



F LLOYD (PENLEY) LTD. – EXTENSION 1 (X) – BIOSECURITY RISK ASSESSMENT

Introduction

During the consultation phase of the development proposals, Natural Resources Wales (NRW) requested that a bio-security risk assessment be undertaken to minimise the risk of importing and spreading invasive non-native species within and outside of the development boundary.

The objectives of the biosecurity risk assessment are to tabulate those species that have been identified as having the potential to be imported or spread during the construction phase of the project. The likely pathways and operational mitigation have also been identified. This is intended to support the planning application for the erection of a warehouse extension and loading bay canopy hereby referred to as Extensions 1 (X) at F Lloyd (Penley) Ltd., Wrexham Industrial Estate.

A preliminary ecological appraisal conducted by UES in May 2022 (report reference UES03411/05) highlighted the presence of Himalayan balsam and Japanese knotweed in the wider site boundary, but beyond the development boundary for Extension 1(X). Although these species are not present within the development boundary, there may be an increased risk of spreading these species as a result of the proposed development activities due to increased activity onsite.

This document will be appended to the contractors Construction Method Statement for use on site.

Risk Assessment

Species	Potential contamination route	Likelihood of risk	Operational Procedure
Himalayan balsam <i>Impatiens glandulifera</i>	Spread of species via construction machinery/ movement of soil. Spread of seeds via contaminated soil to receptor site.	Moderate. Himalayan Balsam is not known to be present within the development boundary; however, it is present within the ownership boundary.	Pre-commencement inspection by suitably experienced botanist to ensure no infected soils will be disturbed by the development proposals. Should infected soils be identified within proximity of the proposed works, this document will be reviewed, and the requirement for further treatment and mitigation measures will be clarified as part of an invasive species method statement. Ensure contractors know what Himalayan Balsam looks like. If it is identified on site, refer to the Welsh Government's Himalayan balsam Code of Practice.



Species	Potential contamination route	Likelihood of risk	Operational Procedure
			Additionally, if this species is found within the development boundary, the likelihood of risk will have increased, and as such biosecurity measures will need to be reviewed. Ensure that all machinery is clean prior to use on site.
Japanese knotweed <i>Reynoutria japonica</i>	Spread of species via construction machinery/ movement of soil. Spread of seeds via contaminated soil to receptor site.	Moderate. Japanese knotweed is not known to be present within the development boundary; however, it is present within the ownership boundary.	Pre-commencement inspection by suitably experienced botanist to ensure no infected soils will be disturbed by the development proposals. Should infected soils be identified within proximity of the proposed works, this document will be reviewed, and the requirement for further treatment and mitigation measures will be clarified as part of an invasive species method statement. Ensure contractors know what Japanese knotweed looks like. If it is identified on site, refer to the Welsh Government's Japanese knotweed Code of Practice. Additionally, if this species is found within the development boundary, the likelihood of risk will have increased, and as such biosecurity measures will need to be reviewed. Ensure that all machinery is clean prior to use on site.
Giant hogweed <i>Heracleum mantegazzianum</i>	Spread of species via construction machinery/ movement of soil. Spread of seeds via contaminated soil to receptor site.	Low. Giant hogweed is not known to be present on site but may be present along the River Clywedog. Low. There are no	Pre-commencement inspection by suitably experienced botanist to ensure no infected soils will be disturbed by the development proposals. Should infected soils be identified within proximity of the proposed works, this document will be reviewed, and the requirement for further treatment and mitigation measures will be clarified as part of an invasive species method statement. Ensure contractors know what giant hogweed looks like. If it is identified on site, refer to the Welsh Government's giant hogweed



Species	Potential contamination route	Likelihood of risk	Operational Procedure
		requirements to import soil.	Code of Practice. Additionally, if this species is found, the likelihood of risk will have increased, and as such biosecurity measures will need to be reviewed. Ensure that all machinery is clean prior to use on site.
Other invasive species	Spread of other invasive species via construction machinery / movement of soil. Spread of invasive species through contaminated soil.	Low. No other invasive species are known to be present on or within the vicinity of the site. Low. There are no requirements to import soil.	Pre-commencement inspection by suitably experienced botanist to ensure no infected soils will be disturbed by the development proposals. Should infected soils be identified within proximity of the proposed works, this document will be reviewed, and the requirement for further treatment and mitigation measures will be clarified as part of an invasive species method statement. Specific procedures and control measures will need to be implemented to ensure that there is no risk of input into the watercourse. These measures should be set out by the contractors prior to the commencement of works and will need to be agreed with the Local Planning Authority (LPA) and other statutory consultees. Buffer zone to be retained along the length of the River Clywedog which will not be affected by the works, to reduce the risk of deposition of material into the watercourse, including invasive species. Ensure that all machinery is clean prior to use onsite.

Ongoing monitoring

The site will undergo annual monitoring by a suitably qualified ecologist for a period of two-years following the completion of works on site in order to survey the site for colonisation of invasive non-native plant species. If any are found, a suitable control programme will be agreed between the applicant and ecologist.



Appendix 1 – Welsh Government advice sheet: Himalayan balsam

Himalayan balsam



Llywodraeth Cymru
Welsh Government

Correct name: Indian balsam (widely referred to as Himalayan balsam)

Scientific name: *Impatiens glandulifera*

What is Himalayan balsam?

Himalayan balsam is the most common of three introduced balsam species present in the UK:

- 1 Himalayan balsam (*Impatiens glandulifera*)
- 2 Small balsam (*I. parviflora*)
- 3 Orange balsam (*I. capensis*)

As the name suggests, Himalayan balsam was introduced to the UK from the western Himalayas, while Small balsam was introduced from Central Asia and Orange balsam was introduced from North America.

Where do introduced balsams grow?

All introduced balsam species preferentially grow along rivers and canals, around waterbodies and in other damp places. Himalayan balsam is frequently found growing on waste ground and it is increasingly found growing in dryer areas such as roadsides, railway embankments and field margins.

How does Himalayan balsam spread?

Rapid spread is the result of high seed production (up to 2,500 small seeds per plant), explosive seed dispersal from the parent plant (dehiscence) and floating (buoyant) seeds. Each seed pod held on the mature plant contains 4-16 seeds; when these are touched, the seed pod explodes, propelling the seeds up to 7m from the parent plant. Seeds can then float downstream, be carried by attachment to animals (and people) and/or moved in contaminated soil.

Legislation

Because of negative impacts on the UK environment and economy, Himalayan balsam is listed as a species of special concern under retained European Union (EU) law. This means it is an offence to plant or cause these plants to grow in the wild, or intentionally release them into the environment. Schedule 4 of the Invasive Alien Species (Enforcement and Permitting) Order 2019 removes plants listed under the EU IAS Regulation from Schedule 9 of The Wildlife and Countryside Act 1981, although the same offence applies. Also, Himalayan balsam plant material (including soil contaminated with seeds) is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites. Transfer notes shall be kept for each load for a minimum of 2 years.

Why control Himalayan balsam?

Himalayan balsam plants are short-lived (annual), ruderal competitive dominants and are the tallest annual plants in Europe. Rapid growth early in the growing season and a dense, compact canopy restricts native plant species access to light. Competitive growth causes negative ecological and socioeconomic impacts, including:

- **Reduced habitat availability and quality** – reduction of native plant, invertebrate and vertebrate species diversity, altered soil conditions and reduced ecosystem services.
- **Habitat alteration and degradation** – direct negative impacts upon terrestrial and freshwater food webs, particularly via siltation of watercourses.
- **High management costs** – estimated at approximately £1 million per annum UK-wide.
- **Limited soil binding capacity** – shallow-rooting Himalayan balsam does not bind soil as effectively as the root systems of native flora, significantly increasing erosion risk; this is greater in the winter and spring months when balsam dies back (reducing soil binding capacity further) and rainfall is higher.
- **Access restriction** – amenity areas may become inaccessible due to uncontrolled growth (e.g. loss of riverbanks for fishing).



Identification - Himalayan balsam

What does it look like?

Images A-H below show what Himalayan balsam looks like throughout the year.

Where: **A** = full growth in mid-summer (height 2m); **B** = riverbank shown in A during winter months (note dead stems at right and limited native plant cover); **C** = early seeding emergence (cotyledon shown at left, first leaves at right); **D** = immature plant; **E** = dense growth of immature plants (note whorl leaf arrangement and red stem); **F** = mature pinkish, fleshy (succulent) stem (note opposite leaf arrangement at stem nodes) – stems are often branched; **G** = flowers (strongly scented; insect pollinated); **H** = ripe seed pods (c.2-3cm long).



