Pest Pathways into Taranaki

A risk assessment of high-risk pests and pathways

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PLACE GROUP
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Nancy Willems
Angus McKenzie

This report was authored by Nancy Willems of Place Group Ltd and peer reviewed by Angus McKenzie of Place Group Ltd. The following people kindly contributed to this report by agreeing to provide information to the author:

Steve Ellis (Taranaki Regional Council)
Chris Spurdle (Taranaki Regional Council)

Contributions from those who attended the workshop:
Steve Ellis (Taranaki Regional Council)
Brett Bailey (Waikato Regional Council)
Nick Heslop (Taranaki Regional Council)
Dave West (Taranaki Regional Council)
Michael Langford (AsureQuality)
Rod Smillie (Horizons Regional Council)
Sophia Clark (MPI)

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1. Purpose

Place Group Limited was engaged by the Taranaki Regional Council (TRC) to undertake an assessment of high risk pest pathways into the Taranaki region, identify high risk candidate species and prepare a risk assessment inventory to inform future TRC management of pests[1] and pathways.

This report documents the key findings of the completed risk assessment and sets out recommended options for the future management of pest pathways into the Taranaki Region.

This report and the supporting pest inventory will assist TRC to:

- Inform and implement regional surveillance, incursion response and communication activities;
- Further explore and implement regulatory and/or non-regulatory methods for managing pests and pathways.
- Determine the most effective allocation of resources in relation to pathway management within the region.

2. Background

There are a range of harmful organisms present in New Zealand that are not yet present in the Taranaki region. The most effective form of pest management, in terms of achieving eradication aims and deriving value for money, is to avoid the establishment of new pest species.

The Taranaki Regional Pest Management Plan 2018-2028 does not include species that are not already present within the region. Instead they are addressed as part of the TRC Biosecurity Strategy 2018-2038. Objective 4.1 of the Biosecurity Strategy sets out the Council's aims in relation to the establishment of new pests and reducing spread as follows:

"...avoid the introduction or establishment of harmful organisms present in New Zealand but not yet present in Taranaki, and reduce the spread of other harmful organisms already in the region over the duration of this strategy."

Pathway management is viewed by TRC as a key preventative measure for reducing the rate of spread of pest plants and animals, and stopping new species from arriving in the region. The TRC Biosecurity Strategy includes the following actions to achieve Objective 4.1:

1. Undertake risk assessments and contingency planning for harmful organisms not yet present in the region.
2. Undertake surveillance of high risk pathways to ensure the early detection of harmful organisms in the region.

[1] For the purposes of this report the term 'pest' is being used in its wider commonly understood meaning rather than its narrower statutory meaning under the Biosecurity Act 1993, which limits its application to species declared as such in a plan.

3. In the event surveillance identifies the presence of new harmful organisms to the region, consider the appropriate incursion response.
4. Support national pathway initiatives to change people's behaviours and reduce the potential spread of harmful organisms and their impacts.

This report has been prepared in relation to complete Action 1. It includes risk assessment to identify high risk pests and pathways for the Taranaki region and explores whether TRC is best placed to manage the pathways identified in a lead or supporting role. The recommendations and next steps set out in this report will guide the further progression of Actions 2 to 4.

The project brief provided by TRC for the risk assessment is included as Appendix 1.

3. Pathway Management

Managing pest pathways is a preventative measure that aims to slow the rate at which new organisms are delivered into the region (MAF, 2010). This can be cost effective in that managing a single pathway can slow the rate of incursions of a range of pests, and reduces the costs incurred from controlling established populations. It is not always critical to know the species entrained in those pathways (MAF, 2010), although identifying high risk species and connecting them with pathways enables methods of managing a particular pathway to be tested for potential effectiveness against those species.

Regional Pest Management Plans (RPMP) and/or Regional Pathways Management Plans (PMP) are regulatory tools that a regional council can use to manage pest pathways. Both plans enable the use of rules and powers under Part 6 of the BSA and the Council's role is to lead the implementation of such plans. The plan can include laying out the roles and responsibilities of other agencies, landowners and the Council itself. The legislative context for pathway management under the Biosecurity and other Acts is summarised in Appendix 2 to this report. The BSA also provides broader functions and powers that are not necessarily linked to the regulatory RPMP and PMP and can include surveillance, monitoring, and education and awareness activities.

The common factor for most pathways is that they are generally controlled by people in some way (WRC, 2017). The exceptions to this are the environmental, natural or wild pathways (hereafter referred to as natural) - wind, floods, ocean currents, and wild/feral animals. Managing these is almost difficult in many cases (eg; movement of waterfowl) and may be limited to attempting to contain the pest to reduce the ability of some natural pathways to operate (eg; physical containment to prevent water from moving an aquatic pest plant).

Vectors and/or pathways, controlled by people, in which pests are caught and moved, can be broadly grouped as follows (noting that the below is not an exhaustive list of vectors/pathways):

- Machines - including vehicles, floating platforms, machinery of all kinds and especially those used to work soil, aggregate or vegetation (eg; earthmoving and agricultural machinery, roadside mowers), vessels/water craft of all sizes and types.

- Equipment - this is generally hand held equipment associated with human activities and includes fishing gear (eg; rods, reels, nets, waders, lures), tools (eg; scrub bars, chainsaws, handheld tools like spades), aquaculture equipment, and could be larger equipment associated with machinery, or needing machinery to move or manipulate.

- Substrates/materials/transport mediums/organic matter - soil/compost and aggregate, spoil and fill, mulch, green waste, potting mix (nursery sourced plants), any other organic materials, bulk construction materials (eg; fenceposts, timber), demolition material, water (bilge, ballast, residual water in vessel compartments or other equipment used in marine or freshwater).

- Harvested crops - stock feed, human food crops including aquaculture.

Managing these vectors/pathways can be difficult where entry to and exit from sites or the region are dispersed and/or numerous and/or with high volumes of movements, and conversely may be more feasible in terms of management when there is a physical bottleneck where vectors can be intercepted at one or a few locations.

4. Pathway Management in Taranaki

The following section summarises the key terrestrial, aquatic and marine pathways into the Taranaki Region and potential opportunities for pathway management by the TRC[2].

To a greater or lesser extent the vectors/pathways listed in section 3 above are relevant to marine, aquatic and terrestrial species and environments, potentially transporting pests via all the major transport mechanisms and networks - road, rail, air, shipping. These pathways connect Taranaki to adjacent regions, and further afield. The arrival of pests from essentially all of New Zealand, and other countries in the case of marine pathways, is limited only by the ability of the pest to have viable material that can survive the trip, although a nearby source population of a pest increases the risk of that pest arriving in the region as viable material.

4.1. Terrestrial pathways

Taranaki Region has three main terrestrial pest entry points via road at State Highway 3 to the north and south, and SH 43 via Whangamomona, with significantly less traffic volume. There is a fourth minor road travelling east-west via Ohura/Waitaanga.

Railways similarly have only two entry points into the region.

While this makes the number of main entry points on land potentially manageable, the volume of traffic travelling by SH 3 into the region makes it very challenging in many regards, and not a feasible option to physically monitor and manage the regional borders on an ongoing basis. The advantage that it may offer, however, is that in the instance of a significantly high risk pest, the road and rail entry points do provide a limited number of sites that could be monitored if the pest was of enough concern to warrant an intensive approach. It could also provide an opportunity for a spot checks approach, observing traffic and noting frequency of things like dirty machinery or recreational

[2] Other organisations can also have a role in pathway management if they choose to do so, and may be declared a management agency responsible for implementation of a pathway management plan (BSA s88).

vessels coming into the region as an indication of how big an issue inter-regional movement by road might be.

Options for the potential ongoing management of terrestrial pathways can be approached by considering the main vectors and targeting those in other ways. For example, the pathways of pest plants associated with crops, like velvetleaf, Chilean needle grass or terrestrial alligator weed, could be targeted by working with primary industry stakeholders to establish protocols around individual on-farm biosecurity or improve machinery hygiene practices. A farm biosecurity plan initiated by the landowner as a separate plan, or incorporated into an overall Farm Environment Plan, could also be an option to address some terrestrial pathways.

High risk terrestrial pathways for the Taranaki Region will exist around the agricultural sector and associated with roading activities. Those with the greatest consequence are those that affect the agricultural sector.

4.2. Aquatic pathways

The associations between aquatic pest plant species, and with exotic fish, indicate they share dispersal pathways and/or that there are shared risk factors for introductions (de Winton *et al*, 2009). Deliberate releases of exotic fish have been the main pathway for pest fish spread in New Zealand to date, and aquatic pest plants may also be released deliberately or accidentally in association. Occasionally a deliberate planting of aquatic plants may bring fish and/or eggs.

Taranaki attracts visitors from outside the region for activities like fishing, and is promoted as providing good fishing opportunities for junior anglers at several locations, and as one of few areas for good sized perch in New Zealand. Several lakes also provide easy access for a range of activities other than fishing. Recreational activities and movements of watercraft and equipment from one freshwater body to another is one of the main pathways for aquatic pests. Deliberate releases of pest fish to establish new fishing areas is an ongoing risk.

Some lakes in Taranaki have infestations of aquatic weeds, while others do not. Preventing the spread of weeds from one lake to another within the region is worth consideration, particularly for sites that are free of all aquatic pest plants.

Management of drainage schemes, and roading activities, are key areas where machinery will move from site to site, often still carrying fragments of plant material in the remnants of drain cleanings and attached to machinery. This is particularly high risk where machinery is moving from one region to another. Dumping of spoil at the work site where material can enter adjacent wetlands or waterways can also spread pests into new sites, either directly or with flowing water. These pathways are evidenced by heavy infestations of more common weed species like reed sweetgrass (*Glyceria maximal*) around and extending out from culvert inlets and outlets, and on piles of spoil from clearing drains or constructing roads and bridges.

Neighbouring and nearby regions, particularly the Waikato and Bay of Plenty, provide a significant source of multiple new aquatic pests to the region, and the potential for multiple pests to arrive on a single vector like machinery and recreational watercraft and equipment. Interregional

movements of specialised equipment for flood management, road construction or earthmoving in general, and transport of materials like aggregates and stock will be key pathways for aquatic pests.

4.3. Marine Pathways

Port Taranaki is a key entry point for marine pests to the region. Vessels entering the port are coming in from a range of domestic and international ports. While the biosecurity aspects of international entries are managed by MPI as part of their border control functions, domestic movements are not. Entry to the port by vessels originating from or travelling via other domestic ports with known marine infestations could be targeted by Port Taranaki with protocols, following existing national or international guidance, to reduce the likelihood of moving a new marine pest into the Port Taranaki. This is likely to require support or encouragement from TRC.

Surveillance for marine pests at Port Taranaki is undertaken under the national surveillance programme led by MPI. High risk sites around New Zealand, including Port Taranaki, are checked twice a year through a combination of trapping, underwater searches and shore searches. While there are five key target species not currently in New Zealand[3], these surveys also identify new species to a site, and gather information about established pests expanding their range. Any finds that can't be identified as local species are sent to labs for testing. Findings are reported annually.

Under the Pest Management National Plan of Action (MAF, 2011) distinctions were made as to the default lead intervention agency responsible for bringing parties with the necessary powers, functions, and resources together for pests in the marine environment. This was adopted as a matter of policy by Cabinet and regional council Chief Executives. This distinction clearly identified MAF (now MPI) as the lead for inter-regional pathway and vector management for marine pests.

There will be opportunities for TRC to collaborate with other regions and directly with ports and vessels that are regular visitors to the Port to improve the management of marine pest pathways to slow their spread into Port Taranaki. However, MPI is technically charged with leading interregional pathways management for marine pests, with regional councils in a collaborative and supporting role, and TRC should join with other regional councils in encouraging MPI to take up this role to the fullest extent.

5. Species risk assessment

The following sets out the methodology undertaken to develop a risk assessment inventory for the Taranaki Region. Table 1 sets out criteria for considering whether candidate organisms are within the scope of the risk assessment. The results of the assessment are provided in Section 6.

[3] Northern Pacific seastar, *Asterias amurensis*; Asian clam, *Potamocorbula amurensis*; European shore crab, *Carcinus maenas*; Chinese mitten crab, *Eriocheir sinensis*; Aquarium weed, *Caulerpa taxifolia*.

Table 1: Organisms in and out of scope

Organisms in Scope	Organisms out of Scope
• Pests (as per BSA definition) from other regions. • Unwanted organisms. • Invasive species not present in the Taranaki region but present in adjacent or nearby regions. • Other invasive species present in New Zealand with a high risk of being spread through known pathways. • Terrestrial, freshwater and marine invasive species. • Biodiversity, economic or social impacts that are regional in significance.	• Invasive species not present in New Zealand. • Invasive species having adverse and unintended impacts that are not regionally significant. • Invasive species for which the benefits of control accrue to individuals rather than the region. • Invasive species not capable of becoming established in the region.

5.1. Methodology

5.1.1. Step 1- Candidate species long list

Candidate species were identified in a stepwise fashion. Through a high level literature review, an initial long list of candidate species was identified in relation to the following criteria from the Taranaki Regional Council Biosecurity Strategy 2018-2038:

- Present in New Zealand;
- Not present in Taranaki;
- Present in adjacent or nearby regions or on known pathways.
- Capable of establishing in the region;
- Likely to have regionally significant adverse and unintended impacts.

Consideration was given to a wide range of species, and their distribution in New Zealand, alongside knowledge and evidence of the consequences of the pest in other locations in terms of invasiveness, effects, and ability and costs to eradicate or control once established. This first list unintentionally included some species that are in fact present in Taranaki, however this was not evident from the initial searches.

Close proximity to source populations of pests increases the likelihood of those pests being moved into Taranaki Region, so pests in adjacent regions are more likely to be transported into Taranaki than those that are 'one region over' or further away. It is acknowledged that inter-regional movements from all over the North Island and/or New Zealand can negate this assumption for pest organisms with viable material (eg; seeds, eggs) that can survive for longer periods of time, however

interactions between Taranaki and its adjacent regions are more likely to bring live propagules into the region with short travel times. The cost of transport for stock feed, for example, will influence farmers to source from as close as possible, if sources are not available within the region.

Table 2: Adjacent and 'nearby' regions

Adjacent Regions	Nearby Regions
Waikato Manawatu-Whanganui (Horizons)	Wellington Hawke's Bay Bay of Plenty Auckland

Nearby regions were defined as those on the North Island bordering the adjacent Waikato and Manawatu-Whanganui (Horizons) regions.

All marine pests present in New Zealand were included as candidate species. Taranaki has direct links with ports with infestations of marine pests. In addition, domestic vessel movements are nation-wide, with ship movements touching nearly every major port and harbour in New Zealand either directly or indirectly. This exposes Port Taranaki to all marine pests currently present in New Zealand. While the port is also exposed to international shipping traffic, species not known to be present in New Zealand are outside the scope of this project and the Ministry for Primary Industries is responsible for border control.

5.1.2. Step 2 - long list to short list

A workshop was held in Taranaki on 18th February 2020 with a range of biosecurity expertise from Taranaki Regional Council, Waikato Regional Council, AsureQuality[4], Horizons Regional Council and Ministry for Primary Industries. The workshop was facilitated by Place Group.

The session focused on discussion about pathways, species and potential approaches to the Taranaki risk assessment work. Discussion arrived at an agreed approach as follows:

1. The candidate species list was vetted to remove any that were already in Taranaki Region. This reduced the initial long list from 66 species down to a list of 43. This list included some uncertainties.

2. The remaining species were further assessed by the panel. A qualitative assessment considered:

    a. The likelihood of a species arriving in Taranaki and establishing;

[4] https://www.asurequality.com/our-services/pest-and-disease-management-solutions/ AsureQuality responds to pest or disease outbreaks and implements operational solutions for biosecurity, in partnership with MPI and other Government, Industry and Communities.

b. the potential consequences of establishment;
c. key pathways by which the species is likely to arrive.

