RINSE

RINSE Activity 3

Final Report

2 Mers Seas Zeeën
INTERREG IV A
FRANCE - ENGLAND - VLAANDEREN - NEDERLAND

"Investing in your future"
Crossborder cooperation programme
2007-2013 Part-financed by the European Union
(European Regional Development Fund)

Report by Bournemouth University, Activity leader
Dr JR Britton, Dr A Ruiz-Navarro

RINSE

Floating pennywort *Hydrocotyle ranunculoides* (Simon Mortimer)

American Mink *Neovison vison*

(Peter Trimming)

Topmouth gudgeon *Pseudorasbora parva*

(GB NNSS)

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Activity 3
Field Trials and Demonstration Projects

Report by Bournemouth University, Activity leader

Dr JR Britton, Dr A Ruiz-Navarro

On behalf of the project consortium

Executive Summary

Activity 3 within the RINSE project was composed of seven sub-actions which combined to provide strong insights into how management interventions can reduce the impact of non-native species in Europe. The first sub-action consisted of field trials, with three studies designed to experimentally test the effectiveness of management interventions on the invasive plant species Australian swamp stonecrop (*Crassula helmsii*) and the invasive fish species topmouth gudgeon (*Pseudorasbora parva*). These trials demonstrated that whilst population control was possible, evidenced by significant reductions in invader presence within the study area, these reductions did not constitute eradication but were sufficient to reduce the ecological impacts of the target species. The trials were also very effective at highlighting the efficacy of different management methods. For example, use of a native predatory fish species as a biocontrol agent was shown to be effective at reducing the population density of topmouth gudgeon and maintaining this over a sustained period. Conversely, trapping and removal of fish was relatively ineffective as any individuals remaining in the pond were able to compensate for losses through increased growth and reproductive output.

Field demonstrations built upon these trials by exploring the different environmental management options for invasive species. The majority of demonstrations focused on invasive plants and revealed a wide range of methods and approaches delivering varying degrees of success. Classical biocontrol of *Azolla filiculoides* using a weevil was widely applied across the Two Seas area, demonstrating cross-border benefits. Whilst this was a successful example, it also underlined the difficulties of working across countries with different legislation, policy and procedure on the management of invasive species. In France for example, it was initially difficult to release the weevils into the environment. Herbicide treatment successfully eradicated floating pennywort *Hydrocotyle ranunculoides* successfully eradicated floating pennywort *Hydrocotyle ranunculoides* from a river in eastern England after long-term application (several years). Physical removal of plants by hand-pulling was also successful method, demonstrated in reductions of the density of Himalayan balsam *Impatiens glandulifera* along a river course in Hampshire (Southern England). Volunteer groups were used to supply the intensive labour effort, providing both a cost-effective approach and social benefits. Catchment level strategies are generally encouraged in the management of invasive species, especially in the case of invasive plant species. However, a demonstration on a river catchment in Southern England revealed that multiple ownership of riparian land can inhibit this approach by constraining access to all of the invaded areas. Strategies which successfully influence land-owners into co-operation were therefore shown to be extremely important. Evaluation of field trial and demonstration outputs revealed some general points in relation to managing invasive species. These included using citizen science and volunteers to increase sampling and control efforts, the difficulty of achieving eradication with limited resources and the effectiveness of certain techniques in reducing INS abundance and thereby releasing native communities from their constraining influence.

The sub-action relating to the establishment of an informal cross-border expert advisory service was challenging to achieve, given the previously highlighted difficulties of working across RINSE countries with different legislation, policies and protocols in place. Consequently, an open system was not operated and an informal service was used within the RINSE partnership instead. Much of the focus was on the demonstrations, with partners able to liaise with each other in order to achieve better demonstration design. This was reflected in the biocontrol of *Azolla*, as the network enabled greater access to cross-border demonstration sites. Demonstrations on non-native goose management were also successful, as this network enabled three project partners to work together more effectively. This service was enhanced through the Work-Shadow Exchanges, with six representatives from three Belgian stakeholders visiting the RINSE Lead Partner to learn more about control techniques for invasive deer.

Within this Activity, three partner Workshops were held, allowing progress to be discussed and reviewed. Three Best Practice management Workshops were also held, attracting delegates from across Europe. These were open to all interested individuals and stake-holders, and included presentations from invited experts based outside of the RINSE consortium. These Workshops covered the control of INS such as mink, muskrat, geese, ruddy duck, aquatic plant species and catchment-level strategies.

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Activity 3 within the project 'Reducing the Impact of Non-native Species in Europe', hereafter referred to as RINSE, concerned the design, initiation, execution and evaluation of a series of field trials and demonstrations focusing on the management invasive non-native species (INS) impacts in Europe, specifically in the Two Seas area. This also included several workshops, which aided the dissemination of this work and its associated outputs. The Work Package was divided into seven sub-actions described below, with the number of referring to the Activity Action within RINSE project documentation. The Lead for Activity 3 is Bournemouth University.

3.1 Field trials

This involved the cross-border development and delivery of systematic, scientific trials using contemporary and novel methods to control and eradicate INS. Field trials tested the efficacy of methodologies to eliminate or reduce the abundance and detrimental impacts of target INS whilst minimizing impacts on non-target species. To ensure the outputs of 3.1 are transferable to other Activities, the proposed target species were selected to be broadly representative of species groups.

3.2 Demonstration projects

This involved the design and delivery of management intervention case studies using a less rigorous approach than in 3.1 but which was still able to quantify management effectiveness. Partners with expertise in particular species demonstrated their chosen management interventions and gathered evidence of their efficacy.

3.3 Evaluation of INS management measures

The outcomes of 3.1 and 3.2 were evaluated, including data collected on i) pre- and post-trial abundance of target species; ii) pre- and post-trial assessment of non-target species; and iii) cost effectiveness. The reporting of this sub-action is embedded within 3.1 and 3.2, although it is also summarised discretely within this section.

3.4 Establish an informal cross-border expert advisory service

This sub-action aimed to provide technical advice to RINSE partners on INS management including the design of field projects, INS monitoring and evaluation. The Activity Lead Partner (Bournemouth University) provided a "match making" service, serving as a central point for partners' queries and providing email and Skype links to appropriate experts.

3.5 Partner workshops:

Three RINSE partner Workshops were provided in order to jointly develop field trials and demonstration projects through presentations and discussions with all relevant partners.

