ECOLOGICALLY SIGNIFICANT MARINE SITES
IN MARLBOROUGH, NEW ZEALAND

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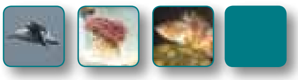

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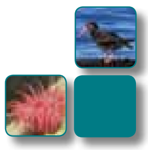

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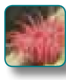
AUTHORS

Rob Davidson has been involved in marine biology for 27 years. Rob holds a Master of Science with First Class Honours from the University of Canterbury, 1987, is a current member of the New Zealand Marine Sciences Society and has presented 18 conference papers and published 10 papers in internationally peer reviewed scientific journals. He has worked for MAF and the Dept. of Conservation and since 1994 is the director of an independent science consultancy. During his time at DOC, he coordinated or was involved in many large scale ecological surveys of coastal areas throughout Nelson and Marlborough. He has implemented monitoring programmes spanning up to 17 years, relating to Cook Strait ferry impacts, marine farm recovery and marine reserve monitoring. As a consultant, Rob has provided scientific information for over 600 resource consent applications and impact assessments. Over his working career he has conducted over 4000 dives throughout the Marlborough area and has an extensive knowledge of the underwater features and values of Marlborough.

Clinton Duffy is a marine scientist employed with the Marine Conservation Section of the Department of Conservation. He holds a M.Sc. (Hons) in Zoology from the University of Canterbury, 1990, and worked as a marine and freshwater technical support officer for the Department's Nelson/Marlborough, East Coast Hawke's Bay and Wanganui Conservancies from 1990-1999, and as Scientific Officer (marine ecology) attached to National office since 1999. Clinton has published 22 papers in internationally peer reviewed scientific journals and authored nine other scientific publications and reports. His areas of expertise include marine survey and monitoring; biogeography of New Zealand reef fishes, algae and invertebrates; and the conservation biology, taxonomy and behaviour of sharks and rays. He has dived, either in a professional or private capacity, around much of New Zealand's coastline from the Kermadec Islands to Stewart Island, including co-ordination of a dive survey of shallow subtidal habitats of the Marlborough Sounds in 1989-90.

Peter Gaze worked for many years with Ecology Division of DSIR, involved with research into the distribution, conservation and economic value of birdlife in New Zealand. This included a study of forest bird ecology, in particular rifleman, kereru and mohua. Peter is also a co-author of the first atlas of bird distribution in New Zealand. His current role with Department of Conservation is primarily to provide technical advice on fauna conservation work in Nelson and Marlborough. Both roles have included projects working on the islands and wildlife of the Marlborough Sounds. A plan written for the management of these islands continues to guide the work of the department. Peter has a long association with bird research and conservation throughout New Zealand and he is currently the secretary for the Ornithological Society of New Zealand. Related fields of interest include the impact and control of mammalian predators as well as reptile conservation including leading the Department's recovery of tuatara for the last ten years.

Andrew Baxter has 28 years experience in coastal and marine management, specialising in marine ecology including marine mammals. He graduated from the University of Canterbury in 1981 with a BSc with First Class Honours in Zoology. Following two years working for the Taranaki Catchment Commission as a marine biologist, Andrew worked as a fisheries management scientist for MAF Fisheries based in Wellington from 1984 to 1987. Since shifting to Nelson in October 1987, he has been employed as a marine ecologist for the Nelson/Marlborough Conservancy of the Department of Conservation. Andrew's current work duties include: technical oversight and co-ordination of the Department's coastal and marine duties in Nelson and Marlborough; marine reserve implementation, management and monitoring; technical input on Resource Management Act matters; and marine mammal management.

Sam DuFresne has over 13 years of experience studying marine mammals, beginning with his master's thesis in 1998. He has conducted a number of dolphin surveys in New Zealand focussed mainly on Hector's dolphins and has worked in places as diverse as Far East Russia, Hawaii and Western Australia. After graduating with a PhD from the University of Otago in 2005, Sam worked as an independent consultant, specialising in marine mammals. As a consultant, Sam worked closely with DOC, MFish, NIWA, Cawthron, various regional councils and a number of industry clients, providing expert advice and research services on a range of species and issues. In 2009 Sam relocated to St Andrews (Scotland), where he worked as a senior research scientist at SMRU Ltd, focussing mainly on marine mammals and renewable energy projects. He is now based in Perth (Western Australia) working for Blue Planet Marine on a range of marine megafauna projects relating primarily to the booming offshore oil and gas industry.

Shannel Courtney is a Nelson-based plant ecologist with the Department of Conservation. In 1983 he attained a Master of Science in plant ecology at Canterbury University and has worked for the New Zealand Wildlife Service, New Zealand Department of Lands and Survey and New Zealand Forest Service on management issues. For much of his 27-year career, he has been involved in the assessment of natural areas for ecological significance and has led various ecological surveys of the East Cape, Taranaki, Marlborough and Nelson regions. For the last 10 years, he has specialised in threatened plant conservation and co-ordinates the recovery of nationally threatened and at-risk species in the Nelson region and Marlborough Sounds. He is currently on the National Threatened Plant Panel and on the committee of the New Zealand Plant Conservation Network. In 2008 he was awarded the Loder Cup in recognition of his services to plant conservation.

