Our coast

Coastal water quality

Northland is known for its coastal environment, which includes 14 major harbours, many smaller estuaries and long stretches of open, sandy coastline.

The 'wild' west coast of the region is buffeted by the Tasman Sea and is dominated by several long, straight, sandy beaches, the most famous being Te Oneroa a Tohe (Ninety Mile Beach) in the Far North. Two significant harbours are also found along this coastline, the Kaipara Harbour, which is shared with the Auckland region, and the Hokianga Harbour, north of the great Waipoua Forest.

Sunset along Te Oneroa a Tohe (Ninety Mile Beach)

The east coast is bounded by the Pacific Ocean and although calmer than the west, is more rugged. This coastline is dotted with bays, headlands, estuaries and inlets and the majority of Northland's harbours are found along this coast including the Whangaroa Harbour, Bay of Islands and Whāngārei Harbour.

Numerous islands can also be found offshore of the east coast including the Cavalli Islands, the Hen and Chickens and the world famous Poor Knights Islands.

All of these sites are known for their diverse and plentiful marine life and their wildlife conservation value.

The council carries out monitoring of this coastal environment to record its current condition, the effects of human activity and to detect any changes, positive or negative, over time. Coastal water quality is monitored through a number of council state of the environment programmes. Maintaining coastal water quality at a good level is important to Northland's residents, economy and the many diverse forms of marine life that live in this environment.

What do we want for our coastal water quality?

The operative Regional Policy Statement for Northland includes community objectives for each natural and physical resource in the region. For coastal water quality the objectives are:

- The maintenance or enhancement of the water quality of natural water bodies and coastal waters in Northland to be suitable, in the long-term, and after reasonable mixing of any contaminant with the receiving environment and disregarding the effect of any natural events, for the purposes of aquatic ecosystem, contact recreation, aesthetic and cultural purposes and the gathering of shellfish for human consumption or cultural purposes.
- The reduction and minimisation of the quantities of contaminants which adversely affect water quality entering coastal waters in particular those that are potentially toxic, persistent or bio-accumulative.
- Avoid, remedy or mitigate the adverse effects of discharges of contaminants on the traditional, cultural and spiritual values of water held by tangata whenua.
- The efficient and effective control and minimisation of the impact of oil pollution in the Coastal Marine Area.

The policy statement also includes the following anticipated environmental results expected as a consequence of carrying out the policies and methods to achieve the coastal water quality objectives:

- Water quality suitable for desired purpose.
- Contaminants in water bodies are reduced.
- The adverse effects of contaminants in water bodies and coastal waters are avoided, remedied or mitigated.
- Improved aquatic habitat.

Note: the operative Regional Policy Statement is currently being reviewed. The proposed Regional Policy Statement (2013) is available at www.nrc.govt.nz/newRPS

Taiharuru Estuary with a view to the Hen and Chickens Islands

What are the issues affecting coastal water quality?

Pathogens

Water that contains high levels of pathogens (disease-causing organisms) can be harmful to human health. Swallowing water contaminated with pathogens, or being exposed to pathogenic water through cuts in the skin or inhalation of spray, can lead to skin, eye and ear infections, and stomach and respiratory illnesses.

Aquatic foods (kai moana) can also become contaminated with faecal pathogens from exposure to contaminated water. Such pathogens can stay in the flesh of shellfish long after the surrounding water quality has improved. Bacterial and viral contamination can affect both recreational and commercial shellfish gathering.

Bacteria occur naturally in the environment and elevated levels of bacteria in water can result from the re-suspension of bacteria-rich sediment during rough weather, particularly the sediment from around mangroves. Wild animals, such as seabirds, also account for bacterial contamination in some places, particularly in enclosed areas or roosting locations where their faeces can accumulate. However, bacterial contamination can also result from human activity. Livestock effluent, wastewater discharges, sewage overflows, and faulty or poorly maintained septic tank systems, can all cause bacterial contamination in the marine environment.

Nutrients

While nutrients are essential for all forms of life, nutrients that enter the environment from anthropogenic sources, such as fertiliser, stormwater from developed areas, treated wastewater, sewage overflows and failing septic systems, may exceed the needs of an ecosystem. Too much nutrient in the water can cause excessive plant growth leading to algal blooms and lowered levels of dissolved oxygen. This can reduce the life-supporting capacity of the water, and pose a significant human health risk through contact with toxic algal blooms and eating contaminated shellfish. Excessive plant growth can also look unattractive and can cause an unpleasant odour when it dies and decays.

Sediment

The erosion of soil and its transport as sediment through the freshwater system to the coastal environment is a natural process. However, deforestation for agriculture, forestry and urban development has dramatically increased sediment loads reaching the coastal environment, which can have a number of adverse environmental impacts. Increased suspended sediment concentrations in coastal waters can:

- Restrict light transmission in the water column and thus affect the amount of photosynthesis (primary production) of aquatic plants. Seaweeds and seagrass, typically require more light for photosynthesis than phytoplankton and are particularly susceptible to increased concentrations of suspended sediments as these plants are fixed to the seabed (Thrush *et al*.: 2004).
- Have negative impacts on suspension feeding animals, by clogging feeding

structures, interfering with particle selection and requiring the use of energy to clear away unwanted particles (Thrush *et al*.: 2004).

- Negatively impact the abundance and diversity of fish assemblages by clogging gills and reducing feeding efficiency.
- Discolour the water and reduce water clarity making it less suitable/attractive for recreation, for example, swimming.

Sediment can also have further adverse impacts when it is deposited on the seabed, which is discussed in the '*What is the current state of our harbours and estuaries?*' section of this report.

Sediment in a coastal stream after small-scale earthworks were undertaken without adequate sediment control

What is our coastal swimming water quality like?

Coastal water quality at a selection of the region's most popular coastal swimming sites has been monitored by the council through the Recreational Swimming Water Quality Programme since the summer of 2000.

The programme is a joint project between the council, the Northland District Health Board and the three district councils (see also 'Freshwater quality' section). Water quality is monitored for 12 to 18 weeks over the summer period (usually from the end of November until the end of March). Water samples are collected once a week from these sites and analysed for faecal indicator bacteria. In open coastal locations, levels of *Enterococci* bacteria are measured. In enclosed coastal locations where bacteria (enterococci) may be naturally occurring, levels of faecal coliforms are also measured.
The sample results are compared against the Ministry for the Environment *Microbiological*

Water Quality Guidelines (Ministry for the Environment: 2003) to determine if a site has acceptable levels of bacteria for swimming (Table 37 and Table 38).

At the end of the sampling week, each site is given a grading based on its suitability for swimming – red for 'considered unsuitable', orange for 'potentially unsuitable' and green for 'considered suitable' for swimming. These results are posted on the council website at www.nrc.govt.nz/swimming and forwarded to the health board and district councils, so that these agencies can issue public health warnings or erect warning signs.

At the end of the sampling season each site is given an overall grading based on the number of samples that were considered 'suitable' or 'unsuitable' during the season. This provides the public with an indication of how suitable a site is for swimming outside of the monitoring period.

Table 37: Single sample guidelines for open coastal sites (Ministry for the Environment: 2003)

***Enterococci* count**	**Category**	**Response**
Sample < 140 per 100 ml	Surveillance (considered suitable for swimming)	§ No response necessary – weekly sampling continues.
140 < Sample < 280 per 100 ml	Alert (considered potentially unsuitable for swimming)	§ Situation monitored and further sampling undertaken if levels remain elevated.
Sample > 280 per 100 ml	Action (considered unsuitable for swimming)	§ Follow-up samples taken within 24 hours to confirm high result. § Warning signs erected if result confirmed. § Public informed through the media that a public health risk exists. § If results remain above action threshold, site investigation undertaken.

Table 38: Single sample guidelines for enclosed coastal sites (harbours and estuaries)

Faecal coliform count	Category	Enterococci count	Category	Grade
Sample < 150 per 100 ml	Surveillance (suitable)	Sample < 140 per 100 ml	Surveillance (suitable)	Suitable + suitable = surveillance
150 < Sample < 600 per 100 ml	Alert (potentially unsuitable)	140 < Sample < 280 per 100 ml	Alert (potentially unsuitable)	Any other combination = alert
Sample > 600 per 100 ml	Action (unsuitable)	Sample > 280 per 100 ml	Action (unsuitable)	Unsuitable + unsuitable = action

For more information on the programme, or a more detailed description of monitoring methods and grading, please refer to the technical report "*Recreational Swimming Water Quality in Northland 2010-11*". Find a copy at: www.nrc.govt.nz/swimmingWQreports

Recreational Swimming Water Quality Programme

A total of 74 coastal swimming sites were monitored over the five swimming seasons (shown on Table 40). Table 40 also shows the number of samples taken from each site and the number of samples that fell outside the recommended guidelines, or rather those that were above the 'action' or 'red' threshold for each site.

Table 39 shows the coastal water compliance grading system broken down into four categories.

Table 39: Grading categories for coastal water quality

Category
95-100% samples <280/ml *Enterococci*
90-95% samples <280/ml *Enterococci*
75-90% samples <280/ml *Enterococci*
<75% samples <280/ml *Enterococci*

An overall median of the data for each site has also been calculated to give an indication of the site's general suitability for swimming – sites in bold are permanent monitoring sites. These sites remain in the programme each year to provide a benchmark against which to monitor change over time. Figure 80 shows compliance with guidelines over time for the 15 permanent coastal monitoring sites. In general, yearly compliance rates vary depending on annual rainfall and drought periods. Other sites are added or removed each season depending on demand and resources. The medians for all sites are within the "suitable for swimming" category.

Figure 79: Coastal water quality annual grading results 2007/08 – 2011/12

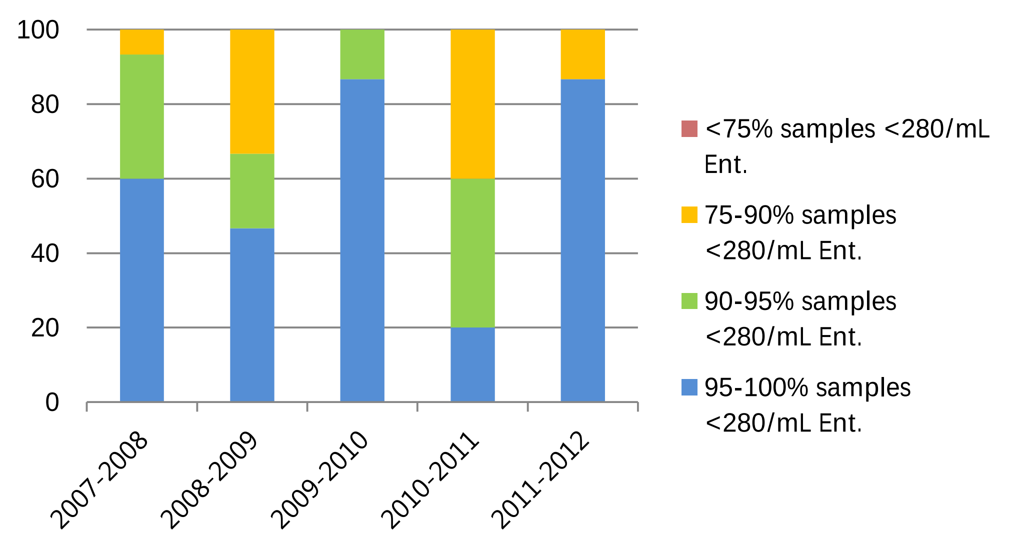


Table 40: Statistics for the coastal recreational bathing programme sites from 2007/08 to 2011/12. Sites in bold are permanent monitoring sites

Site name	Total No. of sample	Median value (Ent/100mL) compared to guidelines listed in Table 38	Percentage of samples within guidelines listed in Table 39
Ahipara at beach off Kaka Street (camp ground)	23	10	95.7
Baylys Beach at Sea View Road	33	10	100.0
Bland Bay at beach	19	10	94.7
Cable Bay at East beach	45	10	100.0
Church Bay at mid bay	64	10	95.3
Cooper's Beach at Kanekane Street east	50	10	96.0
Glinks Gully at Beach off Marine Drive	33	10	100.0
Hōreke	12	20	100.0
Intertidal beach off One Tree Point east cliffs	38	10	92.1
Kerikeri opposite boat ramp	3	10	66.7
Kerikeri Inlet at Skudders Beach	26	42	76.9
Kowharewa Bay	54	10	88.9
Langs Beach at midway along beach	71	10	98.6
Langs Beach at north end of beach	36	10	100.0
Mangawhai	25	10	96.0
Mangawhai above camp ground	33	10	97.0
Mangawhai opposite Norfolk pine	33	10	97.0
Mangawhai Harbour at Picnic Bay	24	10	95.8
Mangawhai Harbour at pontoon	11	10	90.9
Mangawhai Heads at motor camp foreshore	23	10	95.7