3.6 Management workshops:

Best Practice management methods for reducing the impact of INS in Europe were disseminated via three workshops open to all interested individuals and stakeholders. Workshops featured presentations from experts based outside of the RINSE consortium on topics including the control of INS mammals, birds, aquatic plants and catchment-level INS control strategies.

3.7 Identify opportunities for work shadow exchange

The rationale was to provide project partners with in-field experience of management techniques, allowing this new knowledge to be taken back to partner organisations and disseminated.

For 3.1 and 3.2, comprehensive Partner Reports are available in the language of the RINSE partner. In some cases, Partner Annexes discussing specific management demonstrations in detail are available.

3.1 Field trials

3.1.1 Overview

Four management trials were completed, with the target species and RINSE partner responsible provided in Table 1.

Table 1. Summary of management trials completed in RINSE sub-action 3.1

Section	Taxonomic group	Target species	RINSE Partner
3.1.2	Plant	*Crassula helmsii*	6
3.1.3	Plant	*Mahonia aquifolium and Rosa rugosa*	7
3.1.4	Fish	*Pseudorasbora parva*	2, 7
3.1.5	Bird	*Alopochen aegyptiacus*	7, 8, 9

3.1.2 Australian swamp stonecrop Crassula helmsi *in New Forest*

Target species

Australian swamp stonecrop *Crassula helmsii* is a perennial plant found in a range of aquatic habitats. Native to Australia and New Zealand, it is tolerant of a wide range of environmental conditions and is capable of forming thick stands of 100% cover, which may cause negative environmental and economic impacts. *C. helmsii* was first recorded in the National Park of New Forest (Hampshire, England) in 1976 and whilst now geographically widespread, is restricted to around 20% of all ponds. *C. helmsii* is considered a serious issue in the New Forest and is a factor in the failure to meet good ecological status in the Water Framework Directive (WFD) objectives and Favourable Condition in some Site of Special Scientific Interest (SSSI) units.

Aim of the trial

The aims of the trials were to 1) assess the efficacy of management control techniques to reduce and extirpate *C. helmsii* from New Forest ponds; and 2) quantify the impacts of treatments on non-target flora and fauna. For a treatment to demonstrate successful control or extirpation of *C. helmsii*, it would need to comply with the following criteria:

1) Complete removal of *C. helmsii* completely as quickly as possible.

2) If only control (not eradication) is achievable, subsequent re- growth and domination will not occur.

3) The treatment will not have a long-term adverse impact on native flora and fauna.

Target audience

The trials were aimed primarily at land owners and land managers within the New Forest 'Special Area of Conservation'. However, the target audience of this report is any landowner, land manager or policy makers considering control measures for *C. helmsii*.

Economic and social benefits of management

Aside from impacts on biodiversity, *C. helmsii* has been found to block drainage channels and limit the recreational use of lakes and canals. For example, the value of recreation to the region around the Grand Canal (Ireland) has been estimated to be 1.2 billion Euros. The cost of removing *C. helmsii* from a 2.2km section of the canal if an effective control method was found, would be around 170,000 Euros. There may also be impacts on tourism as a result of changes to the 'naturalness' of an area. The New Forest currently receives 13.5 million visitors per year. Estimates put control costs at around 700,000 Euros if an effective treatment method can be identified.

Cross-border benefits

C. helmsii is currently classified as an INS in several European countries and US states. Identification of an effective control method has clear cross-border benefits through providing a successful management technique that could be applied across the Two Seas Region.

Methods

Three different *C. helmsii* treatment techniques were used to meet the aim of the trial:

1. Herbicide treatment, using applications of Roundup Pro Biactive at a dose rate of 3 litres ha^{-1}. Ponds needed to be completely dry for the treatment to be effective, with multiple treatments required for complete eradication of *C. helmsii*.
2. Hot foam treatment with a biodegradable foaming agent made of a combination of plant oils and sugars developed by Weeding Technologies Ltd. This novel technique used a very hot foam mixture (above 97°C for 2 seconds or longer at lower temperatures) delivered onto the target area of a dry pond. The foam retains heat for longer than water alone, allowing more time for the high temperatures to kill *C. helmsii*.3
3. Aquatic dye treatment suppresses light availability and thereby limits photosynthetic activity. *C. helmsii* is able to grow all year round, therefore this technique was used over winter months when other plant growth was limited and when water depth is greater (favourable). A combination of Dyofix blue and black pond dyes was used.

A total of 25 ponds were originally selected for the trials, with the same number of ponds in each treatment category and a control pond where no treatment would be applied.

no treatment would be applied. Ponds were selected in clusters, so that ponds with similar geology, grazing pressure and habitat types would be subjected to each of the three different treatments, allowing comparison. After the trials commenced, three ponds were removed due to their unsuitability for the treatment. Overall, three ponds were treated with hot foam, five ponds were treated with herbicide and four ponds were treated with aquatic dye. A further two ponds were treated with both hot foam and aquatic dye. Seven ponds and one area of extensive pond margin remained in the control group.

Pre- and post-treatment surveys were conducted to assess the efficacy of each method. These consisted of:

- Surveys of vegetation cover were undertaken prior to treatment and each spring (February) and summer (July) following treatment.
- Plant surveys were undertaken prior to treatment and each summer (July) following treatment. These included wetland plants within the outer edge of the pond and terrestrial plants within the winter water line.
- Aquatic invertebrate surveys were undertaken prior to treatment and each summer (July) following treatment. Surveys used a standardised three minute hand-net sampling method developed for the National Pond Survey followed by identification to species level, with the exception of true flies (Diptera).

Timetable

2011: Pre-treatment surveys and Year 1 treatment.

2012: Post-treatment surveys and Year 2 treatment.

2013: Post-treatment surveys.

Results

C. helmsii was not eradicated in any of the treated ponds. The herbicide treatment in 2011 was the only method that significantly reduced the average cover of *C. helmsii* (Figure 1). However, twelve months after treatment, *C. helmsii* cover returned to pre- herbicide treatment levels across all of the ponds.

