Phragmites karka Scale up Trials 2022 to June 2024

Prepared by

Awahuri Forest Kitchener Park Trust

For

Horizons'- Kanorau Koiora Taketake - Indigenous Biodiversity Community Grants

Copies to key alliances and partners
Horizons- River Engineers, Biodiversity, (LTP) Councillors
MPI Bio Security – Pest Management Programmes.
Manawatū District Council – Parks and Reserves, Councillors
Kauwhata INC- NKONK.
Landcare Trust- Manawatu-Whanganui Region
Green by Nature-Manawatū

Horizons Biodiversity Fund August 2022 to June 2024 AF/KP Trust

INDEX

Project Manager, Awahuri Forest Kitchener Park Trust – Bessie Nicholls, Trustee

Contracted:

R & D Manager, Green by Nature – Aaron Madden, Biodiversity Project Manager

1. Overview

This demonstrates what the $81,300 dollars over two years from the Horizons Kanorau Koiora Taketake Biodiversity Community Grant July 2022 to June 2024 has been used on:
1, Applied Research and Development inputs, outputs and outcomes to date. Science report Plus gifted and uncharged time and resources
2, The peripheral supporting and strategic activities outside of the applied R&D costs.

A. Actions finished.
B. Actions still in motion.
C. Actions/recommendations that still need to be actioned to support containment/control of *Phragmites karka* infestations primarily in AF/KP, in waterways, across the Horizons Region, and Nationally.

Through this funding, the AF/KP Trust has found methodologies that look promising for containment/control of *Phragmites karka*. These methodologies have been developed specifically under compliance and protection requirements around ecosystems in streams, rivers, bogs, flood plains, wetlands, riparian plantings and wetland forests ecosystems. Unfortunately, what we have developed at this point is expensive and highly labour intensive, particularly when taking into consideration the existing spread of this weed across three Regions and specifically in the Horizons Region. Further work needs to be done to refine methods to make them more cost effective and applicable to the new infestations on our coastlines. There also needs to be long-term monitoring to ensure outcomes are permanent and not just seasonal success.

At no point does the AF/KP Trust claim to have complied with pure scientific methodologies. Our work has been documented and relies very much on actions and observations live in the field. Our intent was, and still is, applied R&D with the objectives to find management mechanisms and methodologies that work quickly in our environments/ecosystems and promote rapid workable solutions. This approach may be unacceptable to pure science, but we do not have the luxury of funds or time as this weed spread seems to be accelerating faster than it has in the past.

2. Compliance with Contract

1. January to April 2024 reporting methodologies – via public event held on 25th March. Podcast and event slides already submitted and available to Horizons and public.
2. Final report due 30th June 2024 – attached.

Additional requirements

a) Validating initial R&D – ways of managing *Phragmites* in the Park.
b) Taking more successful plot trials to scale up across AF/KP and into Makino Stream and other sensitive areas. Monitor plots and scale up areas.

c) A senior scientist from MPI will monitor and supervise on an ongoing basis for two years. Prepare final report that pro-optimum control strategies for Phragmites karka that are endorsed by MPI supervisor and results published

a. Primarily two initial R&D plot methodologies pre-Horizons support were taken forward. Other learnings from other plots were also taken forward and incorporated into the project thinking and design. The first was the tarpaulin plots part of the project. This was partially successful, but proved to be quite impractical to apply to many ecosystems this plant is found in. This method could potentially be used in small, isolated sites and followed up with sprays or cut and fill method to eradicate an infestation totally. The second being the cut and fill method was taken forward to fine tune methods of application, best equipment, and optimum rates of chemical used. Additional methodologies were looked at and refined across different ecosystems. One of these is currently showing signs of success, but the outcome will not be known for several seasonal cycles. These are all recorded in the technical report from the Trust's contractor, Aaron Madden from Green by Nature. Further research on many questions that have arisen have not been done due to time and cost restraints e.g., rhizome uptake of chemicals.
b. The most successful methodology, cut and fill, was scaled up and taken into sections of the Makino Stream and the Rangitikei River. This method was also approved by Horizons Compliance Team to ensure it didn't harm stream and river life. Spraying chemicals in these ecosystems carries a much higher risk and requires a resource consent, which may be difficult and certainly require a lengthy process to get. This is why focus on this methodology is so important. Most of the infestations across the region are in ecosystems that will require this type of methodology. From the stream and forest plots we learnt more refined delivery methods to increase the weed management success. When working on and assessing these delivery methods it is apparent the cost of the manpower is expensive. Further work is being done on a different spray method that will possibly in time be a precursor, weakening the plant and reducing the cost of application of the cut and fill method. This could be applied on areas that are not directly within river and stream channels. Time and several seasons are required to refine this methodology and assess any regrowth. It should be noted over the time of this R&D project more infestations have occurred in the forest itself due to flood-borne materials. It is a similar story along all the downstream areas in waterways and out onto our beaches.
c. The senior scientist from MPI for the first 18 months of this project was Dr Andrea Clavijo McCormick. Dr Andrea continually supported the project with science input and visited the site for two days, assessing and discussing methodologies and strategic inputs into the project. Dr Andrea participated in multiple phone consultations and also joined the Trust when presenting on webinars. Dr Andrea's role in MPI changed as she was promoted to another role. Callum Mclean, a scientist responsible for the nine national eradication plants, and Jasmine (Jazz) Hessell, a frontline MPI person were then appointed in her place. Jazz also attended and participated in the education day the Trust initiated and ran, supported by Landcare Trust, in May 2024. This time, work, and knowledge was not charged to the Trust or the project. It is all MPI's contribution in kind to the project.
d. The control strategies developed to date were published and shared in the education event on the 25th of March 2024. It is planned at this point a second much wider event on best practise Phragmites will be initiated by MPI later this year. Due to significant restructuring in

government department this is not assured at this point. Time working on this project. The Trust has exceeded the time requirements spent on this project. Due to the most successful method of management to date being incredibly labour intensive and application method used high volumes of chemical the Trust, under its existing MOU with Ngāti Kauwhata, brought in their Jobs for Nature team. This was under supervision of the Trust and our contractor Aaron Madden. Each of the Kauwhata team is registered under GrowSafe to manage some chemicals but they do not have transport or storage facilities. Only a small portion of their time is allocated to the cost of the project. Also, volunteer Trustees on desk research, identifying regional spread and ecosystem and types of infestations and strategic actions.

3. Background

a. History

Phragmites karka has been in the Horizons region for many years. Although it was first noted in the Tangimoana estuary in 2006, it was well established in that area by that point in time. Initially, this infestation was identified as *Phragmites australis* and then *Arundo donax* and then eventually as *Phragmites karka*.

A site identified in March this year in Whanganui city has been anecdotally reported to have been present in the mid-1990's and thought by locals and maintenance people to be a bamboo species.

A visible site by the South Street bridge crossing the Makino stream in the township of Feilding was also thought to be bamboo. Anecdotal conversations and references indicate it may have been there for well over ten years. When identified as *Phragmites karka* in late 2019, the response from local people, Council etc was "we thought it was bamboo". This common response is part of the reason this weed has spread so effectively across the Region. No one knew what this plant was as no one has educated the public about its existence over the last 18 years.

There are several stories and proposed ideas as to how this weed came to be in the Region. As this weed is now so widespread and has adapted to numerous ecosystems, it is no longer relevant as to who brought it in or how it was introduced to the Region. To look for the source of infestation and control from this is no longer possible, nor does it help with trying to manage it now.

Although this weed has been known to be in the Region for 18 years little attention has been given to it. The Ellison Reserve group in Tangimoana were supported intermittently to manage it around the boat ramp. They also brought it to Horizons under the LTP consultation in 2018. Nothing came of this. Horizons started to look at *Phragmites karka* in 2015 and even ran a small trial looking at effects of spraying it with various herbicides. This faded out when the staff member concerned left Horizons. In 2019 AF/KP Trust started questioning why they were having increased spread of a reed in the forest. They were told by Horizons it was *Arundo donax*. The Trust took this to MPI Biosecurity and found it was *Phragmites karka*, a sister plant to *Phragmites australis* – a registered plant in the National Interest Pest Responses (NIPR) Programme.

The Trust believes *Phragmites karka* should be a registered weed in the Horizons region and potentially Nationally due to its identified behaviours and spread creating risk to other Regions. Nearly all information is now available to progress toward this. At a minimum, there needs to be an awareness promotion of this weed and its risk in general. We have now clearly identified spread mechanisms are both waterborne and human activity. Public ignorance is a key issue and awareness could reduce some of the spread.

b. Spread and nature of infestations.