Species were grouped as terrestrial, aquatic (freshwater) and marine to assist with pathways. This stage was able to use Waikato Regional Council's plan for velvet leaf (WRC, 2017) for guidance. The velvet leaf plan provides a comprehensive identification of pathways that are relevant to most of the candidate species that occur in terrestrial and aquatic environments. With the exception of marine pests, all the candidate species were logically linked to one or more pathways, or types of pathways, identified in the WRC plan. The broad species groupings generally followed common pathways of spread.

Alligator weed was treated as both an aquatic and terrestrial pest because it occurs in both habitats, to assess whether this changed the pathways for movement.

Pathways were considered in terms of volume and frequency of movements, and the potential for those pathways to move an organism from one place to another. Because many of the species travel by common pathways, on common vectors, the requirements for managing pathways provides a narrowed focus for effort, and each pathway can cover multiple species.

3. Species that were considered unlikely to be transported into the region, or were unlikely to have significant consequences were eliminated, leaving a short list of species that are likely to arrive in Taranaki via a range of pathways, and would have a high level of consequence for the region if they arrive and establish.

5.1.3. Inventory

Information for each of the candidate species was then gathered into an inventory using internet searches to access a range of documentation. Information for each species includes the references used to populate the inventory. The inventory is included as Appendix 3 to the report. Information was sought as per the project brief, and for each species includes (as far as possible):

- Description, taxonomy and general biology,
- history of introduction and spread in New Zealand,
- current and potential distribution,
- current and potential pathways,
- current and potential costs and benefits,
- management options, including current control practices, feasibility of eradication, and legislative management responses.

In the course of sourcing information for the inventory, two more species, purple nutsedge (aka nut grass) and rough horsetail were removed when online records indicating that they are already present in Taranaki were found and confirmed by TRC staff.

A single plant of sea spurge has been found within the Taranaki Region, however the species is retained on the basis that the plant was removed and no further specimens have been found since. It therefore remains valid as a species of risk to the region.

6. Priority species for Taranaki

Tables 3 to 5 summarise the species that are considered most likely to arrive in Taranaki and will have a high level of consequence if they establish. The regulatory status of each species is provided to indicate whether or not a regulatory response is available. Further information on all the species listed is included in Appendix 3, and includes whether a species is in a neighbouring or nearby RPMP and the intermediate outcome sought.

Table 3: Terrestrial pests

Common name	Scientific name	Status*
Alligator weed	*Alternanthera philoxeroides*	UO; NPPA
Bat-wing passion-flower	*Passiflora apetala*	UO
Broom corn millet[5]	*Panicum miliaceum*	
Chilean needle grass	*Nasella neesiana*	NPPA
Dama wallaby	*Macropus eugenii*	UO (status expires 20 September 2021)
Darwin ants	*Doleromyrma darwiniana*	ant surveillance programme led by MPI
Pyp grass	*Ehrharta villosa*	UO; NIPR
Sea spurge	*Euphorbia paralias*	UO
Velvet leaf	*Abutilon theophrasti*	UO
Exotic pets such as Eastern water dragon; blue tongued skink.		Currently none, however National Pest Pet Biosecurity Accord may address these.

* refers to any status formally recognised under the BSA and or MPI national programme.

The aquatic weed species identified to be of risk to Taranaki feature as high risk species as rated by the Aquatic Weed Risk Assessment Model (Champion and Clayton, 2000). These are considered

[5] Climex modelling for this pest should be further investigated to confirm whether it is a risk to Taranaki

species that score over 50 under the AWRAM model, with only water poppy scoring under that threshold with an AWRAM score of 45.

Table 4: Aquatic pests

Common name	Scientific name	Status*
Alligator weed	*Alternanthera philoxeroides*	UO; NPPA
Bullhead catfish	*Ameiurus nebulosus*	Part 5b (26ZM) Conservation Act 1987
Eel grass	*Vallisneria spiralis*	UO; NPPA
Koi carp	*Cyprinus carpio*	UO
Manchurian wild rice	Zizania latifolia	UO; NPPA; NIPR
Purple loosestrife	*Lythrum salicaria*	UO; NPPA
Salvinia	*Salvinia molesta*	NO; UO; NPPA; NIPR
Tench	*Tinca tinca*	Part 5b (26ZM) Conservation Act 1987
Water poppy	*Hydrocleys nymphoides*	UO; NPPA

* refers to any status formally recognised under the BSA and or MPI national programme.

Table 5: Marine pests

Common name	Scientific name	Status*
Asian paddle crab	*Charybdis japonica*	None - likely to be picked up under the MPI-led high risk site surveillance programme for marine species.
Australian droplet tunicate	*Eudistoma elongatum*	
Clubbed tunicate	*Styela clava*	UO
Medittranean fanworm	*Sabella spallanzanii*	NO; UO

* refers to any status formally recognised under the BSA and or MPI national programme.

7. Management priorities for Taranaki Regional Council

Most of the highest risk species for the region in terms of likelihood of entry and consequence of establishment have a pest status outside the Taranaki Region that enables the Council or other organisations to respond to new incursions within the BSA or other regulatory framework without additional measures necessarily being required.

Unwanted organisms are covered in s52 and s53 of the BSA which enables an enforcement response from TRC (regardless of whether they are listed in the RPMP or not) and the ability to control the pest where it is found – s13 (1) (h) provides for any action (by a regional council) to give effect to any provision of the Act. Surveillance is enabled in s103 (3) of the BSA. Species where MPI is the lead agency (eg; under NIPR) may involve TRC in a supporting role, but otherwise do not require a regional level plan mechanism. In the absence of any other regulatory powers, including where TRC has not declared the species a pest in the existing RPMP, TRC (or another organisation) can declare a small scale pest management plan (s13 (1) (fa) of the BSA) for a new incursion which can then declare the Part 6 powers that will be used to manage the incursion.

Table 6 summarises the key responsibilities of each agency in relation to each pest status. Of note, the Department of Conservation could lead a response for a new aquatic species under provisions in the Conservation Act 1987.

Table 6: Pest status and role of TRC in surveillance and responding to new incursions to the region.

Status	Lead agency	TRC role
Unwanted Organism (UO)	Species dependent	Surveillance; Lead or support response to new incursion to region.
Notifiable Organism (NO)	MPI	Surveillance; Support
National Pest Plant Accord plant (NPPA)	The Accord is a partnership led by MPI and including regional councils, amongst others; lead is species dependent.	Support MPI programme by undertaking surveillance and inspections; Support or lead new incursion.
National Interest Pest Response (NIPR)	MPI	Surveillance; support
National Pest Pet Biosecurity Accord[6] (NPPBA)	The Accord is a partnership led by MPI and including regional councils, amongst others; lead is species dependent.	Support MPI programme by undertaking surveillance and inspections; Support or lead new incursion.

[6] As yet no pet species have been regulated under this Accord. For information about the accord: https://www.mpi.govt.nz/protection-and-response/finding-and-reporting-pests-and-diseases/keeping-watch/stopping-pets-becoming-pests/

Place Group has identified a number of recommended actions for the future management of pest pathways by the TRC as set out below. Actions are grouped into the following themes:

- Priority species
- Surveillance and response
- Interagency partnerships and collaboration
- Awareness, education and engagement

7.1. Recommended actions for the TRC in relation to priority species

7.1.1. Planning and advocacy

That the TRC:

- ➢ Prioritise high risk species that do not have a status that invokes provisions under the BSA for inclusion in the next RPMP (or as an amendment to the current plan) to enable some regulatory provisions.

- ➢ Promote species for inclusion in the Unwanted Organisms register, NPPA or NPPBA if they are considered of sufficient concern. Alternatively investigate why they are not already on the UO register or included in the Accord lists and reassess risk for the region.

- ➢ Consider other pest species that are not UO/NO/NPPA etc that are of risk to the Taranaki region for species focussed surveillance, response planning and/or inclusion in the next RPMP. This assessment would consider species not already included in this inventory that may be of lesser risk but still pose significant potential issues for the region.

- ➢ Gather detailed control information for individual species to facilitate a rapid response in the event of an incursion, particularly chemical control options for pest plants that include herbicides and rates so that the information is easily accessible.

- ➢ For UO and NPPA species regulatory tools are available and actions can focus on advocacy, support, education and continuous improvement of surveillance and response.

7.1.2. Surveillance and response

That the TRC:

- ➢ Continue the required surveillance to prevent the propagation or distribution of NPPA plants and NPPBA animals.
  - Build and maintain relationships with retail outlets
  - Consider surveillance at different times of the year to include species that may be available seasonally

- Ensure personnel are both well trained in the identification of unwanted organisms and distinguishing them from other similar species and are also able to communicate effectively with retailers
- Use existing channels through MPI to advocate for additional species as UOs if they are of concern

➢ Continuous improvement approach and reviews of surveillance and response/readiness systems and practices. Investment into this area of work can prevent the need to spend significantly more on needing to engage in eradication programmes or to manage an established species indefinitely.
- For example: Include surveillance at key sites where various materials are sourced - eg; quarries and other aggregate suppliers, bulk potting mix, mulch and landscaping materials - to enable containment and management of issues on site.
- Investigate and support other initiatives to research and develop new methods of surveillance (eg; use of drones for aquatic pest surveillance; dogs being used to detect Chilean needle grass).
- Collaborate with other regions or at national level on common issues to share costs.
- Actively participate in initiatives like the national Freshwater Biodiversity Partnership Programme that aims to improve tools and knowledge around freshwater pests for example, by helping identify a research need that will be of benefit to others.

➢ Use summer students or assign time to an FTE for proactive biosecurity surveillance work, such as targeted surveys of specific habitat types (eg; wetlands or a section of drainage network) and/or short list of key high risk species. Species would need to be prioritised and appropriate training provided for identification. This would assist with:
- Ensuring a new species has not arrived unnoticed.
- Identifying a new incursion early.
- Containing an incursion particularly where it might otherwise be easily spread (eg; aquatic weeds in drainage networks where contractors move across one property or multiple properties in a single day for drain clearing).
- Avoiding landowners spreading drain cleanings or other spoil that contain pest organisms.
- Improving landowner awareness by being visible and interacting with the community.

➢ Proactive planning for response to new incursions so that a response can be activated as soon as possible. Standard practices around isolating an infestation to delineate and contain is the first priority, however other actions could include:
- Draft small scale management plans for new incursions that TRC will be required to respond to as the lead agency. This reduces the work needed between detection and the ability to declare the plan by public notice.
- Logistics and operations planning in a similar way to emergency management planning in order to activate a response in a few days. This could include having response ready equipment and identified roles for individuals in a response team.
- Establishing protocols with other agencies and neighbouring regions, including the lead and support roles for TRC and other agencies.

- Purchasing or establishing access to specialised equipment to help contain species types (eg; a floating boom to contain a new water hyacinth sighting and prevent it escaping the water body).

➢ Use forward tracing and back tracing (as per WRC, 2017). Trace forward to identify further risk sites and trace back to the extent that it's likely to provide useful information.
- Note: While trace back is highly valuable in the early stages of a response/programme, its value significantly diminishes over time and it can be a source of distraction, with effort best invested elsewhere. Judging the level of effort warranted/to be invested in trace back will need to be weighed up by an experienced investigator at the time.
- This can also add to mutual support between neighbouring regions by locating potential source or new site in another region.

➢ Provide appropriate positive support and response to businesses and individuals who have a new incursion on their property to effectively contain and eliminate it from the site.
- Aim for positive support so that businesses and individuals are not concealing pest issues because they believe they will be prosecuted.

7.1.3. Interagency partnerships and collaboration

➢ Partnerships with industry bodies – that the TRC

- Access existing forums and communications channels to improve farmer/landowner knowledge (eg; DairyNZ discussion groups and websites).
- Work with agricultural contractors to develop pragmatic options for improved machinery hygiene or ways of working to minimise spread within and between properties. There is an Agricultural Contractors Association that could be approached as a starting point.
- Work with roading and rail contractors, agencies (NZTA, District Councils, NZ Rail) and suppliers to improve their biosecurity measures. This should include machinery hygiene practices, sourcing of clean materials, containment of pests at the source (eg; quarries for aggregates), monitoring and follow-up for new infestations that are connected with their work.

➢ Use and encourage the use of commercial incentives to implement good hygiene practices, for example including hygiene requirements and cost recovery (for an incursion response and/or ongoing control needs) in purchasing and supply contracts. This may not be a direct TRC action, however others can be encouraged to use it (eg; NZTA etc).

➢ Take a proactive approach to building on existing relationships with other organisations like the Department of Conservation and the Ministry for Primary Industries to improve communication and information sharing.

- Work with the Department of Conservation and Fish & Game NZ (where appropriate) in pest fish survey work to ensure the extent of exotic fish in the region is well known from up to date information.
  - The introduction of any aquatic life into an area where they do not already occur is an offence under Part 5b (26ZM) of the Conservation Act 1987.
  - Fish & Game NZ, Taranaki, is committed to the removal of any new incursions of coarse fish outside of their existing range, therefore having good information about the existing range will be important in getting support for removal of future incursions.

- Develop agreements and protocols for information and data sharing particularly with neighbouring and nearby regions. There should be a sufficient level of formality to these agreements to ensure that they are not reliant on relationships between individual staff members, and compatible data management tools applied.

- Actively advocate for national and sub-national management plans to control unwanted organisms that require a multi-regional approach to most efficiently and effectively control the species. This is particularly applicable to marine pests, but also applies to aquatic and terrestrial species.

- Participate in national and sub-national initiatives to effectively control unwanted organisms that require a consistent and coordinated multi-regional approach. Check, Clean, Dry and the Freshwater Biosecurity Partnerships Programme is one example.

- For marine species, consider whether the national surveillance is sufficient for Taranaki to identify marine pests new to the port, or whether additional surveillance work might be needed.
  - If more is considered necessary, work with the teams already monitoring in the Port twice a year to expand their surveillance while they are there as a more efficient logistical and cost option than getting a separate team or separate site visit for more targeted searches.

- Work with domestic shipping companies who regularly use Port Taranaki around improved hygiene/biofouling measures to reduce the movement of new pests from other ports. Regional Council could work with Port Taranaki to establish and implement protocols with domestic shipping companies.

- Establish relationships with domestic ports that share shipping routes with Taranaki to keep up to date on new incursions or major infestations with a view to sharing forward and back tracing information for pest spread. Relationships are likely to be most appropriately established between Port Taranaki (as opposed to TRC) and other domestic ports, however the Regional Council may need to provide a level of support, inducement or encouragement to enable this.

- Actively pursue options for inter-regional collaboration around marine pathways management, and to advocate for a national approach to inter-regional movement of marine pests. Options include:

- Developing a marine pest pathways management plan that is consistent with other Councils from both North and South Islands.
- Taking a lead role in approaching MPI with regard to a national marine pathways plan.

7.1.4. Awareness, education and engagement

That the TRC:

- Maximise opportunities for advocacy and education to improve knowledge in the community in general, to support early identification and response.
  - This includes regional communications opportunities
  - Join/support/advocate for national level initiatives
  - Consider targeted campaigns using a range of channels and media for specific pests or groups of pests.

- Promote a "my farm is an island approach" to encourage farmers to:
  - Not allow dirty machinery to enter or leave the property.
  - Communicate to and work with contractors if they have infestations on their property to reduce the spread.
  - Consider machinery cleaning facilities (high pressure hose and bunded area to contain materials) at a main entrance.
  - Not allow contaminated feed to leave the property.
  - Consider supporting landowner to develop a farm biosecurity plan or incorporate biosecurity into a whole farm environment plan to help manage significant pests and contain them within a property or part of a property.
  - Leveraging other drivers for whole farm planning (eg; NPS for Freshwater) may provide an opportunity to incorporate biosecurity into farm plan content.

- Encourage reporting of unusual sightings
  - Easy, friendly, responsive process for the individual.
  - Serious and respectful response to the report in a timely manner so that the community knows that the Regional Council takes this seriously and the individual feels like they have done a good thing and will do it again.
  - Use opportunities to publicise incidents where a report in from a member of the public has enabled a timely response to a new incursion.
  - Build positive relationships and provide good support to landowners.