Image acknowledgements (this page and following page)

Small balsam leaf arrangement: © André Karwath 2005 – link: [https://commons.wikimedia.org/wiki/File:Impatiens_parviflora_-_blossom_front_\(aka\).jpg#/media/File:Impatiens_parviflora_-_plant_\(aka\).jpg](https://commons.wikimedia.org/wiki/File:Impatiens_parviflora_-_blossom_front_(aka).jpg#/media/File:Impatiens_parviflora_-_plant_(aka).jpg)

Orange balsam leaf shape & size: © British Nature Guide 2014

Orange balsam leaf arrangement: © Robert Flogaus-Faust 2013 – link: <https://www.biolib.cz/en/taxonimage/id395730/>

Orange balsam flower structure & colour: © Trevor Renals 2021

Touch-me-not balsam leaf shape & size: © Herbarium Online 2021

Touch-me-not balsam leaf arrangement: © Tatiana Gerus 2012 – link: [https://commons.wikimedia.org/wiki/File:Impatiens_noli-tangere_\(7818663064\).jpg](https://commons.wikimedia.org/wiki/File:Impatiens_noli-tangere_(7818663064).jpg)

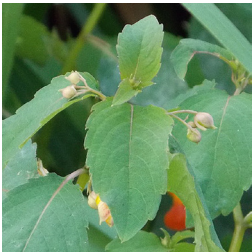
Touch-me-not balsam flower structure & colour: Peter Follett 2005 British Wild Flowers – link: <http://www.british-wild-flowers.co.uk/B-Flowers/Balsam,%20Touch-me-not.htm>



Identification - distinguishing between introduced and native balsams

Key identification features

Introduced and native balsams look quite similar, though there are clear differences in leaf shape and arrangement and flower colour and size. All balsams have stems with distinctive nodes (stem segments); at each node, leaves may be paired opposite, attached alternatively upwards along the stem (i.e., the leaves are not paired opposite one another at each node), or held in whorls of three. **The nationally scarce native balsam, Touch-me-not balsam (*I. noli-tangere*) is included here for reference.** Note that measurements not in brackets are sizes commonly achieved; those in brackets are occasionally observed.

Common name	Himalayan balsam	Small balsam	Orange balsam	Touch-me-not balsam
Height	Up to 2.0(3.0)m in height	Up to 0.6(1.0)m in height	Up to 0.6(1.5)m in height	Up to 0.6(1.0)m in height
Lower leaf shape & size	 Up to 15cm long	 Up to 10cm long	 c.10cm long	 c.10cm long
Lower leaf description	Lanceolate (lance tip); dark green at maturity; reddish midrib and teeth; finely serrated teeth (24-75 teeth per side)	Oval to lanceolate; finely serrated teeth (20-30 teeth per side)	Oval to lanceolate; coarse teeth (6-12 teeth per side)	Oval to lanceolate; coarse teeth (6-15 teeth per side)
Leaf arrangement	 Opposite (above) or whorl (below)	 Alternate	 Alternate	 Alternate
Flower shape, colour & size	 Pink, purple, white; 4.0cm	 Pale yellow; 0.6-1.8cm	 Orange with red/brown spots; 2-3.5cm	 Yellow with brownish spots; 2-3.5cm
Flowering period	June-November	June-October	June-September	June-September

Himalayan balsam lifecycle - control and management

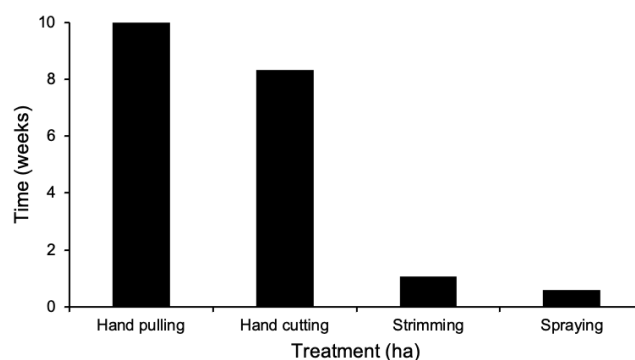
Project planning & biosecurity

Invasive plant management programme goal setting, health & safety, biosecurity and survey information is provided in detail in the Welsh Government document [Information for community and voluntary groups in Wales: Practical control of Japanese knotweed](#). **Note that biosecurity considerations are especially important for Himalayan balsam as all spread is via small seeds (in contrast with Japanese knotweed).**

Research

Published information about effective, sustainable Himalayan balsam management control is limited as there have been few field studies investigating its control. Lack of information may lead to excessive herbicide use, and costly, labour intensive and unsuccessful management strategies. No control treatment is without its drawbacks. Control programmes that do not involve herbicide use may be characterised by high carbon dioxide (CO₂) emissions, labour and cost requirements. The primary focus of any management programme should be to bring the invasive plant under control, followed by vegetation recovery so passive recolonisation by native plants can occur. Ultimately, a control method is unsustainable where the likelihood of success is low, the management process is indefinite, and recovery of native vegetation is limited. Key control and management terms, including plant protection product (PPP or herbicide) descriptions are provided in Annex 1.

While many control methods are effective for Himalayan balsam, the requirement for a long-term management strategy (3-5 years) means that many methods are only suitable for small populations (<1,000m²); for larger areas project resources to successfully meet the objectives of the management programme (management and/or local eradication) may be insufficient. To illustrate this, the following graph shows estimates for how long it would take to hand pull, hand cut, trim and spray 1 hectare (10,000m²) of balsam. This is based on unpublished field testing data at the 25m² scale (Jones pers comm. 2022).



Projected treatment times by method per hectare (ha). Where: hand pulling = 10.0 weeks; hand cutting = 8.3 weeks; strimming = 1.1 weeks; spraying = 0.6 weeks. Weeks are defined as a one person working a 40hr week.



Himalayan balsam lifecycle - control and management

Timing of Himalayan balsam growth stages and treatment application												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growth stages: approximate - species, weather and altitude dependent												
Primary germination												
Secondary germination												
Seedling plant growth												
Maturity (max. height)												
Flowering												
Seed production												
Die back												
Treatment application – physical												
Cutting & pulling												
Treatment application – biological (host and non-specific)*												
Grazing												
Treatment application – chemical												
Selective												
Non-selective, non-residual (glyphosate)												
Non-selective, residual												
*Note: trials of the host-specific biocontrol agent for Himalayan balsam (rust fungus, <i>Puccinia komarovii</i> var. <i>glanduliferae</i>) are ongoing and to achieve control additional rust strains are required. Specifications for the application of non-specific grazing animals (livestock) for balsam control are not provided in this document as this is a complex and highly site-specific process and formal guidance has not yet been published.												

Importance of the Himalayan balsam lifecycle

To achieve effective management of invasive plants such as Himalayan balsam which spread rapidly by seed, flowering must be prevented for several years to deplete the soil seed bank. The quicker that depletion is achieved, the fewer treatments will be required in the longer-term, reducing overall project costs, herbicide use and CO₂ emissions. Himalayan balsam populations have a reservoir of seeds (propagules) in the upper layer of the soil (30,000 seeds m²) which remain viable for up to 3 years. In certain settings, local eradication of Himalayan balsam populations can be achieved, though there always remains some risk of reinvasion from other areas and/or upstream during flooding.

Evidence-based recommendations provided below draw on Advanced Invasives unpublished field research combined with biological understanding of Himalayan balsam (i.e., lifecycle processes). Recommendations are further supported through consultation with expert practitioners who have worked extensively with Himalayan balsam in the UK. Timings of Himalayan balsam growth stages are shown above along with recommended treatment timings. While all methods of chemical and physical (mechanical) control are effective, these must be applied three times per year to ensure that no seed is set; where this is not achieved, population recovery and management failure will result. Note that the growth stages in the diagram above are approximate and dependent upon weather conditions and altitude. Also note that the earlier in the growing season that control methods are applied, the less likely that balsam plants will reach maturity, flower and set seed – **do not leave treatment too late in the**

growing season as time and resources will be wasted and inter-season management will be ineffective. Also note that management of the population at an early stage of establishment will be easier and more labour- and cost-effective.

Full treatment specifications

Three physical (one based on powered equipment, two based on labour) and three Integrated Pest Management (IPM) systems are recommended for the sustainable management of Himalayan balsam. Note that in the fourth and fifth years of an effective 5-year balsam management programme based on IPM systems, herbicide application frequency can be reduced, as the few remaining balsam plants can be managed quickly by cutting using powered equipment (though this will increase project costs). **Note that cutting should not be used where balsam is growing amongst Japanese knotweed as this will result in knotweed spread and reduce the efficacy of knotweed control when using glyphosate-based herbicides.**

Himalayan balsam - treatment specifications

Treatment 1: Physical management system - Cutting

- **Use near water:** Yes
- **Frequency:** Cutting three times per year, all years of treatment
- **Herbicide:** N/A
- **Method:** Cutting using powered equipment (e.g. brush cutter, mower, flail) below the 1st stem node; plants cut above this point will continue to grow in a branching pattern and will flower and set seed. Note that access must be considered for larger equipment.
- **Rate:** N/A
- **Timing:** Apply from time that plants are large enough that the plant can be cut accurately below the 1st stem node (c.50cm tall) from March/April; apply all three control methods between March/April and August. Undertake the first cut in March/April, the second cut between May and July and the third cut in July/August.

Treatment 1: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Treatment 1: Physical management system - Cutting</i>												
Cutting 1 st treatment												
Cutting 2 nd treatment												
Cutting 3 rd treatment												

Treatment 1: Notes

- Aim to undertake all treatments as early as possible to minimise flowering and seed pod formation. Note that viable seed can be produced on intact flowering plants following cutting.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Higher labour requirements and CO₂ emissions compared with IPM system treatments recommended.
- Himalayan balsam herbicide resistance development is not relevant.



