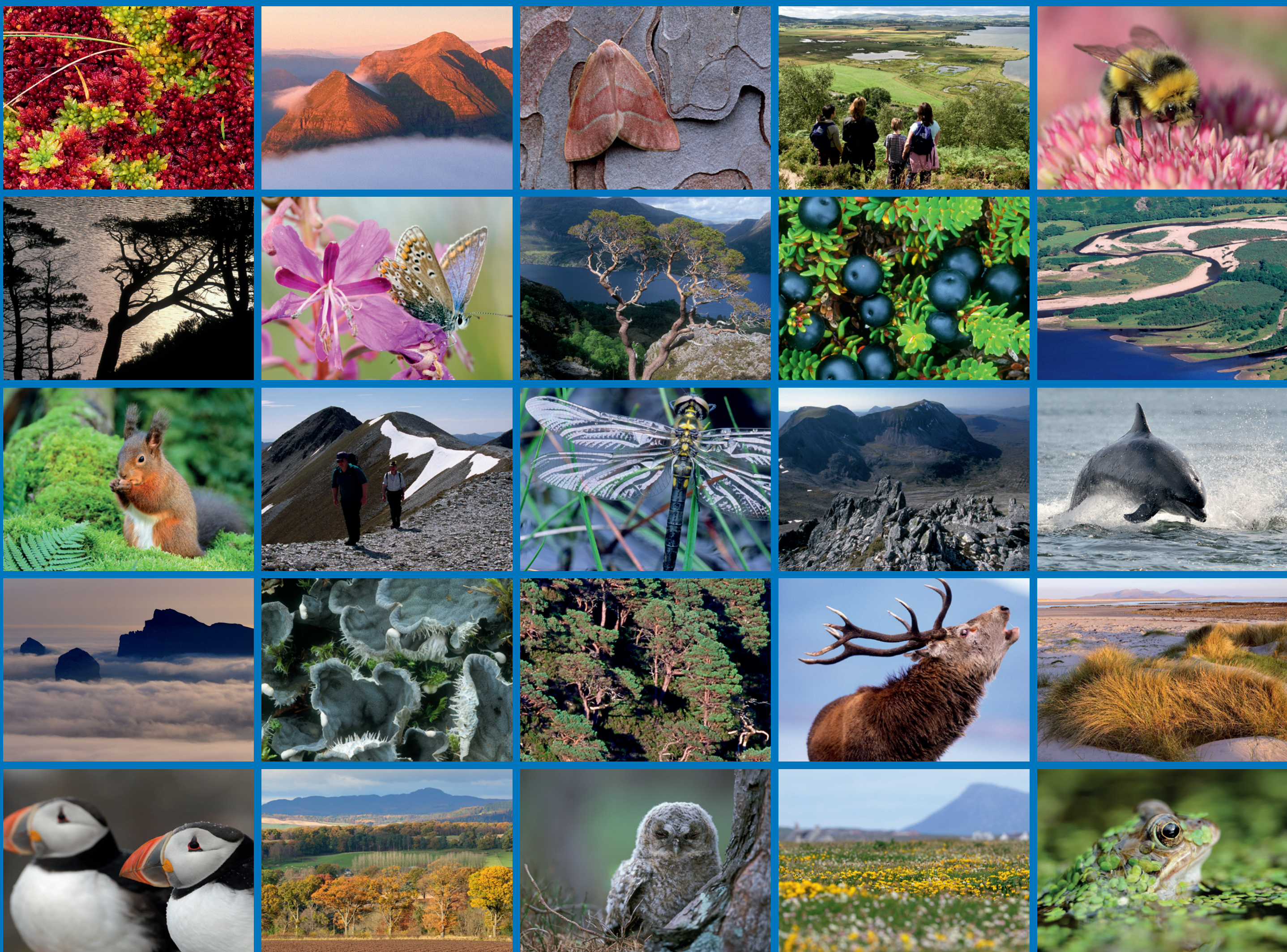
Scottish Natural Heritage
Research Report No. 979

# INNS Strategy for the Clyde Catchment – strategy report



Scottish Natural Heritage
Dualchas Nàdair na h-Alba
nature.scot

# RESEARCH REPORT

**Research Report No. 979**

## INNS Strategy for the Clyde Catchment – strategy report

For further information on this report please contact:

Gail Foster
Scottish Natural Heritage
Cadzow Court
3 Wellhall Road
HAMILTON
ML3 9BG
Telephone: 01698 477907
E-mail: gail.foster@nature.scot

This report should be quoted as:

McGillivray, C., Grimmond, K. & Yeomans, W. 2019. INNS Strategy for the Clyde Catchment – strategy report. *Scottish Natural Heritage Research Report No. 979.*

# RESEARCH REPORT
# Summary

## INNS Strategy for the Clyde Catchment – strategy report

**Research Report No. 979**
**Project No: 014649**
**Contractor: Clyde River Foundation**
**Year of publication: 2019**

**Keywords**

INNS; River Clyde Catchment; Japanese knotweed; Himalayan balsam; Giant hogweed

**Background**

The Clyde River Foundation (CRF) was contracted by Scottish Natural Heritage (SNH) to develop an Invasive Non-native Plant Species (INNS) Management Strategy and Action Plan for the Clyde Catchment upstream of the Glasgow Tidal Weir in response to a priority action identified in the River Basin Management Plan. The three species of concern were Japanese knotweed (*Fallopia japonica*), Giant hogweed (*Heracleum mantegazzianum*) and Himalayan balsam (*Impatiens glandulifera*) and the project reviewed and mapped the distribution of each, while identifying gaps in current knowledge. This report suggests a strategy for the treatment of the three INNS, based upon our experience collating historical data, collecting distribution information using a rapid "bridge-hopping" survey, and ground-truthing the method by undertaking targeted walkover surveys to determine the upstream extent of the INNS in three sub-catchments.

**Main findings**

- At least 328 km (12.2%) of the 2692 km of river length in the study area have either been colonised or are at high risk of colonisation from upstream by at least one of the three INNS of concern.
- Distribution surveys should be completed as the highest priority across the study area, then the remainder of the Clyde catchment to fully document the scale of the INNS problem in the system.
- The upstream limit of riparian INNS must be confirmed before treatment.
- All treatments must proceed in a downstream direction.
- Isolated outlying INNS should be targeted as an early response to try and prevent downstream spread into stretches that are otherwise INNS-free.
- Strategic priorities for future surveying, treatment and management are discussed and three Pilot Studies scoped.

- The appointment of a dedicated INNS Control Officer for the study area (and perhaps the wider Clyde catchment) is recommended to build dedicated capacity for survey, treatment, monitoring and assessment of control and eradication measures.

*For further information on this project contact*:
Gail Foster, Scottish Natural Heritage, Cadzow Court, 3 Wellhall Road, Hamilton, ML3 9BG.
Tel: 01698 477907 or gail.foster@nature.scot
*For further information on the SNH Research & Technical Support Programme contact:*
Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725000 or research@nature.scot.

**Table of Contents** **Page**

# 1. INTRODUCTION

The Clyde River Foundation (CRF) was contracted by Scottish Natural Heritage (SNH) to develop an Invasive Non-native Plant Species (INNS) Management Strategy and Action Plan for the Clyde Catchment upstream of the Glasgow Tidal Weir in response to a priority action identified in the River Basin Management Plan. The three main species of concern are Japanese knotweed (*Fallopia japonica*), Giant hogweed (*Heracleum mantegazzianum*) and Himalayan balsam (*Impatiens glandulifera*) and the first phases of the project reviewed and mapped the known distribution of each. The maps provided a clear exposition of gaps in knowledge of the known distribution of the three species over the study area and a novel field method was deployed in an attempt to complete the geographical survey coverage and to prioritise areas for early action.

This third, and final, report summarises the findings from the previous phases and suggests strategies which might be used in future management of the three species. Essentially, the options can be categorised as:

i) do nothing;
ii) continue piecemeal treatment; or
iii) undertake strategic, targeted treatment/removal.

The first two options are the *status quo*, while this study makes a case for considering the latter.

## 2. SURVEY AREA

The survey area covers parts of the City of Glasgow and North and South Lanarkshire. The area contains a total of 2,692 km of double-bank linear riparian habitat (CEH Digital River Map 1:50 000) (Figure 1 and Figure 1a) although it is acknowledged that the species of interest may occur away from rivers.

