of the virus in mussels at low infection levels (Hine, 2002; Keeley *et al.*, 2009).

Other diseases that have been shown to cause adverse effects or limited mortality in New Zealand mussels include:

1. Infection with *Vibrio* spp.—*Vibrio splendidus* and *Vibrio* sp. DO1 have been shown to cause larval *P. canaliculus* mortality in the hatchery (Kesarcodi-Watson *et al.*, 2009a; Kesarcodi-Watson *et al.*, 2009b), but *Vibrio* spp. have not been reported to cause mortality in juvenile or adult *P. canaliculus*. *Vibrio* spp. are ubiquitous in marine environments and have been isolated from shellfish, molluscs and the sediment (Romero *et al.*, 2014). The bacteria have only been shown to cause mortality in mussels under stressful environmental conditions and/or very high bacterial concentrations (Romero *et al.*, 2014; Oden *et al.*, 2016; Polsenaere *et al.*, 2017).

2. Infection with spionid polychaete worms (*Boccardia* spp. and *Polydora* spp.)—spionid polychaete worms or "mudworms" from various genera are widespread in the marine environment and infect a range of shellfish, including *P. canaliculus* and *M. planulatus*. Infections are associated with stress and poor husbandry, and only severe infestations cause disease (Diggles *et al.*, 2002; Read & Handley, 2004; Tubbs *et al.*, 2007; Castinel *et al.*, 2014). *P. haswelli* is an exotic species that was first found in New Zealand in 1996, and was only found to infect *P. canaliculus* in 2003 (Read, 2010).

3. Infection with platyhelminth flatworms (*Postenterogonia orbicularis*[4] and other species)—infection is associated with overcrowding and poor husbandry with the severity of disease dependant on infection level. In mussels, overseeding allows flatworms to avoid being eaten by fish, particularly near the surface (Handley, 2013). *Postenterogonia orbicularis* are usually free-living in the marine environment and are of minor significance to New Zealand shellfish (Diggles *et al.*, 2002; Tubbs *et al.*, 2007; Webb, 2008). However, it has destructive potential in international mussel populations (Webb, 2008).

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[3] Previously *Mytilus galloprovincialis*.

[4] Previously called *Enterogonia orbicularis*.

4. Infection with pea crabs (*Nepinnotheres novaezelandiae*)—infection rates in both wild and farmed mussels are typically 4–5%, though rates of up to 70% have been reported (Jones, 1977; Hickman, 1978; Trottier *et al.*, 2012). *Nepinnotheres novaezelandiae* is not known to cause mortality in mussels, but infected mussels were found to be 30% smaller in total wet weight (Trottier *et al.*, 2012; Trottier, 2014).

All five pathogens or parasites are ubiquitous in the marine environment and are likely to be able to persist in the Raglan area without the presence of the proposed farm.

Several pathogens have been found in mussels that are not known to cause disease or mortality in mussels (Castinel *et al.*, 2019; Webb & Duncan, 2019). Mussels may act as a carrier for certain pathogens, but the risk of transmission from mussels to other susceptible species is considered minimal or unknown at present (Handley, 2013; Castinel *et al.*, 2019).

HARMFUL MICROALGAE

Harmful algal blooms are caused by a variety of phytoplankton species (primarily dinoflagellates). They are a sporadic problem for the mussel industry with naturally occurring blooms preventing harvest of shellfish, and sometimes, transport of spat. Human consumption of mussels that have ingested harmful algae can result in a number of forms of shellfish poisoning. Harmful algae can also cause mortality in bivalves and fish (Simon & Dauer, 1972; Wear & Gardner, 2001; Rolton *et al.*, 2022).

The first documented harmful algal bloom (*Gymnodinium breve*) in New Zealand occurred in Northland in the summer of 1992–93 (O'Hara, 1993). The Ministry of Fisheries temporarily banned all transport of bivalves between the North and South Island due to *G. breve* not being present in the Marlborough Sounds, which created a serious shortage of spat for the industry (MacKenzie *et al.*, 1994; MacKenzie *et al.*, 1995). Similarly, a bloom of *Gymnodinium catenatum* in 2000–01 in North Island resulted in restrictions on the transfer of Kaitaia spat material containing cysts for almost a year (MacKenzie & Taylor, 2002). Experiments were conducted on methods to reduce the risk of transferring toxic phytoplankton along with mussel spat, including the removal of spat from the seaweed or killing the dinoflagellate (Hay *et al.*, 1994; Hickman *et al.*, 1994). Washing of Kaitaia spat material was found to be successful at reducing cyst numbers to below practical detection limits (<100 cysts/kg), and 'cleaned spat' was permitted to be transported to the South Island (MacKenzie, 2014). The New Zealand mussel industry developed a voluntary code of practice to reduce the risk of transferring toxic algal cysts with Kaitaia spat (NZMIC, 2002). However, there has been no need to implement the washing procedure in recent years (Sim-Smith et al., 2016).