Himalayan balsam - treatment specifications

Treatments 2 & 3: Physical management systems - Labour-based hand pulling & cutting

For smaller areas of Himalayan balsam less than 1,000 m² in extent, hand pulling and cutting may be appropriate in cases where there is a coordinated, motivated volunteer workforce. While other treatments recommended can be applied three times per year, hand pulling and cutting using a volunteer workforce should be considered a continuous control method, the efficacy of which is dependent upon effective onsite monitoring with ongoing treatment of balsam growth as and when it is found. Note that hand pulling and cutting treatments are physically demanding and not suitable for all volunteers. Also, it can be hard to retain volunteer interest as it is very repetitive work. When planning the management programme, these limitations must be considered, otherwise management programme failure will result.

- **Use near water:** Yes
- **Frequency:** Continuous within-season application, all years of treatment
- **Herbicide:** N/A
- **Rate:** N/A

- **Pulling method:** Pull whole plant out along with the root; grasp stem firmly and draw upwards deliberately to prevent the stem breaking above the 1st stem node; plants breaking above this point will continue to grow in a branching pattern and will flower and set seed.
- **Pulling timing:** Apply when plants are large enough that the plant can be pulled out of the ground intact (c.50cm tall) from March/April to August; ongoing treatment to minimise flowering and seed pod formation. Minimum treatment frequency of once per month.

- **Cutting method:** Cut using hand-held equipment (e.g. machete, scythe) below the 1st stem node; plants cut above this point will continue to grow in a branching pattern and will flower and set seed.
- **Cutting timing:** Apply when plants are large enough that the plant can be cut accurately below the 1st stem node (c.50cm tall) from March/April to August; ongoing treatment to minimise flowering and seed pod formation. Minimum treatment frequency of once per month.

Treatments 2 & 3: Control method application timings. Where: green = continuous application.												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Treatment 2: Physical management systems - Labour-based hand pulling & cutting												
Pulling/cutting treatment												

Treatments 2 & 3: Notes

- Can be used near water but hand pulling treatment in particular may increase erosion risk; reinvasion from upstream is also likely, and progress along riverbanks using this treatment will be very slow.
- Note that viable seed can be produced on intact flowering plants following pulling.
- Additional equipment requirement: rakes, forks and wheelbarrows.
- Aim to 'forward-load' management early in the growing season while plants are more accessible and there are fewer bees (avoid stings!); **don't leave treatment until the last minute.**
- Ensure good waste management processes are agreed before beginning this treatment method as large volumes of waste will be generated. Create access routes and disposal areas away from water to prevent waste piles containing soil and seed from previous growing seasons being washed downstream during flooding. **Do not dispose of any waste material in general compost.**
- Himalayan balsam plant material (including soil contaminated with seeds) is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites; **do not move any plant or soil waste generated by management from the area where it produced.**
- Check waste piles periodically for any plants re-rooting from roots and stem nodes, as these will flower and seed.
- **Himalayan balsam should not be allowed to flower or set seed.** However, in certain limited circumstances, flowers and seed pods can be carefully bagged by dipping the top of the plant into a large transparent bag (so you can see what you are doing!) and pulling it off – minimise this procedure as it takes a lot of time and some seeds will inevitably escape. Dispose of flowers and seed pods along with other waste away from water following good biosecurity procedures as sticky seeds will adhere to boots and clothing.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Hand pulling and cutting have the highest labour requirements of all treatments recommended, and significant CO₂ emissions are associated with frequent volunteer transport.
- Himalayan balsam herbicide resistance development is not relevant.

Himalayan balsam - treatment specifications

Treatment 4: Integrated Pest Management (IPM) system - Glyphosate + cutting

- **Use near water:** Yes
- **Frequency:** Glyphosate twice per year, cutting once per year, all years of treatment
- **Herbicide:** Glyphosate
- **Method:** Foliar spray using hand-held, knapsack or large volume sprayers – weed wiping may also be suitable; cutting using powered equipment (e.g. brush cutter, mower, flail) below the 1st stem node; plants cut above this point will continue to grow in a branching pattern and will flower and set seed. Note that access must be considered for larger equipment.
- **Rate:** Half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all three control methods between March and August. Undertake the first glyphosate application between March and May and the second glyphosate application between April and June. Cutting of remaining Himalayan balsam plants should be undertaken between June and August, one month after the final herbicide treatment and before seed pod formation.

Treatment 4: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Integrated Pest Management (IPM) system - Glyphosate + cutting</i>												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												
Cutting												

Treatment 4: Notes

- Can be applied effectively earlier than cutting, as plants can be treated with herbicides before they reach a height of 50cm in March/April.
- Aim to undertake all treatments as early as possible to minimise flowering and seed pod formation. Note that viable seed can be produced on intact flowering plants following cutting and ineffective herbicide application.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Higher labour requirements and CO₂ emissions than other IPM systems.
- Himalayan balsam herbicide resistance development should be considered, ensure total within-season control of whole population.



Himalayan balsam - treatment specifications

Treatment 5: Integrated Pest Management (IPM) system - Residual + glyphosate + cutting

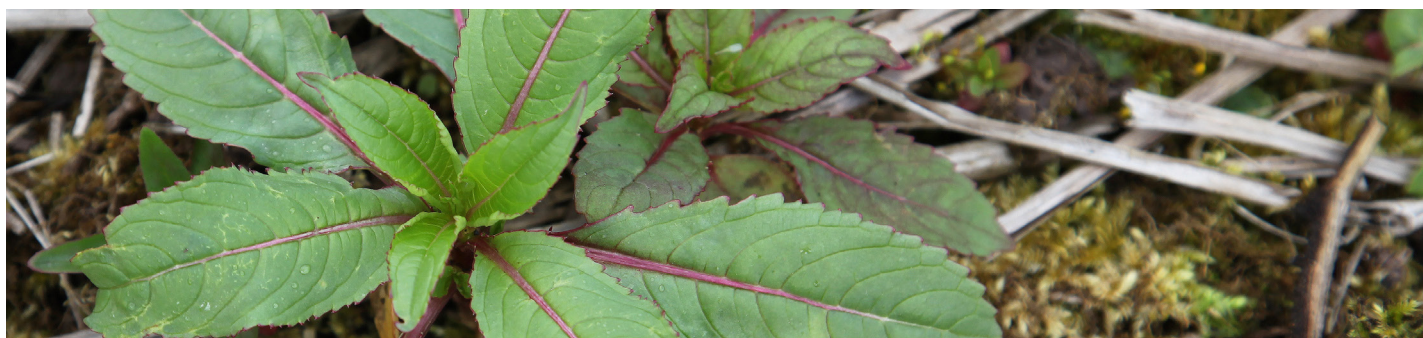
- **Use near water:** No
- **Frequency:** Residual once per year, glyphosate twice per year, years 1 & 2; Glyphosate twice per year, cutting once per year, years 3 to 5.
- **Herbicide:** Residual (e.g. flazasulfuron) + glyphosate
- **Method:** Soil and foliar spray using hand-held, knapsack or large volume sprayers.
- **Rate:** Residual herbicide at full (maximum permitted) application rate (see product label), once per year; glyphosate at half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all control methods between February and August.
Years 1 & 2: Undertake the residual application between February and April. Undertake the first glyphosate application between April and June and the second glyphosate application between June and August.
Years 3 to 5: Undertake the first glyphosate application between March and May and the second glyphosate application between April and June. Cutting of remaining Himalayan balsam plants should be undertaken between June and August, one month after the final herbicide treatment and before seed pod formation.

Treatment 5: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Integrated Pest Management (IPM) system - Residual + glyphosate + cutting												
Years 1 & 2												
Residual												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												
Years 3 to 5												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												
Cutting												

Treatment 5: Notes

- Can be applied effectively earlier than cutting, as plants can be treated with herbicides before they reach a height of 50cm in March/April.
- Aim to undertake all treatments as early as possible to minimise flowering and seed pod formation. Note that viable seed can be produced on intact flowering plants following cutting and ineffective herbicide application.
- Inclusion of a residual herbicide within this IPM system has the advantage of controlling Himalayan balsam populations more quickly than other recommended treatments. Residual herbicides should only be applied for 2 years to permit full recovery of native plants in years 3-5 (limiting potential for control site recolonisation by invasive plants). Note that this IPM system emits less CO₂ than other treatments and uses less herbicide over the whole 3-5 year treatment lifecycle than other IPM systems.
- Residual herbicides do not kill mature Himalayan balsam plants; early application is required to control a high proportion of seed germinating early in the growing season.
- Glyphosate-based herbicides work more slowly and are less effective when plants reach full maturity later in the growing season (July/August onwards); earlier treatments are strongly recommended. **Note that the 2nd glyphosate application window is targeted at controlling late germinating plants and plants which have escaped previous treatments.**
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Himalayan balsam herbicide resistance development should be considered, ensure total within-season control of whole population.



