NOBANIS - Invasive Alien Species Fact Sheet

Heracleum mantegazzianum

This fact sheet is based on: "The Giant Hogweed Best Practice Manual. Guidelines for the management and control of an invasive weed in Europe", edited by Charlotte Nielsen, Hans Peter Ravn, Wolfgang Nentwig and Max Wade 2005 within the "Giant Alien Project" financed by the European Commission (2002-2005), published by Forest and Landscape Denmark, Hørsholm, ISBN: 87-7903-209-5 - - Compiled by: Frank Klingenstein, Federal Agency for Nature Conservation, Konstantinstr. 110, DE-53179 Bonn, Germany; ++49(0)228/8491-264; frank.klingenstein@bfn.de

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Species description

Scientific name: *Heracleum mantegazzianum* SOMMIER AND LEVIER (1895), Apiaceae
Synonyms: *Heracleum tauricum* STEVEN, *Heracleum caucasicum* STEVEN, *Heracleum giganteum* HORNEM., *Heracleum panaces* WILLD. EX STEVEN, *Heracleum pubescens* (HOFFM.) M. BIEB., *Heracleum speciosum* WEINM., *Pastinaca pubescens* (HOFFM.) CALEST., *Sphondylium pubescens* HOFFM. The species is closely related and quite similar to *Heracleum sosnowskyi* MANDEN and *Heracleum persicum* DESF. and their taxonomy is not fully clarified yet.
Common names: Giant hogweed (GB), Giant cow parsnip (US, CA), Riesen-Bärenklau, Herkulesstaude (DE), Kæmpe-Bjørneklo (DK), Hiid-karuputk (EE), Kaukaasianjättiputki (FI), Berce de caucase (FR), Tröllahvönn, Bjarnarkló (IS), Mantegaco barštis (LT), Mantegaci latvānis (LV), Reuzenberenklauw (NL), Kjempebjønnkjeks (NO), Barszcz Mantegazziego (PL), Jättefloka, Jättebjörnloka, Kaukasisk jättefloka (SE).

Fig. 1. Population of *Heracleum mantegazzianum*, photo by Klaus Adolphi, Köln

Fig. 2 and 3. Leaves and sub-umbel, photos by Uwe Starfinger, Berlin

Species identification
H. mantegazzianum is among the largest herbs in Europe, usually growing 2-3 m (but up to 4-5 m) high. Its size is therefore the most distinct characteristic of *H. mantegazzianum*. Stems are usually 5-10 cm in diameter and are often purple spotted or continuously purple. Leaves of mature plants are divided to a varying extent either into three approximately equal parts which may themselves be similarly divided or divided into more than three leaflets arranged in rows along the central leaf stalk. Leaves can grow up to 3 m in length. White or rarely pinkish flowers are clustered in an umbrella-shaped head (umbel) that is up to 80 cm across. Each compound umbel has 30-150 rays. A total of more than 80,000 flowers can occur on a single plant. Flowering typically lasts from June to August. The green oval (elliptic) fruits form by July then turn dry and hay-coloured with swollen brown oil canals. *H. mantegazzianum* is a monocarpic plant (*i.e.* it dies after flowering). Like all tall hogweeds it contains phototoxic sap. (All the above information is from Nielsen *et al.* 2005.)

Native range
The native range of *Heracleum mantegazzianum* is the western Caucasus region.

Alien distribution

History of introduction and geographical spread
The first record of introduction derives from Great Britain in 1817, when *H. mantegazzianum* was recorded on the seed list at Kew Botanic Gardens, London. In 1828, the first natural population was recorded, growing wild in Cambridgeshire, England. Soon after, the plant began to spread rapidly across Europe (*e.g.* Pyšek 1991 for the Czech Republic). Of the 19 countries for which historical data are available, 14 countries (74%) have first records of the plants presence before 1900 (*e.g.* Sweden: first record 1894 in Östergötland), two have first records between 1900 and 1960 and the remaining three countries after 1960. (All the above information is from Nielsen *et al.* 2005.) In Latvia *H. mantegazzianum* was introduced the first time in 1932 as an ornamental plant in parks and gardens (Bērziņš et al. 2003) from where it did not escape to the wild yet. In Estonia the species was first mentioned in 1814 in the list of seeds of Tartu University botanical garden. The oldest remained herbarium example is from 1883 from Sindi (SW Estonia) (Kull *et al.* 2005, Holm 2004, B. Holm, pers. comm).