- There are some wider pieces of work or existing work that could be explored around improving levels of awareness and engagement, increasing individual willingness to do their part, and identifying and addressing barriers to uptake.

8. Emerging tools and resources

8.1. Freshwater Biosecurity Partnership Programme

The Freshwater Biosecurity Partnership Programme (led by MPI) 2016-2026 Strategy is looking at a range of actions to improve collaboration around managing freshwater pests. It includes a range of work that will be of interest to TRC, including relationship management, pathway management, risk assessments, behaviour change, science and research, best practice support for surveillance tools and response planning, regulatory tools, information sharing and capability building. The programme overall should help fill some gaps around freshwater biosecurity and promote programmes of work that will be of national interest and benefit across the regions. Participation will be key to influencing the direction and keeping up to date with developments.

The Strategy can be found here: http://www.mpi.govt.nz/news-and-resources/publications/ .

8.2. Best Management Practice for Aquatic Weed Control (Champion *et al,* 2019)

This is an Envirolink funded project contracted to NIWA that provides a framework of best practice to support decision-making and management of aquatic weeds by regional councils. The Part 1 report is complete. It includes two of three tools:

- A strategic analysis tool that provides guidance and rationale for applying appropriate management options based on the NPD programmes and objectives (including a no management option).

- An incursion detection tool that includes prioritisation of target species based on proximity to a region and dispersal pathways, and regional prioritisation of sites for surveillance. It also includes surveillance techniques and their strategic application and strategies to improve the containment of incursions.

The framework recommends identifying aquatic ecosystems and their relative value and weed status as a first step in protecting regional freshwater resources from the impact of invasive aquatic species, and this could be actioned ahead of the next RPMP.

The Part 2 report will provide an inventory of aquatic weeds with information specific to each weed including actual and potential distribution, potential impacts and methods of control. This would be a fairly definitive information source for aquatic weeds and it is recommended that the inventory information from this current project be replaced when the Part 2 report becomes available. Very few of the species listed are unlikely to naturalise in Taranaki if they are not already present.

In addition, the risk assessments could also be reviewed and the strategic analysis tool applied for the next RPMP review in 2028 and consideration of aquatic weeds as part of that process.

9. Immediate next steps

The list of recommendations for addressing high risk species and pathways for Taranaki Region are included in Sections 8 and 9. Forward planning aimed at identifying potential and likely threats and ensuring that biosecurity systems and processes are in place to promote early detection and action is required for effective pathway management.

In considering where effort is best placed in the short to medium term (1-3 years), up-front investment to address pests at the bottom of the invasion curve through pathway management is considered the highest priority.

9.1. Proactive surveillance:

Develop a strategic proactive surveillance programme with annual, targeted surveillance for terrestrial and aquatic pests. Options could include:

a. Dedicating part of an FTE to targeted surveillance

b. Employing summer students or graduates to undertake surveillance annually (seasonally appropriate for the pests involved), noting that they would need to be competent in identifying the pests concerned and/or would require suitable training.

c. Engaging with landowners and/or service for additional eyes on the ground and/or to facilitate access to land or sites like quarries or aggregate stock-piling facilities.

Species that are not already within the region rely on passive surveillance, ie sightings by landowners and the general public. This increases the risk of a pest being well established before being noticed, particularly where awareness of the need to report unusual sightings is low. For aquatic species, there is a higher risk of them spreading through waterways during flooding events before arriving at a site where they are noticed.

Proactive surveillance can be planned to target high risk species in specific habitats or at specific times of year when target species are most likely to be visible, and/or planned for efficient logistics.

9.2. Response planning:

Undertake early and detailed response planning for the event of a new incursion. Planning should include:

a. Working with other relevant agencies to be clear on protocols, roles and responsibilities for individual pests or categories of pests, and formalising these arrangements

b. Drafting small scale management plans or templates that can then be finalised or filled in to respond to a species incursion

c. Gathering detailed information into one storage location that provides comprehensive information about how to contain and control the species of interest (eg; containment options/tools; chemical control options, rates and repeat cycles; personnel or contract providers appropriately qualified and potentially able to provide on the ground response)

In a similar way to emergency response planning, having protocols, communications channels and roles and responsibilities laid out ahead of a response can help improve the efficiency and effectiveness of the response. While there may not be quite the same level of urgency of response for some pests, others will require a much quicker response (eg; plants vs animals). Having resources to hand, rather than scrambling for information, equipment and answers, is critical to smoothing the response process.

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Appendices

Appendix 1 - project scope provide by TRC

Project Concept Brief:
Review of pest pathways into Taranaki

Project Description

For the Taranaki Regional Council (the Council) to commission a consultant to undertake risk assessments for harmful organisms not present in the Taranaki region by:

- examining high risk pathways for the accidental or deliberate spread of harmful organisms;
- identifying in the order of 20 harmful organism species not present in the Taranaki region but present in adjacent or nearby regions or on known pathway and species that are capable of becoming established in the region and likely to have regionally significant adverse and unintended impacts; and
- preparing a Risk Assessment Inventory of potential invasive plants and animals present in New Zealand but not yet present in Taranaki and which are likely to have regionally significant adverse and unintended impacts.

The project gives effect to Action 1 set out in the *Taranaki Regional Council Biosecurity Strategy 2018-2038* and involves commissioning a consultant with the appropriate experience and expertise to undertake risk assessments and prepare a Risk Assessment Inventory of potential invasive plants and animals present in New Zealand but not yet present or established in Taranaki, for which there is a high risk they may spread to this region, and which would have regionally significant adverse and unintended impacts.

Reason(s) for the Project

The most effective form of 'pest' management is to avoid a problem becoming a problem in the first place. The Council's stated objective, as set out in Section4.1 of the *Taranaki Regional Council Biosecurity Strategy is to "…avoid the introduction or establishment of harmful organisms present in New Zealand but not yet present in Taranaki, and reduce the spread of other harmful organisms already in the region over the duration of this Strategy.*"

There are a large number of potentially harmful species established in New Zealand that are not yet present in Taranaki. However, over time, these may be spread by humans along 'pathways' – either intentionally or unintentionally. Examples of intentional spread might be via the pet trade, examples of unintentional spread might be the accidental spread of weeds or invasive ants via dirty or infected equipment or goods.

The concept underpinning the pathway approach in pest management is to prevent harmful organisms from reaching a destination in the first place rather than responding after the species has arrived, then, becomes established, and becomes a problem.

The first step in this process is to undertake forward planning to clearly identify potential and likely threats so as to ensure biosecurity systems and processes are in place to promote early detection and action.

The project will inform and support the Council's regional surveillance, incursion response and social marketing activities by providing an objective, evidence-based foundation for policy development and determining the best allocation of resources to prevent the introduction of new harmful species to Taranaki. This includes the merits or otherwise of developing regulatory (i.e. inter-regional pathway plans, a regional pathway plan) and/or other policy instruments.

Benefits

The project will have the following benefits:

- objective, evidence-based foundation for policy development
- inform the prioritisation (if appropriate) of Council resources to prevent the introduction of new harmful species to Taranaki
- inform the targeting of key pathways and developing a contingency response in Taranaki
- proactively consider management options for preventing the introduction of new harmful species to Taranaki
- increased public awareness of pathway risks
- improved biosecurity outcomes by avoiding or reducing the spread of new harmful species to Taranaki.

Key Dates

Forecast Start Date: 1/11/2019
Forecast End Date: 14/04/2020

Resources

People: S Hall, S Ellis, D West, C Spurdle, consultant.
Budget:

In Scope

- Pests (as per BSA definition) from other regions.
- Unwanted organisms.
- Other invasive species not present in the Taranaki region but present in adjacent or nearby regions.
- Other invasive species present in New Zealand with a high risk of being spread through known pathways.
- Terrestrial, freshwater and marine invasive species.
- Biodiversity, economic or social impacts that are regional in significance.

Out of Scope

- Invasive species not present in New Zealand.
- Invasive species having adverse and unintended impacts that are not regionally significant.
- Invasive species for which the benefits of control accrue to individuals rather than the region.
- Invasive species not capable of becoming established in the region.

Project Method

This project involves commissioning a consultant to undertake a desktop analyse and undertaking risk assessments for harmful organisms not present in the Taranaki region. Project methodology initially involves establishing a project team to have input and oversee the project. It will comprise S Hall, S Ellis, D West and C Spurdle. S Hall will be project owner.

The Project involves the following component parts and milestones:

1. **Develop project brief:** Project team to confirm project brief to establish project objectives, scope, methodology and timelines, including candidate species of interest. Estimated completion date – *28 November 2019*.
2. **Commission consultant:** Prepare contract and appoint a suitably qualified and experienced consultant to undertake the project.
3. **Undertake workshops to identify candidate species of interest:** Consultant to undertake a workshop(s) of Council Environment Services staff plus representatives from neighbouring councils, MPI and Assure Quality to canvas potential candidate species of interest – these being harmful organism species not present in the Taranaki region but present in adjacent or nearby regions, or on known pathway, and likely to have regionally significant adverse and unintended impact.
4. **Select candidate species of interest** Consultant in discussions with the Council to apply a risk matrix based to prioritise and identify in the order of 20 candidate species that pose the most immediate risk to Taranaki. Criterion for the risk assessment to be confirmed with the consultant but as a minimum would consider: (1) likelihood of the species spreading to Taranaki; (2) the actual and potential impacts of the species should it become established; and (3) technical feasibility of managing the species.
5. **Gather information and prepare Inventory:** Consultant to undertake a desktop analysis of relevant websites and pest management plans and strategies, and interview people with the appropriate experience and expertise (e.g. Council staff) to gather relevant information on the 20 candidate species of interest.

   Available resources include the following:

   - Taranaki Regional Council Biosecurity Strategy
   - Pest Management Plan for Taranaki
   - Pest and pathway plans from other regions
   - Climex modelling
   - Land type/use models.

   In relation to each identified priority candidate species, consultant to prepare Inventory sheet that summarises information from a range of existing sources on candidate species, including:

   - description, taxonomy and general biology
   - history of introduction and spread in New Zealand
   - current and potential distribution
   - current and potential pathways
   - current and potential costs and benefits
   - management options, including current control practices, feasibility of eradication, and legislative management responses.
6. **Prepare a Risk Assessment Inventory:** Consultant to prepare a draft Risk Assessment Inventory of potential invasive plants and animals present in New Zealand but not yet present in Taranaki.

Project team to review prior to finalising draft content. Estimated completion date – *14 April 2020*.

Appendix 2 - Legislative context

Biosecurity Act 1993

Under the Biosecurity Act 1993 (BSA) Regional Councils are responsible for providing regional leadership with regard to pest management within the region.

The BSA is enabling, rather than prescriptive. It provides a level of flexibility with regard to the approaches taken by regional councils to manage pests and pathways and a regional council is not legally obliged to manage a pest by way of a Plan.

Regional Pest Management Plans (RPMP) and/or Regional Pathways Management Plans (PMP) are tools that a regional council can use to provide leadership and manage pests. Both Plans enable the use of rules and powers under Part 6 of the BSA and the Council's role is to lead the implementation of the plan. The plan can include laying out the roles and responsibilities of other agencies, landowners and the Council itself.

Declaring a species to be a pest in an RPMP or PMP allows the application of S52 and S53 of the BSA as a minimum standard. Those sections ban anyone from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Some pests have an additional 'status' at national level which invokes the provisions of S52 and S53 whether the pest is in the RPMP/PMP or not. The status may already include some controls, and/or provide direction as to the lead and support agencies in a response.

Other legislation

Regulations outside the BSA enable enforcement to prevent or respond to the spread of pest organisms and require cooperation and communication between agencies. The Regional Council role alongside other legislation is mainly advocacy and support of the lead agency, however the BSA leadership role enables a higher level of influence and collaboration alongside the agencies responsible under those Acts.

Other legislation that supports or provides for pest management include:

- Conservation Act 1987 - The introduction of any aquatic life into an area where they do not already occur is an offence under Part 5b (26ZM) of the Conservation Act 1987.
    - Lead agency: Department of Conservation.

- Fisheries regulations - recreational and commercial fishers are required to kill catfish on capture.
    - Lead agency: Department of Conservation; Fish & Game New Zealand.

- Wild Animal Control Act 1977 - controls hunting and release of game animals like deer, goats and pigs, and regulates deer farming and safari parks. It gives local authorities the power to control wild animals under an operations plan approved by the Minister of Conservation.
    - Lead agency: Department of Conservation.

- The Resource Management Act 1991- includes powers that may be complementary to the BSA, e.g. by ensuring that biosecurity issues such as biofouling are not exacerbated by use and development activities regulated under the RMA. The BSA cannot override controls imposed under the RMA, like resource consent requirements, however pest management actions can be imposed as conditions of consent.
    - Several agencies have a range of roles under the RMA.

Appendix 3: Species inventory

Alligator weed

(*Alternanthera philoxeroides)*

Other common names: pig weed

Family: Alternanthera

There are 4 species of *Alternanthera* in New Zealand, including *A. philoxeroides*: *A denticulata* (lesser joyweed) is considered native, although there is some uncertainty and it may have been naturalised from Australia; *A nahui* (nahui) is native; *A. pungens* is exotic.

Summary of invasiveness:

Alligator weed is considered one of the worst weeds in the world because it can invade terrestrial and aquatic habitats. It is difficult to control, particularly the terrestrial form with extensive underground rhizomatous root systems. These root systems can remain dormant in the ground for several years, and in one such example, the plant re-emerged when soil was disturbed after remaining dormant for six years (Embling, 2019). It reproduces from small fragments and grows in a wide range of climatic conditions and habitats.

It is listed as invasive in at least 14 countries around the world ranging from tropical to temperate, and is a problem in about 30 countries. Once established it is an aggressive invader and can disrupt natural aquatic and sub-aquatic ecosystems, shoreline vegetation and terrestrial habitats. It clogs waterways, making it a problem for recreation, navigation, irrigation and drainage and flood schemes. It is toxic to stock, can outcompete pasture and crops and is likely to interfere with whitebait spawning areas.

Description:

Alligator weed is perennial and stoloniferous. The growth habit is sprawling and leaves are bright green and waxy, between 5-10 cm long, up to 2 cm wide and arranged in opposite pairs on the stem. The white flower looks like a small clover flower and appears at the end of a longish stalk, however it is not known to flower in New Zealand. Stems are thick, soft and hollow and often have a reddish tinge. (Champion and Hofstra, 2014).

The growth form varies between the terrestrial and aquatic forms. Away from open water the plant produces deep taproots and has an extensive root mass reaching below 50 cm in some cases. The leaves of terrestrial plants are smaller and they tend to have fewer flowers. In New Zealand, the terrestrial form of the plant tends to die out over winter in cooler areas, especially those subject to regular frosts , and then re-emerges in spring.

Plants growing over open water grow more vigorously than terrestrial plants and the stems are thicker and taller with larger internal air spaces. Leaves are larger and darker, roots shorter and more filamentous and rising mainly from nodes. Floating mats are made up of interwoven stems and can stretch many metres across the water surface and over 1 metre thick. These mats can break away and continue to grow in free floating form.

Similar species:

In terrestrial locations it can be mistaken for willow weed (*Ludwigia species*), however willow weed has alternate leaves. The native *Alternanthera* species are smaller and the flowers are located at the base of paired leaves, not on a stalk. (Champion and Hofstra, 2014).

Habitat:

It occurs in New Zealand in slow flowing water bodies, swamps, ponds, stream banks, dune hollows and in poorly drained soils in pasture, crops and orchards, and urban lawns (Champion and Hofstra, 2014). Alligator weed often grows at the interface between aquatic and terrestrial environments. It tolerates brackish conditions up to 30% sea water (Van Oosterhout, 2007), and a wide range of temperature and soil drainage conditions (Champion and Hofstra, 2014).