Shellfish around New Zealand have been monitored for the presence of harmful algae since January 1993 when shellfish toxicity was first detected in New Zealand. Phytoplankton or shellfish monitoring is conducted weekly to fortnightly by both the government and the aquaculture industry (MPI, 2022). Shellfish growing areas are closed for harvest if marine toxins are detected in shellfish flesh samples above the specified limits (NZFSA, 2006), and no spat or seed movements are permitted from areas that exceed the harmful algal concentrations that required flesh testing (AQNZ, 2021). Harmful algal blooms around 90

Mile Beach are uncommon events, with only three events occurring between 2000 and 2017 (MPI, unpub. data). Harmful algal blooms also occasionally occur around the Raglan area (e.g., Hatton, 2018; MPI, 2020).

POTENTIAL BIOSECURITY RISKS OF THE PROPOSED FARM

Harmful organisms may be transmitted around the country by natural dispersal (water or wild animals) or by human-mediated pathways. There are four main sources of biosecurity risk that are associated with mussel farming. These are risks associated with:

1. Farm placement and its structures.
2. Transfer of stock.
3. Transfer of equipment.
4. The movement of farm vessels (McKindsey *et al.*, 2007; Minchin, 2007; Georgiades *et al.*, 2016; Fletcher & Johnston, 2020).

An overview of each of these risks, an assessment of the specific risks associated with the proposed farm, and recommended mitigation and monitoring options are given in this report. There are many other vectors that are outside of the aquaculture industry that are also potential risks for the introduction or spread of pests and diseases, but a discussion of these is outside of the scope of this report. A review of vectors of marine biosecurity risk in the Waikato region is given by Fletcher and Johnston (2020).

FARM PLACEMENT AND ITS STRUCTURES

Marine farms provide ideal habitat for numerous biofouling organisms. Plentiful, firm surfaces for colonisation, coupled with good water flow in highly productive, surface waters means that many pests flourish on marine farms. Routine cleaning of biofouling organisms on floats and dropper ropes can reduce the abundance of pests on the farm, but fouling material is typically discarded on the seabed beneath the farm where pests may continue to live. Furthermore, fouling organisms are not easily removed from fixed farm equipment such as anchors and warps.

The continual presence of mussels on the farm also means that there is a continuous host for mussel pathogens or parasites. Thus, mussel farms may act as reservoirs for pests and diseases. As the number of marine farms and coastal developments increase, the potential for cumulative effects also grows, with farms potentially acting as ‘stepping stones’ for pests and diseases, facilitating their persistence in the environment and increasing their abundance and spread to new areas. Currently, there is very little coastal development off the Raglan coast, with only two marine farms present along Waikato’s west coast: a mussel spat catching farm in Aotea Harbour, and an oyster farm in Kawhia Harbour.

No marine pests are known to occur in the coastal area offshore of Raglan, and therefore, there is unlikely to be a natural source of pests to the area. The proposed location of the farm 3 km offshore in an exposed environment is likely to greatly reduce the biofouling community that can grow on farm structures or on the seabed beneath the farm. A study of the biofouling community on two offshore mussel farms located in Tasman Bay and Opotiki found that they had an impoverished biofouling community compared to inshore mussel farms. In particular, very little biofouling was present on the Opotiki farm, which only used spat caught on site. The lack of biofouling on offshore farms was attributed to: a) the exposed conditions at the site; and, b) the large distances (~8 km) between the farms and gamete source locations, which prevented the natural spread of species with limited larval dispersal abilities to the farms (Atalah *et al.*, 2016).

All of the diseases known to adversely affect mussels are ubiquitous to New Zealand's marine environment, and therefore, the pathogens or parasites are likely to be able to survive in the area without the presence of the farm. Husbandry-related diseases can be managed by controlling stocking densities or fallowing the farm if required.

Overall, the biosecurity risks of the proposed farm acting as a reservoir for pests and diseases is assessed as less than minor, provided that no new pests or diseases are introduced into the area that are able to survive on the farm. Changes in the occurrence of harmful organisms near the proposed farm may require changes in farm biosecurity management, which should be addressed in a Biosecurity Management Plan that is regularly reviewed and updated as necessary.

AQUACULTURE STOCK

The translocation of aquaculture stock has been associated with the introduction of harmful organisms at new locations, and is considered to be one of the most important transmission pathways for harmful organisms (Peeler *et al.*, 2007; Georgiades *et al.*, 2016). In New Zealand, transfers of aquaculture stock have been implicated in the transfer of *U. pinnatifida* from Marlborough Sounds to the Firth of Thames (Forrest & Blakemore, 2002), the spread of *D. vexillum* around the Marlborough Sounds (Forrest *et al.*, 2011), the spread of *E. elongatum* around northern New Zealand (Page *et al.*, 2011), and the spread of ostreid herpes virus (µvariant-1) around New Zealand (Castinel *et al.*, 2014).