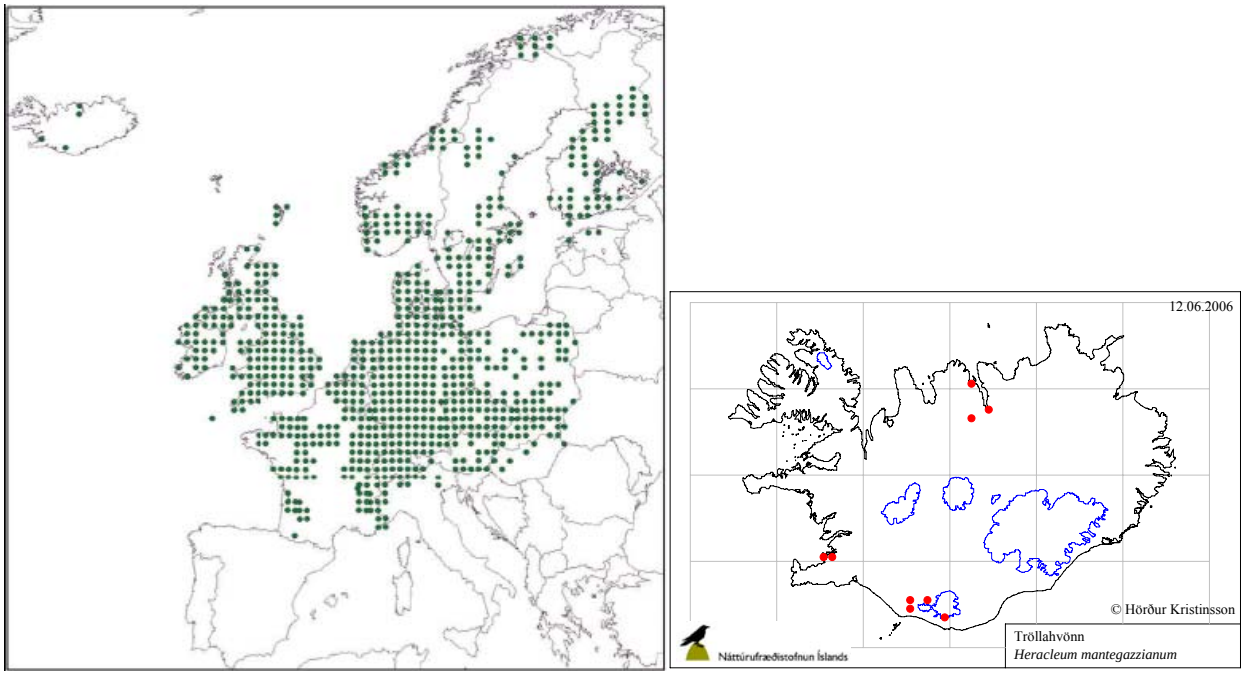

Fig. 4. Current distribution of *H. mantegazzianum* in Europe. Distribution data for Norway and France is based on presence or absence at county/department level. An updated map for Norway may be found in Fremstad and Elven 2006. As a result the illustrated distribution in these areas may over-represent the actual distribution (Nielsen *et al.* 2005)
Fig. 5. Detailed distribution of H. mantegazzianum in Iceland (Source: Icelandic Institute of Natural History (Náttúrufræðistofnun Íslands), Flora of Iceland database)

