GIANT HOGWEED BY THE RIVER ALLAN AND THE UPPER FORTH: CHARTING THE CHANGE 1985-2013

Guy Harewood

In 1985 a survey of Giant Hogweed (*Heracleum mantegazzianum*) along the banks of the River Allan and part of the River Forth was carried out by Stirling University (R. Neiland, J. Proctor and R. Sexton) and published in Volume 9 of *Forth Naturalist and Historian* (FNH*)* Journal. At this time the danger that this alien species with its toxic sap could overwhelm our river banks was beginning to be appreciated and the survey showed colonies were already established all the way downstream from Greenloaning to Cambuskenneth.

Last summer FNH obtained a grant from Scottish Natural Heritage (SNH) as part of the *What's Changed Project* to repeat the 1985 survey and establish whether giant hogweed had spread or been held in check. Local Countryside Rangers Guy Harewood and Claire Bird led the project with the assistance of ten volunteers. The survey was conducted using a similar methodology to that employed in 1985 allowing changes in the distribution during the intervening 28 years to be accurately charted.

Giant Hogweeed is a native of the Caucasus Mountains in Russia and was introduced into England as a garden plant in 1817. By 1828 it was reported growing wild in Cambridgeshire and since then it has become widespread throughout the UK including Scotland. It may have been introduced into the Stirling area by a stream which drains into the River Allan from the gardens of Cromlix House (NN 785 059) where it is known to have been planted in the first decade of the last century (Neiland et al, 1985).

Ecology

As its name implies, giant hogweed grows tall, with mature plants reaching 3-5 metres in height and leaves over a metre wide. It has a large umbel of up to 60,000 small white flowers allowing up to 120,000 small, paper thin seeds to be produced per plant (Dodd et al, 1994). An average plant bears about 20,000 seeds, but individual plants with over 100,000 seeds have been reported (Nielsen et al, 2005). One study in the Czech Republic cited a 3.3 metre tall giant hogweed plant which produced 107,984 seeds (Caffrey, 1999). In the ground seeds can stay dormant for up to 7 years because they contain a rich and abundant food store (Andersen, 1994). However, Moravcová et al (2007) reported that only 1.2 % of the seeds in their study remained viable after 3 years of burial. Although there is some dispute over the precise length of time that seeds remain viable it is clear that there is a huge seed bank. For example, in a stand of 50 plants approximately 1,000,000 seeds will be produced each year.

Giant hogweed plants are monocarpic. They grow for several years, usually flowering in the third to fifth year after which they set seed and die. In unfavourable conditions such as on nutrient poor, shaded or dry sites or those that are regularly grazed, flowering is postponed until sufficient reserves have been accumulated. In such conditions, plants can live for at least 12 years (Nielsen et al, 2005).

Being small and light giant hogweed seeds are easily dispersed. They can be carried 10 to 50 m from the parent plant by the wind (Caffrey, 1994). Studies of individuals about 2 m tall show that 60-90 % of seeds fall on the ground within a radius of 4 m of the parent plant; the density of seeds declining rapidly with increasing distance from the source (Nielsen et al, 2005). Clegg and Grace (1974) and Dawe and White (1979) (cited by Moravcová et al 2007) also report that giant hogweed seeds have the ability to float for up to 3 days. Therefore, when water is the primary dispersal route, such as in riparian or coastal zones or areas prone to flooding, there is the potential for seeds to move over huge distances.

Seeds normally result from cross fertilisation between two different plants but there can be an overlap in the formation of male and female flowers in a single umbel, which makes self-fertilization possible. This means that even a single isolated plant is capable of founding a new population (Nielsen et al, 2005).

Impacts and control

The continued spread of this plant is a cause of great concern because of its impact on human health and on the ecology of infested areas (Caffrey, 2001).

The plant's enormous size, immense seed production and ability to survive in a variety of habitats and conditions helps it out-compete our native plants. As a result it ultimately produces large dense stands in which most other species are virtually excluded. Being the largest forb in central Europe its large leaves allow it to intercept most of the available light (Pysek, 1994) and in dominant stands up to 80 % of the incoming light is absorbed (Nielsen et al, 2005). As a consequence little or no light reaches the surrounding vegetation which ultimately dies.

