Ancholme Internal Drainage Board Non-Native Invasive Species Assessment Report

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Contract

This Non-native Species report has been produced for the Ancholme Internal Drainage Board and incorporates work undertaken for as part of previous ecological survey work and Biodiversity Action Plan production and implementation.

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Purpose

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Abbreviations

BAP ..... Biodiversity Action Plan

CEH ..... Centre for Ecology and Hydrology

Defra..... Department of Environment, Food and Rural Affairs

EA ..... Environment Agency

Ha ..... Hectare

IDB ..... Internal Drainage Board

NNSS..... Non-Native Species Secretariat

WTN..... Waste Transfer Notes

1 Introduction

1.1 Introduction

Internal Drainage Boards (IDB's) have a duty to conserve and enhance biodiversity. Maintenance and improvement works undertaken by IDBs have the potential to positively enhance biodiversity through identifying, reporting and effectively managing threats to biodiversity. Reckless or poor management of non-native, invasive species, primarily plant species, has the potential to adversely impact on the status of biodiversity across the Ancholme drainage district through the spread of non-native, invasive species and hence the out competing of native species.

1.2 Biodiversity

The Convention on Biodiversity agreed at the Earth Summit in Rio de Janeiro in 1992 defined biodiversity as:

"The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

The term biodiversity encompasses the whole spectrum of living organisms, including plants, birds, mammals and insects. It includes both common and rare species, as well as the genetic diversity within species. Biodiversity also refers to the habitats and ecosystems that support these species.

1.3 Legislation

1.3.1 Flora

The Wildlife and Countryside Act 1981 (as amended) consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and Council Directive 79/409/EEC on the conservation of wild birds (Birds Directive) in Great Britain (JNCC, 2010).

Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) lists 62 plant species, or groups of plants, and 69 animal species for which it is an offence to release or cause to spread in the wild. Of particular note are the terrestrial plant species Japanese Knotweed *Fallopia japonica*, Himalayan Balsam *Impatiens glandulifera* and Giant Hogweed *Heracleum mantegazzianum*, all of which are characteristic of riparian environments and which may be or become present on drains managed by Ancholme IDB. Watercourses also provide ideal corridors along which these species can spread.

In addition to its listing on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), Japanese Knotweed is also listed as controlled waste under the Environment Protection Act (Duty of Care) Regulations 1991. Soil containing rhizome material is regarded as a contaminated material and if taken off site it must be disposed of at a licensed landfill site. Similarly, Giant Hogweed is listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) and is also classified as controlled waste under the Environment Protection Act (Duty of Care) Regulations 1991 and the same protocols apply to its disposal. Any material left on site must be buried to a depth of 1m (Defra, 2013). Giant Hogweed poses a risk to human health, as a result health and safety protocol must be adhered to in its control and disposal.

Himalayan Balsam, although listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) is not classed as controlled waste.

When disposing of controlled waste or soil contaminated with non-native invasive plant material (including seeds) Waste Transfer Notes (WTNs) must be obtained for any such material leaving the works site. Vehicles used to transport the contaminant must be covered to prevent seeds and plant material from blowing away and spreading and hence prevent committing an offence which can result in prosecution or fines (Defra, 2013).

Several aquatic plants listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) are also of potential threat to drainage systems as a result of their invasive potential. Water Fern *Azolla filiculoides*, Floating Pennywort *Hydrocotyle ranunculoides*, Curly Waterweed *Lagarosiphon major*, Australian Swamp Stonecrop *Crassula helmsii*, Water-primroses *Ludwigia*

spp., Parrot's Feather *Myriophyllum aquaticum* and Waterweed *Elodea* spp. species are of concern. Furthermore, management of these species is often more challenging as they are present within the channel and water flow facilitates dispersal.

1.3.2 Fauna

With regard to fauna, Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), lists 69 animal species for which it is an offence to release or cause to spread in the wild. Animals of particular concern within drainage channels are the American Mink *Neovison vison* and American Signal Crayfish *Pacifastacus leniusculus*.

1.4 IDB Responsibilities and Obligations

Ancholme IDB has Permissive Powers under the Land Drainage Act 1991 (as amended). Under this Act, the board may choose to undertake maintenance work on any watercourse within its district for the purpose of cleansing, repairing, maintaining, improving or constructing new works within its district.

Internal Drainage Boards are obliged under international agreements, arising from the 1992 United Nations Conference on the Environment and Development (commonly known as the Rio Earth Summit), and national commitments (Article 6A of the Rio Convention on Biological Diversity) to carry out maintenance works in a manner that does not compromise the biodiversity status of drainage districts. Biodiversity Action Plans (BAPs) have been produced for individual IDBs, including Ancholme IDB, in order to ensure that these commitments can be translated into effective action at the local level with a view to also maintaining and enhancing biodiversity.

The Ancholme IDB BAP, produced in 2009, sets realistic objectives for the conservation and enhancement of biodiversity within the Ancholme drainage district and specifies targeted actions and priority species and habitats as identified in the biodiversity audit.

The Ancholme IDB BAP contains a number of actions relating to non-native invasive species, and this report helps with achievement of these, specifically:

- **Action 4.1** - *Record and monitor non-native invasive plants and animals on and/or adjacent to DB watercourses* - this report collates all records of non-native invasive species within the drainage district available to the authors at the time of writing
- **Action 4.2** - *Assess feasibility of controlling stands of invasive plants on DB watercourses*
- **Action 20.4** - *Investigate the distribution of Mink in the drainage district.*
- **Action 20.5** - *Assess whether Mink control would benefit Water Vole recovery/recolonisation and/or site safeguard*

2 Non-Native Invasive Species: Descriptions and Identification

2.1 Introduction

The correct identification of non-native invasive species is important in watercourse management and controlling threats to biodiversity. Many non-native invasive species resemble native species and mistaken identity has the potential to have adverse impacts on biodiversity status. The following sections give background information on non-native invasive species that are associated with drains and similar water bodies, and are thus likely to pose a threat to the biodiversity status of the Ancholme drainage district and implementation of the BAP. Information for these species has been obtained primarily from the Non-Native Species Secretariat (NNSS) species database.

2.2 Submerged Species

2.2.1 Waterweed Elodea Species

Canadian Waterweed *Elodea canadensis* and Nuttall's Waterweed *Elodea nuttallii* are non-native submerged, aquatic plants and the two main non-native waterweed species in the UK. Canadian Waterweed was first recorded in the mid-1800s, whereas Nuttall's Waterweed has a much more recent establishment, being first recorded in 1966. Both species can grow up to 3m in length, are perennial and spread rapidly through vegetative propagation. With the exception of their white flowers which extend just above the water surface on thread like stalks, these plants remain fully submerged within the water.