Reproduction

The plant is not known to flower or set seed in New Zealand and it reproduces vegetatively either by extension of stems or stem fragmentation. Stem fragments will re-grow where they are distributed to suitable new locations.

History of introduction and spread in New Zealand

Alligator weed is native to South America and is thought to have been accidentally introduced to New Zealand from ballast that was discharged by ships entering rivers in Northland. It was first recorded in 1906.

Alligator weed was first reported in the Waikato in the 1980's at two sites on the Hauraki Plains. It was discovered on the Waikato River in 1990. It is now established in the lower Waikato River and at approximately 140 known sites (including farms, market gardens and urban areas) elsewhere in the Region. Most of the infestations are a result of human activities (e.g. movement of contaminated soil, green waste and machinery). Control of the weed is occurring at all the known sites (Embling, 2019).

Current and potential distribution in New Zealand

Alligator weed is widespread in the Northland and Auckland Regions with scattered sites in Waikato, Bay of Plenty and Manawatu-Wanganui Regions. Presence in the Manawatu-Wanganui suggests that Taranaki's conditions are suitable for establishment.

Current and potential pathways

Spread is by vegetative material including roots. The plant will regrow from stem fragments that include a node or root.

Fragments are resilient Alligator weed fragments are very resistant to desiccation (drying out). It is unlikely that fragments ever dry out enough to render them unviable under field conditions. Fragments are also able to withstand moderate damage (i.e. from earthmoving equipment or trampling by stock) and still form buds, shoots and roots. Even damaged fragments can remain viable for long periods of time, particularly when in contact with soil or mud (Kruger 2005).

Vectors include:

- Water and flooding - floating rafts or smaller pieces.

- Watercraft, vehicles, machinery
- Animals (attached by mud, carried in hooves)
- Stock feed
- Spoil and drain cleanings.
- Fishing nets or other gear
- on boat trailers, outboard motors and in anchor wells
- It has also been found being grown by some communities as a leafy vegetable, being mistaken for *A. sessilis*. In some countries it has been intentionally introduced as an aquarium and ornamental aquatic plant.

Potential costs and benefits

Toxic to stock - can cause blindness and other health problems
Clogs waterways, drains, culverts, pumps. Blocks access for recreational use.
Can outcompete pasture and crops affecting farm production and profit.
Likely to interfere with whitebait spawning

Floating mats and the mass of stems in flood and drainage schemes accumulate sediment.

Alligator weed "in the north" was estimated, in 2017, to be costing land managers $6.4 million per year (Fowler, 2017).

An alligator weed infestation near Cambridge took almost 10 years to fully eradicate.

Management Options

Prevention (from arrival in region); containment.
Individual farm weed hygiene plan.
Exclude stock during the growing period (in some areas the plant will die out over winter).

Farmers should protect their properties from alligator weed and other serious pest plants by:

- insisting all contractors practice good weed hygiene, cleaning their equipment before entering the farm
- ensuring supplementary feed brought onto the farm is weed free
- ensuring aggregates, soil and sand brought onto the farm is weed free.

Machinery should be cleaned before leaving an infested area, and the cleaning area bunded and monitored to contain and treat any viable material.

Material that is manually removed/controlled needs to be carefully disposed of to ensure it is no longer viable. Options include drying it out completely and then burning (if not completely dry some of the roots will not burn). Boiling for small quantities.

Current control practices and options

Biological control - three agents have been released - a moth and two beetles, however only the moth and one of the beetles appears to have established (Landcare Research 2007). Alligator weed flea beetle has provided partial control in Northland, however it has not been effective in the Waikato due to sub-optimal temperatures for the beetle (Embling, 2019). Other options are still being investigated.

Mechanical and manual control has been used for small isolated infestations however it is time-consuming and costly and every fragment of the plant needs to be captured and removed to prevent re-establishment. Neither are recommended, particularly for larger infestations because any form of mechanical or manual control, either on water or land, will spread fragments further in the immediate area or enable them to move them to new areas.

Containment - using fences and restricting access (van Oosterhout, 2007); prevent disturbance (no mowing, cutting, slashing, earthworks, cultivation, grazing).

Chemical control - Herbicide use for ongoing suppression of alligator weed requires diligence and ongoing repeated monitoring and applications. Alligator weed only translocates very small amounts of systemic herbicides to the root system, so particularly for terrestrial plants, the strategy is to spray two to three times every year so that the plant is forced to re-grow and depletes the reserves in the root system over time by not being allowed to replenish those reserves with extensive regrowth - five to six sets of leaves, 10 cm stem length or 30 cm crown width for prostrate growth forms. Spraying should be done whenever there is sufficient growth.

Metsulfuron-methyl is recommended over glyphosate on land, and glyphosate in aquatic situations because glyphosate causes less viable stem fragments following the herbicide application, which reduces floating fragments that can spread along waterways (Clements et al, 2017). A recommended regime is to use glyphosate to control the floating biomass over water and once infestations have been forced back to the embankment, use metsulfuron (or imazapyr) on the embankments and on land for longer term control (Clements et al, 2017).

Van Oosterhout (2007) provides comprehensive advice and recommendations for the control of alligator weed, although it is important to note that the recommendation for the combined use of metsulfuron and glyphosate between aquatic and land populations should not be used, and the recommendations provided by Clements *et al* (2017) are applied.

Feasibility of eradication

Van Oosterhuis (2007) notes that eradication is not feasible where infestations are well established, and strategically it is important to respond quickly and eradicate small, new or isolated infestations as quickly as possible. Ie rapid response. Larger infestations require extensive suppression (leading to eradication) over several years before eradication could be considered a feasible objective.

Immediate eradication is generally feasible for:

- small numbers of individual scattered plants (through deep manual digging)
- areas of infestation up to 5 m × 5 m (through deep manual digging)
- areas of infestation up to 10 m × 10 m with shallow roots (up to 30 cm deep) (through shallow mechanical excavation).

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Waikato Region: Progressive Containment. Rules relating to subdivision and land development are included in the RPMP to reduce the risk of spread, and breaching these rules is an offence under S154N(19) of the Biosecurity Act 1993 (Embling, 2019).

Horizons: Eradication. Known from one site near Taumarunui.

In Bay of Plenty Region it has a range of programmes depending on the location and level of infestation in the region:

- Eastern BOP (Otamarakau/Kawerau/Murupara/Rangitaiki) - progressive containment.
    - Found from Matahina Dam to the coast on the Rangitaiki River and spreading into nearby waterways from floods; below Awaiti flood-gates on the Tarawera River; terrestrial site in an orchard near Opotiki.
- Western BOP (West of Te Puke) - eradication
- Rotorua and mid region - exclusion

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Asian paddle crab

(Charybdis japonica)

Summary of invasiveness

Life history traits make Asian paddle crab invasive, including long larval life that facilitates spread, rapid growth to maturity, high reproductive rates, wide environmental tolerance and a broad diet (Northland Regional Council, 2017).

Description

Colour ranges from off-white and pale green, through olive-green to deep chestnut brown with purplish markings. The back legs have flattened swimming paddles. The shell is up to 12 cm wide, with six prominent spines on each side, and there are five spines on the upper surface of each claw. (MPI, 2019). The marine pest ID guide provides diagnostic information for distinguishing this crab from other similar species.

Asian paddle crabs are generalist predators that feed mainly on shellfish, fish and polychaete worms (Northland Regional Council, 2017).

Similar species

Swimming/paddle crab (*Ovalipes catharus)* - multiple features including five flattened spines on the carapace, one on the claw and two distinct reddish 'spots' on the shell.

Dwarf swimming crab (*Liocarcinus corrugatus*) - five spines, not six; much smaller and has fine corrugations over most of the shell.

Hairy red swimming crab (*Nectocarcinus antarcticus*) - four spines and red to pinkish-red colour.

Habitat

Estuaries, harbours and most coastal habitats; sand and mud substrates, from low tide to 15 meters depth (MPI, 2019).

Reproduction

Females produce an average of 85,000 eggs that may be released several times per year. Larvae float in the water for 3-4 weeks, moving with the tides and currents. It is thought that breeding only occurs at water temperatures above 20°C, which may restrict it's distribution. Fowler (2011) found gravid females first appearing in November in Auckland.

History of introduction and spread in New Zealand

First detected in New Zealand in 2000 in Waitemata Harbour, Auckland, and slowly moving around the coast. Asian paddle crab is native to the coastal regions of China, Japan, Korea, Taiwan and Malaysia (GISD, 2015).

Current and potential distribution in New Zealand

Present in Northland in Whangarei Harbour and widespread in the Hauraki Gulf and Waitemata Harbour in the Auckland Region. They have been present in Tauranga Harbour for several years and were recently found in Ohiwa Harbour in the Eastern Bay of Plenty in early 2020 during a routine dive survey (Tim Senior, pers comm, 20 April 2020).

Current and potential pathways

Larvae move in tides and currents and adults are capable of swimming large distances. Both adults and larvae can be spread in ship sea chests, ballast water, within heavy biofoul, fishing nets and bait tanks. They are sought after for food in their native range, and could be moved intentionally. (Northland Regional Council, 2017).

Potential costs and benefits

Highly detrimental to shellfish aquaculture. Asian paddle crabs are aggressive predators that displace native and fisheries species. They can carry diseases that affect crab, lobster, shrimp and prawn fisheries, eg; white spot syndrome virus, although the New Zealand population has not yet been found to carry it (CABI, 2020).

Management options

Current control practices

Trapping - dome shaped pot with open funnel entrances of type commonly used in Japan (GISD, 2015).

Feasibility of eradication

Trapping is the only tool available and eradication is unlikely to be feasible once the species arrives.

Legislative management responses

No legal status in New Zealand. Under management (MPI marine porthole, 2020).

Inclusion in RPMP or Pathways Management Plan to declare Asian paddle crab as a pest.

Northland Regional Council considered sustained control the preferred option to slow the spread of the species, combined with a pathway plan approach to enable enforcement options for clear exacerbators and opportunities to improve awareness and seek additional funding (Northland Regional Council, 2017).

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Australian droplet tunicate

(*Eudistoma elongatum)*

Summary of invasiveness

Prolific breeder and tolerates a range of habitats including soft bottom substrates and hard structures. Larvae are free-swimming for up to 6 hours. It can reproduce in water temperatures above 14°C, so it has the potential to spread to the south of its current range (Page *et al*, 2011), although spread in Taranaki may be limited to summer months - it dies back to low densities in winter in Northland.

Description

The Eudistoma sea squirt, also known as the Australian droplet tunicate, forms large colonies that attach to hard surfaces and look like clusters of white or cream-coloured cylindrical tubes . Each colony contains numerous small individuals and they can appear orange flecked due to the colour of the larvae within them. The species is firm and gelatinous to the touch and the cylindrical colonies are generally 5-30 cm long, but can occasionally reach 1.5 m in length. Colonies are generally 5-20 mm in diameter and regress and over-winter as small (c.10 mm) cream buds, re-growing the following spring to larger colonies (Northland Regional Council, 2020)

Similar species

Colonial Sea Squirt - Didemnum spp.

Habitat

Eudistoma is generally found in soft-bottomed tidal habitats and on hard structures such as wharf piles, aquaculture equipment and mangrove roots. It prefers submerged habitats just below the waterline, but can be found out of the water for periods during low tide (Northland Regional Council, 2020).

Reproduction

This species is a prolific breeder, reproducing for at least nine months of the year, from October through to June (Spring to late Autumn). The larvae are free-swimming for approximately six hours before they begin to settle on surfaces. Reproductive output decreases after high rainfall and in the early winter months due to the colony size also decreasing (Northland Regional Council, 2020).

History of introduction and spread in New Zealand

It was first reported in New Zealand in early 2005, but was not originally regarded as a pest, given its low density and the fact it appeared to die off in winter. In the summer of 2007-2008 it became more prolific in a number of locations in Northland and has continued to reappear over the summer months (MPI, 2020).

Current and potential distribution in New Zealand

Eudistoma elongatum has been reported present in Opua, Kerikeri, Russell and the Waikare Inlet in the Bay of Islands, Whangarei Harbour, Tauranga Harbour (historically), and Picton (historically) (MPI, 2016). Eudistoma has the potential to spread further within already occupied harbours, and

to more southern harbours in New Zealand (Page *et al*, 2011). It has spread throughout harbour and oyster farms in Northland (Page *et al*, 2011).

Current and potential pathways

Dispersal may occur by fragmentation; however, we have no data on the ability of fragments to reattach (Michael Page etc)

Potential costs and benefits

The Eudistoma sea squirt competes with native species for both space and food. It has a rapid growth rate, can inhabit a wide range of habitats, and can reach high abundances. It is also possible that it can ingest and kill the eggs and larvae of native species. When present in high densities the Australian droplet tunicate has the potential to have significant impacts on habitats and species. However some of the competitive ability of this species is minimised by the fact it is only present in large numbers during summer months and dies down during rain events and winter months (Northland Regional Council, 2020).

It is a nuisance in aquaculture, smothering oyster racks and therefore may result in higher labour costs for cleaning of equipment (Heath, 2014).

Management options

Current control practices

Only acetic acid was effective at killing colonies above water. Control using heat or other chemicals was not feasible for shallow subtidal populations identified in the study (Page *et al*, 2011).

Feasibility of eradication

Page *et al* (2011) indicate that "eradication is difficult or impossible due to the subtidal distribution of many colonies".

Legislative management responses

No status in New Zealand.

Northland RPMP: sustained control marine
BOP RPMP: Exclusion

Not in Waikato or Horizons RPMP.

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Bat-wing passion flower

(Passiflora apetala)

Summary of invasiveness

Passion flower is shade tolerant and has the ability to smother, shade and strangle other plants, growing up into the canopy. It is an emerging threat in New Zealand. It is sought as an ornamental subtropical plant and birds find the berries attractive and disperse seeds in their droppings. The vines produce large numbers of fruit as small black berries the size of a small grape. Plants grow rapidly from seed and can develop to mature fruit after 32 weeks. The seeds remain viable for more than 10 years. (T.E.R.R.A.I.N, accessed 16 April 2020), and it can grow from stems or plant fragments that touch the ground.

Description

It has leaves with two large lobes (that resemble a bat wing) and some have pale green stripes along the midribs. It has small yellow/green coloured flowers (7-12mm diameter) and produces small black berries about the size of a small grape (7-15mm diameter). The berries are inedible and non-toxic to humans but attractive to birds. (NZPCN; accessed 16 April 2020).

Similar species

No information found, however leaf shape and small green flowers are identifying characteristics.

Habitat

Regenerating native forest and scrub, home gardens and amongst hedges and fence lines where birds perch (NZPCN; accessed 16 April 2020).

Reproduction

By seed, which is spread by birds feeding on berries.

History of introduction and spread in New Zealand

Originates from Costa Rica and Panama in Central America and was imported approximately 30 years ago (NZPCN; accessed 16 April 2020).

Current and potential distribution in New Zealand

Distribution is restricted to the Northland and Auckland regions.

Current and potential pathways

Mostly natural spread by birds, historically by subtropical plant collectors for gardens.

Potential costs and benefits

Mostly a threat to biodiversity values as a smothering climbing plant that is also shade tolerant and spread by birds.

Management options

Current control practices

No information found. Other plants in the genus *Passiflora* can be controlled with herbicides.

Feasibility of eradication

No information found.

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Northland RPMP: eradication
Waikato and Bay of Plenty: Exclusion
Horizons: not included.

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Broom corn millet

(Panicum miliaceum)

Summary of invasiveness

Although the cultivated type is grown for human consumption, the wild form is weedier. It is a cropping weed, competing with the harvest for water, nutrients and sunlight when it reaches over the crop canopy. It also clogs harvest machinery.

The plant grows quickly and can set viable seed within six weeks of emergence, and seed production continues for a long period. The seed is persistent in the soil and germination and growth temperature tolerances are similar to corn and maize, although the optimum is warmer.