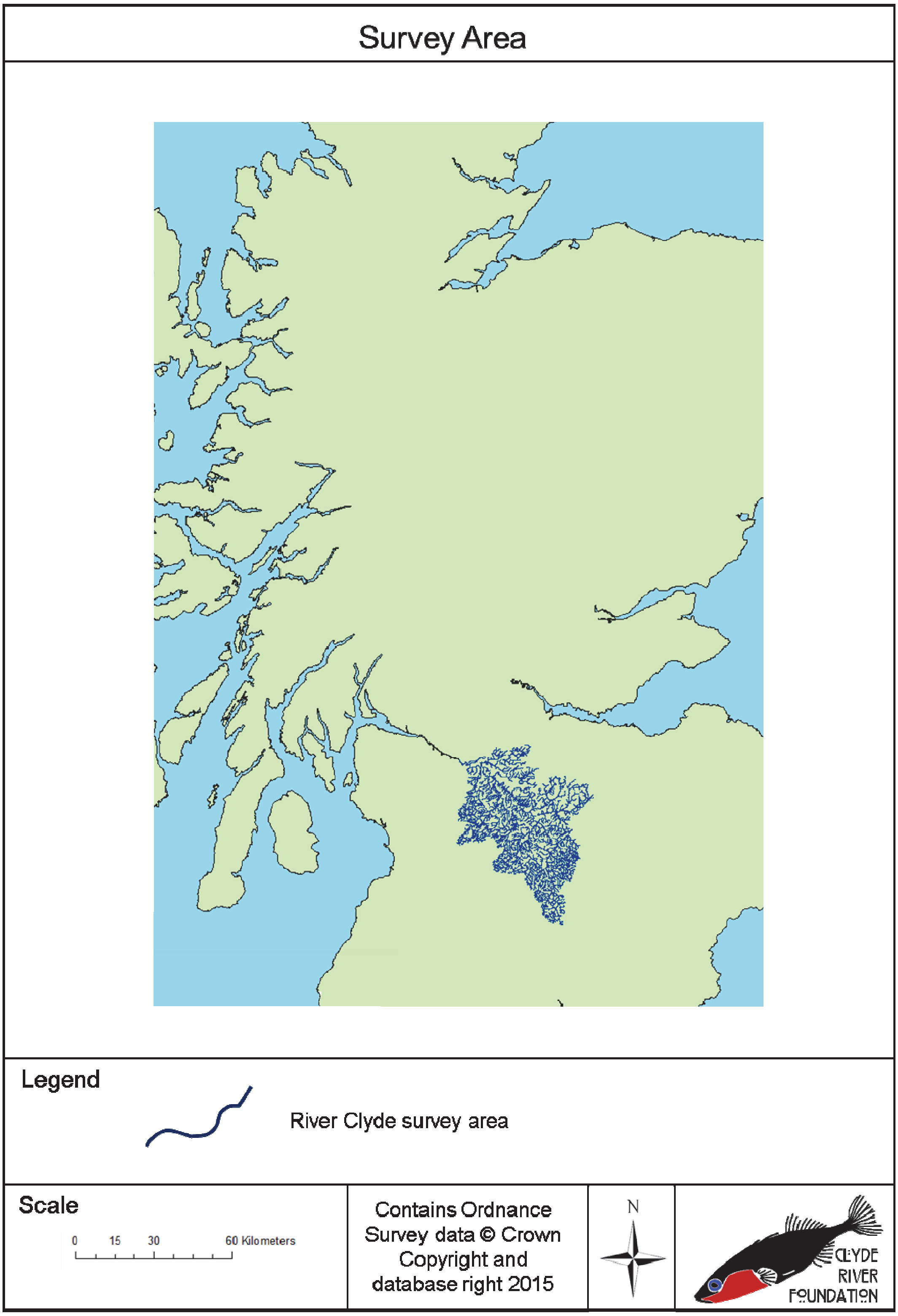



*Figure 1. Survey Area: The River Clyde upstream of the Tidal Weir in Glasgow.*

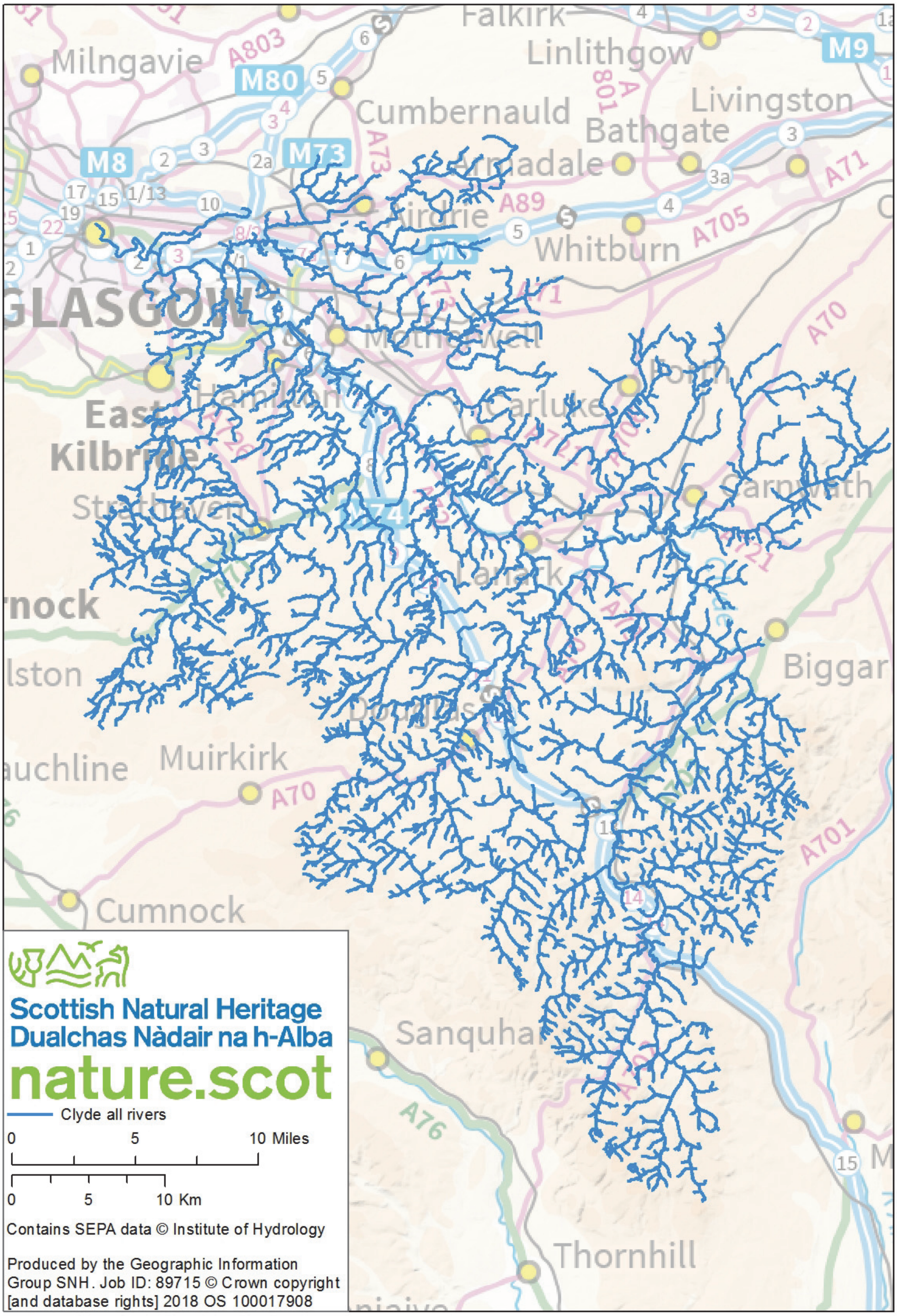



*Figure 2a. Survey Area Expanded: The River Clyde upstream of the Tidal Weir in Glasgow.*

## 3. PLANT DISTRIBUTION

Results from desk and field surveys carried out in 2015[1,2] identified known locations of the three species of concern and the areas at risk of colonisation from plants located upstream (Figure 2 - Japanese knotweed, Figure 3 - Himalayan balsam and Figure 4 - Giant hogweed). The known lengths of river colonised and at risk from upstream plants are quantified in Table 1.

*Table 1. River length in the study area colonised or with a high likelihood of colonisation by riparian INNS (where the total river length is 2692.17 km).*

| INNS | Length of River Colonised | |
|---|---|---|
| | km | % of total river length |
| Japanese knotweed | 303.70 | 11.28 |
| Giant hogweed | 118.03 | 4.38 |
| Himalayan balsam | 110.09 | 4.09 |
| **Three INNS combined (including overlaps)** | **328.61** | **12.21** |

**Note:** the red distribution line in Figure 2 was added following the discovery of a single stand of Japanese knotweed near Abington in 2017. It adds an extra 50km of vulnerable riparian habitat to that discussed for Japanese knotweed in the text. A rapid response to this particular record could be a particularly cost-effective intervention.

[1] McGillivray, C. & Yeomans, W. 2019a. INNS Strategy for the Clyde Catchment – collation report. *Scottish Natural Heritage Research Report No. 977*.

[2] McGillivray, C. & Yeomans, W. 2019b. INNS Strategy for the Clyde Catchment – field report. *Scottish Natural Heritage Research Report No. 978*.

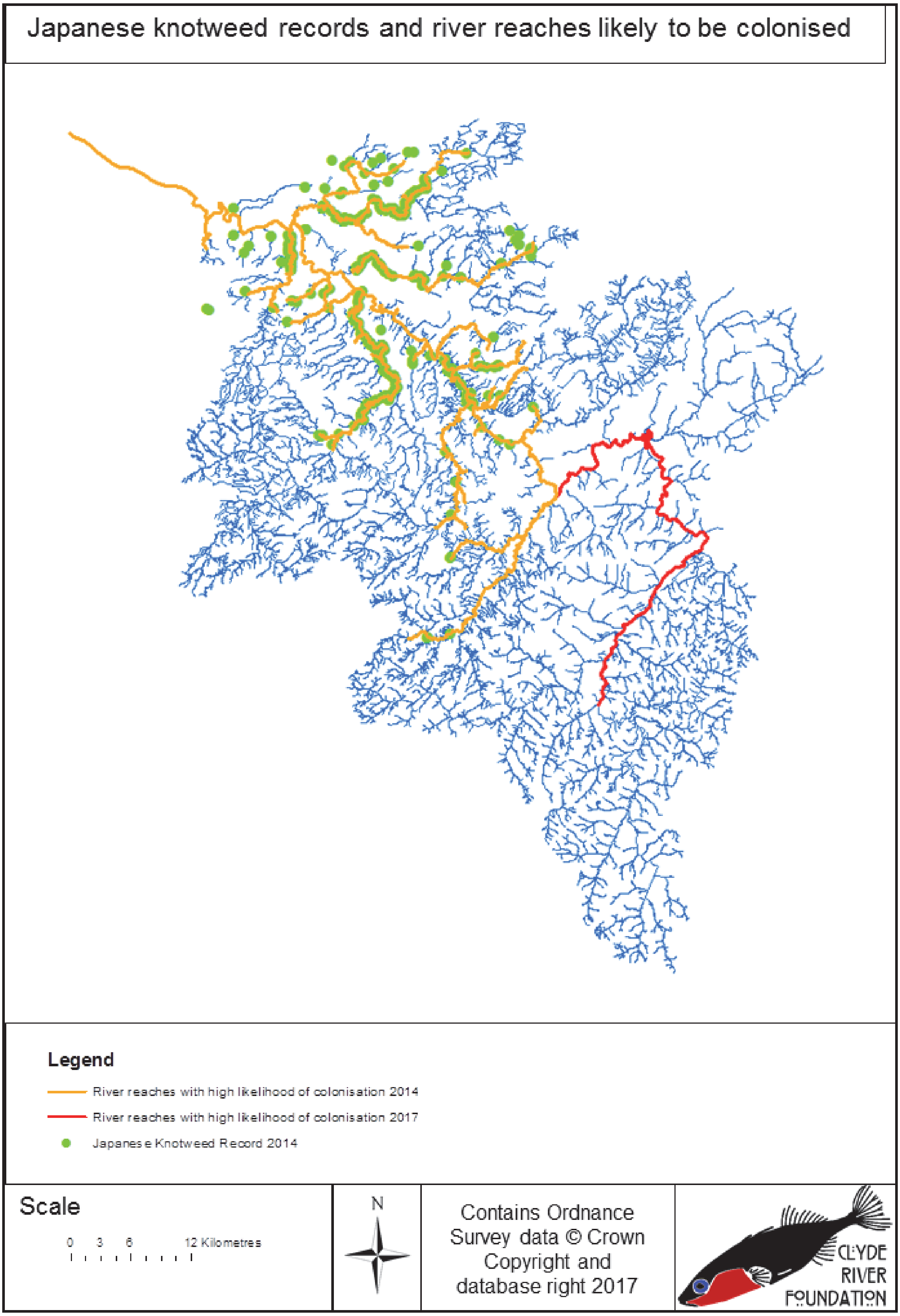



*Figure 3. Japanese knotweed records and river reaches likely to be colonised in a downstream direction due to upstream presence of Japanese knotweed.*

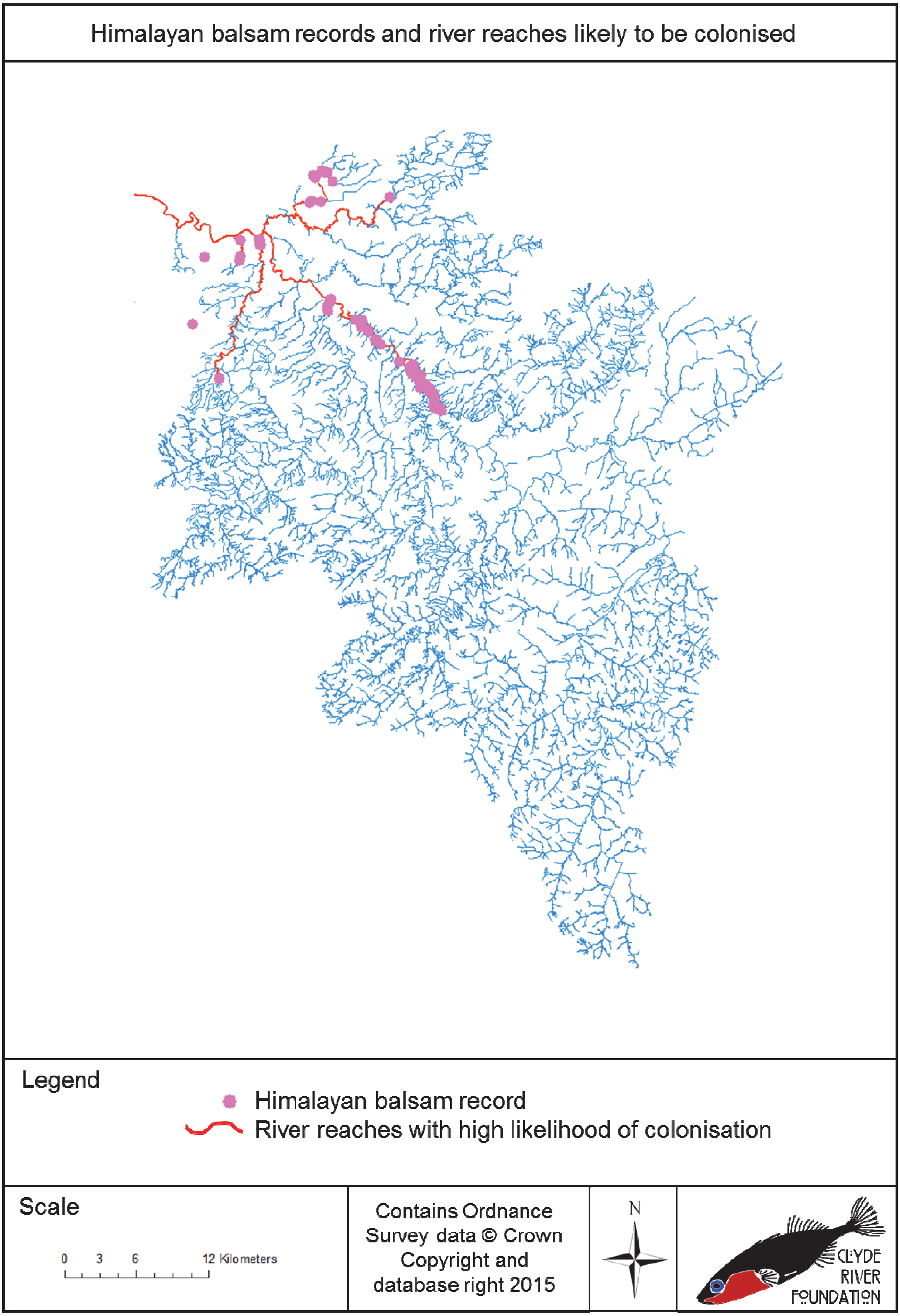



*Figure 4. Himalayan balsam records and river reaches likely to be colonised in a downstream direction due to upstream presence of Himalayan balsam.*