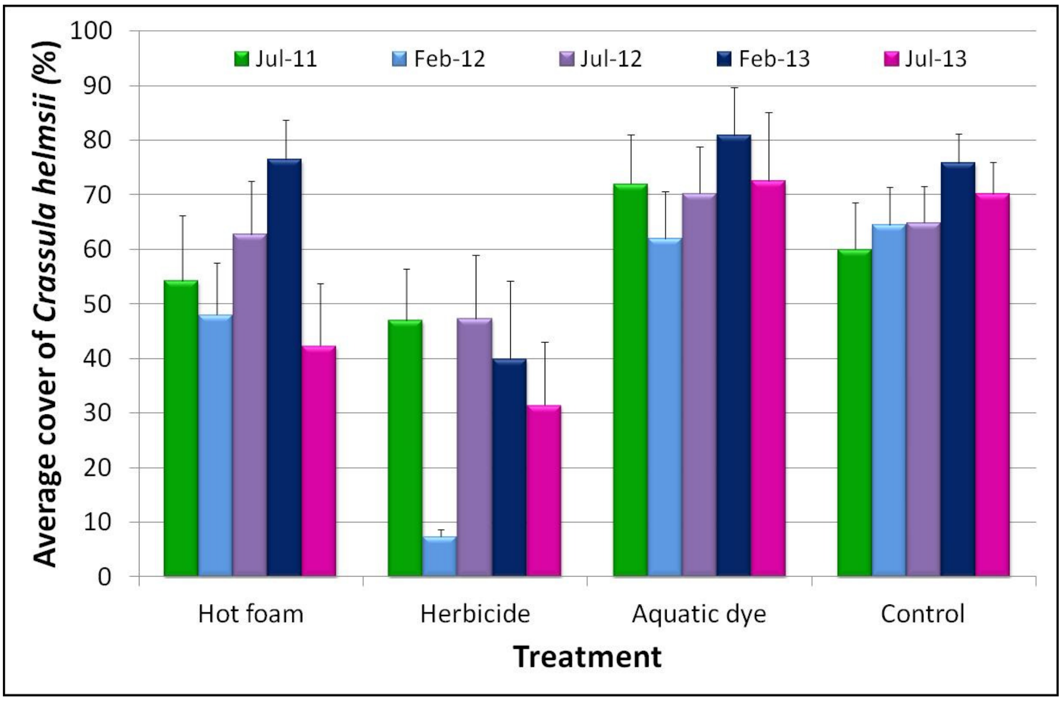

Figure 1. Differences in the percentage cover of *C. helmsii* in treatment groups before (2011) and after treatments (2012 and 2013).

A similar pattern was seen in the percentage cover of non-target native plants across both treatment years and treatment types. This indicates that treatments targeting *C. helmsii* had little negative impact on native species. Furthermore, the treatments had not given *C. helmsii* a competitive edge over native species. In relation to this, the amount of bare ground significantly increased only following herbicide treatment, although twelve months after the first treatment the amount of bare ground had returned to pre-treatment levels. All native plant species recorded during pre-treatment surveys were detected and recorded post-treatment, regardless of treatment type. Eight of the ponds in the trials achieved high or very high conservation status, whilst the rest achieved moderate status. In total, 102 macroinvertebrate species were recorded in the trial. In July 2013 a total of 82 species were recorded of which 17% were species of conservation concern. Results showed that treatment did not have any effect on the number of invertebrate species between years (Figure 2).

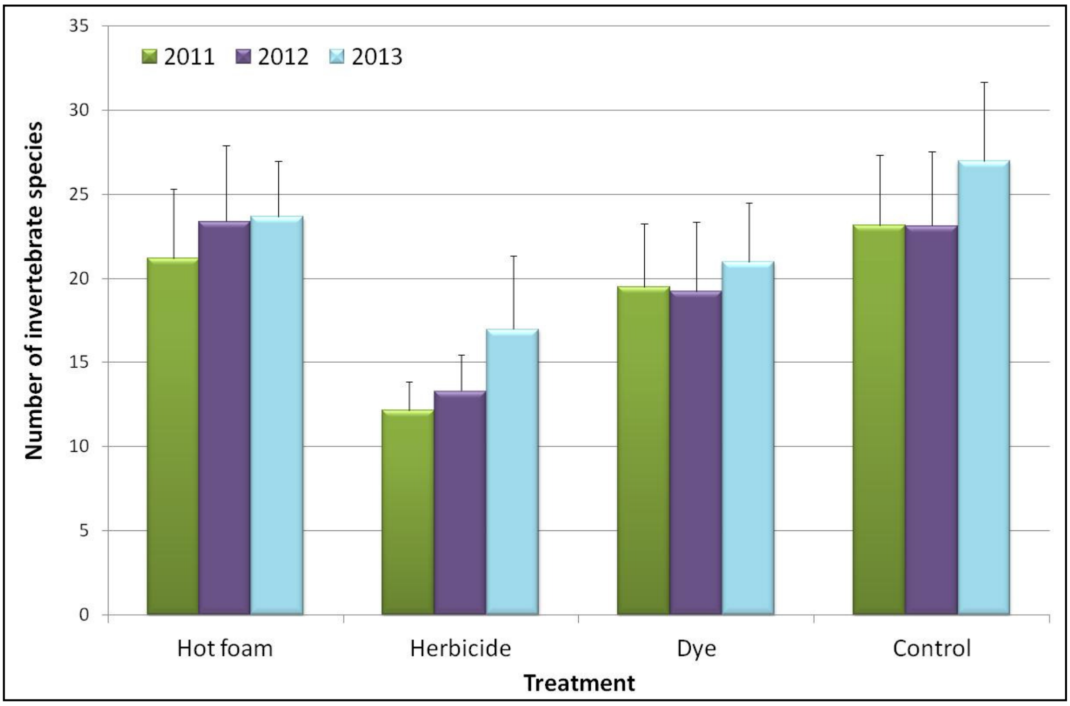

Figure 2 Average macroinvertebrate species richness of ponds in *C. helmsii* treatment groups before (2011) and after treatments (2012 and 2013).

Conclusions and recommendations

- None of the treatments were successful according to the first two criteria of the control programme.
- None of the treatments had an adverse effect on the cover or composition of native plant and macroinvertebrate communities. However, the cover of *C. helmsii* appears to increase which will ultimately have a detrimental effect on native plant species, including those of conservation concern.
- Wet summer conditions increased all plant growth, including *C. helmsii*, whilst dry summers and associated increases in

- poaching appeared to reduce the cover of *C. helmsii*. It is suggested that unless *C. helmsii* is removed it will recover to the same or greater extent as soon as favourable conditions return. As such, any management control method will require re-application year-on-year.

