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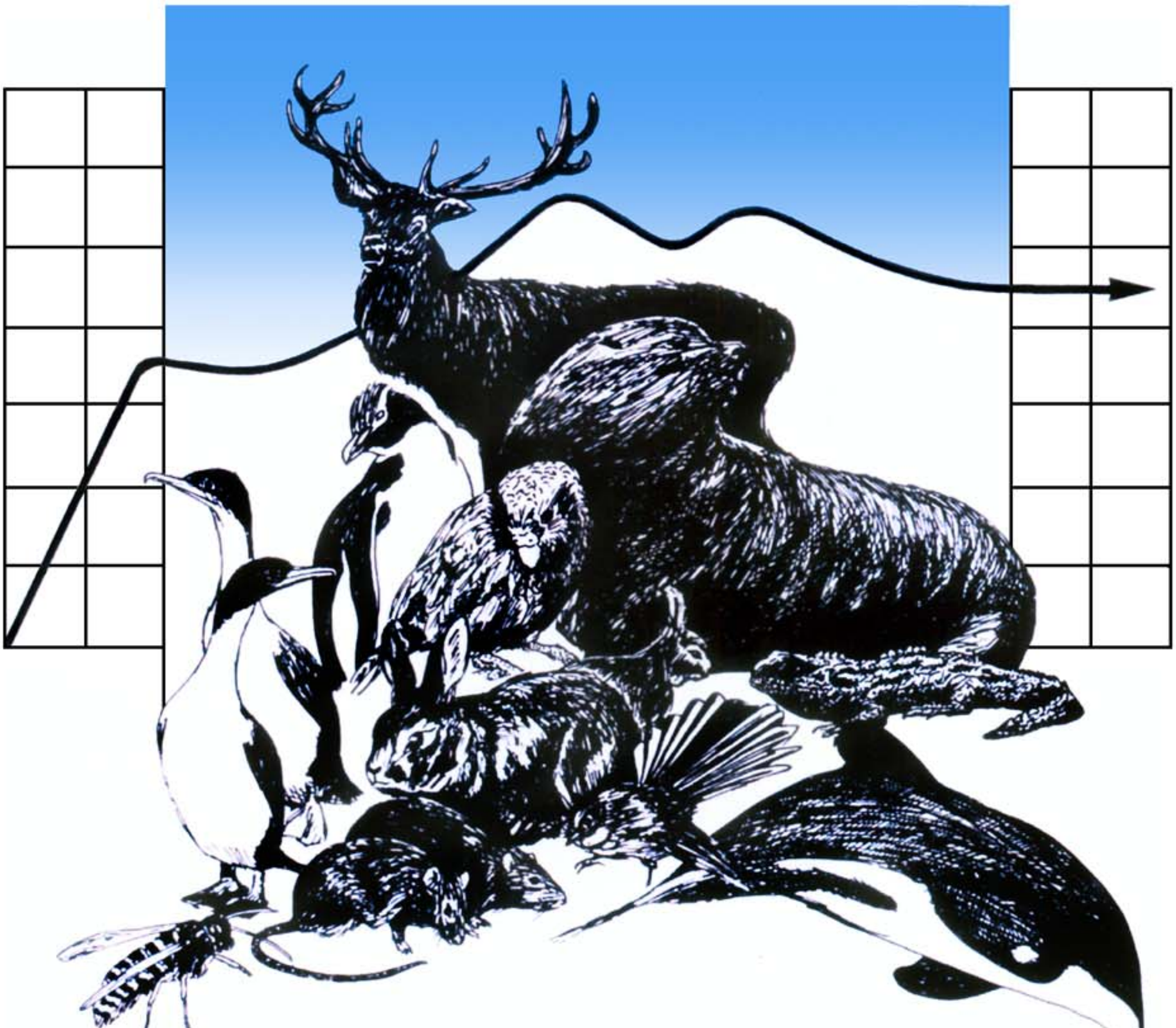

WILDLIFE MANAGEMENT

The effect of recreational scallop dredging on horse mussel (*Atrina zelandica*) populations in Tauranga Harbour

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A report prepared on behalf of the Tauranga Moana Customary Fisheries Committee

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CONTENTS

Executive Summary

◊ Concerns have been raised about the state of the horse mussel (*Atrina zelandica*) population in Tauranga Harbour by local iwi whose divers have noticed rapid declines in abundance. Horse mussels are important to Maori as a customary food resource.