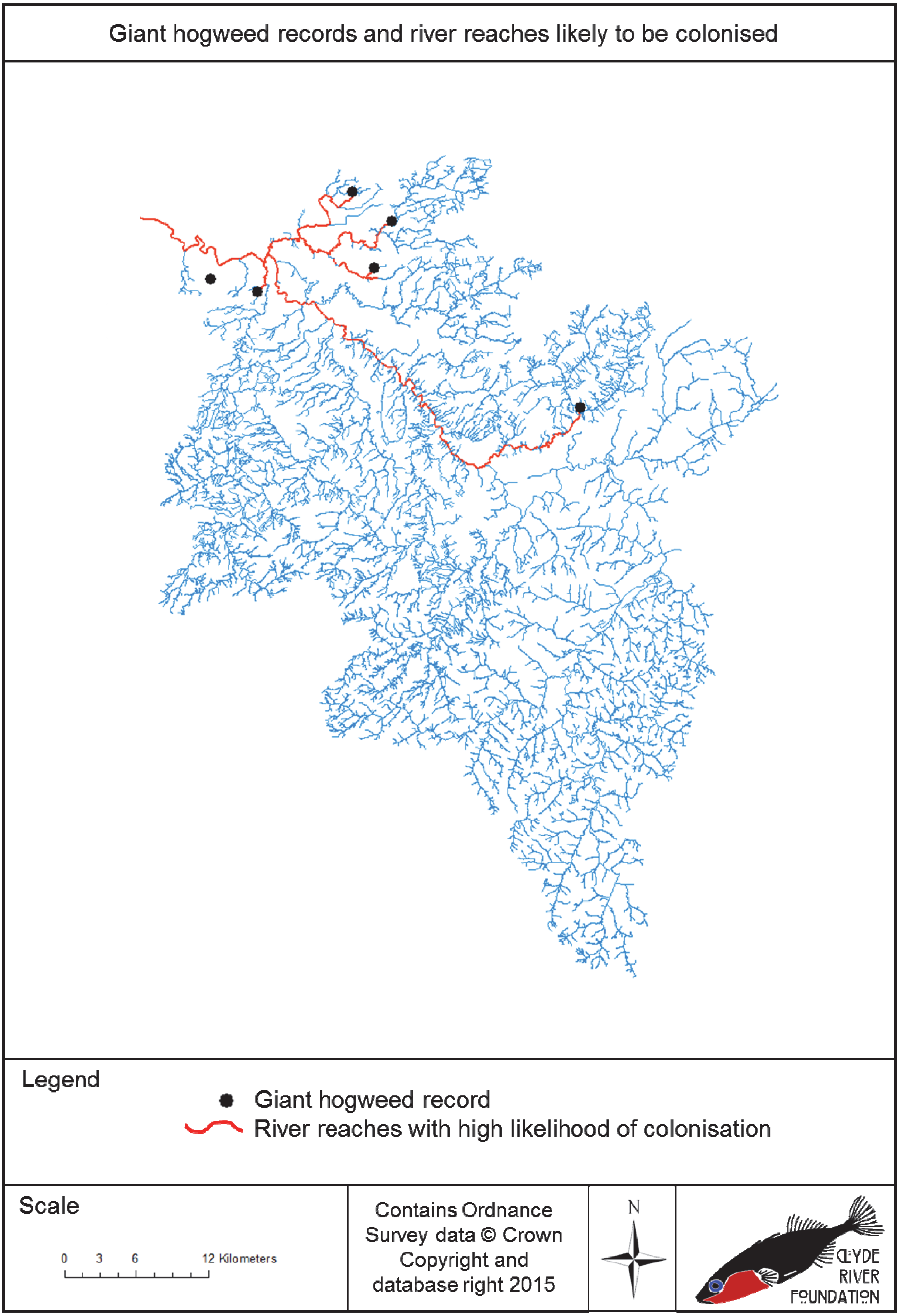



*Figure 5. Giant hogweed records and river reaches likely to be colonised in a downstream direction due to upstream presence of Giant hogweed.*

### 3.1 Catchment survey bridge coverage

The aspirational target of covering the entire study area was not met because the data set of bridge locations provided by the Central Scotland Green Network Trust (CSGNT) was found to be incomplete. It is thought that the data sets used to produce the CSGNT GIS layer showing bridge crossings were referenced against a river network mapped at scale of 1:50,000, which frequently omits smaller watercourses. When reviewed, therefore, many existing road crossings were not identified (these were added from more detailed maps held by the CRF).

A total of 535 bridges were used for surveying (Figure 5). Some 107 bridges were not surveyed from because INNS were already known to be upstream. It is thought that the sub-catchments still to be surveyed in the study area, because they are relatively rural, will contain fewer unidentified bridges but will take longer to survey on average because of increased travel time between sites. A minimum of 213 bridges remain which can be used for surveying in the area of interest.

It is estimated that 20 man-days are required to complete the bridge-hopping survey (10 days for a two person survey team) and this is an essential pre-requisite for efficient treatment of the study area.

### 3.2 Walkover survey

The bridge-hopping survey results were ground-truthed using a walkover survey to determine the furthest upstream limit of the INNS colonisation.

The ground-truthing carried out suggests that bridge-hopping is a rapid and accurate method of determining the distribution of INNS across a river catchment. The upstream distribution suggested by bridge-hopping can be determined accurately by a subsequent walkover survey and this method can help fine-tune the distribution map. The combination of these methods will not determine the location of all plants requiring treatment during a control or eradication programme, and therefore it is not a substitute for full walkovers of affected reaches. The upstream limit of colonisation will, however, provide a reference point from which to determine future management options for the control of INNS along the river corridor downstream.

### 3.3 Survey summary

The bridge-hopping survey is a cost effective and rapid mapping method to determine the widespread distribution of INNS across the river network. It should be followed by a walkover survey to identify the upstream limit of the INNS distribution. Bridge-hopping does require accurate base maps of rivers and road networks to enable planners to correctly identify all bridge crossings and field surveyors must be alert to the possible presence of unmapped crossings.

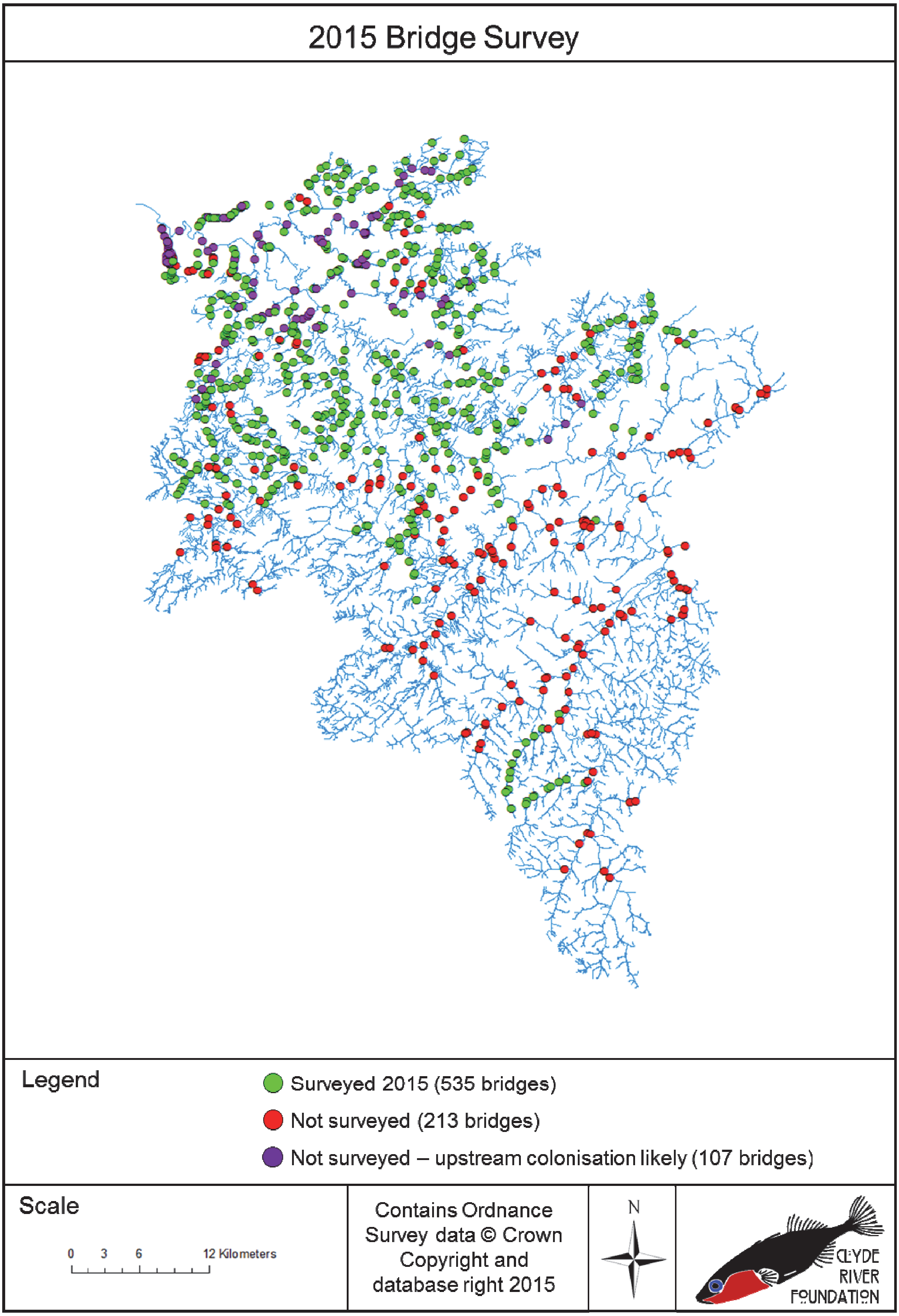



*Figure 6. Coverage achieved by the 2015 bridge-hopping survey.*

# 4. DEVELOPING THE STRATEGY

## 4.1 Scale

The mapping scale of currently available data was a concern in this study. Currently, most users of watercourses rely on the Centre for Ecology and Hydrology (CEH) Digital River Map which is at a scale of 1:50 000. This was proven to be inaccurate in the current survey and not sufficiently detailed to include first and second order streams. The 1:50 000 map omitted at least 374 bridges from the 2015 survey area; only 161 bridges were identified when cross-referenced with the current road network. The CRF has developed its own river network digital map for most of the survey area at a scale of 1:25,000 which identifies most water courses, including 1st order streams and drainage channels, all of which can aid in the dispersal of each of the three INNS. It is therefore essential that when field surveying, operatives do not assume that the location of the crossings with which they have been supplied is comprehensive and should be prepared to undertake *ad hoc* surveys accordingly.

The desk study phase of this project revealed that the distribution data available through current recording schemes such as Plant Tracker and Botanical Society of Britain and Ireland (BSBI) are not reported at a sufficiently high resolution to allow confidence in the location on the ground. When requesting location information from such sources, this should be a National Grid References to at least an eight-figure accuracy, not just the nearest 1,000m square area which is the current level of resolution available in some packages.

It may be that the scale of data mapping is more problematic in urban areas than rural regions. Urban areas see more human activity due to engineering and building works so there is greater change to the natural river network and a greater density of roads. Rural areas tend to be less impacted but this should not be assumed and field surveyors should be alert to unmapped crossings.

## 4.2 River catchment survey coverage

The bridge-hopping method can, by definition, only cover survey reaches downstream of the most upstream bridge on each watercourse. Reaches upstream of the limit of sight at the top bridge in each system ("unsurveyable rivers") require walkover surveys to determine the presence/absence of INNS[3]. In practice, the method makes the assumption that the unsurveyable reaches are INNS-free – this would always be checked in advance of treatment for control or eradication. This assumption is made on the basis that the majority of large-scale INNS spread is mediated by human activity and where access is possible. Lack of road access greatly reduces the chance of passive spread by human activity. The surveys to date have covered 18% of the possible 24% surveyeable river length in the study area (Figure 6). The remaining 76% was considered unsurveyable by the bridge-hopping method but most of these watercourses are located in rural areas, which our surveys suggest are less likely to be colonised by INNS (which appear mainly in urban areas and are often associated with transport links).

## 4.3 Urban vs rural accessibility: a sub-catchment comparison

Accessibility among urban and rural rivers may differ markedly due to differences in road densities. To demonstrate this, three sub-catchments were compared; a predominantly urban river (the North Calder Water), a mixed urban-rural river (the Avon Water) and a rural river (the Camps Water) (Figure 7).

[3] Drone technology may assist in the future assist in surveying some riparian areas, however identification of species on the ground is still currently best practice.

Comparing surveyable river lengths within the three sub-catchments, a larger proportion of the urban North Calder Water was covered because the denser road network provided more data collecting opportunities than did the more rural sub-catchments (Figure 8). When prioritising areas for treatment, accessibility and extent of survey coverage from the bridge hopping survey should be considered.