Deviations

The design of the field trials had built in flexibility so that problems encountered during the trial could be addressed at each stage. Additional ponds were included at the start of the programme to allow those that were unsuitable to be dropped. Contractors were employed under new contracts at the start of each season to ensure that changes in the treatment protocol based on the results of the previous season could be incorporated into the work plan. The rainfall record shows that the average annual values for the New Forest region in 2012 was >170% of the long-term mean. Consequently, no ponds dried out during this summer (as would be expected) and hot foam and herbicide treatments were not possible.

Problems encountered

The following problems and challenges were encountered during the trial:

- In wet years, hot foam and herbicide treatments were not possible and resulted in complete re-growth of *C. helmsii*, thus the control programme had to start again. This is costly and may do damage to vulnerable plant communities in the long run.
- On damp sediments and thick mats of *C. helmsii*, the hot foam treatment was not able to reach the required lethal temperature for a sufficiently long period of time.
- On grazed sites, fragments buried in soft sediments by the action

- of livestock trampling on the pond margin allowed re-growth – one treatment per year was not sufficient.
- Patches of *C. helmsii* were missed by contractors, often because these patches were some distance from the pond margin, and these provided a source for recolonisation.
- In ponds treated with aquatic dye that had shallow margins, *C. helmsii* grew longer stems to reach the surface. Broken fragments floated from the pond centre to the margin and re-grew.
- Following heavy rain the intensity of the dye was diluted especially on ponds with an inflow/ outflow.

Lessons learnt

Further trials using different methods (including biological control) were required, therefore treatments were applied to the trial ponds again in summer 2013 with the following revisions:

- Undertake a minimum of 2 applications of herbicide per year, to treat re-growth.
- Undertake the application of herbicide and hot foam only on very dry hard turf or in combination with a treatment to eliminate submerged growth.
- Where possible, ponds should be fenced from grazing livestock during treatment, to prevent sward on the pond margin from being broken up (not possible for New Forest ponds).
- Undertake aquatic dye treatments in combination with terrestrial treatment, to treat shallow pond margins during summer drawdown phase and to treat fragments floating from the pond centre to the pond margin.
- Mark extent of *C. helmsii* at sites before the day of application to ensure that the whole area is treated, improving efficiency of

- application for contractors.
- Monitor the intensity of dye treatment and repeat the application following periods of heavy rain.

Currently there are no effective methods for the eradication of *C. helmsii* from a New Forest pond. Without this, re-growth will always occur, which, over time will increase with the potential to exclude native plants unless sites are heavily grazed to maintain a partially open sward.

3.1.3 Invasive shrubs Mahonia aquifolium and Rosa rugosa in Flanders

Target species

The invasive shrubs *Mahonia aquifolium* and *Rosa rugosa* are a major management challenge in sand dunes and thus information on effective management techniques is urgently required. Both species differ in their ecology and invasiveness, and provide good model species for a range of invasive shrubs with clonal growth. The Oregon grape, *M. aquifolium* shows rapid clonal growth with stolons, but is also frequently spread over large distances by birds which consume the fruit. Native to western North America, it is a very popular ornamental plant that can colonise a wide range of natural and anthropogenically-disturbed habitats. In Flanders, *M. aquifolium* established recently and is rapidly expanding with highest densities found in urbanized environments and in the sand dunes on the western part of the coast. Through its strong vegetative growth using root suckers, the species can appear locally as mono-specific stands, overgrowing and eventually displacing native species and heavily impacting dune succession and ecosystem integrity.

The Japanese rose *R. rugosa* is native to the Pacific coasts of China, Korea and Japan. Due to its vegetative propagation by root suckers, it can rapidly occupy large areas, forming dense, mono-specific stands. This species is used worldwide as a functional and ornamental plant in urban areas and along roads. In coastal dunes, it is also used for sand fixation. Thus, in many European countries *R. rugosa* is present in coastal dunes where it often becomes invasive. The relative success of *R. rugosa* as an invasive dune species is favoured by the high fragmentation of the dunes along the Belgian coast and its ability to adapt to coastal dune environments, along with pollen and seeds which are easily spread by insects, birds and water. *R. rugosa* does not favour the accommodation of more typical dune species, has an influence on the humus composition, can act as a reservoir for potential pests, can hybridize with other rose species and has an impact on the natural dune succession.

Aim of the trial

The trial had three objectives:

1. Compare the efficacy of different management techniques for individual *M. aquifolium* plants
2. Provide documentation on management using heavy machinery for *M. aquifolium* and *R. rugosa*
3. Reduce the abundance of these species at the sites

Target audience

Conservation managers of dune reserves, officials of Agency for Nature and forest, social economy companies working in the field of INNS management along the coast, other RINSE partners, conservationists, and the scientific community.

Economic and social benefits of management

These field trials and demonstrations were largely experimental, and therefore probably yielded no direct economic benefits. However, the indirect socio-economic benefit is that local managers in the field now have an enhanced knowledge on the efficacy of the potential methods for invasive shrub removal and a better understanding of the species ecology. This way, actions can be targeted, increasing overall cost efficiency of such work.

Cross-border Benefits

Results are applicable for the entire RINSE region.

Methods

Four different removal techniques were applied to 127 individual plants or clones of the same *M. aquifolium* plant at four dune sites and their direct effect was compared. These techniques are particularly useful in sensitive areas that are inaccessible for heavy machinery, or in situations where mechanical removal is inappropriate. The treatments were:

1. Cutting and stem treatment with saturated salt solution
2. Cutting and stem treatment with glyphosate 5% solution
3. Digging out manually with a spade
4. Leaf treatment with glyphosate 5% solution

Firstly, before treatment, the height and width of each individual plant was estimated and the number of stems counted. Photographs were also taken of each plant before and after treatment, and locations were measured. One year later, each location was revisited and regrowth of the plants was noted in three categories: vital regrowth, limited regrowth or no regrowth. Secondly, mechanical removals of *M. aquifolium* and *R. rugosa* were carried out with a crane on a large clonal patch of the species, combined with large-scale landscape restoration. The effort was documented (cost, effort, aftercare) and the outcome monitored in terms of regrowth from different depths. Excavations of *M. aquifolium* were carried out at a heavily infested site with 100% coverage by this species. About 350 m² were dug out on one day. The crane work was accompanied by intensive raking by hand (aftercare), which enabled removal of a lot of the smaller rhizome fragments. For *R. rugosa*, a surface area of approximately 200 m² could be cleared in one day. Hand raking of rhizomes was tried but seemed relatively unsuccessful, as rhizomes were easily fragmented.