Himalayan balsam - treatment specifications

Treatment 6: Integrated Pest Management (IPM) system - Selective + glyphosate

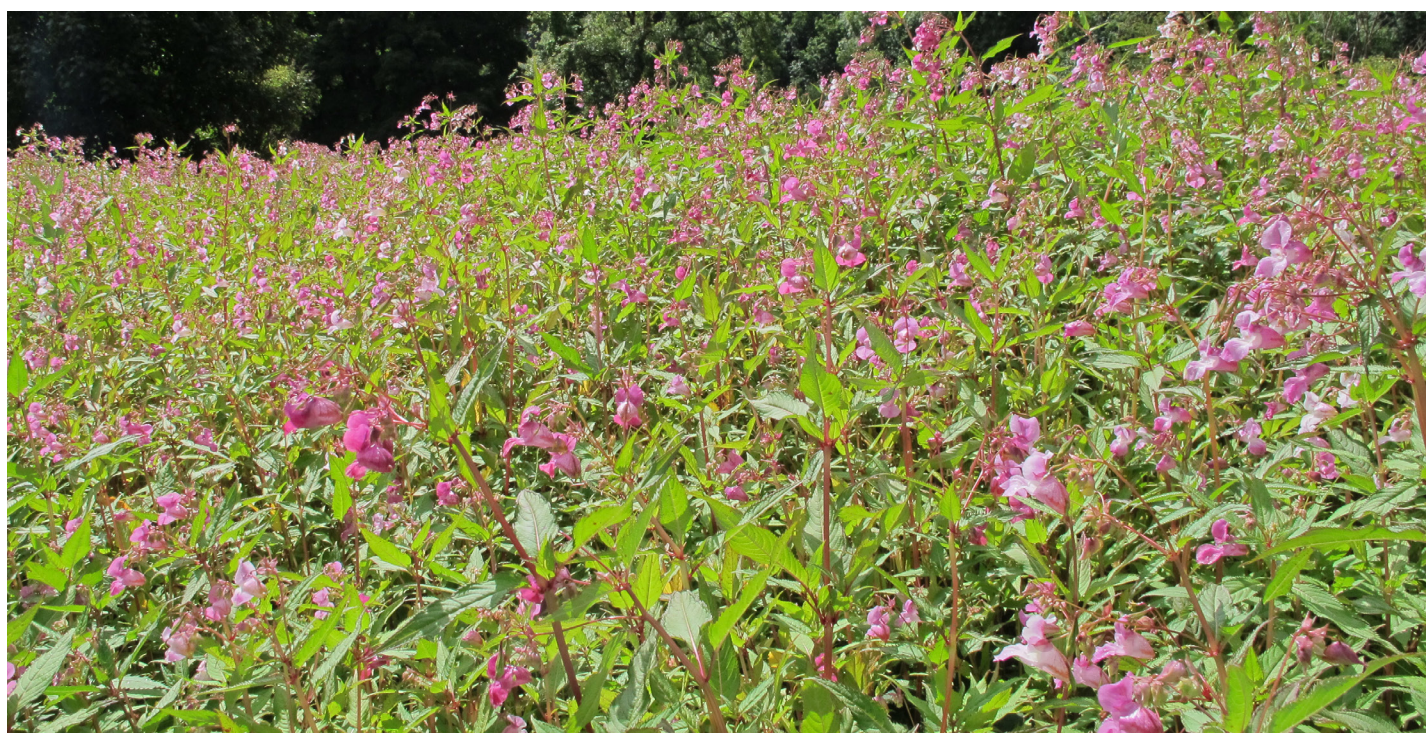
- **Use near water:** No
- **Frequency:** Selective once per year, glyphosate twice per year, all years of treatment
- **Herbicide:** Selective (e.g. triclopyr) + glyphosate
- **Method:** Foliar spray using hand-held, knapsack or large volume sprayers preferably with a long lance.
- **Rate:** Selective herbicide at full (maximum permitted) application rate (see product label), once per year; glyphosate at half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all three control methods between March and August. Undertake the selective application between March and May. Undertake the first glyphosate application between April and June and the second glyphosate application between June and August.

Treatment 6: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Integrated Pest Management (IPM) system - Selective + glyphosate												
Selective												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												

Treatment 6: Notes

- Can be applied effectively earlier than cutting, as plants can be treated with herbicides before they reach a height of 50cm in March/April.
- Aim to undertake all treatments as early as possible to minimise flowering and seed pod formation. Note that viable seed can be produced on intact flowering plants following cutting and ineffective herbicide application.
- Selective herbicides do not kill mature Himalayan balsam plants later in the growing season (May/June onwards).
- Glyphosate-based herbicides work more slowly and are less effective when plants reach full maturity later in the growing season (July/August onwards); earlier treatments are strongly recommended. **Note that the 2nd glyphosate application window is targeted at controlling late germinating plants and plants which have escaped previous treatments.**
- Aim to undertake all treatments as early as possible to minimise flowering and seed pod formation; where herbicide treatments have been delayed and seed pods have formed, supplemental cutting of Himalayan balsam plants can be undertaken using powered equipment between July and August.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Only Treatment 5 (IPM system - Residual + glyphosate + cutting) has lower labour requirements and CO₂ emissions.
- Himalayan balsam herbicide resistance development should be considered, ensure total within-season control of whole population.



Do's and Don'ts of Himalayan balsam treatment

Do's

Improve your Himalayan balsam control results by thinking about the following:

- Always follow the information on the herbicide product label and do not exceed the specified dose on the label.
- Always ensure those who are using plant protection products (herbicides) have the necessary qualifications to do so and consider using specialist contractors. **Details of operator and contractor accreditation information is provided in the Welsh Government document [Information for community and voluntary groups in Wales: Practical control of Japanese knotweed](#).**
- **Timing** – the key to controlling Himalayan balsam is preventing it from seeding and depleting the seed bank; act early in the growing season to reduce labour and herbicide requirements later in the growing season when the plants are larger.
- **Coverage** – good coverage means getting a little herbicide onto most of the leaves – this can be achieved by continually moving the spray lance as the herbicide is applied. **You do not need to excessively apply herbicide(s) to get good results.** Attention to detail (operator performance) is critical. Apply residual herbicides to the soil surface in advance of germination and ensure even soil coverage.
- **Spray retention** – spray enhancers (also known as adjuvants/surfactants) help you to make each application count. Adjuvants improve control results by sticking the herbicide to the leaf – this allows the herbicide to absorb better and the adjuvant protects the herbicide from being washed off by unexpected rainfall.

- **Herbicide absorption** – use water conditioners to get the best performance from your glyphosate products. Glyphosate can stick to salts in water and this stops some of the herbicide working properly. Water conditioners remove salts from the water, before you mix in your glyphosate product.
- **Use the right tools for the job** – think about which of the recommended treatments will work best using the least herbicide and labour.
- Because we can kill Himalayan balsam plants and where we have managed the soil seed bank for 3-5 years, we can talk about local eradication of the plant. Note that eradication of large infestations exceeding 1,000 m² may take 3-5 years to achieve.
- Local eradication is possible and can be considered to have been achieved when all plants have been killed and the seed bank has been managed for 7-15 years.

Don'ts

- Research by Advanced Invasives has found acetic acid-based herbicides to be ineffective for Himalayan balsam control.
- Where spread and/or dispersal onto neighbouring land occurs, including as a result of the application of ineffective treatments, both criminal and civil liability may arise.

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Working terms

Key control and management terms, including plant protection product (PPP or herbicide) and IPM system descriptions. Note that the following are working examples – only apply plant protection products (herbicides) and spray enhancers (also known as adjuvants/surfactants) authorised for use in the areas being treated and ensure that product application is in accordance with all label recommendations.

Non-residual selective herbicides:

- Only control broadleaf weeds from time of application

Synthetic auxin examples –

- Phenoxy-carboxylic acids (2,4-D amine)
- Benzoic acids (dicamba)
- Pyridine-carboxylic acids (triclopyr)

Non-residual non-selective herbicides:

- Control broadleaf and grass weeds from time of application

Example –

- Inhibition of EPSP synthase (glyphosate)

Residual selective herbicides:

- Remain in soil controlling broadleaf weed growth

Synthetic auxin example –

- Pyridine-carboxylic acids (aminopyralid)

Residual non-selective herbicides:

- Remain in soil controlling broadleaf and grass weed growth

Example –

- Inhibition of acetolactate synthase ALS – sulfonylurea (flazasulfuron)

Integrated Pest Management (IPM) systems can also be described more specifically based on control method integration:

- Integrated Weed Management (IWM) system – these systems are truly integrated, often combining physical with chemical control methods e.g., Treatment 2 – glyphosate + tap root cutting.
- Integrated Herbicide Management (IHM) system – these systems integrate herbicides only, often with different properties e.g., Treatment 4 – residual + glyphosate.



Appendix 2 – Welsh Government advice sheet: Japanese knotweed

Japanese knotweed



Llywodraeth Cymru
Welsh Government

Scientific name: *Reynoutria japonica* var. *japonica* (previously *Fallopia japonica*)

Other Schedule 9 Species: Dwarf knotweed, Giant knotweed, Bohemian (hybrid) knotweed

What is Japanese knotweed?

Japanese knotweed is the most common of four invasive knotweed taxa present in the UK (Japanese and Dwarf knotweeds being varieties of the same species):

1a Japanese knotweed (*Reynoutria japonica* var. *japonica*)

1b Dwarf knotweed (*R. japonica* var. *compacta*)

2 Giant knotweed (*R. sachalinensis*)

3 Bohemian (hybrid) knotweed (*R. × bohemica*)

Where do invasive knotweeds grow?

Japanese knotweed is able to grow in most (if not all) soil conditions found in the UK, though these species show a strong preference for man-made habitats. Common habitats where invasive knotweeds are found include roadsides, waste ground, railway embankments and cuttings, mine spoil-tips and along rivers and streams.

How do invasive knotweeds spread?

Invasive knotweeds are long-lived (rhizome-forming perennial), competitive dominant plants that spread by direct rhizome (root) growth and from leaf, stem and rhizome fragments of the parent plant. Pieces of rhizome smaller than 1cm in length can grow into a new plant.