Peter Hamill is an Environmental Scientist employed with the Marlborough District Council, a position he has held since 2000. He has a BSc and PGDipSci from the University of Otago. Peter's role at the Council specialises in freshwater ecology but also covers technical input on Resource Management Act matters in relation to Marlborough's Terrestrial and Marine ecology.

INTRODUCTION

New Zealand is a series of isolated islands in the Pacific Ocean, some 2150 kilometres from the nearest large land mass, that stretch from sub-tropical to sub-Antarctic waters. Within this large range of latitudes the coastline is influenced by a wide variety of processes that shape the marine environment. Biophysical factors including geology, tide, currents, sedimentation, temperature, salinity and variation in exposure and depth have created a highly complex marine environment. As a result our marine environment is diverse and supports a rich assemblage of species, habitats and communities. New Zealand has about 15,000 marine species and it has been estimated that a further 50,000 species could be found[112,113,114].

New Zealand has been separated from other land masses for over 80 million years. This isolation has lead to many of the species that are found in the coastal waters being unique to New Zealand. For example, nearly 60% of our 100 species of rock pool fish are endemic to New Zealand[295].

Marlborough's extensive coastline is no exception when it comes to a diverse marine environment with habitats ranging from the common-place and typical, through to significant sites that support rare, unique or special species.

The intricate coastline of the Marlborough Sounds has been formed as the headwaters of the former Pelorus and Queen Charlotte Valleys have been submerged by tectonic forces and sea level changes. The distinctive submerged river valley coastline ranges from sheltered bays and estuaries of the inner Sounds to open bays, channels, tidal passages and some of the most exposed shores in the world. Marlborough's east coast is markedly different from that of the Sounds, although it too is highly varied with contrasts of rocky and mudstone reefs, gravel beaches and the shallow Wairau Lagoons.

When compared to the knowledge of the biodiversity of our terrestrial environment relatively few studies have focused on identifying, surveying and assessing subtidal marine habitats in New Zealand, including those of Marlborough. Therefore our understanding and knowledge of the coastal and marine environment is limited.

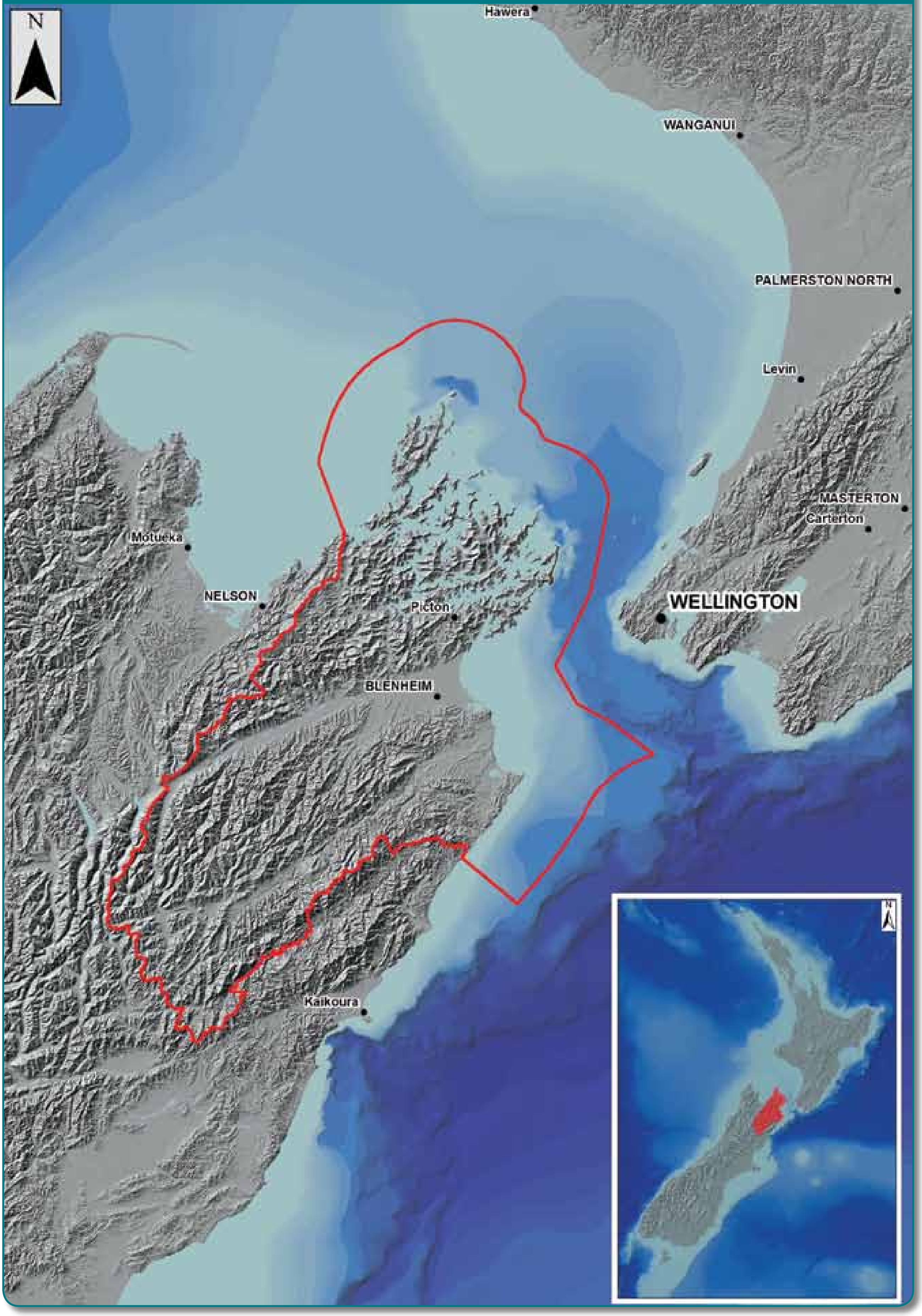
There is little doubt that the number, extent and quality of significant marine areas, as well as the quality of the general marine environment, has declined since the arrival of humans to New Zealand. Land clearance, coastal development, pollution and fishing have taken their toll. However, without baseline information, it is impossible to quantify accurately what has changed and by how much. It is important to identify the location and composition of significant sites – biological features that have conservation, scientific or ecological value – to ensure their sustainable management and protection into the future.