Canadian Waterweed is identifiable by leaves, in whorls of 3, of up to 2cm in length, widest at the middle and rounded or pointed at the tip. Nuttall's Waterweed, in comparison, has longer leaves in whorls of 3 or 4, which can reach 3.5cm in length and are widest at the base. These leaves are also usually distinctly more pointed and twist and curve more than those of Canadian Waterweed (refer to figure Figure 2-1)

The distribution of these species overlaps, however Nuttall's Waterweed is found more frequently in nutrient rich waterbodies. The dense growth of *Elodea* species in slow flowing water bodies, such as drainage ditches, can impede flow and increase flood risk. Furthermore, these species can form dense beds and can out-compete native species.

Figure 2-1 Canadian Waterweed (left) and Nuttall's Waterweed (right) © GBNNSS, with thanks to British Waterways

2.2.2 Curly Waterweed

Curly Waterweed *Lagarosiphon major* was first recorded in Bedfordshire and is now established in many sites across the UK. It is commonly sold as a pond and aquarium plant, and deliberate or accidental release as a result of this use is likely to have been partly instrumental in its spread. It has strongly curled leaves, whorled or spiralled around the stem and can grow up to 3m in length, completely submerged under the water. It can be distinguished from *Elodea* species as its leaves at the base of the plant are arranged spirally around the stem, in *Elodea* species, they are always in whorls (see Figure 2-2). The flowers, borne separately as male and female, are inconspicuous. Curly Waterweed spreads mainly by vegetative propagation through

detached stem fragments and can become easily established and has the potential to choke up waterways, exacerbating flood risk. It can also form dense beds and out-compete native species.

Figure 2-2 Curly Waterweed © RPS Group Plc

2.2.3 Parrot's Feather

Native to central South America, Parrot's Feather *Myriophyllum aquaticum* is a primarily aquatic, perennial plant growing particularly where eutrophic water occurs. It is found all year round and is unlikely to be found in fast flowing water.

As its name suggests its structure resembles that of a feather and spreads vegetatively from small stem fragments. The leaves, which are bright to blue-grey green in colour, form in whorls of 4 to 6. The emergent leaves are more robust and stiff compared to the submerged leaves which are more fragile (see Figure 2-3). Inconspicuous white flowers form at the base of the leaves between May and August. During the winter the emergent plant dies down, however, it can be found submerged throughout the year. During spring the emergent shoots appear and the plant is more conspicuous.

This invasive species can rapidly dominate a watercourse; stems break easily and roots are found around the nodes which facilitate rapid spread through vegetative propagation. As a result Parrot's Feather can cause blockages to water channels and increase flood risk.

Figure 2-3 Parrot's Feather © GBNNSS

2.3 Floating Species

2.3.1 Water Fern

Water-fern *Azolla filiculoides* is a small, floating aquatic plant species that forms on the surface of water bodies. It was first introduced in the late 1800s and has spread rapidly. Spread is primarily through vegetative propagation, however minute spores are also produced which can facilitate wider distribution.

The dense spread of this species can cause sub-surface temperature decline and de-oxygenation which can lead to the suffocation of fish and aquatic invertebrates. Furthermore, it is a health hazard, and a danger to livestock, as dense mats can appear to be solid ground. The plant is green in colour, often with a reddish tinge, turning completely red when exposed to

stresses such as cold temperatures, brackish waters or shading. Leaves are minute, granular and fern-like in appearance with the entire leaf rarely exceeding 2.5cm in length. Beneath the leaves, dark coloured, brittle, roots are present (See Figure 2-4).

Figure 2-4 Water Fern - Red form (left) and Green form (right, © GBNNSS)

2.3.2 Floating Pennywort

Found particularly in ditches and other slow flowing eutrophic water bodies, Floating Pennywort *Hydrocotyle ranunculoides* forms dense mats and spreads vegetatively, able to reproduce from tiny fragments. This species (which can be free-floating or rooted) is identifiable by its shiny, kidney shaped leaves with crinkled edges, which span up to 7cm.

With a growth rate of up to 20cm per day this species can dominate watercourses, causing deoxygenation and temperature reduction which is a thread to biodiversity. Furthermore, the dense mats impede water flow, increasing flood risk and reducing amenity use.

Figure 2-5 Floating Pennywort (left ©Snowdonia National Park Authority, right © GBNNSS)

2.3.3 Water-primroses

Water-primroses *Ludwigia spp.* were introduced as an ornamental water plant and where it grows in the wild it can out-compete native flora and can block waterways. This species is currently issued a Species Alert under the GB rapid response protocol and whilst it has yet to be found in many places in the UK it has caused severe problems in Europe and is therefore of significant concern.

The leaves can vary in shape from round/egg shaped to long and slender. Leaves are dark green, with a paler midrib and can be up to 9cm in length. These leaves are arranged alternately on the fleshy stem which can be 20 to 300cm in length and either smooth or hair (refer to Figure 2-6). The flower comprises 5 bright yellow petals with an approximate diameter of 3 cm (see Figure 2-7). Water-primrose flowers in July and August and dies back in winter leaving distinctive brown stems. Although this plant produces seeds, reproduction is primarily through vegetative means.

Figure 2-6 Water primrose - long leaves (left) and round leaves (right, © GBNNSS)

Figure 2-7 Water-primrose flower ©Trevor Renals

2.3.4 Australian Stonecrop

Australian Swamp Stonecrop *Crassula helmsii*, also known as New Zealand Pigmyweed, can manifest itself in three forms: submerged, emergent and terrestrial. It was introduced as a pond plant to Britain in 1911 and has spread rapidly since the 1970s. This species in its emergent and terrestrial form is recognisable by its fleshy leaves (up to 2cm in length) arranged in opposite pairs on a round stem. The leaves become more sparse and flat from the terrestrial to fully submerged forms and as a consequence, submerged leaves are less easily recognisable or readily observed (see Figure 2-8).

This species reproduces vegetatively from small fragments and is not believed to produce viable seeds in the UK. It forms dense mats and can impede drainage, which increases flood risk. Furthermore, it can out-compete and displace native species.

