



Aquatic Pest Report 2018

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Executive summary

Second only to habitat loss, pest species are a major driver of biodiversity decline within freshwaters globally (Simberloff et al., 2013). A qualitative assessment by Gluckman (2017) shows the current trend of native birds and fish, wetlands and some recreational and cultural values, to be in decline, as a result of the invasive aquatic organisms that are currently established in New Zealand.

The Bay of Plenty region is comprised of some of New Zealand's most well known lakes and rivers. They attract a large number of visitors every year and their health and wellbeing are vital to the success of the region's economy. The popularity and close proximity of the Bay of Plenty lakes and rivers to each other, and to a number of other pest occupied lakes, mean they're extremely susceptible to invasive species and their impacts.

There are four main pest weed species which have been identified as the most invasive and high risk species to have established within the Rotorua lakes. The weed species *Elodea canadensis* (elodea), *Egeria densa* (egeria), *Lagarosiphon major* (lagarosiphon) and *Ceratophyllum demersum* (hornwort), all contribute greatly to water degradation and have adverse effects upon recreational activities. Equipment associated with recreational activities has been identified as one of the principle means by which weed fragments are spread between water bodies. Possibly hidden among these weed fragments and with the ability to 'hitchhike' are pest fish eggs. Two pest fish of most concern to the Bay of Plenty region are *Cyprinus carpio* (Koi carp) and *Ameiurus nebulosus* (catfish), and much like the invasive weed species, have the potential to effect water degradation and affect a number of recreational activities, not to mention cultural, commercial and economic values. These values are also susceptible to invasive algae species, in particular, *Didymosphenia geminata* (didymo) and *Lindavia intermedia* (Lake snow).

The Aquatic Pest Awareness Programme (APAP) aims to identify levels of public awareness whilst educating users about the threats posed by invasive weeds, fish and algae species. The programme educates waterway users of their potential to spread pests, and more so how they can prevent any further spread. Engagement within the awareness programme was implemented with surveys completed at lakes and rivers throughout the Bay of Plenty region. During these surveys, a promotional pack including 'Check, Clean, Dry' and 'Stop the Spread' merchandise and educational material, the messages driving aquatic advocacy, was given to participants. Awareness and educational material was distributed at boat ramps, events and a number of retail and tourism outlets. A portable boat wash station was also set up over a number of days at events and boats ramps to decontaminate boats entering or leaving the waterways.

During the 2017/2018 summer programme, a total of 617 lake and river users were surveyed around the region. Of those, 573 surveys were completed at lakes, where, among individuals with vessels, 76% of those were boat owners/users. Among the 44 river users surveyed, 82% were kayak owners/users.

With that, 74% of lake users said that they Check, Clean, Dry to some extent between waterways, with a higher 82% of river users doing so. Similar to this, 76% of lake users indicated some level of awareness of freshwater pest plants or algae species present in New Zealand's waterways, where a greater 86% of river users noted the same. Between both the lake and river users surveyed, the highest percentage (around 50% of individuals) were from the Bay of Plenty region, with the next largest group being individuals from overseas countries.

The boat wash station saw a total of 129 vessel owners use the free facility. Among the surveys conducted during a survey specific to the station, 12 vessels/trailers were found to have invasive weeds present. Of all of the individuals to have used the boat wash during this summer period, most were from Rotorua (35%) with a total of over 50% being from the Bay of Plenty region collectively. Of those, over 75% had travelled to the site from another freshwater waterway, most of which were within the Bay of Plenty.

For most of the previous surveys, questions have remained largely unchanged; therefore, data between surveys was comparable. This year however, the survey questions differed, resulting in different measures of awareness being analysed and reported.

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Part 1:

Introduction

1.1 Background of Bay of Plenty fresh waterways

The Bay of Plenty region is home to some of New Zealand's most popular lakes and rivers. Located in the central region of the North Island, the Rotorua lakes district consists of 16 lakes of varying sizes and depths that were formed over 140,000 years ago, as a result of the high volcanic activity in the region (Rotorua Te Arawa Lakes Programme, 2015).

The region is the ancestral home of the Te Arawa people who consider the lakes to be tāonga due to their life-sustaining qualities and natural beauty (Te Arawa Lakes Trust, 2012). The lakes are also of significance to all New Zealanders due to their recreational, cultural and economic values. Unfortunately, due to the high number, close proximity and increasing popularity of the lakes, they have become exceedingly susceptible to invasion by non-native aquatic pest species. The principle pathway through which aquatic pests are dispersed is via human activities such as fishing, aquatic tourism and other recreational activities.

In addition to the lakes, there are a number of rivers in the Bay of Plenty region which are famous for their recreational value. The Kaituna, Rangitāiki, Tarawera and Wairoa rivers are held in high regard both domestically and internationally for their white-water rafting and kayaking, making them a regular destination for events such as races and fishing competitions.

The Rotorua district's tourism industry contributes approximately 798M dollars to the economy annually and this figure is set to increase (Rotorua NZ, 2018). As the Rotorua lakes and rivers contribute greatly to the appeal of the region, these lakes and rivers are a vital asset to the region's growth and development.



Figure 1 Overlooking Lake Tarawera from Mount Tarawera.

1.2 Invasive weed species

Since the introduction of invasive weeds to New Zealand, accidental and intentional transfers of these pests between waterways have had substantial economic, recreational and biological impacts on freshwater systems (Champion & Clayton, 2000). These pests have the ability to out-compete native flora and fauna, significantly disrupting fragile ecosystems and detracting from the natural aesthetics of lakes and rivers. Economically, the cost of managing these pests, particularly by the hydro-electricity industry and relevant Government agencies, is large and ongoing. Therefore, identifying the methods of spread and dispersal of these pests is an integral part of managing their impacts (deWinton *et al*, 2010).

Within the Bay of Plenty region's Rotorua lakes district, there are 16 lakes of varying sizes and depths, which are currently under proactive management for four invasive weed species. These are *Ceratophyllum demersum*, *Lagarosiphon major*, *Egeria densa* and *Elodea canadensis* (Figure 2). The distribution of these weeds across the 16 lakes varies (see Appendix 1) as shown on the Aquatic Pest Coordination Group (APCG) biosecurity signage posted at each of the lakes (see Appendix 2). Furthermore, the close proximity of the lakes and the volumes of lake users that visit them make them particularly susceptible to human assisted weed transfer.

An Aquatic Weed Risk Assessment Model (AWRAM) is a useful tool that predicts the weed potential of a new species, by comparing the success of one aquatic species with another. Attributes of ecology, biology, weediness and management of the above species (based on their behaviour in new habitats) is assessed below. Each trait is ranked on a scale of 0–10 and combined to give a total score.

Table 1 Submerged aquatic plant species present in Rotorua lakes ranked according to weed risk. Higher score reflects greater impact (Champion & Clayton, Border Control for Potential for Aquatic Weeds, 2000)

| Common name | Scientific name | AWRAM score |
|-------------------|-------------------------------|-------------|
| Hornwort | <i>Ceratophyllum demersum</i> | 67 |
| Egeria | <i>Egeria densa</i> | 64 |
| Oxygen weed | <i>Lagarosiphon major</i> | 60 |
| Canadian pondweed | <i>Elodea canadensis</i> | 46 |

Invasive weed species possess characteristics that make them problematic to control and difficult to remove when they become well established (Fountain, 2015). This includes an ability to reproduce rapidly and often asexually via fragmentation. Aquatic weed growths can be highly dense, smothering fish and benthic communities. They impede light penetration to native vegetation and restrict recreational activities. In addition, where these weeds have become well established, there has been a noticeable decline in water quality (Hamilton, 2010). These impacts are further exacerbated by the lack of naturally occurring biocontrol's such as grazers and competitors (Francis, 2012). All four weeds are dioecious species (sexes on different plants) and only one sex of each plant was introduced to New Zealand, meaning that natural dispersal is not possible. The dispersal of these weeds is via fragmentation and relies on external influences such as strong currents, wind and human activities (Champion & Clayton, Border Control for Potential for Aquatic Weeds, 2000).

1.2.1 Hornwort

Hornwort is an aquatic macrophyte which is mainly submerged and found within zones of still or slow flowing freshwater. It can be identified by leaves that are finely divided, with minute teeth which make the plant feel rough to the touch. It lacks true roots but has modified leaves that anchor the plant in bottom sediments. In clear lakes, hornwort can be found to depths of 16 m, with its dense beds reaching up to 10 m in height, inhibiting light penetration to native species (Biosecurity New Zealand, 2013).

Hornwort is largely established in the North Island of New Zealand, contributing more detrimental effect than most other aquatic weeds upon freshwater systems. Hornwort is a highly invasive weed due to its ability to inhabit a wide range of different freshwater environments and the rate and ease of which it can form new plants. Unlike many other macrophytes, hornwort is able to thrive in low light and turbid habitats (Pelechaty, Pronin, & Pukacz, 2014). Like most freshwater pest plants in New Zealand, hornwort reproduces via fragmentation and due to the brittle structure of its stems; fragments are readily dislodged and transported naturally by waves and currents or via human activities (Niwa, 2005a).

Hornwort was first found in the Bay of Plenty region in 1981 in Lake Rotoiti (Niwa, 2005a). It has since established in lakes Rotorua, Tarawera, Rotoehu, Rotomahana, and more recently Aniwhenua, Ōkātina and Ōkareka. Note that the latter two are under active control for hornwort. On Lake Ōkātina, a weed cordon, installed for the purpose of reducing the spread of weed fragments, has been installed across an arm of the lake where hornwort is prevalent (Lass & Eldershaw, 2012), and on Lake Ōkareka, positive results have been expressed as a result of an eradication programme in place since August 2015.

1.2.2 Lagarosiphon

Lagarosiphon is a submerged, bottom-rooted freshwater perennial plant which is characterised by curved leaves that are arranged in an alternate spiral rather than in a whorl. Native to South Africa, the invasive oxygen weed has been present in New Zealand since the 1950s presumably imported for use in the aquarium trade. It has since become naturalised in New Zealand and is now widely distributed throughout the North Island and in the northern and eastern regions of the South Island (Manaaki Whenua Landcare Research, 2011). Lagarosiphon is now present in all of the Rotorua lakes except for lakes Rotomahana, Ōkaro and Rotokakahi (Department of Conservation (DoC), 2012).

The invasive weed can inhabit depths of up to 6.5 m in clear water and prospers in shallow, muddy, alkaline waters but is capable of establishing under most freshwater environments (Caffrey & Acevedo, 2007). It can form dense monospecific strands that block light penetration, out competing native flora and fauna and smothering benthic invertebrate populations. In addition, the invasive weed can impede the recreational use of freshwater bodies restricting boat passage and limiting activities such as swimming and fishing (Weedbusters, 2016a).

1.2.3 Egeria

Native to South America, egeria is a member of the oxygen weed group and contains much of the same characteristics as lagarosiphon. Egeria is a bottom rooted freshwater perennial plant with short internodes and leaves that are approximately 10 mm-30 mm long and 2 mm-5 mm wide, giving the plant a leafy appearance (Champion & Hofstra, 2013).

Egeria thrives in turbid, slow flowing water, allowing it to tolerate a wide range of freshwater environments. Its stems grow up to 5 m or until the plant reaches the water's surface, where it then forms dense monospecific strands that restrict water movement, trap sediments and prevents light penetration to other organisms (Invasive Species Specialist Group (ISSG), 2006).

Egeria is widely distributed across the North Island and is present at a few sites in the South Island. In the Bay of Plenty, it was first observed in Lake Rotorua in 1977 and has since been established in Ōkareka, Rotoiti, Rotomahana, Rerewhakaaitu and Tarawera.

1.2.4 Elodea

Elodea was first observed in Christchurch in the Avon River in 1872 but has since become naturalised in fresh waterways throughout New Zealand (Champion *et al*, 2012). Elodea was presumably introduced to New Zealand with the intention of oxygenating waterways to support future introductions of non-native fish species (Champion, Clayton, & Rowe, 2002).

Elodea is a submerged bottom rooted macrophyte that is native to North America. This weed has the ability to grow and multiply rapidly in a wide range of environments, due to its ability to tolerate different conditions (Min *et al*, 2013). Elodea shares similar physical features with lagarosiphon and egeria, but can be distinguished by dark green leaves that are orientated in whorls of three along the stem (Weedbusters, 2016b). It forms dense strands over a variety of substrates and can reach heights of up to 8 m which has negative implications for native flora and fauna, by impeding light penetration and competing for nutrients and space (Champion, Clayton, & Rowe, 2002). Economically, there have been issues presented in terms of management and control for this invasive weed, however, elodea is generally succeeded by more aggressive oxygen weeds such as lagarosiphon and egeria (Weedbusters, 2016b).

Elodea is capable of transfer within a single catchment via natural means (i.e. water flow and wind), however, transfer between catchments is usually via human activities (Weedbusters, 2016b). Rotomahana is the only lake within the Rotorua lakes district lacking elodea.

1.2.5 Pest management in the Bay of Plenty

The Bay of Plenty Regional Pest Management Plan (the Plan) outlines the statutory management for three of the above weed species. The objective for pest plant management, as outlined in section D (contaminant pest plant rules) of the Plan, is to reduce the distribution and density of known populations. Target species include; egeria, hornwort and lagarosiphon (Section D (4)).

To meet the contaminant objective, rules and methods are included in the Plan. Most notably, landowners and occupiers are responsible for these three plants in specified areas (see Figure 3 of the Pest Management Plan). In addition, the summer awareness program (the aquatic advocates) promotes Rule 6 of Section D that; “no person shall move, or allow to be moved, any machinery, vessel, organisms, risk goods, or other goods that are contaminated with any contaminant pest plant, and that any persons seen to be moving these goods be subject to prosecution” (Bay of Plenty Regional Council, 2011).

Hornwort, lagarosiphon and egeria are recognised as high risk aquatic weed species according to the AWARM scale. As a result, these weed species are classified the Biosecurity Act 1993 as “unwanted organisms” and the sale, propagation and distribution of these species is banned under the National Pest Plant Accord, the Biosecurity Act and the RPMP (Ministry for Primary Industries, 2016).



Figure 2 Invasive weed species from left to right: *Elodea canadensis*, *Ceratophyllum demersum*, *Lagarosiphon major* and *Egeria densa*, Lake Aniwhenua.

1.3 Pest fish and algae

Many of our established pest fish species were illegally introduced into New Zealand, either for recreational fishing or ornamental purposes, or as biological controls (Collier & Grainger, 2015). Under the Conservation Act 1987, the introduction of any aquatic life (native or introduced fish, plants or invertebrates) into an area where they don't already occur requires a permit. Unfortunately, purposeful movement of introduced fish species has been occurring between freshwater bodies in New Zealand since their arrival, the consequences of which are remaining prevalent today.

As of 2010, the number of non-native freshwater fish species within New Zealand increased to 21 from a known 12 species in the 1930s (Collier & Grainger, 2015). Of those, species such as *Cyprinus carpio* (koi carp), *Scardinius erythrophthalmus* (rudd), *Tinca tinca* (tench) *Carassius auratus* (goldfish), *Gambusia affinis* (*Gambusia*) and *Perca fluviatilis* (perch) have managed to establish self-sustaining populations across large areas of either or both of the North and South islands (McDowall, 1990). Within the Bay of Plenty region, the many lakes and rivers are relatively free from invasive pest fish species. However, as pest fish populations in the Bay of Plenty's neighbouring regions are both widespread and in high abundance, the lakes and rivers of the region remain at threat.

1.3.1 Catfish

Brown bullhead catfish have become an exceedingly significant threat to the Rotorua lakes and waterways. Catfish are an eradication/exclusion pest within the Bay of Plenty Regional Pest Management Plan, therefore, the Bay of Plenty Regional Council (BOPRC) monitors and enforces rules in aim of both prevention of entry and eradication from the region. Catfish must not be spread or sold, and if caught must be killed and disposed of.

Native to North America, catfish were introduced to New Zealand in the 1870's as a food source for settlers (Barnes & Hicks, 2001). Generally, catfish are highly resilient to adverse conditions and capable of surviving long periods out of water if kept moist, making them easy to spread and difficult to eradicate (Collier & Grainger, 2015). They are also one of the few freshwater fish species that carry out parental care of their broods, thus significantly increasing offspring survival (Blumer, 1985).

Through benthic feeding and stirring up bottom sediments, catfish have the potential to seriously modify invertebrate communities; ecosystem processes and water nutrient levels. The omnivorous nature of catfish means that they both compete with carnivorous native fish, such as eels, and include native fish in their diets. As an example, in recent times, catfish have been associated with the decline of koura (*Paranephrops planifrons*) populations from nearby Waikato River hydro-lakes (Clearwater *et al.* 2014), as well as koura making up to 80% of catfish diet in parts of Lake Taupō (Barnes, 1996). Koura populations both historically and today, hold great significance as a Tāonga and mahinga kai species within the Bay of Plenty lakes (Parkyn, 2007).

Currently, catfish remain widespread in Lake Taupō and the Waikato River system, and can also be found in parts of Northland as well as two isolated populations in the South Island (NIWA, 2018b). During 2016, one catfish was caught and a second sighted during weed harvest work taking place in Te Weta Bay, Lake Rotoiti (Bay of Plenty Regional Council, 2016). Since that event, catfish continue to be sighted and captured in the lake, including the Okere Arm and Okawa Bay (Grayling, 2016). An aquatic pest cordon, the same as the weed cordons, has been installed in Te Weta Bay in aim of monitoring and reducing catfish numbers (Figure 3).



Figure 3 Catfish/cordon sign next to a boat ramp at Lake Rotoiti.

1.3.2 Koi carp

As with catfish, koi carp are listed as an eradication/exclusion pest under the BOPRC Pest Management Plan. It is thought that koi carp were unintentionally introduced into New Zealand during the 1960s together with an intended arrival of ornamental goldfish*. Koi carp were first noticed in the Waikato region in 1983. Following this, in the year 2000, koi carp together with *Gambusia*, were recorded in the top of the south Island, prompting their declaration as unwanted organisms under the Biosecurity Act 1993 (Dean, 2010). Koi are also considered a noxious fish species under the Freshwater Fisheries Regulations 1987, and are therefore illegal to possess, breed, sell, spread or release.

Koi have been known to be less successful in deeper lakes (Jackson *et al.* 2010); yet, as they are capable of moving an average of 39 km within a river system (Daniel *et al.* 2011), the risk of incursion is always exceedingly high. Through sucking up bottom sediment and blowing out what isn't wanted, feeding koi can cause native vegetation to become dislodged. This alteration of plant life and water quality causes both habitat and food loss for native fish, invertebrates and waterfowl, as well as reducing native plant re growth and establishment (Bellrichard, 1996; Laird & Page 1996). Koi are also capable of adverse impacts upon other ecosystems, such as habitat alteration and disturbance within wetlands (Gluckman, 2017).

The known success of koi carp populations has given rise to their reputation as being perhaps the most undesirable invasive freshwater fish in New Zealand. Fortunately, full eradication of established populations in the South Island remains effective; however, populations remain in much of the North Island, with particularly high population density in the Auckland and Waikato regions (NIWA, 2018c). As koi carp look almost identical to wild goldfish, the two are often mistaken for one another. Mistaken identity has the potential for sightings to be dismissed rather than reported. The most distinctive difference between the two species is the presence of two barbells on either side of the mouth on koi carp.