In the Horizons Region, we now have four significant waterway infestations plus infestations in sand dunes, on beaches, and random isolated sites on roadsides, in paddocks, in parks and a native wetland forest. Apart from the infestations in the Makino Stream and Oroua River all stream/river-based infestations are at the lower reaches of the waterways.
Currently in the lower North Island the northern-most known site is in a park in Whanganui city and the two southern-most sites are in the Kapiti District of the Greater Wellington Region. Auckland Region also has eight unconnected sites.

There are broadly two types of infestations. The worst and most destructive to our economy and open spaces is linked to waterways, stopbanks, adjacent land, and beaches. Once an infestation gets into a waterway it spreads downstream, along and inside stream and riverbanks as well as spreading out into the adjacent land.
The second type of infestations are isolated with no apparent links to other infestations. These environments can be quite dry on hillsides, roadsides, and in paddocks. This plant flowers very rarely in the Horizons region and these plumes to date have all been sterile. In the Auckland Region, it flowers more frequently but these are also sterile. This type of spread can only be attributed to human activity. To date in NZ, this plant is not producing viable seed and is being spread vegetatively through fragments of rhizomes and reeds.

1. Waterways and Estuaries.

Once an infestation is established in a waterway or on the side of a stream/riverbank, it spreads within the shallow water and into channels as well as along the river and stream banks then out into surrounding land. A recorded stolon grew over 7 metres in a year supporting very rapid expansion once an infestation is established. Each node on the stolon, reed or rhizome is viable and can send out new reeds, roots and rhizomes. There is very quick development of dense monocultures that crowd out native and exotic species, reducing insect and birdlife, and alters water systems and their flows.
Each winter as we get increased rain and water flows in our waterways, fragments are being caried downstream to establish in new sites and expand from there. This is the same for flood events at any time of the year. Note, although initially we thought rhizomes were the main source of infestation, we now know the reeds are also viable and can create new sites. If the reeds are kept moist, the nodes sprout new roots and reeds just as they do from fragments of rhizomes.
Channels are being compromised adding to potentials for flooding. River sides and stopbanks are smothered in dense reeds and River Engineers, landowners etc cannot assess the integrity of these structures. This poses significant risk to flooding and breaching of stopbanks in high water flow.

In overseas literature, it has been recorded this weed builds land and raises the bed of the channels in waterways. We have seen this occurring in the Horizons Region in several sites e.g.:

A. In the lower Rangitikei River. Channel was being blocked causing water backlogs upstream.
B. In Awahuri Forest Kitchener Park. In an oxbow lagoon that fills with water in winter, parts of the bed of the oxbow have been raised by up to 1.8 metres.

We now have waterway infestations of 3-4 km in the lower reaches of the Whangaehu River, 7 km (could be more, needs investigation) in the lower reaches of the Rangitikei River and 33 km from the Makino Stream in Feilding down the Oroua River to Rangiotu. This is a total of at least 43 km of waterways already infested.
The infestations in these waterways are of concern. They are interfering with water flows and create higher flood risks upstream. Combined with this, the infestations are spreading *Phragmites karka* onto our beaches. To date, there is over 66 km of coastline from the Whangaehu River mouth to the Waiwiri Stream mouth with localised infestations.

Note one. The Trust set up protocols to manage *Phragmites karka* on river and stream sides. River Engineers still need to assess the integrity of stopbanks and river sides. They cannot do this when the area is covered in dense *Phragmites*. Mowing these areas to get visibility for assessment is now more complex. The reeds are viable when kept moist and just cutting them at ground level creates more opportunity for reeds to float downstream. The areas are now fine mulched, and a net is placed across the stream to catch as much of the debris as possible. This slows the annual stream maintenance work down considerably. It does not actually restrict the immediate expansion of the weed or stop pieces being broken or gouged out of the riverbanks when water rises and flows increase in winter or flood events etc.
Note two - Once on the beach. The sea currents tend to move southward putting all the lower Nouth Island seashore and mainland side of Kapiti Island at risk of infestations. It is not known if reeds will float as far as the upper South Island.
Note three. The Makino Stream/Oroua River infestations are also concerning as they are now very close to the Manawatū River. This flows down to Foxton where we are already seeing beach infestations. The international RAMSAR site in Foxton is an area that needs protection.
Note four – A NZ useful guideline for Aquatic Weeds – "Best Management Practise for Aquatic Weed control. Part one The frame work. Prepared for Envirolink March 2019" https://niwa.co.nz/sites/default/files/Best%20Management%20Practice%20for%20Aquatic%20Weeds%20Framework%20May%202019.pdf.

2. Beaches and sand dunes.

Infestations on beaches and sand dunes are a more recent phenomenon. Only one sand dune site was noted in spring 2020 at Tangimoana. Local community volunteers reported this had been there for some time. It comes up and then dies down but did not seem to expand. Several other sites were noted within the estuary and alongside the access to the boat ramp. No other sites were noted or recorded as being on the beaches.

From September 2021 to October 2022 the Horizons Region experienced multiple flooding events. Since that time there have been reports of multiple sightings on beaches and sand dunes. These have been recorded from Whangaehu down to beyond Waitarere Beach. Several working bees have taken place to remove *Phragmites karka* along the beaches. These have used mechanical removal methods. One working bee was at the Pukepuke Stream mouth in late summer 2023. It was reported in May 2024 the *Phragmites karka* weed was back just as it was a year before. The mechanical removal method is not very successful as one remaining fragment can re-establish. Repeated ongoing removal is needed to make this successful.

Note one - it is unknown by the Trust if *Phragmites karka* has infested the Pukepuke Lagoon reserve or any of the inland areas between the Whangaehu to the Rangitikei Rivers.
Note two – Disposal of reeds and rhizomes of *Phragmites karka* are an issue with mechanical removal. This needs to be formally addressed. Composting has been discounted from consultations with members of the composting sector. They do not feel they have processes certified to ensure composting reduces viability of all fragments of the plant. Nor does this sector feel comfortable with their risks of having potential infestations of *Phragmites karka* on their work sites – see recommendations section for plant disposal issue.
Note three- Management of NZ beaches and sand dunes may have different compliance rules when compared with rivers and the cross over point being estuaries. It is unknown at this point if the cut and fill methodology developed for our rivers and wetlands etc are acceptable in this ecosystem. Consultation with Horizons still needs to take place on this aspect. Before this happens, we still need to do work on understanding the uptake behaviour and transfer of chemicals within each section of the rhizome. This is part of the planned next two-year programme. A background document that may be useful to start this conversation is "Management of Phragmites karka invasion in Chilika Lake, Orissa" https://www.chilika.com/pdf/Macrophytes%20Workshop%2017-18%20Jan%202011%20Background%20Paper.pdf.

3. Random isolated sites.

Phragmites karka has been identified in various isolated unconnected places across the region. This pattern of infestation is also what the Auckland Region experiences. To date, Auckland has no waterway link to their infestations. With no seed production, these site infestations can only be attributed to human activity.
Examples in Horizons region

A.) On the roadside 7km before Tangimoana an infestation exists on the berm that had reeds piercing the shingle and edges of the tar seal. This berm is mown frequently. When looking closely at the grass, the reed infestation travels all the way between the roadside and the boundary fence and possibly beyond into the hedge and garden. It is not clear where the infestation started from. The first time it was noticed, tall reeds were observed close to the fence and not noted at that point on the roadway.
B.) An isolated random clump of *Phragmites karka* in a paddock near Tangimoana. This was visible from the road. When inspected, there seemed to be no reason for this to appear at this site. When studied closely, there was faint evidence of an old gravel track through the paddock. Was this brought in by infested river gravels?
C.) The isolated site in Sanson township by the northern 50km sign is known to have been brought in by human activity. The equipment hire company allowed Higgins' contractors to wash and park machinery on their site. This infestation is by the fence where the wash

downs occurred. Neither the company nor Higgins contracting were aware that this weed is invasive and neither took any actions to stop it. Today, it is on both sides of the fence in private land and on public berms. The site owners mow this regularly now and an elderly family member has been cutting *Phragmites* shoots off every few weeks for a couple of years. This is why we no longer see this site. Its rhizome footprint has expanded, but at a much slower rate than in the streams, wetlands, rivers and beaches. This site has the potential to become problematic as the berm slopes down to a drain and culvert that goes under the road. Once into this moister area, the rate of expansion is likely to escalate.

