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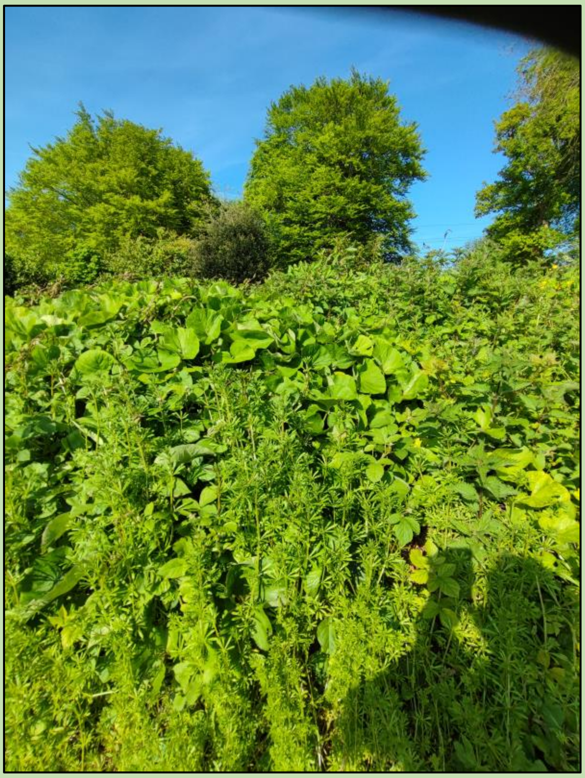
# *Invasive Species Management Plan*

Riverbank at Old Quay School, Ballina



August 2023

Prepared by Envirico on behalf of River Moy Search and Rescue

www.envirico.com

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## Table of Contents

LIST OF TABLES & FIGURES ..... 5

1. INTRODUCTION ..... 6

1.1 Site Manager/Owner: ..... 6

1.2 Site Address: ..... 6

1.3 Site GPS Co-ordinates: ..... 6

1.4 Site Description: ..... 6

1.5 Site Management Objectives and Threats to Objectives: ..... 7

2. ABOUT WINTER HELIOTROPE ..... 8

3. INVASIVE ALIEN SPECIES LEGISLATION ..... 9

Irish Statutory Instrument 477/2011 ..... 9

The Wildlife Amendment Act ..... 10

EU Regulation 1143/2014 ..... 10

4. MANAGEMENT PLAN ..... 11

4.1 Winter heliotrope Treatment Summary ..... 11

4.1.1 Methodology for Leaf Wiping ..... 12

4.2 Vinegar ..... 13

4.2.1 Introduction ..... 13

4..2.2 Vinegar as a herbicide ..... 13

4.2.3 Precautions ..... 14

4.2.4 Reasons for Discounting ..... 15

4.3 Baking Soda ..... 15

4.3.1 Introduction ..... 15

4.3.2 Baking Soda as a herbicide ..... 15

4.3.3 Precautions ..... 16
4.3.4 Reasons for Discounting ..... 16
4.4 Foam treatment ..... 17
4.4.1 Introduction ..... 17
4.4.2 Hot foam as a herbicide ..... 17
4.4.3 Reasons for Discounting ..... 17
4.5 Light exclusion/burial ..... 18
4.5.1 Black Plastic Sheeting ..... 18
4.5.2 Mulches ..... 19
4.5.3. Burial ..... 20
4.5.4 Reasons for Discounting ..... 20
4.6 Electric Treatment ..... 21
4.6.1 Introduction ..... 21
4.6.2 Electric Treatment as a herbicide ..... 21
4.6.3 Reasons for Discounting ..... 22
4.7 Regular Cutting ..... 23
4.7.1 Introduction ..... 23
4.7.2 Reasons for Discounting ..... 23
4.8 Cultivation ..... 23
4.8.1 Introduction ..... 23
4.8.2 Reasons for Discounting ..... 24
4.9 Other Options for Treatment ..... 24
5. BIOSECURITY PROTOCOLS ..... 26
6. CODES OF PRACTICE/SOURCES OF INFORMATION FOR INVASIVE SPECIES ..... 27

7. REFERENCES ..... 28

8. ABOUT ENVIRICO ..... 33

APPENDIX I – Drawings ..... 34

APPENDIX II - Photographs ..... 36

## LIST OF TABLES & FIGURES

### Tables

Table 1 Site management objectives, threats and mitigation for these threats .................................... 7

Table 2 Estimated schedule of works for treatment of Winter heliotrope ......................................... 13

### Drawings

Drawing 1: Winter heliotrope location ........................................................................................ 34

Drawing 2. Map of Killala Bay/Moy Estuary SAC from NPWS Site Conservation Objectives ................ 35

### Figures

Figure 1. Site overview looking northeast ...................................................................................... 36

Figure 2. Site overview looking south with the Old Quay School in the left of the image .................... 36

Figure 3. Main area of Winter heliotrope infestation looking North .................................................. 37

Figure 4. Main stand of Winter heliotrope indicating distance to the shore. ....................................... 37

Figure 5. More patchy distribution of Winter heliotrope, located adjacent to the Tufa habitat ........... 38

Figure 6. Butterbur growing adjacent to the tufa habitat. ................................................................. 38

Figure 7. Butterbur growing adjacent to Quay Road, south of the petrifying spring and Tufa habitat. 39

## 1. INTRODUCTION

Envirico have been engaged by River Moy Search and Rescue to prepare an Invasive species management plan for the treatment of Winter heliotrope on the riverbank of the Old Quay School in Ballina adjacent to the Killala Bay/Moy Estuary SAC (site code: 000458) and River Moy SAC (site code: 002298). Dr. Joanne Denyer has identified petrifying springs and tufa habitat close to the location of the Winter heliotrope. The presence of the Winter heliotrope on the spring has resulted in a failure of a condition assessment undertaken by Denyer Ecology in 2022 and therefore treatment of the Winter heliotrope is required. Consultation with the National Parks and Wildlife Service (NPWS) and Dr. Joanne Denyer has indicated that an Activities Requiring Consent (ARC) should be submitted to NPWS with this management plan, which details the treatment works.