*The common goldfish are suspected to have been introduced into the Rotorua lakes as part of the naturalisation of New Zealand (Thomson, 1922), and have no legal status.

1.3.3 Rudd

Rudd is classified as a 'containment pest' in the Bay of Plenty RPMP, meaning that support and advice is provided to members of the public for the purpose of minimising their effects and preventing further spread. Native to Europe, Russia and Central Asia, rudd were successfully smuggled into New Zealand in 1967 (McDowall, 1990), possibly for their game fish qualities. Within the Auckland/Waikato Fish and Game regions, rudd is considered a designated sports fish under the Freshwater Fisheries Regulations 1983; however, it is otherwise listed as a noxious fish species making it illegal to possess, breed or release under the Biosecurity Act.

It is likely that rudd prey upon some native fish species and compete for their food resources (Cadwallader 1977; Lake *et al.* 2002; Hicks 2003). Rudd also have a known preference for native aquatic plant species over introduced species (Lake *et al.* 2002), therefore having potential to significantly impact the structure of native macrophyte communities. This effect has been previously recorded in several Waikato lakes, where macrophyte communities are known to have collapsed (de Winton & Champion 1993). It has also been suggested that in larger populations, rudd have the potential to significantly alter trout fisheries, a significant economic value, due to their occupancy of spawning tributaries and overlapping diets (Hicks 2003; Lake 1998).

Rudd are known to succeed in lakes, ponds, wetlands and reservoirs, but can also occur in large pools of rivers and streams (Champion *et al.* 2012). The current known distribution for rudd includes parts of both the South and North Islands, with particularly high densities occurring in the far north (NIWA 2018d).

1.3.4 Tench

Like rudd, tench are also classified as a 'containment pest' in the Bay of Plenty RPMP, and a sports fish under the Freshwater Fisheries Regulations 1983. It is illegal to fish for, or to move these fish without a license under the RPMP and Biosecurity Act.

Tench were introduced in the 1870s and did not become widespread or abundant for many decades (McDowell, 2008). Recently, anglers and others have spread tench more extensively and in the early 2000s populations were known to have become widespread, mostly in small lakes (McDowell, 2008). Studies that contain direct evidence for the effects of tench within New Zealand's freshwaters are lacking. There is, however, evidence from both New Zealand and abroad, showing lake water clarity reduction occurs in shallow lakes containing high population densities (Rowe, 2004). It has also been suggested that the known tolerances for tench could allow for further colonisation in New Zealand (Rowe, 2004).

The current known distribution for tench includes much of both the North and South islands (NIWA, 2018e), including populations previously found within the Bay of Plenty (Rowe, 2004).

1.3.5 Gambusia

In the year 2000, the incursion of both koi carp and *Gambusia*, more commonly known as mosquito fish, within the South Island, prompted their declaration as unwanted organisms in New Zealand under the Biosecurity Act 1993. Following their arrival into Auckland in 1930, *Gambusia* are believed to have been introduced as a biological control for mosquitos (Ling, 2004). There are numerous reports documenting the aggressive behaviour of *Gambusia* towards other fish species and their detrimental effects on ecosystems within a range of habitats.

The current known distribution for *Gambusia* only includes the North Island, with particularly dense populations in the far north. A small number are also said to be present in the Rotorua lakes area. Following successful eradication operations, there are no known populations of *Gambusia* in the South Island (NIWA, 2018).

1.3.6 Didymo

Commonly referred to as 'rock snot', didymo (Figure 4) is a single celled algal micro-organism which currently poses one of the most serious threats of incursion upon the North Island of New Zealand, including the Bay of Plenty region. The algae probably arrived in New Zealand via some form of human means, such as fishing equipment or tramping boots (Kilroy, 2004). Following its discovery within the South Island, its impact has been both rapid and widespread. Under the Biosecurity Act 1993, didymo is defined as an 'unwanted organism' and therefore it is an offence to knowingly spread it (Ministry for Primary Industries, 2012).

Although didymo is microscopic, it can attach itself by stalks to stream, river and lake beds. These stalks develop further to form thick brown layers which smother rocks, submerged plant life and other biota (Ministry for Primary Industries, 2012)(Figure 5). It can be distinguished from other species of algae based on its beige/brown/white appearance and its spongy cotton wool like texture (Aboal *et al.* 2008). It is highly aesthetically displeasing and gives off an unpleasant odour.

It has been suggested that there is lack of research to support claims that didymo may have detrimental impacts upon fish populations (Bonnnett *et al.* 2008; Whitton *et al.* 2009). More recently, a study conducted in 2016 by Jellyman & Harding looked at the effects of didymo in 20 South Island rivers, and reported declines in fish biomass of up to 90%, both directly and indirectly resulting from high didymo biomass. These findings included both native and exotic fish species and are primarily associated with changes in invertebrate prey communities following didymo invasion.

In response to its dispersal, there have also been concerns over the potential for didymo to be transported and therefore dispersed via water fowl. Two ways in which this could occur include external transport, via feathers and feet, and internally, via the gut. A report by Kilroy *et al.* (2007) suggests that external transport is unlikely as birds have the natural tendency to regularly groom as well as shedding and drying during flight. More research is required to investigate the risk of external transfer of didymo upon animals other than birds (Kilroy *et al.* 2007). As for transport via the gut, research around gastric pH levels, temperature and light factors have shown survival of didymo cells after internal passage to be extremely unlikely (Kilroy *et al.* 2007).

Findings from Kilroy *et al.* (2014) outline evidence that the proximate cause of blooms within rivers is low concentrations of phosphorous. Also, findings from a study of both north and south island freshwater sites by Kuhajek *et al.* (2014) suggested that: a) water chemistry is unlikely the only variable responsible for its distribution, and b) substrate composition may play a crucial role in the establishment of didymo as it was found to impact the occurrence of cell division. More recently, Bray *et al.* (2017) reported that the development of didymo blooms, as a result of both limited phosphorous and high light conditions, can also show declines in cell density in response to increased densities of competing algae.

Current distribution of didymo includes around 150 rivers throughout the South Island. As it has not yet been detected in the North Island, this has generated many misconceptions around the potential for didymo to invade the North Island. A number of studies, such as those mentioned above, have shown that didymo growth is possible within a range of water chemistries.

There are currently no options for the removal or control of didymo. Following the development and release of the 2005 'Check, Clean, Dry' Campaign, this remains to be the most effective strategy in place for the purpose of increasing public awareness and limiting dispersal. The campaign is largely focused on educating all waterway users of best practices for cleaning of vessels, clothing and other equipment before moving between freshwater bodies.

'Check, Clean, Dry' is currently used as an advocacy slogan for all freshwater pests as it is seen as useful best practise and an effective tool to promote the need to prevent the spread of aquatic pests.



Figure 4 A mass of didymo from a heavily infested South Island riverbed.

1.3.7 Lake snow

Following observations from a number of New Zealand and American Lakes, the arrival of lake snow (*Lindavia intermedia*) in New Zealand is now understood to have originated from North America (Novies *et al.* 2017). Following recent reports, it has been recommended that no immediate action be taken to eradicate or contain the algae. It is therefore certain that lake snow (*Lindavia intermedia*) will establish as an invasive organism in New Zealand is said to become certain (Novis *et al.* 2017).

Having only recently arisen as a freshwater biosecurity concern, Lake snow has been found in Otago lakes (Wakatipu, Wanaka, Hawea and Hayes), a number of Canterbury lakes and in Lake Waikeremoana in the North Island. Recent water testing showed lake snow has yet to detect in the Rotorua lakes, however, further and more comprehensive testing is needed as, like didymo, lake snow is capable of dispersal via a single drop of water. Also, following its discovery in Lake Wakatipu and Lake Hawea, water filtration issues, similar to some presented in Wānaka, have been reported in Queenstown (Scott 2017). The abundance of its slime like substance has been significant enough to require upgrades to urban water infrastructure, and has also proven to be disruptive to recreational fishing on the lakes (Williams 2017).

Although it is said to pose no known human health risk, findings from Novies *et al.* 2017 together with the Otago Regional Council (2017), suggest that the effects of lindavia on lake ecology needs attention. This also comes as a result of Lake snow's known ability to transform lakes from essentially a carbon 'desert' to a series of carbon (and potentially nitrogen) rich oases, resulting in more favourable conditions for bacterial growth. As further impacts of lake snow upon higher trophic levels in the food chain are unknown, management options and public awareness strategies will need to be determined.

1.4 Awareness programme and survey background

The Bay of Plenty region's lakes and waterways are used by many local residents, domestic and international users. The waterways are used for a variety of recreational activities with a range of different equipment, clothing, vessels and trailers entering the water. This equipment has been identified as the primary vectors capable of transferring invasive weed, fish and algae between fresh water ecosystems around New Zealand.

In August of 2004, after the incursion of didymo in the South Island, representatives from the Bay of Plenty Regional Council (BOPRC), the Department of Conservation (DOC), Eastern Fish and Game, Te Arawa Lakes Trust, Land Information New Zealand (LINZ) and the Rotorua Lakes Council (RLC), came together to form the Aquatic Pest Co-ordination Group (APCG). The objectives of the group are to increase biosecurity awareness among water users in the Bay of Plenty and to prevent introductions and further spread of invasive species.

In July 2007, the didymo Long-Term Management Plan (LTM) was implemented across New Zealand, consisting of partnerships between MPI (Formerly MAF: the Ministry of Agriculture and Forestry), DOC, Fish and Game New Zealand, regional councils, impacted industry and Iwi. The LTM outlined objectives, roles and responsibilities for didymo management.

More recently in 2016, MPI established the Freshwater Biosecurity Partnership Programme (FBPP). Formally the LTM programme, the FBPP is a long term strategy extending through to 2021. It brings together the partners as listed above, as well as the addition of local Iwi, Genesis Energy and Meridian Energy. The programme recognises the extension by the LTM to include all freshwater pests in 2011 and provides support and coordination for the APCG group.

Since the forming of the APCG in 2004, the Bay of Plenty Regional Council, with support from MPI, has employed two tertiary students over the busy summer period each year. The primary role for the students is to assist with the Aquatic Pest Advocacy Programme (APAP), a BOPRC initiative. Over previous years, a survey created for the APCG was conducted, in order to determine pest awareness among the general public. This year however, a new survey designed as a part of the National Science Challenges, created by MPI, was conducted nationwide (Appendix 3).

1.5 Aims and objectives

The aim of the Aquatic Pest Advocacy Programme is to educate and create awareness among water users in the Bay of Plenty region, relative to current aquatic pest issues. In addition, the advocacy programme aims to educate users on how to best minimise the spread of these pests, both within the region and beyond, with particular emphasis placed on recreational users.

Educational material and merchandise provided by both MPI and the BOPRC was distributed among both survey participants, see Appendix 4, and to those included in other forms of awareness such as retail outlet visits (Appendix 5). The data collected over the summer period is analysed and made available to members of the APCG and MPI through the creation of this report. Recommendations will be made based on the findings of this report so that the relevant organisations can take informed action where/if required.

Part 2

Methods

Between 11 December 2017 and 21 January 2018, a total of 617 surveys were conducted at twelve of the sixteen Rotorua lakes. Two lakes, Lake Rotomahana and Lake Rotokakahi, are privately owned and are therefore not visited and one, Lake Rotoehu, had toxic algal warnings for the duration of the programme.

Surveying times were scheduled around aquatic events and during times when these water bodies were most likely to have large volumes of users. This was predominantly during public holidays and on weekends. Each survey period was approximately eight hours long and varied, depending on user numbers and weather conditions.

The BOPRCs portable boats' wash station (operated by Geoff and Van Ewert) was also set up and run at some of the Rotorua lakes over the busy summer period. The aim was to clean boats as they were entering or leaving lakes and to engage with boat owners regarding the need to wash vessels between waterways. The boat wash provides a high pressured wash which primarily removes loose fragments from boats and trailers.

In addition, educational material and merchandise were distributed to relevant retail outlets, information centres, tourism and accommodation providers.

Aquatic event organisers were also contacted, and provided with information, merchandise and decontamination equipment where required. The summer advocates also requested to speak at event briefings so as to educate event organisers and participants on aquatic pests and the preventative actions to best reduce the risk of spread.

2.1 Lake surveys

Boat Ramps and other lake side locations at the Bay of Plenty lakes were visited multiple times during the busy summer period. The lakes were broken down into two regions (northern and southern) and were visited on alternating days to ensure time was distributed evenly.

Lake users were observed and approached predominantly while waiting to use the ramp or preparing their vessel to leave. When users were approached, the surveyor asked a series of questions in accordance with the National Science Challenge Survey. Information gathered included:

- Waterway name
- Location where the survey took place
- User type
- Country or region of residence (nearest town)
- Frequency of waterway visits
- Knowledge of any freshwater pest plants and algae
- Negative impacts on users as a result of pest plant presence
- Cleaning methods for vessels and other equipment used in freshwater
- Previously visited waterbodies, in the last two weeks (prior to survey)

To gauge user knowledge on freshwater pest plants both locally and nationally, users were asked to identify aquatic pest plant species that are currently an issue in the Bay of Plenty region's waterways, as well as those outside of the region. Aquatic pest plant species included in the survey were, didymo, hornwort, egeria, lagarosiphon, Lake snow and hydrilla.

Based on the information collected, users were informed about current aquatic pest issues and informed on how to help 'Stop the Spread' of aquatic pests. Education was tailored to the specific recreational purpose of the craft/user and the interest of the lake user e.g. fishermen were mostly spoken to about pest fish and jet boat/jet ski owners spoken to about carpets on trailers.

Upon the completion of surveys/discussions, a promotional pack containing further information and merchandise was given to the user for further reference. This year, surveys were conducted on iPads and the information gathered was uploaded to a central server (ArcGIS) which was then collated and analysed, with the findings published as follows.

Sites visited over the duration of the Summer Aquatic Pest Awareness Program; see Appendix 6 for map locations of these sights.

| Northern region | Southern lakes |
|---|---|
| <ul style="list-style-type: none"> • Lake Ōkātina • Lake Rotoehu <ul style="list-style-type: none"> ▪ Kennedy Bay ▪ Ōtautū Bay • Lake Rotoiti <ul style="list-style-type: none"> ▪ Otaramarae ▪ Delta Ramp ▪ Gisborne Point ▪ Hinehopu Point ▪ Okawa Bay • Lake Rotomā <ul style="list-style-type: none"> ▪ Merge Lodge ▪ Matahī Spit • Lake Rotorua <ul style="list-style-type: none"> ▪ Hannah's Bay ▪ Ngongotahā River Mouth ▪ Hamurana ▪ Hamurana Springs Mouth ▪ Sulphur Point ▪ Rotorua Lake Front | <ul style="list-style-type: none"> • Lake Aniwhenua • Lake Ōkaro • Lake Matahina • Lake Tikitapu • Lake Ōkāreka <ul style="list-style-type: none"> ▪ Acacia Point Reserve ▪ Boyes Beach Reserve ▪ DoC Campground • Lake Rerewhakaaitu <ul style="list-style-type: none"> ▪ Guy Roe Reserve ▪ Domain ▪ Brett Road (DoC Campground) ▪ Ash Pitt Road (Doc Campground) • Lake Tarawera <ul style="list-style-type: none"> ▪ The Landing ▪ Boatshed Bay ▪ Stoney Point ▪ Bay View Road |

2.2 River surveys

In addition to the Rotorua lakes, the awareness program also covered a number of rivers throughout the Bay of Plenty region.

The Following list comprises of the river sights that were visited.

| | |
|---|---|
| <ul style="list-style-type: none">• Western Bay of Plenty<ul style="list-style-type: none">▪ Wairoa River• Eastern Bay of Plenty<ul style="list-style-type: none">▪ Rangitāiki River▪ Whakatāne River | <ul style="list-style-type: none">• Rotorua district<ul style="list-style-type: none">▪ Ngongotahā River▪ Awahou River▪ Kaituna River▪ Hamurana River |
|---|---|

The Rangitāiki River was visited at multiple sites, due to the high volume of users and diverse range of recreational activities along its length. The Rangitāiki River has two man-made lakes located on its course, Lake Aniwhenua and Lake Matahina. These lakes attract holiday campers from all over the country and world, so they presented an ideal opportunity for the surveyors to engage with a wide range of users.

Rotorua river sites were visited less frequently as it was difficult to locate sites with high concentrations of users. As with lake users, river users were approached, pest issues were discussed and then they were asked the same questions in accordance with the National Science Challenge Survey. Educating river users was largely focussed around didymo as many seemed to have directly experienced the impacts of didymo in the South Island.

2.3 Boat wash surveys

During the 2017/2018 summer period, the portable boat wash station was set up and used at four different lakes within the Rotorua region. Due to space constraints at many of the boat ramps on the Rotorua lakes, the use of the boat wash was limited to Boatshed Bay (Lake Tarawera), Acacia Reserve (Lake Ōkāreka) and Matahī Spit (Lake Rotomā). The boat wash was also used once at Lake Tikitapu during the FLOCHELLA event.



Figure 5 The boat wash in use at Lake Tikitapu for the 2018 FLOCHELLA event.

2.4 Retail and tourism awareness

Due to the popularity of the Bay of Plenty region, the retail and tourism outlets service a great deal of people and their interests which includes a diverse range of freshwater activities. Providing information and promotional material to these outlets ensures continual access to aquatic pest information for the many visitors. Over the duration of the 2017/2018 summer programme, a total of 94 outlets were visited within the Bay of Plenty region (Appendix 5). All visits were completed within the first month of the programme in order to ensure outlets were well stocked and informed, before the busy holiday period.

Organisations that were visited were those which frequent the waterways as part of their business or serve customers likely to use or visit the waterways, particularly in Rotorua. High priority was given to outdoor, boat and fishing gear retailers and tourist attractions. Accommodation sites, particularly campgrounds, were also targeted.

Among those business visited, supervisors and managers were spoken to in order to ensure the appropriate distribution of materials and messages. The Check, Clean, Dry Campaign was discussed, relative to what it aims to achieve and why it is so important within the Bay of Plenty region between islands and nationally. The current lack of didymo in the North Island, the eradication of hornwort from the South Island and the importance of stopping the spread of pests between our regional lakes was also discussed. The threat of didymo was emphasised in places such as retail outlets and campgrounds, where tourists frequent, in order to ensure travellers moving between islands could gain good awareness and understanding.

Merchandise supplied by both the Ministry for Primary Industries and Bay of Plenty Regional Council included messages such as “Stop the Spread” and “Check, Clean, Dry”. (Appendix 4).

2.5 Event and school awareness

Attendance at water based events in the Bay of Plenty region is a vital part of the APAP as it provides an opportunity to communicate with a wider audience, therefore increasing aquatic pest awareness. These events cater to groups with a diverse range of interests, from around the country and sometimes abroad; some of whom not having spent much time in the region's many waterways. Events provide an opportunity to distribute information among organisers and participants, as well as friends, family and spectators involved.

After researching local events, organisers were contacted in order to gain insight into their cleaning and decontamination measures in place for their event. Correspondence with organisers helped determine whether it was possible and/or necessary to speak at briefings, if decontamination stations were needed and what merchandise would be most appropriate for distribution.