Site name	Total No. of sample	Median value (Ent/100mL) compared to guidelines listed in Table 38	Percentage of samples within guidelines listed in Table 39
Mangawhai Heads at open coast	48	10	97.9
Matai Bay at South end beach below toilet block	28	10	100.0
Matapōuri Bay at beach	17	5	100.0
Matapōuri at 1st bridge	53	42	88.7
Matapōuri at 2nd bridge	53	20	88.7
Matauri Bay at right of campground	25	10	100.0
McLeod Bay by toilet	56	10	94.6
Ngunguru at boat ramp	13	10	100.0
Ngunguru at motor camp	64	10	98.4
Ngunguru at Norfolk pine	55	10	100.0
Ngunguru Estuary at school	61	20	82.0
Oakura Bay at beach, north end of bay	54	10	98.1
Ocean beach at centre of beach	46	10	100.0
Ohawini Bay at Parutahi beach, Whangaruru	48	10	89.6
Omamari Beach at beach by stream	35	10	97.1
Ōmāpere at Pioneer Walk Road	52	10	98.1
Onerahi opposite play boat	64	10	96.9
Opononi at Hokianga Harbour below hotel	53	10	96.2
Ōpua Foreshore at shop end of beach	45	20	77.8
Pacific Bay at Beach	63	10	90.5
Pahi 150m NW of jetty	47	10	95.7
Pahi at broken rocky groyne	47	10	100.0
Paihia below road junction	13	10	84.6
Paihia in front of toilets	52	10	94.2
Paihia at Te Haumi River	30	10	93.3
Paihia at Waitangi Bridge (beach)	50	10	88.0
Pataua South at east beach	68	10	97.1
Pataua South at footbridge	51	10	96.1
Pataua South at Frog Town	32	10	96.9
Rarawa at Beach Road campground	8	10	100.0
Rāwene at past ramp	50	10	98.0
Ruakaka Beach at near surf club	72	10	98.6
Ruakaka River below motor camp	61	10	95.1
Russell at Mid North Moorings	27	10	92.6
Sandy Bay at centre of beach	41	10	97.6
Shipwreck Bay off beach at end of Wreck Bay Road	21	10	100.0
Taipa estuary at beside motor camp	52	10	96.2
Taupō Bay at beach off Taupō Bay Road	8	10	100.0

Site name	Total No. of sample	Median value (Ent/100mL) compared to guidelines listed in Table 38	Percentage of samples within guidelines listed in Table 39
Tauranga Bay at end of Tauranga Beach Road	7	10	100.0
Taurikura Bay	65	10	90.8
Te Haumi River	25	10	84.0
Teal Bay at Beach	53	10	94.3
Tinopai at foreshore below Puapua Creek	55	10	90.9
Tinopai at below shops	59	10	100.0
Tokerau Beach at Melissa Road	30	10	93.3
Uretiti Beach at Tip Road	42	10	100.0
Urquharts Bay at beach	54	10	92.6
Waipapa Kauri at West Coast Road motor camp	31	10	100.0
Waipu Cove at beach	60	10	98.3
Wellington Bay at beach in front of northern car park	39	10	94.9
Whakapirau	25	10	100.0
Whananaki at east beach	55	10	89.1
Whananaki at footbridge above school	48	25.5	85.4
Woolleys Bay at centre of beach	49	10	100.0

***Note: Sites in bold are permanent monitoring sites**

Figure 80: Coastal bathing sites monitored between 2007/08 and 2011/12, and how their faecal indicator bacteria levels compare with the swimming/contact recreation guidelines

What is the current state of our harbours and estuaries?

Northland's estuaries are important economic, social and cultural assets, with estuarine systems such as the Whāngārei Harbour and the Bay of Islands contributing significantly to Northland's economy and the environment. Estuaries are particularly valued because they are very productive ecosystems that play important roles in the functioning of coastal environments.

However, because estuaries and harbours are located at the end of the freshwater drainage system, they are particularly vulnerable to land-based activities and processes that occur within their catchments. In addition, because of the chemical reactions that take place when freshwater mixes with saltwater, fine sediments flocculate (mix and form solid lumps or masses) and these heavier particles then settle out of the water column. Significantly, terrestrial sediments differ from marine sediments in terms of their physical (grain size) and biogeochemical (microbial composition, nitrogen and phosphorus content) properties and may have contaminants such as heavy metals and polycyclic aromatic hydrocarbons (PAHs) attached or adsorbed. Estuarine environments are therefore depositional areas and often become the ultimate sink for contaminants that start in the catchment; that is, estuaries end up as the dumping ground for any contaminants in the waterways.

In Northland, extensive clearance of natural vegetation cover for agriculture, forestry and urban development has increased the amount of sediment, nutrient and metal contaminant loads that reach our estuarine environments. Significant areas of saltmarsh and mangrove forest, which can act as natural filters for sediments and other contaminants, have also been drained and cleared for agriculture, urban development and infrastructure projects.

Estuary Monitoring Programme

The Northland Regional Council has implemented an estuarine monitoring programme in order to:

- Assess the health of our estuaries and monitor change over time.
- Identify impacts from diffuse inputs and cumulative impacts of contaminants from human activity and development.
- Assess the effectiveness of Northland's regional plans and rules and enable informed decision-making by politicians and resource managers.
- Inform the public and promote awareness of environmental issues impacting estuarine health.

A key element of the programme involves sampling the biological communities of representative intertidal habitats together with the physical (sediment particle size) and chemical properties (nutrient and metal contaminants) of the sediment, which is the habitat for the animals. This should help us to understand the environmental factors that are influencing the biological communities at different sites.

The council has established four estuary monitoring sites in the Whāngārei Harbour, three sites in the Kerikeri Inlet and two sites in each of the Ruakaka Estuary, Kaipara Harbour and Whangaroa Harbour. By December 2011 we had collected three years of baseline data at each site, which will be used to monitor the health of the biological communities over time and relate any changes to the quality of their habitat.

The latest sampling results can be viewed at www.nrc.govt.nz/amr and a full analysis of all results can be viewed in the technical report for each estuary at www.nrc.govt.nz/coastalresearch

Harbour water quality monitoring

The council currently conducts routine monitoring of harbour water quality in the Whāngārei Harbour, the Bay of Islands and the Kaipara Harbour. The council has also conducted short-term monitoring of water quality in the Hokianga Harbour and the Whangaroa Harbour.

Whāngārei Harbour water quality

The council monitors water quality at 16 sites in the Whāngārei Harbour every two months (Figure 81). Twelve chemical and physical water quality parameters are measured, including dissolved oxygen, water clarity, temperature, salinity, faecal bacteria and nutrients. Of the 16 sites monitored, eight have been monitored for more than 10 years, one site for five years and seven sites for three years.

Faecal indicator bacteria results were usually within relevant guidelines for swimming/contact recreation (Table 38) between 2007 and 2011. Seventy-five percent of faecal coliforms were within the Regional Coastal Plan standards, and 89% of Enterococci were within Ministry for the Environment (MfE) guidelines. The highest concentrations were generally found in samples collected from Onerahi to the Town Basin. The results suggest that water quality in the Whāngārei Harbour downstream of Onerahi is normally of a standard that is suitable for swimming and other recreational activities. However, between Onerahi and the Town Basin levels of bacteria were not generally of a standard that is suitable for swimming and recreational activities.

Turbidity levels were also normally within the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (Figure 82). Turbidity is a measure of the degree to which water loses its transparency, due to the presence of suspended particles. When there are lots of suspended particles in the water the murkier it appears and the higher the turbidity. Turbidity can be influenced by water discharges, algae in the water and sediments from erosion and urban runoff.

Interestingly, the highest median turbidity values were recorded in the Mangapai River. The Mangapai River has a relatively small catchment and the majority of the land use is exotic grassland for dairy and dry stock. As expected, the lowest turbidity was generally recorded towards the mouth of the harbour as these sites are furthest from the main freshwater inputs. Overall the results indicate that turbidity was usually within levels required to support healthy aquatic habitat.

Figure 81: Whāngārei Harbour water quality monitoring sites

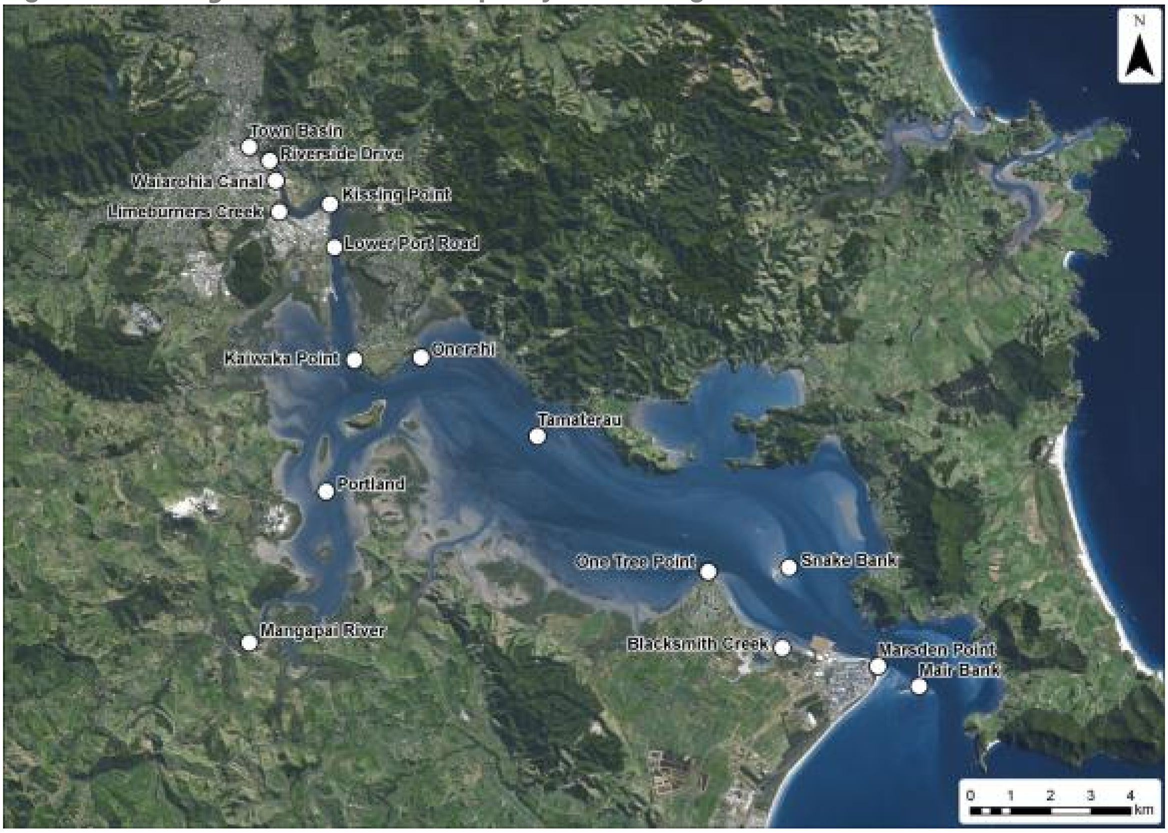
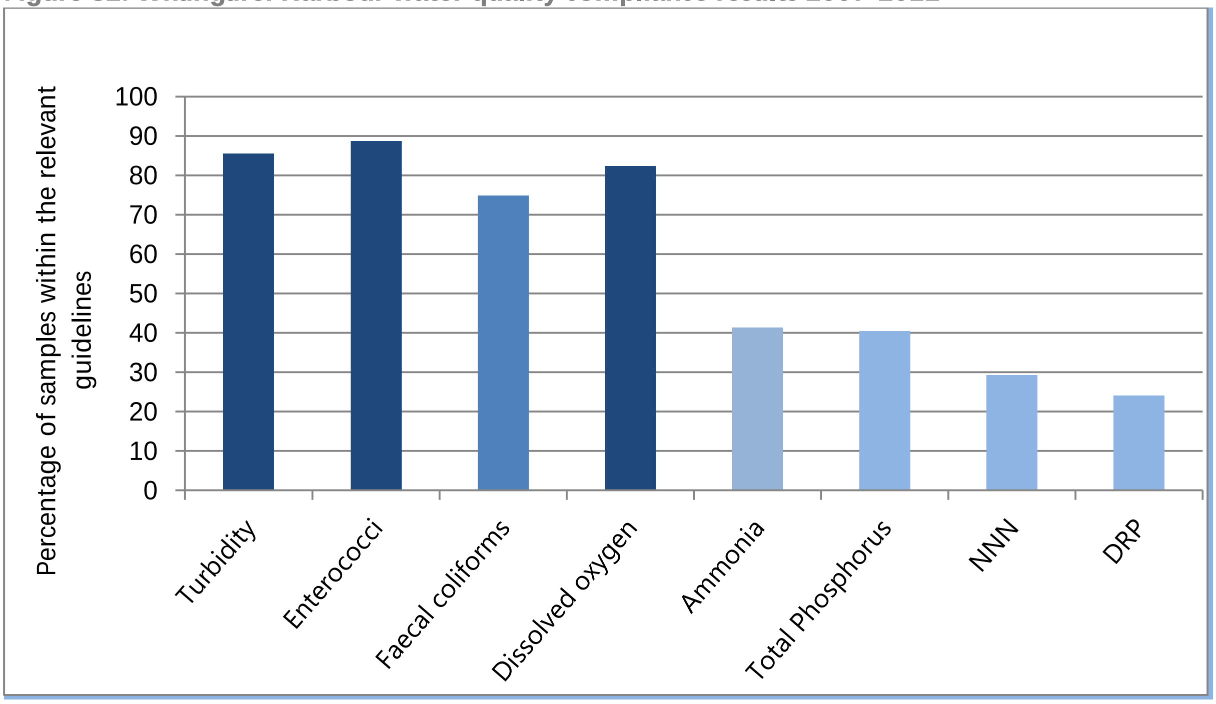


Figure 82: Whāngārei Harbour water quality compliance results 2007-2011



Water quality data collected in the harbour between 2000 and 2010 was analysed to see if there were any trends. The analysis found that there was a decrease in faecal coliforms at Kaiwaka Point and a decrease in enterococci bacteria at Tamaterau, which are positive trends. Enterococci increased at both Marsden Point and One Tree Point, which are negative trends.

Ammonia decreased at two sites and total phosphorus decreased at one site, both positive trends. Dissolved oxygen increased at two sites and water clarity increased at three sites, which are also positive trends, but turbidity increased at two sites – a negative trend.

It should be noted that there is limited data available for trend analysis of some parameters including nutrients, because these parameters have only been monitored for three years, so the results presented here need to be treated with caution.

