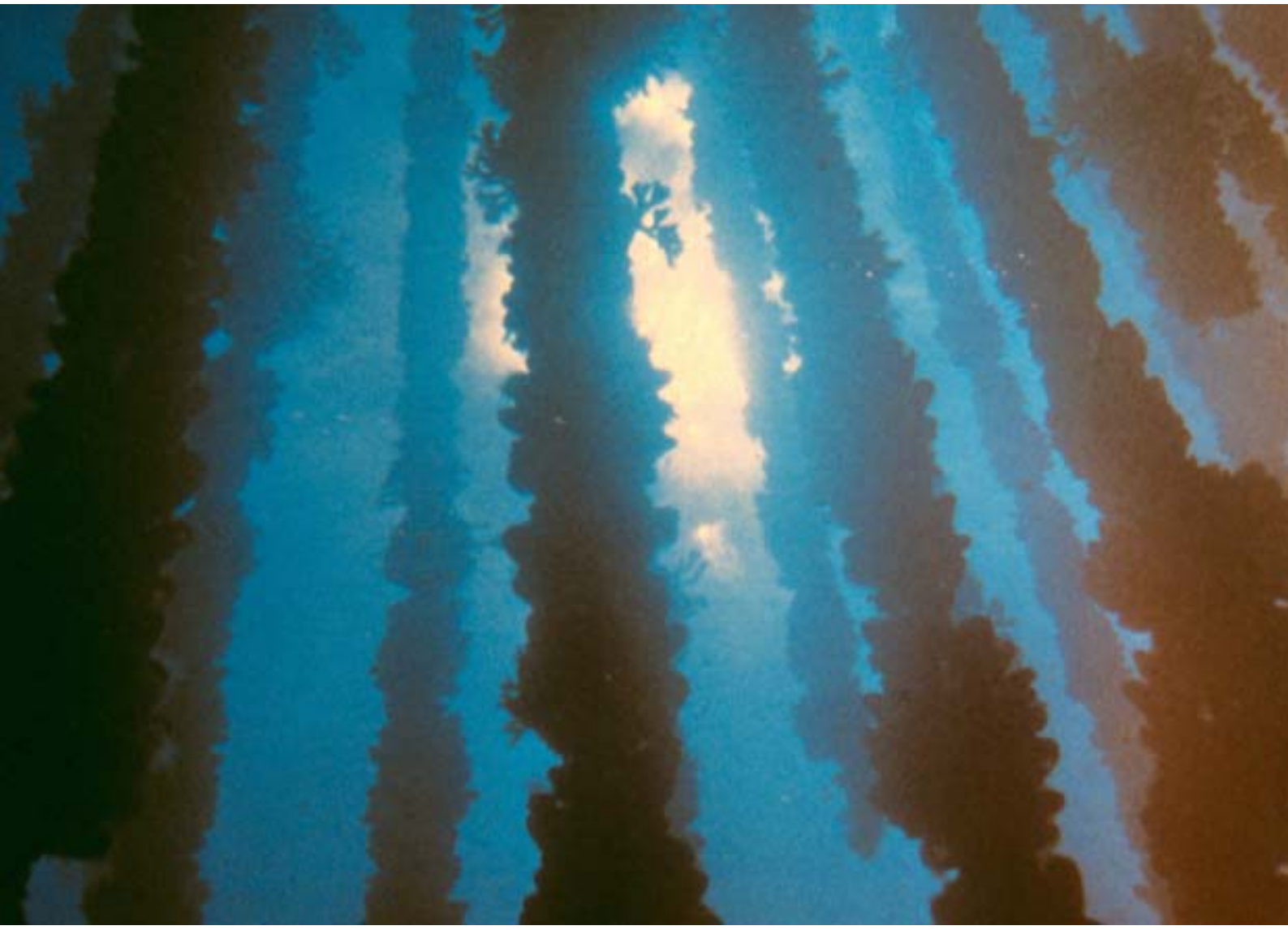
Potential effects of mussel farming on New Zealand's marine mammals and seabirds