This Invasive Species Management plan (IASMP) has been prepared in accordance with current Irish best practice guidelines such as 'The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads' – NRA (2010) and 'Prevention, Control and Eradication of Invasive Alien Species' – EPA (2021)

### 1.1 Site Manager/Owner:
River Moy Search and Rescue Ballina CLG

### 1.2 Site Address:
Old Quay School, Rathmeel, Ballina, Co. Mayo F26EW63

### 1.3 Site GPS Co-ordinates:
54.136323, -9.136217

### 1.4 Site Description:

The site includes the riverbank at the Old Quay Schoolhouse in Ballina, which is adjacent to the Killala Bay/Moy Estuary SAC (site code: 000458) and close to the River Moy SAC site code: 002298). Petrifying springs and tufa habitat have been identified at this location by Dr. Joanne Denyer of Denyer Ecology and is one of the qualifying interests for the River Moy SAC (002298). The riverbank is bounded to the west by the Killala Bay/ Moy Estuary SAC and to the east by Quay Road. The schoolhouse is located on the opposite side of Quay Road. The largest area of Winter heliotrope is located southeast of the tufa habitat, with just isolated plants within the location of the petrifying springs themselves. The main stand is located approximately 15m from the shore. The Winter heliotrope was noted growing in conjunction with the native plant Butterbur (*Petasites hybridus*). See Appendix II, photographic record, page 36.

## 1.5 Site Management Objectives and Threats to Objectives:

The site management objectives, threats to achieving those objectives and the planned strategies for minimising these threats are outlined in Table 1.

Table 1 Site management objectives, threats and mitigation for these threats.

| Objective | Threat(s) | Mitigation |
|---|---|---|
| To prevent the spread of Winter heliotrope as a result of these works. | Movement of equipment and personnel throughout areas contaminated with Winter heliotrope | All equipment used in infested areas must be thoroughly washed down and clean before exiting the exclusion zone.<br><br>All personnel and equipment that enter an exclusion zone must be clean before exiting.<br><br>Strict biosecurity protocols will be implemented, as outlined in the detailed Biosecurity Document. |
| To mitigate against the threat of Winter heliotrope. | Winter heliotrope growth poses a threat to the integrity of the SAC. | A herbicide treatment programme should commence and should continue until the Winter heliotrope has been controlled. |
| To enable works to go ahead in a timely fashion without compromising objectives 1 or 2. | Works may be delayed due to the implementation of biosecurity protocols. | Delays will be minimised by following the protocols laid out in this management plan. |

## 2. ABOUT WINTER HELIOTROPE

Winter Heliotrope (*Petasites pyrenaicus* formerly *Petasites fragrans*) is a species of invasive plant which originates from countries in North Africa and the Central Mediterranean. It was first brought to Ireland in the Victorian period by gardeners as a ground cover in damp areas. It is found in areas of waste ground, cultivated ground, embankments and shaded roadsides.

It has distinctive, shiny green leaves which are kidney shaped. The leaves are hairless above and hairy below with a regular toothed pattern around their edges. From November to March it produces pale pink flower heads which grow on spikes up to 25cm long. It is a strongly scented plant which is said to smell like vanilla. Winter Heliotrope only exists as male plants in Ireland, meaning that it only spreads vegetatively via its rhizomatous root system. It is capable of regenerating itself from very small parts of its fleshy rhizome which makes it very invasive.

Winter Heliotrope forms dense, shaded patches which have the potential to negatively impact on landscape quality and native biodiversity. Its rhizomatous root system also has the potential to negatively impact infrastructure by exposing cracks in concrete etc.

## 3. INVASIVE ALIEN SPECIES LEGISLATION

Winter heliotrope is considered a medium impact invasive species by the National Biodiversity Data Centre but is not subject to Irish Statutory Instrument 477/2011. However, it does have the potential to effect biodiversity by its invasive nature.

We have also ratified a number of international conventions that oblige the Government to address the issue of non-native invasive species, including the Convention on Biological Diversity, the Bern Convention and the International Plant Protection Convention.

### Irish Statutory Instrument 477/2011

The EC Birds and Natural Habitats Regulations introduced important legislation concerning invasive species in the Republic of Ireland. There is a total of thirty-four terrestrial and aquatic alien plant species currently listed in Part 1 of the Third Schedule (as amended by S.I. No. 355/2015).

Article 49 prohibits the introduction, breeding, release or dispersal of certain species; and Article 50 prohibits dealing in and keeping certain species.

Article 49 (2) “Save in accordance with a licence granted under paragraph (7), any person who plants, disperses, allows or causes to disperse, spreads or otherwise causes to grow in any place specified in relation to such plant in the third column of Part 1 of the Third Schedule, any plant which is included in Part 1 of the Third Schedule, shall be guilty of an offence.”

Article 49 (3) states that you can defend against allegations that you committed an offence under Article 49 (1) or (2) by proving that you took all reasonable steps and exercised all due diligence to avoid committing the offence:

Article 49 (3) “Subject to paragraph (4), it shall be a defence to a charge of committing an offence under paragraph (1) or (2) to prove that the accused took all reasonable steps and exercised all due diligence to avoid committing the offence.

Article 50 (2) “Save in accordance with a licence granted under paragraph (7), a person shall be guilty of an offence if he or she imports or transports –

(a) an animal or plant listed in Part 1 or Part 2 of the Third Schedule

(b) anything from which an animal or plant referred to in Part 2 of the Third Schedule can be reproduced or propagated, or

(c) a vector material listed in Part 3 of the Third Schedule, into or in or to any place in the State specified in relation to such an animal or plant or vector material in relation to that animal or plant or vector material in the third column of the Third Schedule."

### The Wildlife Amendment Act

The Wildlife Amendment Act (2000) of *The Wildlife Act (1976)* made it an offence to cause an exotic species of flora to grow in the wild anywhere in the state:

"Any person who plants or otherwise causes to grow in a wild state in any place in the State any (exotic) species of flora, or the flowers, roots, seeds or spores of flora, otherwise than under and in accordance with a licence granted in that behalf by the Minister shall be guilty of an offence."