As with previous years, the focus was on event organisers to take initiative and control of the decontamination process. As a part of lake closure consents for events, organisers and participants must read and abide by the Biosecurity protocol (Appendix 7), in order to take part in events in the Bay of Plenty regions waterways.

The events held/attended during the 2017/2018 summer period in the Bay of Plenty region were:

- Rotorua Half Iron Man, Lake Tikitapu
- New Zealand Water Ski racing, Lake Rotomā
- Fish and Game Boat Fishing Seminar, Lake Tarawera
- Jet Ski racing, Lake Rotorua
- Dewar Shield Blue Lake Regatta, Lake Tikitapu
- Blue Lake Multisport Event, Lake Tikitapu
- Wooden Boat Parade, Lake Rotoiti

- FLOCHELLA/New Zealand Bomb Competition, Lake Tikitapu
- Kiwanis Open Water Swim, Lake Rotomā

Due to the high volume of people travelling between Waikato and Bay of Plenty waterways, two events in the Waikato region were also included in the programme. As the Waikato region's freshwater lakes and river are heavily infested with aquatic pests, which are lacking or in less abundance in the Bay of Plenty region, it was deemed appropriate to attend events in order to educate those lake and river users. The events attended were:

- The National Waka Ama Sprint Championships, Lake Karapiro
- Cambridge Town Cup and New Zealand Club Champs, Lake Karapiro

Schools

Advocates also attended two schools this summer period (Figure 6). Classroom visits at both Ngongotahā and Rotokawa primary schools were made, informing both the children and their teachers of the importance of freshwater biosecurity. A presentation was given about current aquatic pests and their associated risks relevant to our region, with particular focus on the 'Stop the Spread' and 'Check, Clean, Dry' messages.

Current MPI and BOPRC pest species posters (Appendices 2 and 8) were used as visual aids for pest fish and aquatic weed identification, as well as a container with tea stained cotton balls to simulate didymo.



Figure 6 Students of Rotokawa School with advocates Te Wakaunua Miki-Te Kurapa and Jemma Hippolite.

Part 3

Results

3.1 Lake surveys

3.1.1 Distribution of surveys conducted at lakes

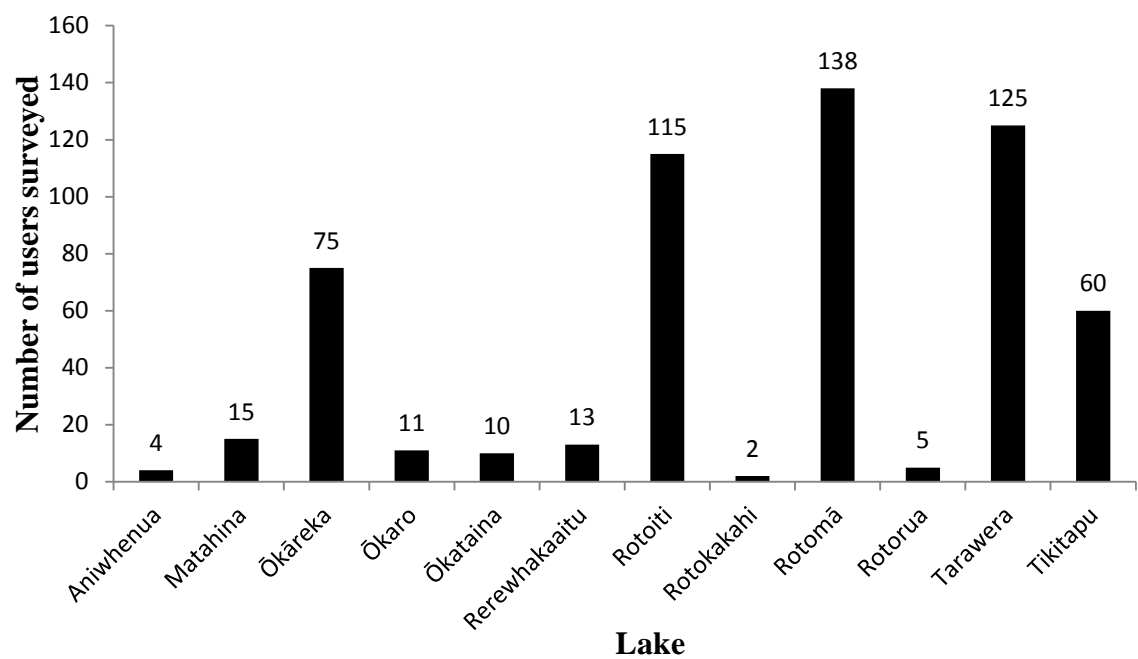


Figure 7 Distribution of surveys conducted at different lakes within the Bay of Plenty region.

3.1.2 Recreational purpose

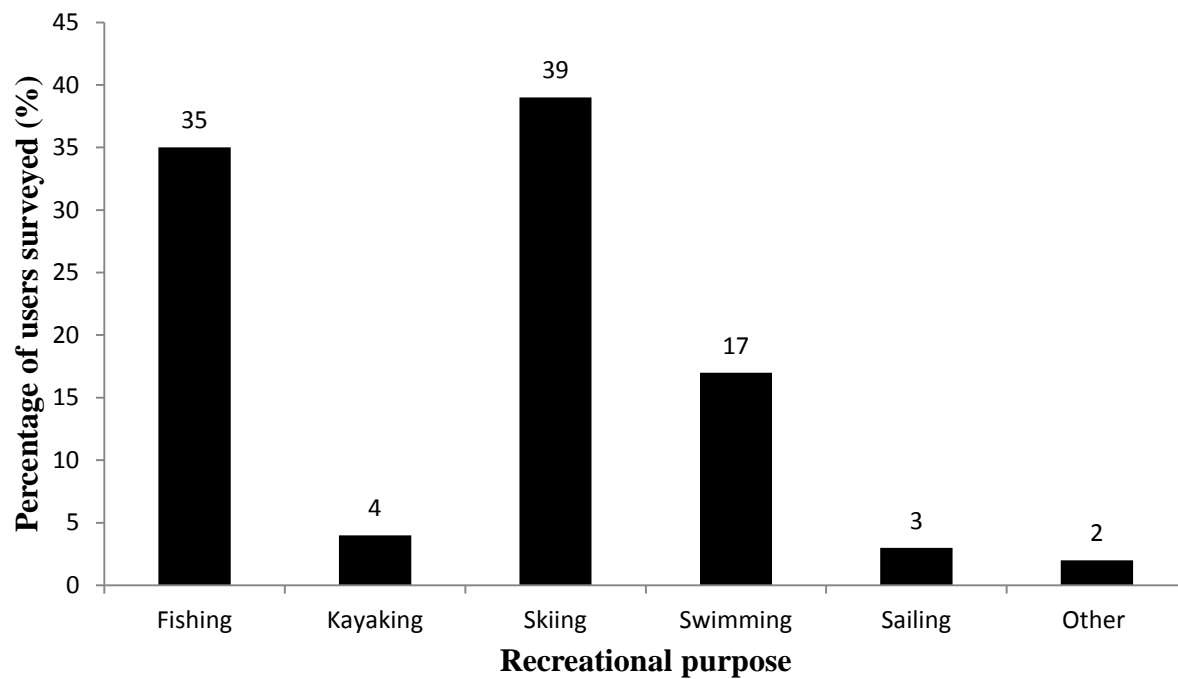


Figure 8 Recreational purpose of users surveyed.

3.1.3 Vessel type

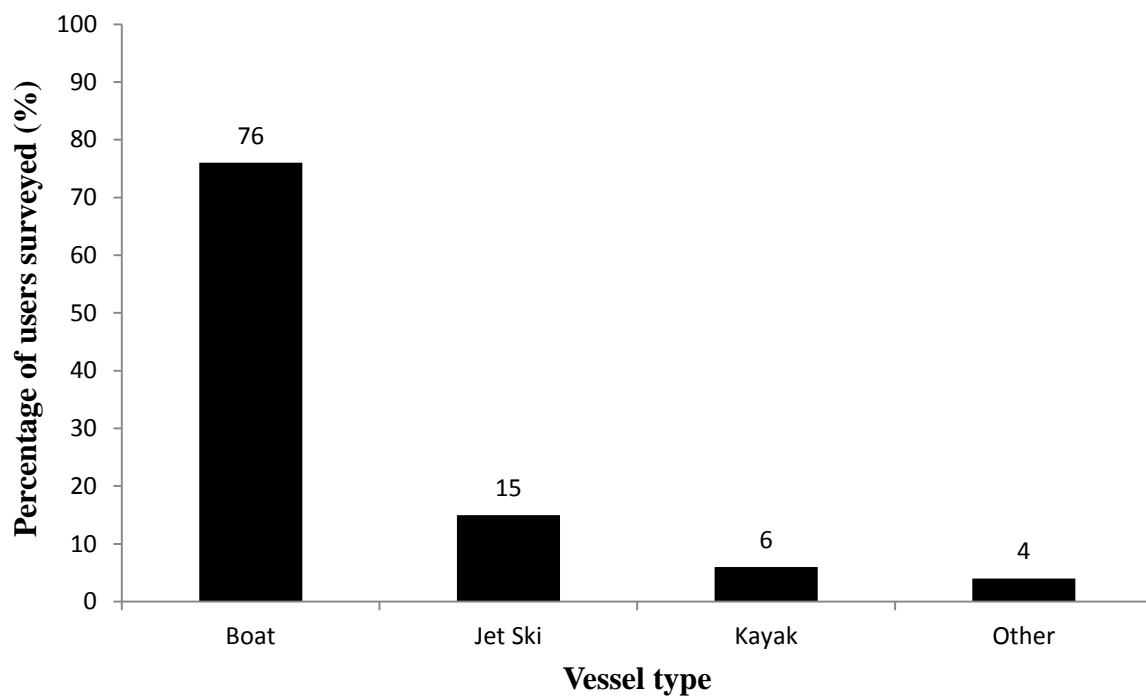


Figure 9 Percentages of vessel types observed at lakes.

3.1.4 Origin of vessels

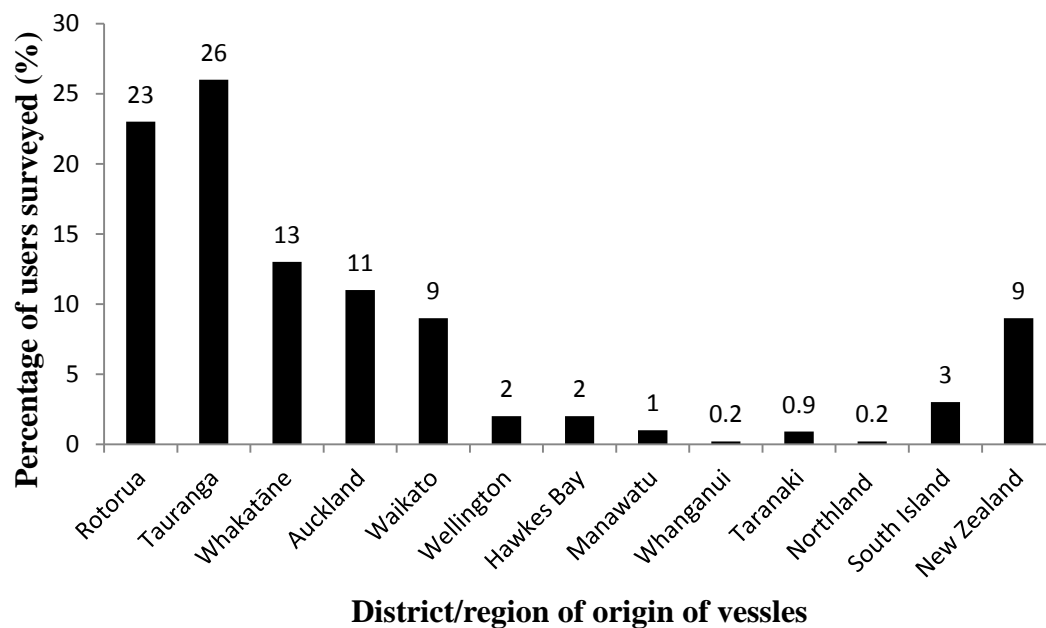


Figure 10 District/region of origin of vessels surveyed.

3.1.5 Origin of users

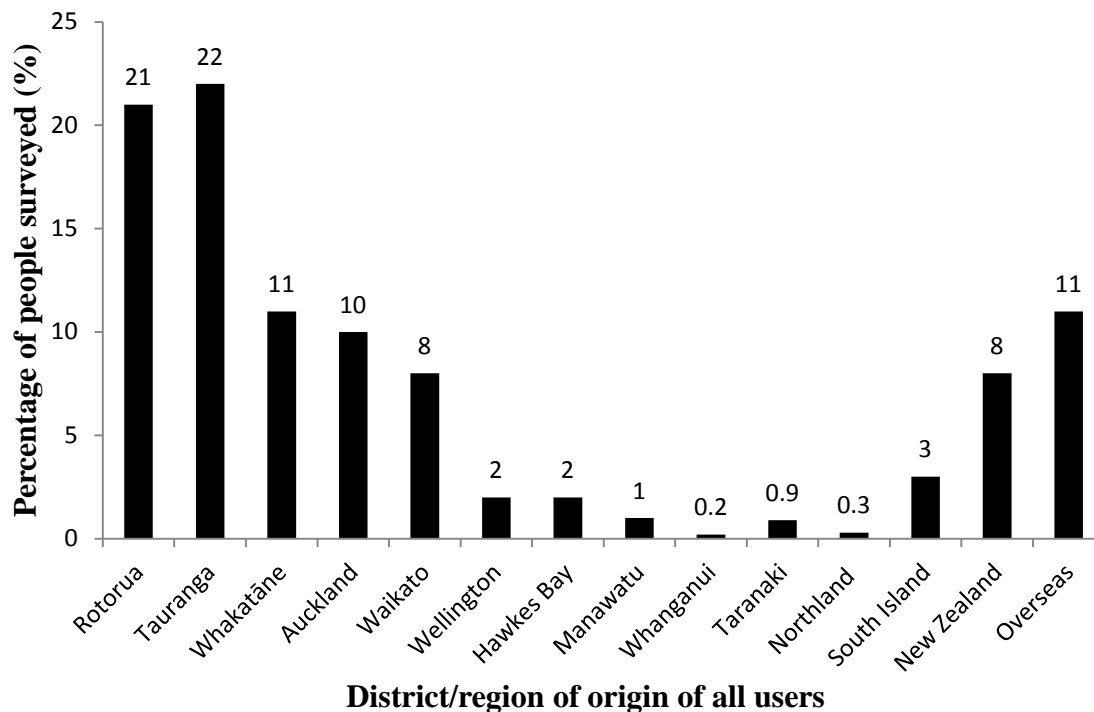


Figure 11 District/region of origin of all users surveyed.

3.1.6 Region of last freshwater body used

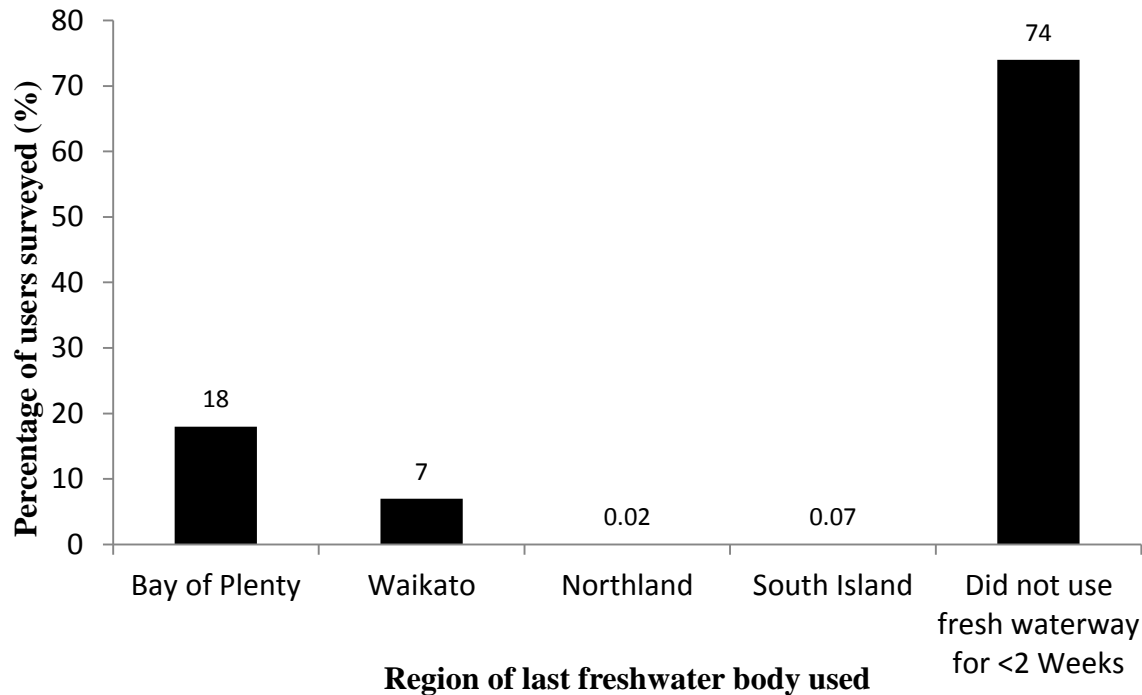


Figure 12 Region of last freshwater body used by users surveyed.

3.1.7 User awareness of any freshwater pest plants or algae

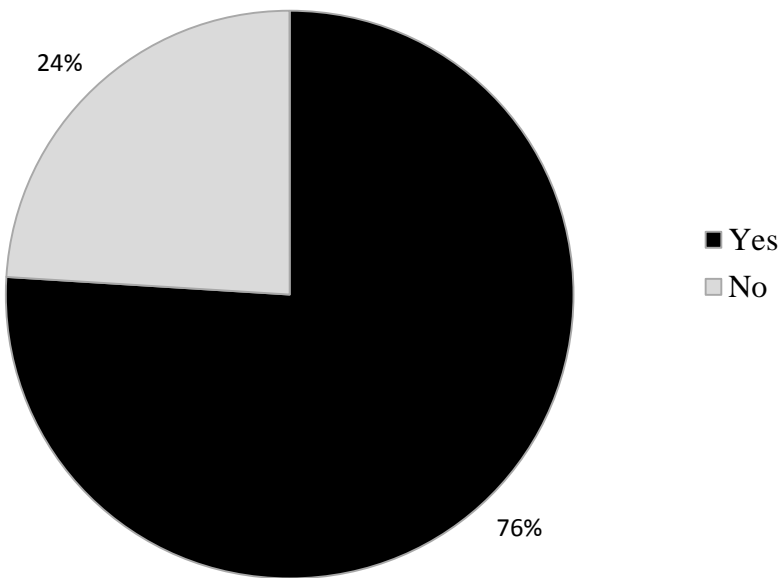


Figure 13 Percentage of users who could or could not name any pest plants or algae.