Note one. The trust has started conversations with members of the infrastructure sector to create protocols for identifying this weed and putting in place actions to minimise the risk of transferring it from one site to another on machinery or contaminated materials. All companies so far have been open to this and genuinely did not know this was a problematic weed.
Note two. There needs to be an education programme for the construction industry. This does not require *Phragmites karka* to be registered as a weed to do this. (Linked also to weed material disposal issues).

4. Strategic actions throughout project

As this is a live applied research project, throughout this project additional supporting and/or facilitating activities had to take place to accommodate the development or testing of findings in the forest and on other sites and ecosystems outside of AF/KP.

1 Consultations with NIWA and MPI and Horizons

These consultations highlighted we could not use methodologies recommended by NIWA to the Auckland region (Page 3 of the Scale Up Trials report). Their situation is vastly different to the forest and river ecosystems that are infested in the Horizons Region. For 12 years, Auckland Region have been cutting and spraying with amitrole and imazapyr. We, the AF/KP Trust, have strong controls around what, if any, chemicals can be used in the forest. In particular, the AF/KP Trust limits chemicals with known residual effects and those that are highly mobile within the soil water. This ecosystem is flooded naturally on a regular basis, and we don't want residue being washed across the forest or into oxbows and the stream. We have trees that are hundreds of years old and rare native plants and animals that are put at risk by these chemicals.
We, the Trust, considered NIWA's recommendation alongside our chemical policies and our ecosystems as well as those along waterways, wetlands etc. These other ecosystems, like the forest are sensitive, and potentially even more sensitive than the forest. The decision was not to use amitrole and imazapyr at all and when/if open spray techniques are used each site will be assessed before this can happen. This has been a controlling factor in the applied R&D approaches to chemicals used and delivery methods of chemicals used.

2 Ngāti Kauwhata team.

It became very apparent with the cut and fill method one person could not cover many plots due to the manpower and time consumed to apply this method. The Trust had been working

on a broader project with Ngāti Kauwhata around skills development for land and water management. We brought the team in and trained them in the current practices and constantly updated versions of delivery. This was not just labour. Practical testing and modification of delivery equipment, ergonomics and health and safety practices were being evolved with this group, alongside chemical applications, volumes and outcomes. Each of this team is registered under GrowSafe for handling chemicals etc. All members of this team have acquired good knowledge on delivery and participate in giving feedback on the practicality of the methods at each iteration.

3 Makino Stream

Once we had manpower, some successes, and skills and learnings from the forest sites, we were able to take these techniques into the Makino Stream. Horizons Compliance Team approved the cut and fill method on the grounds it was not going to expose waterways and soils to chemicals. This became a significant learning curve. Working in water, on slopes, transporting reeds from the stream site, summer heat traps in the stream channel, were all issues we had to work through to understand what was possible. In the future, once all facets of the R&D are finalised and refined, this Kauwhata team that works under supervision of our contract R&D specialist has the potential to become a specialised delivery team across the region. Additional skills relating to site quantification, costing and extending chemical handling to optimum storage and transporting protocols would be required for them to work autonomously.

It was working in the Makino Stream that challenged us by not being able to treat small diameter reeds and they were significantly more common there than in the forest plots. We modified our delivery method, moving from the drench gun approach to using animal vaccination needles. This also allowed modification of where the reed was cut and trapped the herbicide within the treated reed.

4 Horizons River Management Team

Once the team started working on the Makino Stream, a symbiotic relationship formed between the forest and the stream work. The forest being marginally less sensitive than the stream has become the laboratory and the stream the scaled-up delivery testing site. It must be noted all work sites in the stream were selected based on what was the most urgent. We have not tackled all the stream and do not yet know what the longer-term outcomes of this work will be. This needs re-assessment after the winter rains, high water flows, and spring growth starts. Most of the urgent sites worked on are also at risk of reinfestation from surrounding areas. The rate of expansion of this weed cannot be underestimated.

Some riverbanks and stopbanks in the region are so infested with rhizomes other methods need to be considered.

1. It is unknown if these masses of rhizomes infestations have already compromised the structural integrity of these riverbanks and stop banks.
2. The second question is, if we manage to kill off these rhizomes, will the decomposing plant matter compromise the integrity of stop banks.
3. Consideration for deconstructing a stop bank and rebuilding it may be the only solution in some situations.

4. If deconstruction ever becomes an option, we are faced with thousands of cubic metres of infested soils and materials. Current handling and disposal costs through Bonny Glen add significant costs to preventing further contamination of other sites.

For this applied R&D process, it is important the relationship between the parties is retained. Neither can work independently nor can we continue to find practical solutions as fast without the partnership between the local Horizons Engineering Officer and the Trust's R&D programme.

5. Knowledge sharing networking

The Trust made the decision to start spreading the word around the infestation of *Phragmites karka*.

It was very apparent to the Trust that even though this weed has been around for many years and become a familiar site in the Region, very little was known about it and people were unaware of its risks. The public in general, the biodiversity sector, the infrastructure sector, NPPA, MPI, community environmental groups, Weedbusters, Councils etc. all showed limited, to no, knowledge of its presence or understanding of its existing impacts or potential impacts. There is no reference to it on Horizons or local Council's websites. Weedbusters' website doesn't include it in their weed list. Auckland Region was the only that wrote this up as a problem: https://www.tiakitamakimakaurau.nz/protect-and-restore-our-environment/pests-in-auckland/pest-search/phrkar/.

AF/KP Trust initiated conversations with community groups. Trustee site visits and excursions to likely places of infestations was undertaken. A crude, time-permitting, physical assessment of infestations has been done by the Trust. This furthered strategic discussions with local known environmental groups, setting up spotters and personal visits by Trustees to areas in the Region to review an area.

1 Online activity.

1. A database search was done throughout NZ, and it was found this weed is reported on three database sites within NZ and one international database that is supported by NZ. The most comprehensive of these is the internation GBIF site.
   a. Inaturalist https://inaturalist.nz/taxa/166742-Phragmites-karka
   b. Landcare Trust Allen Herbarium https://scd.landcareresearch.co.nz/Search?collectionId=All&query=preferredName%3A%22Phragmites+karka+%28Retz.%29+Trin.+ex+Steud.%22+country%3A%22New+Zealand%22+landDistrict%3A%22Wellington+Land+District%22&currentDisplayTab=list&pageNumber=0&sortFieId=relevance&back=True&sortOrder=ascending&selectAll=false
   c. Auckland Museum https://www.aucklandmuseum.com/discover/collections/search?k=Phragmites+karka
   d. The most comprehensive *Phragmites karka* record in NZ online is the international Global Biodiversity Information Facility GBIF https://www.gbif.org/species/5290154 This database is supported in NZ by MBIE, DOC, and Landcare Research.
2. People started to question what this weed was on the Inaturalist forum. This led to more recordings of infestations, filling in gaps in knowledge of it across the Region. https://inaturalist.nz/taxa/166742-Phragmites-karka
3. Colin Ogle updated the information on *Phragmites karka* on the NZ Plant Conservation Network: https://www.nzpcn.org.nz/flora/species/phragmites-karka/.

4. AF/KP Trust wrote *Phrgmites karka* up on its website. We also formally reported it to the Manawatū District Council.
5. Environment Manawatū wrote it up: https://enm.org.nz/news-1/news/noxious-weed-phragmites-karka-common-reed-found-Manawatū
6. More recently, as a result of the Open Day in March 2024 initiated by AF/KP Trust, it is now reported on the Greater Wellington website: https://www.gw.govt.nz/pest-and-weed-central/?pwsystem=true&pwid=1074. This site, while clearly stating it has no official status, is informative to the public.

2 **Visting sites**

Trustees visited many sites across the region, broadly noting ecosystems, surroundings, and generally getting an understanding of where this weed is, how it got there, and the nature of spread in each ecosystem type. Some of the trips were with others from Councils or community and some were alone. Later, our R&D manager, Aaron Madden, also visited selected sites and additional sites with Horizons River Management staff and various staff from local Councils etc. All these observations have led to the accumulated knowledge base on locality, ecosystems, and spread behaviours.

3 **Community linkages and networks**

A wide number of community links have been made across the Region. The purpose was to spread knowledge and create spotters of the weed. The most significant only are recorded here.