Table 41: Statistically significant trends in water quality data for the Whāngārei Harbour 2000 – 2010

Site name	Parameter	Trend
Town Basin	Dissolved oxygen	Increasing (positive)
Riverside Drive	Turbidity	Increasing (negative)
Limeburners Creek	Dissolved oxygen	Increasing (positive)
Kissing Point	Water clarity	Increasing (positive)
Kaiwaka Point	Faecal coliforms	Decreasing (positive)
Onerahi	Turbidity	Increasing (negative)
Mangapai River	Ammonium (NH_4)	Decreasing (positive)
Tamaterau	Enterococci	Decreasing (positive)
One Tree Point	Enterococci	Increasing (negative)
	Ammonium	Decreasing (positive)
	Total phosphorus	Decreasing (positive)
Marsden Point	Enterococci	Increasing (negative)
	Water clarity	Increasing (positive)
Mair Bank	Water clarity	Increasing (positive)

For more information on water quality results and trends for the Whāngārei Harbour, please refer to the technical report entitled, "*State of the Environment Water Quality in the Whāngārei Harbour 2000-2010*", which is available online at www.nrc.govt.nz/coastalresearch

Bay of Islands water quality

The council monitors water quality at 16 sites in the Bay of Islands Harbour every two months (Figure 83). Twelve chemical and physical water quality parameters are measured. All sites have been monitored since May 2008.

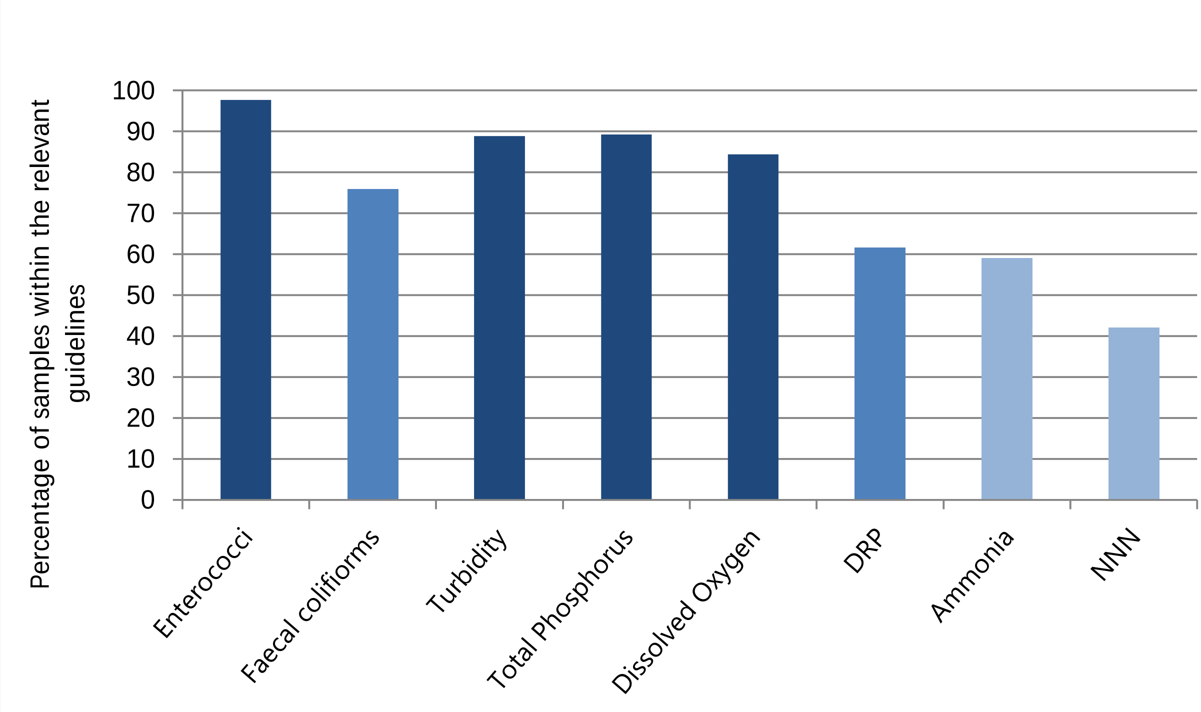
Figure 83: Bay of Islands Harbour water quality monitoring sites

Between 2008 and 2011, faecal indicator bacteria results were usually within the relevant guidelines for swimming/contact recreation Figure 84). Ninety-three percent of faecal coliforms were within the Regional Coastal Plan standards, and 98% of Enterococci were within MfE guidelines. These results suggest that levels of faecal bacteria in the Bay of Islands were normally of a standard that are suitable for swimming and recreational activities. The highest median concentrations of enterococci were recorded at the Waipapa River, Kerikeri River and Kawakawa.

Turbidity levels were also mainly within ANZECC guidelines (Figure 84). The highest median levels of turbidity were recorded at the Waikare Inlet, the Kawakawa River and at Tapu Point. All these sites are located close to the outlet of the Kawakwa River, the river being a major freshwater input to the Bay. Freshwater flows often carry particles and contaminants off the land and out to sea, particularly after rainfall. Overall the results indicate that turbidity was usually within guideline levels.

Nutrient concentrations frequently exceeded the ANZECC guidelines in the Bay of Islands (Figure 84). Fifty-eight percent of samples exceeded the guidelines for nitrate-nitrite nitrogen while 41% and 38% of samples exceeded guideline values for ammonia and dissolved reactive phosphorus respectively. Overall the results indicate that nutrients were at levels that had the potential to have adverse biological effects. Not unexpectedly, the highest concentrations of nutrients were generally recorded at sites located close to freshwater inputs.

Figure 84: Bay of Islands Harbour water quality compliance results 2008-2011



There is limited data available for trend analysis, because the monitoring programme has only been carried out for three years, so the results presented here need to be treated with caution. The trend analysis found that there have been deceases in concentrations of dissolved reactive phosphorus, ammonia and faecal coliforms at several sites throughout the Bay (Table 42) which are all positive trends. An increase in turbidity at Doves Bay was also found, which is a negative trend.

Table 42: Statistically significant trends in water quality data for the Bay of Islands 2008 –2011

Site name	Parameter	Trend
Paihia south-east headland	Dissolved reactive Phosphorus	Decreasing (positive)
Te Haumi River	Faecal coliforms	Decreasing (positive)
Waitangi River	Dissolved reactive Phosphorus	Decreasing (positive)
Waipapa River	Faecal coliforms	Decreasing (positive)
Kerikeri River	Ammonia	Decreasing (positive)
Wainui Island	Dissolved reactive Phosphorus	Decreasing (positive)
Paihia	Dissolved reactive Phosphorus	Decreasing (positive)
Tapu Point	Dissolved reactive Phosphorus	Decreasing (positive)
Ōpua Basin	Dissolved reactive Phosphorus	Decreasing (positive)
Waikare Inlet	Dissolved reactive	Decreasing (positive)

	Phosphorus	
Waikare Inlet	Ammonia	Decreasing (positive)
Doves Bay Marina	Turbidity	Increasing (negative)
Te Puna Inlet	Dissolved reactive Phosphorus	Decreasing (positive)
Paihia north-west headland	Dissolved reactive Phosphorus	Decreasing (positive)

Kaipara Harbour water quality

In 2009, the council implemented a monitoring programme in the Kaipara Harbour in conjunction with Auckland Council. In Northland, nine sites (Figure 85) are monitored each month for a range of parameters including faecal indicator-bacteria (enteroccoci) and nutrients (DRP, NH_4, NNN and TP). A further seven sites are monitored by the Auckland Council.

Figure 85: Kaipara Harbour water quality monitoring sites 2009-2011

Between 2009 and 2011 faecal indicator bacteria results were usually within MfE guidelines for swimming/contact recreation (Figure 86). Only three samples collected from Wahiwaka Creek and one sample from Burgess Island exceeded the guideline values out of a total of 288 samples collected during the three years of monitoring. These results suggest that levels of faecal indicator bacteria in the Kaipara Harbour were normally suitable for swimming and recreational activities. The highest concentrations of enterococci were normally recorded at the site in Wahiwaka Creek. The site at Wahiwaka Creek is located near the head of the Ōtamatea Channel and receives freshwater input from the Wairau and

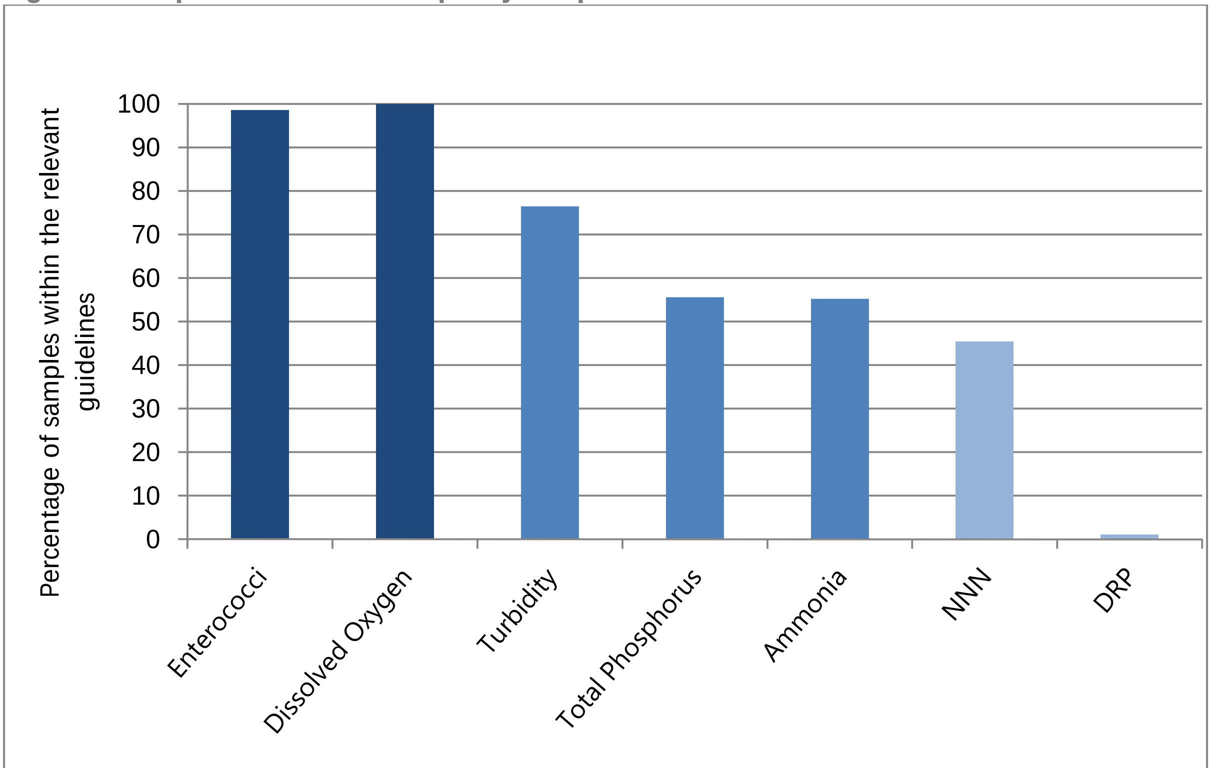
Kaiwaka Rivers. The catchments for these rivers both have a high proportion of pasture for dairy farming and the Maungaturoto and Kaiwaka wastewater treatment plants also discharge into these rivers.

Turbidity levels were normally within ANZECC guidelines (Figure 86). The highest median turbidity values were recorded at Wahiwaka Creek, Burgess Island, Kapua Point, and Hargreaves Basin, which are all located close to freshwater inputs. In contrast, the lowest median turbidity was recorded at the Ōtamatea Channel, which had the highest salinity, indicating that there is little freshwater influence at this site. Overall the results indicate that turbidity was usually within levels that are unlikely to have biological effects.

Nutrient concentrations frequently exceeded the ANZECC guidelines in the Kaipara Harbour. Ninety-nine percent of samples exceeded the Australia and New Zealand conservation council guidelines for dissolved reactive phosphorus, 44% exceeded the guidelines for ammonia and 55% of exceeded guidelines for nitrate-nitrite nitrogen, (Figure 86). These results suggest that nutrient concentrations in the Kaipara Harbour normally exceeded levels that had the potential to have biological effects.

The highest nutrient concentrations were generally recorded at sites located in the upper reaches of the different arms of the harbour while the lowest concentrations were found at the sites in the Five Fathom Channel and the Ōtamatea Channel.

Figure 86: Kaipara Harbour water quality compliance results 2009-2011



There is limited data available for trend analysis, because the monitoring programme has only been carried out since 2009 and so the results presented here need to be treated with caution. The trend analysis found that there has been a decrease in the concentration of dissolved reactive phosphorus at Five Fathom Channel, which is a positive trend but an increase in turbidity at Wahiwaka Creek, which is a negative trend (Table 43).