A DISCUSSION PAPER



Department of Conservation
Te Papa Atawhai

Potential effects of mussel farming on New Zealand's marine mammals and seabirds: a discussion paper

Bryde's whale *(Balaenoptera edeni)* found dead after entanglement in a mussel spat catching farm, Great Barrier Island, August 1996. A spat catching line is caught around the whale's jaw and body. (Photo: Dan Woodcock)

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Cover: Underwater view of mussel growing lines. (Photo: Roger Grace)

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ABSTRACT

Mussel farming is an important and expanding industry in New Zealand. In the year 2000, there were nearly 3000 ha of mussel farms, with proposals for a further 39 000 ha including offshore farms of up to 4000 ha each. There have been no concerted attempts to investigate the effects of mussel farms on marine mammals and seabirds. However, there is growing evidence of adverse effects as these animals are in direct competition for space in the most productive coastal waters. Mussel farms deplete phytoplankton and zooplankton; modify the benthic environment, species assemblages, and local hydrodynamics; increase marine litter; and facilitate the spread of unwanted organisms. Thus, the establishment of mussel farms may lead to loss and degradation of wildlife habitat, either by exclusion or as a consequence of changes to the ecosystem. Thus far, the only adverse effects reported within New Zealand are the exclusion of dusky dolphins from mussel farms areas, and the entanglement and deaths of two Bryde's whales in mussel spat-catching lines. Because of the limited extent of mussel farms to date, effects on wildlife were dismissed as inconsequential. However, the proposed increase in the area used for mussel farming changes the scale of effects and prompts concern. The construction of large offshore farms across the seasonal migration routes of large whales is particularly worrying. An ecologically sustainable mussel farming industry requires a programme to monitor the industry's effects on wildlife and other forms of marine biodiversity. This report provides a resource to assist the mussel farming industry, coastal planners and researchers in the development of an ecologically sustainable industry.

Keywords: Environmental effects, green-lipped mussel, *Perna canaliculus*, sustainable aquaculture, threatened species.

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1. Introduction

The decline, and in some instances, collapse of ocean fisheries stocks has encouraged rapid worldwide growth of aquaculture (Naylor et al. 2000). During the 10 year period 1987–97, global production of farmed fish doubled and now accounts for one quarter of all fish consumption (Food and Agricultural Organisation 1999). New Zealand's aquaculture industry is burgeoning, with aquaculture exports currently worth more than half a billion dollars a year and increasing 10% annually.

A wide array of marine species is cultivated within New Zealand, but the dominant species is the green-lipped mussel (*Perna canaliculus*), marketed using the trade-marked name Greenshell® Mussel. Chinook or king salmon (*Oncorynchus tshawytscha*) and Japanese or Pacific oysters (*Crassostrea gigas*) are also commercially important. Other marine species currently being farmed on a small scale, either commercially or experimentally, include: abalone or paua (*Haliotis iris*), rock lobster or crayfish (*Jasus edwardsii*), king fish (*Serolia lalandi*), mullet (*Mugil cephalus*), blue cod (*Parapercis colias*), seahorse (*Hippocampus abdominalis*), seaweeds and sponges. Cultivation techniques are being developed for: paddle crabs (*Ovalipes catharus*), snapper (*Pagrus auratus*), turbot (*Colistium nudipinnus*), tuna (*Thunus* spp.), cockles (*Austrovenus stutchburyi*), clams (*Panopea zelandica*) and scallops (*Pecten novaeselandiae*).

Green-lipped mussel cultivation in New Zealand has expanded massively since it began during the 1970s. In the year 2000, nearly 3000 ha of coastal waters were being used for green-lipped mussel cultivation, and there were proposals for a further 39 000 ha (Jeffs et al. 1999; Lupi 2001). Individual mussel farms have been relatively small (usually <50 ha) and restricted to sheltered inshore waters, but recent technological developments allow large mussel farms to be sited in exposed offshore waters.