In the autumn, giant hogweed loses its huge leaves keeping only the stalk. Since few other plants can survive under its canopy the soil is left open and vulnerable to wind and water erosion (Dodd et al, 1994). The Tweed Forum (2006) has been involved in a systematic attempt to eradicate giant hogweed along the River Tweed. They have observed that after producing seed the large, deep tap-root dies and rots to leave a hole up to 15 cm across and 30 cm deep. Within dense stands there can be several thousand plants in a 100 m stretch of river bank. The perforation caused by root rotting together with a lack of any vegetation sward and associated root mat results in the soil being exposed to

the full erosive force of the river and whole sections of riverbank can disappear during peak flows.

Giant hogweed also poses a health and safety risk. The plant exudes a sap, which contains several photosensitizing furanocoumarins. In contact with the human skin and in combination with ultraviolet radiation, these compounds cause blistering of the skin (Nielsen et al, 2005). Local instances have occurred involving children playing at the water's edge in Bridge of Allan and estate workers trying to clear the plant from the banks. .

In some of the worst affected areas the plants can form an almost impenetrable barrier preventing access to the river for both fishing and other recreation use; so the economic impacts of this invasive plant cannot be overlooked.

A number of methods are currently employed to try to control, and ultimately halt, the plant's spread. Manual and mechanical methods include root cutting, mowing, cutting the plant, and umbel removal. With the exception of root cutting, these methods do not immediately kill the plants. Death occurs ultimately as a result of the depletion of the plants nutrient reserves and requires two to three treatments per year during several growing seasons (Nielsen et al, 2005).

Chemical control of giant hogweed, using systemic herbicides such as glyphosate and triclopyr, has proved both effective and cheap. The plant is also readily grazed by sheep and cows which appear to suffer no ill-effects. This has proved to be very effective method of control (Nielsen et al, 2005) and some grazed fields in heavily infested areas can remain virtually free of the plant.

Thiele and Otte (2006) describe the primary factors that constrain giant hogweed establishment as land usage, shading and low-productive site conditions. They also state that the majority of invaded sites have been subject to human related habitat changes, with the most important process being land-use decline or abandonment. Land management is therefore a viable control mechanism as giant hogweed cannot readily establish in areas of well managed land such as farmland and parkland. Although the Allan Water and River Forth do pass through much agricultural land, riverbanks are often fenced or left unploughed and therefore provide a suitable unmanaged habitat for the plant.

Any effective control programme needs to be both in place for many years and also to have the active participation of all the land owners. The Tweed Forum (2014) has demonstrated that this is possible and report that after 10 years of catchment-wide control, giant hogweed coverage is greatly reduced. All plants in the project area have been prevented from flowering during this period which should result in a reduction in the seed bank and eventual eradication.

Survey methodology

The 1985 survey mapped the giant hogweed up to 50 m from the water's edge on the banks of the River Allan and a section of the River Forth downstream from its confluence with the Allan to Stirling Bridge. The survey started from the A822 road bridge over the Allan Water north of Greenloaning (NN 835 079) and finished at the footbridge over the River Forth between Riverside and Cambuskenneth (NS 805 940). It was conducted over 5 days between 3rd and 24th August. To be broadly consistent with this the follow-up 2013 survey was carried out on the between 14th-20th August. Where possible the number of adult and immature plants were counted and their position captured using a hand-held GPS. Where they were too numerous the estimated numbers and density of mature plants was recorded using a classification system comparable to the original survey. If the stands where too large to record with a single GPS coordinate the area of the colony was recorded using GPS coordinates at the start and end of the stand.

The survey was conducted by groups of volunteers each led by a Countryside Ranger who briefed the group on the survey methodology and the identification of invasive non-native species. Japanese knotweed, Himalayan balsam and American skunk cabbage were also recorded.

Comparison with 1985

The data showed that along the upper reaches of the Allan from Greenloaning down to Cromlix there were only a few individual flowering giant hogweed plants (Figure 1) in contrast to 1985 when there had been 12 colonies each with more than 50 mature plants. However in some areas the banks were still covered in young immature plants. This pattern resulted from the death of older plants as a result of herbicide application and grazing by sheep and cattle. During 2013 the River Forth Fisheries Trust (RFFT) were in the first year of a systematic eradication programme. Together with their volunteer sprayers they worked down from Geenloaning to Cromlix during the spring and summer killing off the older plants and leaving the seedlings. They will return in 2014 to kill the regrowth. In addition many areas were subject to grazing up to the water's edge and the only mature plants found here were on inaccessible slopes.