Figure 2-8 Australian Swamp Stonecrop (right, © GBNNSS)

2.4 Bank Side Species

2.4.1 Himalayan Balsam

Himalayan Balsam *Impatiens glandulifera* is an annual non-native plant, found predominantly on river banks and in damp woodland. It can out-compete native species and, as it is an annual plant, it leaves bank sides exposed during the autumn and winter which can increase erosion and sediment levels in watercourses.

Plants can reach 2m in height and they produce trumpet like pink flowers during spring and continuously until the first frost (see Figure 2-9). The mature seed pods are explosive and can spread the seeds up to 7m from the parent plant when touched. The seeds are also dispersed by water and can remain viable in a watercourse for up to two years.

Figure 2-9 Himalayan Balsam in flower © GBNNSS

2.4.2 Japanese Knotweed

Japanese Knotweed *Fallopia japonica* is a tall bamboo-like plant, native to Japan and North-East Asia. Key features of the plant are its purple, speckled stems, which are zig-zagged, with regular nodes from which further stems grow (See Figure 2-10). The plant has shovel-shaped leaves with a flat base and creamy-white flowers during the summer months. Japanese Knotweed has a high rate of regeneration and spread, reproducing vegetatively from small fragments; consequently this plant should never be flail mowed and undertaking such operations in the vicinity of this plant should be done so with extreme caution.

Rhizomes of Japanese Knotweed can spread up to 7m from the above-ground stand itself and as a result it is important, when working near this species, that a sufficient buffer zone is maintained around the stand itself to prevent disturbing the rhizomes and resulting in the spread of the plant in the locality and further afield.

Figure 2-10 Japanese Knotweed

2.4.3 Giant Hogweed

Giant Hogweed *Heracleum mantegazzianum* resembles native Hogweed *Heracleum sphondylium,* and superficially other umbellifer species such as Cow Parsley *Anthriscus sylvestris.* It can grow to up 5m in height, reaching heights significantly greater than the native species (Figure 2-11). This species was first introduced as an ornamental species in the late 19th Century. Seeds are dispersed by wind or water and can remain viable for up to five years. In water, seeds can float for up to 3 days enabling far reaching dispersal, which is of concern particularly in fast flowing watercourses, where the seeds can travel a significant distance downstream.

Contact with the plant, the sap in particular which is phototoxic, can cause severe blistering and scarring after exposure to sunlight and undertaking any management of this species should therefore be done extremely carefully with appropriate personal protective equipment.

Figure 2-11 Giant Hogweed plant (left © RPS Group Plc) stem, flower head (middle and right © GBNNSS).

2.5 Fauna

2.5.1 American Mink

American Mink *Neovison vison* are a non-native mustelid species, introduced in the 1920s for the fur farming trade. Mink have become established in the wild as a result of escape from these farms and through deliberate release in the 1950s, and they are now found throughout Britain. This species, listed on Schedule 9 to the Wildlife and Countryside Act 1981 (as amended), has significant adverse impacts on native protected wildlife. They are known predators or Water Vole *Arvicola amphibius* and wetland birds (including their eggs). Furthermore, they are known to cause substantial declines in fish populations and are a pest to the fish farming industry.

American Mink (Figure 2-12) resemble the native mustelids Polecat *Mustela putorius and* Otter *Lutra lutra. Mink are considerably smaller than Otter; with Otters often reaching body lengths double that of Mink. With a body length of 30-47cm, Mink are of similar size to Polecat, however unlike Polecat, Mink lack white markings on the face above the upper lip (*Figure 2-13*).*

Mink scats can vary greatly with diet, ranging from solid, sausage-like and 6-8cm long, to liquid. They are deposited in prominent places and have a noticeably pungent odour.

Figure 2-12 American Mink (© Laurie Campbell - http://www.gwct.org.uk/)

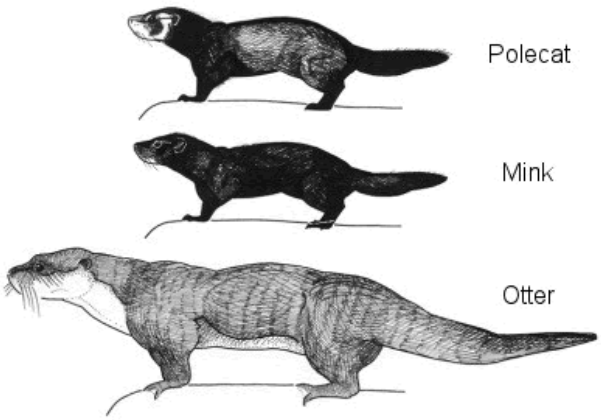

Figure 2-13 Comparing the size of Polecat, Mink and Otter. © www.hikingnature.com

2.5.2 American Signal Crayfish

Following importation to the UK food market in the 1970s, populations of the American Signal Crayfish *Pacifastacus leniusculus* have established in rivers, streams, canals, lakes and reservoirs across England, Wales and parts of Scotland. This aggressive invertebrate has adapted to exploit freshwater habitats resulting in the displacement of native flora and fauna, including the native White-clawed Crayfish *Austropotamobius pallipes*. The non-native crayfish also carry Crayfish Plague, a water mould *Aphanomyces astaci*, to which native crayfish species are highly susceptible.

Distinguishing the American Signal Crayfish from the native White-clawed Crayfish is essential. American Signal Crayfish are noticeably larger than the native species and are red-brown in colour, compared to the olive green of the White-clawed Crayfish. Signal Crayfish also have very large claws, with a white or turquoise blotch on the topside of the hinge, which lends to their name. The underside of the claw is also bright red in colour (refer to Figure 2-14). The claws of the native White-clawed Crayfish are much smaller and more in relation to their body size with a pink/white underside. White-clawed Crayfish also have three spines above the cervical groove (located across the carapace) which is unique to this species.

A number of other non-native crayfish species can also be encountered in UK watercourses, however the American Signal Crayfish is the most common.

Figure 2-14 American Signal Crayfish (both, © GBNNSS)

3 Distribution within Drainage District

3.1 Introduction

The presence of non-native invasive species has been recorded in the Ancholme drainage district following walkover surveys undertaken between 2003 and 2012. Historical ecological data has also been requested from the Lincolnshire Wildlife Trust and Lincolnshire Ecological Records Centre and post-1990 downloaded from the Environment Agency Geostore (Environment Agency, 2012). Section 2 of this report focuses on a wide range of non-native invasive flora and fauna that have the potential to significantly adversely affect the biodiversity in the district.

Five non-native invasive species have been recorded in the district: Canadian Waterweed, Nuttall's Waterweed, Giant Hogweed, Himalayan Balsam and American Mink.