Timetable

Spring 2013: Inventory of target species and other non-native plant species in the dunes (T_0)

March-May 2013: Trial design, treatment of individual plants on four locations.

November 2013: Mid-term follow-up of treated plants on two locations; removal with crane.

May 2014: Follow-up of treated plants on all locations. Data input and analysis.

Results

In the treatment of individual plants (Fig. 3), with the exception of leaf treatment (77% kill rate), kill rates were generally low: 38% for stem treatment, 27% for digging and 4% for salt treatment (considered as a cutting treatment). These results only give an impression of the aboveground regrowth after one year. Excavation of a number of individuals revealed that some roots do reshoot, even if the aboveground part of the plant looks completely dead. The kill rates are therefore probably overestimated.

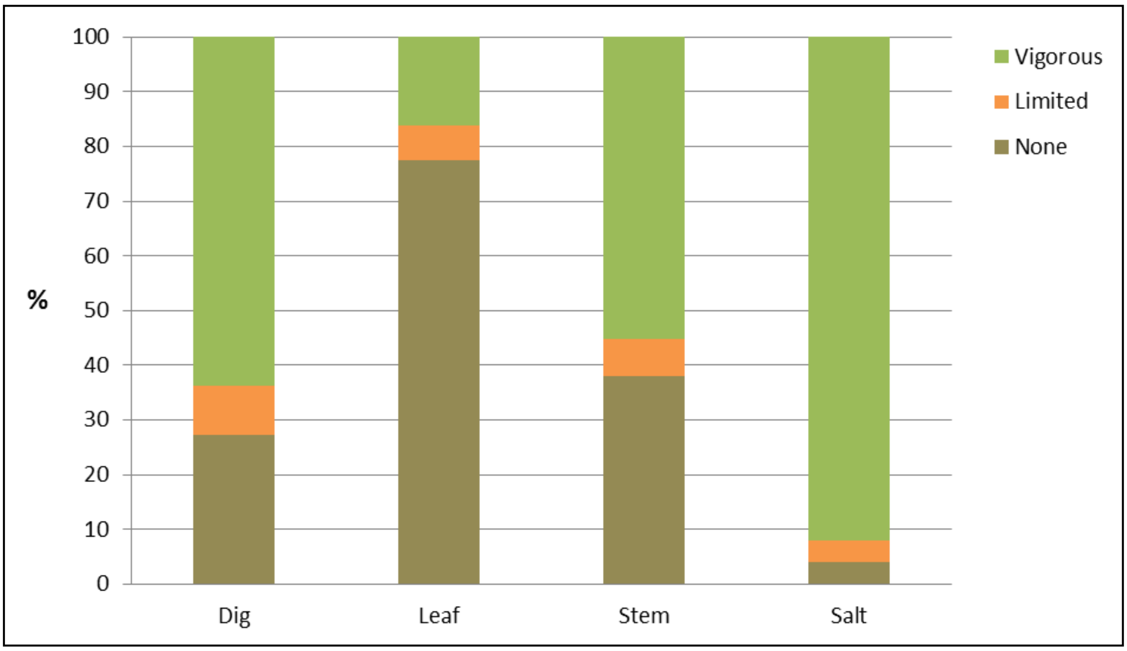

Figure 3 Regrowth percentages one year after eradication treatments on *M. aquifolium*.

Where *M. aquifolium* had been mechanically removed, only limited regrowth was observed when revisited. This came from rhizome fragments which were superficially buried and could therefore easily be pulled out by hand. However, a lot of regrowth of *R. rugosa* was observed and most of it originated from superficially buried rhizomes. The observed shoots were up to 25 cm in length. The depth from which reshooting can occur is unclear. The site should be followed for several years and any reshooting rhizomes should be dug up.

Conclusions and recommendations

Leaf spraying with glyphosate seemed by far the most effective way to remove isolated *M. aquifolium* individuals. Still, regrowth can occur from belowground plant parts. Therefore, revisiting of treated sites will be necessary in order to obtain complete removal. The non-target effects of glyphosate leaf-treatment are unknown, but visual inspections showed very little collateral damage around treated plants. Manual excavating of individuals is labour intensive and regrowth from thin root or rhizome fragments is nearly inevitable. Cutting, even with glyphosate stem treatment, gives very poor results and is therefore not recommended. Optimizing the use of herbicides therefore thus seems the most appropriate way to tackle *M. aquifolium*. Further experiments should be carried out, testing different types and concentrations of herbicide and optimal treatment timing.

Large patches of *M. aquifolium* and *R. rugosa* can be removed with heavy machinery, equipped with a barred shovel. Several hundred square metres per day can be achieved, depending on the terrain conditions. Dry conditions are ideal as they facilitate the separation of soil fraction and plant material. Manual aftercare on site and revisiting of the sites the next growing season are necessary nevertheless. Regrowth from the rhizomes of root fragments is inevitable but shoots appear mostly from superficially buried fragments. These can easily be removed by hand pulling.

In addition to these actions performed, the RINSE partnership engaged in networking with a local stakeholder forum in order to set up preventive actions towards garden centers, public bodies and private owners. Future projects will further build upon this work. These experiences with *M. aquifolium* and *R. rugosa* are useful for a wide range of other invasive species.

Deviations

No major deviations from the original setup.

Problems encountered

Trial and demonstrations were performed in nature reserves and were therefore not allowed during breeding seasons. Due to the relatively high moisture content of the soil, it was sometimes difficult to shake the soil out of the plant material. Each shovel had to be shaken for about half a minute which was clearly time consuming and limited the treated surface area considerably.

Lessons learnt

These invasive plants can be effectively managed but this requires the correct methodology and application over a number of years.

3.1.4 Habitat characterization, ecological impact and control of topmouth gudgeon Pseudorasbora parva *populations*

Target species

This trial referred to the Southeast Asian cyprinid fish topmouth gudgeon *Pseudorasbora parva*, although as they are a strong model pest fish then aspects of the trial are highly relevant for other small invasive fishes in the Two Seas Area.

Aim of the trial

The project aim was to evaluate the effectiveness of biocontrol and removals to reduce topmouth gudgeon population levels and maintain these at a low level that would minimise their natural dispersal from open waters and reduce their potential consequences for native species. To assist meeting this project aim, work was also completed on determining the habitat characteristics between invasive topmouth gudgeon and those in their native range, and their potential ecological impacts on native fishes and communities through their feeding interactions.