The New Zealand mussel industry is heavily reliant on the transfer of mussel spat around the country. Around 60–80% of the industry's spat supply is collected from 90 Mile Beach attached to drift seaweed (known as 'Kaitaia spat') and shipped around the country (Jeffs *et al.*, 2005; Dodgshun *et al.*, 2007; Inglis *et al.*, 2013), with the remaining spat captured *in situ* from spat-collecting areas or bred in a hatchery. Mussel farmers also frequently transfer juvenile mussels between farms, that may be transferred attached to rope or as washed, single seed.

The biosecurity risks of the proposed farm associated with the transfer of aquaculture stock depends on whether the farm is used for a nursery farm only, or as a grow-out farm.

1. If the proposed farm is used only as a nursery farm then there is no chance of introducing harmful organisms to the Raglan area via stock movements as no stock will be moved onto the farm. Movement of spat and ropes off the farm will pose a small risk of introducing novel harmful organisms to the receiving location, but this risk is very low due to lack of known harmful organisms in the Raglan area, and the harmful organisms that are already present in mussel farming areas in the Hauraki Gulf.

2. If the proposed farm is used to on-grow hatchery spat, then it is conceivable that harmful organisms may be transferred to the Raglan area via stock movements. However this risk is expected to be less than minor due to hatchery spat being produced in a controlled environment with appropriate water treatment and biosecurity procedures in place (Fletcher & Johnston, 2020).
3. If the proposed farm is used to on-grow Kaitaia spat, then there is a risk that harmful organisms are transferred to the Raglan area with the Kaitaia spat.
    a. There is a risk of transferring harmful algae with the spat material. This risk is reduced by the regular, frequent monitoring of phytoplankton and shellfish from 90 Mile Beach for the presence of harmful algae (MPI, 2022), and a requirement not to move spat from areas that exceed the harmful algal concentrations that required flesh testing (AQNZ, 2021). However, a low residual risk still remains.
    b. There is a risk of transferring novel pests to the Raglan area. No pests have been reported from studies on the composition of the spat material (Jeffs *et al.*, 2018), but it is possible that viable pest material may be transferred to the farm with Kaitaia spat. Currently, three key pests of concern, *E. elongatum*, *U. pinnatifida* and *P. doppelgangera* are present in the Far North that have not been recorded in the Raglan area (Figure 4 & Figure 5). Adult *Eudistoma elongatum* and *P. doppelgangera* are likely to pose a very low biosecurity risk because they are unlikely to be attached to drift seaweed as they colonise hard substrates, and they are highly unlikely to be able to survive the environmental conditions at the proposed site. *Undaria pinnatifida* poses a higher risk as it would be difficult to detect amidst the Kaitaia spat material and it could possibly survive the exposed conditions at the proposed site. *Undaria pinnatifida* has been recorded from Houhora and Parengarenga Harbour in the Far North (Figure 4), and therefore the risks of transferring pests to the Raglan area via Kaitaia spat are assessed as more than minor.

AQUACULTURE EQUIPMENT AND PERSONNEL

Submerged aquaculture equipment (ropes, floats, anchors etc.) can become fouled with pest species and/or contaminated with pathogens. Equipment that is transported and redeployed in another location without cleaning and disinfection may facilitate the introduction and spread of pests and diseases. In particular, untreated used spat rope that is redeployed on the spat farm poses a high risk of introducing harmful organisms to the site. Some pests are capable of withstanding long periods of air exposure, e.g., *U. pinnatifida* gametophytes can survive 8 weeks of air exposure at 95% relative humidity at 10 °C (Forrest & Blakemore, 2006). The likelihood of introducing new pests or diseases to the area via submerged equipment can be minimised by:

1. using new equipment; or,

2. cleaning and disinfecting[5] used impermeable equipment such as floats prior to use on the spat farm;
3. cleaning used rope and storing on land for at least 12 weeks[6] before use on the spat farm.

The applicant has stated that treatment of used spat rope will be the same as what is currently applied for the Aotea Harbour spat farm, i.e., 12 weeks of storage on land. This treatment of spat rope has been successfully applied for the past ~10 years for used rope that is deployed in the Aotea Harbour (R. Dockery, pers. comm.), and no marine pests are known to occur in the harbour despite the abundance of several pest species in the grow-out farm locations. Provided that used equipment is treated as recommended above, the risk of introducing pests to the Raglan area via farm equipment is assessed as minor.