3.2 Species Records

The distributions of the non-native invasive species that have been recorded within the district are shown in

Figure 3-4 to Figure 3-5 below. Further detail regarding the species records, including year and approximate location are given in Table 3-1.

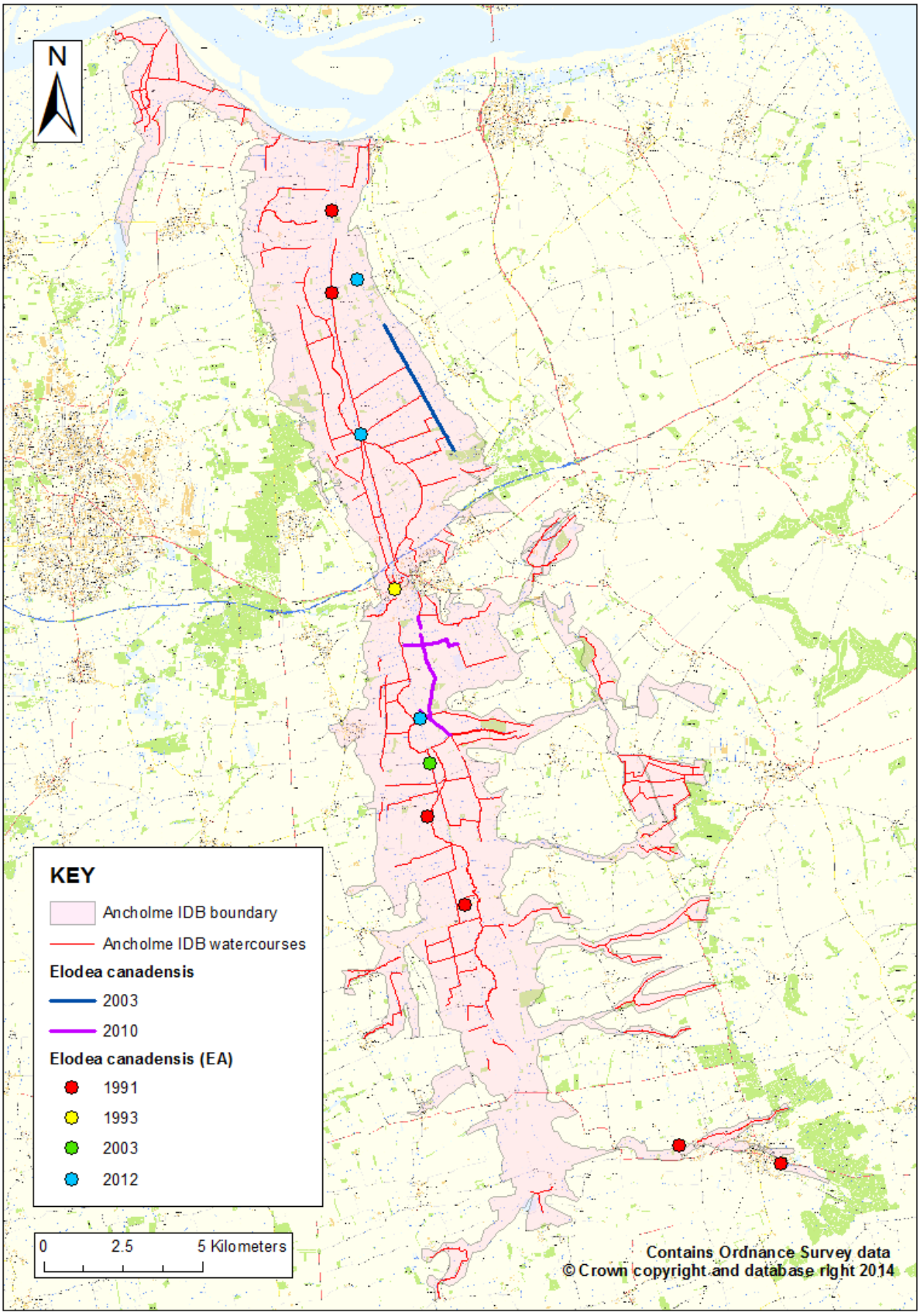

Figure 3-1 Distribution of Canadian Waterweed in the Ancholme district (both IDB and Environment Agency (EA) records)