3.1.8 Number of plant or algae species named

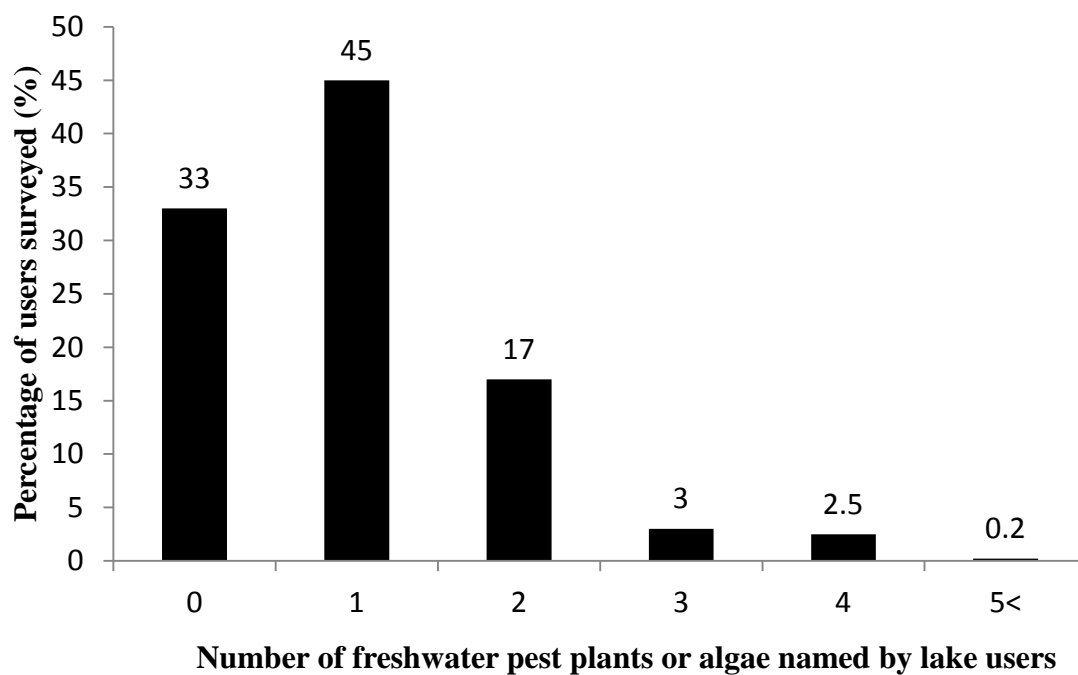


Figure 14 Number of plant or algae species named by users who were aware of freshwater pest plants.

3.1.9 Users who Check, Clean, Dry vessels/equipment

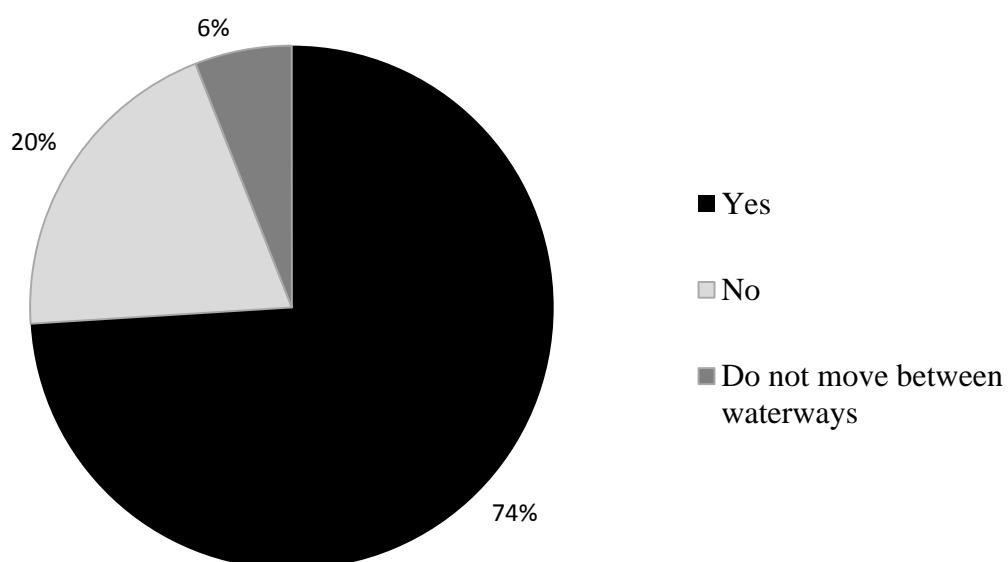


Figure 15 Percentage of users who Check, Clean, Dry, or do not move between different fresh waterways.

3.2 River surveys

3.2.1 Distribution of surveys conducted at rivers

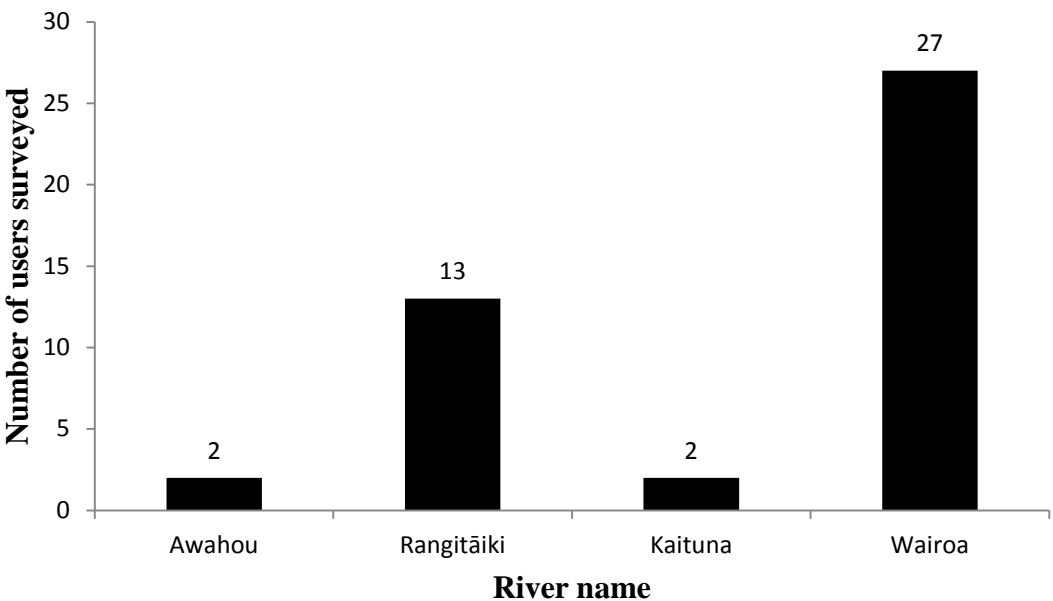


Figure 16 Distribution of surveys conducted at river sites within the Bay of Plenty region.

3.2.2 Recreational purpose

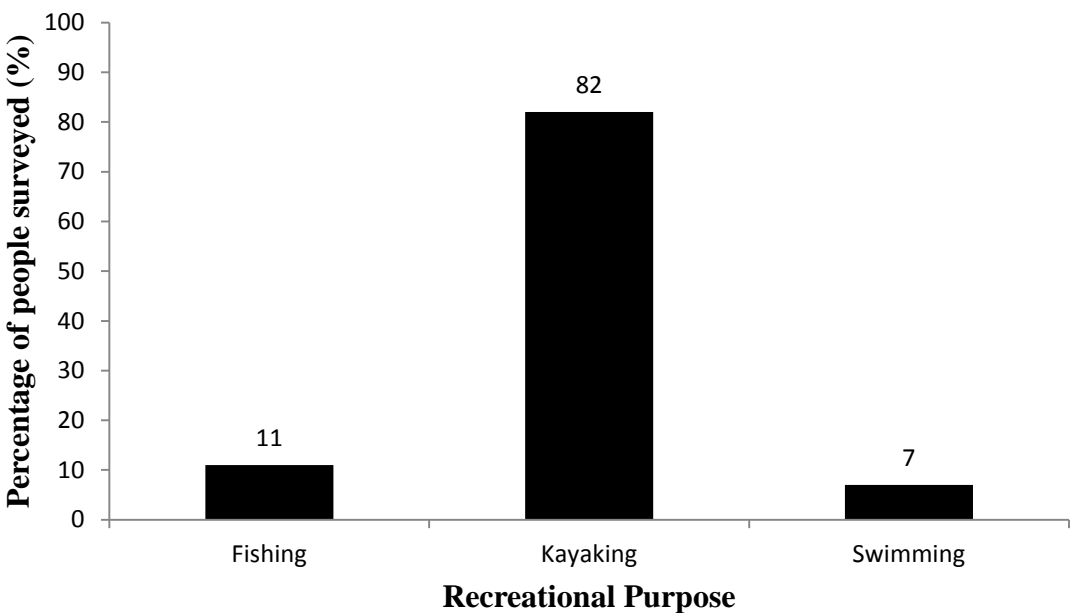


Figure 17 Recreational purpose of users surveyed at different river sites.

3.2.3 Origin of users

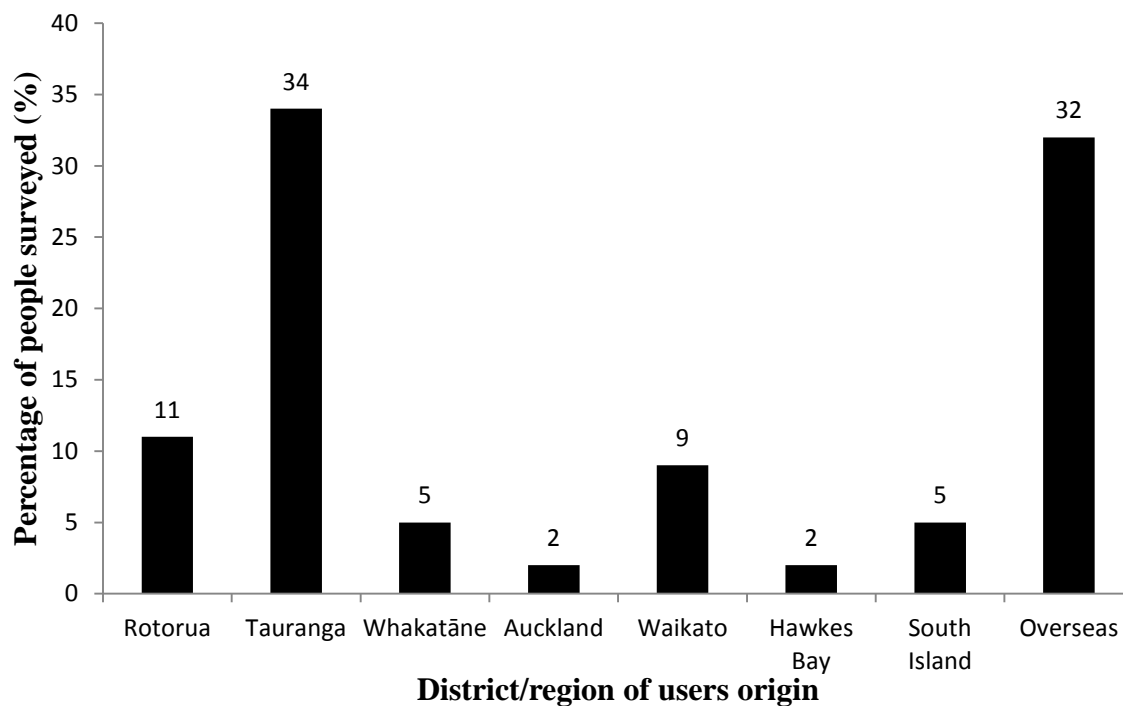


Figure 18 District/region of origin of users surveyed.

3.2.4 Region of last freshwater body used

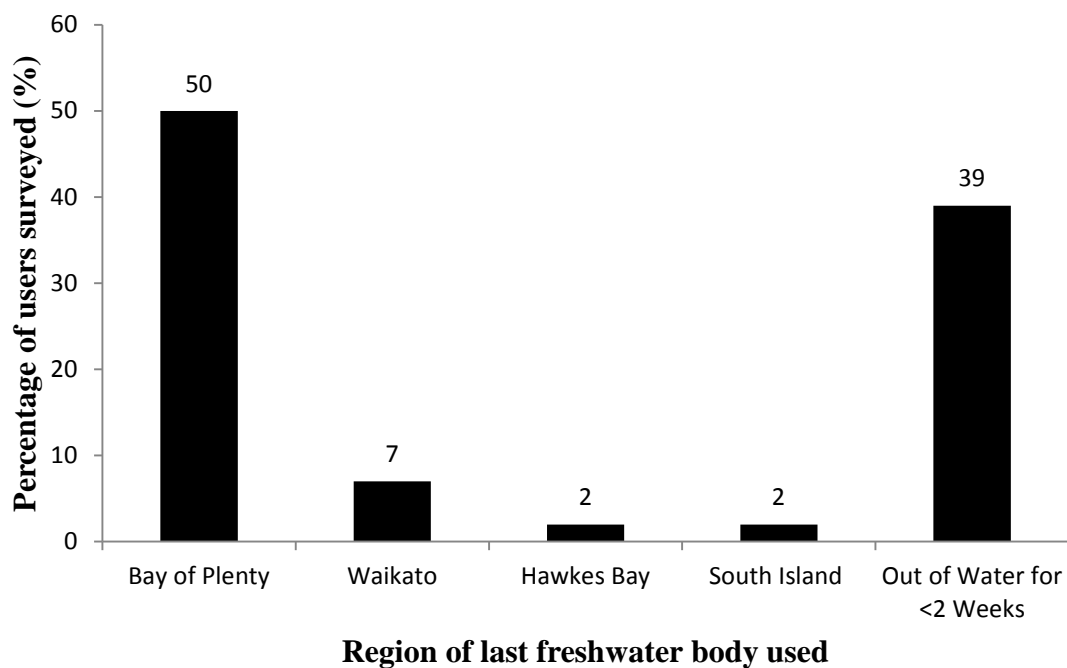


Figure 19 Region of last fresh waterbody used by users surveyed.

3.2.5 User awareness of any freshwater pest plants or algae

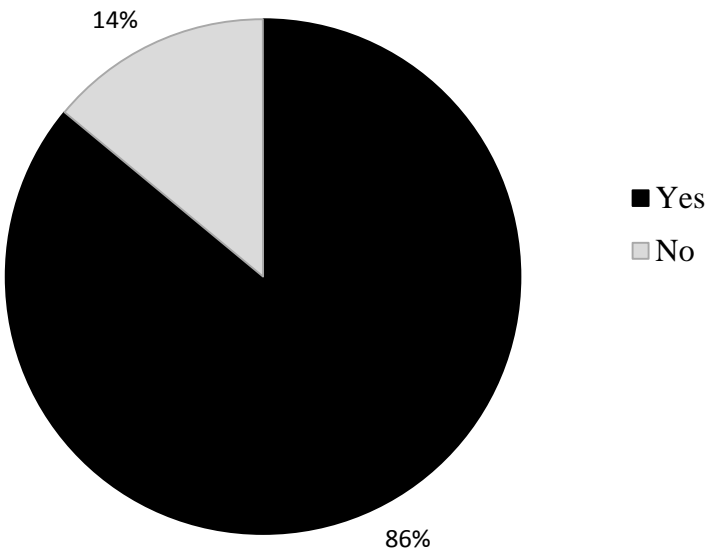


Figure 20 Percentage of users with some knowledge of freshwater pest plants or algae.

3.2.6 Number of plant species named by users

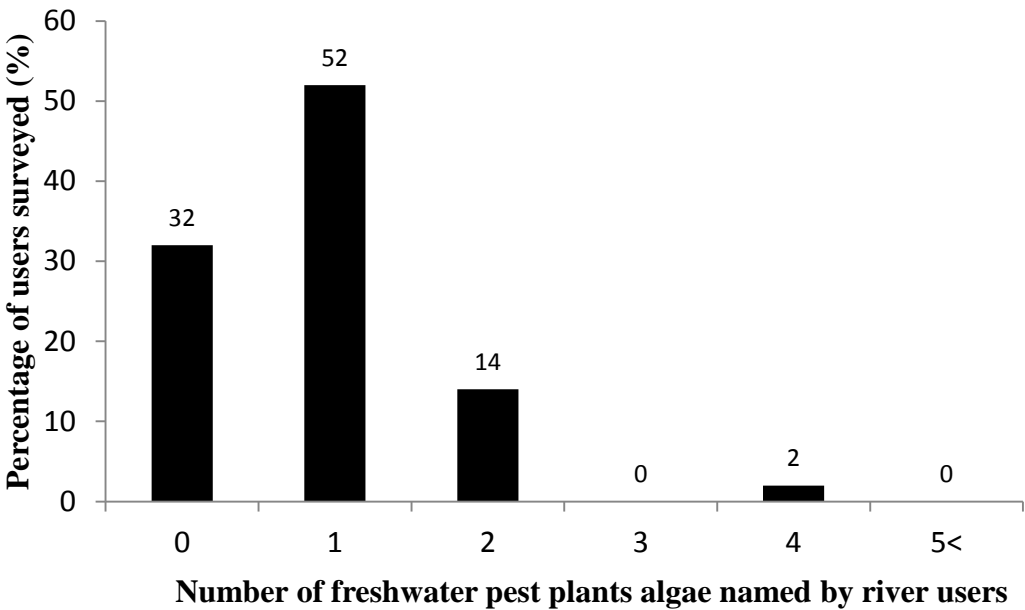


Figure 21 Number of plant species named by users who were aware of freshwater pest plants or algae.

3.2.7 Users who Check, Clean, Dry vessels/equipment

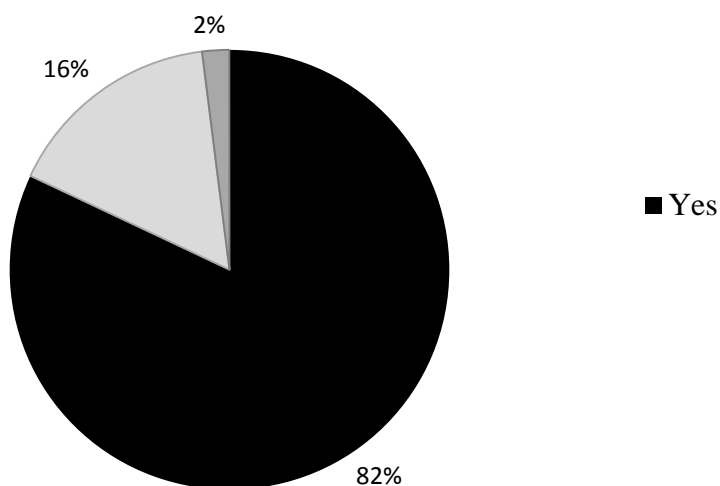


Figure 22 Percentage of users who Check, Clean, Dry their vessels/equipment when moving between waterways.