This report identifies and describes the ecological values for significant sites that support rare, unique or special features, from the top of the high tide mark to the edge of the regional boundary 22 km offshore, for an area that stretches from Cape Soucis in Tasman Bay (Croisilles Harbour) in the north-west, through the Marlborough Sounds, and south to Willawa Point, near Kekerengu, on the east coast.

The marine environment is defined as areas that support marine plants or animals, and includes the intertidal zone (estuaries, river mouths, brackish lagoons, rocky coast, beaches); the shallow subtidal zone (channels, bays, reefs); and the neritic zone (sea floor and water shallower than 200m). See Appendix 2 for a detailed description of marine habitats found in the study area. Some terrestrial sites have also been included, notably where sea-birds nest, roost and breed, and where seals haul-out and breed.

This report outlines known information on areas with conservation, scientific or ecological value that have come from a variety of sources including previous reports, however some sites have only been recently discovered and require further study. There is no doubt that many areas remain unknown, while some existing areas are often poorly described or their extent remains unmapped.

MAP 1 - MARLBOROUGH DISTRICT BOUNDARY



ISSUES AND THREATS

The marine environment is vulnerable to human disturbance for several reasons. The coast and sea is considered by most New Zealanders as “public space” and is used for a wide variety of activities. Unlike a lot of the land area however, most marine areas in New Zealand have limited or no formal protection. As many activities in the marine area are largely “out of sight” or difficult to measure or study, they may be easily overlooked or go unnoticed. Some impacts might appear minor, such as the effect of an individual fisher, but the cumulative impact of all users and activities is usually much greater. There is also a perception that the sea is large and immune to damage.

Some of the highest marine ecological values are quite localised and include habitats and species that are very fragile and easily damaged. For example, in some soft-bottom habitats organisms such as bryozoans and tubeworms can form a biological skin over the seafloor, increasing species diversity as well as providing refuge and food for adult and juvenile fish[90]. These habitats are fragile and vulnerable to physical damage, either directly (e.g. from dredging and bottom trawling) or indirectly (e.g. land clearance increasing sedimentation that can smother marine life). Without good baseline information it is impossible to establish accurately the extent of marine habitat loss or modification since the arrival of humans. But anecdotal evidence suggests it could be very high.

The following sections provide an overview of marine management issues in Marlborough.

LAND CLEARANCE AND SEDIMENTATION

Sedimentation from historical large-scale deforestation has had a widespread impact on New Zealand’s marine environment. Increased sedimentation can change the composition of the seabed and the associated flora and fauna, and Marlborough has not been spared[302]. The initial clearance of forests and development for agriculture, horticulture and exotic forestry both locally and within river catchments has increased sedimentation in estuaries and near-shore environments[193,220,221]. As a consequence the region’s marine environment is probably very different today compared to centuries ago. Unfortunately these changes have largely gone undocumented and their full scale is unknown.