### EU Regulation 1143/2014

EU Regulation 1143/2014 on invasive alien species entered into force on 1 January 2015. It provides for a set of measures to be taken across the EU in relation to invasive alien species included on a list of Invasive Alien Species of Union concern.

## 4. MANAGEMENT PLAN

### 4.1 Winter heliotrope Treatment Summary

Due to the deep rhizome network of this plant, the only effective in situ treatment method suitable for the management of Winter heliotrope at this location is chemical. Other non-chemical methods have been assessed and the reasons for discounting detailed below.

**Chemical Control** can be implemented by foliar spray or by leaf wiping. Both methods should be applied twice annually, first early in the year (Mar - Apr) and repeated in early summer (May – Jun). Both sides of the leaves should be targeted. Several years of treatment are likely to be necessary to achieve control. A period of two full growing seasons with no growth are required to declare the infestation controlled. The initial treatment will be undertaken in October 2023 in order to commence treatment at the earliest possible juncture. This will be followed with twice annual treatments until control is achieved. Annual monitoring of the site by the petrifying spring ecologist, Dr. Joanne Denyer, will be undertaken for the duration of the treatment.

**Recommended Treatment:** The use of conventional herbicides, such as Glyphosate, in order to treat invasive plant species has been used for decades. These, largely systemic herbicides, have the ability to travel through the plant tissues, effecting internal systems and functions, therefore reducing growth. If applied correctly, under the appropriate conditions, licencing and training, conventional herbicides can be administered with minimal impact on adjacent species and habitats. Glyphosate is strongly adsorbed by clay minerals in the soil and remains in the upper levels bound to clay or organic matter; very little escapes to groundwater. In a Canadian study, the maximum reported groundwater concentrations for the two compounds (glyphosate and its breakdown product aminomethylphosphonic acid (AMPA) were 2.03 and 4.88 ppb respectively, far below the maximum acceptable concentration of 280 ppb in drinking water established by Health Canada (2017).

Chemicals other than glyphosate e.g. 'Synero' are more effective in treating Winter heliotrope but are not licenced for use adjacent to water. Petrifying springs are dominated by bryophytes, which have varying sensitivities to glyphosate e.g. some species do not respond at all. As the impacts of glyphosate on petrifying spring vegetation is not known, leaf wiping will be used to reduce any potential short term impacts to the spring vegetation. To this end, annual monitoring will be undertaken by a petrifying springs ecologist to assess any impacts from herbicide treatment.

Due to the location of the Winter heliotrope adjacent to the SAC and the presence of sensitive tufa springs in close proximity, a glyphosate based herbicide application by leaf wiping is the recommended treatment method. Leaf wiping should only be carried out in ideal weather conditions, when leaves are dry and there is no rain forecast for 6 hours after application. The initial treatment should take place in the Autumn of this year followed by ongoing treatment each spring and summer until the infestation is controlled (no growth is observed for two full consecutive growing seasons).

#### *4.1.1 Methodology for Leaf Wiping*

The herbicide used will be Roundup Biactive XL (PCS No. 04660). Roundup Biactive XL is an aquatic-approved, glyphosate-based herbicide that is highly effective against Winter heliotrope. Roundup Biactive XL is a glyphosate formulation which having no hazard classification, offers a high standard of operator safety. All herbicide treatment works will be carried out under the supervision of a suitably experienced ecologist.

- Arrive on site
- Assess weather conditions
- Carry out on-site risk assessment.
- 'Toolbox talk' to ensure site personnel (as appropriate) understand specifics of works to be carried out.
- Erect signage to warn of herbicide treatment in progress, where appropriate.
- Check all equipment is in good working order
- Mix herbicide to dilution rate as recommended on the product label. Fill container with herbicide ensuring the lid is correctly sealed and placed within a drip tray.
- The leaves of each plant will be treated by applying the herbicide by brush on both sides of each leaf. The utmost care will be taken to ensure the herbicide only contacts the target leaf.
- The brush and herbicide container will be contained within/over a drip tray at all times during operations.
- Ensure there are no unauthorised personnel in the treatment area. If any unauthorised personnel or member of the public enters into the work area, works are to cease until the individual(s) have moved to a distance of more than 5m.
- Full PPE to be worn during leaf wiping operations in order to reduce risk of contact by the skin, eyes, throat, stomach or lungs from the herbicide being used. All guards, shields, etc. to be checked and in place.
- On completion, rinse out equipment and store safely.

- Before leaving the site, the operative should remove and clean equipment, PPE and footwear on-site to prevent spread of Winter heliotrope.
- Leave site, removing all signage and empty containers as appropriate.

Table 2 Estimated schedule of works for treatment of Winter heliotrope

| Treatment | Action | Time | Year |
|---|---|---|---|
| 1 | Apply systemic herbicide as necessary | *Sep-Oct* | *2023* |
| 2 | Monitor for growth and apply systemic herbicide as necessary | *Mar - Apr* | *2024* |
| 3 | Monitor for growth and apply systemic herbicide as necessary | *May - Jun* | *2024* |
| 4 | Monitor for growth and apply systemic herbicide as necessary | *Mar - Apr* | *2025* |
| 5 | Monitor for growth and apply systemic herbicide as necessary | *May - Jun* | *2025* |
| 6 | Monitor for growth and apply systemic herbicide as necessary | *Mar - Apr* | *2026* |
| 7 | Monitor for growth and apply systemic herbicide as necessary | *May - Jun* | *2026* |
| 8 | Monitor for growth and apply systemic herbicide as necessary | *Mar - Apr* | *2027* |
| 9 | Monitor for growth and apply systemic herbicide as necessary | *May – Jun* | *2027* |

Note: This schedule is an estimate only and it may take more or fewer visits to achieve control

## 4.2 Vinegar

### *4.2.1 Introduction*

Vinegar is a dilute solution of acetic (ethanoic) acid ($CH_3COOH$) in water (Adams, 2014). The acetic acid content of table vinegar varies but is generally between 4 and 6% (w/v) with greater acetic acid concentrations available commercially. Acetic acid is produced by the oxidation of ethanol by acetic acid bacteria, and, in most countries, commercial production involves a double fermentation where ethanol is produced by the fermentation of sugars by yeast. The principle uses of vinegar are as a condiment and a food ingredient to flavour and acidify foods.