Description

Broom corn millet (Panicum miliaceum L.) is a highly drought-tolerant cereal that is widely cultivated in the semiarid regions of Asia, Europe, and other continents. (Zou, C., Li, L., Miki, D. et al). A wild biotype emerged in 1970 which quickly became weedy, reaching greater height and producing twice as much seed.

Broom corn millet has broad grass-like leaves up to 2 cm wide and plants resemble maize but with long hairs on the leaf sheath. The leaf blades are hairy on the upper and lower surfaces and along the edges. The leaf sheaths are also very hairy with overlapping margins. Ligules are a line of dense hairs.

Flower spikelets are individually carried on the end of branched panicles and the panicles can be 15-30 cm long. The seeds are egg-shaped, about 3 x 2 mm in size, and encased in a shiny seed coat. (AgPest, 2020).

Similar species

Habitat

Broom corn millet is a weed of crops. It originated in the tropics and temperate regions and can grow in dry climates.

Reproduction

BCM is fast growing and can set viable seed within six weeks of emergence. Its seed is extremely persistent in the soil and will survive for many years (Foundation for Arable Research, 2010).

History of introduction and spread in New Zealand

Since 1961 broom corn millet has undergone multiple entries into New Zealand, finally becoming widespread in sweetcorn crops in Hawke's Bay, Poverty Bay and Marlborough between 1995 and 2005 (James *et al,* 2011). The early incursions would have been of the cultivated type and apparently have not persisted.

However, some of the later incursions were of the wild-type, which have established and been widely dispersed in sweet corn crops by harvesting machinery (James *et al*, 2011).

Current and potential distribution in New Zealand

It has rapidly spread through sweet corn crops in Gisborne, Hawkes Bay and Marlborough and maize growers in these regions are also beginning to find it in their crops (Foundation for Arable Research, 2010). Also found in Bay of Plenty and Auckland Regions (Waikato Regional Council, 2014).

Current and potential pathways

The seed is transferred between properties in harvesting equipment and sweet corn waste (sold as stock food) (Foundation for Arable Research, 2010). Also through livestock and in contaminated grains (Waikato Regional Council, 2014)

Potential costs and benefits

Broom corn millet reduces crop yields by competition and interferes with harvest by clogging machinery. In one study, it was shown to reduce crop yield by 13 –22%, when present at a density of 10 plants/m2. Competes with maize and sweet corn for water and nutrients early in its life cycle. Later, when it has become tall enough, it competes for sunlight as it can reach over 2 m high in crops (AgPest, 2020).

Waikato Regional Council (2014) estimated control costs of approximately $180/ha/annum, and considered the benefits of the Exclusion programme for the RPMP exceeded costs, with the benefit sitting with the agricultural community.

Management options

Current control practices

Broom corn millet can be controlled by a targeted herbicide programme. Including pre-emergence herbicides was more effective, however post-emergence follow-up will be needed as seeds will continue to germinate through the growing season as long as the temperatures are suitable (Foundation for Arable Research, 2010).

Feasibility of eradication

No information found.

Legislative management responses

No status in New Zealand.

Waikato RPMP: Exclusion.
Horizons have not included broom corn millet in their RPMP.

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Brown Bullhead Catfish

(*Ameiurus nebulosus*)

Summary of invasiveness

Invasive overseas, and tolerant of poor water quality, generalist feeders. Male catfish are territorial. There is a lack of effective control tools available.

Description

The brown bullhead catfish is dark brown to olive green colour with paler sides and bellies. In addition to the eight distinctive barbels around their mouth, catfish also have relatively small eyes and a smooth skin. The leading edge on their dorsal and pectoral fins has a sharp spine, and thus catfish should be handled very carefully to avoid injury from the spine. Catfish are an extremely robust fish and can survive for long periods out of water. They commonly grow to 200–300 mm in length.

Catfish normally reach a maximum length of 300–350 mm long, some may reach up to 500 mm in length and more than 3 kg in weight (Scott & Crossman 1973).

Catfish are opportunistic generalists, feeding nocturnally on or near the bottom. The young feed mostly on chironomid larvae, cladocerans and amphipods (Scott & Crossman 1973). The adults are omnivorous with a diet composed of detritus, molluscs, invertebrate larvae, terrestrial insects, leeches, crustaceans, worms, plant material, fish and fish eggs (McDowall 1990).

Similar species

None in New Zealand.

Habitat

In their native range, catfish occupy lakes and sluggish streams with muddy or weedy beds. Catfish are tolerant of a wide range of environmental conditions that may be limiting for other fish species, and can survive temperatures as high as 36oC and oxygen levels as low as 0.2 ppm (Scott & Crossman 1973).

Catfish prefer slow flowing streams and the edges of lakes, often amongst aquatic plants.

Reproduction

Catfish spawn in shallow depressions on the substrate in the shallows. The male guards and fans the eggs during development, and also guards the larvae for about a week after hatching. Catfish are carnivorous and use their sensitive barbels to probe the substrate and locate insects, crustaceans, molluscs and small fish. Freshwater crayfish are a major prey species for catfish in Lake Taupo.

History of introduction and spread in New Zealand

The catfish in New Zealand originated from fresh and brackish waters in North America, where their native range is east of the Rocky Mountains from southern Canada to Central America.

Catfish were released into New Zealand in 1877, and the first consignment of 140 live catfish were released into St Johns Lake, Auckland (McDowall, 1990).

Current and potential distribution in New Zealand

Catfish have been present in New Zealand since the late 1800s. For many years, they were rarely encountered with the only known populations occurring in the lower Waikato River and in Lake Mahinapua south of Hokitika. They were first recorded from Lake Taupo in 1985. Since then, catfish have gradually spread throughout Lake Taupo and down the Waikato River. In 1997, catfish were recorded for the first time from the Kaituna Lagoon near Lake Ellesmere, and in 2003 from a stream entering Hokianga Harbour. Accidental introductions via boat trailers and especially fyke nets used for eeling are continuing to spread this species around New Zealand.

They are widespread in the Waikato River system, but are also found in Northland and there are two isolated populations in the South Island.

Current and potential pathways

Accidental introductions via boat trailers and especially fyke nets used for eeling is continuing to spread this species around New Zealand. Catfish are tolerant of low oxygen levels which enable survival during accidental transfers. Possibility of deliberate spread by coarse anglers.

Catfish are moderately strong swimmers and will likely increase their range through natural dispersal in connected networks of waterways.

Potential costs and benefits

Can contribute to poor water clarity by consumption of zooplankton, re-suspension of sediment and up-rooting submerged macrophytes. Excretion of nutrients in faeces exacerbates nutrient re-suspension.

Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present, and catfish presence is significantly correlated with the incidence of New Zealand lakes ‘flipping’.

Opportunistic generalist feeders, therefore a wide range of taxa are potentially impacted by predation. Documented eating common bullies as well as a wide range of invertebrates including kōura (preferred food source where available), Trichoptera, Gastropoda, Chironomidae. May affect charophyte establishment and persistence.

Implicated in local extinctions of freshwater species overseas. Indirect impacts through reductions in water quality.

Numerous impacts on mauri of wai māori (see ‘Water quality’, ‘Species diversity’ and ‘Threatened species’).

(Auckland Council, 2018).

Management options

Current control practices

Lack of effective control tools available. Chemical control (e.g. rotenone) is non-selective, therefore potential non-target impacts on native fish. Chemical control is also less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal.

Fyke netting is effective for catching catfish and eels (LakesWater Quality Society Symposium 2017), however the ability to eradicate catfish using nets is unknown. Other options are being investigated for controlling catfish in the Rotorua Lakes.

Feasibility of eradication

Difficult.

Legislative management responses

Catfish are regulated under the Conservation Act and the Freshwater Fisheries Regulations 1983. The release or transfer of aquatic life is prohibited under section 26ZM of the Conservation Act, unless Ministerial approval is obtained. The Department of Conservation and the Fish and Game Council (in relation to sports fish) have the statutory authority to act on illegal liberations of fish.

The Fisheries (Amateur Fishing) Regulations 2013 provides that a person must not possess a live brown bullhead catfish, but does not expressly forbid fishing for the species. The Fisheries (Commercial Fishing) Regulations 2001 also provides that no person may sell live brown bullhead catfish.

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Chilean needle grass

(Nassella neesiana)

Summary of invasiveness

It has broad ecological tolerances including drought and seasonal waterlogging. It is invasive in a number of countries overseas including Australia and the USA. It is difficult to control with seed remaining viable for up to a decade. Seeds are easily spread by a range of vectors.

Description

Erect, tufted, perennial tussock up to 1 m tall, somewhat like fescue in appearance. The leaves are <5 mm wide, flat, strongly ribbed on the upper surface with rough bristly edges. The upper surface is bright green and the underside a dull grey-green. The distinctive flowerheads are large, drooping and purplish and appear from November-December. The seeds have a long hair and a very sharp, pointed base that penetrates animal hides. Seeds are produced at three points on the plant - the main panicle, mid-stem at the leaf joins and at the base of the plant (Marlborough District Council, 2018).

Similar species

Tall fescue (*Schedonorus phoenix* aka *Lolium arundinaceum* subsp*. arundinaceum*) is similar in growth but CNG has narrower leaves and the spear-like attachment on the seed is distinctive.

Habitat

It grows on dry north-facing hill country, forestry blocks, edges of farm tracks, river banks; around hay barns, sheep yards and power poles, fencelines and other places where stock rub themselves. It can thrive in both high and low fertility sites and under moderate to severe moisture stress. (AgPest website, accessed 20 April 2020).

Reproduction

CNG seeds prolifically and builds large seed banks in the soil. It reproduces by either cross or self fertilisation and some seeds are produced in unopened flowers at the base of the flower stem.

Seeds germinate during autumn and winter and establish new plants. Reproductive tillers are produced from mid-September to mid-October and main seed heads are formed by mid-November. Seeds mature between December and January before being shed into soil or amongst the parent plant and can be carried to new sites. Hidden seeds form in flowers that are located at the base of the flower stems and ripen in February so that the plant can still reproduce from the base of the plant even under hard grazing or mowing. (AgPest website, accessed 20 April 2020).

History of introduction and spread in New Zealand

First identified as a pest in Canterbury in the 1940s.

Current and potential distribution in New Zealand

Potential to infest up to 15 million hectares of New Zealand. Currently present in Hawkes Bay (600 ha), Marlborough (2,800 ha) and Canterbury (220ha). (MPI, 2020).

Modelling indicates that coastal areas of Taranaki Region, particularly in the southern parts of the region are suitable to optimal for CNG .

Current and potential pathways

Spreads by seed attached to clothing, shoes, vehicles and animals. Also spread in stock feed, and where it grows along waterways will spread by water.

Potential costs and benefits

Unpalatable to stock, CNG reduces pasture productivity and the seeds damage pelts (no value as sheepskins), can penetrate into muscle tissue, reducing carcass value, and can blind livestock. Enforced containment measures can be restrictive and inconvenient, reducing a property's carrying capacity when those areas can't be grazed, and successful control is difficult and expensive.

During winter and early spring, CNG can provide palatable moderate quality fodder for cattle and sheep (AgPest, 2020).

Management options

There are two dogs in Canterbury trained to detect CNG in pasture as an added surveillance tool.

Current control practices

Early detection and response while the population is still small is key, as is containment of an existing population, ie good on farm biosecurity. Once established, control before seeding, revegetate and maintain pasture with desirable species. Keep stock and machinery out while in seed and follow up 6 monthly until eliminated. Small infestations can be grubbed out before seed set, and chemical controls will work ("taskforce", glyphosate, haloxyfop).

Biological control using a rust fungus has been approved and was released in Marlborough in 2018.

Feasibility of eradication

Possible over medium to long term time-frames - seed banks survive for around a decade.

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

It is a legal offence to knowingly allow CNG to spread from a property and precautions must be taken to prevent it spreading.

Regional Councils are responsible for managing CNG in their regions including control, regulations and informing farm owners.

Horizons RPMP: Exclusion

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Clubbed Tunicate

(Styela clava)

Summary of invasiveness

The organism can tolerate a wide range of water temperatures and salinity (MPI, 2013). It is capable of forming monospecific stands and potentially out-competing native species (Northland Regional Council, 2017).

Description

The clubbed tunicate has a long, tough, leathery skinned cylindrical form, tapering to a stalk with a disc shaped holdfast that anchors them to hard surfaces. The sea squirt ranges in colour from yellowish to reddish to brownish and can grow up to 160mm in length. Underwater it often appears fuzzy with secondary growth coating it. Under water, two short siphons or openings are visible at the top of the organism. Similar looking native New Zealand species such as Pyura pachydermatina also have a stalk, however, their stalk is much longer. (Marine Biosecurity Porthole, 2020).

Similar species

Similar looking native New Zealand species such as *Pyura pachydermatina* also have a stalk, however, their stalk is much longer (Marine Biosecurity Porthole, 2020).

Habitat

Styela prefers protected areas such as bays and harbours, away from wave action. It establishes from the low tide mark down to approximately 25 metres. It prefers to settle on hard surfaces, particularly man-made structures. Anything in the water that is not covered in silt or coated with antifouling paint is at risk. It may also be found attached to rocks, seaweed and on shellfish.

Reproduction

Styela is hermaphroditic but male and female gonads mature at different times and they are not self-fertile. It reproduces sexually, releasing eggs and sperm into the water. Spawning is temperature dependent and it is believed to only be able to spawn in waters above 15°C. Fertilisation is external and eggs and larvae are free swimming for between one to three days (24-28 hours at 20°C is given by Clarke and Therriault, 2007), after which they settle and metamorphose into the sessile adult (CABI, 2020).

History of introduction and spread in New Zealand

The species was first recorded in New Zealand in 2005 and was discovered in Port Nelson in 2010 (Forest, 2013).

Current and potential distribution in New Zealand

Present from Northland to Tauranga, Porirua, Picton, Tarakohe, Nelson, Picton, Lyttelton Harbour and Otago Harbours.

Current and potential pathways

The short planktonic phase leads to short larval dispersal distances, and human-aided dispersal as part of fouling on vessel hulls or as larvae in seawater retained in vessels are the key pathways (MPI, 2013).

Potential costs and benefits

The clubbed tunicate can outcompete other species due to it reaching such high densities and being an efficient suspension feeder.

As a fouling organism it can decrease the productivity of cultured species and increase aquaculture processing and harvesting costs. It also results in higher fuel and maintenance costs for vessels. In Japan it has caused asthmatic symptoms in individuals who shuck fouled oysters in poorly ventilated areas.

Management options

Current control practices

Hand removal (picking or scraping the organism from its point of attachment) is the most reliable control method, but this is obviously costly in terms of time and effort. Very small individuals are likely to be missed and manual removal can stimulate reproduction and should only be attempted when water is <15°C. Other ways of killing styela involve lengthy exposure to air and/or extreme temperatures. Sprays and dips of high salt, hydrated lime, and acetic acid solutions have also been tried on tunicates.

The deliberate introduction of the common shore crab (Carcinus maenas) into cages surrounding the sea squirt was not successful as a control agent (NIWA)

Feasibility of eradication

MPI (2013): "It is not feasible to eradicate Styela clava in New Zealand due to its widespread distribution and the fact that it has been present in New Zealand for some years. However, local elimination may be possible, and could slow the spread .... Efforts are now focused on managing this pest long term and, importantly, preventing its spread from infested areas to other locations, particularly those of high environmental, social, or economic value."

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Waikato and Horizons RPMPs do not include marine pests.
Bay of Plenty Proposed RPMP: Progressive containment.

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Dama Wallaby

(Macropus eugenii)

Summary of invasiveness

Once established wallabies can be very difficult to eradicate, because of their cryptic nature. When moving into new areas they can remain unnoticed until well established. Control options are challenging and the population in the central North Island continues to expand despite efforts over many years.

Description

Looks like a small grey-brown kangaroo with a pale underbelly. Adults stand up to half a metre tall. A thin white stripe runs from under the eye to the nose. Adults sometimes have a reddish brown patch across their shoulders (BOPRC, ND).