◊ The Tauranga Moana Customary Fisheries Committee represents the three iwi of the Tauranga region and they wish to see a section 186A closure implemented upon recreational scallop dredging in the harbour near horse mussel beds.

◊ Horse mussels have been identified as a key species in marine benthic ecosystems because they are filter feeders and they also create habitat complexity by protruding above the sediment surface. They reduce predation rates on juvenile stages of commercially important fish and shellfish species. They also have potential as indicator species for sediment loading in estuaries.

◊ The effects of scallop dredging on *Atrina* include, crushing of individuals, removal as bycatch, and damage to individuals that leaves them vulnerable to predation

◊ The conclusion of this report is that a temporary closure on recreational scallop dredging is scientifically justified to ensure the sustainability of the horse mussel customary fishery and the overall health of the marine benthic ecosystem

1. Background

1.1 Biology

The horse mussel, *Atrina zelandica*, is a pinnid bivalve that is endemic to New Zealand waters and is generally found on muddy to sandy soft-sediment substrates in sheltered waters around much of the country, mainly in lower inter-tidal and subtidal shallow water (Ministry of Fisheries, Cummings *et al*, 1998). They are New Zealand's largest bivalve, reaching lengths of up to 400mm (Ministry of Fisheries). Horse mussels are found in dense groups and live partially embedded in the sediment, anchored to particles in the substrate by means of a group of threads called a byssus (Ministry of Fisheries; Gunson, 1983). The anterior half to one-third of their shell protrudes above the sediment surface which ensures that the water intake is clear of surface deposits and incidentally provides several species of algae and invertebrates with a surface for attachment (Ministry of Fisheries; Cummings *et al*, 1998). The thin shells are made of material that lacks the high lime content of most shells and is therefore more fragile (Gunson, 1983).

Horse mussels are dioecious broadcast spawners, but little else is known about their breeding habits (Ministry of Fisheries). The pelagic larva is a free-swimming stage that lasts between several days to weeks yet the settlement locations are unknown and may or may not be within the adult beds (Ministry of Fisheries).

There is also a distinct lack of information on the age, growth and mortality of horse mussels (Ministry of Fisheries). It appears that they grow most rapidly in the first two to four years of life, reaching their characteristic large size at around five years (Ministry of Fisheries). Notably it seems that horse mussels are periodically subject to widespread die-offs for which the cause is not definitely known but possible reasons include storm scour, shell damage and subsequent predation, and exceeding carrying capacity (Ministry of Fisheries).

1.2 Importance to Maori

Historically horse mussels were an important food source to Maori, although they are probably underrepresented in midden shell counts because of the fragile and short-lived nature of the shell (Ministry of Fisheries). The Ministry of Fisheries has no estimates of current customary use of horse mussels. From discussions with Maori divers in the Tauranga region it is clear that horse mussels are still harvested by Maori as a food source. The three iwi of the Tauranga Region; Ngaiterangi, Ngati Ranginui and Ngati Pukenga want to see the populations of horse mussels protected to ensure the resource is there for years to come so that future generations can also utilise the resource.

1.3 Status in Tauranga Harbour

The importance of marine soft-sediment habitats is often underestimated and they can be highly heterogeneous due to both broad-scale factors (e.g. hydrodynamic and nutrient regimes) and smaller-scale physical and biological features (Thrush & Dayton, 2002). These habitats support very high species diversity and the organisms that live on or in the sediments themselves create much of the three-dimensional habitat structure through either their activities (e.g. burrowing), or merely their presence on the sediment, as is the case with horse mussels (Thrush & Dayton, 2002).

Tauranga Harbour is a natural tidal estuary which occupies an area of c.200km^2 (Cole *et al*, 2000). Human activities include maintenance dredging to maintain navigation channels, port activities, and stormwater discharges (Cole *et al*, 2000). The harbour also provides habitat for diverse and dense populations of macrobenthic organisms, some of which are harvested for commercial or recreational purposes (Cole *et al*, 2000). The harbour is extremely popular for recreational users with one of the highest rates of pleasure boat ownership in New Zealand (Lawrie, 2006).