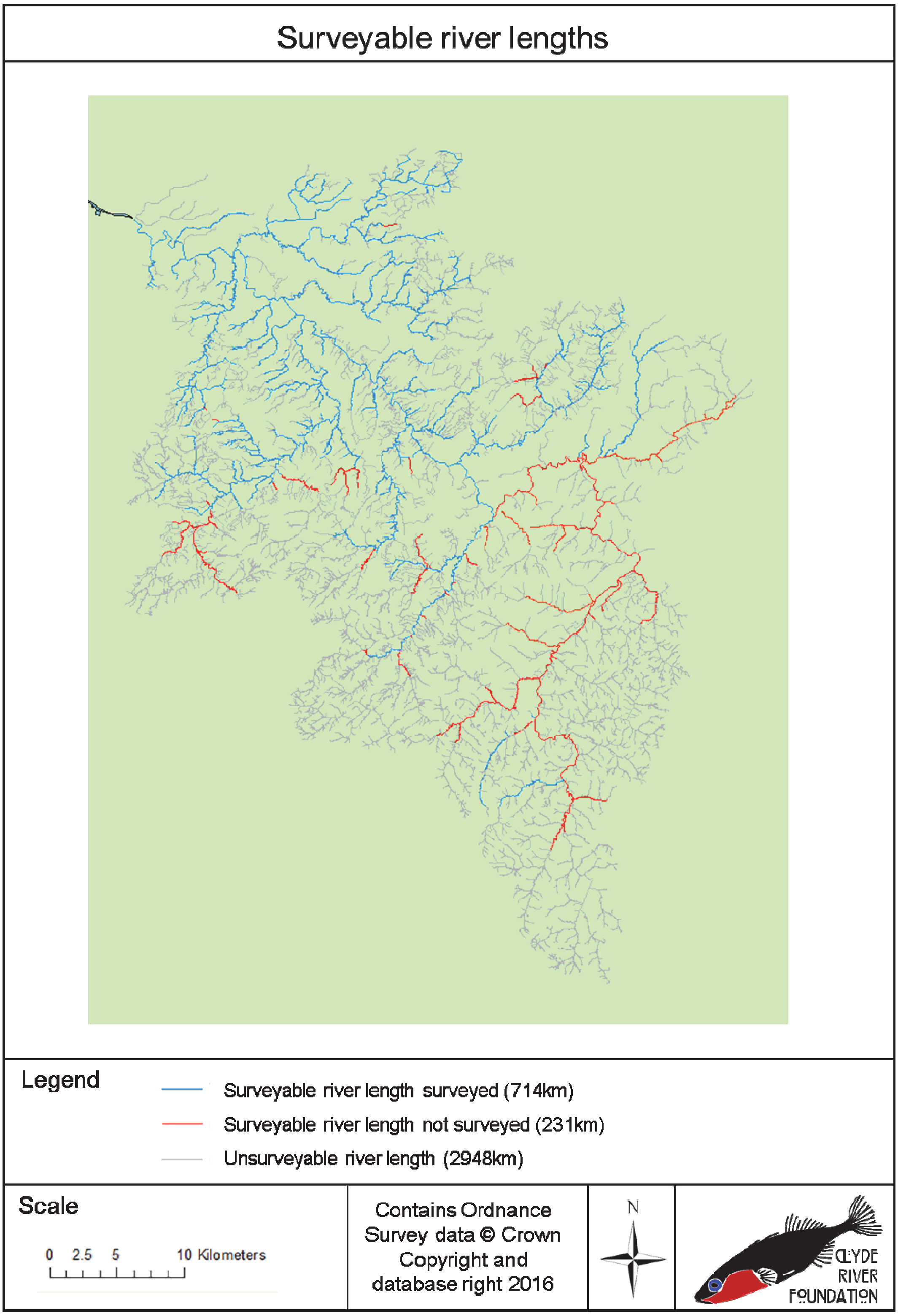



*Figure 7. Survey coverage; River length of "surveyable" and "unsurveyable" stretches in the 2015 bridge-hopping study.*

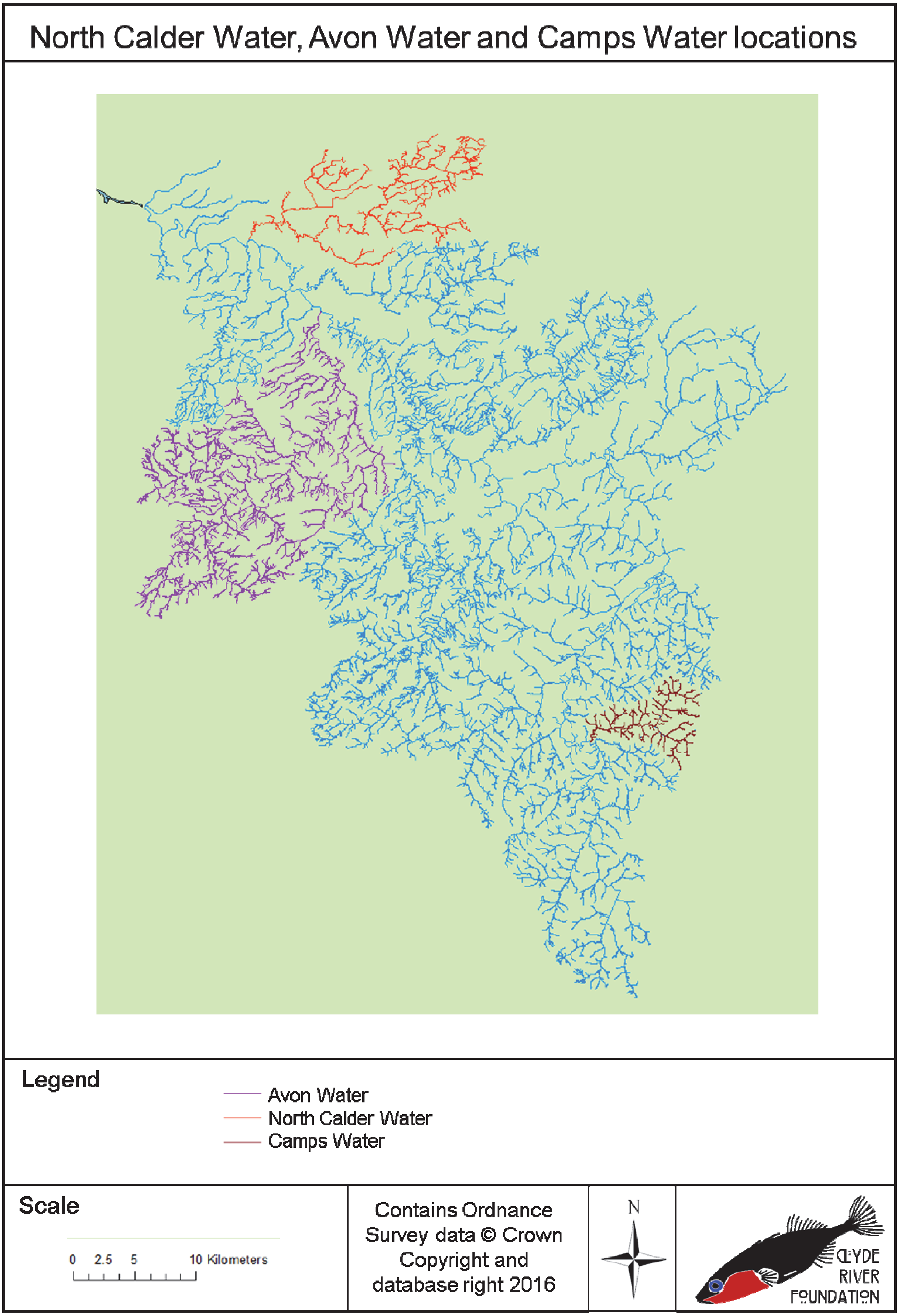



*Figure 8. Locations of Avon, North Calder and Camps Waters.*

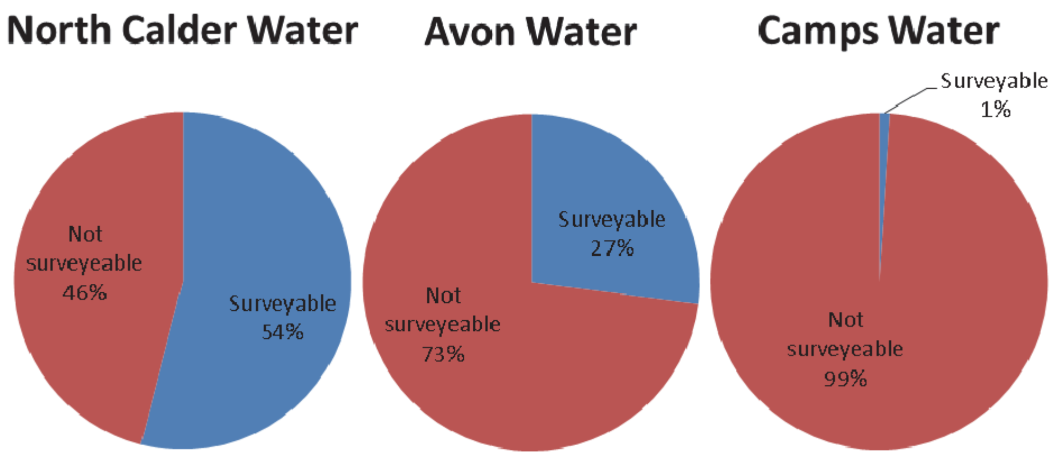



*Figure 9. Percentage of example sub-catchments considered surveyable by bridge-hopping. The sub-catchments analysed are the North Calder Water (predominantly urban), Avon Water (mixed urban-rural) and Camps Water (rural).*

### 4.4 Pre-treatment data gathering

It is essential before any INNS treatment begins that the river network upstream of the intended management area is surveyed. This will identify opportunities for recolonisation by native species after treatment and will be more cost effective in the long term. It would be prudent before any catchment-scale work is undertaken to complete the bridge survey to ensure that no unknown INNS are located upstream, particularly when dealing with the River Clyde mainstem.

The substantial (but incomplete) INNS dataset for the study area is only accurate at the time of surveying and should therefore be considered a conservative estimate of the distribution of the species of interest. It is unlikely that the geographical extent of any of these species will reduce without active intervention and in the absence of treatment, their ranges are likely to increase. The do-nothing option regarding treatment, therefore surrenders the initiative to actively reduce INNS range and allows consolidation and further spread of the species of interest.

## 5. STRATEGY PRIORITISATION

To enable the construction of an effective INNS control strategy, it is efficient to adhere to a small number of basic principles to guide site selection, species for treatment and timescale. Clear, measurable objectives need to be identified for each round of treatment e.g.

- species for treatment
- extent of treatment
- timescale of project
- measure of success

Sections 5.1 – 5.8 identify the most practical criteria to prioritise against when designing an INNS control strategy for the River Clyde catchment. At this stage, they are neither hierarchal nor weighted against each other.

### 5.1 Prioritisation by species

This priority is likely to be most significant when dealing with biodiversity issues, conservation of specific species or meeting local biodiversity action plan (LBAP) outcomes and the steps for the Biodiversity Route Map set out by the Scottish Government. Each of the three INNS has different environmental impacts and therefore can be seen as more or less problematic depending upon the particular location. The assumption made here is, however, that the presence of any one of the species impacts negatively upon the environment and that control and/or eradication is desirable. That may not be possible in all cases and prioritisation by species may be necessary.

It may therefore be the aim of an initiative to remove only one of the three species of INNS, rather than eradication of all three. Control projects undertaken elsewhere in Scotland have shown that when one species is removed, another non-native rather than native species may recolonise the cleared area.[4] Succession planning may be necessary to minimise this effect.

Initially, simply raising awareness of the presence of an INNS species can have a positive impact on reducing spread (e.g. making identification guides available, so that accurate distribution is known or identifying unsuitable control methods to stakeholders, so that Japanese knotweed is never strimmed). Considerable information and guidance is available on the biology, ecology, relevant legislation and control methods for each of the three species of interest.[5] Summary attributes to be considered when prioritising single species removal are outlined in Table 2.