Pathways of introduction
The main mechanism of introduction into Europe, accounting for the first records in most of western and northern Europe, was as an ornamental curiosity. Seeds were gratefully received and planted in botanic gardens and the grounds of important estates. The species became an exclusive garden plant, where seeds were also exchanged between garden lovers. With the time, it became a decorative plant cultivated in many gardens and parks in the whole of Western, Central and Eastern Europe (Vinogradova 2004). Moreover, seeds were often spread by bee keepers due to the numerous flowers. The use as garden plant declined and awareness of bee keepers increased, after warnings about the danger of the plant appeared in scientific literature and public sources since the middle of the 1900s. In the Baltic, Central, Western and Eastern areas of East Europe it is also used as a fodder plant (Vinogradova 2004) (*e.g.* in Estonia the species was used as a silage plant and even in late 1980s propagated as a good fodder plant; Heinsoo *et al.* 1986, Kull *et al.* 2005, Holm 2004).

Today the species is still available in garden shops and planted in some places (*e.g.* listed by the Royal Horticultural Society of Great Britain until 2002; RHS 2004). From the sites where it has been introduced intentionally, it has spread unintentionally by seeds, garden rubbish and contaminated soil.

Alien status in region
H. mantegazzianum is established in nearly every Nordic and Baltic country except Russia and Latvia, where it is found only in parks and invasion of natural habitats has not yet been observed (Gavrilova 2003), although the distribution is still uncertain (Gavrilova and Roze 2005). For the

European Russia, the species, as well as *H. sosnowskyi* Manden., but much less often, can be met in all areas of the temperate zone (Tikhomirov 2006). *E.g.* for the center of the Leningrad region, this species is indicated as feral and seldom in settlements, on fringes of fields and along roads (Tsvelev 2000). The species is also recorded in Kiev (Ukraine) (Mosyakin and Yavorska 2002). See also table 1. In Lithuania it is not recorded, but is expected to be found, because for some time the species was cultivated in the Kaunas Botanic Garden and some gardeners obtained seeds from various sources (Zigmantas Gudžinskas; pers. comm. 2006). In NE Poland this species may be misidentified. Within Europe, the earliest established populations are found in Great Britain, Ireland and Central Europe (north- and mid western France, Switzerland, Luxemburg, Belgium, Netherlands, Germany, Denmark, Czech Republic, Slovakia).

	Not found	**Not established**	**Rare**	**local**	**Common**	**Very common**	**Not known**
Denmark					X		
Estonia			X				
European part of Russia			X				
Finland				X			
Faroe Islands	X						
Germany					X		
Greenland							X
Iceland			X				
Latvia	X						
Lithuania	X						
Norway				X			
Poland				X			
Sweden				X			

Table 1. The frequency and establishment of *Heracleum mantegazzianum*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** - The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** - No information was available.

Ecology

Habitat description

H. mantegazzianum is in its native areas a plant of forest edges and glades, often growing along stream-sides, in mountain areas with annual rainfall between 1000 and 2000 mm per year and a temperate, continental climate of hot summers and cold winters (CABI 2004).
In its alien range it needs rich soils with sufficient water supply, *e.g.* abandoned fresh meadows, unused and often disturbed fringes along roads, railways, rubbish dumps and waste ground, and if conditions are sufficiently humid, along watercourses and on river banks (Tiley *et al.* 1996).

Reproduction and life cycle

Giant Hogweed plants do not reproduce vegetatively and rely exclusively on reproduction by seed. Usually they die after bearing seeds once. They persist in a rosette stage and usually flower in their third to fifth year. Under unfavourable conditions, such as on nutrient poor, shaded or dry sites or

when regularly grazed, flowering is postponed until sufficient reserves have been accumulated. Given such conditions, plants can live for at least 12 years. The above ground parts of the plant die in September/October and growth begins again from March. Plants destined to flower begin growth early, in January, and have more erect leaves. Stem elongation is apparent in April/May. The terminal bud, sheathed in bracts, appears in June and flowers are open from June to August, but mainly in July (CABI 2004).