1. Ellison Reserve group. This community environmental group is based at Tangimoana where the first *Phragmites karka* infestations were recorded in 2006. This group with the support of MDC, DOC and Horizons had several working bees to mechanically remove this weed from the boat ramp between 2012 and 2016. The infestations have returned and now are greater than they were in 2016. The Ellison Reserve group also took a number of submissions to Horizons. The last being a submission to the LTP process in 2018. Nothing has come of their drive to get some long-term answers to managing *Phragmites karka*.
2. Environment Manawatū Network. Through the Source to Sea division, we have linked with multiple community-based groups and had radio interviews, presented at network meetings and individual groups forums, the most recent being Forest and Bird.
3. Landcare Trust. This group have linked us to several forums where we have presented on *Phragmites karka.* Some of these forums have been national and some localised. The most recent partnering with Landcare Trust was on March 25th where we held a joint event identifying *Phragmites karka* and updating people on the latest findings. A workshop was held as the last part of this event. Landcare has also linked us into River Accords.
4. Iwi – Ngāti Kauwhata has been the prime iwi we have worked with. They are local to the forest and Makino Stream. More recently we have linked with iwi from the Horowhenua and Rangitikei areas on awareness and identifying the weed.
5. Links with industry are also underway to look at preventing the movement of *Phragmites karka* resulting in new infestations, whether this be in waterways or random sites on roads, in paddocks etc.

4 Media, publicity and events

1. Over the last two years we have spoken on radio twice and had two articles published in local newspapers. One of these went national. We presented papers on two national webinars as well as the presentations to community groups referred to above.
2. **The event.** A targeted audience event was held on the 25th of March 2024. 63 people participated through attendance and online. Key partners in this were AF/KP Trust, Landcare Trust, Ngāti Kauwhata, Manawatū District Council, Horizons Regional Council, Green by Nature and Auckland Regional Council. The Trust was getting an increasing number of requests from entities wanting to know about *Phragmites karka.* It was decided an education event was the most expedient forum to spread knowledge and information.
    a. The target audience was biodiversity/biosecurity specialists from both public and community sectors plus the infrastructure industry. Four Regional Councils, five District Councils, three iwi , MPI, Landcare Trust two companies, one River Accord representative, Forest and Bird, the Foxton RAMSAR site and numerous interested individuals and community groups participated.
    b. The last session of the day was a workshop. From this there were many recommendations from the group to move the issue of *Phragmites* going forward.
    c. The two most pressing were to put in a submission to the Horizons LTP and to initiate the process for getting *Phragmites karka* listed as a weed. The submission to the LTP process has been completed with no outcome or planned activity under the Horizons Long Term Plan.
    d. This second action had two different opinions on whether this should be a national weed issue or a regional weed issue. The Trust and others have started the review of what knowledge we have available for the requirements of registering a listed weed. We now have most of the information required. Two aspects are outstanding.

    Processes

    i. Some management processes around beaches and seashore management.
    ii. More work on processes relating to plant material handling and removal and disposal. Particularly around reed destruction with the cut and fill method and when using mechanical removal processes requiring removal of plant materials from one site to another for destruction.

    The costs.

    i. We need to work on reducing costs of delivery in relation to current methodologies.
    ii. Cost benefit analysis. We can see the risks and damage to natural ecosystems. Unfortunately, most of this does not generate a dollar value e.g., displacement of native forest, eel holes being blocked by rhizomes, loss of insect life from reduced range of habitats, increase in rat populations due to more secure nesting habitats resulting in higher predation of koura, small fish etc.

    Damage from flooding and stopbank collapses are more tangible costs. We, the Trust, don't have expertise in costing these areas nor have we identified expertise in our network. We have initiated discussions with MBIE and other entities to look at this work in the future.

    The issue of land value when *Phragmites karka* encroaches onto highly productive land and when urban private land and dwellings are

compromised by infestations from public land (there are a few private properties in the Feilding township that have *Phragmites* spread into their section destroying gardens, concrete paths etc. One homeowner has already had *Phragmites karka* spread from the nearby stream into their property, under the house and up through the walls into their home).

e. Other suggestions

Public recording of *Phragmites* on a single website. Encouraging the use of one database for recording sites etc.

6 Current Ongoing actions

There are number of actions currently being worked on and other actions that still need to be worked on in the near future to longer term.

1. It was initially thought that the rhizomes were the source of regeneration. Reed regeneration is now proven to be another mechanism. Handling and cutting of reeds now needs to have some work put in to define processes that will control spread. Consultations with the infrastructure sector and the composting sector are currently in process.
2. Initial discussions with MBIE and a specialist financial analysis company are in very early stages.
3. Further adaptions to current cut and fill plus mulch and spray plus potential combinations to reduce costs are being fine-tuned.
4. Reviews of work already done need to be carried out on an on-going basis e.g., what has the impact been long-term from the work in the Makino Stream. Does this need to be done annually or biannually etc or do we have to combine delivery of this work with surrounding ecosystems to prevent reinfestations. Have we really killed off some of the plots in the forest or are they just so badly compromised at this point and will take a year or two to recover. All of these and many other questions require time and ongoing observations and input to be answered.

7 Recommendations from this grant funded project.

1. **Horizons continue to support the applied R&D already started and currently led by AF/KP Trust.**

   It is an anomaly that this type of project is being led by a community-based charitable Trust. This was not planned, but events and the process of completing the Horizons grant funded project have resulted in the Trust and its partners/support network becoming the centre of management knowledge for *Phragmites karka* within NZ. To stop and create something new will slow the process down. To remove the Trust and take this exclusively into a CRI or University at this point moves the process from applied, quick, flexible, real-world response to a slower pure science process that is not related directly to the multiple ecosystems we are working with in our own back yard.

There are some issues that require pure science and are well beyond the capability of the AF/KP project and network e.g., our current approved process for delivery of chemicals to *Phragmites karka* in waterways is through direct injection into the plant. This means we are not spraying and not getting spillage from individual open reeds, and we are not impacting the waterways with spray drift. The issue here is what changes are going on inside the plant. Is the chemical that is killing the plant being changed chemically in some form or staying the same form. When dead materials break down what is being released into these bio-diverse sensitive environments? In the long term do we have to kill the plant then remove as much of the dead material as possible.? This question comes from this technique not being used on other weed management in such concentrations.

There is a case for all current parties to discuss and plan wider strategies that are inclusive of science gaps in AF/KP capability. We need Horizons to support this type of discussion.

2. **A pathway to have P*hragmites karka* registered as a notifiable weed in two years.**
   To register a weed does not require pure science. It requires processes, methodologies and costs. The debate as to whether this is regional or national is something that only Horizons, other Regions and MPI can sort out. We, the Trust, and supporters can provide the majority of the information and can apply for weed recognition status. We would ask that we be kept informed of these types of debates so we can process applications appropriately.
   Wider cost implications beyond the costs of delivery methods will have to be looked at outside of the Trust's project activities as we do not have access to the level of information Horizons has. The ongoing management cost of delivery is also a piece of work outside our capacity. We are only able to provide cost of management not a cost benefit analysis.
3. **Horizons and local councils put *Phragmites karka* on their websites.**
   This can be listed as a problem weed to educate the public and industry. Greater Wellington Region has done this, clearly stating the weed has no status, but has created an informative page and contact point for reporting and enquiries.
4. **Horizons take *Phragmites karka* to NPPA.**
   Phragmites karka is not listed under NPPA and should be.
5. **AF/KP look at the uptake of chemicals in the rhizome structures.**
   Due to costs and time, AF/KP has not investigated the uptake of chemicals along the rhizomes. Does the chemical move beyond the first node, or has the success in high reed density areas come from the fact that each node has sent up a reed? This work will explain some of the variables in the results and help us all understand the risks of regrowth later. This is easily done in situ by reverting to using marker dyes and digging through the rhizomes.
6. **To fully engage with infrastructure sector.**
   AF/KP continue to create an education project for the infrastructure sector – roading companies, river shingle miners, landscapers etc. Continue to create protocols for working in infested sites, machinery cleaning and transporting and cheaper disposal than deep burial at Bonny Glen. This will need to support reed disposal and potentially mechanical removal from beaches and sand. If it is deemed existing stop banks need to be deconstructed due to integrity issues, there will be significant volumes of material that will be disposed of.
7. **AF/KP continue to create a skilled workforce to assist in the management of *Phragmites karka*.**
   If this is weed is to be tackled, and trials scaled up outside of the forest, manpower is required for delivery. Much of this delivery does not require highly skilled biodiversity/biosecurity experts or scientist to do this in the context of applied R&D. Thinking, engaged individuals under supervision both facilitate this and make it quicker. This

model is taken from industry where the majority of R&D is applied e.g., food manufacturing, processing, machinery development, and many other sector-based developments take place inside the company with specialist science people and lower cost labour. MBIE via Callaghan Innovation has funded this type of R&D for many years.