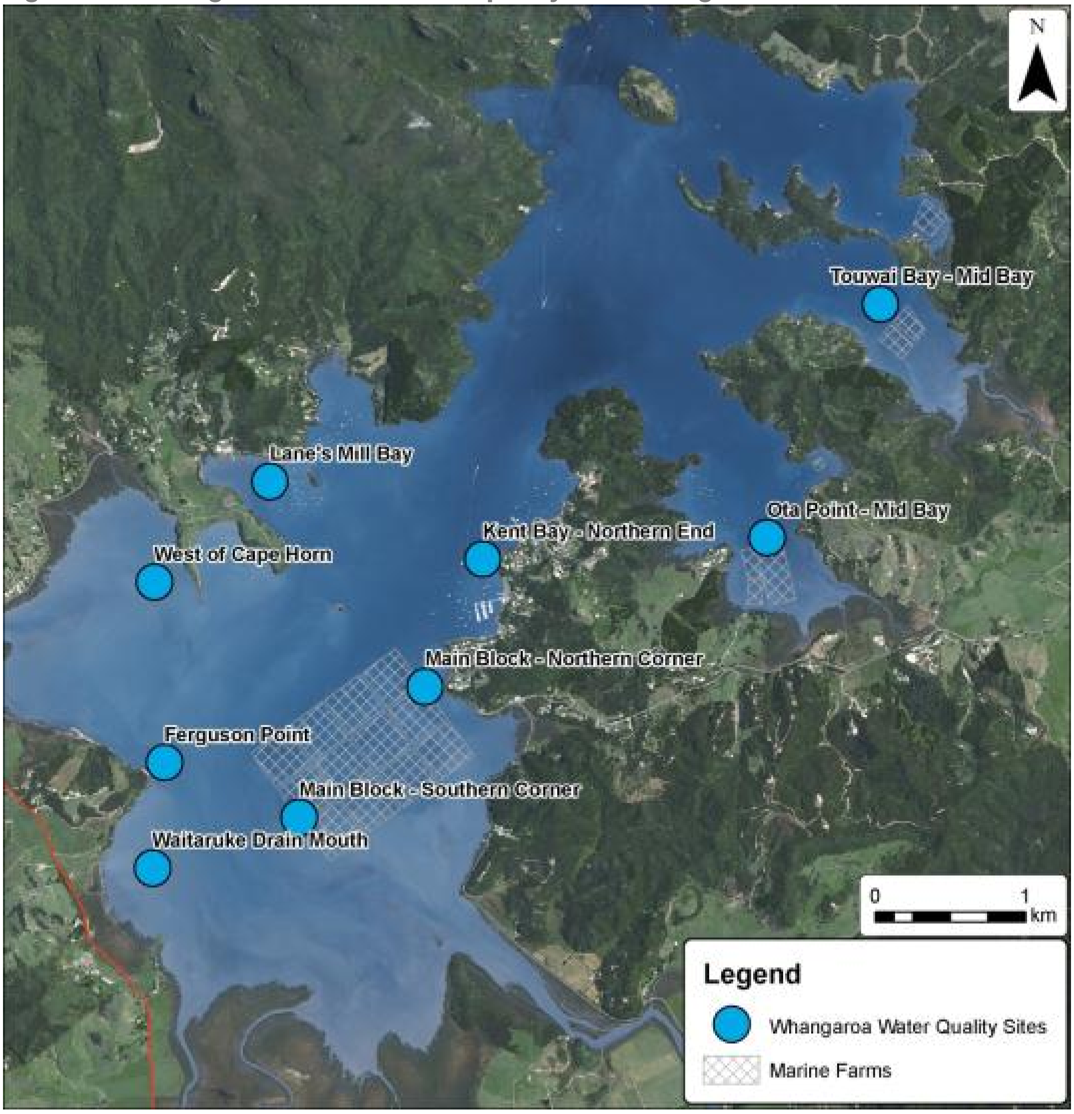
Table 43: Significant trends in water quality data for the Kaipara Harbour 2009-2011

Site name	Parameter	Trend
Five Fathom Channel	Dissolved reactive Phosphorus	Decreasing (positive)
Wahiwaka Creek	Turbidity	Increasing (negative)

Whangaroa Harbour water quality

The council conducted an investigation into the sources of faecal contamination in the Whangaroa Harbour between 2003 and 2011. Bacterial contamination was threatening the operating classification of the harbour for commercial growing of oysters and the council, in consultation with a number of stakeholders, initiated this investigation programme. The programme involved sampling 10 sites within the harbour and nine sites from the contributing streams (Figure 87) for turbidity and faecal indicator bacteria (total coliforms, faecal coliforms, and *E. coli*). The overall results from the contributing streams will be reported in 2013.

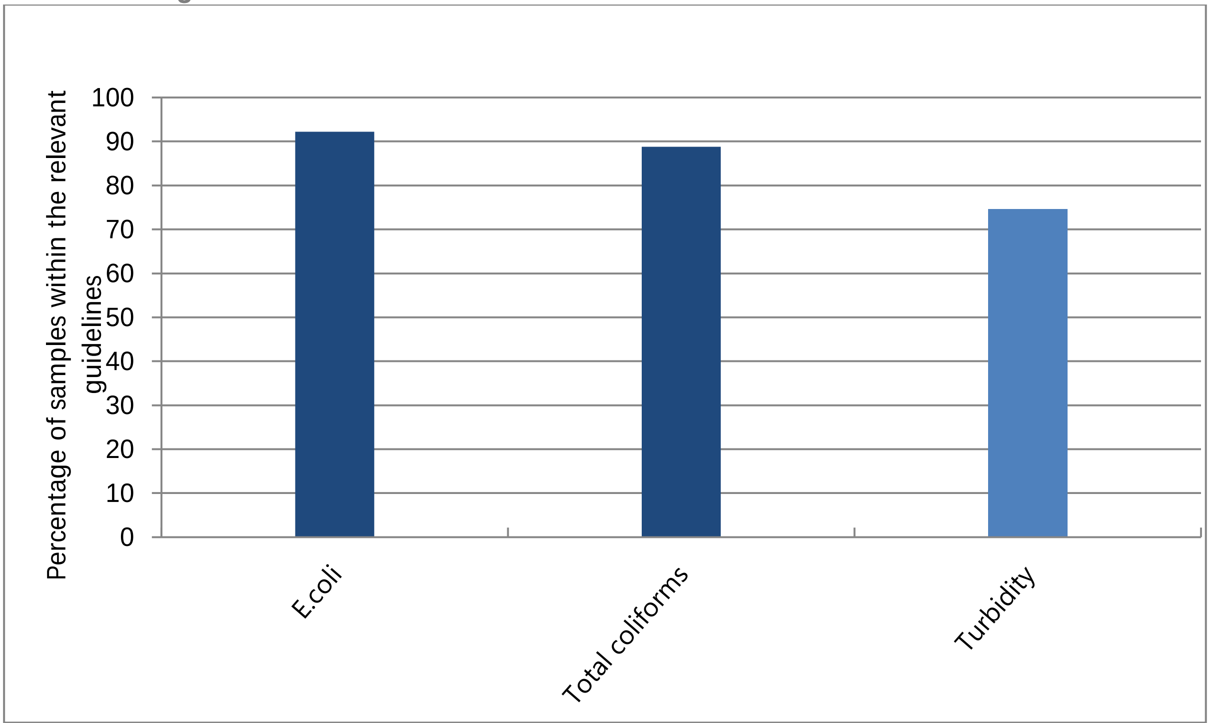
Figure 87: Whangaroa Harbour water quality monitoring sites



The results from 2007-2010 showed that faecal contamination was generally low, with a high percentage of samples below the MfE guidelines values for swimming/contact recreation (Figure 88). Results for specific sampling events following rainfall were elevated due to runoff from land but this is expected and the oyster industry does not harvest following significant rainfall.

The turbidity results showed that inner harbour sites generally had higher turbidity than sites in the outer harbour, and exceeded the ANZECC guidelines on far more occasions. The sites at Waitaruke Drain Mouth and west of Cape Horn frequently exceeded the turbidity guidelines. These two sites appear to be affected by high turbidity from contributing streams, upstream of the sites.

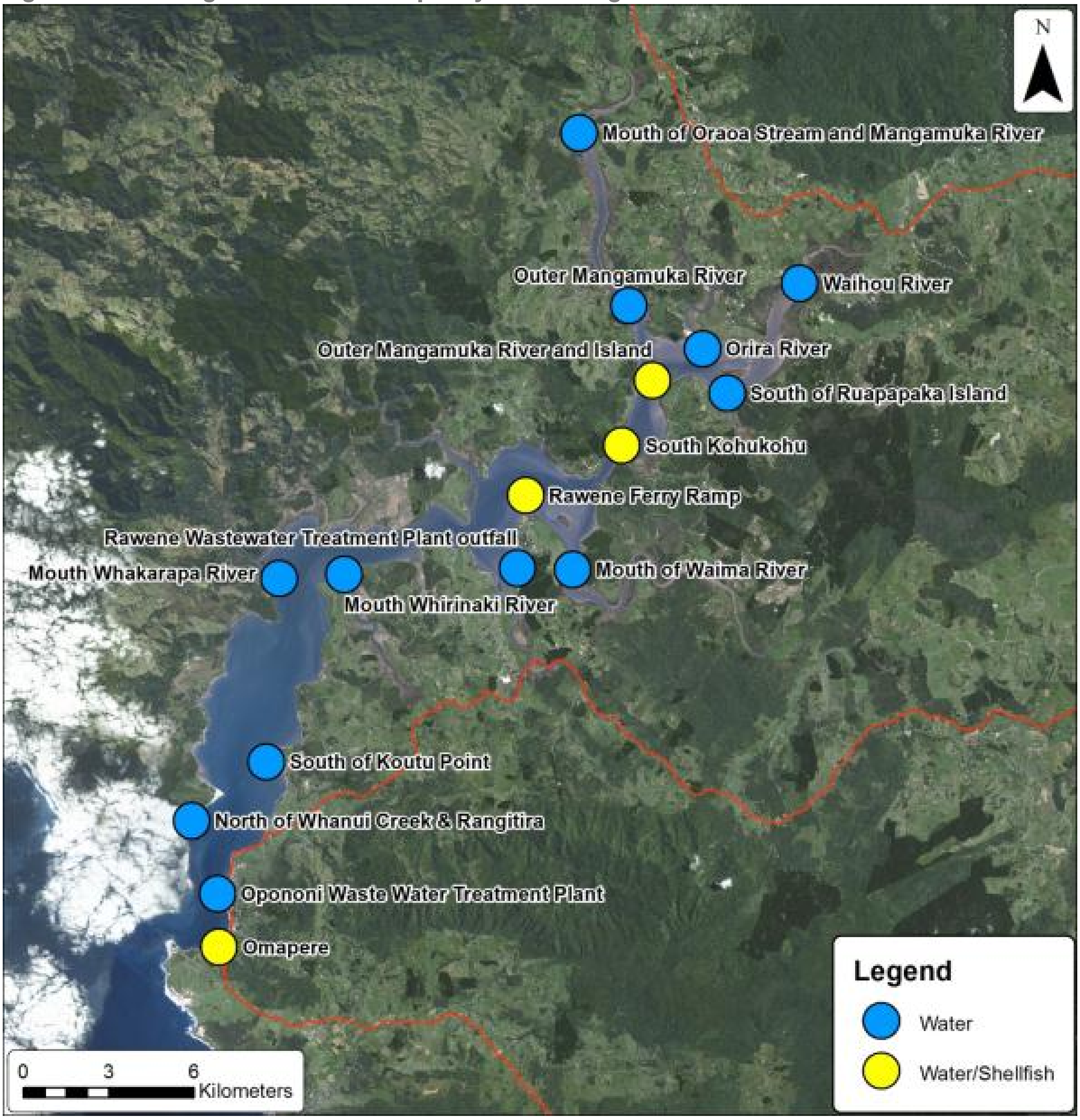
Figure 88: Comparison of faecal indicator bacteria and turbidity levels in Whangaroa Harbour with relevant guidelines 2007-2010



Hokianga Harbour water quality

The council conducted a monitoring programme in the Hokianga Harbour between June 2009 and June 2010. Sixteen sites (Figure 89) were monitored each month for faecal indicator bacteria (*E. coli*, enterococci and faecal coliforms) and nutrients (total nitrogen and total phosphorus). Shellfish were also collected at four of these sites and the shellfish flesh analysed for *E. coli* levels.

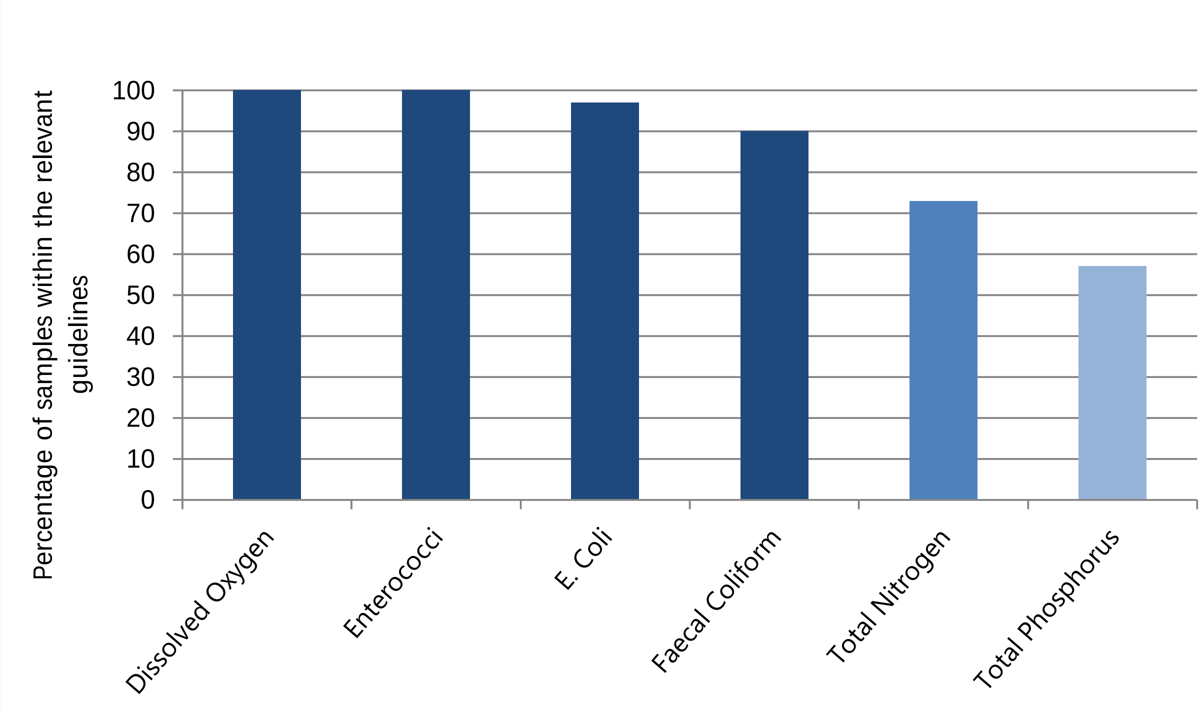
Figure 89: Hokianga Harbour water quality monitoring sites



The water sample results showed that the levels of faecal indicator bacteria were usually within the MfE guidelines for swimming/contact recreation (Figure 90).