A variety of environmental changes occur as a result of marine aquaculture (Kaiser et al. 1998; Cole 2001). It seems probable that these changes affect some of the seabird and marine mammal species dependent on the habitats within and around aquaculture areas. The effects on these species may be detrimental or beneficial. Casual observations indicate that marine aquaculture within New Zealand does affect marine mammals and seabirds. Oyster farms on intertidal flats reduce the area of habitat available for a wide range of wading birds. Salmon farms attract aggregations of Australian gannets (*Sula serrator*) and New Zealand fur seals (*Arctocephalus forsteri*). Gannet deaths result from plunge diving into netted enclosures on salmon farms. Shag species (family: Phalocrocoracidae) habitually roost on mussel farms. In the past, because of the limited extent of areas used for aquaculture, such effects have been dismissed as inconsequential. However, the proposed massive increase in area to be used for mussel cultivation changes the scale of any effects and prompts concern. In particular, the construction of large (2000–4000 ha) mussel farms up to 7 km offshore will extend mussel cultivation into areas used by offshore species (albatrosses, petrels, shearwaters, penguins, dolphins and whales) that have not previously encountered mussel farms.

In this report, a wide array of information on the green-lipped mussel industry and New Zealand's marine mammals and seabirds is presented and used to identify potential effects of mussel farming on marine mammals and seabirds. While this approach is not desirable, it was judged necessary because no research has been undertaken on the effects of mussel farming on marine mammals and seabirds, and consequently there is little reliable information on the topic. This report is intended to draw attention to the potential consequences of large-scale development of mussel farms on wildlife and to provide a resource to assist the mussel farming industry, coastal planners and researchers in the development of an ecologically sustainable industry.

2. Green-lipped mussels

2.1 BIOLOGY

Details are from Jeffs et al. (1999) and Alfaro et al. (2001).

The green-lipped mussel is an endemic New Zealand species, one of several species of mussel (bivalves, family Mytilidae) that occur naturally in New Zealand. Green-lipped mussels are found in a variety of coastal habitats throughout the country, but are most common in central and northern regions. The species is sometimes found in the inter-tidal zone, but is predominantly sub-tidal, occurring most commonly from below low tide level to a depth of about 50 m. It lives in a variety of habitats, anchored either to solid substrates, such as rocky faces or algal holdfasts, or forming clusters on sandy and muddy bottoms in sheltered embayments. The species frequently forms dense beds of up to 100 m^2. Green-lipped mussels feed on phytoplankton and other organic particles, which they filter from water as it circulates through sieve-like gills. The gills are particularly efficient at removing particles in the size-range 3–200 μm. Mucus on the surface of the gills binds the particles into strings. Sorting occurs, with particles suitable for consumption being ingested and the remainder expelled as mucus-bound deposits called pseudofaeces. Suitable food particles are digested and faeces ejected from the anus.

Green-lipped mussels are dioecious broadcast spawners. They begin to mature sexually from 27 mm shell length, and by 40–50 mm, most individuals are sexually mature. Female and male mussels are reproductively synchronized and have consistent gonad cycles of gamete development, discharge, and redevelopment. There is a prolonged spawning season from late spring to autumn, though a small proportion of mussels spawn throughout the year. Sexually mature female mussels produce up to 100 million eggs in a season. Within 48 hours of being fertilised in the water column, the eggs develop into tiny larvae. These drift for 3–5 weeks, feeding on microalgae and dissolved organic material. The larvae may drift several hundred kilometers before attaching themselves to a suitable surface with a byssus thread. Following primary settlement, the larvae, now called spat, often undertake a local post-settlement migration to recruit into an existing mussel bed.

2.2 CULTIVATION

Details are from Jeffs et al. (1999), Lupi (2001), Robb & Davidson (2002) and Spencer (2002).