By contrast the region from Cromlix down past Kinbuck to Dunblane where the banks originally carried only three colonies of flowering plants there are now massive forests occupying hundreds of metres of bank particularly downstream of Ashfield. There had also been similar major increases between Dunblane and Bridge of Allan. In these sections there are long stretches where the river runs through steep inaccessible wooded gorges. There is little or no grazing and where farmland occurs along the banks it supports arable crops where ploughing does not extend to the water's edge. This allows the survival of plants along the banks. These factors together with the absence of any

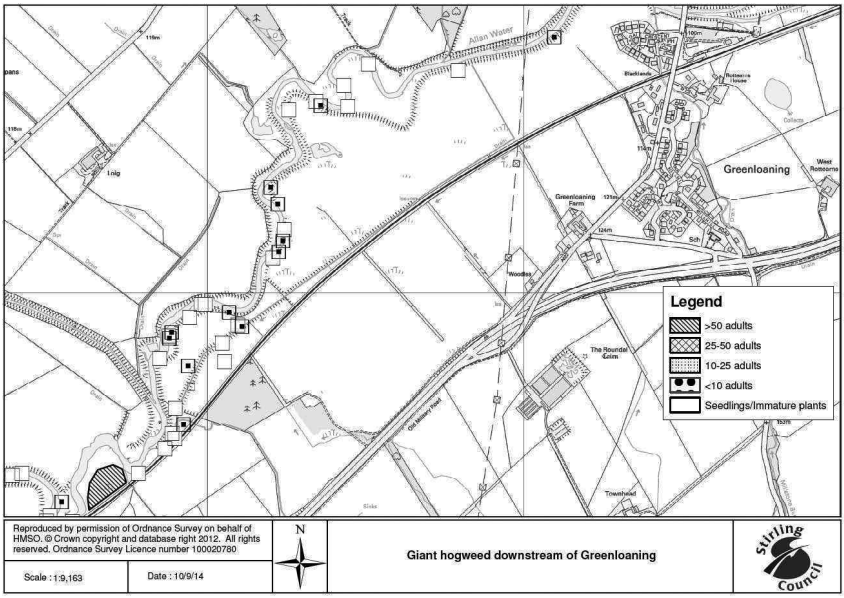

Figure 1. In 1984 there were 12 giant hogweed colonies each with more than 50 mature plants along this stretch of bank downstream of Greenloaning. By 2013 grazing and herbicide treatment had significantly reduced the number of flowering plants but there were still large numbers of seedlings.

systematic chemical control has allowed the giant hogweed to flourish and grow unchecked.

In the 1985 survey the biggest giant hogweed stand was near the Cornton level crossing (NS 789 963). It occupied the derelict Pig Testing Station (now a housing estate) and the adjacent land where Cornton Prison now stands (Figure 2). This stand has been partially eradicated by the development of the site and grazing on the remaining fields but unfortunately the colony has spread to the opposite bank and forms a continuous dense stand from the rail bridge all the way down to the Forth (Figure 2).

The stretch down the River Forth from its junction with the Allan to Cambuskenneth had six small colonies in 1985. Some of these behind the Causewayhead Rd have expanded into major colonies and there is now an almost continuous dense stand from the rail bridge through the rugby club and up to the Ladysneuk Rd to Cambuskenneth. A continuous spraying programme by the Stirling Council fisheries team has all but eliminated mature plants from the opposite side of the river through Raploch and Riverside.