The water sample results showed that 73% of total nitrogen concentrations and 57% of total phosphorus were within ANZECC guidelines. The highest concentrations of nutrients were recorded in the upper harbour, upstream of Rāwene, with low concentrations found near the harbour entrance.

Figure 90: Hokianga Harbour water quality compliance results 2009-2010



Results from the shellfish flesh did not meet the relevant commercial guidelines (New Zealand Food Safety Authority Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice 2006) at all four sites tested. The guidelines state that the *E. coli* median Most Probable Number (MPN) of the shellfish samples must not exceed 230 *E. coli* per 100g and that not more than 10% of the samples must exceed a MPN of 700 per 100g.

Although medians were below 230 *E. coli* /100ml at all four sites, approximately 23-30% of individual samples exceeded the guideline value of 700 *E. coli* per 100g (Table 44).

Table 44: *E. coli* levels in shellfish flesh collected from the Hokianga Harbour between 2009 and 2010

Site		Median	% of individual samples exceeding NZFSA guideline
109685	Outer Mangamuka River and island	42.5	30.00
109686	South Kohukohu	61.5	23.33
109687	Rāwene Ferry Ramp	80.5	23.33
109692	Ōmāpere	78	24.44
NZFSA Guideline (E. Coli/100g W/W)		230	<10

Investigating sources of contamination

In 2009, a review of the council's water quality data at the commercial oyster growing areas of Kerikeri Inlet and Whangaroa was undertaken and found that some sites were not meeting the water quality standards for the collection of shellfish. Results of water and shellfish sampling undertaken by Northland District Health Board in the Houhora Harbour also showed that concentrations of faecal coliform bacteria were occasionally above the guidelines in 2008-2009.

In response to these results, the council and the health board agreed that there were unacceptably high levels of bacteria indictors in these three estuaries and undertook microbial source tracking to determine the potential sources of *E. coli* in coastal waters and shellfish.

The results summarised in Table 45, indicated that the sources of contamination were generally ruminant (herbivore) and wildfowl.

The full technical report, identifying the sources of faecal contamination in coastal waters and shellfish in Northland's waters in 2010, can be viewed at: www.nrc.govt.nz/coastalresearch

Table 45: Results from faecal source tracking work undertaken in the Houhora and Whangaroa Harbours and the Kerikeri Inlet

Site	Water	Sediment
Kerikeri Inlet	Ruminant	Wildfowl and herbivore
Houhora Harbour	No result	Wildfowl and herbivore
Whangaroa Harbour	Ruminant	Wildfowl

Harbour sediment monitoring

Metals in Sediment Programme

Sediment in Whāngārei Harbour

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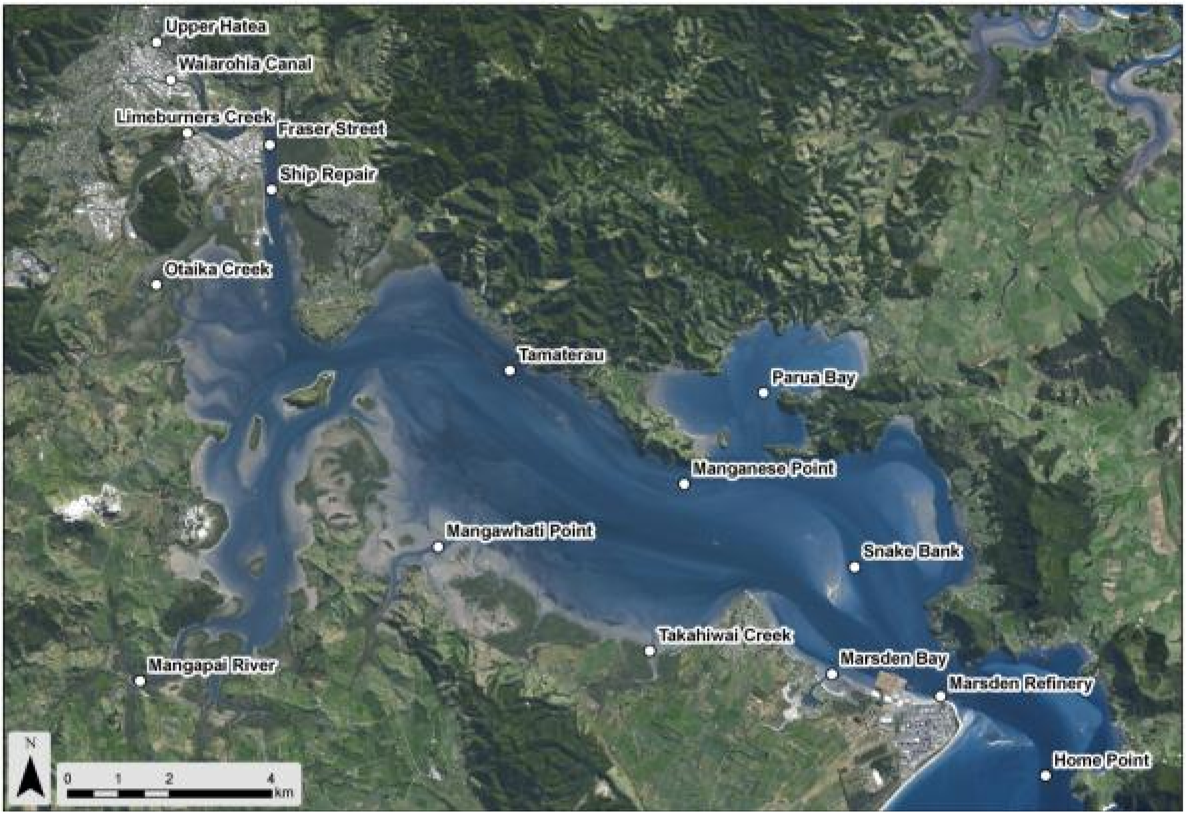
The council monitors metal concentrations and the physical characteristics of sediments every two years, at 16 sub-tidal sites in Whāngārei Harbour (Figure 91). This programme was established in June 2010, although the council had previously monitored the levels of metal contamination in harbour sediments. Sediment samples are analysed for sediment grain size and concentrations of total cadmium, total chromium, total copper, total lead, and total zinc. Concentrations of metal contaminants were compared against the ANZECC guidelines for those metals.

Figure 91: Location of sediment sampling sites in Whāngārei Harbour



Whāngārei Harbour sediment

Heavy metals in sediment

In 2010-2011, all metal concentrations in sediments measured in the Whāngārei Harbour were within guideline levels at all sites, except for the concentration of zinc in the Waiarohia Canal. Sediments collected from sites located in tidal creek environments like the Hātea River and the Otaika Creek, generally had higher proportions of mud and metal concentrations than sites in the main body of the harbour.

This pattern is consistent with these sites being located close to potential sources of contaminants in depositional mud-dominated tidal creek environments.

Sediment accumulation rates

In response to growing concern about sedimentation rates in our estuaries, the council developed a programme to investigate historical sedimentation rates and sources of sedimentation in the Whāngārei Harbour, Kaipara Harbour, and the Bay of Islands. Sediment plates have also been installed to determine current sedimentation rates at our estuary monitoring sites in Kerikeri Inlet, Kaipara Harbour, Whangaroa Harbour and

Ruakaka Estuary.

Installation of a concrete sediment plate in Kerikeri Inlet

In 2011, the council partnered with Northport to investigate sediment accumulation rates in Whāngārei Harbour. The first stage of the project involved the use of the Whāngārei hydrodynamic model to investigate the dispersion and deposition of fine sediment in the harbour from the Hātea River, Otaika Creek and Mangapai River.

Three different flow scenarios were used to investigate the dispersion and deposition of sediment under baseline conditions, a one-year rainfall event and a 10-year rainfall event, using the council's river flow data. The modelling suggested that a large proportion of fine sediment ends up being deposited on intertidal flats in the upper harbour near to these three freshwater sources. The model output also indicates that some sediment is deposited on intertidal flats in Parua Bay and Munro Bay on the northern shore of the harbour, which are relatively remote from any freshwater inputs.

The next stage of the project involved the collection of sediment cores at twelve sites, using a gravity corer to determine sediment accumulation rates for the harbour. These cores will be dated using radioisotopes in order to calculate the accumulation rates over the last 50-150 years.

Gravity corer being deployed to collect sediment cores

Sediment samples have also been collected from the harbour and from different soils in the surrounding land catchment in order to determine the sources of sediment deposited in the harbour using NIWA's compound specific stable isotope method. This sediment source sampling will provide detailed information on which land uses and sub-catchments are contributing sediment to the harbour.

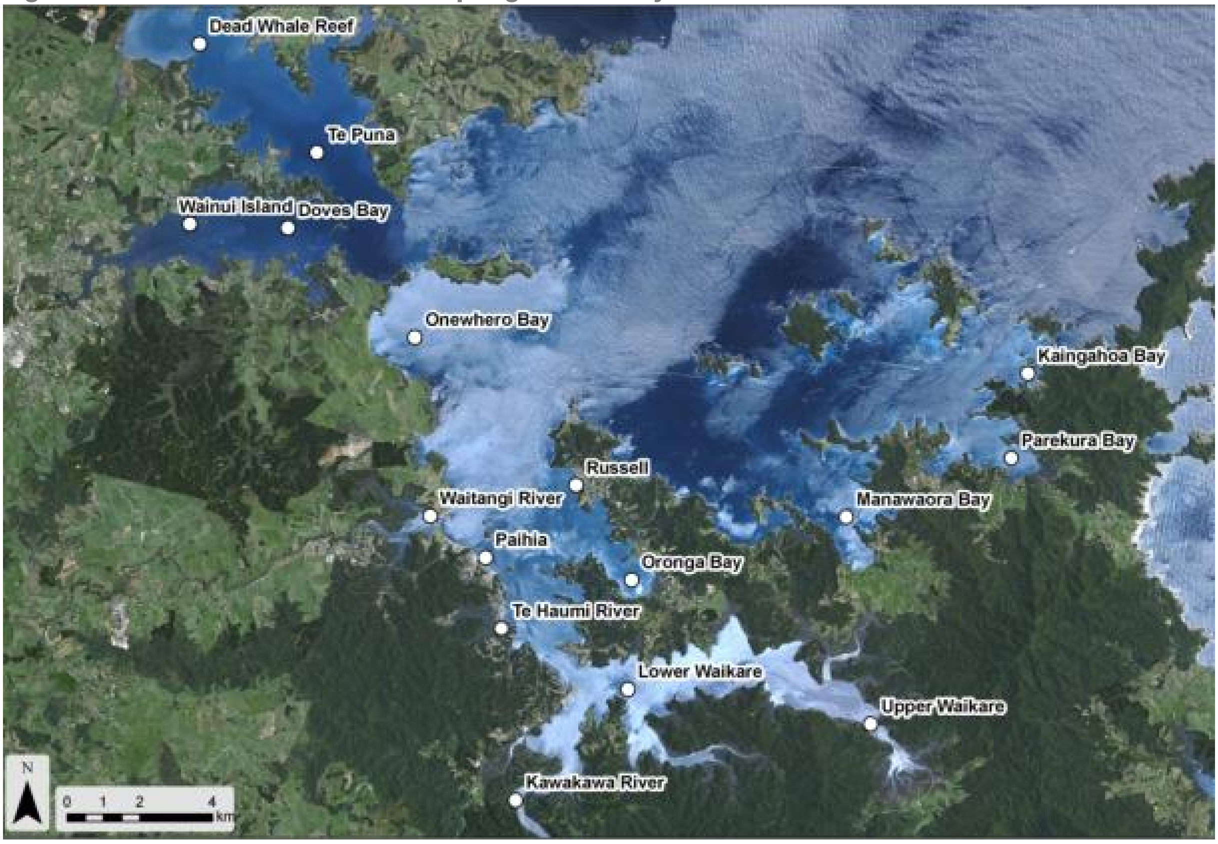
The council also conducted ecological sampling at 39 sites throughout the harbour and this data will be analysed, together with results from the sediment dating, to determine which ecological communities are sensitive and vulnerable to sediment deposition. A full report for this project will be available in mid-2013.

Bay of Islands sediment

In 2010, the council started monitoring the metal concentrations and the physical characteristics of sediments every two years, at 16 sub-tidal sites in the Bay of Islands (Figure 92).

Sediment samples are analysed for sediment grain size and concentrations of total cadmium, total chromium, total copper, total lead, and total zinc. Concentrations of metal contaminants are compared against the ANZECC guidelines for those metals.

Figure 92: Location of sediment sampling sites in Bay of Islands in 2010



Metals in sediment

The metal concentrations measured in sediments collected from the Bay of Islands were all within ANZECC guideline levels. Sediments collected from tidal creeks, such as Kerikeri Inlet, Kawakawa River and the Waikare Inlet generally had higher proportions of mud and metal concentrations, while lower proportions of mud and metal concentrations were recorded in more exposed locations, in the outer Bay, such as Onewhero Bay.

Sediment accumulation rates

In 2011, the council commissioned NIWA to undertake a full analysis and interpretation of sediment and ecological data sets collected as part of the Land Information New Zealand

(LINZ) Oceans 20/20 Bay of Islands survey. This included analysis of 23 sediment cores collected from the Bay of Islands, to determine the sediment accumulation rates and the sources of sediment to the bay. Analysis of ecological data from 25 intertidal and 72 subtidal sites was also undertaken to determine the sensitivity and vulnerability of the ecological communities at each site, to sedimentation.

Radiocarbon dating of shells buried within the sediment cores indicated that accumulation rates have averaged 0.23 ± 0.1mm/year over the last ≤9400 years. The sediment accumulation rate data indicates that on average 23,000 tonnes of sediment per year were deposited in the Bay prior to the mid-1800s. In contrast, over the last approximately 150 years, sedimentation rates have averaged 2.4 mm/year with an average of 509,000 ± 210,000 tonnes of sediment deposited in the Bay of Islands each year. This 22-fold increase in annual sedimentation suggests that a major shift in the sedimentary regime of the Bay of Islands system has occurred as a result of increased soil erosion, following the arrival of people and large-scale catchment deforestation over the last approximately 700 years.