Legislation

Because of negative impacts on the UK environment and economy, all invasive knotweeds are listed under Schedule 9 of The Wildlife and Countryside Act 1981 which means it is an offence to plant or cause these plants to grow in the wild. Also, knotweed plant material is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites. Transfer notes shall be kept for each load for a minimum of 2 years.

Identification - Japanese knotweed

What does it look like?

Images A-H below show what Japanese knotweed looks like below and above ground throughout the year.

Where: **A** = dense rhizome (root) growth at 1-2m depth; **B** = detail of rhizome growth; **C** = cross section through living rhizome (note orange colour); **D** = dormant stem buds in early spring; **E** = developing stem buds in spring; **F** = late spring stem growth; **G** = full growth in mid summer; **H** = dead stems during winter dormancy.



Identification - distinguishing between invasive knotweeds

Key identification features

Invasive knotweeds look quite similar, though there are clear differences in the leaves and stems in particular. All invasive knotweed stems have distinctive nodes (stem segments); one leaf is held at each node, attached alternatively upwards along the stem (i.e., the leaves are not paired opposite one another at each node).

Common name	Japanese knotweed	Dwarf knotweed	Giant knotweed	Bohemian (hybrid) knotweed
Height	2-3m in height	Up to 1m in height	Up to 4m in height	2.5-4 m in height
Lower leaf shape & size	 10-15cm long	 Up to 10cm long	 Up to 40cm long	 Up to 25 cm long
Lower leaf description	Broadly oval, flattened at the base – feels quite tough to the touch with a smooth lower side	Broadly oval, flattened at the base – feels quite tough to the touch with a smooth lower side	Broadly oblong, heart-shaped at the base – feels quite delicate with a furry lower side	Intermediate leaf features – lower surface of the leaf often feels quite coarse
Stems	 Red flecking	 Red flecking	 No red flecking	 Some red flecking
Flower colour & growth	 Creamy white, branched	 Creamy white, unbranched	 Greenish white, branched	 Creamy white, branched
Flowering period	August-October	August-October	August-September	August-September

Invasive knotweed lifecycle - control and management

Research

In 2018 Jones et al. published the first set of results from the [world's largest ongoing field-trial on Japanese knotweed control](#).

The research tested a number of methods of chemical and physical (mechanical) control. Results were unable to show that physical methods were effective and that, of the plant protection products currently available, use of the herbicide glyphosate at the time when the plant is most vulnerable to its effects, is the most effective means of controlling invasive knotweeds. Note that the growth stages in the diagram below are approximate and dependent upon invasive knotweed species, weather conditions and altitude.

Importance of the knotweed lifecycle

Timings of invasive knotweed growth stages are shown below along with recommended timings for treatment. Results of the Jones et al. (2018) research found that glyphosate-based herbicides are highly effective only if they are applied from mid-summer into late autumn (depending on the weather). This is when resources start to be drawn down from above ground growth into the rhizome; if these herbicides are applied sooner in the year, herbicide is not transported down into the rhizome and there is little to no impact on above ground growth in subsequent years.

Timing of invasive knotweed growth stages and treatment application												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Growth stages: approximate - species, weather and altitude dependent												
Bud development												
Stem growth												
Green leaves												
Flowering												
Die back												
Dormancy												
Treatment application - glyphosate-based herbicide												
Biannual foliar spray							First spray	Second spray				
Stem injection												
Annual foliar spray												

Don'ts and Do's of knotweed treatment

Note

This list of Don'ts and Do's for knotweed treatment is based on research by Jones et al. (2018).

Don'ts

- Don't consider undertaking knotweed treatment yourself unless you have the appropriate skills and experience. There are anecdotal reports of mortgages being declined as a result of inadequate/poorly undertaken treatment.
- **Don't think there is a quick fix – invasive knotweeds are resilient weeds that cannot be controlled by herbicide in a single year** – any treatment strategy should be long-term and target both the above ground and extensive below ground parts of the plant.
- Don't undertake treatment methods which are ineffective and risk spreading invasive knotweeds further. Physical control methods were shown by Jones et al. (2018) to be the least effective of the treatments tested and were also the most likely to result in further spread. Physical control methods include: cutting using hand tools, strimmer, mower, flail, thrasher; pulling; surface covering with geomembrane/geotextile; composting and burning.
- Don't try digging out the knotweed yourself, it is easy to miss parts of the rhizome and spread it and you cannot dispose of this plant material along with your garden waste – **in fact, it is illegal to do this.**

- **Don't use unsuitable herbicides** – results of the Jones et al. (2018) research showed that of the herbicide products currently available, glyphosate applied at the time when invasive knotweeds are most vulnerable to its effects is the most effective control treatment. Anyone using professional herbicides must hold a recognised professional training certificate.
- Don't use animals to control knotweed by grazing – previous research has shown that this does not control invasive knotweeds.
- Don't try untested methods of control – these do not work, but are likely to make the problem worse.

Contractor accreditations

When looking for a contractor, the following accreditations and registrations are recommended:

- Amenity Forum Membership
- BASIS Professional Register
- BASIS Amenity Training Register
- BASIS Nominated Storekeeper (NSK) Professional Register

Membership of one of the following trade associations is recommended:

- Property Care Association (PCA)
- Invasive Non-Native Specialists Association (INNSA)

Don'ts and Do's of knotweed treatment

Do's

- Ignore the hysteria – Jones et al. (2018) showed that knotweed can be controlled using glyphosate at the right time of year, though this can usually take three to five years.
- For control and management of invasive knotweeds, based on the research by Jones et al (2018), it is recommended to use one of the following control methods:
 1. **Biannual foliar spray** – half of maximum permitted application rate (see product label) applied twice per year.
 2. **Stem injection** – maximum permitted stump treatment application rate (see product label) applied once in the first year of treatment; however, it used significantly (15 times) more herbicide than either foliar spray treatment.
 3. **Annual foliar spray** – maximum permitted application rate (see product label) applied once per year; **performed almost as well as biannual foliar spray and stem injection, but significantly less labour intensive and more sustainable in the long term.**
- Monitoring - check for signs of regrowth and if this appears, seek expert advice. The images below show deformed Japanese knotweed regrowth following treatment with glyphosate-based herbicides.
- **Once knotweed has been effectively controlled using herbicide don't disturb this land by digging, for example, as it is likely to come back; even if the above ground parts of the plant are dead, the below ground rhizome system may not be.**
- If you need to remove knotweed from your land quickly or need to stop it spreading below ground on to neighbouring land, contact a suitably qualified contractor to undertake physical remediation (e.g. installation of barrier membranes).
- **Use the right control methods** – it is an offence to cause invasive knotweeds to grow in the wild and they can cause a private nuisance. This means that allowing actions which cause the spread of knotweed from your land may constitute a criminal offence and/or may give rise to liability under a private nuisance claim.

What does knotweed treated with herbicide look like?

Images I-K below show what deformed Japanese knotweed regrowth looks like following treatment with glyphosate-based herbicides.



Please note that this leaflet is for information only. If you have any specific legal concerns regarding Japanese knotweed, we recommend that you take legal advice.

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Appendix 3 – Welsh Government advice sheet: Giant hogweed

Giant hogweed



Llywodraeth Cymru
Welsh Government

Scientific name: *Heracleum mantegazzianum*

What is Giant hogweed?

Giant hogweed is the most common of two introduced hogweeds present in the UK:

1 Giant hogweed (*Heracleum mantegazzianum*)

2 Persian hogweed (*H. persicum*)

Giant hogweed was introduced to the UK from southwest Asia, while Persian hogweed was introduced from the Middle East. Sosnowsky's hogweed (*H. sosnowskyi*) originating in southwest Asia has not been reported in the UK to date but is widespread in continental Europe. Where Giant hogweed and native Hogweed (*H. spondylium*) grow in close proximity, hybrids have occasionally been reported in the UK.

Where does Giant hogweed grow?

Initially a garden escape in the UK, Giant hogweed spread rapidly along watercourses, colonising damp ground and wasteland. Subsequently, Giant hogweed has invaded secondary habitats, including roadsides, railway embankments, amenity areas and field margins.

How does Giant hogweed spread?

Rapid spread is the result of exceptionally high seed production and germination rates: each plant can produce 20,000-100,000 seeds, over 90% of which may germinate. Most seed (60-90%) is shed directly around the mature plant (up to 5m away) and here, self-thinning may result in just 1-2% of seedlings surviving. However, a significant proportion of seed is also spread indirectly by people (e.g. roadside slipstreams) and natural processes (e.g. river flow, attached to animals), avoiding seedling competition and establishing successfully.

Legislation

Because introduced hogweeds are toxic to people and animals and due to the negative impacts of Giant hogweed on the UK environment and economy, Giant, Persian and Sosnowsky's hogweeds are listed as species of special concern under retained European Union (EU) law. This means it is an offence to plant or cause these plants to grow in the wild, or intentionally release them into the environment. Schedule 4 of the Invasive Alien Species (Enforcement and Permitting) Order 2019 removes plants listed under the EU IAS Regulation from Schedule 9 of The Wildlife and Countryside Act 1981, although the same offence applies. Also, Giant hogweed plant material (including soil contaminated with seeds) is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites. Transfer notes shall be kept for each load for a minimum of 2 years.