Similar species

There are five species of wallaby in New Zealand, however dama wallaby is of the most immediate risk to the Taranaki Region, excluding the potential for any species to be deliberately introduced. It is one of the smallest species and most of the other species lack the light coloured face markings. The closest in size - parma - is darker in colour overall and has a long tail, and is confined to Kawau Island None of the larger wallabies are found outside the South Island.

Habitat

Wallabies prefer the margins of forest and scrub habitats where they can shelter during the day and feed on grasses and pasture species at night. They inhabit predominantly podocarp/tawa/mixed hardwood forest with adjoining areas of manuka scrub, bracken and pasture (Pest Detective).

Reproduction

Females are sexually mature at 12 months old. Most births occur in January/February with young staying in the pouch for 250 days (DoC).

History of introduction and spread in New Zealand

Wallaby were first introduced to New Zealand around 1870 by Sir George Grey, when they were released onto Kawau Island. Dama wallaby, sourced from Kawau Island, were subsequently liberated near Lake Ōkāreka in 1912 (BOPRC, ND).

Current and potential distribution in New Zealand

The range of dama wallaby now extends over 200,000 ha in an area around Rotorua, Kawerau and south to Rainbow Mountain, plus outlier populations elsewhere in the region.

Current and potential pathways

As wallabies breed and disperse they can become established in new areas. Wallaby spread has been slowed by physical barriers such as the lakes and rivers. Aside from natural spread, dispersal is most likely to be deliberate movement by humans (BOPRC, ND).

Potential costs and benefits

Wallabies browse on native and exotic vegetation. When present in high densities, they can remove all seedlings and saplings, and change the pattern of forest succession and structure and composition of the forest. In this regard, wallabies can have a similar effect to possums (Pest Detective).

In exotic plantations they will damage seedlings and will compete with stock for pasture (BOPRC, ND).

Management options

Current control practices

Night shooting (centrefire .222 or .223, .22 magnum are most effective), exclusion fencing.

Ground baiting and bait stations - the only toxins registered for wallabies are 1080 and Feratox (cyanide capsules). They are vulnerable to broadcast baiting, but are reluctant to feed from some types of bait stations (BOPRC, ND).

Trapping, either leg-hold or live capture box traps, are unlikely to be effective in controlling an established population.

Feasibility of eradication

Unlikely.

Legislative management responses

- Unwanted organism (status expires 20 September 2021)

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Bay of Plenty - Dama wallaby are a containment pest under the RPMP.
Horizons - Exclusion
Waikato - Progressive containment

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Darwin Ants

(Doleromyrma darwiniana)

Family: Formicidae

Summary of invasiveness

They can form large inter-connected colonies with multiple queens. Although they are slow to spread naturally (queens do not fly to a new colony site) (Auckland Council, 2018), human mediated spread is likely because they are so small and can be concealed in a wide range of freight and materials. There are large colonies established in Christchurch with smaller populations elsewhere, including Mount Maunganui.

Description

Darwin ants are light to dark honey-brown, with a dark brown head and lighter body, and 12 segmented antennae. Workers are around 2 mm and queens 5 mm long.

Similar species

They are similar in appearance to Argentine ants but give off a strong odour when crushed; there is little or no odour for Argentine ants, to whom they are closely related.

Habitat

In New Zealand they tend to be associated with human population centers. They occupy dry forest and coastal scrub areas in their native range. (Auckland Council, 2018).

Reproduction

No information found relating to the details of reproduction. Colonies expand by 'budding' into new nests and queens walk to a new colony rather than flying.

History of introduction and spread in New Zealand

This species was first recorded as nesting here in 1959, from Penrose, Auckland (Taylor 1959). The nest was destroyed by Department of Agriculture officials. A probably separate establishment in Christchurch was first reported in 1979 (Keall 1979) and it has since been located at several localities in the Christchurch-Lyttelton area (Keall & Somerfield 1980) (Don and Harris, no date)

Current and potential distribution in New Zealand

Apart from some spreading northward in the Auckland area, this species still tends to remain associated very closely with towns or cities with ports, strongly suggesting separate port invasions in some cases. It has been recorded in Whangarei, Mt Maunganui, Gisborne, Napier, Blenheim, Nelson and Lyttelton (Don and Harris, no date).

Current and potential pathways

Spread in freight, materials being moved, vehicles, mobile homes. Commonly found nesting in situations such as potted plants, probably facilitating their spread around New Zealand (Don and Harris, no date).

Potential costs and benefits

Impacts expected to be similar to Argentine ants. Likely to impact litter decomposition by removing invertebrates and microbes associated with breaking down leaf litter.

Likely to compete strongly with other species that feed on honeydew or nectar.

Predation by Darwin's ants implicated as a factor in the failure of the boneseed leaf roller moth biocontrol agent. Therefore potential to undermine biocontrol investment and indirectly facilitate pest plant invasions (Auckland Council, 2018).

There are numerous potential impacts of Darwin ants on the commercial sector in urban environments; including ants invading food processing plants and becoming important pests of the hospitality industry, and potential to become a threat to the horticulture industry (Nelson City Council, 2020).

Management options

Current control practices

Identification is key to controlling ants to ensure the best strategy is applied. Commercial exterminators can access a range of insecticides and are certified in their use.

Feasibility of eradication

Highly unlikely.

Legislative management responses

No status in New Zealand, however they are subject to the MPI led national ant surveillance programme.

Waikato RPMP: Advisory animal.
Horizons have not included Darwin ants in their RPMP.
Bay of Plenty: non-RPMP pest "considered part of the region's biosecurity framework" but not subject to RPMP provisions.

References

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Eastern Water Dragon

(Physignathus lesueurii/Intellagama lesueurii)

Summary of invasiveness

They have broad environmental tolerances. In their native range they are found from tropical rainforest in the north of Australia to alpine streams in the south and can use urban parks provided the water source meets their needs.

Description

The Eastern water dragon is a medium to large sized lizard, with some specimens growing up to 80cm in length including their long tail. They are dark brown to light brown and mature males have a brighter orange chest, with a row of spines beginning on the head and leading down along their back. They can be recognised by the black band running along the side of the head behind the eyes.

Habitat

Eastern water dragons are semi-aquatic lizards that are found along the east coast of Australia. They are normally found around creeks, rivers or lakes. The lizards can remain submerged for up to 30 minutes and rise to the surface where they are able to breathe, while checking the area for danger before emerging back onto land (Gisborne Online Zoo).

They have broad environmental tolerances. In their native range they are found from tropical rainforest in the north of Australia to alpine streams in the south. They require flowing water with ample tree cover and basking sites and will use urban areas provided the water source meets needs. They are often found in tree branches overhanging water, and will drop into the water when disturbed. In cooler areas they will hibernate during winter by sealing themselves inside a burrow, emerging when the temperatures warm up again. (Auckland Council, 2018).

Reproduction

Males become sexually mature at c.5 years old (snout-vent length 210 mm and weight 400 g), and aggressively defend territories.The breeding season is during spring. Mating occurs near waterways and the females lay eggs away from the river in nests. The nests are usually in moist soil, within rotting vegetation in November to December. Female dragons can lay between 10-20 eggs. (Gisborne Online Zoo). Females may not breed every year.

In the wild, males aggressively defend territories during the breeding season. Sperm storage has not been documented in this species, but is known to occur in a closely related species which has the ability to store sperm for up to 580 days after mating. Incubation length depends on temperature, with eggs incubated at warmer temperatures hatching earlier. Risk of escape from captivity (Auckland Council, 2018).

History of introduction and spread in New Zealand

Eastern water dragons are legally sold as pets in New Zealand.

Current and potential distribution in New Zealand

Modelling indicates a very high risk of establishing in the wild in parts of New Zealand (Northland Regional Council, no date).

Current and potential pathways

Most likely to occur through escapes from captivity or dumping/release into the wild (Auckland Council, 2018). There has been at least one water dragon re-captured in a reserve in the Manawatu in 2017 (DOC, 2017).

Potential costs and benefits

Quick, effective omnivores that eat a variety of insects, aquatic organisms, moths, wasps, crustaceans, small vertebrates, fruit and plant matter. Likely to impact native endangered species by competing for food resources (Auckland Council, 2018).

Management options

Current control practices

No information available. A 2017 incident recorded by DOC caught an individual lizard on a cool evening when the lizard was low on energy from the cold (DOC, 2017).

Feasibility of eradication

No information available.

Legislative management responses

Eastern water dragons may be held in captivity, bred and sold, but it is illegal to release them into the wild.

The National Pest Pet Biosecurity Accord is established to promote responsible pet ownership and potentially establish controls on some pet species, however there are no exotic pet species regulated under this record at this point in time.

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Eel grass

(Vallisneria australis)

Summary of invasiveness

Considered weedy in 23 countries, including New Zealand , it will dominate stream vegetation, although it is noted that *Egeria densa* will displace it in some locations (Williams and Champion, 2008).

Description

Eel grass is a perennial, fully submerged aquatic plant that grows in fresh water up to 9 m deep. The leaves are long and strap like, slimy to the touch and usually light green, but do vary to brown. The plant is bottom rooting with stout rhizomes and forms dense beds. Leaves are produced from nodes at regular intervals along the rhizomes.

Similar species

There are other species of *Valisneria* worldwide, however only *V. spiralis* and *V. australis* are known to be in New Zealand. *V. australis* is found in Lake Pupuke (Auckland) and nearby locations (CABI, 2020).

NZPCN lists *V australis* with *V spiralis* and *V gigantea* as synonyms. Clarification would be useful.

Habitat

Static or flowing freshwater systems <9m deep. Tolerates low salinity. Grows fastest in water temperatures of 25°C.

Streams, drains, wetlands, lake margins, ponds and aquariums.

Reproduction

There are only male plants in New Zealand, so no viable seeds are produced. Spread locally by rhizomes, or intentional planting into new water bodies.

History of introduction and spread in New Zealand

In New Zealand, *V. spiralis* is reported to have been present on the North Island in Lake Wiritoa in the Manawatu-Wanganui region, since 1978, and Meola Creek in the Auckland region since 1982 (de Winton et al., 2009). From 2001 to 2008, the species was documented from 82 sites in the Wellington region, mostly in garden pools. Since 2000 it has also been reported from the Northland region and the Opawa River at Blenheim in the Marlborough region on the South Island (de Winton et al., 2009; P Champion, NIWA, New Zealand, personal communication, 2010).

Current and potential distribution in New Zealand

V. gigantea is known only from Lake Pukepuke (Auckland Region), and *V. spiralis* has been present in Lake Wiritoa in the Manawatu-Whanganui region since 1978 (de Winton *et al*, 2009). *V.*

spiralis is also found around the Auckland region and in Greater Wellington, Northland, and Marlborough (de Winton *et al*, 2009).

Current and potential pathways

It spreads locally by rhizomes and to new sites by intentional planting into new water bodies, and contaminated machinery.

Patterns of distribution when the prohibited status of V. spiralis was removed indicate deliberate planting as the main source, and the prohibited status was reinstated in 2007 with the plant added to the NPPA list (de Winton et al, 2009).

They are popular aquarium plants with debate on aquarium websites as to whether or not they are legal to have or share (Aquarium World forums accessed 9 April 2020). It appeared for sale (listed as *V. gigantea*) on trademe with a seller located in Palmerston North in February 2020 (https://www.trademe.co.nz/a.asp?id=88540303), and other species also appear for sale online (Eg; Aquatic Plants website https://aquaticplants.co.nz/product-category/stem-plants/)

Potential costs and benefits

Dense beds of vegetation block dams and waterways, trap sediment, impede drainage, disrupt recreational activities, and interfere with hydro turbines. Outcompetes native species for light, nutrients and space.

It is considered a drowning hazard due to tangling in the species, with at least one reported fatality at Lake Pupuke.

Management options

Current control practices

Auckland Council suggests small infestations can be controlled by divers hand pulling plants.

Other options for control include mechanical removal, for example a weed harvester or suction dredge), chemical control, manipulation of habitat by drainage or weed mats, and potentially biocontrol using grass carp. (GISD, 2020). Methods that allow root fragments to break off will encourage spread.

It is important to note that grass carp are not species specific and will browse weeds starting from highest preference.

The plant is resistant to management. No consistent herbicide control has been achieved in NZ field sites. Mechanical removal combined with covering with weed mat has been used. Cutting will check weed growth for 3-4 months but does not kill it. (Williams and Champion, 2008).

Feasibility of eradication

Virtually impossible to eliminate. Only treat if necessary as interference often makes the problem worse. Regular follow up required.

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Horizons RPMP: Progressive containment.
Waikato RPMP: Exclusion.
Auckland RPMP: Exclusion.

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Koi carp

(Cyprinus carpio)

Summary of invasiveness

Koi have been so widely distributed that they are found on every continent except Antarctica. A single female can produce 1-2 million eggs, and their prolific breeding means that they can completely dominate aquatic ecosystems. They make up 80% of the fish biomass in the lower Waikato River catchment (NIWA, 2020).

Description

Koi carp are a variety of common carp, which is native to Asia. Wild common carp tend to be olive green but as the New Zealand stocks are derived from the ornamental Japanese koi they exhibit distinctive black, red, orange, gold and white patterns. They grow up to 12 kg and 75 cm in length. The key diagnostic in New Zealand are the two pairs of barbels at the corner of their mouths. (NIWA, 2020).

Similar species

Koi will hybridise with goldfish, and hybrids will range in appearance between the two species (DOC, 2020).

Habitat

Koi carp prefer still waters, spreading from rivers into lakes, streams or backwaters in rivers. They are highly tolerant of poor water quality – surviving well in degraded water and contributing to the decline. (DOC, 2020).

Reproduction

They are prolific breeders. The fish congregate for spawning in large numbers in the shallows of rivers and lakes, and spawning occurs in spring and early summer. Females can produce 1-2 million eggs in a season.

History of introduction and spread in New Zealand

It is not known whether the introduction of koi carp here was deliberate or accidental, but feral breeding stocks were first noticed in the Waikato in 1983. They are now common throughout the lower Waikato system, and have been spread mainly into ponds throughout the North Island. The first South Island record of koi carp occurred in Nelson in 2000, but most of the South Island populations have now been successfully eradicated. (NIWA, 2020).

Current and potential distribution in New Zealand

Koi are widely established in the lower Waikato River catchment area, including lakes and wetlands. There are also populations in the Auckland and Northland Regions, occasional incursions in the Bay of Plenty have been found in the past. They have also been found in the South Island, however these populations have been eradicated (NIWA, 2020).

Current and potential pathways

Key pathways are deliberate release and spreading through catchments and subcatchments during floods. Eggs may also be transported on other surfaces, including weed fragments attached to water craft and equipment used for water related recreation. Escape from enclosed ponds is also a likely pathway, as koi are still valued as ornamental fish and occasionally found in ponds.

Potential costs and benefits

Koi eat a wide variety of organisms including plants and animals. One feeding method is to suck up and expel material from the bottom of water bodies to filter out edible material. This means that they increase the turbidity of the water by constantly stirring up the substrate. This also mobilises nutrients, and the turbidity will prevent the growth of macrophytes. Koi presence in a water body will produce a system that is highly turbid and nutrient rich, with few macrophytes. This in turn affects benthic communities, indigenous fish and food sources for water birds. Koi feed on fish eggs and juvenile fish of other species, including NZ indigenous fish.

Once present in a water body they are extremely difficult to manage.

Management options

Current control practices

Electric fishing, one way traps, rotenone pesticide and netting are used to control carp but can only be implemented in small waterbodies and non-flowing habitats (DOC, 2020).

A carp herpes virus is being investigated as an option for biological control of carp in Australia, and while their research programme is largely complete, they have yet to have a decision as to whether it will be released into the environment. The virus is carp specific, however will not eradicate carp without other complementary measures such as genetic and sex biasing approaches.

Feasibility of eradication

Very low once established with current methods, especially into flowing water bodies. Possible within enclosed water bodies with no outflow.