Many areas in the Marlborough Sounds that are no longer farmed are now covered in regenerating scrub and early forest. This change in land management should result in less sediment entering the marine environment as forested catchments generally have lower rates of sediment run-off than cleared land. However, some areas have been planted in production forestry which can cause

Following forestry harvest, Marlborough Sounds (MDC) increased sedimentation during development and during and after harvest. A 1992 study[132] estimated that up to 218 tonnes of sediment per sq km could be eroded from roadways during logging operations in the Sounds each year. The report stated that a significant proportion of that sediment would end up in local bays and sediment in the adjacent waters could climb to 1000 milligrams per litre compared to background levels of 15-20 milligrams per litre. This sediment quickly settles out on the seafloor. Studies from Paterson Inlet on Stewart Island suggest that catchments with stable native forests release only low levels of sediment into coastal areas[79,172,385]. As a consequence the inlet supports many seafloor habitats and communities that are absent or rare from most parts of New Zealand. There are a range of measures that can reduce or manage sediment entering the marine environment. These include land retirement, fencing and replanting riparian zones, enforcing riparian zones, construction of sediment traps or settling areas, adopting forest harvesting methods that reduce sediment output and ensuring new forest blocks are planted away from sensitive marine habitats.

DISCARDED RUBBISH

Inorganic rubbish at sea such as strapping bands, polystyrene, plastic bags and discarded fishing line can pose a risk to marine life, particularly birds and marine mammals[311]. For example, gannets have been known to build their nests from synthetic material discarded from mussel farms instead of seaweed. This can catch on their serrated beaks. Monofilament line discarded by fishermen has occasionally entangled shags who try to use it for nesting material. Marine mammals and birds also run the risk of harm from swallowing plastic mistaken as food. Protocols such as the Mussel Industry Code of Environmental Practice, beach clean-ups and public education and awareness programmes have helped reduce these problems.

Shag entangled in fishing nylon (MDC)

BOTTOM-TOWED DEVICES AND ANCHORING

Fishing dredges, trawls and anchors can threaten fragile marine habitats, communities and species[371]. Long-lived species such as rhodoliths, sponge gardens and bryozoan beds are particularly susceptible to disturbance[147,183,203,204,283,352,354].

Bottom-towed devices (e.g. commercial and recreational dredges, trawls and danish seines) are known to alter seafloor habitats[71,116,167,168,186,187,203,204,371,372]. International studies have shown that slow-growing fauna such as sponges and soft corals can take many years to recover after disturbance[203] or in some cases no recovery occurs[328]. These stable, often long-lived communities are displaced by disturbance and are succeeded by short-lived opportunistic species including worms and “amphipods”.

Soft-bottom biogenic habitats such as tubeworm and bryozoan mounds support relatively high species diversity and are important fish habitat, especially for juveniles[40,197,381]. However, these habitats are fragile and particularly susceptible to damage by bottom towed devices. Loss or damage of these areas often results in the removal of the very habitat on which the fishery relies.

A study investigating the effects of dredging in Foveaux Strait demonstrated that blue cod had a less diverse diet from dredged areas compared with biogenic reef areas[197]. A second report suggested that dredging in Foveaux Strait may impede the growth of juvenile blue cod[49]. It stated that recovering biogenic reef may provide important habitat for the early development of blue cod. It also said that some areas of recovering biogenic reef may require remedial action to protect them from further damage and to allow dredged areas sufficient time to recover if the blue cod fishery was to be managed effectively.

Researchers found that the seafloor habitat of some oyster beds regenerated once dredging stopped, and blue cod and oyster numbers rebuilt to commercial levels[71]. When the oyster dredging restarted the habitats were modified once more, and the relative density of blue cod on the oyster beds fell.

There are analogies in freshwater environments. Stable lake or spring-fed streams support very different plants and animals compared with freshwater streams that regularly flood[342]. Likewise, on land, there are clear differences between areas that are regularly burnt compared with undisturbed land.

Once important marine areas are identified, education and protection measures are needed to sustainably manage the important habitats and communities that remain. Protection of these areas may also allow damaged habitats to recover, which would enhance biodiversity and potentially the fisheries.

INFILLING AND RECLAMATION

Natural infilling usually occurs in shallow waters or estuaries and often takes place over a long period of time. Man-made reclamations are rapid and cause permanent loss of marine habitat. It is rare that reclamations are removed and marine areas reinstated. Although individual reclamations are often small, they can be significant in Marlborough as estuarine areas are relatively uncommon. Important habitats have been lost at Lake Grassmere, Havelock[99], Picton and Waikawa and more recently at Mahau Sound. Future applications to infill or reclaim marine areas require careful assessment, especially those over estuarine or intertidal habitats.

FENCING AND STOCK

Estuarine habitats, especially salt marsh and herb field communities, are vulnerable to stock grazing and trampling. Adequate fencing with sufficient buffers around the fringes would largely eliminate this physical damage and would also reduce sediment and contaminants reaching habitats near the shore.

EXOTIC SPECIES

Various exotic marine species, some invasive or adventive, have arrived in Marlborough and are now well established[72,285]. Some of the most recent and best known examples include cord grass, Pacific oyster, Japanese kelp, club tunicate and the ascidian *Didemnum vexillum*. Other species do not receive as much publicity but are also well established, such as the bryozoan *Bugula neritina*.