8. **Retain and strengthen the relationship between Horizons River Management team and AF/KP Trust.**
   There are many issues still yet to be investigated in relation to rivers, stopbanks and riparian sites. Stopbank integrity, processes to clear stopbanks for annual assessment and long-term management of channels plus downstream movement of *Phragmites karka* in flood or high water have not really been addressed yet. There is still more to understand.
9. **Look more closely at infestations on our beaches.**
   The infestations on beaches and sand dunes were new events during this programme. To date, no real investigation has taken place as to how these are occurring e.g., are they from rhizomes or is it predominantly reed-initiated infestation. How far can material be carried in the sea currents? What is the best control method in this environment? What protocols and regulations are in place to protect these ecosystems that are different to rivers and stream?
10. **MPI Biosecurity**
    AFKP Trust continue to work with MPI science advisors. The input, site visits, skype calls, joint webinar presentations, overviews, and feedback from the scientist from MPI have been valuable to the Trust.
11. **Biocontrols**
    The Trust has not been able to identify any validated or useful online material for the development of biocontrol's for *Phragmites karka*. There has been biocontrol work done on *Phragmites australis* for nearly 20 years. A recent potential for *P. australis* being a moth introduced from Switzerland to Canada. We cannot find evidence to consider this for *Phragmites karka.* In fact, it is likely that the moth is specific to one European variety or sub-species of *P. australis* since there is at least one sub-species of *P. australis* native to North America. A compounding issue is *Phragmites karka* genetics are sometime referred to as a mixture, on other occasions there is four or five varieties of *P. karka* referred to. If we embark on looking at biocontrols internationally the first issue it to ensure we are talking about the same plant genetically.

8 Costing of project

Refer to Horizons' project reporting form for this information.

Green by Nature

Phragmites karka Scale Up Trials 2022-2024 Final Report

[June 2024]

[For Awahuri Forest Kitchener Park Trust]

Recreational Services
CREATING EXCEPTIONAL SPACES

This report was prepared by:

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Green by Nature

For:

Awahuri Forest Kitchener Park Trust

INTRODUCTION

The Awahuri Forest Kitchener Park Trust (AFKP Trust) received funding from Horizons Regional Council's Kanorau Koiora Taketake – Biodiversity Community Grant to progress *Phragmites karka* control trials. Funding ran for two financial years – July 2022 to June 2024 – and covered work to find and publicise effective management techniques for *Phragmites karka* including:

- Validating and continuing the initial small plot research and development carried out by Recreational Services for the AFKP Trust to find ways of managing *Phragmites karka* within AFKP.
- Taking the more successful small plot trial methodologies and scaling up these trials across AFKP and the Makino Stream to assess the effectiveness, practicality, and costs of *Phragmites karka* management across the whole region in streams, rivers, estuaries, and other sensitive infested areas.

Bessie Nicholls, AFKP Trustee, was the Contract Manager and the AFKP Trust contracted Recreational Services[1] to run the trials. I (Aaron Madden) joined Recreational Services in October 2022 as the Biodiversity Project Manager, responsible for managing the technical aspects of the project and supervision of labour. Much of that labour was provided by Ngā Kaitiaki o Ngāti Kauwhata's Mana Taiao team.

One condition of the funding contract was scientific oversight from the Ministry for Primary Industries (MPI). This was provided by Andrea Clavijo McCormick until an internal redeployment led to MPI assigning the oversight role to Callum Mclean and Jasmine Hessell in September 2023.

This report summarises the design process and scale up trial work undertaken in the two years of the project covered by the Horizons grant. It includes relevant information from the June 2023 report, which covered the first year of the funding period and should be read in conjunction with the January 2023 report, which summarised the issues around *Phragmites karka* and the informal trial work that occurred before the grant funding.

[1] Since October 2023, Recreational Services has been trading as Green by Nature.

PRE-TRIAL DISCUSSIONS AND AGREEMENTS

Andrea Clavijo McCormick and I had an online meeting with Paul Champion (who had recently retired from NIWA) on 31 January 2023. Paul contributed his knowledge and experiences (mainly with *Phragmites australis*).

Paul's herbicide of choice for *P. australis* control had been imazapyr. He stated it was preferred over others including haloxyfop, which he claimed gave inferior results. He cited Auckland Council's use of imazapyr on *P. karka* sites as examples of successful control.

The potential for non-target damage when using imazapyr was discussed with Paul, albeit briefly. My concerns about affecting desirable native plants near treated areas remained at the end of the discussion.

I met with Mike Beech, Pest Plant Coordinator at Horizons Regional Council on 03 February 2023, and he agreed that the potential non-target effects of imazapyr at a site like AFKP warranted a cautious approach.

Andrea and I had a follow-up online meeting with Auckland Council staff on 21 February 2023 to discuss their programme. They described their control method as follows[2]:

- imazapyr at 14 – 20 mL/L for foliar spraying of regrowth following cut and "paste" with amitrole (amitrole at 200 mL/L is sprayed on recently cut stems).
- Sites checked every 1 to 2 months. If regrowth is less than knee high, then the site is foliar sprayed with imazapyr; if more than knee high, then it is cut again and sprayed with amitrole.
- Removal of biomass to deep burial landfill (at least 2 m depth) is part of the process.

Regrowth from the rhizomes continued at all the Auckland sites despite treatment durations of up to 12 years. The Auckland Council method of amitrole or imazapyr[3] was considered for inclusion in these trials. During discussions with AFKP Trustees it was decided to avoid the use of amitrole and imazapyr due to the potential for damage to native flora. Haloxyfop remained the only herbicide the Trust was confident to trial within AFKP due to the potential for non-target damage.

In association with Andrea, it was agreed that the primary focus of the trials at AFKP would be the cut and fill method using haloxyfop, which had shown the most promise during the informal trials. It also had the lowest potential for non-target damage, critical in a native forest environment.

It was agreed in discussions with Nick Heslop, Horizons' Community Biodiversity Advisor, and Andrea in late 2022 that aerial spraying of mature *P. karka* should be included in the trials. If effective, it was thought aerial spraying would be suitable[4] for large infestations such as along the Rangitikei River. Another option was cutting/mulching the tops and then spraying the regrowth, which could be either aerial[4] or ground-based spraying.

Mike Beech and I discussed the extensive Rangitikei River infestations and the cost involved in removing and burying the cut biomass. Horizons' River Management team had disposed of some rhizomes from a *Phragmites karka* patch excavated on the Rangitikei River and understood how

[2] I later learned that there were several variations on this process, but none had been effective at eradication.
[3] Imazapyr is no longer able to be purchased in New Zealand.
[4] Subsequent discussions with Horizons' River Management staff resulted in aerial spraying with haloxyfop being rejected because of potential damage to the desirable grass species used for surface erosion protection on stopbanks and berms.

costly it was for landfill disposal. Given that none of the cut tops left on site at AFKP had shown any signs of regrowth[5], we agreed that the tops may not need to be buried or even removed.

However, we thought the potential effects of that much biomass being relocated in a flood event in the Rangitikei River system would be undesirable. Also, Bessie had taken sections of *P. karka* stems from a mulching operation [as part of Horizons' annual Makino Stream maintenance works] next to the South Street bridge and many had put out roots and shoots in 8 days when placed on sand and water.

Mulching, rather than cutting, was deemed the best method for extensive infestations. Our earlier observations indicated that the plant's response to removing the tops differed depending on the time of year it was done. In the informal trials, summer (early February 2022) cutting resulted in rapid height regrowth without producing sufficient low foliage to spray[6]. Winter cutting (early June 2022) resulted in shorter, finer, leafier regrowth in spring that we believed would have been far more suitable for spraying.

When asked, the Auckland Council staff replied they had not noticed differences in regrowth behaviour at varying cutting dates. Interestingly, stems along a short section of the Makino Stream stopbank cut in early February 2023 did produce leafy regrowth. That supported the Auckland observations and contrasted with the February 2022 result from the informal trials.