### *4..2.2 Vinegar as a herbicide*

Vinegar has the potential to be a natural contact herbicide as acetic acid can destroy cell membranes, which can result in plant tissue desiccation and plant death (Owens, 2002). Acetic acid is considered a contact herbicide rather than a systemic herbicide, as there is no evidence that acetic acid is absorbed into the plant and translocated to other plant parts, such as the rhizome, to inflict damage (Webber *et al.,* 2018). As a contact herbicide, acetic acid should be more effective on seedlings and annuals than on more mature plants and perennials. Systemic herbicides are absorbed and transported through the plant's vascular system, killing the entire plant. Contact herbicides kill the part of the plant in contact with the herbicide. Plants that readily regrow from the roots, such as Winter Heliotrope, even when the foliage is destroyed, will be more difficult to kill with vinegar or other contact herbicides. Multiple applications and application timing in respect to the weed's size, maturity or life cycle may increase control. Acetic acid readily breaks down producing water as a by-product therefore it does not persist in the environment (Webber *et al.,* 2018).

Radhakrishnan *et al.* (2002) applied vinegar with acetic acid concentrations of 5, 10, 15 and 20% to three annual weed species (Fat-hen (*Chenopodium album*), Velvetleat (*Abutilon theophrasti*) and Green Amaranth (*Amaranthus hybridus*)), one grass weed species (Nodding Bristlegrass (*Setaria faberi*)) and one perennial weed species (Creeping Thistle (*Cirsium arvense*)) in a greenhouse setting. The vinegar was applied with a hand sprayer to "obtain a uniform wetting of all foliage". Weed control efficacy increased with acetic acid concentration and decreased with plant maturity: lower concentrations (5 and 10%) were more effective in killing the weed species during the early stages of maturity while at later states of maturity they were not as effective as the 15 and 20% concentrations. Vinegar provided 95-100% kill at all growth stages of the weeds studied at 15 and 20% concentrations. Creeping Thistle was the most susceptible species with 100% kill of top growth with 5% vinegar. There was, however, some regrowth from the roots of plants of all age groups.

Other research investigating the use of 10% acetic acid for the control of broadleaf weeds within sweet onion (*Allium cepa*) crops produced outstanding weed control on seedling broadleaf weeds less than 2.5cm tall and having at the most 5 seedling leaves (Webber and Shrefler, 2009a, 2009b). Webber et al. (2018) showed broadleaf weed (Carpetweed (*Mollugo verticillata*), Cutleaf Evening Primrose (*Oenothera laciniata*), Spiny Amaranth (*Amaranthus spinosus*), Eclipta (*Eclipta prostrata*)) control to be 84% or greater for plots receiving either 10% acetic acid applied at 935 L/ha or 20% acetic acid applied at 187 or 935 L/ha. A 30% concentration of acetic acid applied twice at 280 L/ha provided ≥70% control of one to two leaf southern crabgrass 7 days after application (Glenn *et al*., 2015).

### *4.2.3 Precautions*

Care must be taken when handling vinegar, especially when the acetic acid concentration increases above that normally contained in table vinegar. Vinegars with concentrations of acetic acid ≥11% can burn skin and cause serious eye injury, including blindness (Webber *et al.,* 2012). Protective clothing that includes eye protection and gloves should be used.

Vinegar may affect the pH of the soil it is applied to. In an experiment applying vinegar to the base of crops the pH of soils at the beginning of the experiment ranged from 5.9 to 6.6 and declined to 4.7 to 5.2 in the vinegar treated plots a month later (Radhakrishnan *et al.*, 2003). The pH in the treated plots, however, ranged from 5.8 to 7.1 five months later so the effect may not be temporary in nature. Vinegar may also have a detrimental effect on soil organisms due to the sudden change in pH of the soil. However, there is very little research in this area.

#### *4.2.4 Reasons for Discounting*

- Systemic herbicides are absorbed and transported through the plant's vascular system, killing the entire plant. Contact herbicides kill the part of the plant in contact with the herbicide. Acetic acid is considered a contact herbicide rather than a systemic herbicide, as there is no evidence that acetic acid is absorbed into the plant and translocated to other plant parts, such as the rhizome, to inflict damage.
- Acetic acid may readily change the soil pH and may have unintended impacts on this sensitive site.

### 4.3 Baking Soda

#### *4.3.1 Introduction*

Sodium bicarbonate, commonly known as baking soda or bicarbonate of soda is a chemical compound with the formula $NaHCO_3$. It is a salt composed of a sodium cation and a bicarbonate anion. Baking soda kills weeds by drawing water from the plants cells, effectively killing off the foliage. It is a non-selective contact herbicide meaning it will kill off any plant it comes in contact with.

#### *4.3.2 Baking Soda as a herbicide*

Baking soda has been shown to be effective in controlling bryophytes (liverworts and mosses) in a number of settings e.g. in containerised coniferous seedlings (Egorov *et al*., 2021), in bentgrass putting greens (Settle *et al*., 2006) and potted nursery plants (Mathers, 2016). Baking soda is also effective at controlling powdery mildew at a rate of 1oz/per gallon of water (McCown, 2003).

Very little scientific data, however, is available on the use of baking soda as a herbicide for the control of plant species other than bryophytes or fungi. One study, nonetheless, showed that a formulation of sodium bicarbonate including cinnamon, wheat flour, corn flour and cumin (Garden Weasel AG Crabgrass Killer) applied twice at 976 or 1,465 kg/ha provided ≥70% control of one to two leaf southern crabgrass (*Digitaria ciliaris*) 7 days after application (Glenn *et al.*, 2015). These applications of AG

Crabgrass Killer, however, caused >20% injury of the lawn turfgrass species (St. Augustine grass), observed 7 days after application. The authors concluded that, due to high turfgrass injury and little residual control of the weed species that the sodium bicarbonate formulation was not suitable for control of southern crabgrass in St. Augustine grass swards.