Many exotic species appear to have had little impact on natural communities but others such as cord grass and *Didemnum* have had a more serious effect. The arrival of species like the North Pacific sea star would pose a serious threat to the economy and ecology of the area. Once an exotic species is introduced into the marine environment it is virtually impossible to contain or eradicate it. Border controls are essential to minimise the chance of new species arriving.

POLLUTION AND ENRICHMENT

Pollution and enrichment can come from many sources including boat-washing areas, storm water, industrial discharges, marine farms, agricultural run-off, oil spills and sewage. Marine areas near ports and developed coastal areas usually have higher levels of contaminants such as chemicals, herbicides, pesticides, metals, hydrocarbons, pathogens (viruses and bacteria) and raised nutrient levels than open coast areas.

The impact of contaminants depends on their nature, the quantities involved, the level of mixing, and the sensitivity of the environment. High levels of nutrients can result in plankton blooms. Hydrocarbons, mainly from oil and fuel spills, can kill birds, mammals and other sea life. Pathogens, metals and various other chemicals can cause illness in humans and wildlife, and can be lethal at high levels.

Mud and sand habitats, especially those in estuaries and sheltered harbours and bays, tend to act as a "sink" for contaminants. Many chemicals or metals are taken up by filter-feeding and deposit-feeding species such as mussels, cockles, snails, worms and crabs. However, many persistent contaminants are also transmitted through and accumulate in the food chain. Mammals are at or near the top of marine food chains and are particularly vulnerable to the build-up of contaminants such as organochlorines and metals. Many of these contaminants bond with fatty tissues and the only way these chemicals leave the animal is through lactation resulting in contaminants being passed from mothers to their young[311]. Species such as Hector's dolphin that spend a lot of time in near-shore environments are particularly susceptible to pollution. Dusky dolphin and common dolphin are also known to accumulate pollutants[200,359]. In general, however, New Zealand marine mammals tend to have lower levels of accumulated contaminants than those in the northern hemisphere. Man-made contaminants mainly affect marine mammals by impairing reproduction or may result in indirect and direct mortality.

SHIPPING AND BOATING IMPACTS

Ship wakes can impact on intertidal and shallow subtidal habitats and communities[84]. A 2010 study[89] showed that waves from ferries, especially fast ferries, had an adverse impact on large areas of Tory Channel and the inner Queen Charlotte Sound. These marine communities partially recovered after the fast ferries slowed down or stopped operating, however conventional ferry impacts remain[89,90].

Vessel strike, (collision with a boat or ship) is a risk for marine mammals, with larger whales being particularly susceptible especially in busy shipping lanes[22,28]. Humpback and southern right whales migrate through Cook Strait and are occasionally seen within the confines of the Marlborough Sounds and are therefore susceptible to vessel strike. Dolphins and killer whales are also vulnerable and can be hurt or killed if hit by a fast moving boat or a propeller[361,376]. Most seabirds are able to avoid power boats but sometimes they get hit, particularly penguins and shags.

Boats and ships can also disturb mammals and seabirds while passing by, or by getting too close while viewing marine wildlife[24,25,288]. Several bird species are particularly vulnerable to disturbance. King shags[217,219] nest on exposed rock faces of remote islands and reefs in the Sounds and passing vessels can unsettle or spook nesting adults which destroy nests in their haste to get away. White-fronted tern, red-billed gull and gannet colonies are also vulnerable to disturbance, although the risk is more from predatory black-backed gulls using the opportunity to take eggs and chicks from the unguarded nests.

There is growing evidence that regular, repeated interactions between boats and marine mammals can change marine mammal behaviour and distribution. Sperm whales, bottlenose dolphins, Hector's dolphins, common dolphins, and dusky dolphins are all known to be susceptible to disturbance[24,25,29,57,69,162,233,234,235,236,237,250,288,313,314,358,361,362,391]. Changes in behaviour and distribution could also affect bonding, resting, foraging and feeding, energy levels, reproductive success and the overall fitness of the population.

The Marine Mammals Protection Regulations 1992 are designed to minimise the impact of vessels on the normal behaviour of marine mammals. The regulations include vessel approach speeds and distances, and the number of vessels in the area[57].

MARINE FARMS

The majority of marine farms in Marlborough are located in Pelorus Sound with smaller numbers in Croisilles Harbour, East Bay (Queen Charlotte Sound), Tory Channel, Port Underwood and some bays in the outer Sounds. No farms have been established between Rarangi and Willawa Point, although a 424 ha farm has been approved in Clifford Bay, south of the Awatere River mouth. Most marine farms in Marlborough grow mussels, however, Pacific oyster and salmon is also farmed. Other species that have been consented to be farmed include paua, snapper, scallops, kingfish, butterfish, hapuku, mullet, seaweeds, rock lobster, sponges, sea cucumbers and seahorses.