Target audience

The target audience includes fishery managers, aquaculturists, water managers, and regulators and legislators. Outputs should also be of interest to conservation bodies across the RINSE area given the potential consequences of topmouth gudgeon on native fish communities through disease transmission.

Economic and social benefits of management

Topmouth gudgeon are a pest species that can transmit a novel disease to European fishes. From a recreational fishery perspective, their propensity to form highly abundant populations comprised of a high proportion of fish below 60 mm causes interference with angling techniques. From an aquaculture perspective, there is concern that transmission of the rosette agent *Sphaerothecum destruens*, for which topmouth gudgeon are a healthy host, to farmed fish could invoke high mortality rates and so substantial economic losses. The adverse effects of inter-specific competition and disease impacts arising from topmouth gudgeon are believed to threaten wild fish stocks in invaded areas, impacting wild fisheries that provide an important social amenity, with angling a proven pastime that improves human well-being.

Cross-border benefits

Topmouth gudgeon is invasive across the Two Seas Area, including England (where management actions have decreased their rate of dispersal) and Belgium. Consequently, their management is important in reducing their impacts and thus this project has considerable cross border benefits. Indeed, aspects of this trial were completed between RINSE partners in both Belgium and England, facilitating the sharing of information in both countries.

Methods

1. Habitat Characterization

Primary data were collated on the distribution of topmouth gudgeon in rivers and agricultural canals in northern Kyushu Island, Japan, where the fish is native. Species distribution models were then developed to predict the distribution of topmouth gudgeon and to analyse the impact of different environmental condition on Topmouth gudgeon distribution. Fuzzy habitat preference models (FHPMs) and Random Forests (RF) were applied to link landscape features to the distribution of Topmouth gudgeon based on field observation data collected from two distinct eco-regions, the north-western (NW) and north-eastern (NE) parts of Kyushu Island, and the significant habitat variables influencing distribution were stored. In the next step, topmouth gudgeon distribution was modelled in the invasive range based on data collected in running waters between 2000 and 2012 in Flanders, Belgium. Different data mining techniques like generalised additive models, generalised linear models, Random Forests and fuzzy hill-climbing were applied to reveal the factors affecting Topmouth gudgeon distribution. The focus was on both biotic and abiotic factors, since biotic factors have often been neglected in invasion ecology when modelling species distribution. The abiotic variables quantified habitat conditions in the study area, whereas the biotic variables described the co-occurrence of Topmouth gudgeon and other fish species. In this way, species interactions like competition for food and habitat were integrated in the models.

2. Ecological impact

A major ecological impact of topmouth gudgeon has been postulated as the adverse consequences for native species of high inter-specific competition for food resources. Consequently, this aspect of the trial focused on the following three aspects in order to evaluate the extent of inter-specific competition from their invasive populations.

i. Conditions for forming high density populations: In England, topmouth gudgeon in ponds have been recorded at extreme densities (> 60 m^{-2}), but with populations at lower abundances in many cases. Ponds with higher densities tended to be those that were heavily fished by recreational anglers, suggesting that the input of angler bait could be assisting topmouth gudgeon establishment. The aim here was to experimentally determine the conditions for topmouth gudgeon rapid establishment through an experimental mesocosm experiment in which controls were mesocosms with 8 mature topmouth gudgeon added (4 male, 4 female) with no angler bait added and treatments where the same number of fish were present but with small amounts of angler bait were added daily (a 2mm diameter fishmeal pellet, as a subsidy to the natural food). The control and treatments were also repeated with natural terrestrial food blocked from entering the pond by covering them an insect net (0.5 mm^{-2}). Starting at the beginning of the topmouth gudgeon reproductive season, the experiment ran for 100 days; at the end, the numbers of progeny produced by the 8 mature topmouth gudgeon were counted and compared between the treatments.

ii. Trophic niche convergence or divergence in controlled conditions: If topmouth gudgeon are to compete with native fish, it must first be demonstrated that they are sharing food resources. This was tested in experimental mesocosms using 8 fish in each. The controls comprised of one of the following: 8 topmouth gudgeon, 8 carp *Cyprinus carpio*, 8 tench *Tinca tinca* and 8 3 spined stickleback *Gasterosteus aculeatus*. Treatments were then 4 topmouth gudgeon with 4 carp, or 4 tench, or 4 sticklebacks. The fish were left to co-habit the mesocosms for 100 days. At its conclusion, the fish were removed and analysed for their stable isotopes of $d^{13}C$ and $d^{15}N$, which provides information on their feeding relationships. The data were expressed for each species as the extent of their trophic niche width and, in the treatments, the extent to which this overlapped with the other species (as a metric indicating the sharing of food resources).

iii. Trophic niche convergence or divergence in wild conditions: the same analytical method, stable isotope analysis, was applied to data collected from three ponds in Belgium in March and October 2013 to determine the feeding relationships of more complex fish communities.

3. Control of topmouth gudgeon Pseudorasbora parva *populations*

Topmouth gudgeon in England have been successfully extirpated using the chemical rotenone from a series of ponds in England and Wales to prevent their wider dispersal into the environment. This trial was designed to identify the effectiveness of two alternative methods to manage their populations: biocontrol (through predator release) and removals (through sustained trapping of fish). Whilst population extirpation was considered as unrealistic by both methods, the aim was to determine the extent to which population abundance could be reduced and then this reduction be sustained. This was completed experimentally in ponds of 200 m^{-2} on a biosecure aquaculture site that was licensed for holding the species. These were drained and refilled, and then 1500 mature topmouth gudgeon released into each (February 2012). The control and treatments were replicated four times. The control was left as it was, i.e. there were no management interventions. The first treatment involved the introduction in March 2012 of 20 mature perch *Perca fluviatilis* of 10 to 15 cm a native facultative predatory fish. The second treatment involved the removal of topmouth gudgeon through sustained use of as fish trap in two periods per year, in March (pre-reproduction) and October (post-reproduction). Four traps were used per pond, with each trap being 1.06 x 0.4 x 0.4 cm in dimension and baited using 21mm diameter fishmeal based pellets. Changes in topmouth gudgeon abundance were measured using catch per unit effort (CPUE) of the fish traps, expressed as number of fish per hour per trap (n trap h^{-1}). At the end of the experiment, the CPUE of the control and treatments were tested statistically to determine the significance of any differences.