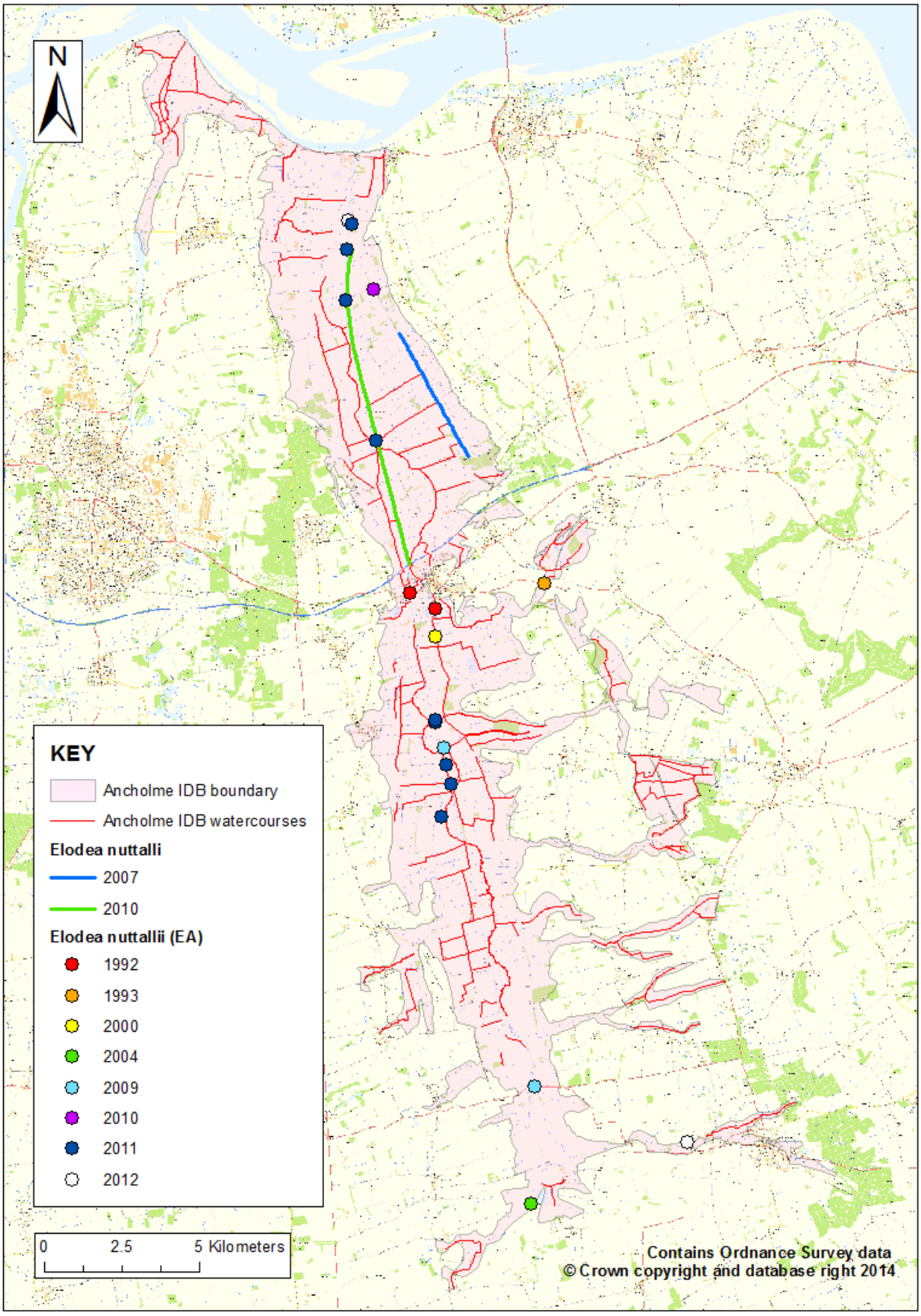

Figure 3-2 Distribution of Nuttall's Waterweed in the Ancholme district (both IDB and EA records)