Numerous websites (www.idealhome.co.uk, www.gardenine.com, www.hunker.com, https://gardenerdy.com, https://www.express.co.uk to name a few) advocate the use of baking soda as a herbicide to control unwanted weeds. Some of these websites suggest pouring neat baking soda over unwanted weeds, for example McKnight (2019) advises one teaspoon of baking soda per weed to coat the entire plant, paying particular attention to the weed's stem. Others suggest coating the plant in water prior to applying the baking soda (Oliphant, 2021) while others suggest making a solution of baking soda with water and spraying it directly onto the weed (Worley, 2020). For the control of moss in a putting green sward, baking soda was spot applied as a solution of 6 oz. baking soda per gallon of water to provide season-long control of moss (Settle *et al*., 2006). With the exception of bryophytes and fungi, repeated applications of a baking soda solution may be needed to control weeds. Baking soda also seems to be effective on young weeds but it is not as efficient on more mature specimens (Worley, 2020).

### *4.3.3 Precautions*

As baking soda is a sodium (salt) compound, it should not be used in soils that are sensitive to increased salt, such as those near the sea. These soils will already have a high concentration of salts and increasing salt content further could have a detrimental effect on non-target species. It is also best to avoid using baking soda on non-target species and it is phytotoxic to most plants. For example, in one experiment baking soda was phototoxic on the active growth of 8 of the 10 non-target species (Mathers, 2016). It was also shown to be toxic to non-target grass species in a putting green setting (Settle *et al*., 2006). The amount of baking soda that enters the soil should be limited as it can make the soil sterile. Generally, however, in high rainfall areas this would be less of a problem.

### *4.3.4 Reasons for Discounting*

- There is no evidence to show that baking soda, as a contact herbicide, would be effective in controlling Winter heliotrope
- Baking soda is a non-selective contact herbicide, meaning it will kill off any plant it comes in contact with. This may be particularly relevant in this sensitive setting.

- Baking soda has a detrimental effect on soil microorganisms, particularly in low rainfall situations.
- Very little scientific data is available on the use of baking soda as a herbicide for the control of plant species other than bryophytes or fungi.

## 4.4 Foam treatment

### *4.4.1 Introduction*

Foam treatment of weeds such as with Foamstream™, manufactured by Weedingtech, is another herbicide free option of treating unwanted weeds. This method of weed control is suitable and safe for use around people, animals, waterways and delicate ecosystems (Bridge, 2005; Weeding Technologies Limited, 2018). Foamstream works by combining hot water with a biodegradable foam. The active ingredient in the process is the heat in the hot water which breaks down the cellular structure of the plant. The foam acts as a thermal blanket over the hot water and maintains the heat on the plant for long enough to kill or sufficiently damage the weed. The foam dissipates within minutes and results can be observed within hours of treatment depending on the target species.

### *4.4.2 Hot foam as a herbicide*

Waipuna™ hot foam is a biodegradable organic compound of coconut and corn sugars. It was shown to be as effective as a glyphosate herbicide in the control of the invasive aquatic plant, New Zealand pygmyweed (*Crassula helmsii*) in an experiment carried out on a RSPB reserve in the UK (Bridge, 2005). Both treatment methods resulted in an approximate 50% kill rate over areas where they were applied (Bridge, 2005).

As detailed by Martelloni, *et al*. (2020) in an assessment comparing multiple methods of weed removal, namely, flaming; glyphosate; hot foam and nonanoic acid, it was found that hot foam was the most effective method. Hot foam, in this study, led to 100% weed control one - two days post treatment within both sites and replications. It was also noted that the sites treated required between 26 - 27 days post hot foam treatment to recover to 90%.

### *4.4.3 Reasons for Discounting*

- There is a high energy demand associated with this system.

- Does not eradicate growth of species, only controls (Martelloni, *et al.,* 2020), as seen on an RSPB site by Bridge, 2005, indicating that the technique used did not eradicate the subject species, merely controlled its spread.
- The technology is designed mainly for the control of above ground growth, rather than eradication of the overall plant. The requirement for heat to reach the root to kill it means it would not be effective for plants more than a couple of feet tall. In relation to the technique's impact on Winter heliotrope, it appears that hot foam has the potential to decrease above ground growth, although evidence does not suggest that it can result in the death of rhizomes.
- The output from hot foam devices is very hot and contact with the foam or nozzle can cause severe burns.
- Hot foam systems are also costly initially, with a machine in the UK costing £26,500 and foam costing roughly £4 an hour to run (Pesticide Action Network UK, 2016).

## 4.5 Light exclusion/burial

### *4.5.1 Black Plastic Sheeting*

Black plastic was laid over areas of New Zealand pygmyweed and then topped with approximately a meter of soil (Bridge, 2005). This methodology achieved a 100% kill rate of the invasive species. However, the author concluded that it was a very labour-intensive method of control, causing a lot of disturbance and thus was not suitable for large infestations.

In relation to Japanese Knotweed, heavy duty black plastic sheeting has been used in a number of countries for the control of Japanese Knotweed. The method involves cutting stems cleanly at the base in summer, covering the sharp stems in a cushion of thick mulch which could be manure, grass clippings or straw, and then covering the infected area with the most heavy-duty tarp or plastic sheeting that can be sourced. It needs to cover the entire area with stems and extend beyond the stem limit by 5-10 feet, so that rhizomes that extend underground cannot access light. The plastic is then covered by rocks, sticks, soil, sand and mulch to prevent UV light reaching under the sheet allowing photosynthesis. The coverings must be monitored for repairs and any new growth. The arrangement must be kept in place for five years to ensure the rhizome has run out of energy and died. It has been noted, however, that when optimum conditions are not present for growth, Japanese Knotweed can go into dormancy for up to 20 years (EA, 2013).