Mussel farm (MDC)

Mussel shell debris below a mussel farm (Rob Davidson)

The mussel industry in Marlborough is large with 63,000 tonnes of mussels being produced in 2009. Approximately 7500 tonnes of salmon is produced from the Marlborough Sounds, representing 75% of New Zealand's total.

A variety of studies have been undertaken to investigate the impact of this marine farming on the environment[52,65,86,111,135,136,205,207,232,272,274] and the recovery of the seafloor once a mussel farm is removed[92,97]. The studies show that marine farms alter the nearby seafloor environment. The scale and nature of the impact depends on the type of farm and species, how it is managed, water depth, tidal currents, bottom type and water circulation. Generally, farms placed over silt and clay seabed in relatively deep water with good water circulation show less habitat change than farms placed over shallow coarse substrata or in areas with poor water circulation. For mussel farms in areas of shallow coarse substrata with poor circulation the seabed can get completely covered in mussel shell debris and develop an anaerobic layer close to the surface of the underlying sediment. The community composition both within and on the seafloor can also change and there is a reduction in water movement and phytoplankton in and down-current of a mussel farm.

Research also points to the displacement of dolphins (notably where dusky dolphins feed). The entanglement threat to whales such as the southern right and humpback if farms are established in traditional migratory routes[251].

Admiralty Bay is a well known example where aquaculture development has overlapped with dolphin habitat. Dusky dolphins migrate from the east coast of the South Island to the Marlborough Sounds in winter and spring. Admiralty Bay is known to be an important dusky dolphin foraging habitat, where the dolphins hunt cooperatively on aggregations of bait-fish, especially pilchards[373]. Admiralty Bay also supports a large number of mussel farms around its perimeter and there have been numerous applications to extend existing farms or establish large offshore sites. Though many of the offshore farm applications were subsequently withdrawn, the potential for more marine farms in Admiralty Bay focused attention on the potential impact of marine farms on feeding grounds for dusky dolphins.

Dusky dolphins work together to herd schools of fish into a tight "bait-ball" on which they prey. Sea birds, fur seals, sharks and large predatory fish can also gather once the bait-ball is formed[374]. In order to form these "bait balls" the dolphins need sufficient space to manoeuvre and herd their prey and this tends not to occur in marine farm areas, possibly because feeding bouts are disrupted when they drift into a marine farm or because space is too limited[373].

Spotted shag roosting on mussel float (DOC)

Variable oyster catcher (DOC)

In contrast, some sea bird species, particularly spotted shag and white-fronted tern, are able to benefit from mussel farm floats[232]. The floats provide safe perching sites while these birds wait for foraging opportunities nearby or beneath the mussel lines. In central parts of Pelorus Sound between Tawero Point and Forsyth Bay, king[219], spotted, little and pied shags, Caspian terns, black-backed gulls and red-billed gulls are often seen roosting on mussel floats, while variable oyster catchers regularly feed on the fauna that grow on backbones and floats.

BY-CATCH OF SEA BIRDS AND MARINE MAMMALS

Commercial and recreational set-netting occurs throughout much of the study area but is most common in the outer Sounds (apart from flounder netting in sheltered bays). By-catch of non-target species, including seabirds and marine mammals is an ongoing problem[365].

In order to protect Hector's dolphin from set net mortality a recreational and commercial set net ban was introduced on 1 October 2008 which includes the sea area from Cape Jackson south including Queen Charlotte Sound and Tory Channel. The wider set net ban includes coastal areas offshore to 4 nautical miles. Some flat fish netting is however still permitted in inner Queen Charlotte Sound and there is an exemption for commercial butterfish netting down to the Needles on the east coast. The set

Wandering albatross
(Jamie Sigmund)

net ban will have an indirect benefit for certain seabirds which are vulnerable to setnets. It is probable that the setnet restrictions will also result in an increase in the density of reef fishes that are targeted by netting (e.g. moki, tarakihi and butterfish).

Some shags species are also accidentally hooked by line-fishing from boats, particularly when stray-lining or live-baiting near the surface. Changing fishing techniques until the birds leave can avoid hooking the wrong catch. Some fishers have successfully used PVC pipes to return under-size fish which reduces fish mortality and discourages bird feeding around boats.

PREDATOR COLONISATION OF ISLANDS

All marine birds are susceptible to predation when they come onshore to breed[239,252]. The most vulnerable are small species such as diving petrel and fairy prion that now breed only on rat-free islands.

Ship rats are occasionally found on boats and can establish themselves on an island after a ship wreck or casual visit[152]. Recreational boat owners picnicking on a predator-free island have also been known to let their pet cat or dog loose, thus creating an immediate threat for the wildlife.

Organised visits to predator free islands require biosecurity checks to reduce the the risk of introducing predators, and minimise the risk of other foreign species becoming established. The remaining threat is from ship wrecks and casual or illegal visits.

Marine farms can also create opportunities for predators as rats and stoats are very able swimmers and marine farm structures may act as “stepping stones” between the mainland and islands. Rats could also be introduced from vessels servicing marine farms or from a farm’s accommodation and storage facilities.