[4] CIRB project (Controlling invasive priority non-native species and restoring native biodiversity) ran from 2011 – 2014 and was a partnership between Queens University Belfast, Rivers and Fisheries Trusts of Scotland, University of Ulster and Inland Fisheries Ireland. The final report is available at: http://www.ayrshireriverstrust.org/wp-content/uploads/2015/02/CIRB-final-report.pdf

[5] http://www.property-care.org/homeowners/invasive-weed-control/

*Table 2. Factors to consider when planning INNS removal in the River Clyde catchment, by species.*

| Species | Pros | Cons |
|---|---|---|
| Japanese knotweed | Is not dangerous to human health | Most widespread throughout the catchment<br><br>Is extremely difficult to eradicate and requires commitment over several years before an impact is seen, especially with large stands.<br><br>Must be treated by trained personnel with correct PPE<br><br>Requires specialist removal technique, not easily achieved using volunteer help unless trained Glyphosate treatment is non-selective and there are associated health risks |
| Giant hogweed | Is the least widespread throughout the catchment | Is dangerous to human health and removal must be done by trained personnel with correct PPE<br><br>Seedbank can last up to 15 years so requires continued funding and commitment |
| Himalayan balsam | Is not dangerous to human health<br><br>Can be managed using volunteers with no outlay for specialist removal equipment<br><br>Seedbank is active only for 24 months and so complete eradication is possible[6]<br><br>Non-chemical control is possible within two years | Seed dispersal is prolific and removal must be undertaken before seed pods begin to develop<br><br>Is easily transported on clothes/footwear, etc. so appropriate biosecurity measures must be implemented before leaving site |

### *5.1.1 Treatment by species*

Effective species-specific treatment is based upon the growth cycle of each. Personal protective equipment should be worn at all times and only trained personnel should attempt treatment of Giant hogweed and Japanese knotweed. Guidance on species treatment is available[7,8].

[6] https://www.rhs.org.uk/advice/profile?pid=480
[7] http://www.netregs.org.uk/environmental-topics/land/japanese-knotweed-giant-hogweed-and-other-invasive-weeds/
[8] http://www.property-care.org/homeowners/invasive-weed-control/

**Japanese Knotweed**

Japanese knotweed should be treated from approximately the end of September, when the flowers are beginning to yellow but before the first frosts of the year.

*Spraying (for larger stands)*

Large stands are sprayed using Glyphosate and then re-sprayed three weeks later. An extended lance should be used to help ensure penetration as deep as possible into the stand. Both the upper and lower surfaces of the leaves should be sprayed to help ensure adequate uptake of the herbicide.

*Stem Injection (for small stands or individual plants)*

Using a stem injector Glyphosate is injected straight into the stem between the first and third 'growth node' on stem. There is no need to handle or remove the plant material following stem injection.

**Giant Hogweed**

Giant hogweed should be sprayed with Glyphosate in April or May before the plant starts to flower. Spraying does not kill the seed bank and will require annual treatments for 3-5 years.

**Himalayan Balsam**

*Non-chemical control*

Plants are hand pulled directly from the ground. Once pulled the stem is then broken below the first node of the plant to prevent re-growth from the plant base (Figure 9).

Hand pulling should be undertaken from early summer before the plant seeds.

*Chemical control (for larger stands)*

If necessary, very large stands of Himalayan balsam can be sprayed with herbicide in spring before flowering. The preferred method is hand pulling where possible.

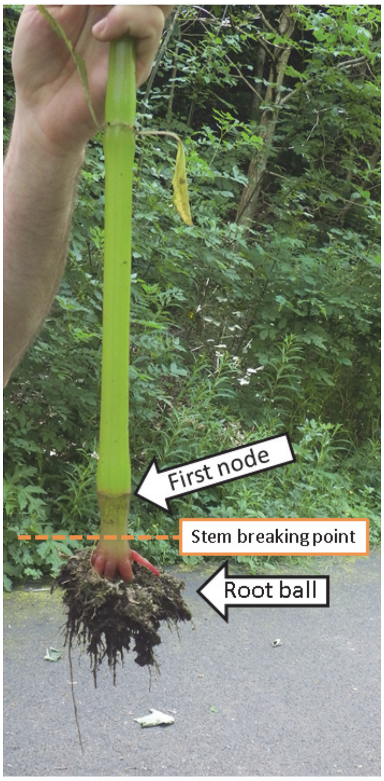



*Figure 10. Himalayan balsam stem breaking point.*

**5.2 Prioritisation by local authority area**

The INNS of interest are not evenly distributed across the study area. Each of the three Councils has its own local priorities and plans, but a co-ordinated approach could produce more efficient and effective control across the study area and beyond. It is unlikely that the eight Councils covering the whole Clyde catchment (Figure 10) have the resources to fund active INNS control across the system and co-ordinated action in targeted high priority areas would be cost-effective. Some of the Councils are disadvantaged by local conditions and their geographical location and a prerequisite to any large-scale treatment effort is to complete the coverage of the bridge-hopping surveys across the entire Clyde catchment to assess the scale of the task.

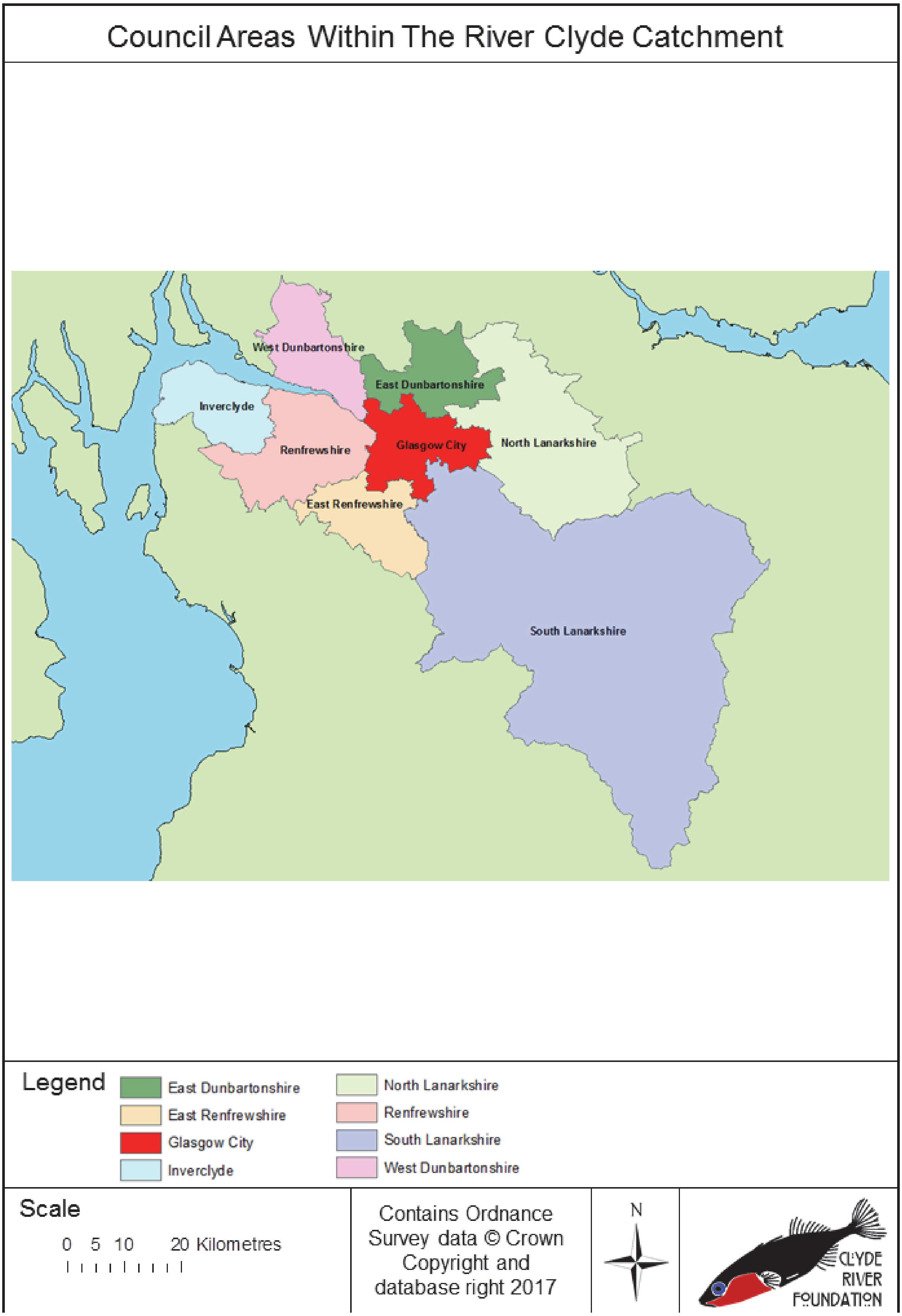



*Figure 11. Council areas within River Clyde Catchment.*

For example, in terms of riparian INNS control, the Glasgow City Council area is geographically disadvantaged. It is surrounded by other local authorities and is also located at the furthest downstream point of the freshwater River Clyde. Glasgow City has all three INNS in abundance within its boundary but as a result of its location any management project limited to Glasgow is immediately undermined because of the high risk of re-infestation from upstream. Therefore before any effective management can begin within Glasgow City, successful treatment programmes need to be implemented upstream to prevent recolonisation.

The strategy would therefore seek to prioritise strategically across all eight Council areas, with control works undertaken **systematically downstream** through the river network, rather than following political boundaries. Councils would, however, be encouraged to "firefight" areas of concern within their own boundaries, e.g. when Giant hogweed appears in public parks or along walkways, and poses a public health risk.

### *5.2.1 Coordination between Councils and private landowners*

Private landowners and Councils have a legal responsibility to prevent the spread of INNS from their land. Under the Wildlife and Natural Environment Act (2011) it is an offence to plant or otherwise allow INNS to grow in the wild and this includes permitting the spread of INNS. It is therefore essential that both Councils and landowners collaborate to minimise the risk of spread and recolonisation.

The range and number of landowners in a catchment will add to the complexity of delivering riparian INNS control. The strategy recommends creating a post with the responsibility for co-ordinating the agreements, permissions and practical treatments necessary to initiate and maintain INNS control across the Clyde system. This should be tested on a single trial catchment, reviewed, and the improved template rolled out across the system.

## 5.3 Prioritisation by sub-catchment

Prioritising riparian INNS treatment and control by sub-catchment is logical and probably gives the greatest chance of success. Sub-catchments of rivers rarely cross local authority boundaries, they tend to be congruent with them, and this approach would divide the River Clyde catchment into manageable treatment areas. This strategy could be applied in stand-alone (independent) areas or in neighbouring catchments simultaneously.

### *5.3.1 Independent areas*

These treatment areas could be geographically isolated from each other, so long as one is not downstream of the other. This would permit systematic treatment from upstream to downstream across the whole of the sub-catchment. One assumption for the success of this strategy is that there would be no recolonisation over land from neighbouring catchments. Treatment would stop on meeting a confluence which could introduce any of the target species from upstream on the other watercourse. An example of the independent area strategy is shown in Figure 11.

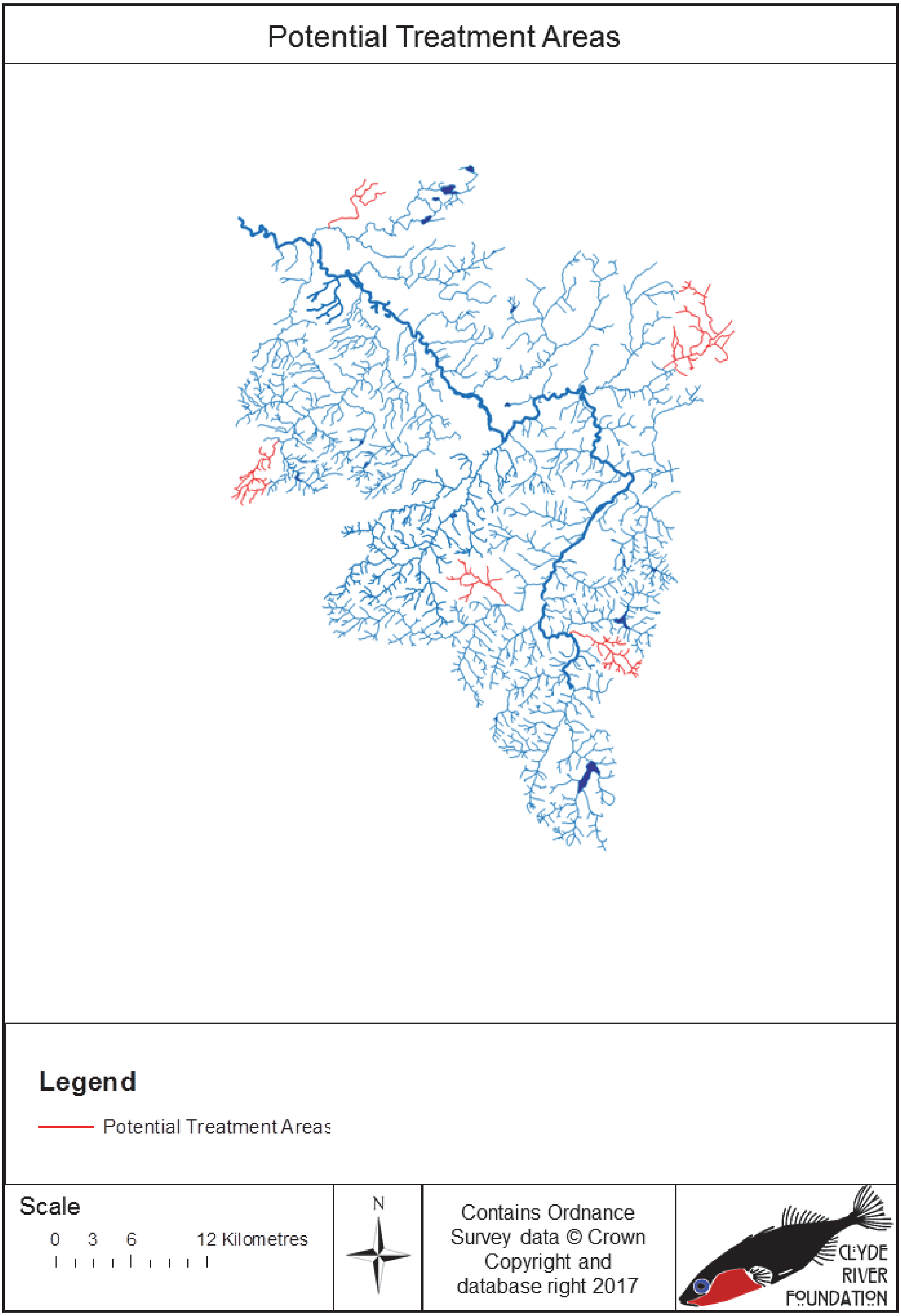



*Figure 12. Independent area strategy; mapped example of how independent areas across sub-catchments could be treated.*

### *5.3.2 Neighbouring catchments*

The independent area strategy but with work occurring simultaneously across two or more catchments. Future work continues in the neighbouring watercourse as shown in Figure 12, where two potential geographical treatment areas are shown for comparison (Projects A and B). Operationally, within each project, when treatment of Section 1 comes close to an untreated neighbouring watercourse downstream treatment stops and work then begins on the neighbouring area (Section 2) and continues in this manner until complete. This will result in the furthest upstream rivers being treated before moving further downstream, working around the catchment rather than linearly.