Why control Giant hogweed?

Giant hogweed flowers once and then dies (monocarpic), though it may take from two to twelve seasons to produce flowers (biennial/perennial), depending on light, nutrient and water availability. Typically, more seeds are produced when growing conditions are optimal. In the first year of growth, seeds germinate and grow rapidly above ground and accumulate resources below ground in a deep tap root. The plant can form dense, competitive ground cover restricting native plant access to space and light. When flowering, Giant hogweed is among the tallest perennial herbs in Europe reaching up to 5.5 m tall in full growth.

Giant hogweed produces phytotoxins (poisons of plant origin) such as furanocoumarins which are contained in all parts of the plant to deter insect predators in the native range. **When phytotoxins come into direct contact with the skin of mammals (particularly people and some herbivores) and the contact area is exposed to direct light, blistering and scarring results (phytophotodermatitis);** this may recur for several years following exposure.

Giant hogweed competitive growth therefore has significant human health implications, in addition to negative ecological and socioeconomic impacts which include:

- **Human and animal health (agriculture)** – phytotoxins cause photodermatitis in people and some livestock.
- **Reduced habitat availability and quality** – reduction of native plant diversity.
- **Habitat alteration and degradation** – direct negative impacts upon terrestrial and freshwater food webs, particularly via siltation of watercourses.
- **High management costs** – estimated at approximately £2.4 million per annum UK-wide.
- **Limited soil binding capacity** – following dormancy/death of Giant hogweed in late autumn, few native plants remain to protect the soil surface from heavy rainfall in the winter and spring months, increasing erosion risk.
- **Access restriction** – amenity areas such as riverbanks may become inaccessible due to uncontrolled growth and safety concerns.
- **Litigation** – where spread and/or dispersal onto neighbouring land occurs (e.g. as a result of the application of ineffective treatments) **both criminal and civil liability may arise.**

Identification - Giant hogweed

What does it look like?

Images A-G below show what Giant hogweed looks like throughout the year.

Where: **A** = seedlings and immature (first year) plants in spring; **B** = mature (second year onwards) basal leaf growth in summer, showing deep incisions (sharply divided lobes), serrations and spiked ends; note dense growth which excludes native plant species from early in the growing season; **C** = hollow stem showing red/purple/brown blotches (blotches may rarely be continuous) and sharp bristles (5-10cm diameter at maturity); **D** = mature basal leaf growth with developing flower stems in summer (plant height c.1m); **E** = mature flowering plant showing flower stem (height c.3.5m) and large flower head (umbel; insect pollinated; can self-pollinate; 1m diameter) containing thousands of small flowers; note large dark green leaves (c.2m long) with deep incisions (sharply divided lobes), serrations and spiked ends; **F** = dead flower stems and seed heads (umbels) in summer surrounded by immature seedlings and mature plants that have developed from seed produced in previous growing seasons; **G** = bank of watercourse in spring (note dead stems, emergent hogweed growth and limited native plant cover). Note that all parts of the Giant hogweed plant (including the seeds) have a strong resinous smell. Please see below for full image acknowledgements and copyright information.

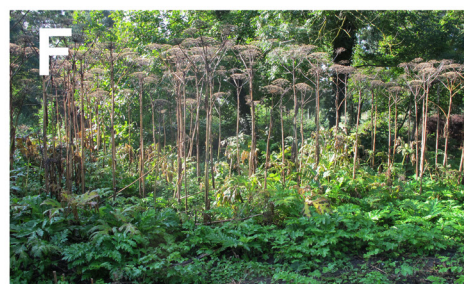


Image acknowledgements (this page and following page)

Images A, D & G: courtesy of Brian Taylor (© The Knotweed Company 2021); Image E: courtesy of Gethin Bowes (© Caerphilly CBC)

Persian hogweed leaf: courtesy of Asgarpanah et al. (2012) – link: <https://academicjournals.org/journal/JMPR/article-abstract/590FF9632220>



Identification - distinguishing between invasive and native hogweeds

Key identification features

Giant hogweed plants in flower are quite unmistakable. However, immature (first year) and mature plants (second year onwards) subject to natural disturbance (e.g. trampling) and control methods (e.g. cutting, herbicides) may be quite similar in appearance to the UK native Hogweed (*H. sphondylium*). Where Giant hogweed and native Hogweed grow in close proximity, hybrids have occasionally been reported (*Heracleum mantegazzianum* × *Heracleum sphondylium*) with intermediate characters. Persian hogweed (*H. persicum*) is included here for reference. Note that measurements not in brackets are sizes commonly achieved; those in brackets are occasionally observed.

Common name	Giant hogweed	Persian hogweed	Hogweed (native)
Height	Up to 3.5(5.5)m in height	1.5-3.0m in height	Up to 2.0(3.0)m in height
Lower leaf shape & size	 2.5(3)m long	 Up to 2m long	 <0.6m long
Lower leaf description	Pinnate to ternate leaves with deep incisions (sharply divided lobes), serrations and spiked ends; dark green at maturity	Pinnate to ternate leaves with deep incisions (sharply divided lobes), serrations and spiked ends (less pronounced than Giant hogweed leaves); dark green at maturity	Pinnate lobed leaves; grey-green at full maturity
Leaf stem diameter	5-10cm	1-2cm	1-2cm
Flower head (umbel) diameter	>40cm	>40cm Note that flower head is more 'domed' than that of Giant hogweed	Up to 15(30)cm
Flowering period	June-August	June-August	June-August

Giant hogweed lifecycle - control and management

Project planning & biosecurity

Invasive plant management programme goal setting, health & safety, biosecurity and survey information is provided in detail in the Welsh Government document [Information for community and voluntary groups in Wales: Practical control of Japanese knotweed](#). **Note that health & safety and biosecurity considerations are especially important for Giant hogweed as the plant is toxic and in contrast with Japanese knotweed, all spread is via small seeds. Avoid direct contact with any part of the plant and always wear gloves, long sleeved shirts and long trousers when working near Giant hogweed plants.**

Research

European and North American field trials have been conducted to determine which control methods work for Giant hogweed control. Effective findings from this research are summarised below in the context of the Giant hogweed lifecycle and Integrated Pest Management (IPM) system management programmes. Key control and management terms, including plant protection product (PPP or herbicide) descriptions are provided in Annex 1 and full details of the international research findings are provided in Annex 2.

Giant hogweed lifecycle - control and management

Importance of the Giant hogweed lifecycle

It is important to understand the lifecycle of Giant hogweed in order that individuals and populations can be managed effectively. Most of the time, when Giant hogweed is located and scheduled for treatment a population will already have established containing individuals at a range of growth stages (seedling, immature and mature), with an associated seedbank in situ. Consequently, initial management recommendations should account for this population structure, though as management progresses and the invasive plant population and seed bank are depleted, management will increasingly focus on isolated individuals.

Control of the Giant hogweed seedbank is essential for the effective, long-term management of the plant: in autumn following flowering and seed release, there may be up to 12,000 seeds per m². Seed is understood to be viable for 7-12 years, though there are no definitive studies of seed longevity. 95% of the seed is concentrated in the top 5cm of the soil profile; however, as seed production is prolific (up to 100,000 seeds per plant), the remaining 5% present in lower soil layers represents a significant quantity of seed. High seed production and germination rates (more than 90%) result in early growing season seedling densities of several thousand per m², though only 1-2% of these establish as immature plants in the first year of growth. To achieve effective management of invasive plants which spread rapidly by seed, flowering must be prevented for several years to deplete the soil seed bank. The quicker that depletion is achieved, the fewer treatments will be required in the longer-term, reducing overall project costs, herbicide use and CO₂ emissions. **Given the extended viability of Giant hogweed seed, it is recommended that management programmes are planned for a minimum of 10 years.**

Evidence-based recommendations provided below draw on international field research combined with biological understanding of Giant hogweed (i.e., lifecycle processes).

Recommendations are further supported through consultation with expert practitioners who have worked extensively with this invasive plant in the UK and Ireland. Timings of Giant hogweed growth stages are shown below along with recommended treatment timings. It is recommended that chemical and physical control methods must be applied three times per year to ensure that no seed is set; where this is not achieved, population recovery and management failure will result. Note that the growth stages in the diagram below are approximate and dependent upon weather conditions and altitude. Also note that the earlier in the growing season that control methods are applied, the less likely that Giant hogweed plants will reach maturity, flower and set seed – **do not leave treatment too late in the growing season as time and resources will be wasted and inter-season management will be ineffective. Also note that management of the population at an early stage of establishment will be easier and more labour- and cost-effective.**

Full treatment specifications

One physical and three Integrated Pest Management (IPM) systems are recommended for the effective and sustainable management of Giant hogweed over 10 years. Treatment specifications are suitable for the management of Giant and Persian hogweeds. **Note that seed germination occurs through to the autumn and in the first years of a management programme, the density of the plant population and seed bank may be reduced more quickly by targeting these late germinating seedlings with glyphosate-based herbicides. Always follow the information on the herbicide product label and do not exceed the specified dose on the label.** Ensuring all mature plants are killed by June is difficult in large infestations and some plants may flower. Historically, seed heads were removed and stored in a plastic bag prior to disposal; this is not recommended here due to health & safety and biosecurity considerations.