Timetable

Year 1: Gather data for habitat modelling. Run the competition experiment. Set up the population control experiment and sample.

Year 2: Complete the modelling. Run the trophic niche experiment and the wild pond trophic niche. Complete the population control experiment.

Results

1. Habitat characterization

In their native range, topmouth gudgeon revealed a clear habitat preference for areas of lower elevation, a gentler slope and a smaller number of river-to-river connections as general landscape features across the ecoregions. Weak preferences were observed for sites with a higher number of river-to-canal connections, a higher canal network index, a larger area of paddy fields, a larger residential area, more crop fields and fewer forests and orchards. Of these site-specific features, five landscape features (elevation, slope, canal network index, area of paddy fields, and presence of forests and orchards) were identified as the most important features for predicting their distribution. In Flanders, the model outputs revealed that biotic variables were more important for the distribution of topmouth gudgeon than abiotic variables. The most important abiotic variables were water depth and velocity, while the presence of bitterling, stone loach and three-spined stickleback were the most important biotic variables. Surprisingly, the presence of bitterling was the most important variable, whereas the impact of the presence of predators like pike *Esox lucius* and perch was limited.

2. Ecological impact

i. The outputs of the experiments revealed that in mesocosms receiving subsidies of fishmeal pellets, the number of progeny (‘young-of-the-year’) produced by the mature topmouth gudgeon was significantly elevated (Fig. 4).

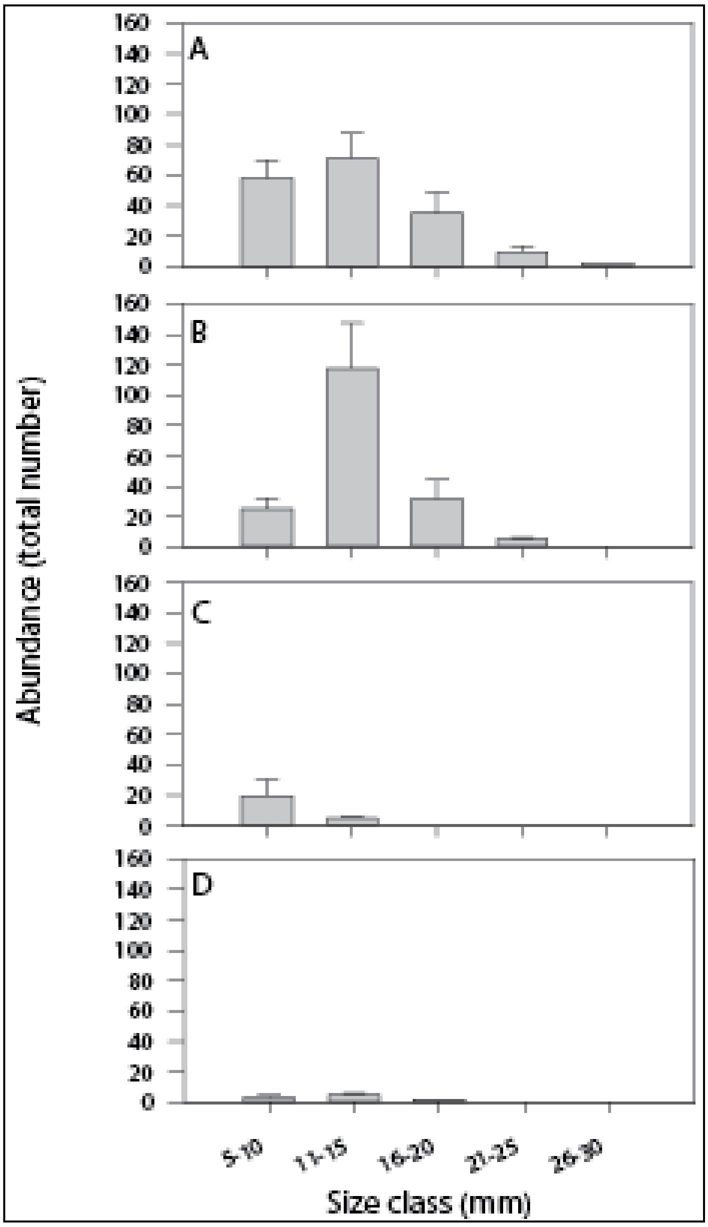

Figure 4 Number of topmouth gudgeon young-of-the-year recovered from the mesocosms, according to their size class, where:

A: With fish meal pellets, with natural terrestrial subsidies

B: With fish meal pellets, with natural terrestrial subsidies blocked

C: Without fish meal pellets, with natural terrestrial subsidies

ii. In the experimental mesocosms, the trophic niche size of each species was always higher when they were allopatric (i.e. not co-habiting) than when they were sympatric (i.e. co-habiting), thus the effect of sympatry was a decrease in each species' trophic niche width (Fig. 5). There was no sympatric combination of species in which any sharing of the trophic niche width of the co-habiting species was apparent. Thus, in these experimental conditions, there was no evidence that topmouth gudgeon were competing with the other species; conversely, the species diverged in their resource use and so avoided competition (Fig. 5).