3.3 Boat wash survey

3.3.1 Distribution of surveys conducted at lake sites

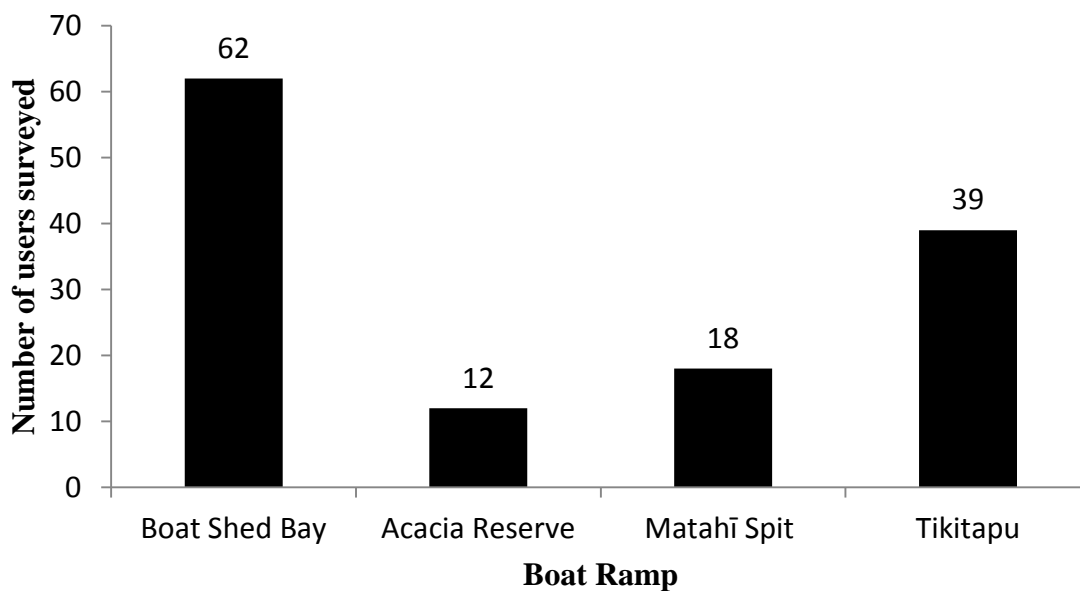


Figure 23 Distribution of surveys conducted at Boatshed Bay, Acacia Reserve, Matahī Spit and Tikitapu boat ramps.

3.3.2 Origin of owners

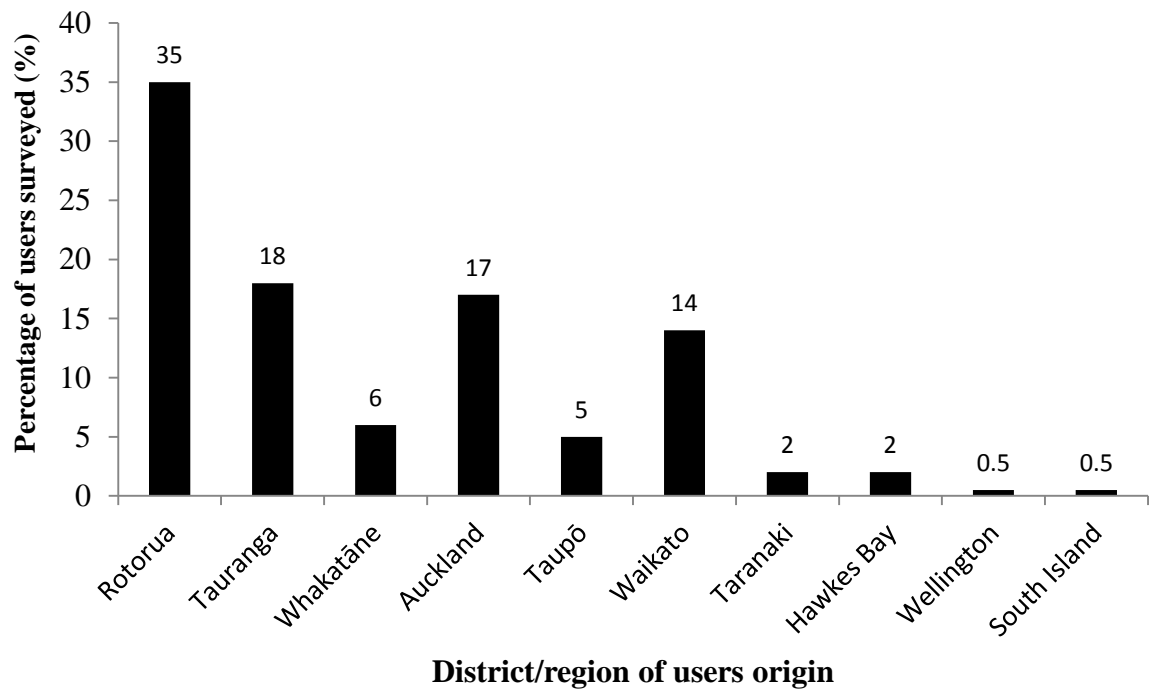


Figure 24 District/region of origin of users surveyed.

3.3.3 Vessel type

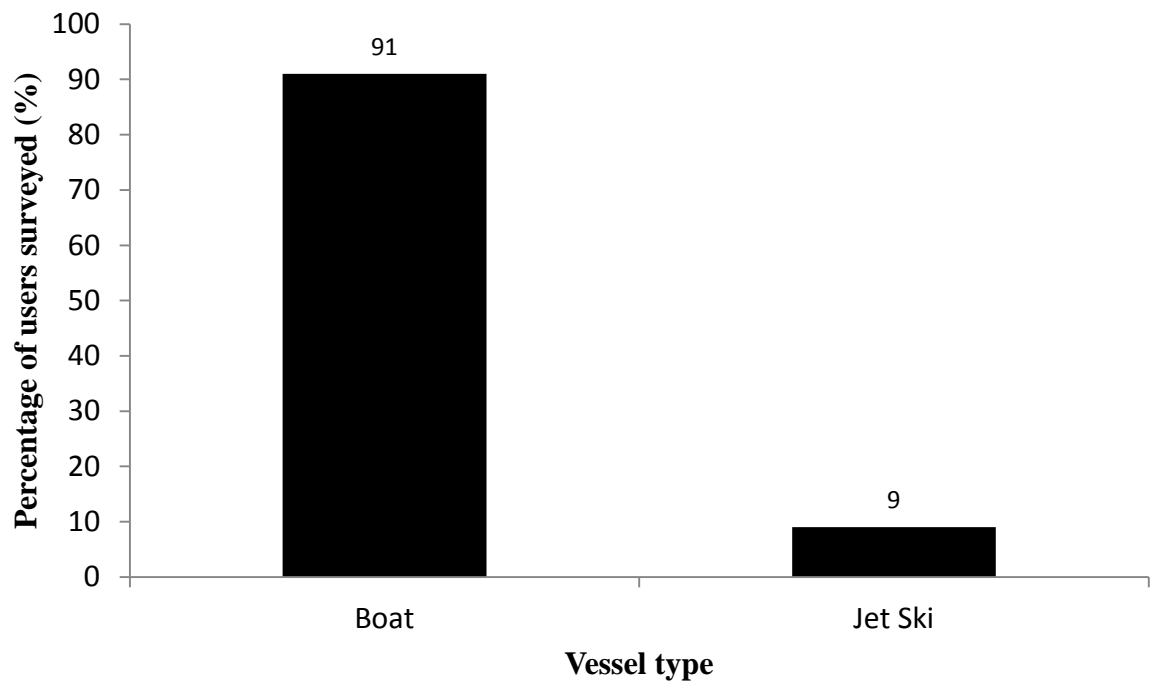


Figure 25 Percentage of different vessel types that used the boat wash.

3.3.4 Last waterbody used

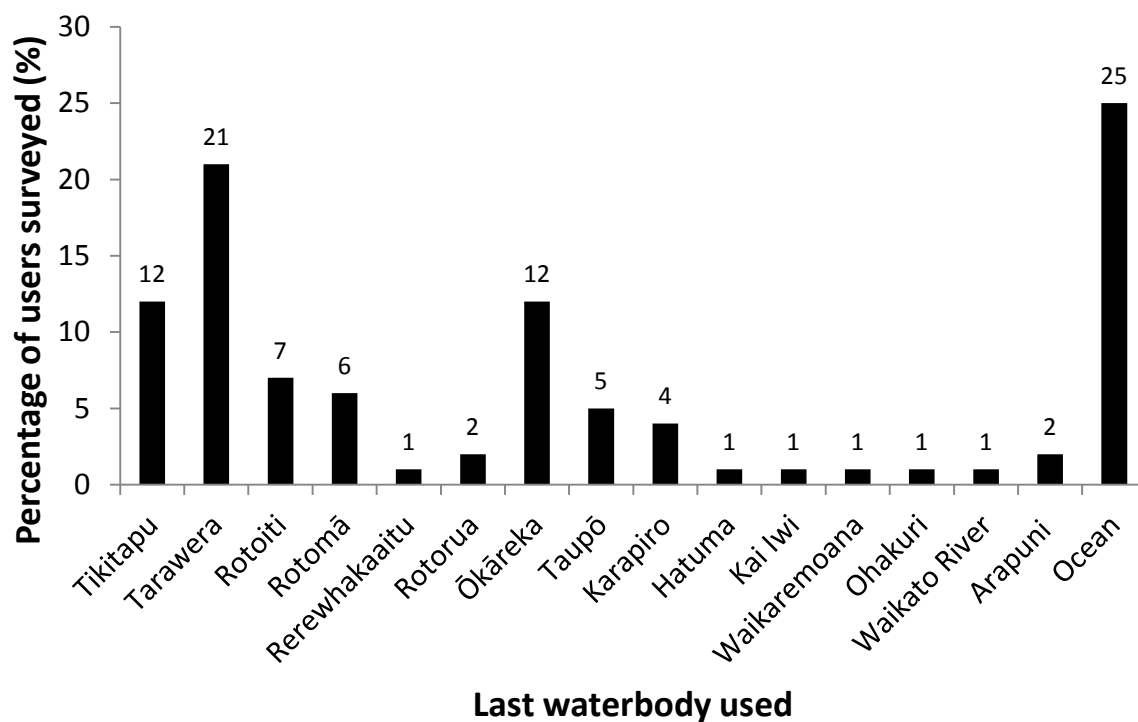


Figure 26 Last waterbody used by users surveyed.

3.3.5 Awareness of pest weeds/fish

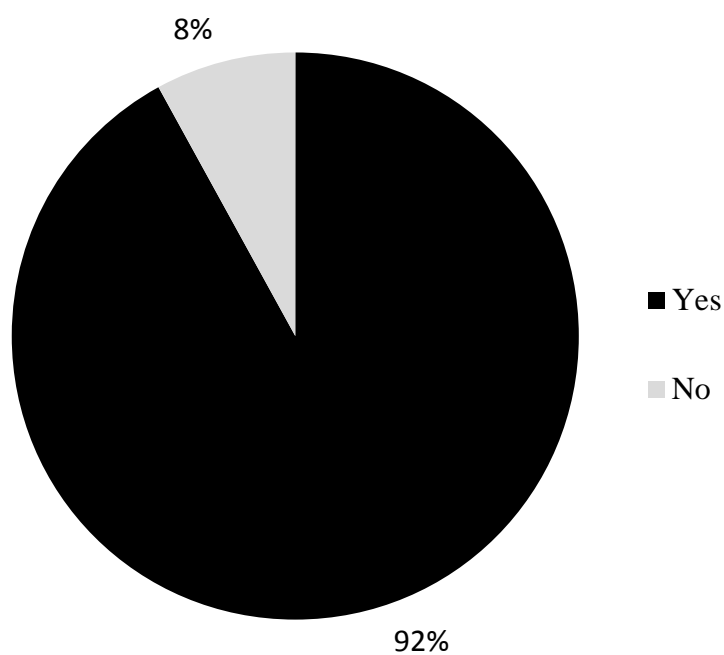


Figure 27 Percentage of users with knowledge of pest weeds and fish.

3.3.6 Do you clean your vessel between waterbodies

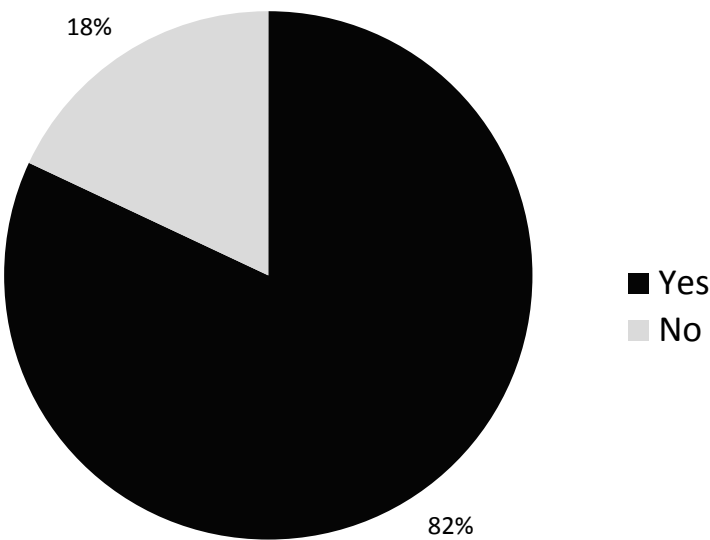


Figure 28 Percentage of users who clean their vessels when moving between waterbodies.

3.3.7 Vessels with weed intercepted at two ramps

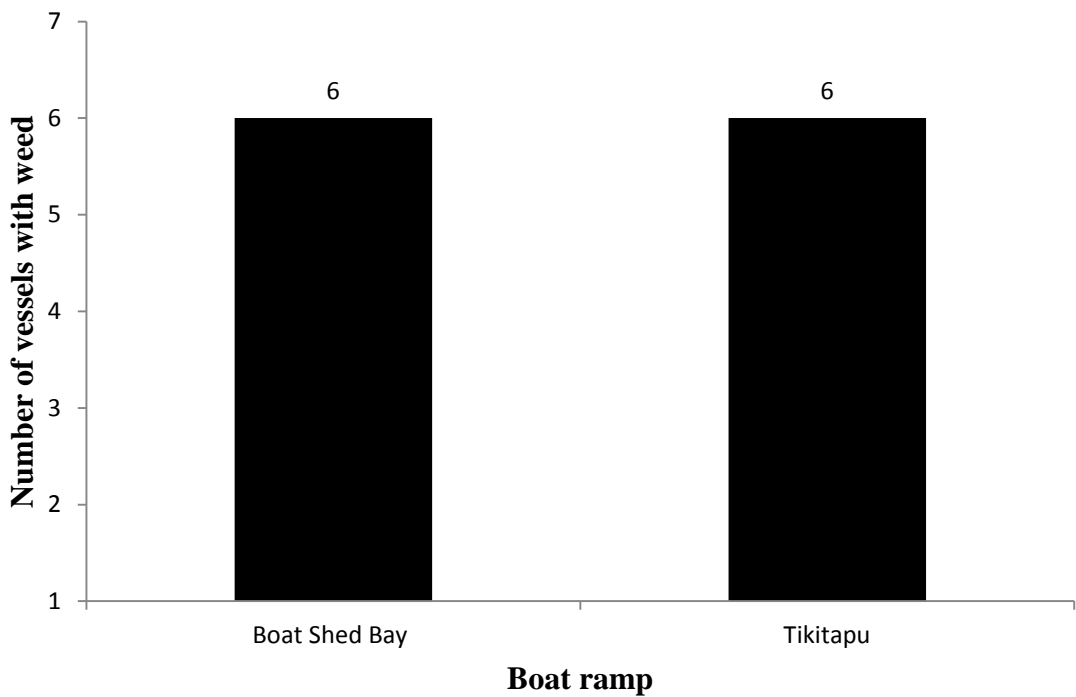


Figure 29 Number of weed bearing vessels intercepted at lakes Tarawera and Tikitapu.

Part 4

Discussion

4.1 Lake surveys

During the surveying period of the 2017/2018 Aquatic Pest Awareness Programme, priority was placed on visiting larger lakes with greater recreational use. This ensured that greater numbers of lake users could be reached and engaged with in shorter timeframes. Recommendations from previous reports and current knowledge of aquatic pest issues allowed advocates to prioritise lakes based on their popularity, main recreational activities (for example, water sports prohibited in Lake Ōkātina), and current aquatic pest issues. Quieter lakes were visited less frequently due to the low concentrations of users. To maximise lake coverage, advocates would often split up and visit separate sites, specifically on days when multiple lakes were likely to have high user numbers. It is important to note that the number of surveys conducted at each lake does not reflect the actual number of lake users visiting the lakes, they are only indicative of the amount of time spent at each lake, which was not quantified.

Lake Rotomā is the most pristine lake in the Rotorua lakes district in regards to its water quality and relative absence of aquatic weeds. It is also a highly regarded site for recreational purposes and events, particularly during the summer period. These aspects, along with the number of reported weed incursions in previous years and its close proximity to lakes Rotoehu and Rotoiti (which harbour a number of aquatic pests), made it a high priority site for surveying and educating users. Its location makes it easily accessible to users from all over the Bay of Plenty region and its popularity attracts regular visitors from all over New Zealand.

Lake Rotoiti is a large lake and is popular with users from both Rotorua and Tauranga. In previous years it has been noted that the Okawa Bay and Hinehopu boat ramps contained large amounts of weed in and around the loading area during the summer period. However, this year, weeds were not as prevalent in these areas. This may have been due to recent storms and high rainfalls increasing the water levels in the lake and not allowing weeds to become established.

Lake Tarawera is a popular destination for fishing and other recreational activities. The lake is well known for its geothermal hot springs on its shores which attracts visitors throughout the year. During the summer months, the lake receives an influx of boat traffic from all around the country. This presents a high biosecurity risk, as it increases the potential for weeds to be moved to and from other fresh water bodies. Due to restrictions in parking space at many of the boat ramps at Lake Tarawera, efforts were largely focussed on Boatshed Bay. Boatshed Bay was ideal for users as it contained a large parking area, two boat ramps and a large turning circle.

Lakes Ōkāreka and Tikitapu were frequently visited but less time was allocated to these lakes, generally due to the most common lake use being swimming, which presents a much lower risk than boating or jet skiing. The advocates attended multiple events at Tikitapu and conducted surveys upon vessel users who were preparing to launch or leave the lake. At Lake Ōkāreka, advocates conducted most of their surveys at Boyes Beach and the DOC campsite. This provided an opportunity to engage with international travellers who tend to make up the majority of visitors to those sites and who visit multiple lakes and rivers throughout the country.

Lakes Rerewhakaaitu, Ōkaro, Aniwhenua and Matahina were only visited three times over the duration of the programme due to their remoteness and the lower concentrations of users. Of the users surveyed, it was found that the majority were locals or yearly visitors. Due to the low number of users surveyed at these sites, advocates were able to allocate more time to each individual for educational purposes.

4.1.1 Types of vessels and recreational purpose

In line with previous years, the majority of vessels and recreational lake users were outboard motorboat owners; (76%) followed by jet skis (15%). Jet Ski numbers show an increase consistent with user numbers of previous years.

As almost all users surveyed were fishing or skiing (Figure 7), education around how and why equipment poses a great risk for weed transportation was highlighted. Due to the risk of vessels and trailers as vectors, these were also an important target for checking and removal of weed fragments. As a number of trailers are built using carpet, users were urged to take more care when checking and cleaning these as softer substrates are capable of staying wet a lot longer, prolonging the life span of weed fragments and algal cells.

4.1.2 Origin of users and last waterbody used

The majority of users surveyed this summer came from the Bay of Plenty region, making up over 50% of total lake users surveyed (Figure 10), with 22% coming from Tauranga followed Rotorua (21%) and Whakatāne (11%).

Users from areas which are considered to be high risk include water bodies within the Auckland region (10%), Waikato (8%) and the South Island (3%). These areas have been considered high risk due to the abundance of aquatic pest weeds, fish and didymo. Users from these areas made up 21% to the total users surveyed. A large number of these users stated one of the main reasons they travel to the Rotorua lakes, is their superior water quality and belief that the Rotorua lakes have an absence or low number of aquatic pests.