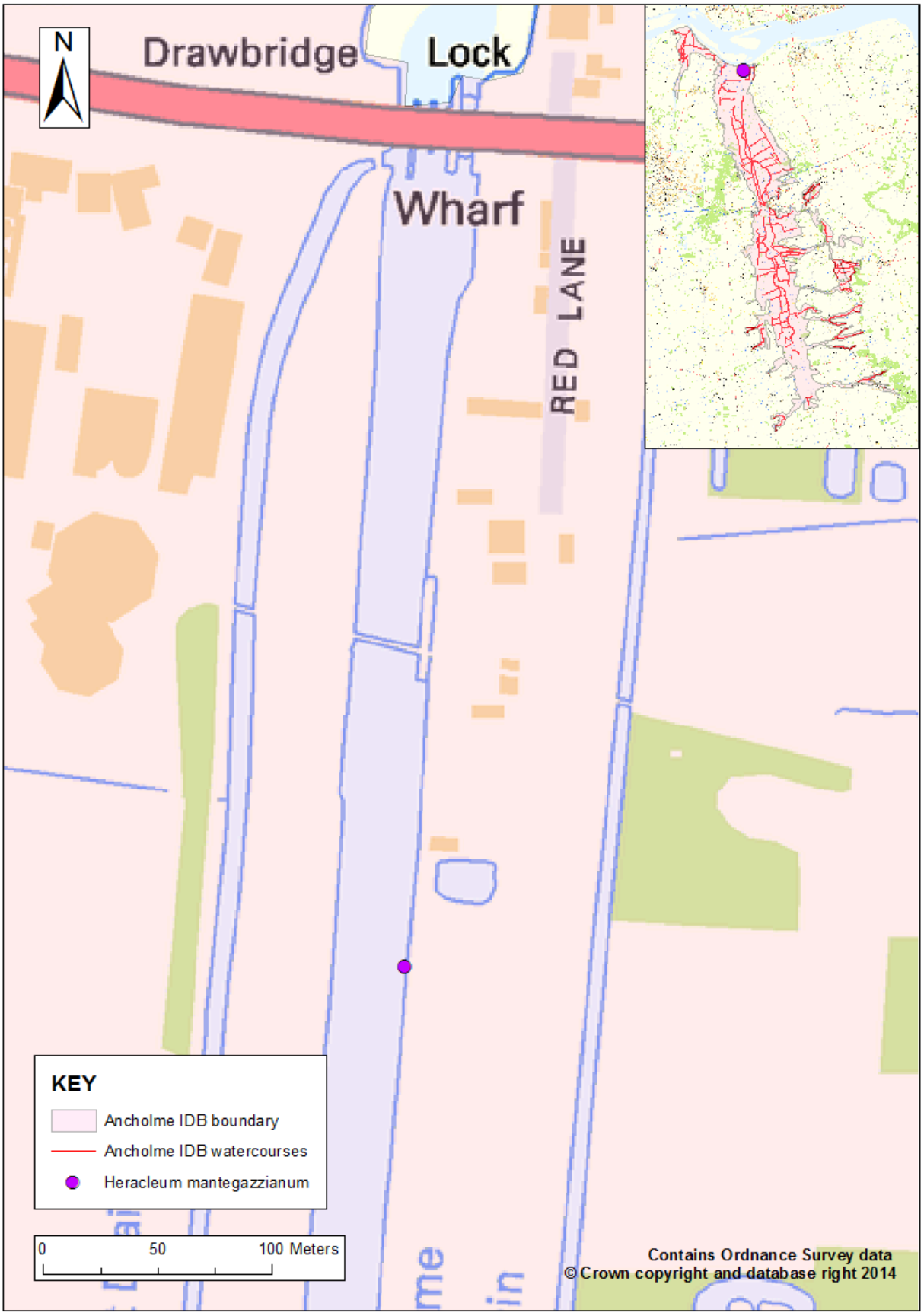

Figure 3-3 Distribution of Giant Hogweed in the Ancholme district

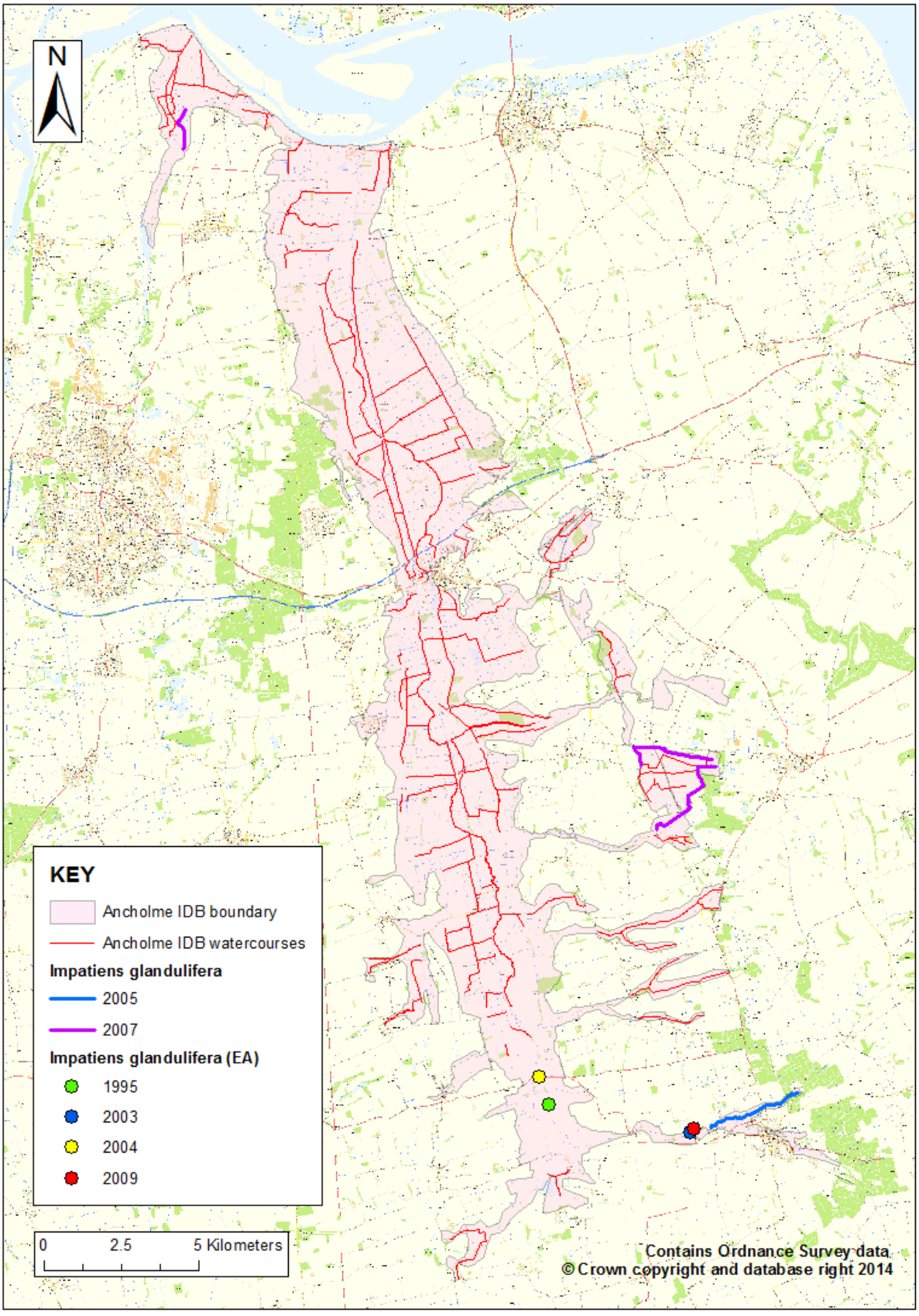

Figure 3-4 Distribution of Himalayan Balsam in the Ancholme District (both IDB and EA records)

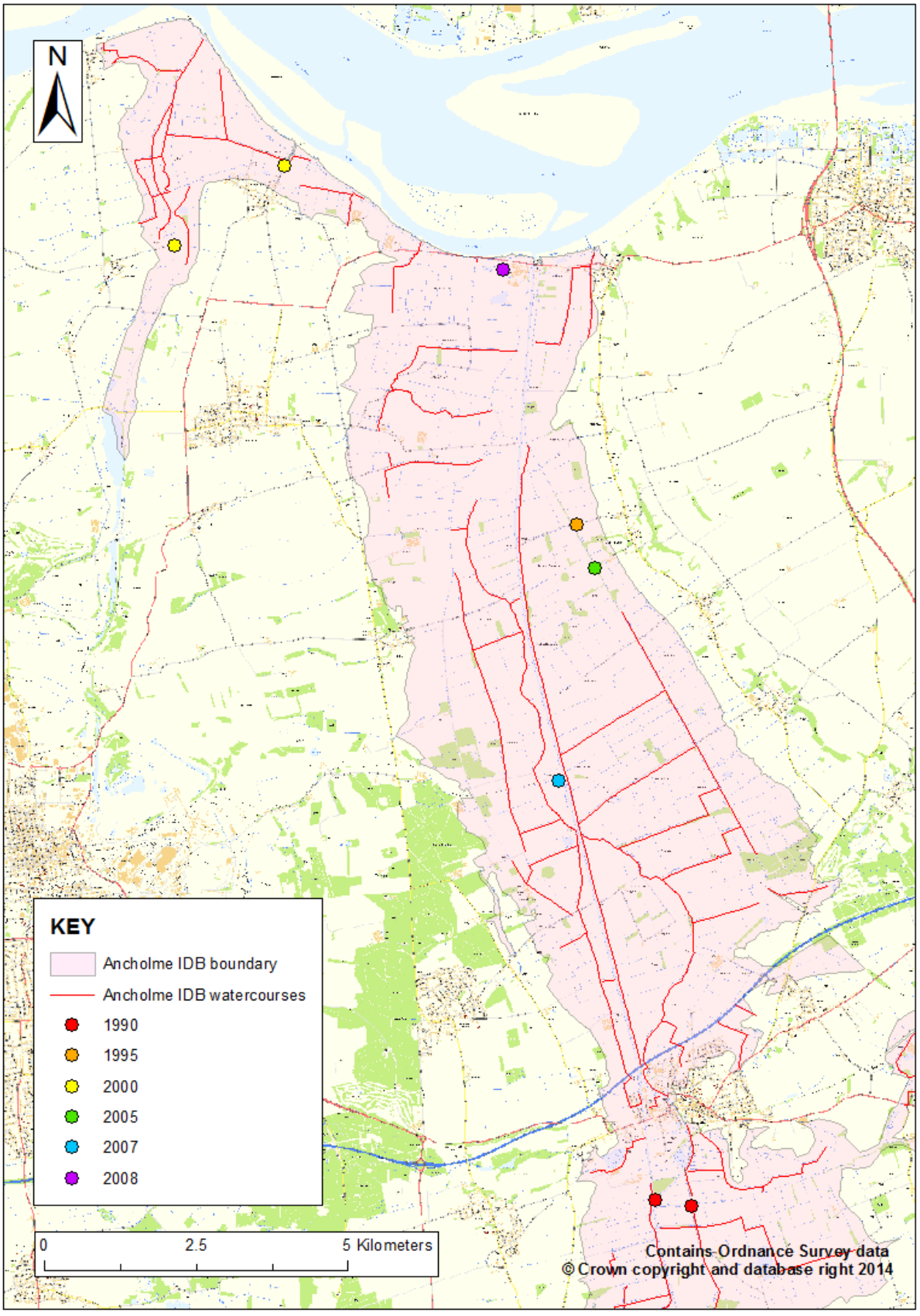

Figure 3-5 Distribution of American Mink in the Ancholme District

Table 3-1: Non-native species records for the Ancholme District. The location of each record is accurate to the drain or an approximate grid reference.