[illegible]

Giant hogweed - treatment specifications

Treatment 1: Physical management system - Tap root cutting

- **Use near water:** Yes
- **Frequency:** Cutting three times per year, all years of treatment
- **Herbicide:** N/A
- **Method:** Cutting taproot below ground using a spade or specialist equipment at least 15cm below the lowest leaves (basal rosette); plants cut above this may continue to grow, flower and set seed.
- **Rate:** N/A
- **Timing:** Apply all three control methods between February and June. Undertake the first cut between February and April, the second cut in April/May and the third cut in May/June.

Treatment 1: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Integrated Pest Management (IPM) system - Tap root cutting												
Cutting 1 st treatment												
Cutting 2 nd treatment												
Cutting 3 rd treatment												

Treatment 1: Notes

- **Only use on individual plants and smaller stands (<200 individuals).**
- **Aim to undertake all treatments as early as possible to minimise flowering and seed production. Note that viable seed can be produced on intact flower heads following tap root cutting later in the growing season (plant resources permitting).**
- Additional equipment requirement: spades and/or specialist hand cutting equipment, rakes, forks and wheelbarrows.
- Ensure good waste management processes are agreed before beginning this treatment method as waste will be generated. Create access routes and disposal areas away from water to prevent waste piles containing soil and seed from previous growing seasons being washed downstream during flooding. **Do not dispose of any waste material in general compost.**
- Giant hogweed plant material (including soil contaminated with seeds) is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites; **do not move any Giant hogweed plant material and/or soil waste generated by management from the area where it was produced.**
- Check waste piles periodically for any plants re-rooting, as these may flower and seed.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Higher labour requirements compared with other IPM system treatments recommended.
- Giant hogweed herbicide resistance development is not relevant.



Giant hogweed - treatment specifications

Treatment 2: Integrated Pest Management (IPM) system - Glyphosate + tap root cutting

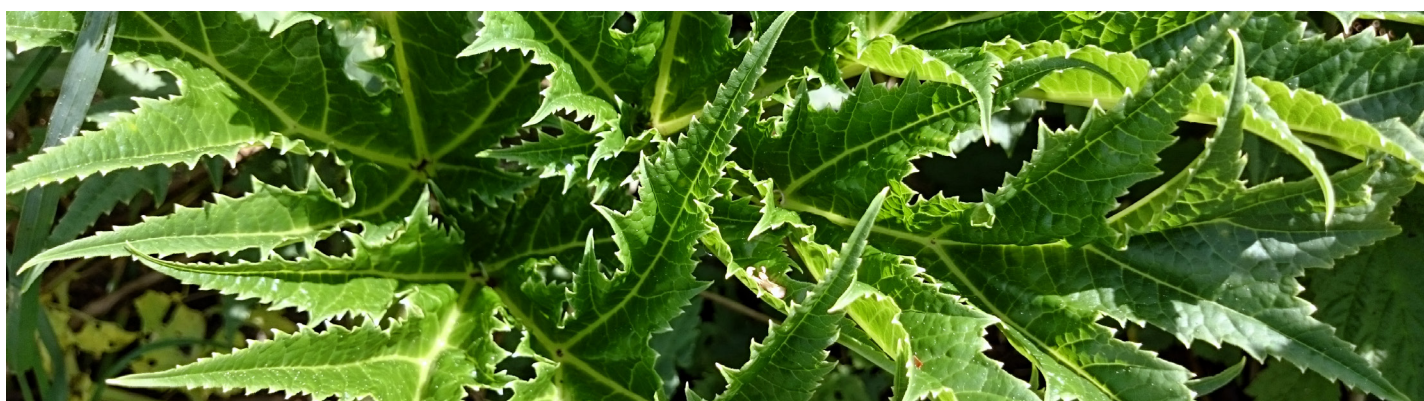
- **Use near water:** Yes
- **Frequency:** Glyphosate twice per year, cutting once per year, all years of treatment
- **Herbicide:** Glyphosate
- **Method:** Foliar spray using hand-held, knapsack or large volume sprayers preferably with a long lance – weed wiping may also be suitable; Cutting taproot below ground using a spade or specialist equipment at least 15cm below the lowest leaves (basal rosette); plants cut above this may continue to grow, flower and set seed.
- **Rate:** Half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all three control methods between February and June. Undertake the first glyphosate application between February and April and the second glyphosate application in April/ May. Cutting of remaining Giant hogweed plants should be undertaken in May/June, one month after the final herbicide treatment and before seed production.

Treatment 2: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Integrated Pest Management (IPM) system - Glyphosate + tap root cutting												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												
Cutting												

Treatment 2: Notes

- Apply from February onwards when Giant hogweed seedlings and established plants are actively growing, and monthly rainfall (precipitation) is declining.
- Note that where glyphosate herbicide is applied as a 'spot treatment' to scattered patches of individuals (as opposed to 'blanket spraying' of large, dense areas of growth) this herbicide can be used three times (i.e., in place of tap root cutting) where herbicide application does not exceed the specified dose on the herbicide product label. Check with the manufacturer of the product if required.
- **Aim to undertake all treatments as early as possible to minimise flowering and seed production. Note that viable seed can be produced on intact flower heads following tap root cutting later in the growing season and ineffective herbicide application.**
- Additional equipment requirement: spades and/or specialist hand cutting equipment, rakes, forks and wheelbarrows.
- Ensure good waste management processes are agreed before beginning this treatment method as waste will be generated. Create access routes and disposal areas away from water to prevent waste piles containing soil and seed from previous growing seasons being washed downstream during flooding. **Do not dispose of any waste material in general compost.**
- Giant hogweed plant material (including soil contaminated with seeds) is a 'controlled waste' under the Environmental Protection Act 1990 which means it can only be transported by a registered waste carrier to suitably permitted or exempt sites; **do not move any Giant hogweed plant material and/or soil waste generated by management from the area where it was produced.**
- Check waste piles periodically for any plants re-rooting, as these may flower and seed.
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Higher labour requirements and CO₂ emissions than herbicide-based IPM systems.
- Giant hogweed herbicide resistance development should be considered, ensure total within-season control of whole population.



Giant hogweed - treatment specifications

Treatment 3: Integrated Pest Management (IPM) system - Selective + glyphosate

- **Use near water:** No
- **Frequency:** Selective once per year, glyphosate twice per year, all years of treatment
- **Herbicide:** Selective (e.g. triclopyr) + glyphosate
- **Method:** Foliar spray using hand-held, knapsack or large volume sprayers preferably with a long lance.
- **Rate:** Selective herbicide at full (maximum permitted) application rate (see product label), once per year; glyphosate at half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all three control methods between February and June. Undertake the selective application between February and April. Undertake the first glyphosate application in April/May and the second glyphosate application in May/June.

Treatment 3: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Integrated Pest Management (IPM) system - Selective + glyphosate</i>												
Selective												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												

Treatment 3: Notes

- Apply from February onwards when Giant hogweed seedlings and established plants are actively growing, and monthly rainfall (precipitation) is declining.
- **Aim to undertake all treatments as early as possible to minimise flowering and seed production. Note that viable seed can be produced following ineffective herbicide application.**
- This IPM system has the advantage of controlling Giant hogweed seedlings early in the growing season while retaining the grass sward as selective herbicides only control broadleaf weeds from the time of application.
- Selective herbicides may not kill mature Giant hogweed plants later in the growing season (May/June onwards).
- Glyphosate-based herbicides work more slowly and are less effective when plants reach full maturity later in the growing season (June onwards); earlier treatments are strongly recommended. **Note that the 2nd glyphosate application window is targeted at controlling late germinating plants and plants which have escaped previous treatments.**
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Lower labour requirements and CO₂ emissions than IPM systems incorporating physical treatments.
- Giant hogweed herbicide resistance development should be considered, ensure total within-season control of whole population.



Courtesy of Gethin Bowes

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Giant hogweed - treatment specifications