Within the Bay, mud is accumulating more rapidly in the Waikare Inlet, areas around the Veronica Channel and Te Rāwhiti than in the central Bay, Kerikeri Inlet and the Te Puna Inlet.

Analysis of present day sediment sources, using the compound specific stable isotope method indicated that pasture is responsible for more than 60% of the sediment entering the Bay of Islands from all the major rivers, except the Waikare, which is dominated by native forest and kanuka scrub. The main sources of sediment to the Bay therefore appear to be consistent with the current land uses in these catchments although the relationship was not one to one. For example, there was a lack of material linked to citrus orchards and mature pine forests, which suggests that there is little soil erosion from these land uses. In contrast, there was a relatively large contribution of sediment from recently clear-felled pine forestry in delta sediments from the Te Puna and Kawakawa inlets. Recently cleared pine forest leaves the soil vulnerable to erosion for up to six years until replanting and canopy closure has occurred.

Past sources of sediment deposited in the Bay over the last several thousand years was also determined at five sites using radioisotope dating and stable isotope analysis of fatty acids. At Russell, for example, pre-Polynesian sediment deposits were composed of soils derived from native forest soils and bracken but by the 1850s the soil signatures for potatoes and dry stock pasture were detected. The signature for dairying pasture was detected from the 1870s and in the late 1940s soils derived from citrus orchards appeared in the sediment deposits.

The vulnerability of ecological communities was determined by examining the sensitivity of any dominant habitat-forming species and the most abundant species to sediment deposition. The analysis revealed that all areas of the Bay of Islands had some intertidal sites with sensitive communities, while the most sensitive subtidal communities were found mainly in the outer Bay of Islands and Te Rāwhiti.

The analysis also indicated that the sediment accumulation rates were an important predictor of the ecological community structure although only a small amount of the variability in the communities was explained by this. As the sediment accumulation rates provided some predictive ability for the ecological data, the rates were used along with the site vulnerability information to determine the sensitivity of each site. This revealed that the most sensitive sites were generally found in Te Rāwhiti although a sensitive intertidal and subtidal site was found in the area around the Veronica Channel.

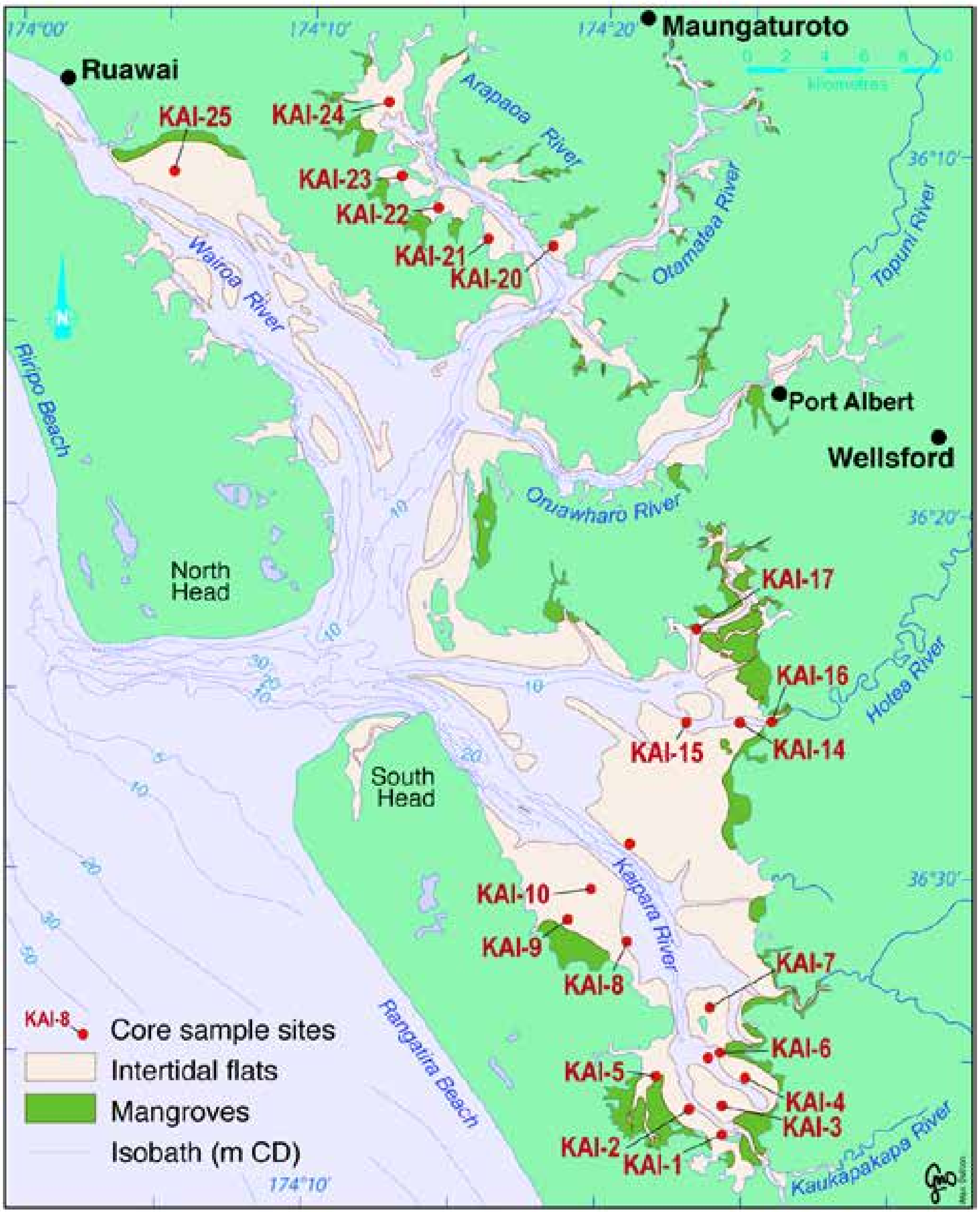
The technical report can be viewed at www.nrc.govt.nz/coastalresearch

Kaipara Harbour sediment

Sediment accumulation rates

In 2009, Northland Regional Council partnered with Auckland Council and NIWA to investigate historical sediment accumulation in the Kaipara Harbour. The project involved the collection and analysis of sediment cores to reconstruct the sedimentation history of the harbour and identify the sources of catchment sediment that have accumulated over the last century.

Figure 93: Location of core sites in Kaipara Harbour 2010



Sediment cores up to 1.7m long were collected at 18 sites throughout the harbour (Figure 93) using a gravity corer deployed from NIWA's research vessel the Rangitahi III.

Analysis indicated that during the last 50-100 years the average sediment accumulation rate for the Kaipara Harbour was 6.7mm per year, although if data from two outlier cores is excluded, the average is 4mm per year. In either case, the average sediment accumulation rate in the Kaipara Harbour is in the upper range of average values measured in North Island estuaries and coastal marine environments. It is likely that most sediment is delivered to the Kaipara Harbour by episodic floods, when mud laden stormwater discharges into the harbour and some cores contained excellent examples of flood deposits, composed of pure layers of mud up to 60mm thick.

Further work to determine the sources of sediment is currently being undertaken by NIWA and initial results indicate that the Wairoa River is the major source of sediment deposited in the northern Kaipara and that sediment from this river is also deposited in the southern Kaipara Harbour.

The technical report can be viewed at www.nrc.govt.nz/kaiparasediment

What is being done?

Land management

The way that land is managed can impact upon coastal water quality in a number of ways; sediment, nutrient runoff and leaching and contamination with faecal material all contribute to a decline in water quality.

The council uses a number of different approaches to assist landowners and community groups to put in place practices that improve water quality.

- The council's environment fund can help with the cost of fencing stock out of on-farm waterways and the Coastal Marine Area. The fund will cover up to 50% of the cost of qualifying projects. These projects assist in the reduction of sediment, nutrients and faecal contamination.
- The council's environment fund can also provide poplars and willows to help stabilise erosion prone sites in order to reduce the amount of sediment entering waterways.

Council staff offer advice and promote good land management practices to landowners. This is frequently done in conjunction with community groups focussed on water quality and may take the form of running farm workshops on flagship sites, provision of water quality improvement plans to landowners or providing technical support.

On-going monitoring

Long-term monitoring programmes provide valuable information about how environmental conditions at different sites change over time. The larger the data set, the more confidence we can have in any trends identified in the data.

Any trends that are identified can then be analysed in relation to weather data or changes in human activity and land-use in the surrounding catchment. This can help us to identify what is causing the change, positive or negative, and whether or not we can do anything about it. The on-going monitoring therefore helps to tell us if the methods and rules in the Regional Policy Statement and regional plans are effective.

Resource consents

As well as state of the environment monitoring, the council also monitors resource consents, such as discharges to coastal waters including municipal wastewater and stormwater discharges, or when investigating environmental incidents. By monitoring these, the council can assess the effect of specific activities on water quality of the receiving environment and take appropriate action if any undesirable effects are identified.

Faecal source tracking

Five coastal recreational swimming water sites identified as having water quality occasionally unsuitable for swimming have been investigated by the council in order to identify the source of bacterial contamination at these sites. Faecal source tracking work has been undertaken on samples collected from these sites to identify which animal/s the faecal contamination has come from.

Results from this work to date have shown that, out of five coastal sites investigated, four are contaminated with bird faecal matter, one with human and two with herbivore (for example, cows, sheep, etc.) faecal matter.

Once this information has been collected, the council can take action to reduce contamination at these sites, for example, by encouraging landowners to fence livestock out of water bodies or by working with people to fix their septic tank systems. However, in the case of wild animal contamination, little can be done other than erecting permanent warning signs to inform the public about the source of the contamination and the health risks of swimming at these sites.

How are we measuring up against our objectives?

The following are anticipated environmental results listed in the operative Regional Policy Statement:

Water quality suitable for desired purpose

- Only Whāngārei Harbour and the Bay of Islands have been designated for desired purpose. In Whāngārei Harbour, the water quality in areas classified for contact recreation was unsuitable for the desired purpose at some sites according to the council's monitoring results. In areas classified as General Quality Standard (a more stringent standard than contact recreation) concentrations of faecal coliforms and dissolved oxygen were at levels that were suitable for the desired purpose according to council monitoring. However, the concentrations of dissolved reactive phosphorus and ammonia were not at levels suitable for the desired purpose.

- In the Bay of Islands, the water quality in areas classified for contact recreation was suitable for the desired purpose. In areas classified for General Quality Standard the concentrations of dissolved oxygen and dissolved reactive phosphorus were at levels that were suitable for the desired purpose. However, the concentrations of faecal coliforms and ammonia were not at levels suitable for the desired purpose.

Contaminants in water bodies reduced

- Analysis of water quality data collected from the Bay of Islands between 2008 and 2011 found that faecal coliforms and ammonia decreased at two sites and that dissolved reactive phosphorus decreased at seven sites. An increase in turbidity at Doves Bay was the only negative trend. However, it should be noted that there is limited data available for trend analysis, because the monitoring programme has only been in place for three years, so the results presented earlier in this section need to be treated with caution.
- In Whāngārei Harbour, trend analysis found decreasing trends for ammonia and faecal indicator bacteria at two sites and a decrease in total phosphorus at one site. Negative trends for bacteria and turbidity were found at two sites. However, it should be noted that there is limited data available for trend analysis of some parameters including nutrients, because these parameters have only been monitored for three years, so the results presented earlier in this section need to be treated with caution.

The adverse effects of contaminants in water bodies and coastal waters be avoided, remedied or mitigated

- Consented discharges to the coastal marine environment have consent conditions relating to effluent quality and all consented discharges are monitored for compliance with their consent conditions.
- In Northland a lot of contaminants enter water bodies and coastal waters from diffuse sources rather than point source discharges. Such diffuse sources of contaminants including runoff from urban land and forestry are much harder to monitor and manage.
- The council works with landowners and community groups to reduce contaminants from diffuse sources by encouraging fencing and restoration of wetlands, fencing stock out of waterways and the coastal marine area, developing plans to stabilise erosion prone land and by helping farmers develop farm plans.
- The Proposed Regional Policy Statement for Northland directs the council to amend its regional plans so that they better manage diffuse source contaminations. Amendments include enhanced controls on access of livestock to the beds and margins of water bodies and requirements for the use of good management practices in primary production activities.

Improved aquatic habitat

- Stock access to and use of the coastal marine area can impact on the health and water quality of our harbours, estuaries and coastline. Animals below the tide line browse estuarine plants, crush shellfish, and drop their dung and urine in areas where fish breed and people collect seafood.
- As at 1 July 2009, under the rules of the Regional Coastal Plan for Northland, access to and use of the coastal marine area by stock became a prohibited activity in areas where stock have access to the area. Landowners are now required to put in place some form of fencing or other barrier to keep stock out of the coast.
- The Northland Regional Council, through its Environment Fund, has provided financial assistance to landowners to fence their property to protect the coastal marine area from stock. In the 2011-2012 year, $32,800 of funding was allocated to landowners and was used to assist with the cost of fencing 14km of coast. These projects may be funded at between 33% and 50% of the total cost of fencing, depending on the ecological values present.

Marine biodiversity and biosecurity

What do we want for our marine ecosystems?

The operative Regional Policy Statement for Northland states the following objectives relating to marine biodiversity and biosecurity:

- Maintenance of the biodiversity of the Northland region.
- Protection of the life-supporting capacity of ecosystems through avoiding, remedying or mitigating (in that order of priority) the adverse effects of activities, substances and introduced species on the functioning of natural ecosystems.
- Protection of areas of significant indigenous vegetation and the significant habitats of indigenous fauna.