Species	Location	Year
Canadian Waterweed *Elodea canadensis*	Faraway & Thirty foot drains	2010
	Newstead Drain West	2010
	North Eastern Area Soak Drain	2003
	SE9730019001	1991
	SE9729916401	1991
	TF1150088800	1991
	TF0830089400	1991
	TF0149997000	1991
	TF0030099800	1991
	SE9930007000	1993
	TA0040001500	2003
	SE9810016800	2012
	SE9820011900	2012
	TA0010002900	2012
Nuttall's Waterweed *Elodea nuttallii*	North Eastern Area Soak Drain	2007
	Weir Dyke	2010
	TA0010006500	1992
	SE9930007000	1992
	TF0030099800	1993
	TA0360007300	1993
	TA0010005600	2000
	TF0320087300	2004
	TF0330091100	2009
	TA0040002000	2009
	SE9810016800	2010
	SE9740018900	2011
	SE9726518076	2011
	SE9722116439	2011
	TF0029899800	2011
	TA0062300831	2011
	TA0044401452	2011
	TA0012102810	2011
	TA0010002900	2011
	SE9820011900	2011
	SE9729819000	2012
	TF0820089301	2012
Giant Hogweed *Heracleum mantegazzianum*	SE 97500 20701	2000

Species	Location	Year
Himalayan Balsam *Impatiens glandulifera*	TF 03596 90208	1995
	TF 08199 89298	2003
	TF 03299 91102	2004
	TF 08301 89401	2009
	Brimmer Beck	2005
	Mission Church Drain	2007
	Cutley Beck	2007
	Cliff Drain	2007
	Nettleton Beck	2007
American Mink *Neovison vison*	SE995057	1990
	SE982168	1995
	SE985161	1995
	TA001056	1990
	SE916214	2000
	SE934227	2000
	SE979126	2007
	SE9721	2008

4 Implications and Potential for Control

4.1 Introduction

The effective control of non-native invasive species can help to prevent the deterioration of aquatic and riparian habitats. Eradicating established or widespread populations of non-native invasive species can also promote the re-colonisation of native flora and fauna, thus enhancing native species biodiversity.

In addition to environmental benefits, the advantages of controlling non-native, invasive species also include:

- Preventing legal prosecution
- Reducing flood risk
- Promoting the normal functioning of drains, including water flow
- Avoiding a need for excessive future management costs

4.2 Implications for Maintenance

4.2.1 Biosecurity

A fundamental aspect of controlling the spread of non-native invasive species and disease is the implementation of appropriate biosecurity measures. The success of invasive non-native species owes partly to their capacity to reproduce and disperse quickly and out-compete native flora and fauna. By ensuring that appropriate protocol is in place, such as the use of disinfectants and following Defra's **Check-Clean-Dry** campaign (see below), the human spread of these species can be limited.

4.2.2 Check Clean Dry

Defra's campaign to help stop the spread of non-native invasive plants and animals consists of three main points:

- ***Check*** – Ensuring that all equipment, machinery and vehicles are free from mud, plant or other organic matter.
- ***Clean*** – Equipment should be hosed down or pressure washed on site. Any washings should not be allowed to enter another watercourse or drainage system other than the water body where the equipment was used. Where possible, chemical disinfectant should be used at the appropriate dilution to kill diseases.
- ***Dry*** – Equipment should be thoroughly dried for 48 hours before being used elsewhere. Some non-native organisms can survive in damp conditions for up to 15 days and in dry conditions for up to 2 days. Thoroughly drying equipment is one of the best disinfection methods.

Further information can be found at: http://www.nonnativespecies.org/checkcleandry/.

5 Potential Control Techniques

Section 5.1 details possible control techniques for each of the species recorded within the Ancholme drainage district. It is important to note that any control methods must be fully assessed for suitability before implementation and that site-specific control methods are used. Tailoring the control technique to the site will ensure that the control effort is as efficient as possible, which will have obvious economic and biodiversity benefits.

5.1 Flora

5.1.1 *Elodea* Species

Table 5-1 describes potential control techniques for Canadian Waterweed and Nuttall's Waterweed and the advantages and limitations of each method.

Table 5-1 Potential Control Techniques applicable for Canadian Waterweed and Nuttall's Waterweed

Control Technique	Method	Summary
Mechanical clearance	Areas of infestation can be cut and removed from the waterbody (either by weed bucket, weed boat or with a solid bucket) before being deposited on the bank tops in small piles to naturally decompose. Large quantities of the plant should be removed from the site entirely and used for composting or alternative disposal ([1]Newman, J.R. and Duenas, M.A., 2010 and [2]Newman, J.R. and Duenas, M.A., 2010). March to September is the optimum time for physical control.	**Advantages:** Direct control method which will not adversely affect native flora in the long-term. Impact on water flow is instantaneous. Continued and regular cutting will weaken the plants and reduce the infestation **Disadvantages:** This method is only a short-term solution and so repetition will be needed which is likely to be costly and time consuming.
Manual pulling	A hand pulling technique, using rakes or other tools, can be adopted followed by disposing the vegetation on the banks or by composting away from the infested area ([1] Angling Trust, 2010). March to September is the optimum time for physical control.	**Advantages:** Easy, direct control method which will not adversely affect native flora in the long-term. It is also inexpensive. **Disadvantages:** This method can be time-consuming and can only be carried out if there is good access available ([1]Angling Trust, 2010). This method is only a short-term solution and so repetition may be needed which is likely to be costly and time consuming.
Plant suppression with shading from vegetation	Planting of trees/hedgerows or native, floating broad-leaved species to generate shade to limit growth.	**Advantages:** Technique works with natural process and may minimise long-term management needs. Woody vegetation can help with bank stability and improve water quality. **Disadvantages:** Non-selective and can reduce species-richness. Woody vegetation can restrict access for other maintenance.