The New Hampshire Department of Agriculture have said the method has been very successful in sensitive areas of the State (Dept. of Agriculture, 201?). However, the Isle of Man Government say in their guidelines that this method has been tried, but was found to be less effective than chemical treatment (DEFA, 2011). A thesis examining control methods of knotweed quotes a conversation the author had with a person in charge of managing knotweed in Glenstal Abbey, Co. Limerick, who says that the method was largely useful in removing the main stands, and that follow-up measures were needed to eradicate smaller, newer stands (Macfarlane, 2011).

2021 EPA Guidelines on the control of Winter heliotrope states that 'The use of membrane barriers is not proven to be a successful control method for winter heliotrope. Even young plants with no significant rhizome network have been shown to survive for extended periods of time when deprived of light during experiments at the Institute of Technology Sligo. Mulching is appropriate only as a temporary biosecurity measure to prevent the accidental dispersal of vegetation during treatment works.'

With regards to burial, studies have shown it to be a difficult method to achieve successfully. A Japanese Rose infestation on coastal sand dunes in Denmark was uprooted, and placed in 2-3m deep excavations that were covered by sand. All fragments were buried in at least 1m of sand. Harrowing took place afterwards to prevent re-sprouting. 84% of excavated sites experienced re-sprouting within two months, with the margins becoming particularly dense. The results showed that tiny fragments of the plant were buried much less than 1m accidentally, and that uprooting was not thorough enough along the margins of root systems. The authors point out that uprooting and burial must be done with the utmost care and attention and in combination with hand-pulling and harrowing over several years if it is to eradicate an invasive plant (Kollmann et al., 2009).

### *4.5.2 Mulches*

In Grundy and Bond's 2007 assessment of the use of non-living mulches for weed control through the exclusion of light, looked at a number of types of mulches including sheeted mulches (such as black, clear and coloured polythene sheeting, geotextile, needle-punctured fabrics, paper mulches, newspaper and carpet) and particle mulches (such as shredded and chipped bark or wood mulch, finer particles of wood, crushed rock or gravel mulch, straw and hay, grass clippings, crop wastes and industrial waste materials). The majority of mulches detailed within this assessment displayed an ability to reduce annual weed growth. Particulate mulches were noted to have an effect on soil composition such as with shredded and chipped bark or wood mulch and industrial waste materials (in the form of rubber mulch), being required to be dug between 5 and 7.5 cm deep and 3 cm deep, respectively. In addition to these mulches such as crop wastes, in the form of flax shrives and coffee grounds, were noted as potentially lowering soil pH. The lowering of soil pH and increase in organic matter is a common theme in relation of the addition to particulate mulches.

Sheeted mulches were noted by Grundy and Bond's 2007 assessment as having the potential to supress weeds, although an increase in soil temperature was also remarked, especially in relation to sheet plastics. Needle-punched fabrics, such as hemp, jute and flax, on the other hand were noted for their ability to decomposed, therefore not requiring removal off site. These mulches however, along with paper and newspaper, appear to only last one or two seasons, potentially not enough time to adequately supress winter heliotrope. Carpet on the other hand has the potential to last multiple seasons, although particles produced as a result of its breakdown are noted as being an issue.

### *4.5.3. Burial*

However, burial is mentioned as a possible method for the control of Winter Heliotrope as part of the National Roads Authority guidelines on the control of invasive species in Ireland. Since heliotrope has an extensive rhizome network, digging is really only practical on a smaller scale the guidelines state. Any fragment of root left behind could let the plant regenerate in a favourable disturbed soil environment (National Roads Authority, 2010). Burial must take place at a depth of at least 2m to prevent regeneration and could possibly be composted if infestations are small. Follow-up visits are also needed to deal with regeneration.

Light exclusion/ burial of plant material can be as effective as the use of herbicides for the treatment of above ground growth for 'weedy' species, although data relating to its effects on Winter Heliotrope are scarce. It is thought, due to the wide network of rhizome held by a Winter Heliotrope stand, that light exclusion would only be a temporary measure in supressing this species.

### *4.5.4 Reasons for Discounting*

- The use of black plastic has not been proven to be a successful control method for Winter heliotrope.
- This method is non-selective and will impact any species covered including damaging spring vegetation, which would not be acceptable in this location.
- The use of mulches, sheeting and burial have the potential to increase nutrient content, which would impact on sensitive locations.

- The use of black plastic as a means of light exclusion is labour intensive and expensive with heavy duty root barrier membrane costing €2.50/$m^2$.
- Covering large areas with plastic sheeting is not practical, particularly in areas with shrub or tree growth.
- The burial method causes a high level of disturbance and can severely impact the surrounding environment through the use of heavy machinery and would not be feasible in a riverside location.

## 4.6 Electric Treatment

### *4.6.1 Introduction*

Electric treatment for the control of plants has been noted as far back as the 1800's where a number of patents concerning the practice were filed in the US. The use of electrical currents to disinfect soils, restriction of seed germination and killing of weed and invasive species has been noted across the world, particularly in relation to their use in nature reserves and national parks.

### *4.6.2 Electric Treatment as a herbicide*

Electric treatments were used in a two year field trial conducted on Common Ragweed (*Ambrosia artemisiifolia*) and Japanese Knotweed (*Fallopia japonica*). While the treatment used (by Electroherb™) did not result in eradication of knotweed or even significantly decrease the number of stems, it was still recommended as the best emerging alternative to herbicide. It was also successful for ragweed. The study suggests the treatment is best used for young annual grass and broadleaf plants.

A trial in Exmoor National Park explored the use of electric treatment on Japanese Knotweed using Rootwave Pro, a device that forces an electric current through the plant that causes a rapid rise in temperature, damaging the cellular structure of the plant above and below ground. While the full results of the trial have yet to be seen due to pandemic-related delays, the team found that while one treatment a year was not enough, two treatments revealed that some sites were much more affected than others. After two treatments, some sites still showed vigorous growth of smaller shoots, but not at the height they would have reached without treatment, while other sites showed little sign of regrowth (The Exmoor Non-Native Species Project, 2021). The reason for this is unclear, but the project speculates it could be down to light availability, soil substrate and other environmental factors.