The policy statement also includes the following anticipated environmental results that are expected as a result of the implementation of the policies and methods, to achieve the marine biodiversity and biosecurity objectives:

- An increase in the areas of significant indigenous vegetation and the significant habitats of indigenous fauna which are formally protected.
- No significant increase in the number of threatened species in the region.

Note: the operative Regional Policy Statement is currently being reviewed. The proposed Regional Policy Statement (2013) is available at www.nrc.govt.nz/newRPS

What is the state of our marine biodiversity?

Northland has 3025 kilometres of coastline, including 14 major harbours, many smaller estuaries, rocky shoreline and long stretches of open, sandy coastline. Coastal habitats include mangrove forests, saltmarsh, seagrass beds, intertidal sand and mud flats, rocky reef, kelp forests and sub-tidal soft bottom sediment. Northland's coastal waters contain the highest diversity of fish and invertebrates of any region in mainland New Zealand, and contain marine ecosystems of national and regional importance. Northland also has two marine reserves around the Poor Knights Islands and in Whāngārei Harbour and a marine protected area at Mimiwhangata. The marine reserve surrounding the Poor Knights Islands extends for 800m offshore and covers an area of approximately 1980ha. The Whāngārei Harbour Marine Reserve is approximately 254ha and has two sites at Waikaraka and around Motukaroro/Passage Island at Reotahi. The Mimiwhangata Marine Park covers 2000 hectares and includes the Rimariki islands.

Poor Knights Islands, one of Northland's marine reserves featuring world-renowned marine habitat

We still have much to learn about the diversity of Northland's marine flora and fauna because of the size, complexity and inaccessibility of the coastal environment. However, the following projects have helped to increase our knowledge and understanding:

- The Department of Conservation has compiled a marine habitat map for the Northland section of the Northeast Marine Bioregion, which covers an area of 1.34 million hectares of coastal habitat from Ahipara to Mangawhai. This document can be viewed online at www.nrc.govt.nz/Northlandmarinehabitats
- The council has complemented mapping key indigenous marine vegetation, including saltmarsh and mangroves in the Kaipara Harbour, the Bay of Islands and Whāngārei Harbour, using high resolution aerial images. These habitat features can be viewed at http://apps.egl.co.nz/Viewer.html?Viewer=NRC-Public
- The council secured Envirolink funding to undertake a survey of the present and historic extent of seagrass in the Bay of Islands and to identify factors that may have contributed to the decline in seagrass. The project also included a recommendation to protect the remaining seagrass and rehabilitate denuded areas. The project report can be viewed online at www.nrc.govt.nz/BOIseagrass
- The council has implemented an estuary monitoring programme in five Northland

estuaries, which involves sampling benthic invertebrates at representative intertidal sites. Between 2008 and 2011 the council identified over 30,000 organisms belonging to more than 120 different taxa including animals like cockles, pipis, crabs and worms from thirteen estuary monitoring sites. More details about this programme are provided in the previous section and technical reports are available on our website: www.nrc.govt.nz/coastalresearch

- The council also participated in the Bay of Islands Oceans 20/20 coastal survey. The project collected data on seabed habitats and biodiversity in the Bay of Islands and extensive areas outside the Bay, extending south to Mimiwhangata and north to Spirits Bay. The datasets collected include:

  - bacterial biomass and activity
  - benthic and attached algae
  - meiofauna, macro-fauna and epifauna
  - benthic and demersal fish rocky reef assemblages
  - sediment accumulation rates (coring, forensics, sources and analysis)
  - physical oceanography data (tidal and wind driven changes in sea level, salinity measures to determine the timing of freshwater inputs, variability of Bay of Island currents)
  - water quality data (for example, chlorophyll a, salinity, oxygen, metals, pollutants, suspended sediment, etc.)
  - observational data (wildlife such as seabirds, cetaceans, cartilaginous (for example, white sharks), breeding colonies, marine mammal sightings or aggregation areas, biogenic reefs etc.).

Data collected as part of the project is available via the Ocean Survey 20/20 web portal: www.os2020.org.nz

What are the issues affecting marine biodiversity in Northland?

Sediment affecting the Ngunguru Inlet after a storm

Northland's marine environment is used by a range of activities, including fisheries, tourism, recreation and commercial shipping and aquaculture, all of which may have effects on marine biodiversity. A major pressure is runoff and discharges of contaminants from land, particularly sediments and nutrients. Sources include agriculture and forestry activities, and the direct discharge of contaminants from municipal wastewater plants, stormwater systems and industrial sites.

Increased sediment inputs can have a number of impacts on biodiversity. Sediment can restrict light transmission in the water column, which consequently affects primary production. Sediment also smoothers marine plants and animals, and clogs the feeding structures of suspension-feeding animals and the gills of fish.

Increased inputs of nutrients may initially stimulate marine ecosystems because there is an increase in food via additional plant material and organic detritus. However, as primary production increases, the water column and seabed can become starved of oxygen and animals may die or migrate from the affected area. The ecosystem may then become less diverse as it is recolonised by a smaller number of opportunist species tolerant of low oxygen conditions.

Other contaminants such as metals and polycyclic aromatic hydrocarbons can have lethal and sub-lethal effects on marine organisms. In contaminated environments the diversity and species richness may decrease as the community becomes dominated by a smaller number of more tolerant species, which are able to survive and reproduce in these conditions.

The drainage of saltmarsh and reclamation of the coastal environment is another issue for marine biodiversity. Large areas of Northland's saltmarsh, mangrove and intertidal mud flat habitat have historically been reclaimed for agriculture, urban and infrastructure developments.

The proliferation of coastal structures, and in particular hard coastal protection such as rock revetments and seawalls, is a further threat for the remaining intertidal habitat such as saltmarsh. Much of the remaining saltmarsh habitat is now trapped by a fixed landward boundary such as a seawall and rising sea level and expansion of mangrove habitat.
Another issue affecting marine diversity is stock access to the coast. Stock with access to the coast can trample and browse estuarine plants, crush shellfish, and drop their excrement and urine in areas where fish breed and people collect seafood. From 1 July 2009, under the rules of the Regional Coastal Plan for Northland, access to and use of the coastal marine area by stock became a prohibited activity and landowners are now required to place some form of fencing or barrier to prevent their stock from accessing this area.

Stock with access to the coastal marine area

Northland Regional Council, through its environment fund, has provided financial assistance to landowners to fence their property, to protect the coastal marine area from stock. In the 2011-2012 year, $32,800 of funding was allocated to landowners and was used to assist with the cost of fencing 14km of coast. These projects may be funded at between 33% and 50% of the total cost of fencing, depending on the ecological values present.

Marine pest plants and animals

Northland's marine environment is under increasing risk from a variety of non-indigenous marine species that have either established in the region, are present elsewhere in New Zealand, or which may be introduced to Northland, and New Zealand by international shipping.

Many marine species that arrive in New Zealand waters don't survive. Of those that do survive, many do not cause damage. However, the species that survive and become pests generally share common traits, and can cause significant damage. They are usually fast growing, breed prolifically and have a mobile life stage. Most are robust, can survive a range of environmental conditions, and have no natural predators or environmental control agents. These pests are often competitive, and can displace native plants and animals. Others can alter underwater habitats and change the way that ecosystems function. The impact of marine pests is wide-ranging and arguably greater than land-based pests. These invaders can affect our regional economy, recreational and cultural activities and our natural environment.

Marine pests are much harder to detect than pests on land, and they often arrive in larval form.

There are currently limited tools available for control, which makes these pests difficult to eliminate.

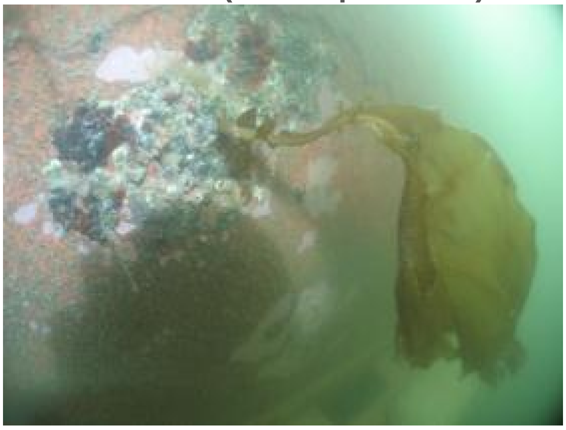
What marine pests are present in Northland?

Over the past 200 years, more than 300 non-indigenous marine species have established populations in New Zealand, and of these approximately 130 have been recorded in Northland (Woods: 2011). The majority of these species, although non-indigenous, are not considered pests and have minimal impacts. However, there are a number of marine pests already present in Northland that have the potential to cause significant impacts:

Mediterranean fanworm (*Sabella spallanzanii*)

The Mediterranean fanworm is a suspension feeding marine bristle worm that is typically found in estuaries or sheltered sites, at depths of anywhere between one to 30m. It consists of a tube, up to 40cm tall, which is always anchored to a hard surface, topped with a single spiral fan. These fanworms can form dense groups that can affect native species by competing for food and space and limit the recruitment of other species. Its ability to produce more than 50,000 eggs per spawning period enables it to form high densities (Currie et al: 2000). Mediterranean fanworm are likely to impact commercially important species, such as mussels and oysters. In February 2012, Mediterranean fanworm were detected and subsequently removed from several commercial vessels moored in Whāngārei Harbour.

Undaria seaweed (Undaria pinnatifida)



(©: Northland Underwater Technical Services)

Undaria seaweed is a highly invasive and opportunistic seaweed which spreads mainly by fouling on boat hulls. Undaria is not known to be established in Northland, but is present in many harbours and ports around New Zealand. Undaria can form dense stands under water which may lead to the exclusion or displacement of native plant and animal species, and can change the structure of ecosystems, especially in areas where native seaweeds are absent. In February 2012, small numbers of undaria plants were detected on several commercial vessels moored in Whāngārei Harbour.

Sea squirts (Ascidians)

Sea squirts are among the most common fouling animals in ports and harbours. They settle and grow in great abundance on a range of man-made substrates such as wharf piles, seawalls, ship hulls and aquaculture structures. Their ability to reproduce, grow and settle quickly can be disastrous for the aquaculture industry.

There are already several invasive sea squirts present in parts of Northland.

Styela sea squirt (*Styela clava*)

(©: MAF Biosecurity NZ)

Styela is a large stalked solitary club shaped sea squirt which sticks to hard substrates. Styela are frequently transported as biofouling on vessels and other mobile marine structures. Styela poses a threat to biodiversity values through its smothering behaviour and can disrupt native ecosystems. Styela is established in Northland at Marsden Cove Marina in Whāngārei, and Ōpua and Russell in the Bay of Islands.

Eudistoma sea squirt (*Eudistoma elongatum*)

Eudistoma is a colonial sea squirt which forms clusters of white tubes containing many small individuals. It prefers muddy bottomed tidal areas and attaches to man-made structures such as wharf piles and aquaculture equipment. Eudistoma is more prolific in the summer months where it appears in large volumes. Rainfall during the winter months, resulting in freshwater in the tidal zone, tends to knock the population back, but it regrows quickly in the summer. Eudistoma is found in the Bay of Islands, Houhora, Pārengarenga and Whāngārei harbours.

Didemnum sea squirt (*Didemnum vexillum*)

(©: MAF Biosecurity NZ)

Didemnum is a colonial sea squirt which looks like dripping candle wax over mussel lines or channel markers. The species is able to populate via a free swimming tailed larvae stage or asexually through a process of budding. Typically the species occupies hard surfaces such as wharf structures, ship hulls, floats, pilings, moorings, ropes, rock outcrops and gravel seabeds. The organism chokes off bottom dwellers and can cover ground required by fish to lay eggs. This species is present in Whāngārei Harbour.

Pyura sea squirt (*Pyura praeputialis*)

Pyura is a sessile sea squirt which settles on rocky shores between the mid to low tide mark. Individual pyura form dense colonies which create a mat over rocks and green lipped mussels. Pyura have also been observed in muddy estuaries in and around oysters. Populations have been found in the Far North including an oyster farm in Pārengarenga Harbour. They are not known to be established anywhere else in New Zealand.

Little is currently known about the long-term risks posed by this species to Northland however localised impacts on green lipped mussel beds have been observed and if left to spread, it is possible this species could affect traditional kaimoana harvesting over large areas.

Pyura sea squirt

Spartina

Spartina on the edge of an estuary

Spartina is a salt-tolerant marine grass growing up to 1.5m high, and is one of the only plants that can grow in the intertidal areas of estuaries. It spreads mainly by underground rhizomes, bits of which break off when exposed by erosion on tidal stream banks. The main species in Northland, *Spartina alterniflora*, does not flower or produce viable seed. Spartina forms dense mats, taking over coastal marine areas and leading to a loss of habitat for birds, recreational fisheries and seafood. The mats trap sediments and can severely modify the marine mud flat ecosystem, and restrict access to estuarine areas.

Spartina was introduced to the North Island and Northland in the early 1950s and was actively promoted to protect stopbanks, as stock forage, and in combination with drainage, aid in the conversion of tidal mud flats to farmland. As a consequence the plant was established in most of Northland's harbours and some estuaries.

What are the issues with marine biosecurity?

Marine pest species arrive in New Zealand primarily through international shipping, as hull fouling or in ballast water. Ballast water is seawater used in ships to assist with stability, steerage, safety and fuel efficiency. The ship usually takes water on in one port, carries it to another, and discharges it when cargo is loaded. Ballast water may contain plants and animals found in the water around the ship. Some of these species are able to survive in the ballast water until it is discharged in the new port and may become established there. The seaweed undaria was probably brought to New Zealand in the ballast water of ships from Asia.

New Zealand now has rules controlling the discharge of international ballast water. Ballast water loaded in another country's waters must not be discharged inside New Zealand territorial waters without permission (Biosecurity NZ: 2005). Permission is generally only granted when the ship has exchanged its ballast water with mid-ocean water, as this water is much less likely to introduce pest species that can survive in shallow, coastal waters. However, there are currently no rules controlling domestic ballast water or bilge water discharge, which could contribute to the spread of pests between New Zealand ports.