Flowers are visited and probably pollinated by a wide range of insects, including a number of Hymenoptera and Diptera and at least one Coleoptera (Tiley *et al.* 1996). Flowers are insect-pollinated and hermaphrodite (having both male and female parts in the same flower) but seeds produced by self-pollination are also viable. This means that even a single plant is capable of founding a new population.

In central Europe, plants flower from mid June to late July and seeds are released from late August to October. An average plant bears about 20,000 seeds (almost half of them on the terminal umbel), but individual plants with over 100,000 seeds have been reported. Most of the seeds are able to germinate, and the reproductive potential of the plant is therefore enormous.

Seeds mature in a short-term persistent seed bank (in autumn up to 12,000 living seeds/ m^2 in dense stands). The majority of seeds (95%) are concentrated in the upper 5 cm soil layer. The breaking of dormancy is required over winter (two months at 2-4°C are sufficient) and in spring there are on average more than 2,000 living seeds/ m^2. Seeds germinate very easily and after germination of the short-term persistent seed bank in spring, the seed bank only contains about 200 living seeds/ m^2 in the summer. These remain dormant and about 8% survive in the soil for more than one year and about 5% survive for two years. It is not yet known how long seeds can survive in the soil, but at least five years seems to be realistic.

Seedlings reach high densities up to several thousands/m^2 early in spring and although 98% of seedlings die the surviving plants create populations with an almost complete cover of large leaf rosettes in the following years. On average about 10% of plants flower and complete their life cycle, while the remainders survive in the rosette stage to the next year.

Several pathogen mycobiota (Seier *et al.* 2003) and at least 34 arthropod species (Burki and Nentwig, 1998) are associated with *H. mantegazzianum* in its native range. (All the above information based on Nielsen *et al.* 2005.)

Dispersal and spread

The majority of seeds are released close to the parent plants, 60-90% of seeds fall to the ground within a radius of 4 m of the parent plant. Only a few seeds are spread into more distant surroundings, *e.g.* with stronger wind, especially in winter when seeds are blown over the frozen or snow-covered soil surface. If populations grow along streams and rivers, water can spread seeds in large numbers and over considerable distances, especially during floods (Nielsen *et al.* 2005). Giant Hogweed is also spread by various human activities; *e.g.* seeds stick to tyres of cars. Whole umbels with dry seeds are sometimes transported by people as they are decorative. In addition, seeds are often translocated by soil or attached to clothes or animals (fur, claws) *e.g.* sheep, cattle or game.

At the local scale, an invading front of Giant Hogweed populations has been observed advancing in the Czech Republic at an average rate of about 10 m/yr, and the area invaded can increase by more than 1,200 m^2 each year. At the country scale, the number of localities doubled each 14 years during the phase of rapid invasion (Nielsen *et al.* 2005).

Impact

Affected habitats and indigenous organisms
Stands of *H. mantegazzianum* may range from linear stands to patches covering square metres to hectares. The density of populations may vary from sparse growth (1-3 adult individuals/10 m^2) to dominant stands (more than 20 adult individuals/10 m^2). Its enormous height and leaf area enable plants to overtop most indigenous plant species. Hence, it is a strong competitor for light and can absorb up to 80% of light in dominant stands. As a consequence, other light demanding species will be shaded out and suppressed, the composition and species diversity will change. For invaded areas in central Europe a decrease in species richness and densities has been shown (Nielsen *et al.* 2005, Otte and Franke 1998, Pyšek and Pyšek 1995).
High densities are mostly reached in abandoned grasslands and ruderal habitats, where Giant Hogweed is not the reason for the loss of species diversity, but a consequence of abandonment and ruderalisation. This effect can also be caused by indigenous species (*e.g.* Stinging Nettle, *Urtica dioica*).

It also grows in natural or semi-natural habitats like floodplains, but under natural conditions (*e.g.* intact alluvial forests) it only reaches low population densities. Little is known about the species' food web effects and impact on animals.