The same trial was conducted on other invasive species in the area. Treatment on Skunk Cabbage was successful with only central shoots remaining, Giant Hogweed was inconclusive as it became clear treatment was needed on both the main stem and basal leaves, while Montbretia proved difficult to treat as the narrow plant structure was challenging to target with the electrode used. Overall, this method was described as a good addition to the toolkit of control measures, but some sites may not be suitable for electric treatment (The Exmoor Non-Native Species Project, 2021).

Issues with this treatment method include that it is expensive. A Rootwave Pro costs £12,000 with specialized boots and equipment also needed. Operators must be trained by the product manufacturer in its use and it has proven difficult to cover staff with insurance due to the novelty of the technology. It can only be used when it is not raining, where a 4x4 or gator can access to within 27m of a stand, and cannot be used to treat plants on the opposite bank of a river (The Exmoor Non-Native Species Project, 2021).

According to the manufacturers of Rootwave Pro (Ubiqutek), populations of microbes living in the region surrounding the plants roots may be temporarily reduced (studies in progress). Worms may come to the surface during treatment and some worms in the strongest current path between the treated weed and the Treatment Return may not survive. There is almost no scientific research into the effects of this type of application of on soil chemistry. However, it is likely that any application of electricity to vegetation would have only a mild and transient impact on soil chemistry.

### *4.6.3 Reasons for Discounting*

- It is not yet certain as to the end results of Electrical Treatment on invasive species at Exmoor National Park. As Winter Heliotrope shares some of the same deep rhizome properties of Japanese Knotweed, it is thought that like this species it would need multiple annual applications  of Electric treatment in order to be effective.
- This method is expensive, with requirements for an initial outlay in terms of a machine, associated equipment and training.
- Electric treatment has the potential to effect adjacent plant seed and growth within the area.
- There may be difficulties in getting insurance for operators.
- There are limitations in relation to when the treatment can be applied. For example it cannot be applied during rain or when there are members of the public around.
- There may be issues accessing stands in difficult terrain.
- Soil microorganisms may be affected by the use of this treatment.

### 4.7 Regular Cutting

#### *4.7.1 Introduction*

Mowing or cutting invasive plant species is a method that, depending on its application and follow-up, could result in positive control or catalyse the spread of some species. For instance, the cutting or mowing of Japanese Knotweed is not recommended. It is not seen to be effective in either eradicating or controlling knotweed populations (Cygan, 2018), and can exasperate the spread since fragments of just 0.7g could result in growth of a new plant (Julien, 2008). For Winter Heliotrope, while mowing or cutting is not mentioned as a method of control in official guidelines from the NRA or from Irish bodies, garden service and help websites recommend regular mowing as an option for eradication on a lawn, but difficult if on uneven ground (Down Garden Services, 2021) (Helen Yemm, 2020).

With the high likelihood of spreading invasive species if mowing is not done at the right time or without removing cut material (cutting should be before flowering or seeding, but without triggering higher seed production), it is usually done in conjunction with herbicide application (Macfarlane, 2011), and rarely used as a method of control on its own.

#### *4.7.2 Reasons for Discounting*

- Will exacerbate the problem by actually spreading the plant.
- Usually not an effective method of eradication or control on its own and is usually used in conjunction with chemical control.
- May increase the fertility of the soil if cuttings are left in situ.

### 4.8 Cultivation

#### *4.8.1 Introduction*

Cultivation is the act of loosening the soil and is used to destroy weeds in agriculture and to aerate the soil for crops. In relation to weeds, cultivation can come in a variety of methods by hand or machines which is successful in an agricultural setting (Bond, Turner and Grundy, 2003). There is however, little evidence to suggest that cultivation is a method that is being used on its own as a control method for invasive species, particularly perennials and rhizomatous plants.

One method, used in the control of Japanese knotweed, involves scraping the first 25cm of topsoil with an excavator into a pile containing rhizomes. The area is then cultivated to a depth of 50cm, and the soil containing the rhizome is replaced on the original site. This causes the rhizomes to become fragmented into many pieces, which will then grow into many small shoots. The purpose of this is to expose as many leaves as possible to herbicide treatment to have the maximum impact in damaging and eventually killing the root (National Roads Authority, 2010). This needs to be repeated several times and usually over years to kill off the infestation completely. Whilst this method is not mentioned anywhere as currently being used to control Winter Heliotrope and there is no evidence to show that it works, the fact that it only spreads in Ireland through rhizomes suggests it could be controlled in this way, in combination with herbicide. The Guidelines on Control of winter heliotrope published by the EPA in 2021 states that 'The use of soil cultivation by repeated digging to expose and weaken rhizomes is recommended as a control method by the Royal Horticultural Society (RHS, 2008). There is no empirical evidence available to prove that this is successful, and the method carries a high risk of spread.'

### *4.8.2 Reasons for Discounting*

- Likely to cause spread of Winter heliotrope unless used in conjunction with chemical control.
- High level of disturbance on the area in which it is used and would be destructive to sensitive habitats.
- Relatively expensive, factoring in plant hire, expert machinery operatives, repeat applications of herbicide.

## 4.9 Other Options for Treatment

There are three other treatments in the realm of controlling invasive alien species; introduction of a pest/predator, grazing, and herbicide treatment.

Biological control is the use of an organism such as a pest, parasite or predator that could be introduced to control invasive species. The introduction of a new species is not a viable option as there is simply not enough evidence to support introducing any one or group of organisms that would specifically target the invasive alien to the degree required, and the lack of knowledge around the impacts such an introduction could have on our native ecosystems or agriculture in Ireland. It would also be unethical to introduce such a risk when there are other control methods that could be used, chemical or otherwise that do not pose that risk. There are also strict licencing procedures in place to regulate the process of introducing any alien species, even for experimental purposes.