This strategy decreases the likelihood of recolonisation from a neighbouring catchment but it requires careful planning, significant resources and co-operative working between local authorities and private land owners.

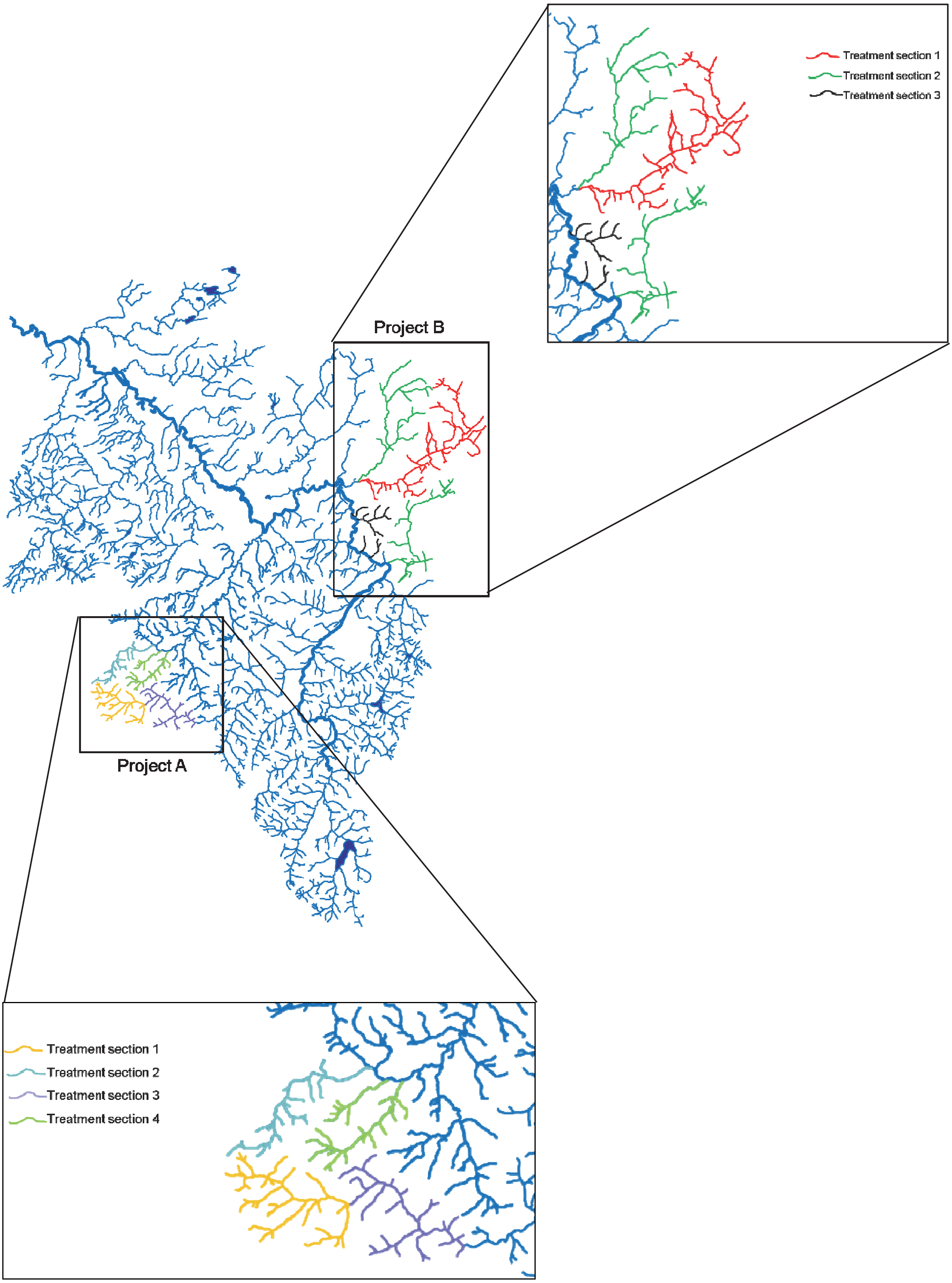



*Figure 13. Neighbouring catchment strategy; two potential examples of co-ordinated treatment in adjacent sub-catchments.*

### 5.4 Prioritisation of isolated plants/stands

Due to the widespread and discontinuous distribution of riparian INNS, it would be efficient to tackle isolated upstream populations rapidly before they initiate downstream colonisation of larger stretches. Two extreme examples of such "outliers" were found during the field survey; Japanese knotweed on the Douglas Water and Giant hogweed on the Mouse Water (Figure 2[9] and Figure 4[10] respectively) and a further one during report production, Japanese knotweed on the main River Clyde at Abington[11] (Figure 2). Targeting such isolated plant colonies decreases the risk of passive downstream colonisation and thus reduces costs in the long term.

### 5.5 Prioritisation by risk of flood and bank erosion

This is borne out of concerns regarding the potential effects of INNS on river bank stability and flood risk to properties near rivers. Flood risk is a major concern across Scotland; locally, the White Cart Water Flood Prevention Scheme was completed in 2011. Flooding has many causes but one of the contributing factors is bank erosion. Bank erosion is a natural process and is essential to river health, transporting substrate materials downstream, dissipating energy from the flowing water and creating new habitats. The natural process can be altered by riparian INNS and enhanced erosion can lead to bank instability, failure and flooding. Erosion rates may be increased by water scouring bare banking, devoid of plant cover or marginal vegetation. In winter months in Scotland, areas colonised by riparian INNS become potentially susceptible to bank erosion as the plants die back and the lack of understory and/or effects of shallow root systems may leave the soil vulnerable to washout during high flows,[12] as shown in Figures 13-16.

Effective riparian INNS control can lead to a reduction in erosion and flood risk and can be targeted at known high priority areas, particularly large stands of plants or areas with high levels of access and public activity, the latter for Health & Safety reasons.

[9] As marked by the southernmost green dot in Figure 2.
[10] As marked by the southernmost black dot in Figure 4.
[11] As marked by the southernmost point on the red line in Figure 2.
[12] https://www.naturaldevon.org.uk/home/devon-invasive-species-initiative/japanese-knotweed/whats-the-problem/

*Figure 14. Japanese knotweed in winter.*

*Figure 15. Bank erosion associated with Japanese knotweed.*

*Figure 16. Bank erosion associated with Japanese knotweed.*

*Figure 17. Bank erosion associated with Japanese knotweed.*

## 5.6 Prioritisation by cost

Cost may be the ultimate determinant of how control measures are deployed; larger budgets can mean a larger geographical area covered or the potential use of more expensive treatments. The cost of managing INNS in Scotland was estimated at £244,736,000[13] in 2010 and Japanese knotweed removal is estimated at >£1,000[14] per square metre. Cost is also perhaps the most effective persuasion for landowners to proactively remove Japanese knotweed as it can reduce land and building value and in some instances prevent mortgages being made available. The professional surveyors' body RICS has estimated that the cost per household for even minor damage could be £15,000[15] of which £3,000-£5,000 would be necessary for knotweed removal by a specialised contractor.

The relative cost of removal for each of the three species varies greatly, and that for Japanese knotweed and Giant hogweed is high compared to that for Himalayan balsam (Table 3). The duration of treatment is extremely important in a riparian INNS management strategy; and it must be funded for several years. Indirect costs are difficult to assess but should be borne in mind (e.g. delays to land development).

Strategically, it is essential to operate effectively but within budget; and it is necessary to assess what is possible per unit cost. That must be determined in the objectives of the project and is better informed by seeking advice on best practice and carrying out a small-scale pilot study in advance.

*Table 3. Relative costs of INNS removal.*

| **Species** | **Duration of treatment** | **Types of treatment** | **Relative cost of treatment** |
|---|---|---|---|
| Japanese knotweed | 3-4 years | Chemical – specialist application requires trained personnel<br>Mechanical removal is not the most effective method as the waste is then treated as hazardous | **High**[16]<br>Cost of stem injection or other treatment by contractor or trained personnel has been estimated at £1000/$m^2$ |
| Giant hogweed | 7-15 years[3] | Chemical - specialist application requires trained personnel | **High**<br>Cost of spraying equipment, PPE and trained personnel |
| Himalayan balsam | 2 years | Mechanical removal | **Low to Medium**<br>No specialist equipment required. Removal can be done by trained volunteers but using contractors allows a more rapid response, reducing the probability of further spread |

13 www.nonnativespecies.org/downloadDocument.cfm?id=487
14 http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=1495
15 https://consultations.rics.org/consult.ti/japaneseknotweed/view?objectId=1228500
16 https://www.rhs.org.uk/advice/profile?pid=480

Contractor costs for the treatment and removal of Japanese knotweed depend upon the contractor concerned, the area to be treated, and the treatment programme (Table 4). Absolute costs for an eradication programme are therefore difficult to quantify but can be considerable.

*Table 4. Example of comparative costs of Japanese knotweed treatments by a contractor*[17]

| **Size of infestation** | **Small ($<50\ m^2$)** | **Medium ($50\ m^2 - 100\ m^2$)** | **Large ($100\ m^2 - 500\ m^2$)** | **Very Large ($500m^2 - 1000\ m^2$)** |
|---|---|---|---|---|
| Herbicide Treatment | £2,000-£3,000 | £3,000-£5,000 | £4,000-£6,500 | £5,000-£10,000 |
| Reduced dig and root barriers | £2,000-£5,000 | £5,000-£10,000 | £15,000-£40,000 | >£40,000 |
| Pick and sort / screening | £2,000-£5,000 | £5,000-£10,000 | £15,000-£40,000 | >£40,000 |
| Onsite relocation and herbicide (treatment bund / lay down area) | £5,000-£10,000 | £8,000-£15,000 | £12,500-£20,000 | £18,000-£30,000 |
| Burial on site | £5,000-£15,000 | £12,500-£20,000 | £18,500-£35,000 | £30,000-£75,000 |
| Full excavation and disposal (dig and dump) | £5,000-£20,000 | £15,000-£40,000 | £35,000-£120,000 | £100,000-£200,000 |

It was also possible to derive costs of INNS treatment empirically from a project managed by the Ayrshire Rivers Trust from 2011-2013 (Table 5). The aim of the CIRB project[4] was to control priority invasive non-native riparian plants and restore native biodiversity. The majority of INNS control was carried out by contractors, with the rest being carried out by a Project Officer and trained volunteers. The costs for treatment were determined by a tendering process and were therefore market tested at the time.