Users surveyed from the South Island increased by 2%. These users are considered to be high risk. Due to the proliferation of didymo in the South Island, users from the South Island present a high risk of transferal of didymo to the North Island.

Overseas users are also considered high risk due to their lack of knowledge around biosecurity matters specific to New Zealand, as well as movements between catchments. Users from overseas made up 11% of all lake users, most of which were spoken to at campgrounds. This was a large increase over previous surveys.

Vessel owners also largely originate from the Bay of Plenty region, creating a total of over 50% (Figure 10). Twenty six percent of vessel owners were from Tauranga, followed by Rotorua (23%) and Whakatāne (13%). Ten percent travelled from the Auckland region, 8% from Waikato and the South Island (3%).

Most users (74%) stated they had not visited another fresh water body in the two weeks prior to completing the survey. When prompted further, some users would admit to having done so, casting some doubt over the accuracy of the results. During the previous summer period, 57.5% of users had previously been in another Bay of Plenty waterway. Compared to the current 18%, perhaps the difference in question format, with the addition of the two week timeframe, removed some bias in answers given.

4.1.3 Levels of pest plant and algae awareness

Two questions were asked to determine levels of aquatic pest awareness among water users. Firstly, users were asked if they had any knowledge of any freshwater pest plants (and algae) that are an issue in New Zealand. If users answered yes, they were then asked to name them. Among lake users, 76% said they knew of some. When asked to name them, 67% could name, without prompting, one or more of the pest plants or algae as listed in the survey app.

The perceived high level of awareness is very positive; however, as the questions during this summer period differed slightly from previous surveys, the data is not totally comparable to previous years.

Questions regarding pest fish were not included in this year's survey so levels of awareness and interest were unable to be quantified. However, due to the recent incursion of catfish in Lake Rotoiti, information about pest fish, particularly catfish, was made available to all users.

Most users were concerned about the presence of catfish in the Bay of Plenty; this feedback was consistent with previous survey results. It is expected that interest and overall awareness of pest fish might increase, and therefore subsequently interest and awareness in pest plant and algae species may also increase in future.

Although users, when surveyed, were asked to give a yes or no answer, as to whether or not pest plants impact their lake and river enjoyment (Appendix 3), the responses were highly variable (not just yes or no). Responses were likely biased towards responses to pest plants rather than aquatic pests overall, resulting in the exclusion of response data in this report.

4.1.4 Users who Check, Clean, Dry

This year, 74% of lake users surveyed claimed to Check, Clean, Dry to some extent when moving between waterways. Six percent of users stated that they didn't move between fresh waterways. The Check, Clean, Dry question posed in previous years was in reference to 'before launching', versus this year's reference to 'actions to stop the spread'. In previous years, advocates spoke with users prior to them using the lake, in order to determine which water body they had most previously used. With this, users were educated around the correct cleaning procedure before launching vessels, particularly if they were found to have last been at a more infested water body. Seventy four percent of lake users from the previous survey stated to Check, Clean, Dry method to some extent before entering the waterway.

Regardless of what users reported doing, information and material containing the key messages was provided to all of those who either did not have any cleaning equipment, or, to those who had run out from previous years, including those who may have become complacent.

During the summer period, emphasis was placed upon reminding users of the ease by which aquatic pests are transferred. This included educating users on how they are capable of being vectors, by way of not cleaning gear or checking for weed fragments. In particular, the ease of spread by a single weed fragment, which could also be carrying pest fish eggs, as well as a single drop of water as a means of spreading algae, was highlighted.

4.2 River surveys

This summer period, 44 river users were surveyed. As the river sites are often frequented at more random times and occasions, visits were much less than those at the lake sites.

4.2.1 Types of vessels and recreational purpose

While conducting surveys at different river sites in the Bay of Plenty, kayakers made up a total of 82% of users. The high number of kayakers surveyed this summer is consistent with previous years, which allowed advocates to tailor their discussions to this particular audience.

It was observed that kayakers and white water rafters in the Bay of Plenty had a close and well connected community. For this reason, issues such as freshwater pest and cleaning vessels were well communicated among these users. Many had kayaked in the South Island and had directly observed the effects of didymo. This further encouraged the awareness/need to clean vessels among the kayaking community.

As only 11% of the users surveyed were fishermen, yet fishing is a largely popular activity specific to this region, data may not be a true reflection of all river users. Therefore, it could be beneficial to increase efforts around reaching those users effectively and efficiently.

4.2.2 Origin of users and last waterbody used

River users surveyed this summer period were mostly from the Bay of Plenty region (50%), with 32% originating from overseas and the remaining from other north and south Island regions. Similarly, the same majority of user's most previous waterbodies visited were within the Bay of Plenty region (50%). Aside from 11% of users recently visiting other north and south island regions, 39% of users stated to not have used another fresh waterway in the two weeks prior, perhaps in correlation of the percentage of overseas visitors.

Users surveyed from the South Island this summer period made up 2%, however, results from the previous summer period did not include this data, so is therefore incomparable. These users are considered to be high risk due to the proliferation of didymo in the South Island and therefore the risk of transferal upon the North Island. As with the lake data and similarly to South Island users, overseas users are also considered high risk due to their lack of knowledge around biosecurity matters specific to New Zealand, as well as movements between catchments. Further collection of this data would be useful for future comparisons, particularly as the previous reports showed 100% didymo awareness yet only 40% reported having check and clean before launching.

4.2.3 Levels of pest plant and algae awareness

Although surveys completed at river sites were less than that of lake surveys, 86% of river users claimed to have some level of knowledge of problem pest plants or algae. Similarly, 68% of those who gave this response were capable of naming one or more, unprompted, of the species as listed in the app. Although not displayed in the results, didymo awareness was the highest of all other species named among these users.

4.2.4 Users who Check, Clean, Dry

As with the lake user surveys, river users were asked to describe which actions they took in order to stop the spread of freshwater pests. Of the river users, 82% reported to adopt the Check, Clean, Dry method between waterways, with 2% stating to not move between waterways on the same day. During the previous summer, it was found that 60% of the river users surveyed did not. However, as stated in the lake survey discussion, users were asked whether or not they used the method before entering the water at that time, rather than between waterways. Also, survey numbers were different which doesn't allow for comparisons.

As pest awareness among river users is higher than that of lake users (86% versus 76% as above), this could be attributed to didymo education and information in the South Island. As didymo has been shown to be capable of establishing itself in the North Island, education around transferal and cleaning methods must remain in place and of high importance.



Figure 30 A group of kayakers at the Wairoa Dam show their support of the Check, Clean, Dry message.

4.3 Boat wash surveys

The primary objective of the boat wash was to reduce the spread of aquatic pests by cleaning boats and also educating vessel owners and the general public alike, about the aquatic pest issues in the Rotorua lakes and preventative actions that could be taken to help stop the spread.

Vessels were not required to go through the free boat wash station but the summer advocates and the boat wash operators encouraged vessel owners to make use of the free facility. For those who did use the boat wash, an information pack containing educational material about the 'Check, Clean, Dry' Campaign and other merchandise was provided. Once the wash down process was complete, the boat wash operator completed a survey with vessel owners, see Appendix 9.

The overall response by vessel owners and members of the public alike was very positive. The boat wash was a useful tool for engaging with lake users as people showed curiosity towards the boat wash and an interest in what it was intended to achieve.

The boat wash serviced a total of 129 vessels over the summer period with 39 of those being serviced during the one-day FLOCHELLA event at Lake Tikitapu. While the overall number is a significant decrease from the previous year's number of 203, poor weather conditions over the summer period meant that the boat wash was not used as frequently.

Lake Tarawera proved to be the busiest lake for the boat wash during the 2017/2018 summer period, with 62 vessels being cleaned and surveyed. This was followed by Lake Tikitapu with 39, Lake Rotomā with 18 and Lake Ōkāreka with 12. It is important to note that the small number of surveys at Lake Rotomā is not indicative of vessel user numbers but of time spent at that site. Due to a large number of vessel owners originating from the Whakatāne District, many of these lake users only use their vessels in the ocean. Over 50% of vessel owners who used the boat wash originated from the Bay of Plenty region with 35% originating from Rotorua, 18% from Tauranga and 6% from Whakatāne. Seventeen percent of vessels came from the Auckland region and 14% from the Waikato region.

It was found that 92% of vessel owners had some knowledge of freshwater pest species, however, their level of knowledge could not be quantified due to a lack of questions in the survey requiring more specific responses. Also, 82% of all vessel owners said that their vessels were regularly cleaned between waterways. Regardless, all users were educated about the risks of not cleaning their vessels and encouraged to do so regardless of the last waterbody they used.

This summer saw an increase in the number of vessels with weed found on them. A total of 12 vessels were found to contain weed fragments (predominantly hornwort) attached to trailers and propellers, which is an alarming 200% increase from 2016/2017 data. Six incursions were recorded at Boatshed Bay and the latter six were recorded at a single event at Lake Tikitapu.

As a precautionary measure, vessels and trailers in attendance of the FLOCHELLA event were required to use the boat wash station and were subject to inspections by the summer advocates for weed fragments. Six vessels were intercepted and found to have weed fragments attached to their trailers and propellers. Of the six vessels intercepted, one was denied entry into the lake due to the presence of hornwort (which is not present in Lake Tikitapu) found on the trailer and propeller.



Figure 31 A boat trailer heavily infested with Hornwort after exiting Lake Tarawera following a heavy storm.

4.4 Pest fish awareness

As with previous summers, educating waterway users on the lack of invasive fish species within the Bay of Plenty and the presence of catfish in Lake Rotoiti was largely emphasised. Unlike surveys in previous years, questions specific to pest fish weren't available during this year's programme. This meant that as user awareness wasn't quantified, education around distribution, dispersal and sighting procedures became an integral addition to discussions with users.

Some lake and river users made mention of some pest fish species while completing the survey, without prompting, which seemed to be largely due to their presence in our neighbouring regions. Many users also expressed some confusion around differentiating between koi carp and goldfish; so again, educating users on this as well as correct sighting procedures became vital. There were also a number of comments around differentiating between native and non-native species, largely in regard to appearance and impacts. The survey undertaken during the 2016/2017 programme indicated that awareness for pest fish was low, while a large number of users were aware of what to do in the instance of finding a pest fish. These findings serve as an indication/reminder for the need of survey questions regarding pest fish species in or around the Bay of Plenty region.

As there are a number of confirmed catfish populations in Lake Rotoiti, the threat of further establishment is possibly critical. For this reason, future emphasis must still be placed upon pest fish education and information, in order to reduce further spread.

4.5 Retail and tourism awareness

The Bay of Plenty region is highly popular among both domestic and international travellers. Both retail and tourism outlets were visited in order to gain information in relation to the wide range of freshwater activities available within the region. Providing information regarding aquatic pests to these sectors has been highly successful in previous years, enabling for information to be accessed all year round among both staff and members of the public. As noted in previous years, a high level of focus was needed around backpacker hostels, holiday's parks, outdoor retail stores, and high risk tourism operations, such as white water rafting operations.

The majority of those spoken too indicated that they were happy to either continue or to become proactive communicators of the Check, Clean, Dry Campaign. By way of understanding the risks associated within their line of business or customer activities, many indicated that they would make an effort to have discussions about the campaign and its importance with their staff and customers, as well as displaying and distributing materials containing the pest awareness messages and information. Some were also interested in receiving additional merchandise to hand out to customers with new purchases, such as boat buyers.

Backpacker accommodation has always been highly targeted as the majority of people staying in this type of accommodation are often widely travelled. Those travellers often move off the beaten track and can come from, or plan to visit, some of New Zealand's most remote and pristine waterways. From this, users have great potential for being vectors of didymo dispersal from the South to the North Island, therefore, education and awareness is paramount. Providing posters proved popular for these visits and tended to be displayed in common areas.

Holiday parks and outdoor retail stores, such as Hunting and Fishing, Top 10 Holiday Parks and motor boat sellers, gain business from individuals and groups who are highly likely to be lake and river users. As there is a strong relationship between the region's freshwater ways health and the success of those businesses, those owners and managers tended to be highly receptive to receiving and dispersing information and merchandise. A number of holiday parks also have wash down facilities for boats which are available to their guests.

Much like the above, high risk tourism operators also have a strong relationship between fresh water health and business success. By visiting these outlets and providing updated information regarding the current risks within the region, conversations are both encouraged and reinforced among both staff and clients. Conversations, including encouragement for these operators to remain or to become proactive in biosecurity measures, are largely complimented by the relationship formed between business owners and the Regional Council. The aquatic advocate programme is a large contributor to these relationships.

4.6 Event and school awareness

Speaking to event organisers and competitors either at briefings or during events offered the chance to not only raise awareness of aquatic pest risks, but to also provide information regarding vessel and equipment decontamination. These events can bring large captive audiences to a single location, so being granted permission to speak to a crowd of people offered the opportunity to spread awareness that would have otherwise taken a considerable amount of time and effort. Many of the competitors taking part in these summer events weren't necessarily regular users of the Rotorua lakes, therefore, potentially arriving with little or no knowledge of the freshwater biosecurity issues specific to the Bay of Plenty waterways.

As with more recent years, emphasis was put on the importance of event organisers taking responsibility for manning decontamination stations/efforts. All organisers are aware of the procedures/protocol they must adhere to in order to reduce further spread or incursion of pest species, with some organisers having chosen to introduce a form of decontamination sign off for competitors before entering the waterways.

Rotorua Half Ironman, Lake Tikitapu

In previous years, it was noted that an increase in decontamination efforts were necessary for the Rotorua Half Iron Man event. The event manager was receptive and helpful to advocates this year. It was advised that many competitors over the years have become more proactive about ensuring their gear is clean, before their arrival to the event registration. Prior to the event, competitors were briefed by organisers of the biosecurity protocol and risks relevant to our regional lakes, particularly Tikitapu, with a number of messages/reminders given via email, Facebook and the events website. At the event registration, a number of Bay of Plenty biosecurity brochures were handed out as well as other promotional material. This year, two decontamination stations (containing a 10% Simple Green solution) were also taken to the pre-event registration along with signage, reminding people of the importance of dipping their wetsuits/advising the competitors to dip their suits both before and after entering the lake. As the event does not provide volunteers to assist with the station, it would be greatly beneficial in the future to make the wetsuit dipping a condition of entry in order to ensure full compliance.

This is particularly important at Lake Tikitapu as it only contains two of the four pest weed species currently present within the Rotorua lakes.

New Zealand Water Ski Racing, Lake Rotomā

Prior to race day, organisers sent a copy of the biosecurity protocol to all event participants together with the race registration details. Due to the relaxed nature of this event when competitors aren't on the water, many of the participants were able to be spoken to throughout the day, including a number of surveys being completed. A small educational talk was also given at the events debrief by advocates, reminding participants to ensure that they 'Check, Clean, Dry' when moving between waterways. This is particularly important to participants when returning to Rotomā for future events as it lacks the highly invasive hornwort weed.

Fish and Game Boat Fishing Seminar, Lake Tarawera

The annual Fish and Game Boat Fishing Seminar was attended by advocates this year, as well as a number of previous years. The half day event provides the opportunity to speak with a large number of fishermen/women, both those who are new to the sport and those more experienced. This year's seminar coordinator kindly provided some time in the schedule for advocates to address everyone, allowing the 'Stop the Spread' and 'Check, Clean, Dry' messages to be reiterated. Information regarding the Weed Cordons (Lass & Eldershaw, 2012) currently in place was also discussed; highlighting details relative to the purpose of the cordons, as well as possible effects around trout fishing (see Figure 31). At the conclusion of the seminar, advocates were provided some time to talk with some of the fishermen further, including answering questions and handing out promotional material. Promotional lures were included in the material handed out this year and were very well received, allowing for more individual conversations to be had.

Jet Ski Riders Association, Lake Rotorua

With many of the association's competitions often taking place in Lake Taupo, inclusive of regular attendance by DOC staff, the event organiser was happy to be contacted in regards to biosecurity protocols within the Rotorua lakes. At a previous time, this event was held at Lake Rotomā, which only contains two of the four pest weeds of concern within the surrounding lake. It was therefore a condition that the boat wash be used for every participant's vessel entering the lake. This year, the conditions of use didn't contain the compulsory boat wash at the event, on account of it being held in Lake Rotorua. The organiser mentioned that all racers were informed of the necessary cleaning procedures which were to be strictly adhered to before or during the event registration check-in. This included a friendly reminder message sent out via Facebook on the BOPRC's behalf, reminding racers of the current state of the Rotorua lakes, and to 'Stop the Spread' and 'Clean, Check, Dry'. There was also some time for event participants to be spoken to both during the opening day briefing and one on one. Merchandise packs were also taken and distributed among racers, most of whom supported by a large group of friends and family members, therefore, likely increasing the reach of the messages.

Dewar Shield Blue Lake Rowing Regatta, Lake Tikitapu

The Rotorua Rowing Club president was spoken to prior to this event, with arrangements made for the registration check-in and first race day proceedings. Together with the standard information that is sent out, organisers included a message to all clubs to ensure vessels were clean and dry for at least three days prior to arrival at the event check-in point the night before the event. Anyone who did not follow those guidelines had their vessels and gear checked and cleaned by event staff before completing their arrival check-in process. The organisers noted that awareness and compliance with cleaning procedures had increased greatly among participants over recent years. They made a strong point that they are always aware and cautious around reducing the spread of invasive organisms, including greater caution surrounding competitors from the Waikato region. Organisers were given a range of promotional material which they chose to hand out to racers as they collected their race cards. This ensured that all clubs participating received the material and the event organisers were interested in continuing this process in future.

Blue Lake Multisport, Lake Tikitapu

The Multisport event organiser was eager to follow with previous years' events by requesting the decontamination stations and merchandise for use at the event. This year, two decontamination stations (containing a Simple Green solution) were taken to the pre-event registration location along with signage reminding people of the importance of dipping their wetsuits/equipment, including signage advising the competitors to dip their suits both before and after entering the lake. Event volunteers manned the stations themselves, where previous year's stations were run by advocates. With full compliance from all participants, the requirement to dip their suits before checking in for the race was a great success, with the necessary biosecurity requirements for the lake being fully met.

Wooden Boat Parade, Lake Rotoiti

The Wooden Boat Parade is an annual event held at Lake Rotoiti by the Lake Rotoiti Classic and Wooden Boat Association, regular users of the lake. As this event doesn't require lake closure to any extent, the event's organiser was sent an email containing a pdf version of the biosecurity protocol by advocates. For the check-in process during the evening prior to the event, merchandise was distributed among participants by the organisers and was noted to be very popular among recipients. Unfortunately, the boats entering the lake for this event were unable to enter the boat wash station due to size constraints. For this reason, additional information with the necessary cleaning methods for boats and trailers (z booklets), as well as detergent and large spray bottles for boat owners was provided.