In 2004 horse mussels were introduced into Quota Management System and were allocated a total allowable catch (TAC) of 103 t with 29 t for commercial fisheries, 9 t each for customary and recreational fisheries and 56 t allowed for other sources of mortality (Ministry of Fisheries). The commercial catch is taken as bycatch from bottom trawls (90%), dredges and Danish seines (Ministry of Fisheries). While in most years reported catches have been small the Ministry of Fisheries says it is likely that there is a high level of discarded horse mussel catch that goes unreported. Horse mussels are taken occasionally by recreational fishers, and the Ministry of Fisheries acknowledges that they are a traditional food of Maori. However no estimates are available for either the recreational or customary take of horse mussels (Ministry of Fisheries).

The status of horse mussel populations in the harbour is unknown, which is expected given the fact that the Ministry of Fisheries has no stock estimates for the species. They state that, "There are no estimates of reference or current biomass for any horse mussel fishstock. It is not known whether horse mussel stocks are at, above, or below a level that can produce MSY (*maximum sustainable yield*)". However anecdotal evidence from Maori divers in the harbour indicates an alarming rate of decline in the beds. They attribute this to the impact of recreational scallop dredging and a population boom in the predatory seastar *Coscinasterias muricata*. The Tauranga Harbour integrated management strategy disagrees with the Ministry of Fisheries' claim that there are very few issues with the management of Tauranga Harbour and says that it is clear there are concerns about fishing matters in the harbour (Lawrie, 2006). Some of the fisheries-related issues in the harbour include concerns about recreational harvesting pressure depleting shellfish stocks and exerting a selective pressure that results in smaller shellfish, the effects of increased suspended sediment on shellfish size, and the effects on the benthic habitat and species assemblages from scallop dredging (Lawrie, 2006).

2. Issues

2.1 Ecological Significance of Atrina

Atrina zelandica is both a key species and an ecosystem engineer (Nicholls, 2002; Guite'rrez *et al*, 2003). A key species is one that either directly or indirectly modifies other parts of the community by affecting energy flows or the transfer of food from one part of the ecosystem to another (Nicholls, 2002). Ecosystem engineers are organisms which contribute to the creation, modification or maintenance of habitats (Guite'rrez *et al*, 2003). They do so through controlling the availability of resources to other species by causing physical state changes in abiotic or biotic materials (Guite'rrez *et al*, 2003). The impact of engineers on the functioning of an ecosystem ranges from minor to highly significant (Guite'rrez *et al*, 2003).

Bivalves expend a great deal of energy drawing water over their gills to feed (Thrush & Dayton, 2002). *Atrina* filter their food out of the water column and in doing so can remove as much as 80% of the small particles suspended in the water (Nicholls, 2002). They also package any particles that are unable to be ingested in mucous and expel them (Thrush & Dayton, 2002). These packages are known as pseudofaeces and they noticeably influence the rate of particle deposition to the sea floor (Thrush & Dayton, 2002).

The relationship between hydrodynamic conditions and the benthic habitat drives many important processes which occur at the sediment-water interface (Thrush & Dayton, 2002). Because they protrude from the sea floor and produce active feeding currents horse mussels affect how sediment is carried around and settles on the sea bed (Nicholls, 2002). Laboratory studies have shown that feeding currents of bivalves modify flow conditions (Eckman, 1983, 1985; Ertman and Jumars, 1988; Monismith et al., 1990; O'Riordan et al., 1993, 1995; Cummings *et al*, 1998), and this in turn influences localized rates of erosion and deposition (Thrush & Dayton, 2002). By being large structures protruding above the sediment surface horse mussels affect boundary flow conditions by increasing drag (Cummings *et al*, 1998). In high densities, beds of *Atrina* are able to cause "skimming flow" over the mussel bed which will invariably influence the exchange processes between the water column and the benthos (Cummings *et al*, 1998).