During the middle of the twentieth century extensive natural beds of green-lipped mussels in Hauraki Gulf, Marlborough Sounds and Tasman Bay (Fig. 1) were harvested commercially by dredging. At its peak, this dredge fishery produced 2 000 tonnes of mussels annually. By 1970, the mussel fishery had collapsed. This collapse led to the development of aquaculture methods for the species.

Mussel species belonging to the related genus *Mytilus* (predominantly *M. edulis*) have been cultivated in other parts of the world for hundreds of years, whereas cultivation of the green-lipped mussel is recent and is unique to New Zealand. Green-lipped mussel cultivation is undertaken using a double long-line

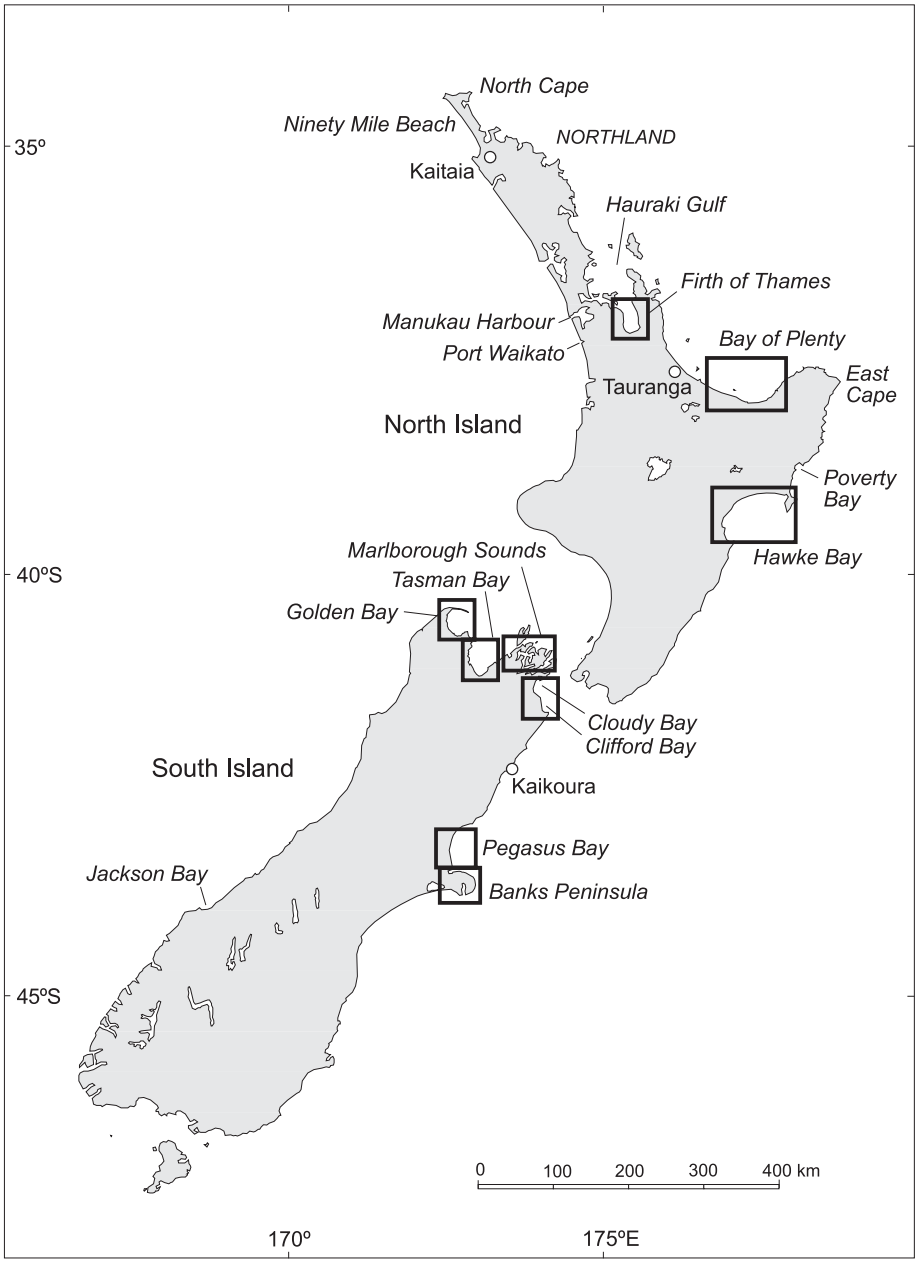

Figure 1. Map of New Zealand with place names referred to in text, and showing locations of detailed maps (Fig. 6).

method (Figs 2–5). A series of large plastic buoys (c. 1.4 × 0.7 m) are typically connected by two ropes (c. 30 mm diam.) to form a backbone, which is retained in place at each end via an anchor warp to either a large concrete block or an anchor (screw, or steel Danforth) embedded in the substrate. It is proposed that in large offshore farms sited in exposed situations, the buoys will be submerged 15 to 20 m below the sea surface to minimise wave action and reduce navigation hazards. Mussels are grown on ropes (c. 16 mm diam.) or droppers suspended from the backbone down into the water column in a series of loops, which hang under the weight of the mussel crop. The droppers are spaced about 1 m apart and, depending on the water depth, may extend down to 30 m, but are normally kept clear of the bottom. The backbones are positioned in parallel rows 15 to 20 m apart in sheltered inshore areas and 50 to 60 m apart in exposed situations.

Growing ropes are seeded with mussel spat. Most (80%) spat comes from Kaitaia, where spat from extensive offshore mussel beds settles on drifting seaweed that periodically washes up on Ninety Mile Beach, allowing easy harvesting of the spat. The remainder of the spat is collected in spat catching farms. The structures of these farms vary considerably. Typically, they resemble mussel farms on the surface. However, below the surface there is a second backbone