ENVIRONMENTAL VARIABLES

The distribution of plants and animals in the study area is determined by the interplay of many factors[301,330,332,342]. These include physical variables such as geology, topography, substrate, depth, tidal currents, wave action, temperature, sedimentation, salinity and light penetration[330,332,333,334,344]. Land clearance, coastal development, fishing and aquaculture can alter the natural plant and animal patterns formed by these environmental variables. The following sections briefly discuss some of the key environmental factors that shape Marlborough's coastal marine environment.

TOPOGRAPHY AND GEOLOGY

The Marlborough Sounds, including its estuaries and numerous inlets and bays, extends from Cape Soucis at the western entrance to Croisilles Harbour, to Rarangi. With its convoluted make-up, the Sounds has a coastline of approximately 1,722 km, which is 11% of New Zealand's total length of coastline.

The landmass of the Marlborough Sounds is the remains of a submerged mountain chain extending between the North Island and South Islands that started sinking. The land is still sinking and the highest peaks are now only 1,000-1,200 metres above sea level. This process, combined with rising sea levels, has flooded the valley floors and lower hill slopes[220,221,222]. The numerous small, medium and large bays form larger areas such as Croisilles Harbour, Pelorus and Queen Charlotte Sounds, Tory Channel and Port Underwood[223].

In comparison, the south Marlborough coastline from Rarangi to Willawa Point stretches only 92 km and is relatively straight. It is dominated by long stretches of open coastline, much of it mixed sand and gravel beaches interrupted only by Cape Campbell and the occasional rock headland.

A dominant feature of Marlborough's geology are the major active faultlines that slice the region into blocks. The Wairau Fault, one of the branches of the Alpine Fault, divides Marlborough into two regions of contrasting geological structure. To the north lies the Upper Paleozoic greywacke and schist of the Richmond and Bryant Ranges and the Marlborough Sounds; to the south lie basement greywacke and argillite of Triassic to Cretaceous age with younger sediments on top[383].

The Marlborough Sounds are dominated by siliceous rocks; mainly greywacke which merges eastwards into schist[221,222]. Along the western side are bands of basic rocks (basalt and basaltic sediments, as well as serpentinitic greywacke), and ultramafic rocks that form a northern extension of the Nelson "mineral belt".

Central and outer Queen Charlotte Sound (MDC)

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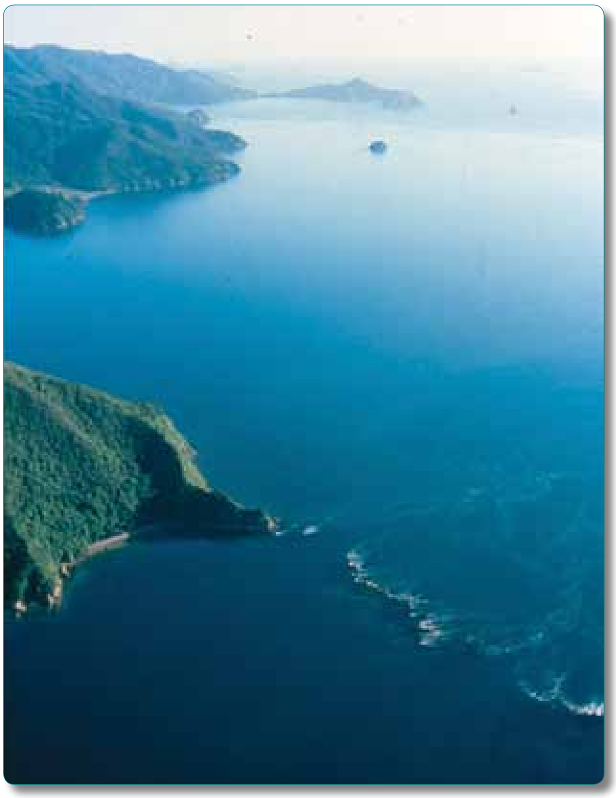
The south Marlborough coast is made up of low coastal hills interspersed with post-glacial alluvial plains, estuaries and beaches. The hills are made up of sedimentary sandstone, limestone and mudstone, post glacial loess and recent river and coastal deposits. Most freshwater flows are small and often dry up in the summer, however larger rivers such as the Wairau and Awatere provide a continual flow to the coast.

PHYSICAL PROCESSES

Tidal current, French Pass (MDC)



French Pass (DOC)

As well as the geology and topography, a number of other physical factors help create a highly diverse marine environment in Marlborough[284]. These include:

- wave exposure – sheltered inner bays and Sounds to exposed outer coasts
- sea temperature – generally colder in the east
- tidal influence – currents, tidal height and water exchange
- turbidity and sedimentation[302] – greatest within the inner Pelorus Sound, Kenepuru Sound, Port Underwood, Clifford Bay and Cloudy Bay
- salinity – lowest near the Wairau and Awatere river mouths and Havelock Estuary.