FLOCHELLA, Lake Tikitapu

Originally known as the annual New Zealand Bomb Comp, held on Lake Taupō, FLOCHELLA is a new combined event which was held over four days on Lake Tikitapu over Waitangi Weekend 2018. FLOCHELLA is New Zealand's only water-based festival, with over 6000 tickets being sold, 50 of which being boat tickets. The event's organiser was sent a biosecurity event protocol letter, which was then sent through to those who obtained a boat ticket for the event. It was also arranged that the boat wash station would be set up on the day of the concert in order to decontaminate all boats entering the lake (see Figure 31). Each boat that entered the water was also provided with a pack which contained merchandise like those distributed at all other events. On the concert day and other days, safety divers were also in the lake for the duration of the Bomb Competition. It was therefore organised that the decontamination stations would be set up each day for the divers/those using swimming equipment of any type, and that they would be manned by event volunteers. Unfortunately, the decontamination remained mostly unused. Other merchandise, particularly spray bottles and detergent, were also supplied to the event organiser for distribution over the full duration of the event. As aforementioned, a small number of boat owners arrived to the event with weed fragments on their boat and trailer. As a result, and as it was the first time for the event to be run in Rotorua, the biosecurity protocol enforcement/lake closure consent guidelines for the event will come under review.

Kiwanis Open Water Swim, Lake Rotomā

The annual Kiwanis Lake Rotomā Swim is held on Waitangi Day each year. Like other events, organisers were sent the biosecurity protocol which was then sent on to all race participants. The organiser informed advocates that for all organised club events, cleaning procedures are well understood and adhered to. Upon check-in before entering the water to race, all participants gear gets cleaned with Simple Green solution through a spray hose which is handled by event volunteers. Merchandise for this event was also provided, including drink bottles and key rings, and was given to racers in spot prize packs made up and distributed by the event organisers.

Waka Ama National Champs, Lake Karapiro, Waikato

Due to the large volume of participants/attendees at the 2018 Waka Ama Nationals, packs of merchandise were pre-made and delivered to the event. The packs were then distributed among all of the attending clubs during their registration/sign-in on the first day of racing. This ensured that all clubs received a supply of merchandise with the 'Clean, Check, Dry' message. Like other events, the distribution to all participating clubs meant that the message was spread among racers from all over the country. Fortunately, the event announcer happily accepted a request to read a short message over the venue's loud speaker, which was repeated throughout the days over the events duration. The announcement contained/reiterated the 'Clean, Check, Dry' message, reminding attendees of the procedure, and was read on behalf of both the Waikato and Bay of Plenty Regional Councils. The announcement was also a reminder of the importance of the 'Stop the Spread' message in relation to the difference in pest species presence/abundance between Waikato waterways and the Bay of Plenty waterways.

Cambridge Town Cup and New Zealand Club Champs, Lake Karapiro, Waikato

Much like the Waka Ama Nationals event, the large amount of participants at the Town Cup and Club Champs meant that information/merchandise was distributed on the first day of the event. Merchandise was given to the event organisers and was to be distributed among the attending clubs during on behalf of both the Waikato and Bay of Plenty Regional Councils. This ensured that all clubs received a supply of merchandise with the 'Clean, Check, Dry' message. Again, the distribution among all participating clubs meant that the message was spread among racers from all over the country.

As the rowing event attracts large numbers of participants who have travelled between the South and North island, didymo awareness was high. At both events, visible weed in the lake was also commented on a number of times, followed by some comments relating to pest fish. As weed fragments on the vessels exiting the lake were highly common and visible, many people noted this as being a reason for them washing their vessels/equipment between waterways, as well as dirt from travelling on the road.

Schools

Feedback from both students and teachers following the school visits was highly positive. Visits conducted during the 2017/2018 summer period educated students on a number of risks currently associated with aquatic pests and their potential to spread within our waterways. Following the presentation, students were given a quiz, followed by spot prizes and prize packs containing merchandise. All students were also given 'Check, Clean, Dry' tattoos which they could also hand out to friends. The success of the school visits was made apparent by a few members of the public, whom, when approached at the lakes to be surveyed, commented on the 'Clean, Clean, Dry' or 'Stop the Spread' messages as a result of their children speaking with them following the visit

4.7 Other issues for discussion

Following the 2017/2018 advocacy programme and previous year's outcomes, a number of other issues for discussion and recommendations have been prepared. These issues and recommendations are also attributed to a study by Anderson et al. (2014) which assessed the effectiveness of New Zealand's biosecurity programmes, with focus on the Bay of Plenty region.

Many waterways users who had been spoken to before seemed to appreciate and benefit from being approached again. A number of these users had positive responses to the updated signage, as well as the weed cordons in place, largely due to their 'visible pest monitoring/control' aspect, as viewed by the public. They encouraged questions which in turn led to informative discussions which many people seemed to gain new awareness from. This is also reflective of the high percentage of individuals who Check, Clean, Dry, as most survey participants are from the Bay of Plenty region.

The increase in recreational waterway users, as seen by the increase in vessel owners, continues to be an issue of concern, due to their abilities as pest vectors. Of great concern during the 2017/2018 period was the large increase in jet ski riders/owners, consistent with previous year's data. Thankfully, working closely with the lakes maritime patrol team enabled educational messages to be relayed more frequently as the new owners become more familiar with both the navigational and biosecurity lake use rules.

A large number of boat owners commented on the difficulty of cleaning their boat between lakes due to resources. The boat wash station is an effective tool for reducing the spread of freshwater pest in the Rotorua lakes. In addition to cleaning boats, the boat wash provides an opportunity for meaningful engagement with vessel owners and lake users alike. However, one issue that was often highlighted by lake users was the need for permanent boat wash facilities at popular boat ramps. While the boat wash can prevent weed incursions, this is currently limited to when the boat wash is in operation.

While consistency with 'Stop the Spread' and 'Check, Clean, Dry' merchandise appears to continually and significantly raise public awareness, consistency among advocacy messages and data collection may also play an important role. While keeping with consistent messages, survey questions which are region specific and can be compared annually are likely the most beneficial to understanding both awareness and the behaviour among water users.

Part 5

Conclusion

The Rotorua lakes are significant assets to both the Bay of Plenty region and to the country. For this reason, the health of the lakes; their water quality and biodiversity, is worth protecting for today's enjoyment and for future generations to come. This can be said for all of the freshwater waterways within the Bay of Plenty region, and with the number, proximity and popularity of these waterways, they are all considered to be highly susceptible to invasion of aquatic pests by the many lake users.

The most threatening aquatic pest weeds within the Rotorua lakes region have been identified as hornwort, egeria, elodea and lagarosiphon. These four weeds contribute to water degradation and affects upon native community structures and can therefore be attributed to losses or reductions of native species. Several recreational activities have been identified over time as being the main means by which these weeds spread between lakes and waterways. These activities include, but are not limited to, fishing, kayaking and boating. Pest weeds and fragments can be moved between water bodies by becoming attached to trailers, vessels and different equipment associated with these activities. Pest fish eggs, such as those of catfish or koi carp, are also capable of movement between waterways by their attachment to those weed fragments.

In 2004, a freshwater algae called didymo was detected in a South Island waterway, resulting in widespread establishment within numerous other freshwater bodies. With its failure to establish in the North Island, its threat of incursion remains high due to its potential to spread via a single drop of water and its capabilities for proliferating. A more recent arrival, lake snow, also has potential to further its current known impacts and effects upon freshwater bodies, and is therefore a species to remain aware of relative to this programme and Bay of Plenty lakes and rivers.

The 2017/2018 Aquatic Pest Awareness Programme aimed to identify levels of public awareness and educate water users around invasive weeds (particularly hornwort), pest fish species and didymo. This summer period saw a total of 617 users surveyed at lakes and rivers throughout the Bay of Plenty region. The APAP is reaching many of those who are most at risk of causing aquatic incursions within the Bay of Plenty region. Freshwater users largely appreciate the work conducted by the BOPRC around the many freshwater ways, with many users often making positive remarks and giving encouragement. The largely positive mind set among users to 'Check, Clean, Dry' their vessels and equipment has remained more or less consistent over the duration of the programme, which is fundamental in the prevention of pests being spread.

With most of the survey data comprising of Bay of Plenty users, continued efforts are imperative to the future status of both the Bay of Plenty waterways as well as its surrounding regions. Despite shifting levels in awareness, a number of vessels and trailers were still found with weed present; this was most commonly the dominant hornwort weed. This is of particular ongoing concern, as it seems a number of people are unaware or care little about the risks hornwort poses to the cleaner lakes such as Rotomā and Tikitapu. As awareness remains crucial in its role of pest spread prevention, so too must behaviour change among freshwater way users across the country, particularly with the increasing catfish numbers in Lake Rotoiti, and as behaviours still fail to reflect awareness levels.

Part 6

Recommendations

6.1 Biosecurity recommendations

- 1 As the Bay of Plenty receives frequent visits from non-locals, it would perhaps benefit from the addition of biosecurity billboards/banners between waterways. Neighbouring and other regions would also benefit from this form of 'publicity', particularly as events attract many visitors from those regions.
- 2 Following a number of prevented incursions due to the boat wash facility, as well as numerous complaints and comments of complacency due to lack of cleaning stations, it would be beneficial to explore and perhaps implement public wash down facilities.
- 3 A review on compliance procedures by event managers and commercial operators could be beneficial as the biosecurity protocol is likely/often not fully adhered to.
- 4 Both the weed cordons and current signage around the region's waterways have been met with positive feedback and good levels of pest awareness. As not all survey sites have signage or weed cordons, an increase in those and similar efforts would be a great benefit. The consistency of appearance and information has received the most positive feedback.
- 5 As pest fish sighting reports are known to be low, the current signage and reporting methods may need to be reviewed in order to increase both correct identification and therefore reporting's from the public.
- 6 Lack of pest fish identification, although not quantified in this report, seemed to be largely due to people's inability to distinguish between pest species and native species. Perhaps more comparative material could be made available to the public. The same can also be said for pest weeds and native weeds, as well as some algae species.
- 7 Much like felt waders were known to be, vessel trailers with carpet are a good vector for pest species transfer, due to its soft substrate. It would be beneficial to further explore this in regards to the potential for banning the use of carpet on vessel trailers.
- 8 Following comments on the merchandise distributed, a lot of positive feedback was received around the 'functional' promotional giveaways such as cooler bags and drink bottles. Educational material was also well received when more concise information was given, for example, the 'Z-booklet' and the boating book given out by maritime wardens, which contained a small 'environment' section. Further collaboration between the maritime and biosecurity sectors could be very useful.

6.2 General recommendations

Survey and behaviours

- 1 The survey questions could include a type of rating system on reasons/likeness to Check, Clean, Dry, in an effort to further understand behaviour changes among freshwater users. For example, the serving of instant fines or presence of cleaning facilities.
- 2 The programme could look to include a bi-annual survey question to allow for public concerns and opinions, in order to allow for both existing and potential biosecurity initiatives to be evaluated in more detail.

- 3 In order to increase survey numbers, including region specific data, the use of volunteers such as university students could be helpful to advocates, particularly during weekends when multiple sites are busy.
- 4 Having pictures (including comparisons) within the survey app would be highly useful as many survey participants asked for this information. Those participants weren't necessarily able to access this from the signs or other information in place.
- 5 To increase knowledge of user's levels of awareness, and therefore educational efforts, survey questions could include the purpose of use when vessel owners have previously used another fresh waterway.
- 6 A number of people seem to have an attitude of 'I can't see the effects, therefore I don't care'. Perhaps a more hands and eye on approach could be established.
- 7 Following a lack of regard for health warnings issued in regards to toxic algae during the summer period, it is important to remind people of the current issues at hand. Relevance of pest concerns was often questioned, similar to the 'can't see it, don't care' attitude, as aforementioned.
- 8 Jet ski numbers are significantly increasing; therefore, it is important to engage with as many jet ski owners as possible. Attendance at events and contact with clubs is an integral part of this engagement.
- 9 As kayakers are capable of launching almost anywhere, more efforts are necessary around reaching these users. Speaking with commercial operators and clubs should be a high priority.

Retail and tourism

- 1 Begin visits to retail and related business outlets early in the summer to ensure they are well stocked with information before the busy holiday period.
- 2 Encourage the likes of fishing and boat stores to distribute merchandise when selling a boat/rod/license etc. Ensure to both provide enough material and keep in touch with managers and supervisors.
- 3 Campgrounds and backpackers often accommodate travellers who tend to partake in activities in the outdoors and should therefore be well stocked with posters/merchandise specific to didymo.
- 4 Contact rental car companies and provide them with brochures/information to hand to customers, many travellers are surveyed around lakes and have very little awareness. An increase in material in different languages would be highly beneficial.

Events

- 1 Prior to all events, contact the Water Administration Officer at the Rotorua office in order to get up to date contact details for event managers.
- 2 Contact event managers at least one week prior to their event. This is important as it ensures organisers are able to communicate messages to participants prior to arrival/registration. This also includes providing merchandise.
- 3 Seek out events where other regional staff, such as harbour patrol, will be working and arrange to collaborate. This can include material distribution and speaking with water users.
- 4 If possible, arrange to speak about aquatic pests and cleaning vessels and equipment at event briefings. This can also include event debriefs.

- 5 Encourage organisers to be proactive in decontaminations efforts; this largely includes providing a decontamination station which would ideally be supervised by event staff/volunteers and run during the pre-event registration. Also, encourage the use of the boat wash at as many events as possible.
- 6 Contact water user clubs and arrange to speak at events and share information around pest management/pests, relative to both the Bay of Plenty and nationally.

Additional

- 1 Having a copy of the 'Boating in the Bay of Plenty' booklet is helpful to have on hand, as many people have questions about information given in the book, for example safety and navigation rules.
- 2 It is useful for advocates to be familiar with navigation rules and to be prepared to take down details for the harbour wardens. This also includes relaying information between wardens and advocates at times.
- 3 Visit more remote locations, such as Lakes Rerewhakaaitu and Matahina, and rivers, during busy periods to ensure that travel time is justified, and to reach high numbers of campers/tourists during peak times.
- 4 The Wairoa Dam release kayakers, usually arrive an hour or so prior to the release. This is a great time to survey the river users and distribute merchandise. Generally, river sites require fewer visits due to the same users being frequent visitors.
- 5 It is helpful to have a general understanding of the statutory obligations of the organisations concerned with the lakes and rivers. Many members of the public ask questions not directly relevant to Regional Council. This also includes having contact details on hand.
- 6 Following bad/rough weather, a large amount of weed fragments become dislodged at the more heavily infested lakes, such as Rotoiti. For this reason, efforts are best to be focused around least infested lakes such as Rotomā during those subsequent days.

Part 6

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Appendices



The current known distribution of four pest weed species between eleven of the Rotorua lakes



Aquatic Pest Coordination Group Biosecurity signage at the Rotorua lakes



Appendix 3

National Science Challenge Survey

×


My Survey

☰

Date: *
1 January 2018

Waterway: *

Region:

Location: *


Location Notes:
If there is no cellphone coverage or offline basemaps in the current area, notes about the current location can be entered here. The survey can then be saved and the location can be placed on the map when back in mobile coverage.

Event Name:
If required

Location where interview took place: *

User type: *

✓

×

My Survey

☰

What is your current country of residence *
New Zealand

Town/City (or nearest)

Region of residence

How often do you visit this lake/river? At least... *

Do you know of any freshwater pest plants that are problems in New Zealand? *
☐ Yes ☐ No

Have freshwater pest plants impacted on your enjoyment of any lakes and rivers? *
☐ Yes ☒ No

Which (if any) of these actions have you personally taken to help stop the spread of freshwater pests?
☐ Checked equipment
☐ Cleaned equipment
☐ Dried equipment
☐ Frozen equipment
☐ Used different sets of equipment for different waterways
☐ Decided not to move between waterways on the same day

In the last 2 weeks, have you visited other lakes/ivers? *
☐ Yes ☐ No

✓

Appendix 4

Ministry for Primary Industries and Bay of Plenty Regional Council material distributed

From Ministry for Primary Industries

- 250 mL and 1L Check, Clean, Dry(CCD) spray bottles
- 20 mL biodegradable detergent sachets
- Z-booklets “How to: Check, Clean, Dry”
- CCD posters (various designs in A3 and A4 sizes)
- CCD “Protect your Patch” brochures
- CCD temporary tattoos
- CCD bumper stickers
- CCD pens
- CCD key rings

From Bay of Plenty Regional Council

- CCD trout lures
- CCD, Pest patrol and Stop the Spread T-shirts
- CCD, Pest patrol and Stop the Spread Hoodies
- CCD, Pest patrol and Stop the Spread floating key rings
- CCD, Pest patrol and Stop the Spread drawstring bags
- CCD, Pest patrol and Stop the Spread trout bags
- CCD, Pest patrol and Stop the Spread lanyards
- CCD, Pest patrol and Stop the Spread waterproof phone cases
- CCD, Pest patrol and Stop the Spread cooler bags
- Pest patrol and Clean your boat, trailer and propeller fluorescent propeller flags
- Pest patrol and Clean your boat drink bottles
- Pest patrol and Clean your boat ponchos
- Pest patrol and Clean your boat tie down

Appendix 5

Retail and tourism outlets visited

| Rotorua sites | Name |
|--------------------------------|-----------------------------------|
| Retail outlets | Dive HQ |
| | Hamills |
| | Hunting and Fishing |
| | Kathmandu |
| | Macpac |
| | Mourea Mini Mart |
| | O'Keefes |
| | Okere Falls Store |
| | Outdoorsman Headquarters |
| | Rotomā Trading Post |
| | Stirling Sports |
| | Telfer Marine |
| | The Happy Angler |
| Tourism outlets | Agrodome |
| | Agrojet Jetboating |
| | Buried Village |
| | Kaitiaki Rafting |
| | Kaituna Cascades |
| | Lake Tarawera Water Taxi |
| | Mitai Maori Village |
| | OGO Zorb |
| | Outside The Zorb |
| | Paradise Valley Springs |
| | Rainbow Springs |
| | Redwoods Information Centre |
| | River Rats |
| | Rotorua White-Water Rafting |
| Accommodation | All Seasons Holiday Park |
| | Blue Lake Top 10 Holiday Park |
| | Cactus Jacks Backpackers |
| | Cosy Cottage Thermal Holiday Park |
| | Crank Backpackers |
| <i>Accommodation continued</i> | Crash Palace |
| | Funky Green Voyager |

| | |
|--|-------------------------------------|
| | Holdens Bay Top 10 Holiday Park |
| | Lake Rotoiti Holiday Park |
| | Oasis Hostel |
| | Planet Backpackers |
| | Regent Flashpackers |
| | Rotorua Central Backpackers |
| | Rotorua Family Holiday Park |
| | Rotorua Thermal Family Holiday Park |
| | Spa Lodge Backpackers |
| | Waiteti Trout Stream Holiday Park |
| | X-base Backpackers |
| | YHA Backpackers |