Marine litter generated by aquaculture activities are a potential transmission pathway. A survey of marine litter on western Coromandel beaches found that plastic rope was the most common type of marine litter found, and 90% of rope is likely to have originated from aquaculture activities. Marine litter was frequently (21% of collected items) fouled with a range of organisms, including two Mediterranean fan worms (Campbell *et al.*, 2017). However, the current biosecurity risk of litter from the proposed farm from is likely to be negligible as no marine pests are known to occur around the farm.

People may also inadvertently transfer harmful organisms that are attached to their clothing/personal protection gear if they move between sites. Personnel that enter the water at multiple sites per day, e.g., divers, pose the greatest personnel biosecurity risk. However, given the scarcity of other marine farms in the region, and the infrequent occurrence of such activity, this risk is likely to be negligible for the proposed farm.

VESSELS

Vessel movements, both recreational and commercial, are recognised as the most significant biosecurity risk for moving pests and diseases to, and around, the Waikato Region. These vessels may transport pests to the area via biofouling of hulls or equipment aboard the vessels, or the discharge of pest fragments, water or sediment that contains microscopic pest life stages. Biosecurity risks are higher for vessel movements between regions, and between distant areas, such as the east and west coasts of the Waikato Region due to the creation of 'novel' pathways (Fletcher & Johnston, 2020).

Service vessels used by the aquaculture industry (e.g., barges, harvesters, launches) can transfer pests and diseases via hull fouling, or water or sediment discharged from decks, bilges and other contained spaces. Aquaculture service vessels generally stay in the same area (Inglis *et al.*, 2013), and therefore the risk of them spreading pests and diseases

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[5] Appropriate disinfectants are given in AQNZ (2021).

[6] This is consistent with the stipulated drying period for rope transferred to the Aotea Harbour in the Coromandel Marine Farmers' Association Biosecurity Management Plan for Greenshell™ Mussels (GSM), scallops and seaweed (Taylor *et al.*, 2022).

between regions is typically small. However, service vessels may still facilitate the spread of pests and diseases within a region.

Trailer vessels and vehicles pose a lower biosecurity risk than non-trailer vessels, due to the extended periods of time vessels and vehicles are out of the water. However, they still have the potential to transport pests via viable fragments, sediment or contained water if they are frequently used at different locations. Trailer vessels and vehicles also have the potential to transport pests overland between localities where pests would not be able to spread easily by natural dispersal e.g., between the east and west coasts of the Waikato Region.

The biosecurity risks associated with vessel and vehicle movements can be mitigated by:

- regular cleaning and antifouling of the vessel's hull and niche areas;
- washing down decks and equipment, and flushing or emptying contained water once the vessel has left a farm and prior to arriving at its destination, and vice versa;
- washing down trailer vessels and vehicles, and emptying any contained water before moving between operational zones, management areas or distant locations.

Creation of the proposed farm will create a novel destination for vessels that is currently not regularly visited by vessels. The applicant states that the farm vessel will be berthed in Raglan Harbour, with normal trips being limited to between the proposed farm sites and the harbour. Manukau Harbour and Port Taranaki will be used as maintenance or emergency ports. The farm vessel will be antifouled at least every 2 years, and the deck and equipment will be washed down daily.

Given the lack of pests in the Raglan area and the limited normal movements of the farm vessel, the biosecurity risks associated with farm vessel movements are assessed as minor, as long as the above mitigation methods are implemented.

CONCLUSIONS

Good farm biosecurity management can minimise the likelihood of spreading pests and diseases, and these should be stipulated in a farm biosecurity management plan (BMP). It is recommended that a BMP include requirements for:

- regular surveillance and recording of the abundance of pest species, new species to the area, or any unusual mortality on the farm;
- reporting the occurrence of unwanted organisms or suspected disease to the Ministry for Primary Industries (MPI);
- providing appropriate training for farm staff in pest surveillance and biosecurity management;
- cleaning and decontaminating all removable farm equipment prior to redeployment in distant areas;
- cleaning fouling organisms off floats and ropes during harvest, and rotating floats to expose fouled surfaces to the sun;

- antifouling all farm vessels according to the manufacturer's recommendations;
- cleaning and decontaminating farm vessels and vehicles before travel between management areas or operational zones;
- washing down vessel decks and emptying or flushing bilges and any other contained spaces before leaving the farm or arriving at the farm;
- keeping accurate records of all stock transfers (i.e., date, origin and destination locations, quantity transferred, and health and performance of stock);
- regular review of the plan periodically, or in response to a new biosecurity incursion.

In summary, the overall biosecurity risk of the proposed farm is **no more than minor** as long as the farm is only used as a nursery farm or for on-growing hatchery spat, and the recommended mitigation methods are implemented, including a 12-week drying time for used rope. The transfer of Kaitaia spat onto the farm poses the greatest biosecurity risk, and the overall biosecurity risk is assessed as **more than minor** if the proposed farm is used to on-grow Kaitaia spat.

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