The effects of these physical factors vary dramatically in Marlborough, especially in the Sounds which separate the deep, exposed and colder waters of Cook Strait from the relatively shallow, sheltered and warmer waters of Tasman Bay.

Waves, wind and tidal currents vary greatly depending on location. The outer Sounds and east coast are exposed to the strongest winds and this, combined with larger distances, generate bigger and more powerful waves than inside the Sounds. Ocean swells are common along the east coast and through Cook Strait and they influence the outer Sounds[231]. However wave action within the sheltered confines of the Sounds is limited to a surface chop strongly affected by tidal currents.

Cook Strait has some of the strongest tidal currents in the world because the tides are out of phase on either side of the country. High tide arrives on the Pacific Ocean side of the Strait five hours before it arrives at the Tasman Sea side, so when it is high tide on one side it is nearly low tide on the other. This difference in water level drives very fast tidal currents (up to 1.4 metres per second or 3 knots) through Cook Strait. Tory Channel and French Pass have currents that can reach 2 metres per second or 4 knots. Tidal currents also occur in the vicinity of Cape Campbell. In contrast many sheltered bays inside the Marlborough Sounds have little tidal movement and it can take more than 10 days to refresh the water.

Tidal height also varies across the region, with much bigger tides in the west (up to around 4.5m in French Pass) compared to the east (up to 1.6m in Picton). This means intertidal shores are narrower in the east compared with the west.

IDENTIFICATION AND ASSESSMENT OF SIGNIFICANT SITES

This report identifies and describes the ecological values for significant sites in Marlborough's marine environment. The following steps were used to identify a list of potential significant sites.

1 Biogeographic areas (areas of similar ecology and habitats) were defined and described.[118]

2 A list important species was developed.

3 A list sites that support important species, communities or habitats was developed, based on information from a variety of sources including;

   a scientific papers and reports,

   b the Marlborough District Council biological database (notably information from resource consent applications),

   c consultation with scientists and fishers, and

   d Department of Conservation study into soft sediment biogenic habitats in the Marlborough Sounds[90].

The following criteria were used to assess the ecological value or significance of each site (see Appendix 1).

1. Representativeness – a good example of biological features.
2. Rarity – status of plants or animals and communities/habitats.
3. Diversity – a wide range of species and habitats.
4. Distinctiveness – ecological features that are unique or outstanding.
5. Size – how large the site is.
6. Connectivity – proximity to other significant areas.
7. Adjacent catchment modifications – protected native vegetation preferred.

Each criterion was individually assessed and ranked as low (L), medium (M) or high (H) for each site. Sites with one or more medium or high scores were classed as "significant" and were included in this report.

The assessment of significant sites was based on existing data or known information, but was not comprehensive because many marine areas are unsurveyed or poorly documented, especially below the low tide mark. Interpretation and use of this report must keep these limitations in mind. For example, there will be many significant sites that have yet to be discovered or recorded. Also, many marine areas ranked "L" are often not well known and it is possible that some could have been ranked higher if better information was available. Therefore it should not be assumed that areas with no identified status do not support "M" or "H" value sites. Many sites that did not achieve medium or high scores still have ecological values and should not be regarded as being of "no value".

The quality and amount of detail for each site varied. Most of the identified sites have some level of survey or study and their boundaries have been reasonably well established. A small number of sites that could not be ranked due to the lack of information have also been included because of their high potential to be significant once surveyed.

BIOGEOGRAPHIC AREAS

There are nine large scale marine biogeographic areas recognised in Marlborough. Seven cover the Marlborough Sounds and two for the east coast south of Rarangi to Willawa Point (Table 1). Although many habitats within each of the biogeographic areas are comparable, the community structure and grouping of species are usually distinct. These areas were used to assess a site's significance – for example the only site of its type in the area; the best site of its kind in the biogeographic area.

The length of the coastline was calculated using the edge of the coast defined as the highest tidal mark (extreme high water springs) and included all estuary and bay boundaries at or near the transition to terrestrial vegetation.

The hectares occupied by each biographical area were defined as the area from high tide to the regional boundary (22 km offshore).

Table 1 - Biogeographic areas from Cape Soucis (Tasman Bay) to Willawa Point (East Coast)

	Biogeographic area	Coastline (km)	Offshore area (ha)
1	Tasman Bay (west of Two Bay Point, D'Urville Island)	180 km	66,919 ha
2	Two Bay Point to Cape Jackson	360 km	277,558 ha
3	Pelorus Sound	590 km	38,477 ha
4	Queen Charlotte Sound	318 km	19,553 ha
5	Tory Channel	86 km	3,004 ha
6	Port Underwood	51 km	2,347 ha
7	Cape Jackson to Rarangi	137 km	86,576 ha
8	Rarangi to Cape Campbell	53 km	138,086 ha
9	Cape Campbell south to Willowa Point	39 km	93,117 ha
	Total	**1,814 km**	**725,637 ha**

MAP 2 - BIOGEOGRAPHIC AREAS