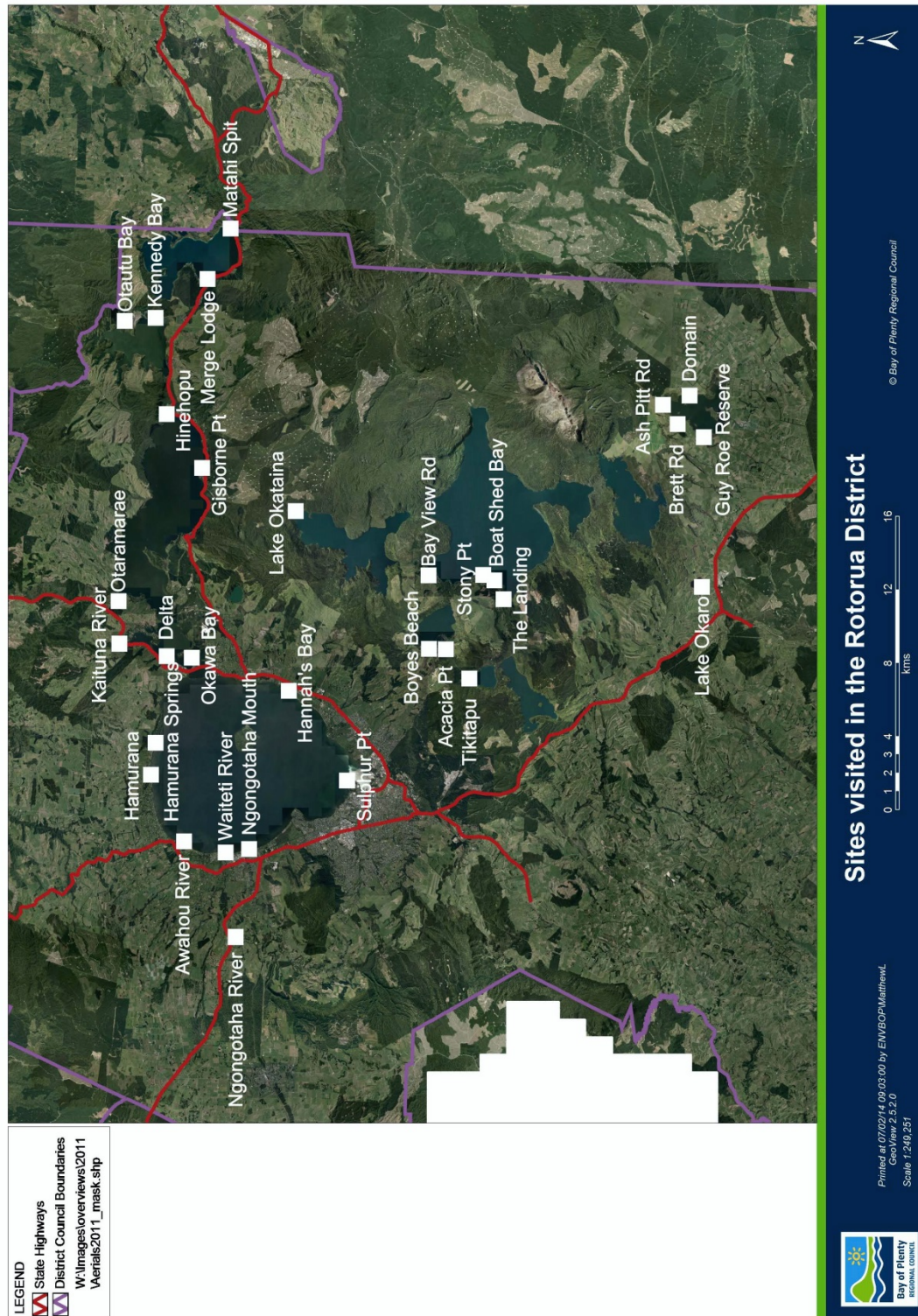
| Tauranga sites | Name |
|------------------------|---------------------------|
| Retail outlets | Bay Marine |
| | Bivouac Outdoors |
| | Broncos Outdoors |
| | Burnsco Mount Maunganui |
| | Burnsco Sulphur Point |
| | Condor marine |
| | Decoro fishing |
| | Hamills |
| | Hunting and Fishing |
| | Kathmandu Bayfair |
| | Kathmandu Tauranga |
| | Macpac |
| | Sportscraft Boats Limited |
| | Sportsworld Te Puke |
| | Steve's Marine Supplies |
| | Stirling Sports |
| | The Bait Shop |
| | The Boat Place |
| | Top Catch Sulphur Point |
| | Top Catch The Mount |
| Tourism outlets | Mount Maunganui i-site |
| | Waimarino Adventure Park |

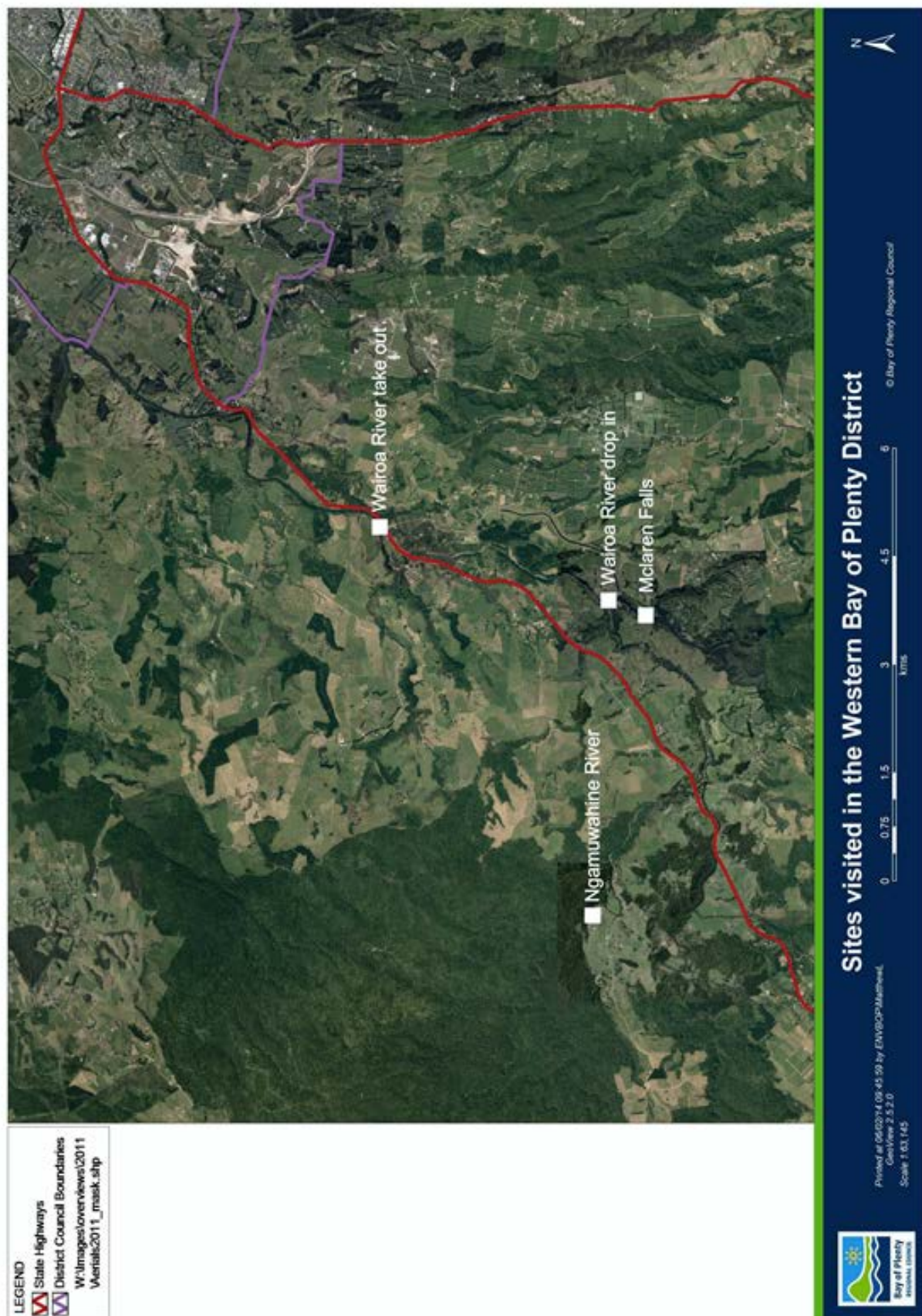
| | |
|----------------------|---------------------------------|
| Accommodation | Apple Tree Backpackers |
| | Beachgrove Holiday Park |
| | Bell Lodge Backpackers |
| | Harbourside Backpackers |
| | Just the Ducks Nuts Backpackers |
| | Kiwi Corral |
| | Loft 109 |
| | Mount Backpackers |
| | Mount Beachside Holiday Park |
| | Pacific Coast Lodge Backpackers |
| | Tauranga Tourist Park |
| | Te Puke Backpackers |

| Whakatāne sites | Name |
|------------------------|---------------------------------|
| Retail outlets | Fishing and More |
| | Great Outdoors |
| | Hunting and Fishing |
| | Iceman |
| | Kathmandu |
| | Sea Marine |
| | Sportsworld |
| | Stirling Sports |
| Tourism outlets | White Island Tours |
| | Whale and Dolphin Watching |
| Accommodation | Karibu Backpackers |
| | Lake Aniwhenua Lodge and Motel |
| | Tuscany Villas |
| | Windsor Lodge Backpackers |
| | Tauranga Tourist Park |
| | Te Puke Backpackers |
| | Mount Beachside Holiday Park |
| | Pacific Coast Lodge Backpackers |

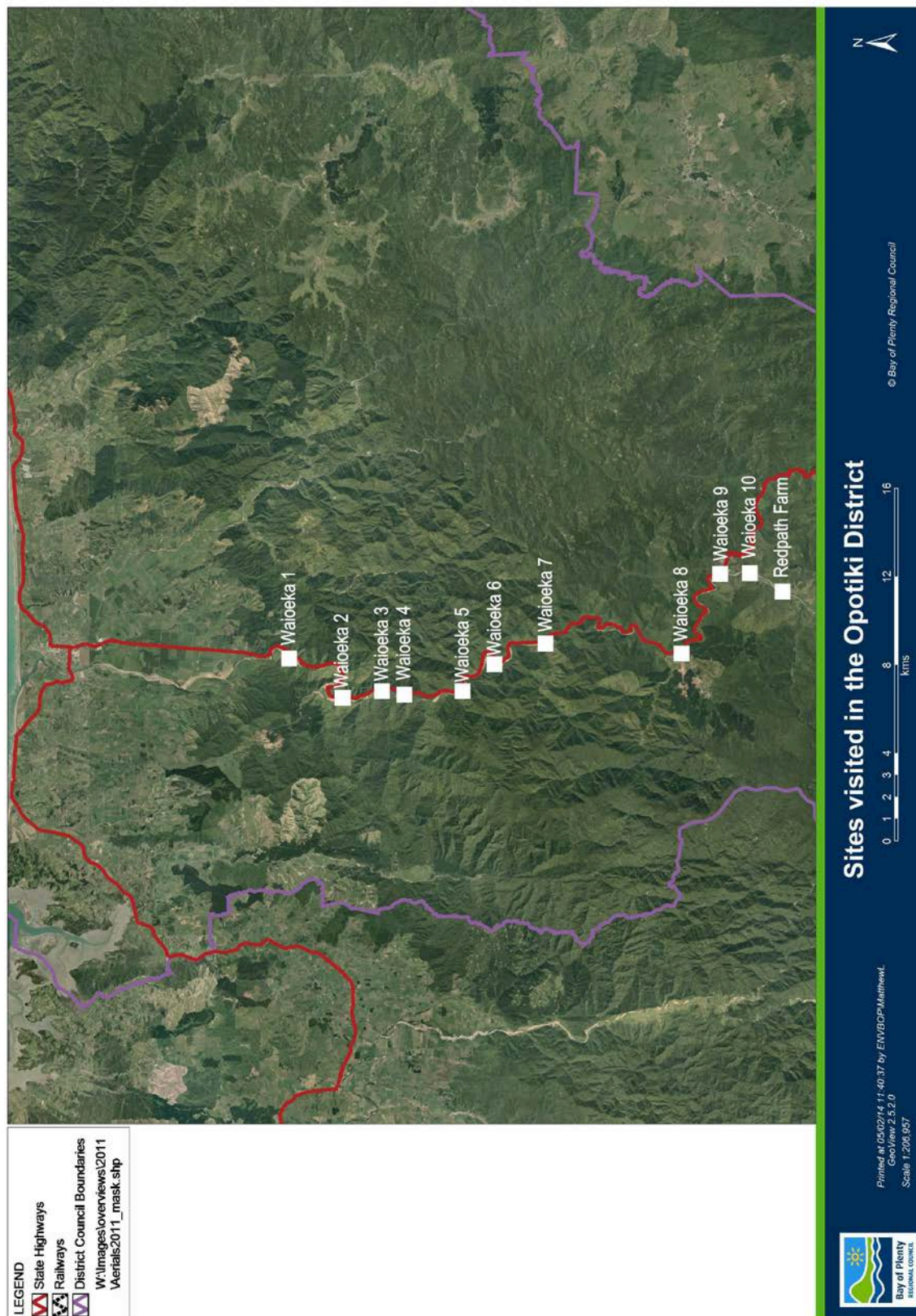
Appendix 6

Sites visited in the Bay of Plenty region









Appendix 7

Biosecurity protocol letter for events



22/09/2015

Bay of Plenty Regional Council's biosecurity protocol for prevention of aquatic pest species incursions during events

Read and abide by this protocol in order to partake in events in Bay of Plenty waterways. Failing to properly clean and decontaminate vessels and equipment before entering any Bay of Plenty waterway is a significant risk. It is an offence under Section 52 of the Biosecurity Act to knowingly communicate a pest or unwanted organism e.g. transport it from one waterway to another. The penalty upon conviction, for an individual person, is imprisonment for a term not exceeding five years and/or a fine not exceeding \$100,000.

Introduction

Bay of Plenty Regional Council (BOPRC) is responsible for managing pests named in the Regional Pest Management Plan for the Bay of Plenty region 2011-2016 (RPMP). Council use powers under the Biosecurity Act 1993 to ensure compliance with the RPMP and to protect the region's natural environment from pests.

The Bay of Plenty region contains a number of lakes and rivers which are popular places for people to recreate and provide habitat for native plant and animal species. Pests can degrade the quality of our waterways and impact on native species and people's enjoyment.

High risk activities and species

The Bay of Plenty is free of a number of pest species, and while some exist within the region, many lakes and rivers remain free of these problematic species. A number of pests are present in New Zealand, the goal of the RPMP is to prevent further pest establishment in the Bay of Plenty.

Particular attention needs to be given to those users who enter Bay of Plenty waterways soon after using Lake Taupō, the Waikato River and all its hydro lakes and many water bodies in the Auckland region where a number of aquatic pests reside.

Vessel cleaning and decontamination before entering Bay of Plenty waterways

All vessels and equipment used as part of any event in the Bay of Plenty region must:

- 1 Be thoroughly cleaned before entering and/or moving between water bodies, remove visible live and dead animal and plant material from trailers, anchor wells, nets, waders, fishing equipment or any other spaces or items potentially housing a pest species.
- 2 Decontaminate all equipment before entering any Bay of Plenty waterway, instructions for the correct decontamination procedure can be found at: <http://www.biosecurity.govt.nz/files/pests/didymo/2010-freshwater-pests-leaflet.pdf> or by contacting a member of BOPRC's Biosecurity Team.

- 3 Ensure all jet skis or jet boats have had their jet unit flushed prior to entering the lake. Jet units are particularly risky in terms of pest spread.
- 4 Ensure all boat trailers are clean, all cavities drained and free of any living or dead plant or animal material. Pest species, particularly pest fish can use these spaces and can be easily transported, particularly if trailers are left submerged in water bodies for extended periods.

Bay of Plenty Regional Council's RPMP rules regarding the transfer of aquatic pests

Rules apply in regard to aquatic pests within the Bay of Plenty region, BOPRC are authorised under the Biosecurity Act 1993 (the Act) to ensure compliance with these rules. Failing to properly clean and decontaminate your vessels and equipment prior to the event could amount to knowingly communicating a pest, a breach of RPMP rules. Those responsible will be prosecuted under the Act.

Offences

- 1 A breach of any RPMP rule is an offence under Section 154 of the Biosecurity Act 1993 with individuals liable on conviction of a fine up to \$5,000.**

Regional Pest Management Plan rules, statutory obligations regarding pest species

Rules specific to aquatic pest species are dependent on their classification. Below is a list of aquatic pest species managed under the RPMP and for whom the rules and statutory obligations apply.

| RPMP classification | Aquatic pest species |
|----------------------------|---|
| Agency Pests | Didymo, Hydrilla, Salvinia, Water hyacinth |
| Exclusion/Eradiation Pests | Alligator weed, Marshwort, Senegal tea, Spartina, Water poppy, Brown bullhead catfish, Koi carp, Perch |
| Containment Pests | Egeria densa (Brazilian waterweed), Hornwort, Lagarosiphon major (oxygen weed), Yellow flag iris, Rudd, Tench |
| Restricted Pests | <i>Elodea canadensis</i> (Canadian pondweed), Mexican water lily, Parrots feather, <i>Gambusia</i> |

The intentional spread of any of the species listed above is an offence. Below is a summary of the plan rules and statutory obligations related to the RPMP.

| RPMP Rules | Rules |
|--|---|
| No person shall move or interfere with any article or substance left in place by an authorised person for the purpose of monitoring, controlling or eradicating any pest plant or pest animal. | Section A(1), B(1), C(1), D(1), E(1) F(1), G(1) |
| No person shall move, or allow to be moved, any machinery, vessel, organism, risk goods or other goods that are contaminated with any pest. | Section B(2), C(3), D(6), E(3) |

| Statutory obligations | |
|---|--|
| No person shall knowingly communicate, cause to be communicated, release, or cause to be released, or otherwise spread any Exclusion and Eradication pest plant or animal | Section A(2), B(3), C(4), D(7), E(4), F(2), G(2) |

For more information on Aquatic Pests visit <http://www.boprc.govt.nz/environment/water/aquatic-pests/> or contact a Regional Council Biosecurity Officer on 0800 884 880.

Appendix 8

Department of Conservation pest fish sighting signage

STOP THE SPREAD . . .

and keep Rotorua lakes free of pest fish

Report any sightings of **KOI CARP** or **CATFISH**



Photo: S. Chatterjee

Koi carp 3-70 cm



Koi carp
Photo: NIWA



Photo: D. Ward

Catfish 3-40 cm



YOU can help by

- **PHOTOGRAPHING** any specimens caught and forwarding to your local DOC office
- Following Check Clean Dry protocols



Why are invasive species a problem?

- Reduce water quality
- Can compete with native species and trout

Other fish of particular concern are rudd and gambusia.



Rudd Photo: NIWA



Gambusia Photo: D. Ward

It is **ILLEGAL** to possess, control, raise, consign or spread invasive species.
(Freshwater Fisheries Regulations 1983)

For further information, or to report suspicious fish, contact your local DOC office or phone 0800 DOC HOTline



Department of Conservation
Te Papa Atahuri



Fish & Game
NEW ZEALAND



Waikato Regional Council



Bay of Plenty
REGIONAL COUNCIL

Appendix 9

Boat wash survey

| | | | | | | |
|---|---------|--------------|-----------|-------|---------|-------|
| Date: | | | Location: | | | |
| Weather: | | | Vessel: | Boat | Jet Ski | Kayak |
| Place of residence: | | | | | | |
| Purpose of voyage: | Fishing | Water sports | | Other | | |
| Water source previously come from: | | | Lake | Sea | River | |
| Location: | | | | | | |
| Do you know about aquatic weeds/fish: | | | Yes/No | | | |
| Do you clean your vessel prior to changing water sources: | | | | | Yes/No | |
| Aquatic weed found on vessel: | Yes/No | Type: | | | | |