Hull fouling is now recognised as the primary mechanism for the introduction of marine pests. In a recent survey of 500 international vessels arriving in New Zealand, non-indigenous species were recorded on almost 60% of vessels, with over 30% having some non-indigenous species that were not known to be established in New Zealand (Inglis et al.: 2010). The Ministry for Primary Industries is currently working toward implementing an Import Health Standard to address the biosecurity risks to New Zealand's marine environments associated with international vessel biofouling.

In Northland, the majority of international shipping visits, both commercial and recreational, occur in the Bay of Islands and Whāngārei Harbour. Northland is a popular destination for international recreational vessels with over 5000 vessels arriving in Ōpua since 1998. Approximately 73% of all international recreational vessels visiting New Zealand use the Bay of Islands or Whāngārei Harbour as the port of entry to the country. Domestic vessel traffic provides a secondary pathway for marine pests to arrive in Northland from other New Zealand locations, and for range extensions to occur for pests already present in Northland (Woods et al: 2011).

International and local shipping are potential pathways for marine pest incursions – approximately 73% of all international recreational vessels visiting New Zealand use the Bay of Islands or Whāngārei Harbour as the port of entry to the country.

Marine aquaculture can also be an important vector for the domestic spread of non-indigenous species. Regular movements of aquaculture equipment and stock represent an incursion risk – pest species could easily be moved into and around Northland, or from Northland to other regions. Although there are some guidelines in use by parts of the aquaculture industry these are currently voluntary.

Marine aquaculture is a potential vector for the spread of marine invasive species in our waters

What is being done?

Regional responsibilities

The Pest Management National Plan of Action aims to make it easier for everyone involved in pest management in New Zealand to act collectively in New Zealand's best interests (MAF Biosecurity: 2011). The plan provides much needed clarity about roles and responsibilities in marine pest management. The Ministry for Primary Industries is responsible for pre-border and border management, and takes the lead in any national incursion responses. The ministry works to prevent the establishment of new pests in New Zealand.

Once a marine pest has established in New Zealand, regional councils are responsible for marine pest management within regions. Some other agencies also have pest management functions and responsibilities. The National Plan of Action emphasises that effective action requires co-operation and partnerships. Given the limited range of control tools currently available for marine pests, most action focusses on preventing the spread of established pests.

Pest management strategies

The primary mechanisms available to the council for the control of pests are the Regional Pest Management Strategies which are developed under the Biosecurity Act 1993. Prior to 2010, the only marine pest included in Northland's pest management strategies was spartina. The current Regional Pest Management Strategies 2010-2015 includes the region's first marine pest strategy, which includes 27 marine organisms of concern to Northland. Spartina is also still included but as part of the Plant Pest Strategy.

The marine pests fall under different classifications in the pest management strategies, depending on whether they are currently present in the region and how widespread they are. The classification of the pests helps guide the strategy's objectives, operational plans and management programmes for each pest. The main pest management methods to address marine pests include education, surveillance, response and working with partners.

The council aims to raise public awareness of marine pests by providing information about the pests, their impacts, and management options through publicity campaigns, publications, events, workshops and providing an advice and identification service. The council also works with partners whenever possible, and during 2011 staff presented a series of free public workshops on marine pests with support from the Ministry for Primary Industries. The free workshops will run again during 2012-13, and are aimed at raising awareness of marine pests, their impacts, how they spread, and how to report them. The council has also initiated a marine industry network group aimed at raising awareness and surveillance within this sector.

The Northland Regional Pest Management Strategies 2010-2015 are available online at: www.nrc.govt.nz/pestmanagement

Marine pest surveillance

There is a national targeted surveillance programme for non-indigenous marine species which is delivered by NIWA under contract to the Ministry for Primary Industries. Both Whāngārei and Ōpua harbours are included in the six-monthly programme, which focusses on early detection of marine pests that are new to New Zealand, and also captures range extensions of existing pests.

A Northland regional surveillance plan for marine pests was developed for the council by NIWA during 2010-11 through an Envirolink grant (Woods et al: 2011). The purpose of the plan is to assist the council to develop and implement a regional surveillance framework which builds upon existing programmes of work. The plan includes information on the species that pose the greatest risks to Northland, the most likely pathways for their arrival, high value areas where pests would have the greatest impacts, and recommendations for increasing both passive and active surveillance in Northland. The workshops and increased public awareness activities are a result of the initial implementation of the surveillance plan.

A targeted marine pest survey was also carried out in Tutukākā Harbour during 2010, and no significant marine pests were detected (Seaward et al: 2011). This harbour is considered a high priority for surveillance as it is the "gateway" to the Poor Knights Islands Marine Reserve, and is visited by a considerable number of domestic and international vessels. Further surveillance is planned in Tutukākā during 2012-13.

Mangōnui and Whāngārei marinas will also be surveyed as part of the Mediterranean fanworm delimitation survey, and will include surveillance for other pests. Settlement arrays have also been placed at Marsden Cove and Nikau Point as part of the Mediterranean fanworm response.

One of the benefits of surveillance and increased public awareness is that it increases the likelihood of early detection of pests. However, in order to respond rapidly and appropriately, established incursion response plans are necessary. These plans are currently being developed as part of the Marine Pest Operational Plan.

Tools in the toolbox

Control methods for marine pests are currently limited, and these pests are difficult to eliminate once established. Where a marine pest is detected early, it can be possible to remove small infestations by hand. Other options currently include the use of wrapping techniques to smother stationary pests, and in some circumstances heat treatment or the use of chemicals.

The pest management strategies also include rules which can be enforced under the Biosecurity Act 1993. For many marine pests included in the pest management strategies, it is an offence for them to be knowingly transported. This rule enables the council to issue a Notice of Direction requiring that a boat infested with a pest be cleaned before it travels within, into or leaves Northland. This has been a critical part of the council's response to the marine pests Mediterranean fanworm and undaria, which were found on commercial vessels moored in Northland. All infested vessels were removed from the water and cleaned at the owner's expense, enabling the council to focus resources on removing small numbers of the pests from nearby structures. On-going surveillance of the affected areas will be required.

The marine policies and rules governing marine pests in other regions is also an important factor when considering how the spread of pests between regions can be reduced. Marine pest partnerships with other regional councils and central government are essential when preventing the movement of marine pests across regional boundaries into the future.

Spartina response

Northland-wide water based spartina surveys were carried out in 1992 and revisited in 2002. It was found that some patches of spartina in open mudflats had spread and increased in size up to 200 times their original cover during this 10-year period. The council started a large scale eradication programme in the Kaipara in 2003. A 15-year joint agency programme to eradicate spartina Northland-wide was approved by council in 2004. The Department of Conservation had already successfully eradicated spartina from Whāngārei Harbour, and as part of the new programme the department undertook spartina eradication in Rangaunu and Pārengarenga harbours, with the council undertaking control throughout the rest of Northland.

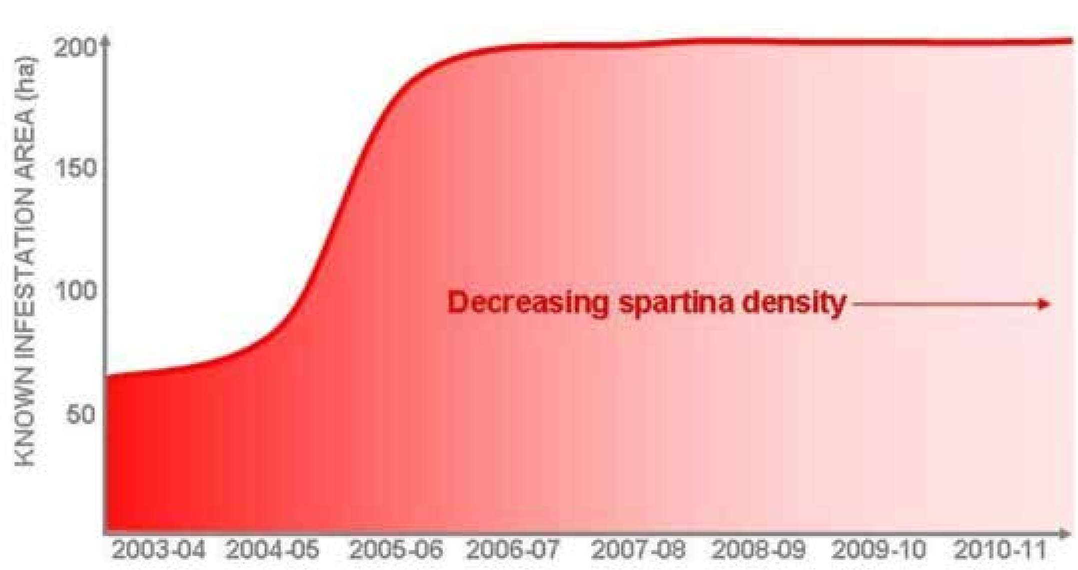
Extensive surveying located spartina sites totalling approximately 200ha in Northland. Major infestations were in the Kaipara, Hokianga and Pārengarenga harbours. Smaller infestations were present in the Houhora, Rangaunu, Mangōnui, Whāngārei and Whangaroa harbours, the Bay of Islands, and the Taipā River. Individual sites ranged in size from patches of a few square metres to a meadow of approximately 15ha.

Eradication of discrete spartina sites can be achieved with a five-year programme of annual herbicide application however extensive surveying is needed to locate all outlying sites and individual plants that may have spread from the initial source. Aerial spraying is the only practical method for initial control of most large sites due to location, accessibility and cost efficiency. This is required for three years and then followed up with ground based spraying methods.

Approximately 95% of the 200ha of spartina has minor or no regrowth with minimal follow up spraying now required (Figure 94).

Occasional live stems are typically being found among dense mangroves or saltmarsh rush meadows that require labour intensive careful surveying to ensure none are missed. Programme costs will continue to decrease as more sites are classed as eradicated (Figure 95).

Figure 94: Spartina eradication results 2004-2011



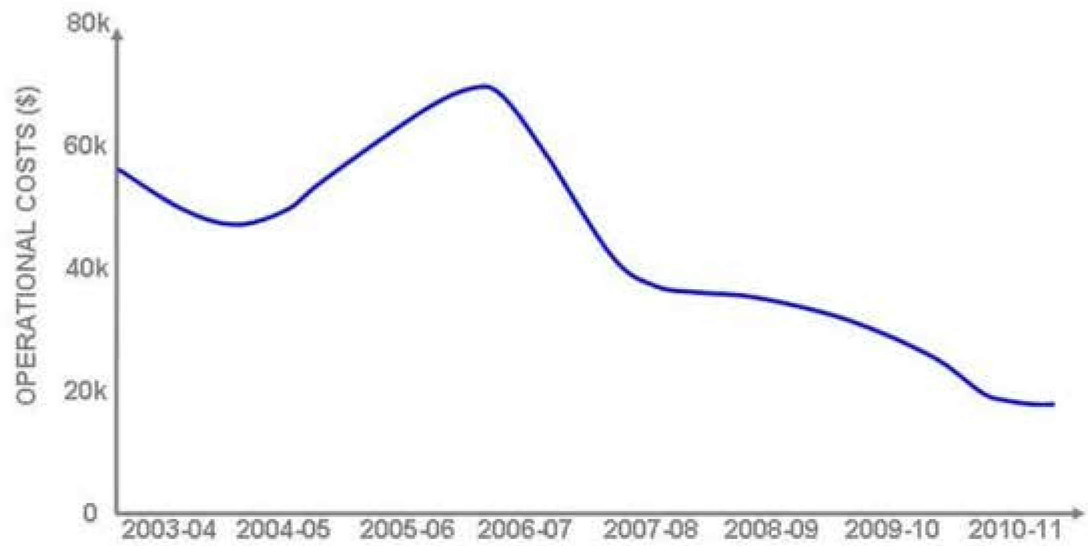


Figure 95: Spartina eradication project operational costs

How are we measuring up against our objectives?

An increase in the areas of significant indigenous vegetation and the significant habitats of indigenous fauna which are formally protected

- Although no new marine reserves have been designated there has been an increase in areas of significant indigenous vegetation and the significant habitats of indigenous fauna, which were formally protected between 2007 and 2011. Plan change 2 to the Regional Coastal Plan for Northland, which was made operative in February 2010, increased the extent of areas designated as Marine Management 1

(Protection) in the Whāngārei Harbour. Designation as a Marine 1 (Protection) Management Area is only applied to areas within Northland's coastal marine area, which have been identified as being areas of important conservation value and the priority in these areas is the protection of the significant values identified as occurring within that particular area.

- In October 2008, the Ministry of Fisheries also introduced measures to manage the effects of fishing on the Hector's and Maui's dolphins including prohibitions and restrictions to set netting and trawling by commercial and recreation fisheries on Northland's west coast. These restrictions extend from Maunganui Bluff to Pariokariwa Point north of New Plymouth (beyond Northland's administrative boundary).

No significant increase in the number of threatened species in the region

- The threat status of New Zealand's marine invertebrates was undertaken in 2009 (Freeman et al: 2010). Although no taxa had improved in threat status the threat status of no taxa had increased. The evaluation was based on known changes in their distribution, abundance of/rate of population decline of 295 taxa, for which there was sufficient information.
- The threat status of New Zealand marine mammals was also reassessed in 2009 (Baker et al: 2010). Within Northland the threat status for the bottlenose dolphin (*Tursiops truncates*) increased to nationally endangered. Population models of the coastal subpopulation found off the northeast coast of Northland indicated that there was a decline in the apparent abundance across the period 1996-1999 to 2003-05. This decline has been attributed to a change in habitat use, high calf mortality, adult mortality among former 'frequent users' of the Bay, or a combination of the three (Trezanos-Pinto: 2009).

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