Genetic effects
Hybridisation with native species, especially *Heracleum sphondylium* L., is recorded in the UK (Stace 1975, Stewart and Grace 1984) and in Germany (Ochsmann 1996), but this is relatively infrequent even where both species occur, perhaps because of the lack of common insect visitors for pollination. The hybrids are virtually sterile. Hybridisation between *H. mantegazzianum* and *Heracleum sosnowskyi* is possible, and one of the reasons why *H. mantegazzianum* is rarely observed in Estonia might be that hybrids are not recognised and *H. mantegazzianum is* mistaken for *Heracleum sosnowsky* (B. Holm, pers. comm.)

Human health effects
The plant is a serious health hazard for humans because it exudes a clear watery sap, which contains several photosensitizing agents (furanocoumarins or furocoumarins) which in combination with daylight cause burnings of the skin (Drever and Hunter 1970). The reaction of the skin depends on individuals' sensitivity. The amount of photosensitizing substances however varies among plant parts. Skin contact with fresh plants should be avoided at any time even in the absence of sunlight. The phototoxic reaction can be activated by ultraviolet radiation only 15 minutes after contact, with a sensitivity peak between 30 min and two hours. After a period of about 24 hours, flushing or reddening of the skin and excessive accumulation of fluid in the skin appears, followed by an inflammatory reaction after three days. Approximately one week later a hyper pigmentation (unusual darkening of the skin) occurs on the affected areas, which can last for months. The affected skin may remain sensitive to ultraviolet light for years. Moisture, *e.g.* sweating or dew, and heat enhance the skin reaction.
The main groups at risk are people coming into contact with the plant through their work such as gardeners or landscape workers. Children are at particular risk, as they may use the hollow stems as pea shooters or spyglasses, etc. Due to the fact that contact with the plant itself is completely painless, workers and children in contact with the plant can continue with their action often for hours.

In addition, several furanocoumarins have been reported to cause cancer and malformations in the growing embryo (Nielsen *et al.* 2005).

USE ADEQUATE PROTECTION TO AVOID INJURIES BY PHYTOPHOTODERMATITIS!

Long sleeves, protective goggles or glasses are necessary. Protection from inhalation and synthetic water-resistant materials are recommended, all body parts should be covered to prevent ultraviolet light from reaching exposed skin. Work should not be done in bright sunlight. Care should be taken not to damage the clothes. Modern power equipment such as trimmers or weed whackers can spray pulverized plant material. In case of exposure to plant sap, one should wash the skin carefully with soap and water as soon as possible and subsequently keep the area away from sunlight for at least 48 hours. Treatment with topical steroids early in the reaction can reduce the severity and ease discomfort. In the following months a sun-cream should be used on the sensitive areas. If sap goes into the eyes, rinse them with water and use sunglasses. Do not hesitate to seek medical advice, particularly after intensive contact.

Fig. 6. Injuries caused by the phototoxic action of sap, photo by Wolfgang Sehlke, Saarbrücken

Economic and societal effects (positive/negative)

H. mantegazzianum has been cultivated for silage in Russia and Estonia (Kull *et al.* 2005; Holm 2004). Fresh weight yields exceeded 90 t per hectare in the third year. A study in Hungary suggested that acetone extracts of the plant could have useful allelopathic effects on other weeds (Solymosi 1994). It is reported to be used as a spice in Iranian cooking. The most important use is as an ornamental in Europe, where it has been a garden plant especially for garden lovers and parks (CABI 2004).

Negative effects are the displacement of other species which may leave sites with dominant *H. mantegazzianum* stands free of vegetation in winter. Sites near watercourses are therefore endangered by erosion (Williamson and Forbes 1982). *H. mantegazzianum* can also be a problem for agriculture because it is an alternative host of the carrot fly *Psila rosea* and the fungi *Sclerotinia sclerotiorum* (Gray and Noble 1965, Tiley *et al.* 1996) but there are no records of direct impact due to increased attacking of crop plants (CABI 2004). The control of the species nevertheless needs significant financial resources, especially if its growth endangers human injuries. In Germany, the total coast is assumed to be 10 mill. €/a: 8 mill. € for the control along traffic routes, 1 mill. € for injuries and 1 mill. € to control it in nature reserves (Reinhardt *et al.* 2003).