rope holding spat catching lines, for spat to settle on, 15 to 20 m under water. Materials used for spat collection include plastic mesh and fibrous rope weighted to sink. Spat catching lines may be hung in rows or be wrapped around box-like structures. They remain in place for 4 to 8 weeks. Spat, either from spat catching farms or from Kaitaia, are seeded onto growing ropes by holding them against the ropes with light tubular stocking, until they attach themselves. Growing mussels are removed from ropes and re-seeded on to new ropes twice before achieving harvestable size.

Harvesting is done from specially designed harvest vessels. The mussel-laden growing ropes are hauled onboard the vessel where the mussels are stripped from the rope. The mussels are then washed and any natural detritus is discarded overboard within the mussel farm boundaries. The entire cycle from initial seeding to the harvest of marketable-size (90–120 mm) mussels usually takes 12 to 24 months, depending on the growing conditions.

Mussel cultivation is currently usually undertaken in sheltered embayments, within 200 m of the low-water mark, and in water between 10 and 30 m deep. The farms are usually located over areas of soft sediments to avoid smothering of reef habitats by biodeposits (Department of Conservation 1995). Permit conditions usually exclude areas within 20 m of rocky reef or other significant fish or seabed habitat because of typically high conservation values of these habitats. Individual areas allocated for mussel farming are normally between 1 and 20 ha (average 3–5 ha), though some existing mussel farms extend over 50 ha. Because mussel farming requires clean pollution-free water, the mussel industry seeks to maintain high water quality, and minimise or eliminate any marine pollution. Currently mussel cultivation does not entail the application of any additional nutrients, or chemicals (i.e. fertilisers, herbicides, or pesticides). However, recent research indicates productivity gains could be achieved by increasing concentrations of available nitrogen (Ogilvie et al. 2000) and experimental fertilising of waters within mussel farms in the Marlborough Sounds is being considered (Booth 2000).

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