*Table 5. Treatment costs for Japanese knotweed (JK), Giant hogweed (GH) and Himalayan balsam (HB), number of man-days, km of river bank treated and litres of chemical used in treatment by contractors in the Ayrshire Rivers Trust CIRB project*[4].

| **Year** | **Species** | **Man-days** | **Cost** | **km covered** | **Chemical Used (L)** |
|---|---|---|---|---|---|
| 2011 | JK | 74 | £14,360 | 46.5 | Not quantified |
| 2012 | JK | 70 | £14,365 | 73 | 93.55 |
| 2013 | JK | 66 | £10,480 | 131.5 | 62.56 |
| 2014 | JK | 84 | £17,440 | 161.5 | 118.02 |
| 2011 | GH | 138.5 | £24,907.50 | 143 | Not quantified |
| 2012 | GH | 127.75 | £27,513.75 | 143 | 111.73 |
| 2013 | GH | 118 | £22,430 | 143 | 87.51 |
| 2014 | GH | 114 | £21,792 | 143 | 87.1 |
| 2012 | HB | 10 | £500 | 8 | Manual control |
| 2013 | HB | 3 | £6250 | 16.5 | 15.2 |

When the mean cost per kilometre treated were calculated, those for Japanese knotweed and Giant hogweed were very similar at just over £200/km, while that for Himalayan balsam was more expensive, at around £340/km (Table 6). The range of costs was considerable for

[17] http://www.phlorum.com/services/japanese-knotweed/japanese-knotweed-removal-cost/

all three species (Table 6) but the lower end of the range was similar for all three at £50-£64/km. At the top end of the costs, Himalayan balsam treatment was almost double that of the other two species (at £800/km).

*Table 6. Mean cost/km/annum of INNS treatment, estimated from the Ayrshire Rivers Trust CIRB project[4] 2011-2013*

| Species | Calculated Mean cost per km of river | Calculated Range of costs per km of river |
|---|---|---|
| Japanese knotweed | £205 | £60 - £484 |
| Giant hogweed | £207 | £64 - £487 |
| Himalayan balsam | £340 | £50 - £800 |

### 5.7 Prioritisation by liability

The principal legislation covering native and non-native species is the Wildlife and Countryside Act 1981 as amended by the Wildlife and Natural Environment (Scotland) Act 2011. The Act contains sections on the release or planting of all non-native species and the keeping, sale and notification of invasive species, in addition to provisions on Species Control Agreements and Species Control Orders.

Non-legal liability could also potentially be related to any of the categories in this non-exhaustive list:

- Public health
- Public safety
- Access rights
- Biodiversity concerns
- Legislation and regulations
- Ethically
- Property rights
- Property value
- Protection of protected species
- Protection of protected areas
- Environmental health and protection
- Financial
- Tourism
- Flood Risk and mitigation
- Destruction of land and property

Prioritising by liability would be time consuming compared to simply dealing with this issue as it arose during the other assessments.

### 5.8 Prioritisation by legislation

The principal legislation covering native and non-native species is the Wildlife and Countryside Act 1981 as amended by the Wildlife and Natural Environment (Scotland) Act 2011. The Act contains sections on the release or planting of all non-native species and the keeping, sale and notification of invasive species, in addition to provisions on Species Control Agreements and Species Control Orders.

The 1981 Act makes it a criminal offence in specific circumstances to introduce non-native plants into the wild. A criminal offence may be committed in two ways:

- by planting in the wild any plant outwith its native range,
- by causing to grow in the wild any plant outwith its native range.
  (Where causing a plant to grow in the wild means that the plant becomes present in the wild as a direct result of someone's actions, even though they did not specifically plant it there).

A Non-Native Species Code of Practice[18] has been developed and issued by the Scottish Government under section 14C of the 1981 Act. This Code of Practice came into effect in July 2012 and identified necessary legal compliance for owners of non-native species and those involved in their care and management to prevent environmental damage.

The presence of INNS can negatively affect the management of water bodies under the EU Water Framework Directive (WFD); they can cause downgrades to "Good" or "Moderate" status or their presence can prevent it from achieving "High" status. There are four current instances of INNS downgrading watercourses in the study area to "Moderate" status under; three are due to rivers containing American signal crayfish (*Pacifastacus leniusculus*) and one is because of the presence of Canadian pondweed (*Elodea canadensis*) in Strathclyde Loch.[19] There are no current examples where riparian INNS alone downgrade a water body and because of the mechanics of the WFD classification system the plants would have to cover a very large percentage of the bank length for that to happen. There is therefore little imperative to prioritise INNS control by effect on WFD quality classification, although at present, the lack of data highlighted by this study may preclude it in any case. Further ground-truthing of fine-scale INNS distribution in the study area would clarify the position in some of the worst affected catchments (e.g. North Calder Water).

[18] http://www.gov.scot/Publications/2012/08/7367
[19] https://www.sepa.org.uk/data-visualisation/water-environment-hub/

## 6. ACTION PLAN

Any future action plan for the Clyde catchment should initially consider all of the priorities identified in Section 5 and the costs and funding for appropriate treatment duration. It is recommended that any INNS treatment follow the steps suggested in the basic treatment plan in Figure 17. **To be both cost effective and successful, treatment must progress in a downstream direction from the most upstream confirmed INNS stand.**

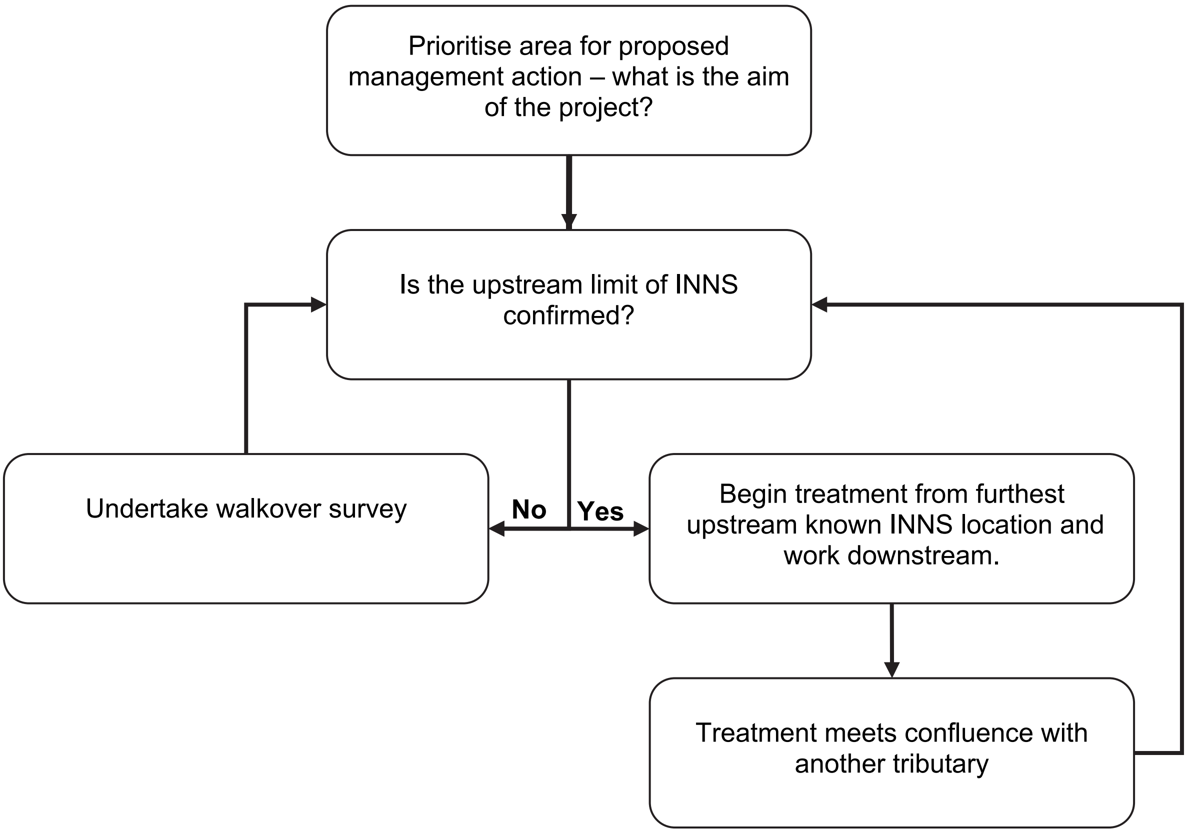



*Figure 18. Basic treatment plan.*

In cases where extreme outlying stands of INNS have been identified, the cost-effectiveness of treating these as the highest priority may be disproportionately advantageous. In these cases, treatment should be considered as preventative and very cost-effective, reducing future downstream colonisation and cost.

The project should be fully costed before INNS treatment begins and sufficient funding needs to be in place for its anticipated duration and for follow up treatment in successive years (for the lifetime of the seedbank at least). Figure 18 illustrates the minimum planning required before commencement of treatment.

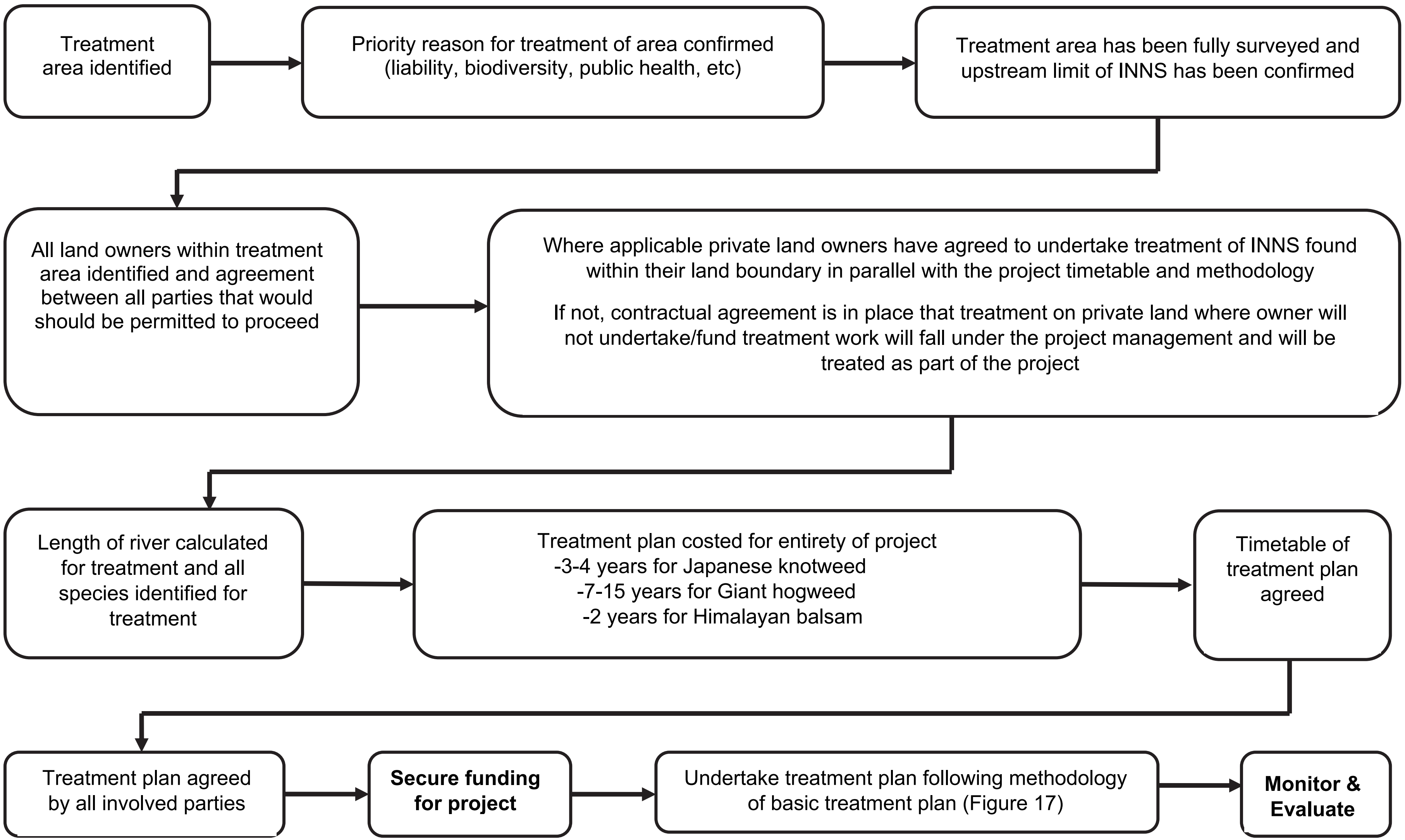



*Figure 19. Basic pre-treatment planning workflow.*

## 6.1 Whole-catchment eradication

Eradication of all three riparian INNS from the study area (and wider Clyde catchment) is an enormous and potentially very expensive task. An estimate of the *minimum* cost of eradication across the study area is given in Table 7 (i.e. based upon the current known distributions shown in Table 1, and the costs of treatment per km given in Table 6). These figures are highly speculative, making no allowance for inflation since 2013 or savings to be made where multiple species can be treated at once, or the potential for significant extra costs where additional years of treatment may be needed. They do, however, provide a ball-park figure for the minimum financial commitment needed to begin to address the riparian INNS problem in the study area in a structured, strategic manner.