In 2005 Estonia initiated a 5-year strategy for the countrywide control of alien Heracleum species (mainly *Heracleum sosnowskyi*, and *H. mantegazzianum*), in 2005 the cost of control for 235 hectares, was 1,4 mill. Estonian krooni (~90.000 €); the expected cost for 2006 is 3,36 mill. Estonian krooni (~240.000 €) for 300 hectares (Lilika Käis pers. comm).

Management approaches

Prevention methods
Legislation on the prohibition of selling the plants does not exist and in regions already highly infested the main spread is by natural means. Prevention is only possible when the existing populations are prevented from building seeds. Moreover, transportation of soil (most probably containing seeds) from areas where the plant grows should be strictly prevented (*e.g.* soil movement within construction or landscaping work, vehicles should be prevented from inadvertently disturbing the soil and transporting seeds to new sites etc.).
In areas endangered by invasion damage to the original vegetation cover should be avoided, which may happen through deposition of plant material from construction places, gardens and other wastes, soil surface destruction through agricultural machinery, removal of single shrubs and trees, and generally all actions that open gaps within a dense vegetation cover (Nielsen *et al.* 2005).

Eradication, control and monitoring efforts
It is crucially important to locate newly established populations as far as possible (by monitoring, help of the public etc.). If new populations establish, rapid measures should be taken immediately. While new infestations are still small, eradication efforts are cheaper and more likely to be successful (Nielsen *et al.* 2005).

If the plant is already widespread and measures are to be taken, a mapping of the extent of populations (which due to their conspicuousness is relatively easy) forms a good basis for a management plan. The management plan should define objectives (eradication, containment or just to keep populations down) and form a basis for decisions about priority areas to manage etc. One basis for priority settings should be valuable habitats and the likelihood of dispersal from the mapped populations (barriers *e.g.* dense scrubland or forest; promoting factors like water courses, roads or railways, donor areas like gardens or populations upstream, potential habitats in the surroundings like abandoned meadows).

A control programme should be based on an Integrated Management Strategy, which evaluates methods of control. Control methods can include mechanical methods, grazing and herbicide application. The management strategy should take into account the specific situation of each location (area covered, density and accessibility) to obtain optimal efficacy, ecology and economy success. It should also be flexible, perhaps including a combination of control methods. Regardless of the control method, management requires repeated and correct application to obtain satisfactory control.

For most control measures, treatment of plants should be started early in the growing season and continue for several years until the soil seed bank is depleted and the root system has died.
The most effective mechanical control method is the cutting or digging of the root by an ordinary spade with a sharpened blade. This should take place in early spring and be repeated in mid-summer. The root has to be cut at least 10 cm below soil level. The cut parts of the plants are pulled out of the soil and either destroyed or left to dry out. The method is very effective, but labour intensive and is therefore recommended to be used for single plants and smaller stands (<200 individuals).

Fig. 7. Manual control, photo by Wolfgang Sehlke, Saarbrücken
Fig. 8. Control by sheep grazing, photo by Inger Weidema, Copenhagen

The removal of umbels can be as effective as cutting the whole plant, but often fails because the timing of removal is crucial: If the treatment is applied too early in the season (before full inflorescence), regeneration is very vigorous and an even larger number of viable seeds is produced. On the other hand, if treatment is too late (at the beginning of seed-setting), there is a risk that seeds will ripen even on cut umbels that are left lying on the ground and not collected and destroyed. The method is therefore most effective when terminal umbels have just started to flower. Even then, there is some regeneration and treated stands must be checked at the time of seed ripening to prevent release of seeds produced by regeneration. This method should only be considered as an improvised solution for control of stands where no other attempts of control have taken place earlier in the season.