The other possible treatment is the use of livestock grazing. Grazing usefulness depends on many factors, including whether the plant in question is dangerous for the animal to eat and the type of livestock used. One thesis, which, examined grazing effect on Japanese Knotweed showed mixed and inconclusive results. A higher intensity stocking rate of cattle when the plant is less than 30cm high had a limited impact on one site, but trampling in sites with mature stands had no significant impact (Macfarlane, 2011). Another site with sporadic knotweed was subjected to grazing by sheep for 15 years, leading to the quantity of knotweed substantially reduced, but not eradicated. Results from horses were inconclusive, and sites where pigs were used showed little sign of control and the possibility it was being spread further (Macfarlane, 2011). Farmers have told Envirico anecdotally that they have used sheep to manage knotweed for instance, but this cannot be corroborated or scientifically proven. It is not a widely used practice and more research is needed to show which grazing regimes can be truly effective in controlling invasive alien species. Ultimately, this control method can be discounted as the use of grazing to control Winter heliotrope is not feasible at this site.

## 5. BIOSECURITY PROTOCOLS

Persons/machinery entering or working within an area infested with an invasive alien species must take certain precautions to prevent the spread of that species. These guidelines must be strictly adhered to at all times.

- All PPE, other equipment and machinery that enter an infested zone must be cleaned before entering.
- Before leaving an infested area, personnel must thoroughly inspect their clothing, PPE, any equipment and their footwear for seeds, rhizomes, or other plant fragments that may be stuck on.
- All personnel should carry a hoof pick or similar implement with which to thoroughly clean the treads of their footwear.
- All footwear must be thoroughly cleaned before leaving an infested zone.
- Each field vehicle should carry a cleaning and disinfection kit that staff can avail of as the need arises and to thoroughly clean/disinfect their PPE/Equipment/Footwear before leaving an infested zone.
- The cleaning and disinfection kits should contain:
    - Stiff bristled brush
    - Water for washing & diluting
    - Biodegradable soap
    - Cloths for cleaning
    - Plastic tub
    - Virkon Aquatic Powder/tablets
    - Rubber/nitrile gloves
- As good practice all staff should follow Inland Fisheries Ireland Biosecurity Protocols when they have entered water or a riparian zone
- If machinery/plant has entered or worked in an infested zone, it must be thoroughly washed down before leaving the area or working in a location free from infestation.

## 6. CODES OF PRACTICE/SOURCES OF INFORMATION FOR INVASIVE SPECIES

### Ireland

- Invasive Species Ireland Horticultural Code of Good Practice (http://invasivespeciesireland.com/wp-content/uploads/2010/07/Horticulture-Code-Final.pdf)
- National Roads Authority – The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads (http://www.tii.ie/technical-services/environment/construction/Management-of-Noxious-Weeds-and-Non-Native-Invasive-Plant-Species-on-National-Road-Schemes.pdf)
- National Biodiversity Data Centre Invasive Species (http://www.biodiversityireland.ie/projects/invasive-species/)
- Invasive Species Ireland Website (http://invasivespeciesireland.com/)
- Sligo Institute of Technology Alien Species (http://staffweb.itsligo.ie/staff/dcotton/Alien_Species.html)
- Online Atlas of the British and Irish Flora (http://www.brc.ac.uk/plantatlas/) – *UK also*

### UK

- Department for Environment, Food and Rural Affairs Horticultural Code of Practice (http://www.botanicgardens.ie/gspc/pdfs/defra%20code%20of%20practice.pdf)
- GB Non-Native Species Secretariat (http://www.nonnativespecies.org)

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## 8. ABOUT ENVIRICO

Envirico are one of Ireland's leading ecological companies. We offer a wide range of services ranging from Bird Nesting Surveys to Natura Impact Statements. We also specialise in invasive species monitoring and control. We tackle invasive alien species found in domestic, commercial and amenity sites in terrestrial, riparian and freshwater habitats.

Our qualifications include:

- MSc Ecology
- BSc Wildlife Biology
- BSc Zoology
- BAgrSc
- PCA Certified Surveyor of Japanese knotweed
- PA1 – Safe use of chemicals
- PA6A – Operating hand-held pesticide equipment
- PA6AW – Operating hand-held applicators to apply pesticides near water
- PA6INJ – Operating hand-held pesticide injection equipment
- PA6MC – Operating other hand-held applicators
- Registered Professional Pesticide User of Pesticides
- SOLAS Safe Pass Certified
- CSCS Personnel
- PTS Certified
- HSE Commercial Divers
- National Powerboat Certificate (Level 2)

Our services include:

- Site-Specific, Best-Practice Management Plans
- Site Excavation and Management
- Chemical Control
- Post-Treatment Monitoring
- Completion Certificate
- Habitat Restoration
- Root Barrier Membrane
- Training in Biosecurity and Identification
- Bird and Mammal surveys
- Habitat Surveys
- RHAT Surveys
- AA Screening & NIS
- Ecological Assessments
- Water Quality Assessment
- Scientific Research
- Strategy Documents


Client:

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Drawing Title:
Drawing 1: Overview

Project Name:
Old Quay School Riverbank

| Project Code: | Drawn: | Approved: |
|---|---|---|
| 0458 | NS | NJS |

| Date: | Drawing Number: |
|---|---|
| 05/09/2023 | 0458/River Moy S&R/Old Quay School/D1 |

Source Background:
Google Satellite

Drawing 1: Winter heliotrope location


Drawing 2. Map of Killala Bay/Moy Estuary SAC from NPWS Site Conservation Objectives

Figure 1. Site overview looking northeast

Figure 2. Site overview looking south with the Old Quay School in the left of the image

Figure 3. Main area of Winter heliotrope infestation looking North

Figure 4. Main stand of Winter heliotrope indicating distance to the shore.

Figure 5. More patchy distribution of Winter heliotrope, located adjacent to the Tufa habitat

Figure 6. Butterbur growing adjacent to the tufa habitat.

Figure 7. Butterbur growing adjacent to Quay Road, south of the petrifying spring and Tufa habitat.