Combined bio-control with genetic and sex biasing approaches is being considered in Australia and may provide higher levels of control.

Legislative management responses

- Unwanted organism
- Noxious animal

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

A containment area has been established between Auckland and Hamilton where recreational fishing is permitted, however all koi must be killed when caught and koi outside the containment area are considered a new incursion and must be reported.

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Mediterranean Fanworm

(Sabella spallanzanii)

Summary of invasiveness

High fecundity, rapid growth and ability to regenerate body structures when damaged. Meditteranean fan worms have wide environmental tolerances, they are a habitat generalist and can settle on a range of substrates and structures. They lack natural predators. Larvae float for around three weeks, and have the ability to extend their life-stage duration if conditions for settlement are unsuitable. (Fletcher, 2014). High potential for natural dispersal as well as human induced spread.

Description

The Mediterranean fanworm is marine polychaete worm. It is a sessile organism that has a long leathery, flexible tube that is pale brown in colour and has a muddy appearance. These tubes normally grow to a length of 10-50 centimetres although in New Zealand individuals 80 centimetres in length have been recorded. It is larger than other native fan worms in New Zealand. The Mediterranean fanworm extends a spiral fan of yellow-orange filaments to collect plankton from the water column (NIWA website accessed 20 April 2020).

Similar species

Some native fan worms are similar, however Mediterranean fanworm is larger.

Habitat

Meditteranan fanworm is generally found in shallow subtidal areas in depths from 1 to 30m (CSIRO, 2001). In shallow waters, worms are solitary and commonly found growing on a wide range of solid surfaces, including artificial materials (rocks, concrete, wood, steel), and benthic organisms (ascidians, mussels, oysters) (Currie *et al,* 2000 cited in CSIRO, 2001). It is also found on wharf piles and facings, channel markers, marina piles and pontoons, and submerged wrecks (CSIRO, 2001). New Zealand incursions have been with biofoul on vessels.

Reproduction

A mature female can produce >50,000 eggs during each spawning event and fertilise the eggs inside the abdominal section of the tube. Spawning may occur from May to late September in central New Zealand based on the sea temperature requirements. Lavae float on ocean currents before settling in suitable locations.

History of introduction and spread in New Zealand

Meditteranean fan worm was first detected in Lyttelton Harbour in March 2008, and extensive populations were then found in Waitemata and Whangarei harbours where it is now well-established. Hull fouling transport is strongly suspected in the New Zealand arrival. (Fletcher, 2014).

Current and potential distribution in New Zealand

It is well-established in the Auckland region, in Waitemata and throughout the harbour area, possibly out into the inner Hauraki gulf, at the marina at Whangaparaoa with other possible

locations. Also in Whangarei in both the marina and the wider harbour, and remains at low densities in Lyttelton Harbour. Isolated incursions have been found in the Coromandel, Tauranga Harbour and Nelson harbour, and a population found on a moored boat in Waikawa Bay near Picton in 2014. (Fletcher, 2014).

Meditteranean fan worm can survive in temperatures from 2-29°C. NZ sea temperatures range from 10°C in the south to 23°C in the north in summer, and in winter from 6-18°C, so the temperature tolerance is within range in all NZ coastal waters.

Current and potential pathways

Boat hulls, ballast water (intra- and inter-regional vessel movements); transfer of equipment, especially equipment that does not move for periods of time.

Once established, natural dispersal is by transportation of larvae by water currents, and larvae from Port Phillip Bay in Australia reached up to 20 km from the parent population before settling and metamorphosing into adult form (Fletcher, 2014).

Potential costs and benefits

The Mediterranean fanworm can form dense colonies of up to 1000 individuals per square metre that will exclude the settlement of other organisms. It also has a high filtering ability that may influence the composition of planktonic communities and abundance of some species. The presence of the Mediterranean fanworm in areas where mussels or oysters are located may affect their growth due to competition for food. The tubes of the Mediterranean fanworm may attach themselves to aquaculture or other marine equipment or vessels and this may increase harvesting or fuel costs, respectively (NIWA, ND).

Management options

Marine pests differ from other pests in that there are few barriers to their movement from one location to another, and every New Zealand port touches every other New Zealand port either directly or indirectly. Port Taranaki has direct connections with domestic vessel movements from other ports known to have marine pests.

MPI is considered the lead agency for the movement of marine pests between regions, and a national marine pests pathway plan would be an option to achieve consistency, and makes sense logistically for domestic shipping. The Top of the North partnership is investigating the feasibility of an inter-regional PMP.

There are gaps in information for this species in New Zealand environments around population dynamics, age and size to sexual maturity and spawning times. This is crucial to determine the likelihood of being able to contain and remove the species before it has spawned. Inferring from other locations raises levels of uncertainty and the potential to miss the key timeframes (Fletcher, 2014).

Current control practices

Cleaning should be done in a dry dock where possible. In-water treatments require significant containment and substances used may affect other non-target marine species.

Anti-fouling of vessels and anti-foul paints.

Physical removal and collection.

Feasibility of eradication

Possible at site level early in the invasion curve using specialised dive teams and/or haul-out cleaning services, ideally before sexual maturity is reached and/or spawning has occurred.

Legislative management responses

- Unwanted organism
- Notifiable organism

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Other regions have included Meditteranean fan worm in their RPMPs.

Pathways Management - Only two pathway management plans for marine pests are operational in New Zealand, Northland and Fiordland. Both include Meditteranean fan worm in their PMP.

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Purple loosestrife

(*Lythrum salicaria*)

Summary of invasiveness

Rapidly invades damp ground and shallow water. Overtops native species with dense bushy growth, is long-lived and produces millions of long-lived, highly viable seeds from an early age. Tolerates hot or cold conditions and low to high nutrient levels in the water, but is intolerant of salt water. (Weedbusters, accessed 7 April 2020).

Its spread and persistence in ecosystems is supported by very high seed production, a vigorous and persistent root system and rapid growth (CABI, 2020).

Description

Tall perennial herb, normally about 6-100 cm tall but can get up to 3 m, with up to 50 stems per rootstock. Roots are a dense, woody mass. It has angled (4-6 sided) reddish-purple or red to purple stems and stalkless leaves that grow either opposite or in whorls from the stem. Leaves are heart-shaped at their base but lance-shaped or narrowly oblong overall. Magenta flowers arise on numerous spikes from December to February. The plant dies off in winter and re-sprouts in spring.

Similar species

Lythrum virgatum is sometimes cultivated and has a similar growth habit. It is smaller in all parts, hairless and has narrower leaves (Champion and Hofstra, 2013).

Habitat

Invades wetlands, lakesides, streams, swamps, bogs that are damp in winter and drier in summer, and creeps onto dry margins and can invade pasture and crops. It can adjust to a range of conditions by adjusting leaf morphology, changing root to shoot ratio and growing shoot and root buds at the site of damage if it is trampled, cut or crushed (Thompson et al, 1987, cited in Champion and Hofstra, 2013).

Reproduction

Spreads by seed - mature plants produced in the order of 600,000 seeds per year. Seeds are spread by wind (limited extent) and water, and germinate in moist soils after overwintering. Seed can also be spread by birds and machinery, and remain viable for up to 3 years (Champion and Hofstra, 2013).

Vegetative spread by underground stems and stem fragments. These could also be moved by machinery and in spoil.

History of introduction and spread in New Zealand

Purple loosestrife is native to Europe, Asia and Australia and was introduced to New Zealand as an ornamental pond and garden plant (Champion and Hofstra, 2013). It also has uses as a medicinal herb in northern Europe (CABI, 2020)

Current and potential distribution in New Zealand

Locally naturalised, especially Horowhenua and Canterbury (Champion and Hofstra, 2013). Distribution is mostly in the south island but there are also populations recorded in the lower north island, including Whanganui in the Manawatu (NZPCN website, accessed 7 April 2020).

Current and potential pathways

Deliberate spread as an ornamental.

Movement by flooding, in stock feed, on animals, on vehicles stuck in mud/soil, and in soil, sand and gravel.

Potential costs and benefits

Forms massive, tall, impenetrable stands, excluding all other species. Destroys wetland and marginal habitats and food sources for many fish and bird species, waterfowl nesting sites are reduced. Affects inanga spawning areas. and causes blockages and flooding, clogging shallow drains and waterways. It is capable of taking over large areas. Purple loosestrife adds nutrients to wetlands and water bodies seasonally in litter as it dies down in winter, which is not part of the natural regime in New Zealand where few wetland species die back.

In the US it is increasingly encroaching on farmland in crops and pasture (Minnesota Sea Grant, accessed 7 April 2020).

Management options

Current control practices

Weedbusters (2020) lists the following options:

- Shading out with other plantings
- Deepening water levels to prevent growth (2-3 weeks to drown weed)
- Lowering water levels and mechanically removing
- Weedmat, starting with top of infestation, and left for 3-4 months
- Chemical control using glyphosate or triclopyr with 3 monthly follow-ups.

Biological control agents are being used in the US and Canada (Minnesota Sea Grant, accessed 7 April 2020).

Where infestations are dug out, all the roots need to be removed and the site needs to be monitored for re-growth. Material needs to be either incinerated, composted or covered with weedmat (2-3 months). Cutting before spraying can reduce non-target bykill.

Areas cleared of purple loosestrife should be replanted as soon as possible to slow reinvasion.

Feasibility of eradication

Likely.

Legislative management responses

Unwanted organism under the biosecurity act

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Pyp Grass

(Ehrharta villosa)

Summary of invasiveness

Pyp grass outcompetes native groundcover species, growing in a dense sward as a monoculture. It will climb up into other plants or structures like fences. Pyp grass develops a mass of interwoven rhizomes, occupying at least half a metre of the topsoil and extending horizontally for many metres.

Description

Perennial grass with long creeping rhizomes. Stems robust and cane-like, 90cm-200cm tall. Leaves bluish-green, 1.5-13 cm long. Like marram grass the leaves are rolled leaving only the outer surface exposed to the sun and wind. Flower head is a panicle up to 25 cm long, narrow and rather lax (Auckland Council website). It grows in a dense sward in New Zealand, which is unlike the more open herb growth in its native South Africa.

Pyp grass grows in summer with rapid growth after spring, summer and autumn rains. Flowers in spring (October-January).

Habitat

Terrestrial. Short tussock land, herbfield, bare land, wetland, mainly on coastline, sand dunes.

Reproduction

Vegetative spread is mainly by rhizomes and fragments of rhizomes, and rooting at the nodes but possible from seed, which can be spread by wind. Seed production is usually low and probably limited by nitrogen. The length of time that seeds remain viable in the soil is unknown. Hodder's (1997) study found no seeds in the soil and suggested that heavy predation by birds and rodents was removing all seeds.

History of introduction and spread in New Zealand

Introduced to New Zealand, at Turakina Beach, in trial plots to stabilise sand dunes by the Ministry of Works in the 1970s (Hodder, 1997). It is unknown how it spread to the other sites known in New Zealand (although now eradicated), but was most likely deliberately planted for the same purpose at other locations.

Current and potential distribution in New Zealand

After being successfully controlled at Blackhead, Hawkes Bay and Waitarere Forest, north of Levin, pyp grass is known to still be present at one coastal site in the North Island, Turakina Beach, south of Wanganui. This site is currently under control (by DOC) with the aim to eradicate pyp grass from this site and therefore New Zealand. (MPI, 2009). The infestation extended into the adjacent exotic forest (along the road) and outside a single private dwelling in the back dunes (McKinnon, 2009).

Current and potential pathways

Seed can be spread short distances by wind and on other vectors like machinery and clothing.

Potential costs and benefits

Pyp grass is a threat to New Zealand's already threatened dune ecosystems where it is expected to invade and degrade sand dune habitats by dominating the indigenous vegetation. In South Australia it is a serious agricultural weed. (MAF, 2009).

Management options

Current control practices

Chemical control at Koitiata used Roundup Transorb, which successfully killed the whole plant including the rhizome (McKinnon, 2009). The following year's report confirmed that this had achieved a good kill (McKinnon, 2010).

Feasibility of eradication

High with repeated follow-up.

Legislative management responses

- Unwanted organism
- National Interest Pest Response species (MPI lead response)

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

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Salvinia

(*Salvinia molesta*)

Summary of invasiveness

Salvinia ranks a close second behind water hyacinth on a list of the world's most noxious aquatic weeds, and recently added to the list of the world's 100 most invasive species (CABI, 2020). Growth rates are rapid - extent can double in 8 days, and it can form dense mats up to 1 m thick. It spreads by fragments. Growth is increased with high nutrients and warm water temperatures.

Description

Salvinia is a free floating aquatic plant with a horizontal rhizome below the water surface. It has two types of frond, buoyant and submerged. The submerged fronds function as roots. The fronds are in whorls of three (two floating), fronds are light to medium green, hairy, and with a distinctive fold in the center. (GISD, 2015).

There are three growth stages. In the first stage leaves are small (~10 mm) and lie flat on the water surface. In stage two the leaves grow to about 25 mm and begin to fold upward, so the structure takes on a keeled shape. Leaves are cupped but do not overlap. In the third and mature phase the leaves grow larger and thicken, leaves are compact, almost vertical and acutely folded (CABI, 2020).

Similar species

The juvenile form resembles *Azolla* species, however the mature form is very distinctive (Champion and Hofstra, 2013).

Habitat

It grows best in water temperatures of 20-30°C and tolerates salinity of 10% seawater. Growth is stimulated by high nutrient levels (GISD, 2015). It prefers stagnant or slow moving water, bays and inlets or tributaries of small streams where it is protected from wave action (CABI, 2020). It can survive on mudbanks.

Reproduction

The plant can not produce viable spores and can only reproduce assexually. It propagates by vegetation growth, and small plant propagules ('daughter plants') will fragment and disperse (GISD, 2015). It also spreads when young growth separates through death or damage of the parent material that links the sections.

History of introduction and spread in New Zealand

It is believed to be a hybrid of horticultural origin from South America (Breitwieser *et al* (eds; 2020)), and the first record is from Western Springs, Auckland in 1961 (Champion and Hofstra, 2013).

Does not produce spores, spreads by fragmentation only through water movement, deliberate 'liberation' of aquarium contents into ponds or lakes.

Current and potential distribution in New Zealand

Salvinia has been found mostly in the warmer areas of the North Island, however it has also been found as far south as Christchurch (MPI, 2014). In 2017 there were 20 sites, mostly in the north, under active management, and included wetlands and small domestic fishponds.

It is a rampant weed of tropical and warm temperate regions, recorded as a naturalised plant in lowland areas of northern New Zealand from near Kaitaia to Hamilton. (Breitwieser *et al* (eds; 2020)). Altitudinal range 0-50 m. It can withstand the occasional frost, although persistent low temperatures and frost will kill the exposed portions of the plant. Unaffected parts of the plants can re-grow (Ensbey, 2018).

Coastal areas of Taranaki Region could support Salvinia (Paul Champion pers comm.; 6 April 2020). It occurs in areas of Australia with similar climatic conditions.

Current and potential pathways

Spreads rapidly by fragmentation and producing plantlets from the old end of the horizontal axis, and can grow from a single node; the death and decay of the older connecting part of the plant can lead to the separation of the viable younger branches. The plant is apparently a sterile hybrid. Fragments spread by water movement, deliberate release (with fish from aquaria) (Champion and Hofstra, 2013). Water currents, animals, contaminated equipment and water craft (eg; boats and trailers) (MPI, 2014).

Early spread was via the aquarium and landscaping trades as an ornamental plant.

Potential costs and benefits

Dense mats block light, reduce water flow and lower oxygen levels in water, which negatively affects biodiversity. It is also a threat to recreational activities and hydro electricity generation.

The mats smother or force out native plants, can attract breeding mosquitoes, block dams and irrigation systems, remove oxygen from the water and create a drowning risk for people and animals. (MPI, 2019)

Management options

Successful management of Salvinia requires early detection, action and implementation of an integrated control program, and different levels and sizes of infestation may require different methods or combinations of methods (Ensbey, 2018).