Plants can be cut manually by using a scythe or a trimmer if the population is small or situated in a location unsuitable for mechanical mowing, *e.g.* along rivers or on slopes. For large and accessible infested areas, mowing with machines is useful. Cutting and mowing techniques must be repeated 2-3 times during the growing season to hinder the re-sprouting plants from storing nutrients in the root and flowering and setting seeds. Mown plant material should be removed from the area and not be piled in heaps, since this will damage the vegetation cover and create favourable conditions for new establishment or the establishment of other unwanted species.

To weaken the population over several years, one strategy can also be to cut only the flowering plants at mid-flowering stage. Production of new seeds will be prevented and vegetative plants will out-shade each other. Nevertheless, a final digging or repeated mowing is necessary.
Grazing (Anderson and Calov 1996) has also proven to be very efficient and a cheap method for the control of large stands but should also be considered for smaller stands if neighbouring areas are grazed and livestock can be relatively easily transferred for shorter periods. Experience has been gained mainly from the use of sheep, but the plant is also very palatable to cattle and there are fewer records of goat and horse grazing. Choosing livestock with pigmentation of the bare skin, *e.g.* blackfaced sheep, can reduce inflammation by the chemicals of hogweed plants. A symptom of

poisoning in the grazers is skin inflammation and blistering around the mouth, nostril, eyes and ears, and potentially the udders and the skin between the anus and the genital organs. Affected animals must be removed from the field temporarily. Clinical studies also showed a reduced fecundity after oral application of furanocoumarins, which has not been reported so far for grazing animals. Sheep and cattle prefer young and fresh plants, and the most efficient control is to begin grazing early in the season. The fenced area should not only include the colony to be controlled but also the surrounding area where seed dispersal may have taken place. Over time, grazing promotes a dense sward of grazing-tolerant species and limits the amount of suitable ground in which hogweed seeds can germinate. Livestock may need a period of time to become accustomed to the hogweed, but soon they develop a preference. In areas with dense stands of hogweed plants, a single cut is recommended to allow establishment of other plant species to obtain a more mixed diet. It is recommended to use a dense regime of animals in spring (20-30 sheep/ha), and reduce grazing pressure at the end of June (5-10 sheep/ha) when most of the plant biomass has been removed. The livestock requires daily inspection and access to water and additional supplements of nutrients (*e.g.* minerals) may be necessary. Inspections of fences should be conducted periodically in order to maintain them.
Ploughing can control an infestation of tall invasive hogweeds on agricultural land. Deep ploughing of the soil (up to 24 cm) will significantly reduce the germination of hogweed seeds due to the upper soil (where the majority of the seeds are concentrated) being buried. The best results are obtained if the established vegetation of invasive hogweed plants is controlled mechanically or chemically prior to the ploughing.

The application of systemic herbicides such as glyphosate and triclopyr is considered effective and cheap. Triclopyr has no effect on germinating grasses and is useful in controlling a range of broad-leaved species such as Giant Hogweed. Glyphosate is registered for use also close to water, and is currently the only herbicide approved for control of tall invasive species of hogweed in all European countries. However, the use of herbicides in, for example, fallow fields or in the vicinity of water could be restricted by national legislation which should be consulted before any herbicidal application. Policies often aim to reduce the pesticides and protect groundwater from herbicides. If herbicides are applied, the plants should be treated early in spring when they are not higher than 20-50 cm and access to the centre of the colony is still possible. A follow-up spraying may need to be carried out before the end of May to kill seedlings which have germinated after the first treatment. Applications should adhere to the dose recommended on the product label and spraying should be done in dry and calm weather. In amenity areas, areas with non-target vegetation and in nature reserves, spraying should be carried out using a nozzle that constricts the spray, by weed-wiper or a brush.

Other methods that are sometimes reported, like the use of salt, household ammonia, heating oil, other chemicals or cryotechnology are not recommended, as the efficiency has not been proved, their application may negatively change the soil and watercourses, or the techniques are still in development. No suitable biocontrol agents are known yet (CABI 2004).