*Table 7. Estimated Minimum Cost of Whole-catchment Eradication*

| Species | River Length Colonised (km) | Mean Treatment Costs/km | Minimum Number of years treatment is necessary | Total Cost |
|---|---|---|---|---|
| Japanese knotweed | 304 | £205 | 3 | **£186,960** |
| Giant hogweed | 119 | £207 | 7 | **£172,431** |
| Himalayan balsam | 111 | £340 | 2 | **£75,480** |
| Three INNS Combined* | | | | **£434,871** |

**Note:** Figures make no allowance for economies where the species are found concurrently or additional costs where further years of treatment are required.

## 6.2 Pilot studies

While a single co-ordinated response to the presence of the INNS across the study area is desirable, small-scale starter projects would inform treatment strategies for wider use. Three possible pilot studies have been identified, to give approximate costs for treatment (these costs are a guide only, and do not account, for example, for inflation or VAT). The three areas considered were:

- The North Calder Water – the field surveys for this sub-catchment are complete for all three INNS,
- The Douglas Water – has outlying isolated populations of Japanese knotweed,
- The Mouse Water – has one outlying isolated population of Giant hogweed

### *6.2.1 The North Calder Water – treating all three INNS across a single subcatchment*

The entire North Calder Water sub-catchment was considered as a pilot study area because the system has already been completely surveyed using the bridge-hopping method. It does not require any further habitat walkover surveys above the top bridges so effort can be concentrated on control downstream of the known upstream limit of INNS. The full catchment falls within a single local authority area, North Lanarkshire, and it has extensive Japanese knotweed colonies and intermittent Himalayan balsam and Giant hogweed records. It flows through predominantly urban areas.

A costed INNS management pilot study for the North Calder Water is described in Table 8. It assumes that treatment of all three INNS follows the Ayrshire River Trust RT CIRB Project[4] methodology. These costs do not include project planning (as discussed in the basic planning workflow, Figure 18) nor account for annual inflation. The costing assumes the minimum number of years per INNS treatment (Table 3) and the mean cost of treatment per affected kilometre (Table 6).

It is estimated that treatment to cover the North Calder Water sub-catchment would cost £159,152 (range = £42,224-£374,738) over seven years (Table 8). These figures are based on current estimated contaminated bank length and not actual mapped locations of individual plants. This cost could be reduced following the Year 1 walkover, when the individual stands and plants would be recorded.

*Table 8. North Calder Water survey checklist and estimated costs.*

| **Activity** | **Status** | **Mean Cost (approx.)** | **Range Cost (approx.)** |
|---|---|---|---|
| Bridge Hopping Survey | Complete | n/a | n/a |
| Upstream limit of INNS confirmed? | Yes | n/a | n/a |
| Treatment for Japanese knotweed | Maximum river length colonised is 58km.<br><br>Will require walking the full length, recording and treating any stands encountered.<br><br>Spraying or stem injection undertaken in September – October.<br><br>Treatment is most effective as plants start to die back to overwinter. | Year 1 – £11,890<br>Year 2 – £11,890<br>Year 3 – £11,890<br><br>Total – £35,670 | Year 1 – £3,480-£28,072<br>Year 2 – £3,480-£28,072<br>Year 3 – £3,480-£28,072<br><br>Total – £10,440-£84,216 |
| Treatment for Giant hogweed | Maximum river length intermittently colonised is 58km.<br><br>Will require walking the full length, recording and treating any stands encountered.<br><br>Spraying to be undertaken in April-May before plants flower. | Year 1 – £12,006<br>Year 2 – £12,006<br>Year 3 – £12,006<br>Year 4 – £12,006<br>Year 5 – £12,006<br>Year 6 – £12,006<br>Year 7 – £12,006<br><br>Total – £84,042 | Year 1 – £3,712-£28,246<br>Year 2 – £3,712-£28,246<br>Year 3 – £3,712-£28,246<br>Year 4 – £3,712-£28,246<br>Year 5 – £3,712-£28,246<br>Year 6 – £3,712-£28,246<br>Year 7 – £3,712-£28,246<br><br>Total – £25,984-£197,722 |
| Treatment for Himalayan balsam | Maximum river length intermittently colonised is 58km.<br><br>Removal in June - July before flowers produce seeds. | Year 1 – £19,720<br>Year 2 – £19,720<br><br>Total – £39,440 | Year 1 – £2,900-£46,400<br>Year 2 – £2,900-£46,400<br><br>Total – £5,800-£92,800 |
| **Total** | | **£159,152** | **£42,224-£374,738** |

*6.2.2 The Douglas Water – treating Japanese knotweed outliers*

The Douglas Water provides an opportunity to test the theory of control in outlying isolated populations to minimise future cost and colonisation downstream of Japanese knotweed in the absence of any other INNS. Field surveys have not yet been completed for this catchment therefore the following assumptions are made:

- there are no further INNS records found,
- there has been no human activity which has promoted spread since the survey,
- there are no more water crossings found.

Due to the low density of plants found along the Douglas Water to date, we are confident that full length treatments will not be required, only isolated stands. These presently comprise four stands totalling approximately 30m in length. Left unchecked, these stands threaten a further 32km of the Douglas Water catchment with downstream colonisation, plus an additional 6.8km of the River Clyde below that.

It is estimated that the cost of treatment to cover the Douglas Water would be £24,795 over three years (range £10,440-£52,416) (Table 9). Downstream colonisation from the untreated Japanese knotweed stands could inflate future treatment costs significantly so it would be demonstrably cost-effective to treat these outliers as a matter of priority.

*Table 9. Douglas Water treatment costs.*

| Activity | Status | Cost (approx.) | Range Cost (approx.) |
|---|---|---|---|
| Bridge Hopping Survey Complete? | No – 35 bridges to be surveyed = 4 man-days. | £1,000 | £1,000 |
| Upstream limit of INNS confirmed | No – 2 upstream sections require survey = 2 man-days | £500 | £500 |
| Walkover complete? | Maximum river length colonised is 33km. Will require walking the full length downstream of most upstream record in Year 1, recording any stands encountered.<br><br>No – 12 man-days needed. | £3,000 | £3,000 |
| Treatment for Japanese knotweed | Maximum river length colonised is 33km. Spraying or stem injection undertaken in September – October (assumed for four colonies only approx. 30 m).<br><br>Treatment is most effective as plants start to die back to overwinter. | Year 1 – £6,765<br>Year 2 – £6,765<br>Year 3 – £6,765<br><br>Total – £20,295 | Year 1 – £1,980-15,972<br>Year 2 – £1,980-15,972<br>Year 3 – £1,980-15,972<br><br>Total – £5,940-£47,916 |
| **Total** | | **£24,795** | **£10,440-£52,416** |

### *6.2.3 The Mouse Water – treating giant hogweed outliers*

The Mouse Water provides an opportunity to apply the theory from Section 6.2.2 to outlying isolated populations of Giant hogweed in the absence of any other INNS. The same assumptions are made as in Section 6.2.2.

Due to the low density of plants found along the Mouse Water to date, full river-length treatments will not be required. Only one isolated stand of approximately 3m in length is currently known but this requires a ground-truthing walkover survey. If left unchecked there is a high risk of colonisation of over 14 km of the Mouse Water catchment downstream, and a further 35km of the River Clyde below that.

It is estimated that the cost of treatment would be £77,001 over seven years (range = £27,952-£173,041) (Table 10). Colonisation from these plants, which are spread by seeds only, could significantly inflate final treatment costs downstream and again, treating these stands immediately would be cost-effective.

*Table 10. Mouse Water treatment costs.*

| Activity | Status | Cost (approx.) | Range Cost (approx.) |
|---|---|---|---|
| Bridge Hopping Survey Complete? | No – 12 bridges to be surveyed = 2 man-days. | £500 | £500 |
| Upstream limit of INNS confirmed? | No – 1 upstream section requires survey = 2 man-days. | £500 | £500 |
| Walkover complete? | Maximum river length colonised is 49km Will require walking full length downstream of most upstream record and treating any stands encountered.<br><br>No – 20 man-days needed. | £5,000 | £5,000 |
| Treatment for Giant hogweed. | Maximum river length colonised is 49km Will require walking full length downstream of most upstream record and treating any stands encountered.<br><br>Spraying to be undertaken at each known record before flowering. (assumed for one known stand and a potential for ten more within vicinity downstream)<br><br>Spraying undertaken in April-May. | Year 1 – £10,143<br>Year 2 – £10,143<br>Year 3 – £10,143<br>Year 4 – £10,143<br>Year 5 – £10,143<br>Year 6 – £10,143<br>Year 7 – £10,143<br><br>Total – £71,001 | Year 1 – £3,136-£23,863<br>Year 2 – £3,136-£23,863<br>Year 3 – £3,136-£23,863<br>Year 4 – £3,136-£23,863<br>Year 5 – £3,136-£23,863<br>Year 6 – £3,136-£23,863<br>Year 7 – £3,136-£23,863<br><br>Total – £21,952-£167,041 |
| **Total** | | **£77,001** | **£27,952-£173,041** |

The proposed pilot studies have identified the cost of the "Do Nothing" option (Table 11). It is clear that treating isolated or outlying populations of INNS would be very cost-effective in obviating the need for larger-scale treatments in the future.

*Table 11. Treatment summary costs and the potential costs of eventual work following "Do Nothing"*

| Pilot Study Area | Current management cost minimising downstream colonisation | Future costs for full bank length downstream colonisation |
|---|---|---|
| North Calder Water<br>(full length treatment annually) | £159,152 | £159,152 |
| Douglas Water | £24,795 | £423,122 |
| Mouse Water | £77,001 | £614,043 |

## 7. SUMMARY AND RECOMMENDATIONS

Potential ecological problems, legal requirements and public health considerations are among the good reasons for developing and implementing INNS removal plans for the study area. Some of the species can also cause significant physical and ecological damage to affected riverbanks, leading to issues with native biodiversity, both riparian and instream, and potentially with flood management and sediment transport. There is likely to be considerable variation in cost:benefit ratios for INNS removal, depending upon the species present, their extent and location, and this will require careful consideration at the project planning stage.

Whichever strategy is used to prioritise INNS treatment or the geographical location identified at which to commence control, the overriding consideration must be to identify the upstream extent of the species of interest in every sub-catchment. Only then can the true magnitude and cost of the challenge be quantified across a catchment or study area (and subsequently, the best areas to treat first identified).

**Recommendation 1:** Complete the bridge-hopping survey and INNS distribution maps for the study area (estimated cost = £9,000).

When the distribution of INNS is better known, it would be prudent to establish a formal INNS Treatment Project across the geographical area of interest (initially for this study area but could become a focal point for INNS control across the Clyde catchment). The project should seek to build capacity by appointing a dedicated INNS Control Officer to document the initial scale of the problem, determine priority areas for treatment and the capabilities of Councils and other organisations to undertake treatment across the study area. The project should also collate all treatment applications logged across the study area by private companies and individuals. Critically, the INNS Control Officer would also monitor the success (or otherwise) of containment or eradication initiatives. Stakeholder engagement would be a large part of the INNS Control Officer's day-to-day work and the postholder should be fully trained and equipped to provide or co-ordinate a rapid response to emerging very high priority treatment requirements. This Officer could be a secondment within a Council or appointed by another body working across the study area. Councils, statutory bodies and NGOs could share the costs. Without criticising the efforts of current initiatives, we feel this issue is sufficiently important that it becomes "someone's problem" – and that there is a greater chance of more rapid success (and therefore improvements to biodiversity) if control and treatment were to be co-ordinated from a single, accountable individual/location with a degree of control over on-the-ground activities.

**Recommendation 2:** Appoint and equip an INNS Control Officer for the study area (estimated cost = £30,000 - £35,000 per annum for three years).

With the INNS Control Officer in post, co-ordinated practical treatment on the ground can begin. The Pilot Projects identified in this study should be the first strategic work commissioned by this Officer.

**Recommendation 3:** The pilot projects should be scoped and initiated for the current study area (estimated cost = £260,948 over 7 years). These present different levels of challenge but are representative of the broad commitment required elsewhere across the study area.

**Recommendation 4:** Other, opportunistic treatments may be identified by the INNS Control Officer in parallel with the Pilot Projects. The Officer should make an assessment of the treatment suitability for the INNS species and the location. Treatments should be discouraged in areas where recolonisation from upstream is likely in the absence of planned treatment upriver (unless there is a persuasive financial, legal or ecological reason for such a spot treatment).

**Recommendation 5:** The INNS Control Officer post would build capacity within the wider catchment, and would be ideally placed to complete bridge-hopping surveys for other areas of the Clyde system (parts of East Renfrewshire, Renfrewshire, Inverclyde and West Dunbartonshire) with only partial coverage. These preparatory projects could be undertaken in parallel with INNS control and assessment in the current study area but would require staff unconstrained by Council boundaries.

**www.nature.scot**


ISBN: 978-1-78391-452-4

Great Glen House, Leachkin Road, Inverness, IV3 8NW
T: 01463 725000

You can download a copy of this publication from the SNH website.

recycle

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
nature.scot