Physical structures in habitats can also act as refuges for both predators and prey and variations in habitat complexity influence variation in predator-prey interactions (Thrush & Dayton, 2002). Through reducing the risk of predation habitat structure complexity can increase both the growth and survivorship rates of the juvenile stages of commercially valuable species (Thrush & Dayton, 2002). A study by Talman et al (2004) also showed an effect of the presence of emergent features such as horse mussels on scallop predation rates. They found that in areas with a greater number of individuals, such as horse mussels and sponges surrounding the scallop the predation rates were lower. They attribute this effect to both the physical refuge these features provide from visual predators and the effect they have on the success of predators that rely on chemical cues to detect prey, such as seastars and gastropods. This could be of special significance for scallop beds in Tauranga Harbour following the increase in the population of the predatory seastar *Coscinasterias muricata.* It is also possible that large structures protruding from the sediment surface act as obstacles that impede the mobility of comparatively slow-moving predators, giving prey species a better chance of avoiding capture (Talman *et al*, 2004).

The Ministry of Fisheries acknowledges the importance of horse mussels to ecosystem structure and function. In their summary of the horse mussel fishery they state that horse mussels, "Provide shelter and refuge for invertebrates and fish, and act as substrata for the settlement of epifauna such as sponges and soft corals. They also affect boundary layer dynamics, and facilitate productivity and biodiversity by depositing pseudofaeces."

2.2 Dredging Impacts

Bottom-towed fishing methods such as trawls and dredges represent the one of the primary threats to habitat structure in the marine benthic environment (Talman *et al*, 2004). Trawls and dredges which are dragged along the sea floor remove and/or kill emergent epifauna, disturb sediments and infaunal species, and overturn physical features such as rocks and boulders (Talman *et al*, 2004). This leads to flatter sea bed topography and the homogenisation of surficial sediments which can alter benthic algal production and nutrient cycling (Thrush *et al*, 2002; Talman *et al*, 2004). The type of impact that fishing gear has on the sea bed relates directly to the mass of the gear, the degree of contact with the seafloor, and the speed at which it is dragged (Thrush & Dayton, 2002).

Horse mussel beds could be directly affected by scallop dredges through either the crushing of individuals or their removal as bycatch (Thrush *et al*, 2002). Mortality rates can also be indirectly affected by dredging because the partial excavation and damage of near-surface dwelling organisms can attract mobile predators and scavengers (Thrush *et al*, 2002). This is relevant to horse mussels because the valves of pinnid bivalves are fragile, and small amounts of damage make *Atrina* vulnerable to whelks and seastars (Backhurst & Cole, 2000). Bottom-fishing also causes the resuspension of benthic sediments into the water column which has led to the smothering of suspension feeders (Thrush & Dayton, 2002). This is of concern because *Atrina* are sensitive to increases in suspended sediment in the water column and a direct relationship has been identified between increasing sediment concentrations and decreasing *Atrina* condition (defined as size and weight of the animal) (Nicholls, 2002).

There are many documented responses of marine soft-sediment communities to increasing disturbance frequency and intensity (Table 1) (Thrush *et al*, 2002). However the potential significance of these changes in benthic communities is often discounted because the effects have not been well documented (Thrush *et al*, 2002). This is because the biological effects of disturbance by bottom-fishing are difficult to isolate and identify owing to the complexity and variability in benthic communities (Thrush *et al*, 2002). In the case of horse mussel beds in Tauranga Harbour the lack of an assessment of the stock means changes due to fishing pressure go undocumented.

Table 1. Predicted changes in marine benthic communities along a gradient of decreasing habitat disturbance by trawling and dredging (Thrush *et al*, 2002).

Decreasing	Increasing
- Scavenger density	- Large epifauna density
- Deposit-feeder density	- Species diversity and richness
- Small-opportunist density	- Long-lived near-surface-dweller density
- Ratio of polychaetes to molluscs	- Ratio of small to large individuals
	- Echinoderm density
	- Total number of individuals

Disturbance regimes in marine benthic habitats are actually play an important role in controlling biodiversity by generating patchiness (Thrush & Dayton, 2002). The spatial heterogeneity generated by the occurrence of local disturbance events can account for patchiness of resources in the environment (Thrush & Dayton, 2002). The heterogeneity this process creates is an essential component in the functioning of ecosystems and also influences the maintenance of diversity and stability at the population, community and ecosystem levels (Thrush & Dayton, 2002). The significance of disturbance events to the maintenance of soft-sediment marine communities has been used to imply that fishing is one form of disturbance that can positively affect biodiversity (Thrush & Dayton, 2002). This is a misleading assertion because fishing disturbance leads to the homogenisation of habitats which results in the loss of small-scale patchiness – the very condition required for the intermediate disturbance hypothesis to apply (Thrush & Dayton, 2002). When the rate of human-induced change exceeds the rate at which nature can respond the result represents a significant threat to the integrity and resilience of marine benthic communities (Thrush & Dayton, 2002).