We planned to do more stem cutting trials to see if the informal trial result was atypical. How the plant responded to cutting was thought to be critical to effective implementation of treatments that included spraying regrowth[5].

Multiple haloxyfop rates for foliar spraying would have required plots for each rate. Suitable plots were limited so a single rate of haloxyfop was chosen (15 mL/L as recommended for bamboo control by Northland Regional Council).

The cut and fill method would trial four different rates of haloxyfop – 20%, 10%, 5%, and 2% (200, 100, 50, and 20 mL/L respectively).

[5] A small percentage of cut stems were later discovered to be regrowing from their nodes.
[6] We later found leafy regrowth was not necessary for achieving a good result.

CONTROL TRIALS

Cut and Fill – First Treatment

The cut and fill method:

1. Stems cut below waist height and just below a node to create the maximum stem volume to dose with haloxyfop solution. Battery powered secateurs used to reduce the risk of repetitive strain injuries to workers.
2. Cut tops placed around the edge of the site to maintain accessways between the cut stems.
3. Stem cavities dosed with [up to] 10 mL of haloxyfop solution from drench guns attached to modified knapsack sprayers. Blue marker dye added to the solution allowed workers to see which stems had been treated already.

Photo 1: Battery powered secateurs and modified knapsack with drench gun.

The smallest treatable stems often required part doses to avoid overflow. Treatable stems were defined as ones that were able to accommodate the tip of the drench gun.

The original plan was to have six workers, operating in three pairs. One worker in each pair would cut the stem and lay the top down and the other would dose the stem.

However, in all but the smallest plots, this resulted in workers clothing contacting previously treated stems and increased the chances of flicking some of the solution out of the stems. The process was modified to cutting the stems and moving the tops to the edge of the plot before treating the stems.

Stem dosing was started at the centre of the plot, slowly moving outwards to the edges of the plot. Plots too large to complete in one day were broken into manageable parts, reducing the need to pass treated stems.

The herbicide used was AGPRO Steed, containing 520 g/L haloxyfop-P as the methyl ester. The four different rates trialled were:

- 20 mL/L or a 2% solution (in plot P)
- 50 mL/L or a 5% solution (in plots A, B, C, and D)
- 100 mL/L or a 10% solution (in plots E, F, and G)
- 200 mL/L or a 20% solution (in plots J, K, and L)

Photo 2: Cut and fill plot locations within Awahuri Forest Kitchener Park.

Table 1: *Phragmites karka* cut and fill trial plots.

Plot ID	Plot Size and Initial Treatment Comments	Treatment Date/s, Labour, & Herbicide
A	40 m^2. Relatively open and straightforward. 5%	08/05/2023, 4 hours (10 m^2/hr). 0.1 L of herbicide ($0.25/$m^2$).
B	200 m^2. Several trees and a small number of vines within patch. Dense clumps of stems. Moderate number of stems arching over almost to the horizontal on top half, with vertical side shoots. 5%	18/05/2023, 33 hours (6 m^2/hr). 1.3 L of herbicide ($0.65/$m^2$).
C	60 m^2. Many vines and long blackberry canes (some dead) within patch. 5%	25/05/2023, 17 hours (3.5 m^2/hr). 0.25 L of herbicide ($0.42/$m^2$).
D	75 m^2. Many vines within patch. 5%	25/05/2023, 16 hours (4.7 m^2/hr). 0.25 L of herbicide ($0.33/$m^2$).
E	200 m^2. Several trees and a small number of vines within patch. First plot treated (original method) and proved to be slower than modified method. 10%	17/05/2023, 26 hours (7.7 m^2/hr). 2.2 L of herbicide ($1.10/$m^2$).
F	300 m^2. One tree and a moderate number of vines within patch. Low density stems on southern side of plot. 10%	26/05/2023, 30 hours (10 m^2/hr). 2.5 L of herbicide ($0.83/$m^2$).
G	450 m^2. Wetland paddock, opposite end of Long Drop Track. Much of the plot is low density stems but lots of vines. 10%	22, 23, 28 November 2023. 61 hours (7.4 m^2/hr). 4 L of herbicide ($0.89/$m^2$).
J	500 m^2 in and adjacent to a section of oxbow lagoon. Extremely difficult site – has high percentage of stems arching over almost horizontally through the vertical stems; arching stems put out many vertical side shoots; many densely packed stem clumps that have caught flood sediments and built silt banks up to 1.8 m tall within the site. Dense vines along eastern side. One live tree and several dead trees within patch. 20%	200 hours total between 08/06/2023 and 01/08/2023 (2.5 m^2/hr). 15 L of herbicide ($3.00/$m^2$).
K	20 m^2. Half the time spent clearing dense vines to get at the stems. Very easy after that. 20%	21/06/2023, 2.5 hours (8 m^2/hr). 0.2 L of herbicide ($1.00/$m^2$).
L	100 m^2. Dense vines along the eastern and southern sides and several trees within the plot. 20%	01/08/2023, 12 hours (8.3 m^2/hr). 1.5 L of herbicide ($1.50/$m^2$).
P	150 m^2. Dense *Phragmites* growing through and around a large pile of dead willow trunks and branches. 2%	02/06/2023, 30 hours (5 m^2/hr). 0.4 L of herbicide ($0.27/$m^2$).

Variation in stem density (stems per m^2), stem straightness, presence of weeds, and underfoot obstacles were all factors in the range of values for average area treated per hour. Where conditions were easy, up to $10m^2$ per hour was achieved but dropped to just 2.5 m^2 per hour in plot J, the most difficult.

Herbicide costs for the initial treatment ranged from \$0.25/m^2 for low density plots at low herbicide rates up to \$3.00/m^2 for high density plots at high herbicide rates.

Photo 3: Upright stems between arching stems made cutting and removal of tops difficult. Plot J.

Photo 4: Low density stems (blue) versus high density stems (yellow) in plot J.

Photo 5: This stem was broken 3.5 months after being treated and the marker dye indicates how well the herbicide mix was transported within the stem.

Blue marker dye in Photo 5 clearly shows that the stem treatment height of approximately 0.6 m and several nodes are no impediment to herbicide mix reaching the base of the stem.

How far the mix is translocated within the rhizome is still unknown but worth investigating in future trials. In the original [informal] trials, two untreated spikes that died were around 0.15 m from the nearest treated stems. It was presumed that the spike deaths were caused by translocation of herbicide within the rhizome. Further to this, it was suggested that the rhizome could be killed if sufficient herbicide was delivered through the treated stems attached to it.

In the formal trial plots, regrowth from rhizomes was observed to be the greatest where stem density was low and vice versa. The best example of this was observed in Plot J, where stem density ranged from < 1 stem per m^2 to > 600 stems per m^2. A count done within a grid placed over the area highlighted in Photo 6 below returned a result of 644 stems per m^2. The reason for the unusual shape of the highlighted area and the implications for waterways are discussed later in this report (under the section titled Silt Capture).

Photo 6: Regrowth levels seven months after treatment in Plot J. High density stems in foreground (best example highlighted) and lower density stems in background.

Regrowth was sparse where stem density was very high. The fact that there was any regrowth in those areas lends weight to the theory that the herbicide does not move long distances within the rhizome network. I suspect that rhizome sections with many close stems were killed and rhizome sections between [relatively] widely-spaced stems survived due to the rhizomes' ability to restrict herbicide translocation.

Using figures of 6 mL of 20% herbicide mix per stem and 600 stems per m^2, high density areas received 720 mL of AGPRO Steed per m^2. If it was as simple as getting a sufficient quantity of herbicide into the rhizome network as proposed after the informal trials, I would have expected to achieve a complete kill in the high density areas.

However, neither of these theories can be completely discounted with any confidence at present. We have no proof of translocation issues nor of the origin of the rhizomes that are sending up the new growth. It is possible they have come from adjacent low density areas or, simply, that they were not attached to any of the treated stems/rhizomes.

Further work is required to determine which, if any, of these theories is correct. Perhaps both are contributing to the outcomes but there may be other factors involved as well.

Cut and Fill – Regrowth Comparisons

Comparisons of regrowth levels between plots showed that there was variation even between plots that received the same herbicide rate (see Table 2 below). Most of those cases can be explained by operator experience (missed stems) and cutting stems too high, along with the previously discussed stem density influence.