For all methods of control, follow-up monitoring of the eradication site for at least five years must be undertaken both within and outside the area treated since the seeds can survive for several years in the soil. Plants in the first year are more difficult to find, so this should be undertaken by staff familiar with the plant in its vegetative stages.

Afforestation is a very cost effective and natural method for areas with no interest or regular use, because the shading effect of trees and/or shrubs shades out *H. mantegazzianum*. The saplings planted should be of a size to ensure the rapid establishment and the development of a closed

canopy. Beech *(Fagus sylvatica)* is very capable of shading whereas firs *(Abies* species) and willows *(Salix* species) are considered less capable. Damage to the original vegetation cover caused by the plantation measures should be avoided.

Sowing grass mixtures combined with regular mowing will lead to a dense sward of grasses and inhibit the germination of seeds in the soil or newly introduced. Therefore, grass mixtures should be sown at high seed densities (4,000 emerging seedlings/ m^2) containing native grass species and cultivars must be chosen that have proven to be competitive, produce dense swards, are suitable for growing in mixtures, and make good growth after repeated cutting (*e.g. Dactylis glomerata : Festuca rubra* (50:50), *Festuca arundinacea : Festuca rubra* (35:65), *Lolium perenne : Festuca rubra : Poa pratensis* (12:35:53)). In non-natural habitats a selective herbicide for broadleaved weeds in the developing grass sward (including newly emerged seedlings of hogweed) may be used as a single application during the vegetative period. In places with high densities of hogweed, above ground cutting after the over-wintering plants have re-sprouted is recommended in the spring. Frequent cutting of the re-established grass sward is recommended, when the height of hogweed seedlings reaches 20-30 cm. To depress hogweed and to stabilize the soils against erosion, a regular cutting is needed. By frequent cutting of naturally established grass species, mainly *Elymus repens* and *Poa pratensis*, a highly competitive grass sward will be achieved. The diversity of such a grass sward will increase gradually as native broadleaved species colonise the sward. The speed of this increase depends on accessibility of seed sources (*e.g.* from nearby natural meadows).

When the eradication of *H. mantegazzianum* has been successful, the risk exists that the area will be left vulnerable to soil erosion and the re-introduction of invasive species. Therefore the area should remain in suitable land use practices (*e.g.* revegetation, regular mowing, no further disturbances of soil, no further deposit of waste or garden rubbish etc.).

It is strongly recommended to directly consult the Giant Hogweed Best Practice Manual by Nielsen *et al.* 2005, which aims to provide practical and complete information including costs, a comprehensive comparison of all methods, etc.

Information and awareness
Awareness raising campaigns should be targeted for key groups involved in outdoor activities, *e.g.* road and river managers, companies deliberately or inadvertently transporting soil, fishermen, farmers, hunters, environmental groups, hiking and cycling clubs etc. The striking appearance of the plants makes it also particularly suitable for involving the public in public awareness raising (by local papers, radio and television programmes, posters, brochures or leaflets). The general public can also be asked to help locating stands and even single plants and report them *e.g.* via internet sites (Nielsen *et al.* 2005). However, due to the health risks and uncertainties of identity of Giant hogweed populations, the public should be recommended not to take any own action.

Knowledge and research
The state of knowledge about *H. mantegazzianum* is comparably good, although some questions like possible biocontrol agents, the maximum dormancy of seeds in the soil and the taxonomic identity within the species complex are still unsolved.

Recommendations or comments from experts and local communities

References and other resources

Contact persons

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Links

Download of the The Giant Hogweed Best Practice Manual (in 8 languages).
Hogweed Site maintained by J. Ochsmann

Fact sheet of the Washington State Noxious Weed Control Board
NeoFlora fact sheet (in German)
Management options for *H. mantegazzianum* and *H. persicum* from Finland's environmental administration (in Finnish)
Management options for *H. mantegazzianum* and *H. persicum* from Finland's environmental administration (in Swedish)

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