It is clear then that recreational scallop dredging in Tauranga Harbour will be impacting negatively, not only on horse mussel beds but on the whole of the benthic community. In fact scallop dredges impact negatively on scallop populations themselves (Talman *et al*, 2004). Scallops are particularly vulnerable to predation in the juvenile phase and highly structured habitats reduce the rates of predation on scallops (Talman *et al*, 2004). Talman et al (2004) compared fished sites to unfished sites in the same geographical region where scallops occur and found that the fished sites were primarily featureless, whereas unfished sites showed great habitat complexity. They concluded that the low level of structural features in the fished habitats was a result of repeated dredging, which smoothes the sea bed topography and removes epibenthos (Talman *et al*, 2004).

3. Action Required

3.1 Research

The lack of knowledge regarding horse mussel stocks in Tauranga Harbour is a major obstacle preventing successful management of this species and research is required to remedy this issue. It is unclear how the Ministry of Fisheries decided upon quota levels for horse mussel harvests without accurate stock assessments and it seems logical that if research was conducted into the status of horse mussel populations in Tauranga Harbour and around New Zealand the Ministry of Fisheries would be better informed when deciding upon sustainable levels of take for this species.

As outlined in section 2.1 of this report the population health of horse mussels is linked to the overall health of the benthic soft-sediment community including commercially important species of fish and shellfish such as scallops. Nicholls (2002) state that it is most efficient to monitor key species like horse mussels because the abundance of these species can be used to monitor impacts, manage ecosystems and predict effects. The paper points out that, in order to manage and predict accurately, information needs to be gathered about key species, such as how sensitive they are to environmental changes and their population fluctuations over time (Nicholls, 2002).

The paper outlines two stages of research required to use a key species as an indicator species; firstly the role of a species and its impact on the ecosystem needs to be determined, then the response of the key species to changes in the environment needs to be investigated (Nicholls, 2002). Nicholls (2002) believes that *Atrina* is a key species with potential as an indicator that could be used to monitor increasing sediment loading in estuaries. The relevance of this is made clear in the Tauranga Harbour integrated management strategy which states that both scientific and observational sources believe that sedimentation is the largest issue currently facing Tauranga Harbour (Lawrie, 2006).

3.2 Request for Section 186A Closure

This report is on behalf of the Tauranga Moana Customary Fisheries Committee. This committee is made up of two representatives from each of the three iwi of the Tauranga Region, the three iwi being Ngaiterangi, Ngati Ranginui and Ngati Pukenga. This committee is the steering committee for Tauranga's 52 kaitiaki (approximately) which is the highest number of kaitiaki for a small region. This committee is requesting a temporary fishing closure on recreational scallop dredging in Tauranga Harbour under Section 186A of the Fisheries Act 1996 which allows the Ministry of Fisheries to temporarily close an area to fishing (Ministry of Fisheries). This report seeks to aid in the request by local iwi for this closure by fulfilling the aspect of the initial information requirements which calls for a description of the fishing method and explanation as to how it is having an adverse effect (Ministry of Fisheries).

Intense human recreational activities such as dredging may require management in order to minimise their environmental and social impacts and ensure that the resource is protected for future recreation and as a habitat/natural resource (Backhurst & Cole, 2000). If one fishery is operating to the detriment of another, as appears to be the case in Tauranga Harbour, then that fishing practice needs to be managed to maintain stocks of both fisheries. The conclusion of this report supports the application for a temporary closure on recreational scallop dredging in Tauranga Harbour. It is vital that the ecological effects of fishing are taken into consideration when management strategies are devised to ensure the conservation and protection of marine environment and the sustainability of the fisheries that are inextricably linked to them (Talman *et al,* 2004).

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