Treatment 4: Integrated Pest Management (IPM) system - Residual + glyphosate

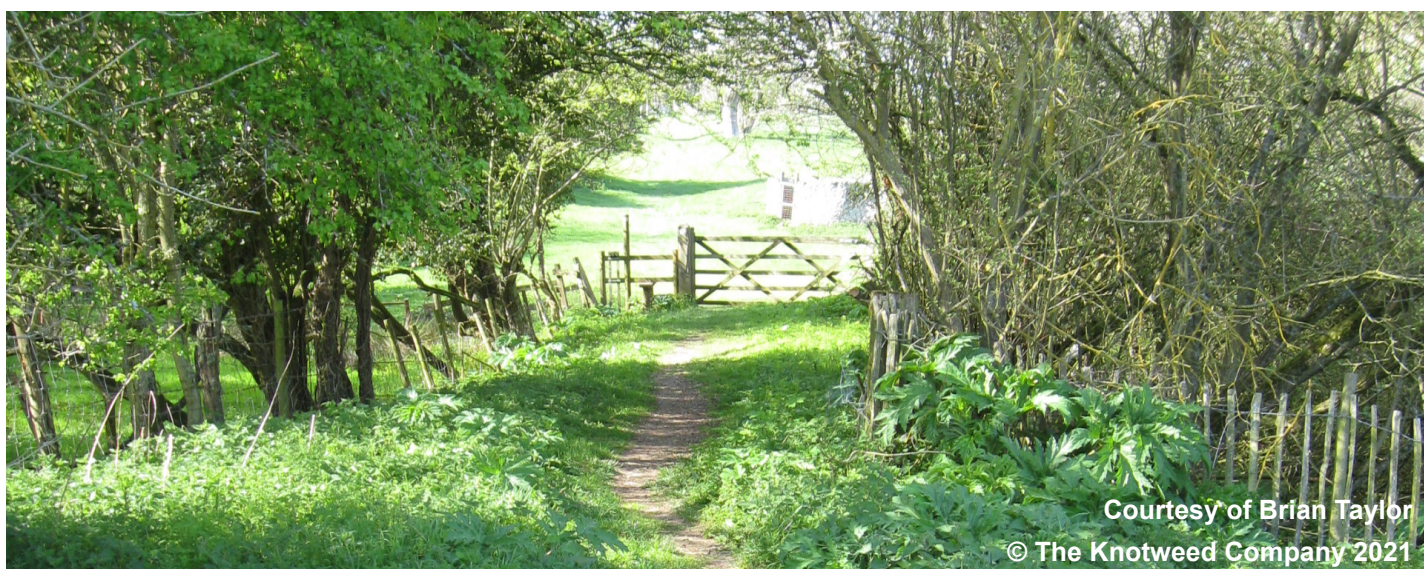
- **Use near water:** No
- **Frequency:** Residual once per year, glyphosate twice per year, all years of treatment
- **Herbicide:** Residual (e.g. flazasulfuron) + glyphosate
- **Method:** Soil and foliar spray using hand-held, knapsack or large volume sprayers preferably with a long lance.
- **Rate:** Residual herbicide at full (maximum permitted) application rate (see product label), once per year; glyphosate at half of maximum permitted application rate (see product label), twice per year.
- **Timing:** Apply all three control methods between February and June. Undertake the selective application between February and March. Undertake the first glyphosate application between April and May and the second glyphosate application in May/June.

Treatment 4: Control method application timings. Where: green = 1st application; blue = 2nd application; red = 3rd application.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Integrated Pest Management (IPM) system - Residual + glyphosate</i>												
Residual												
Glyphosate 1 st treatment												
Glyphosate 2 nd treatment												

Treatment 4: Notes

- Apply from February onwards when Giant hogweed seedlings and established plants are actively growing, and monthly rainfall (precipitation) is declining.
- **Aim to undertake all treatments as early as possible to minimise flowering and seed production. Note that viable seed can be produced following ineffective herbicide application.**
- This IPM system has the advantage of controlling Giant hogweed populations more quickly than other recommended treatments as residual herbicides provide long-term control of seedlings. Residual herbicides should only be applied over the whole control site for 2 years; once the population is under effective management, treatment using these herbicides can be targeted more precisely in areas where it is known that there is a dense seed bank remaining in situ. This approach will maximise recovery of native plants (limiting potential for control site recolonisation by invasive plants). Note that this IPM system emits less CO₂ than other treatments and uses less herbicide over the whole treatment lifecycle than other IPM systems.
- Residual herbicides do not kill mature Giant hogweed plants; early application is required to control a high proportion of seed germinating early in the growing season.
- Glyphosate-based herbicides work more slowly and are less effective when plants reach full maturity later in the growing season (June onwards); earlier treatments are strongly recommended. **Note that the 2nd glyphosate application window is targeted at controlling late germinating plants and plants which have escaped previous treatments.**
- Clean down equipment in a designated wash down area (away from water) prior to moving offsite.
- Lower labour requirements and CO₂ emissions than other physical and IPM systems.
- Giant hogweed herbicide resistance development should be considered, ensure total within-season control of whole population.



Do's and Don'ts of Giant hogweed treatment

Do's

Improve your Giant hogweed control results by thinking about the following:

- Always follow the information on the herbicide product label and do not exceed the specified dose on the label.
- Always ensure those who are using plant protection products (herbicides) have the necessary qualifications to do so and consider using specialist contractors. **Details of operator and contractor accreditation information is provided in the Welsh Government document [Information for community and voluntary groups in Wales: Practical control of Japanese knotweed](#).**
- **Timing** – the key to controlling Giant hogweed is preventing it from seeding and depleting the seed bank; act early in the growing season to reduce labour and herbicide requirements later in the growing season when the plants are larger.
- **Coverage** – good coverage means getting a little herbicide onto most of the leaves – this can be achieved by continually moving the spray lance as the herbicide is applied. **You do not need to excessively apply herbicide(s) to get good results.** Attention to detail (operator performance) is critical. Apply residual herbicides to the soil surface in advance of germination and ensure even soil coverage.
- **Spray retention** – spray enhancers (also known as adjuvants/surfactants) help you to make each application count. Adjuvants improve control results by sticking the herbicide to the leaf – this allows the herbicide to absorb better and the adjuvant protects the herbicide from being washed off by unexpected rainfall.

- **Herbicide absorption** – use water conditioners to get the best performance from your glyphosate products. Glyphosate can stick to salts in water and this stops some of the herbicide working properly. Water conditioners remove salts from the water, before you mix in your glyphosate product.
- **Use the right tools for the job** – think about which of the recommended treatments will work best using the least herbicide and labour.
- **Monitoring & eradication** – check for signs of seedling growth and regrowth from older plants (i.e., from taproots) in subsequent years. Local eradication is possible and can be considered to have been achieved when all plants have been killed and the seed bank has been managed for 7-15 years. Note that eradication of large infestations exceeding 200 mature individuals may take more than 10 years to achieve.

Don'ts

- Research by Advanced Invasives has found acetic acid-based and pelargonic acid-based herbicides to be ineffective for Giant hogweed control.
- Where spread and/or dispersal onto neighbouring land occurs, including as a result of the application of ineffective treatments, both criminal and civil liability may arise.

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- Brian Taylor, Director at The Knotweed Company Ltd

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Working terms

Key control and management terms, including plant protection product (PPP or herbicide) and IPM system descriptions. Note that the following are working examples – only apply plant protection products (herbicides) and spray enhancers (also known as adjuvants/surfactants) authorised for use in the areas being treated and ensure that product application is in accordance with all label recommendations.

Non-residual selective herbicides:

- Only control broadleaf weeds from time of application

Synthetic auxin examples –

- Phenoxy-carboxylic acids (2,4-D amine)
- Benzoic acids (dicamba)
- Pyridine-carboxylic acids (triclopyr)

Non-residual non-selective herbicides:

- Control broadleaf and grass weeds from time of application

Example –

- Inhibition of EPSP synthase (glyphosate)

Residual selective herbicides:

- Remain in soil controlling broadleaf weed growth

Synthetic auxin example –

- Pyridine-carboxylic acids (aminopyralid)

Residual non-selective herbicides:

- Remain in soil controlling broadleaf and grass weed growth

Example –

- Inhibition of acetolactate synthase ALS – sulfonylurea (flazasulfuron)

Integrated Pest Management (IPM) systems can also be described more specifically based on control method integration:

- Integrated Weed Management (IWM) system – these systems are truly integrated, often combining physical with chemical control methods e.g., Treatment 2 – glyphosate + tap root cutting.
- Integrated Herbicide Management (IHM) system – these systems integrate herbicides only, often with different properties e.g., Treatment 4 – residual + glyphosate.

Giant hogweed control and management research

This annex provides details of Giant hogweed control and management research, presented in the context of Integrated Pest Management (IPM) system management programmes.

Physical (mechanical)

Tap root cutting and excavation by hand and/or powered equipment can be highly effective for Giant hogweed management. However, excavation by hand and/or powered equipment in particular pose a safety risk to volunteers and/or contractors, may spread Giant hogweed and are associated with high labour costs and carbon dioxide (CO₂) emissions. Further, excavators cannot be used on riverbanks, where Giant hogweed is often found (Tiley et al. 1996; CEH 2004, Nielsen et al. 2005, Page et al. 2005, Klima & Synowiec 2016).

Biological control

Biological control involves the use of living organisms to manage invasive plants and animals. No host-specific biocontrol agent has been found for Giant hogweed. Grazing, which is a form of non-specific biocontrol, is an effective management method. However, it should not be used as Giant hogweed sap causes blistering and scarring (phytophotodermatitis) in some livestock, may spread the plant further and is not suitable for many areas where Giant hogweed grows (stocking may be problematic; Nielsen et al. 2005, Klingenstein 2007).

Chemical control (plant protection products; PPPs)

Selective (e.g. triclopyr), non-selective (glyphosate) and/or residual herbicides (e.g. flazasulfuron) provided highly effective control of treated plants. Glyphosate applied at half of maximum permitted application rate (see product label) and residual herbicides (flazasulfuron) were most effective at killing Giant hogweed (100%), while selective herbicides (triclopyr, clopyralid) provided between 80-100% control at the maximum permitted application rate. Note that there was no significant difference in control efficacy between selective and glyphosate-based herbicides applied as a foliar spray or using a weed wiper; however, weed-wiping is significantly more labour-intensive. For all herbicides applied as foliar sprays, spray enhancers (also known as adjuvants/surfactants) increased herbicide efficacy between 5-20% (Caffrey 1999, Caffrey 2001, CEH 2004, Nielsen et al. 2005, Page et al. 2005, Meinschmidt & Dittrich 2007, Klima & Synowiec 2016).

Caffrey 1999, Caffrey 2001 and Klima & Synowiec 2016 all recommend three physical and/or chemical treatments per year, accounting for seedling germination, establishment and flowering within the Giant hogweed population under management.