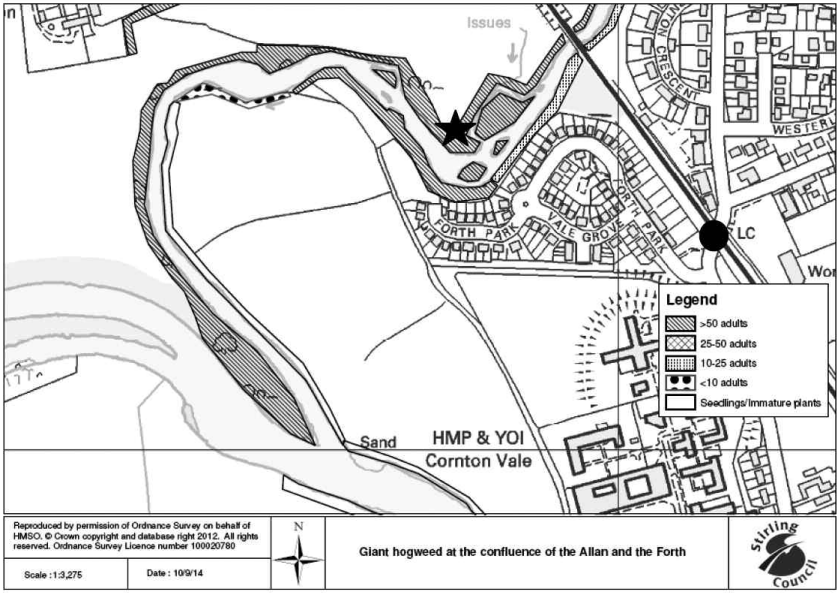

Figure 2. In the 1985 survey the biggest colony of giant hogweed was near the Cornton level crossing (dot). By 2013 this stand has been partially eradicated by the development of the site and grazing on the remaining fields. Unfortunately the giant hogweed has spread to the opposite bank (star) and forms a continuous dense stand from the rail bridge all the way down to the Forth.

The 1985 survey states that *plants were occasionally seen on roadside verges and railway lines close to the rivers* and that one individual was seen about 1 km from the river. The situation is much worse now with giant hogweed found along the majority of the rail line between Stirling and Dunblane as well as along many of the roads around Stirling. It is no longer confined to the river corridor and is well established throughout the Stirling area.

The Neiland et al. survey states that *at most sites where adults were present there were less than 50 flowering plants… the largest colony was in Bridge of Allan where there were many hundreds of adults*. In 2013 there were a large number of areas that each contained many hundreds of flowering plants. In some sites around Dunblane and Bridge of Allan the plants were too numerous to accurately estimate.

In summary these results show that there has been a major increase in the number of giant hogweed plants in many areas. There has also been a significant decrease in areas where effective treatment programmes have been in place and where there is grazing, by cattle and sheep.

Over the intervening years from 1985-2013 a number of attempts have been made to control the plant, some at a very local level and some in a more systematic way. The Clackmannanshire and Stirling Environment Trust (CSET) funded control efforts during 2004, 2006, 2007, 2008 and 2009, with spraying undertaken along the Allan Water stretching from Greenloaning to its confluence with the River Forth. All plants within 6 m of the water's edge were treated. The CSET report (2011) stated that *the dedicated spraying program has had a significant affect on the level of invasive weeds along the Allan Water*. The treatment reduced the number of colonies of mature plants but led to an increase in the number of seedlings and immature plants. This is likely to be due to the increased light available in the absence of mature plants (Morrison, 2011).

As described above RFFT undertook treatment of giant hogweed between Greenloaning and Kinbuck in 2013 and plan to treat the full length of the Allan in 2014, By eliminating the upstream seed sources before moving downstream they hope to eventually eradicate the plant. Unfortunately the long term funding for this Forth Invasive Non-Native Species (FINNS) programme is uncertain and is only currently guaranteed until the end of 2014. In addition to the control measures undertaken through CSET and RFFT local volunteers have been trained in herbicide application and will undertake future spraying in some areas.

The data gathered by this survey shows that despite the investment of £10,000 and thousands of volunteer hours the short-term or non-systematic nature of 30 years of management efforts has resulted in a failure to contain giant hogweed. Due to the plant's growth characteristics a long-term control and eradication plan is essential. The experience of the Tweed Forum (2014) suggests that it takes 10 years to be effective, so there is every likelihood that all these current control efforts will prove in vain unless the spraying programme is repeated annually as new seeds germinate.

All current and planned efforts focus on the river corridors, with little or no consideration for the wider landscape and the avenues for reinvasion from road or rail networks. It will prove almost impossible to eradicate the plant if a seed source exists nearby. The wider you look to control the plant the more complicated the problem becomes with multiple landowners and land managers involved.

To paraphrase the closing paragraph of Neiland et al (1985) '*If Giant Hogweed is to be controlled then a coordinated strategy aimed at eradicating all the colonies is needed, not just those on land owned by any single landowner. Controlling the plants must be maintained over several years to be effective, and this requires long-term planning by the local authorities, landowners and other stakeholders'*. This statement is still as true today as it was nearly 30 years ago.

Figure 3. Volunteer Niall Currie in a dense stand of giant hogweed in 2013 a few metres from the site of the largest stand recorded in 1985.

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