However, I am unable to explain why the result in Plot B was so different from Plots C and D when all three plots received a 5% herbicide solution. Regrowth in Plots C and D was minor to moderate, comparable with plots that received 10%, or even 20%, solutions while Plot B had high levels of regrowth.

That anomaly aside, and taking into account the operator issues, there appeared to be a general trend towards less regrowth with higher herbicide rates and vice versa.

The 2% plot regrew so vigorously that the only clues that it was treated at all are the piles of cut stems around it and the dark green, fresh appearance of its consistently young stems/foliage.

In contrast, the 20% plots generally resulted in the least regrowth, especially in areas with high stem density as discussed previously.

Six of the 11 plots had been re-treated at the time of writing. The remaining plots will be re-treated in the next round of trial work, with the exclusion of Plot P. Results were very poor from the 2% treatment and, given the labour input required for treatment, I have no desire to repeat that rate in Plot P. If there are further trials with the 2% rate, they will be done on smaller plots.

Table 2: Regrowth and Follow-up Treatment

Plot ID	Plot Size, Regrowth and Follow-up Comments	Re-Treatment Date/s, Labour, & Herbicide
A	40 m^2. Moderate levels of regrowth. Stems originally cut very high (up to 1m) and occasional instances of treated stems being dead on top but live at base.	22/04/2024, 2 hours (40 m^2/hour). 0.1 L of herbicide ($0.25/$m^2$).
B	200 m^2. High levels of regrowth. Some obvious instances of missed stems and occasional instances of treated stems being dead on top but live at base.	n/a
C	60 m^2. Minor levels of regrowth. Some regrowth from cut tops in piles around edge of plot.	17/04/2024, 1 hour (60 m^2/hour). 0.1 L of herbicide ($0.13/$m^2$).
D	75 m^2. Minor(-moderate) levels of regrowth but some stems on periphery had missed original treatment due to being hidden by other vegetation.	17/04/2024, 1.5 hours (50 m^2/hour). 0.1 L of herbicide ($0.16/$m^2$).
E	200 m^2. Mostly minor regrowth levels. Relatively high rate of untreated cut stems but it was the first block that was done during the trials and the crew hadn't got their eye in yet. Abundant cut stems left within the plot made access difficult.	23/04/20243, 9 hours (22 m^2/hour). 0.5 L of herbicide ($0.25/$m^2$).
F	300 m^2. Mostly minor levels of regrowth.	n/a
G	450 m^2. Wetland paddock, opposite end of Long Drop Track. Minor-moderate levels of regrowth. Most of the plot was inadvertently mulched during site preparation works in the wetland paddock.	n/a
J	500 m^2 in and adjacent to a section of oxbow lagoon. Almost no regrowth where stems were very high density. Middle section and edges have minor to moderate levels of mixed origin regrowth. Missed stems, stems too small to treat with drench gun, and cut tops laid within plot contributed. A few stolons observed, mainly in damp areas. Regrowth from cut tops in some of the piles around edge of plot. Access still difficult within plot.	4.5 hours on 29/04/2024. 5 hours on 30/04/2024. 17 hours on 02/05/2024. 28.5 hours total (18 m^2/hour). 1.6 L of herbicide ($0.32/$m^2$).
K	20 m^2. Minor levels of regrowth and one cut stem on edge of plot had missed original treatment.	17/04/2024, <0.25 hours (>80 m^2/hour). 0.03 L of herbicide ($0.15/$m^2$).
L	100 m^2. Moderate levels of regrowth. Many stems missed original treatment (first time on the drench gun for one of the two workers drenching that day).	n/a
P	150 m^2. *Phragmites* growing through and around a large pile of dead willow trunks and branches. Very high levels of regrowth – looks like the pre-treatment state.	n/a

Cut and Fill – Regrowth from Cut Stems

It is important to note that there was regrowth from nodes on some of the cut stem tops during this round of trial work.

Thousands of stem tops lay around AFKP after the informal trials and numerous observations had failed to provide any evidence of regrowth from cut stems. Checking through the informal trial records revealed that much of the previous cutting had also occurred during winter so conditions may have been more conducive to regrowth this year.

Photo 7: Regrowth from cut tops on the bottom layer of the pile around Plot J.

Disposal of cut tops needs to be addressed to avoid creating new infestations or re-infesting treated areas.

We fed a pile of cut tops through a wood chipper but the pile had been exposed to the elements for over three months and the old stems and foliage caused multiple blockages. Freshly cut material we tested did not cause any issues in the chipper so we would like to try this again in the next round of work. In both cases, the chipped material itself met our requirements i.e., it was deemed to be too small to regrow.

The alternative to destroying material on site is transporting it to another site for destruction. We had discussions with Central Demolition, who proposed transporting it to another location and burning it. Protocols would be developed to ensure all material is securely contained within the transporting vehicle to avoid potential spread en route.

Cut and Fill – Refinements to Treatment Method

Several issues arose with the use of the drench gun. Within minutes of starting the first plot, it was obvious that access amongst open stems containing herbicide was the biggest issue. It led to a revision of the working process, as described previously.

The number of stems that were too narrow to accept the tip of the drench gun became the next most significant issue.

When moving around within plots, the bottom of the knapsack sometimes caught on the top of cut stems, especially if the site was not flat.

I tested a couple of vaccinator guns and smaller knapsack options before settling on a vaccinator gun (with adjustable dosage rate from 1 to 12.5 mL) and a rigid plastic 5 L knapsack with a carry handle.

Photo 8: Vaccinator gun, rigid plastic 5 L knapsack, and battery powered secateurs.

The treatment method was modified to cutting the stem just above a node and injecting the herbicide solution into the hollow stem through the node. This leaves only a small needle hole in the node and makes it difficult to remove much more than a drop, even by shaking the treated stem. It is possible to treat stems down to less than 5 mm diameter with this equipment.

However, very small stems usually have a “woodier” node than larger stems. In general, the smaller the stem diameter, the higher the needle resistance is through the node and the higher the chance of needle blockage.

Replacing the 18 gauge needles that came with the vaccinator with 14 gauge[7] needles decreased the frequency of blockages.

For the sake of completeness, and because it relates to the equipment discussed above, I include the following summary here.

I tried injecting the herbicide into the hollow internode section through stems that had not been cut rather than through the exposed node within a cut stem. The most number of stems I treated this way before the needle blocked was three so the test was abandoned.

If successful, this technique could have been used for infestations with low densities of stems without the added steps of cutting and destroying the tops. They could simply be left in place to die.

It could still be a viable option with one extra step – punching the hole through the stem with a solid needle/spike. The vaccinator needle could then be inserted into the hole and the stem dosed with the herbicide solution.

[7] 14 gauge needles are larger diameter than 18 gauge needles.

Mulch and Spray

Mulch and Spray is the method we proposed for use on extensive infestations such as those along the berms of the Rangitikei River. Cut and Fill is far too labour intensive to use on sites with hectares of stems.

Cameron Reid from Horizons' River Management team offered up to two days mulching work from one of their contractors who was waiting to begin another project. We gratefully accepted the offer and on 05 and 06 September 2023 four areas totalling approximately 1500 m^2 were reduced to stubble by a long-reach excavator fitted with a mulching head.

Photo 9: Excavator with mulching head. Mulched areas of *Phragmites karka* on the left and behind the excavator.

The operator used multiple passes of the mulching head to gradually reduce the height of the *Phragmites.* This prevented clogging of the head and resulted in mostly small fragments, with very few fragments having intact nodes.

In places where the *Phragmites* extended all the way to the streambank, a fringe was left behind to protect the stream from any potential spray drift. This had been agreed to during a site visit with an officer from Horizons' Regulation team prior to commencing the mulching work.

Photo 10: Approximate boundaries of the four areas used for the mulch and spray trials.

Regrowth was sprayed with 15 mL/L of AGPRO Steed plus 5 mL/L AGPRO Crop Oil on the following dates:

- 01 November 2023
- 30 November 2023
- 10 January 2024
- 23 February 2024
- 14 May 2024

Application method was gun and hose except for the 30 November application, which was done with a knapsack due to the unavailability of the gun and hose equipment.

Photo 11: 29 November – 28 days after 1st spray application.

Photo 12: 19 December – 19 days after 2nd spray application.

Photo 13: 04 January – 35 days after 2nd spray application.

Photo 14: 29 January – 19 days after 3rd spray application.

Photo 15: 23 February – 44 days after 3rd spray application and the day of the 4th application.