Control Technique	Method	Summary
		Vegetation planted will also require management.
Plant suppression with shading with opaque materials	Cover submerged growth with jute matting, weighted down with stones, as developed by Inland Fisheries Ireland ([1]Angling Trust, 2010).	*Advantages* Potentially low labour intensity.
		Disadvantages Untested, and only suitable where there is limited obstructions and an even substrate ([1]Angling Trust, 2010). Cannot be used over long lengths of watercourse and expensive. Non-selective and a risk of deoxygenation.

5.1.2 Giant Hogweed

Table 5-2 describes potential control techniques for Giant Hogweed and the advantages and limitations of each method.

Table 5-2 Potential Control Techniques applicable for Giant Hogweed

Control Technique	Method	Summary
Herbicide Treatment	An application of a glyphosate=based herbicide, usually done with a knapsack sprayer, is effective in controlling the plant. The best time to apply is between March and May, before flowering (6CEH, 2004). This method is most successful in combination with hand cutting and mechanical control. Future spot treatment may be required to control any new growth, and repeated treatments may be required.	**Advantages:** Quick application and effective controller. **Disadvantages:** A license from the Environment Agency will be required prior to the application of herbicide near to water. Chemical control may adversely impact upon any surrounding native flora. Repeat treatments are likely to be needed.
Hand Cutting	Hand cutting can be undertaken if the operator is wearing full appropriate personal protective equipment (6CEH, 2004). It must be done before flowering (May-June) and can provide short-term control.	**Advantages:** Hand cutting is effective in targeting the area of infestation and is effective at controlling small stands. **Disadvantages:** Risk of contact with toxic plant material. Cutting alone will only control growth and will not permanently eradicate the infestation. Repeat cutting operations are likely to be needed.
Mechanical Control	Small areas of infestation can be excavated by digging, to at least 10cm below ground level, whilst larger infestations may be controlled by deep cultivation (ploughing) although this is likely to be impractical on some steep/unstable river and drain banks (6CEH, 2004).	**Advantages:** Can limit the potential for re-growth by damaging the rootstock **Disadvantages:** Mechanical control is restricted to areas away from the edge of watercourses and wherever access is possible. Significant disturbance to soils may result in silt mobilisation.

Methods to control areas of Giant Hogweed are restricted by the toxic nature of this plant. Care should, therefore, be taken to avoid any contact with the plant when identifying, monitoring and controlling infestation.

Disposal of Giant Hogweed

Giant Hogweed plant material is classified as 'controlled waste' and requires correct disposal procedures to be followed in order to avoid committing an offence under the Environmental Protection Act (1990) and Wildlife and Countryside Act (1981, as amended). The Local Authority should be contacted to see whether they offer a collection service or can provide a list of sites that will accept Giant Hogweed.

5.1.3 Himalayan Balsam

Table 5-3 describes potential control techniques for Himalayan Balsam and the advantages and limitations of each method.

Table 5-3 Potential Control Techniques applicable for Himalayan balsam

Control Technique	Method	Summary
Herbicide Treatment	A glyphosate-based herbcicide can be sprayed onto areas of infestation during spring; before the plant begins to flower ([5]CEH, 2004).	**Advantages:** Quick application and effective controller. **Disadvantages:** A license from the Environment Agency will be required prior to the application of herbicide near to water.
Hand Pulling	Manual pulling may be effective in controlling or eradicating small plants which feature shallow roots. Given that the seed bank for this species survives for approximately 18 months, this method can be applied for two years before the plant is successfully eradicated ([5]CEH, 2004).	**Advantages:** Inexpensive and can eradicate small areas of Himalayan balsam. Can be implemented by volunteer groups. **Disadvantages:** This method is only restricted to small areas of infestation and may require multiple efforts to achieve long term eradication. This method is also restricted to outside of the seeding period.
Mechanical Control	The plant is cut below the lowest node, either by hand or with machinery. This is followed with regular mowing ([5]CEH, 2004).	**Advantages:** An effective technique for removing the largest extents of the infestation. **Disadvantages:** Mechanical control is restricted to areas where access is possible. Repeated efforts may be needed which is likely to be costly and time consuming. This method is also restricted to outside of the seeding period.

Avoiding the spread of Himalayan Balsam during control

Should the infestation be located immediately alongside (i.e. within 7-10 m) of a watercourse, all control/eradication efforts and drainage maintenance activities, which are likely to disturb the infestation, should avoid the period in which adult plants develop seed-bearing pods (generally June until early-mid October) (Environment Agency, 2010). Alternatively, extreme care must be taken to ensure that all equipment used at the location of infestation is free of any seeds before leaving the site. It is recommended that a designated cleaning area is established close to the area containing the infestation.

5.2 Fauna

5.2.1 American Mink

Table 5-4 shows potential control techniques for American Mink and the advantages and limitations of each method.

Table 5-4 Potential Control Techniques applicable for American Mink

Control Technique	Method	Summary
Trapping and Shooting	Baited cage traps are placed in locations of known Mink presence and checked once a day. Non-target species are released and Mink are humanely dispatched, whilst still in the trap, with a powerful airgun (Rural Development Service, 2005). Cages preferably should be set up on rafts, as described in the Game and Wildlife Conservation Trust guidance as it enables a more efficient trapping effort and reduces chances of non-target species capture (GWCT, 2007).	**Advantages:** Direct control of Mink where presence is confirmed. Quick and humane method of control. **Disadvantages:** This technique should only be carried out by a licensed and suitably experienced person. Although there is a possibility that curious Mink will explore the cage traps, there is no guarantee that the traps will be successful at a location used by Mink.
Encourage Otter *Lutra lutra* populations	Otters are territorial mammals that are known to kill and eat Mink, and they also occupy similar habitats. Therefore, the encouragement of Otter populations could reduce populations of Mink along watercourses (Bonesi and MacDonald, 2004). This could be achieved through the enhancement/ introduction of habitats and ecological features for Otter, combined with managing the watercourses in a manner that is sympathetic to Otter.	**Advantages:** Encourages an increase in native Otter populations as well as potentially controlling Mink. **Disadvantages:** Studies are still being carried out on the interspecific relationship between Otter and Mink. New habitat opportunities for Otter could be exploited by Mink and there is no guarantee that Otter populations will increase with correct management and provision of ecological features. This method is only likely to be successful along drains that already support Otter populations.

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