Current control practices

Biocontrol agents in other parts of the world, like Australia, have had varying success rates and in cooler areas is limited by the ability of the agents to survive outside tropical areas (CABI, 2020).

Draining a waterbody may not be effective where a thick mat protects and insulates the buds. Plants have been known to survive for 20 months under these conditions (Ensbey, 2018).

Barriers to prevent spread can be effective for short periods of time, and can be useful in combination with chemical control. This methodology was used at Kaituna Wetland in the Bay of

Plenty to contain the infestation while other control methods were applied to reduce and remove it.

Dense mature infestations make it difficult to get adequate contact time for chemical control (Ensbey, 2018).

Chemical control is possible, and requires the use of surfactants to penetrate the hairs on the leaf, which form a waterproof barrier (Oliver, 1993, cited by CABI, 2020).

Feasibility of eradication

Possible.

Legislative management responses

Control/eradication is led by Biosecurity NZ under the National Interest Pest Response programme, with a goal of eradication.

- Unwanted organism
- Notifiable organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Not included in either the Waikato or Horizons RPMP due to their NIPR status.

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Sea Spurge

(Euphorbia paralias)

Summary of invasiveness

Sea spurge seeds are buoyant and can remain viable floating in the sea for several years and can be dispersed very long distances by sea currents (Mallick and Askey-Doran, no date).

Sea spurge can form dense infestations that dominate the foredune and change the dune structure, and is a problem weed in parts of Australia. Local spread of established infestations occurs when the dry fruits explosively eject seeds up to several metres from the parent plant. Sea spurge has a very large reproductive potential, with a single plant being able to produce 5000 seeds per year (Mallick and Askey-Doran, no date). Seed remains viable for up to 9 years (Parks and Wildlife Service, 2015).

Description

Sea spurge is a hardy European shrub that thrives in sand dunes. It has multiple stems that are often reddish at the base, and its spiky, tightly-packed blue/green leaves are 4-20mm long and 1-16mm wide. Green flowers bloom at the stem tips from September to May and the flower stems die off each year. The milky sap that oozes from broken stems is toxic to people and animals. The plants grow to about 1m tall in dense clusters (MPI, 2012)

Similar species

The native *Euphorbia glauca* has reddish flowers and much larger leaves 30-80 mm long. Also similar to NZ linen flax *Linum monogynum*, but linen flax stems are not reddish at the base. (Waikawa Beach Ratepayers Association, 2020).

Habitat

Sea spurge is a coastal weed that develops into dense infestations on sandy beaches and sand dunes (de Lange 2012).

Sandy, free draining substrates on beaches, throughout dune fields, around estuaries, and in other coastal environments including small pockets of sand on otherwise rocky sections of coastline and on cobbled beaches with sufficient interstitial sand. Sea spurge is capable of moving from dune systems into adjoining native vegetation. On sandy beaches, sea spurge can colonise areas from the loose sand just above the high tide line, up and over the fore and primary dunes and into the secondary dune system (Mallick and Askey-Doran, no date).

Reproduction

Sea spurge seed germinates after heavy rain and the seedling grows rapidly producing a long taproot. The root crown is perennial, with new stems being produced each year in spring from the buried root crown. Flowering occurs from spring through autumn. The stems die after flowering, but may sometimes remain on the plant into the following year (Mallick and Askey-Doran, no date).

History of introduction and spread in New Zealand

It is likely to have arrived on ocean currents from Australia (MPI, 2012)

Current and potential distribution in New Zealand

Sea spurge was found near Aotea Harbour in the Waikato in 2012 and a single plant found at Mokau in 2019. A single plant was found at Himatangi Beach, New Plymouth and has been removed, however it does indicate that sea spurge can land and grow in the Taranaki Region.

Current and potential pathways

Long distance dispersal of sea spurge seeds on ocean currents - this is thought to be the pathway for its arrival in New Zealand.. Sea spurge seed can remain in the sea water for several years and remain viable, allowing for transport over very large distances.

Other human facilitated pathways include transport in recreational vessels and ship ballast water and the transport of root fragments and seeds in contaminated sand or soil during earth moving works. The plant spreads locally by explosively ejecting seeds up to several metres from the parent plant. (Mallick and Askey-Doran, no date).

Potential costs and benefits

Public amenity and access through stands - milky sap released by damaged plants causes skin irritation.

Displacement of indigenous dune species.

Alteration to the natural shape and structure of beach and dunes, and may have adverse effects on the nesting habitat of a range of threatened shorebirds (Mallick and Askey-Doran, no date).

Management options

Control should be timed for completion before seed is mature. Repeat follow-up monitoring and control is needed as the seed back will continue to germinate for several years.

Current control practices

Manual hand removal is effective, although the seed may re-grow from the buried root crown. The toxic sap of damaged plants means that protective clothing, eye protection and gloves are needed. Tasmania has successfully removed reasonably large populations of sea spurge by hand weeding (Parks and Wildlife Service, 2015). Most practical for small and/or scattered populations.

Chemical control options include glyphosate and metsulfuron-methyl and foliar spraying, although non-target species can be affected.

A combination of aerial spraying with herbicide and follow-up hand weeding has been shown to be highly effective in controlling sea spurge infestations in difficult to access areas and over a large extent of coastline.

There are no biological control agents available.

(Mallick and Askey-Doran, no date)

Feasibility of eradication

Tasmania has been successful in reducing sea spurge infestations to the point where they consider it possible to eradicate it from their southwest coastline, with follow-up work to exhaust the seed bank. Their work has reduced areas of tens of thousands of plants to a handful over seven years (Parks and Wildlife Service, 2015).

Legislative management responses

- Unwanted organism
- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

MPI is the lead agency for the Waikato and Himatangi Beach incursions.

Waikato - Eradication species in RPMP.
Horizons - not listed in RPMP.

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Tench

(Tinca tinca)

Summary of invasiveness

Tench can breed rapidly and build reasonably dense populations where conditions are suitable, and they lack natural predators in New Zealand (Rowe, 2004).

Description

Tench are generally an olive green colour although this varies from dark to light. There is a single small barbel at each corner of the mouth. The fins tend to be thick and fleshy and the body is covered in small scales. Males have longer and fatter pelvic fins than females.Their eyes are bright orange, and this is their most distinctive characteristic (NIWA, 2020).

It does not feed on other fish, and may be described as a generalised benthic carnivore (Rowe, 2004). It is solitary and mainly nocturnal (Rowe, 2004).

There may be a golden colour variety in the Auckland area, however this doesn't appear to be a firm record.

Similar species

None in New Zealand - tench are distinctive.

Habitat

Tench generally live in still or slow-flowing waters, and are carnivorous, feeding mainly on crustaceans, molluscs and insect larvae. They are generally bottom dwelling (Rowe, 2004).

They hibernate in the mud at the bottom of deep pools in winter.

Their preferred temperature is 20-21◦C and in tank trials avoided water over 25◦C (cited in Rowe, 2004). They tolerate brackish water, turbidity, and low oxygen levels.

Reproduction

Spawning occurs in spring and summer and, like all the Cyprinidae, tench are prolific breeders; a large female may produce hundreds of thousands of small eggs. They stick to aquatic vegetation (Rowe, 2004).

History of introduction and spread in New Zealand

First introduced to New Zealand in 1867, initially as a sports fish, and it has been spread for the purpose of creating new recreational fisheries.

Current and potential distribution in New Zealand

Mostly in Auckland, but also present in some lakes and ponds in Northland, Tauranga and Wellington, as well as sites in the South Island.

Current and potential pathways

Deliberate release is the most likely method of spread. Fish eggs can be transported on weed fragments caught up in water craft, trailers and equipment, however this is considered a less likely pathway (Rowe, 2004).

Potential costs and benefits

High densities of tench have been considered the cause of reduction in benthic invertebrates in overseas lakes and there is some evidence from overseas and in New Zealand that a high density population can reduce the water clarity in shallow lakes (Rowe, 2004). They feed by squirting water to move the surface layer of sediment, which re-suspends find sediments into the water column.

Rowe (2004) considers that tench are unlikely to pose a direct threat to other fish species in lakes, including New Zealand natives, however they have been implicated in environmental changes including reduced invertebrate densities, reduced macrophytes and/or reduced water clarity in shallow lakes and ponds. There may be some indirect effect on native fish through reduced food supply, changes to water quality and reduced macrophyte cover.

The major concern with tench is the potential to degrade lacustrine habitats, especially in shallow lakes and in the synergistic role it may play in this with other exotic species like goldfish and koi carp. Tench have also introduced a new parasitic worm, which can be spread by piscivorous birds and will infect indigenous fish species like koaro.

Management options

Current control practices

Nets, rotenone.

Feasibility of eradication

Difficult, particularly where the water body is not isolated and unconnected.

Legislative management responses

Tench are classified as an acclimatised fish under the Fisheries Act 1983, and are listed via the Conservation Act 1987 as a sports fish to be managed by Fish & Game Councils.

Within the Taranaki Region, Fish & Game's management plan commits them to eradicating any new populations of sports fish arriving in the region, therefore a new incursion of tench into Taranaki could be removed, if physically possible.

Waikato RPMP: Site led
Horizons RPMP: not included

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Velvetleaf

(Abutilon theophrasti)

Summary of invasiveness

Velvet leaf is an aggressive competitor for nutrients and water, lowering crop yield, and is one of the most damaging weeds to crops like maize. Seedlings are vigorous and fast growing (Waikato Regional Council 2017), and the plant is resistant to many herbicides (MPI, 2019). Seeds remain viable in the soil for up to 50 years and are easily transported with the main crop after harvest, although it is thought that 90% of seeds germinate in the first year. Plants keep emerging over summer and autumn. It is primarily a weed of crops and is a major invasive crop weed in other countries (MPI, 2019). It is not killed by processing into silage or passing through an animal's digestive tract.

Description

Velvetleaf is an annual broad-leaved weed that grows between 0.5m and 2.5m tall, with buttery-yellow flowers about 3cm across. It flowers from spring through autumn. The leaves are large and heart-shaped, and velvety to the touch. The plant has distinctive seed pods with 12 to 15 segments in a cup-like ring. Each seedpod is about 2.5cm in diameter (MPI, 2019).

Similar species

Similar to some of the mallow family at seedling stage, but otherwise unmistakable once mature (CABI, 2020).

Habitat

In its introduced areas velvetleaf is found in wasteland, vacant lots, gardens and cultivated fields, especially maize and soybean fields and along fence rows (CABI)(

Reproduction

Germination occurs over a long period during summer, mostly from seeds in the top 25 mm of soil; seeds cannot germinate when buried below 150 mm. Even small plants, produced from seed germinating in late summer, can flower and set seed, with seed maturing about 6 weeks after flowering. Seedlings are vigorous and the plant grows rapidly in its first few months. Root growth is rapid and the plant can grow in lightly shaded conditions (AgPest, no date).

History of introduction and spread in New Zealand

There have been several arrivals of velvet leaf in New Zealand and it was initially imported into New Zealand as a potential fibre source. It is used to produce a jute like fibre in China and some other Asian and North African countries. While it didn't naturalise and spread at that time, it was found again in Helensville, near Auckland and over 10 farms in the Waikato Region. It was found in maize silage, crops and in dairy pastures where maize silage had been fed out (AgPest, no date).

The most recent incursion in 2016 was via fodder beet seed which was then planted on over 600 properties.

Current and potential distribution in New Zealand

The weed is on a number of properties across the country and could be in any crop. Canterbury, Otago, and Southland have the most affected properties. There is also velvetleaf in areas around Auckland and the Waikato. This incursion is associated with maize production. It has been spreading in these areas via dirty maize harvesters and contaminated maize silage (MPI, 2019)

Current and potential pathways

Seeds are spread by farm machinery when harvesting grain (e.g., maize), through livestock, and as a contaminant of grain or silage (AgPest, no date). The Waikato Region identifies all possible pathways for velvetleaf to spread in their long term management plan for velvet leaf. Movement of material on vectors like machinery, stock feed, soil, on stock are all able to move velvet leaf seed from one site to another.

Potential costs and benefits

A serious cropping weed that can affect many arable crops and reduces crop yields. Velvetleaf has been reported as causing up to 70% reduction in crop yields overseas (MPI, 2019).

Management options

Current control practices

Containment and pathway management:

Farmers should protect their properties from velvetleaf and other serious plant pests by:

- insisting all contractors practise good weed hygiene, cleaning their equipment before entering the farm
- ensuring supplementary feed brought onto the farm is weed free
- ensuring manures, aggregates, soil and sand brought onto the farm are weed free
- checking feed crops before purchase to ensure they are weed free.

Manual control by pulling plants can be practical for small infestations, especially before seed has set. Where seed is set, containment of seed is critical and MPI provides the guidance for containing seeds within plastic bags and using drop-sheets to capture seeds.

Chemical controls are available with different substances and methodology for different situations (eg; within crop, pre or post-emergence, pasture).

(This section: Waikato Regional Council, 2016).

Feasibility of eradication

The longevity of the seed bank makes eradication unlikely.

Legislative management responses

- Unwanted organism

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Waikato Region: progressive containment.
Horizons: not listed in RPMP.

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Water poppy

(Hydrocleys nymphoides)

Summary of invasiveness

Rapid growth rate, it covers water bodies by developing a dense mat of stems. This chokes water bodies and can cause flooding. It also shades out other plants, and changes the habitat characteristics for other species (Weedbusters accessed 9 April 2020).

Description

Water poppy is a waterlily-like plant with leaves floating on the water surface. The plant has an underwater stem that is elastic and creeping, and floats near the water surface. Leaves and roots arise from each node along the stem. Leaves are a bright glossy green oval in shape and about 7 cm long. The main vein of the leaf is inflated on the underside. The flowers are made up of three yellow petals with a purple centre and are up to 8 cm across (Champion and Hofstra, 2020), and appear between November and April. Each flower only lasts 1-2 days (NZ Government, 2020)..

Similar species

Yellow water lily (*Nuphar lutea*) - has very thick spongy stolons and much larger leaves (up t 40 x 30 cm); marshwort (*Nymphoides geminata*) and fringed water lily (*Nymphoides peltata*). do not have an inflated mid-vein on the underside of the leaves. They also have wings on the outer edges of their petals (Champion and Hofstra, 2020).

Habitats

Still or slow-flowing water less than 2 m deep. Prefers open, warm, nutrient rich conditions, but will tolerate cool climates.

Reproduction

Vegetative spread by stolon fragments, deliberate planting. New plantlets are produced at the end of the growing season and these break away from the main plant to settle and take root in the mud at a new location (Champion and Hofstra, 2020).

History of introduction and spread in New Zealand

Native to tropical South America, most likely imported as an ornamental pond plant (Champion and Hofstra, 2020).

Current and potential distribution in New Zealand

Locally naturalised in northern North Island south to the Rotorua lakes, eradicated from most known sites (Champion and Hofstra, 2020).

Current and potential pathways

Spreads by plantlets or stem fragments carried by water, boats, fishing gear or machinery. No seed is produced in New Zealand (Weedbusters accessed 9 April 2020).

Potential costs and benefits

Water poppy has dense growth that chokes streams, shallow ponds and lake margins, causing flooding. It shades out other plants, reduces nutrient availability and alters the habitat for other organisms. Dense growth restricts access for recreational use.

Management options

Current control practices

There is very little information about control. Department of Primary Industries in New South Wales, Australia notes two rates of glyphosate under existing permits (NSW Department of Primary Industries, 2019).

Feasibility of eradication

Possible: Water poppy was eradicated from a pond on the margin of Lake Rotoehu in the 1970s (Clayton, 2015).

Legislative management responses

- Unwanted organism
- National Pest Plant Accord

- S52 and S53 of the Biosecurity Act 1993 apply: Banned from selling, propagating or distributing any unwanted organism. Not complying with Sections 52 and 53 is an offence under the Act, and may result in the penalties noted in Section 157(1).

Waikato RPMP: Eradication
Horizons: not included

References

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