Photo 16: 18 March – 24 days after 4th spray application.

Photo 17: 14 May – 57 days after 4th spray application and the day of the 5th application.

Regrowth was allowed to get up to one metre tall before the 1st and 2nd spray applications so that there was ample foliage to absorb the herbicide. Vigorous growth over the Christmas holiday period resulted in even taller stems – up to 1.5 metres – being treated at the 3rd application. A few tall stems were present when the 4th application was made but most were one metre or less.

Prior to the 5th application, a brushcutter blade was used to knock down the dead stems because they obscured, and blocked access to, much of the regrowth. Most of that regrowth was less than 0.5 metres tall at the time of the 5th application even though it had been eight weeks since the previous treatment.

Levels of regrowth dropped off slightly after the 3rd application and more noticeably after the 4th application, but it is too soon to claim that the herbicide treatments are even the major contributing factor in this. Seasonal growth differences may be the significant factor and a longer monitoring period combined with ongoing spray applications is required.

What we can say is that tall regrowth with plenty of foliage is not required to achieve a good kill with spraying. Regrowth in what we dubbed the spike stage was killed just as effectively as the tall, leafy stems.

It is possible that treating shorter regrowth more frequently would be just as effective as treating tall, leafy regrowth. Importantly, it would also avoid/reduce the access issues and visual obstructions caused by the tall, dead stems.

Ideally, we would compare treatment height and frequency in another round of trials using new mulch and spray plots. If that is not possible, then comparing them in separate areas of the existing mulch and spray plots could still be useful.

The mulching part of this Mulch and Spray trial was paid for by Horizons River Management and it was less than two days' work.

Since the mulching, there has been five spray applications (four with gun & hose and one with a knapsack because the gun & hose equipment was being used on another project that week). Each application was up to 3 hours (including setup, travel, and clean-up).

Each of the first three gun & hose applications used 3 litres of herbicide and a litre of crop oil and 200 litres of mix was applied. The knapsack application and fifth gun & hose application used half of that.

Estimated costs were as follows:

- 12 litres of AGPRO Steed = $1,200
- 4 litres of AGPRO Crop Oil = $43
- 18 hours labour @ $60/hour = $1,080
- Vehicle/equipment charges (estimated) = $150

Sub-total for five spray applications was $2,473 or $1.65/$m^2$. Estimated excavator costs were $2,500 or $1.67/$m^2$. The total rate for mulching and five spray applications was $3.32/$m^2$.

Whether the *Phragmites* rhizome system will be killed by repeated spraying with haloxyfop is still unknown. We know from the Auckland situation that amitrole and imazapyr have not achieved a total kill and it would seem unwise to expect that haloxyfop would be any different.

The Mulch and Spray method could be useful as a management tool even if eradication proves to be impossible.

Ground application with gun & hose as we have done in the trial is what would be required for the river infestations. Aerial application of haloxyfop is unacceptable due to the risk of killing the desirable grass species on the stopbanks and uninfested areas of the berm[8]. Oversowing with a non-grass species following mulching may be required to protect the treated river berms from surface erosion.

[8] Personal communication with Horizons' River Management staff.

POTENTIAL COST SAVING OPTIONS

A substantial portion of the cost of the Cut and Fill method is the labour required to cut each stem and move it to the edge of the site (or further). Established infestations often contain tall, intertwined stems and climbing weeds that impact productivity. If we can replace that manual component with something more mechanised, there is an opportunity to save both time and money.

The most obvious ways to do this are to combine components of the Mulch and Spray method with the Cut and Fill method.

Top of the list would be to mulch an infestation, wait for the regrowth to reach a treatable size and then use the Cut and Fill method. The amount of top growth that would have to be removed manually would be substantially less than in the original infestation.

Another variation would be to use the Mulch and Spray method until the Phragmites was deemed to be in a much-weakened state and then the Cut and Fill method to finish it off.[9]

As a quick cost comparison between the two methods, we could say that regrowth density after mulching and four sprays was equivalent to a Cut and Fill plot with one 10% treatment of moderate density stems and a productivity figure of 7 m^2/hour. Using averaged rates of $60/hour and herbicide cost of $1.00/$m^2$, the Cut and Fill plot would cost $9.57/$m^2$. The Mulch and Spray equivalent is about $3.00/$m^2$.

For small sites, cutting near ground level with a brushcutter and removing the cut tops would be a suitable substitute for a mulching head on an excavator. If climbing weeds are present and binding multiple stems together then this method may not lead to much in the way of savings.

Instead of mulching the original infestation, multiple stems might be able to be cut and removed with a felling head[10] attached to an excavator, as used in the forestry industry. This would still require manual cutting to just above a node at the suitable height prior to injecting with herbicide.

However, the excavator would not be able to run over the area to be treated (i.e. restricted to working from the side, with reach issues on wide sites) unless cutting near ground level like the mulching method. In that case, there would be no advantage over mulching aside from the ability to transport cut tops away from the site if that was deemed necessary.

[9] The assumption being that the Cut and Fill method is more effective at damaging the rhizome system than the Mulch and Spray method.

[10] We were approached by a company that sells this type of equipment after learning about our current method from a media release.

SILT CAPTURE

During the Cut and Fill treatment of Plot J, several mounds were discovered within the oxbow lagoon. Where stems were very dense, silt from floodwaters had been captured and roots extended from the stem nodes into the silt. The silt mounds ranged from 0.5 to 1.8 m above the bed of the lagoon.

Mounds that were close to each other were beginning to build connecting walls of silt, effectively forming raised islands with a footprint shape similar to an athletics track.

This island-forming process has the potential to impact waterways by reducing channel capacity and obstructing water flow (perhaps even to the point of creating a living dam across the entire channel).

Photo 18: Silt captured from floodwaters where stems were very dense in Plot J. Height from the bed of the oxbow lagoon to the top of the silt mounds is up to 1.8 m.

CONCLUSIONS

At the time these trials began there was no control method capable of eradicating *Phragmites karka*. One of the Auckland infestations had received regular treatments for 12 years but was still producing regrowth.

Results achieved with a single treatment with the Cut and Fill method are very encouraging.

While there was variation within plots receiving the same herbicide rate, there was a general trend towards less regrowth with higher herbicide rates.

Additionally, effectiveness was increased where stems were growing at high density, as in parts of Plot J (644 stems/m^2 measured). Regrowth was almost non-existent in this situation.

Cut and Fill is a labour-intensive method and therefore costly. Productivity figures for the initial treatment of plots ranged from 10 m^2/hour in the easiest plots down to 2.5 m^2/hour.

Herbicide costs for the initial treatment ranged from \$0.25/m^2 for low density plots at low herbicide rates up to \$3.00/m^2 for higher density plots at high herbicide rates.

In the trial plots that have received a follow-up treatment, productivity ranged from 80 m^2/hour down to 18 m^2/hour. Total stem density – including previously treated stems – and transport distance to the edge of the plot are sometimes greater contributors to productivity differences than regrowth stem density.

Herbicide costs for follow-up treatment ranged from \$0.13/m^2 for low herbicide rates to \$0.32/m^2 for high rates.

Where stems were dense and received a high rate of haloxyfop during the initial treatment (i.e. where initial treatment cost was highest), there was very little regrowth compared to low density areas and/or low rates of haloxyfop. At this early stage, at least, there appears to be a degree of "payback" for incurring high per m^2 costs up front in high density areas.

The Mulch and Spray method was designed as a more affordable management tool for large infestations such as those on the berms of the Rangitikei River.

Estimated costs for mulching mature *Phragmites karka* stands in our trials was \$1.67/m^2. Five applications of haloxyfop on the regrowth – and removal of dead, standing stems – contributed another \$1.65/m^2, bringing the total to \$3.32/m^2.

Regrowth levels decreased after the fourth spray application and were very minor following the fifth application. It is currently unknown how much of this decrease can be attributed to the spraying and how much is seasonal. Further monitoring – accompanied with treatment when necessary – is required before any conclusions on the effectiveness of this method can be drawn.

Potential cost savings have been identified, the most likely being a combination of the two methods. We could use the Mulch and Spray method to clear and weaken the original infestation and the Cut and Fill method as follow-up to kill regrowth and the rhizome system.

There are still many unknowns, including how long/often we will need to treat regrowth before the entire rhizome system is killed.

This round of trials has produced some excellent results but there is a considerable amount of development still required.