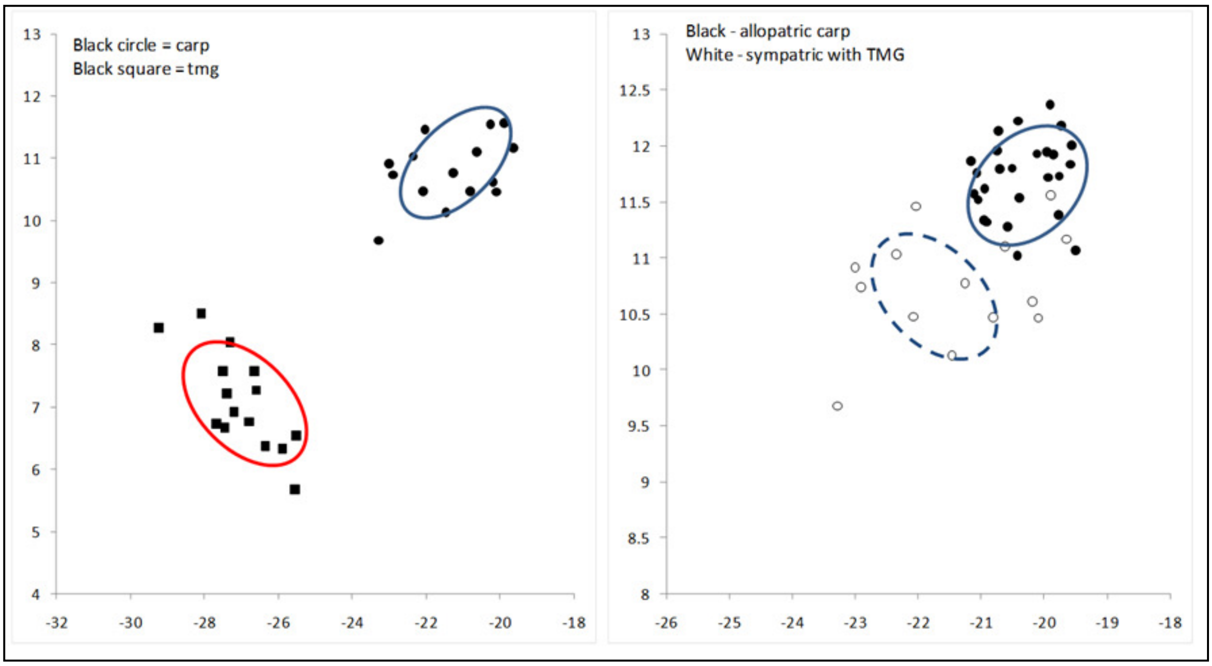

Figure 5 **Left: Stable isotope data for topmouth gudgeon (black square) and carp (black circle) from their sympatric treatment where the blue circle represents the trophic niche width of carp and the red circle the trophic niche width of topmouth gudgeon. Right: Stable isotope data for allopatric carp (black circle) and sympatric carp (white circle) showing the differences in trophic position and size between the contexts. For both graphs, the unit on the Y axis is d^{15}N (‰) and on the X axis is d^{13}C (‰).**

iii. The data from the Belgian ponds indicated that although there was more evidence of trophic niche overlap between topmouth gudgeon and other species, this was low, with topmouth gudgeon trophic niche width being relatively small compared with other fish species, suggesting they were not important influences on the diet of other fishes in the community (see Fig. 6 for an example). The combination of outputs from (ii) and (iii) suggest that topmouth gudgeon, in many situations, do not increase inter-specific competition for native fishes, with trophic niche divergence a common mechanism that avoids this.

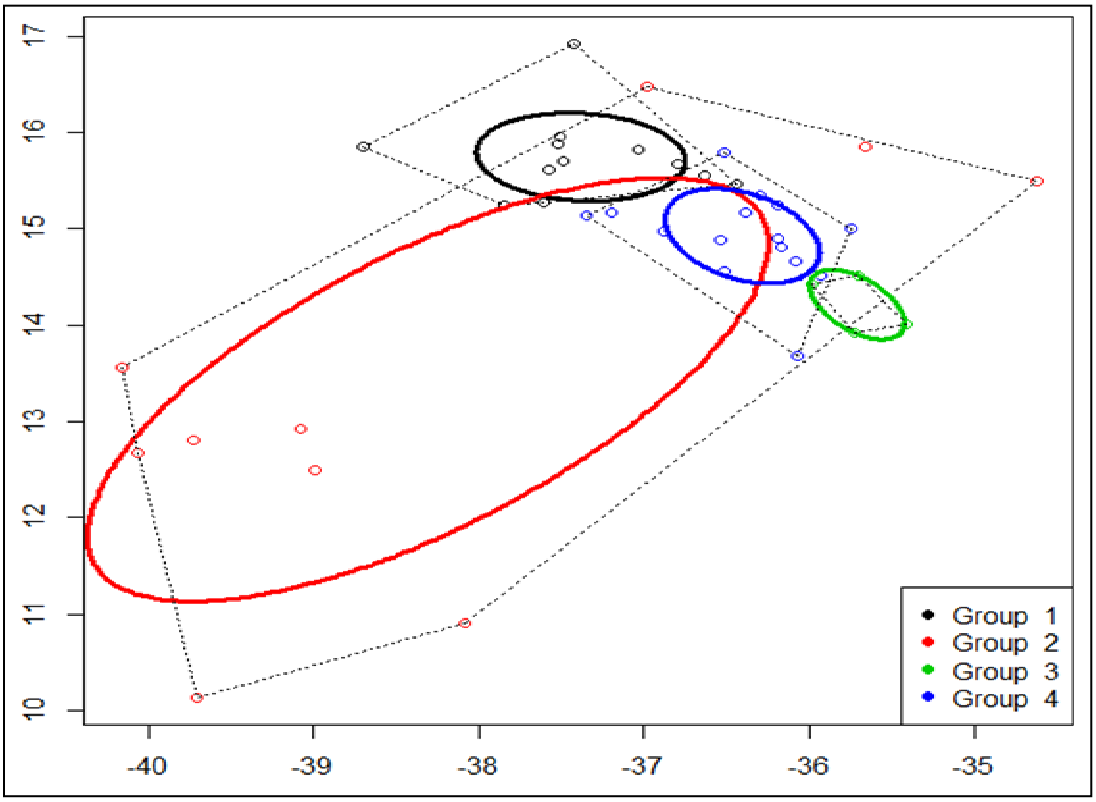

Figure 6 Stable isotope data for topmouth gudgeon (Group 1), 3 spined stickleback (Group 2), bitterling *Rhodeus amarus* (Group 3) and Gibel carp *Carassius gibelio* (Group 4). The circles represent the trophic niche width of each species, with only stickleback's overlapping with the other fishes. The unit on the Y axis is d^{15}N (‰) and on the X axis is d^{13}C (‰).

3. Control of topmouth gudgeon *Pseudorasbora parva* populations

When compared with the control and removal ponds, the biocontrol treatment had significantly reduced topmouth gudgeon CPUE by the end of the trial (ANOVA: Control: $F_{1,22} = 31.1$, $P < 0.001$; removals: $F_{1,22} = 43.51$, $P < 0.001$; Fig. 7). However, there was no significant difference in CPUE between the control and removal treatment ($F_{1,22} = 0.31$, $P > 0.05$; Fig. 7). This was because the large amount of fish removed were able to be compensated in the pond by the fish growing faster and maturing very quickly, something less possible in the biocontrol ponds as the perch were able to consume the nest-guarding male topmouth gudgeon, inhibiting compensation through reproduction. A combination of stomach contents analysis and stable isotope analysis confirmed that the perch were consuming topmouth gudgeon in this treatment, i.e. the mechanism of population control was predation.

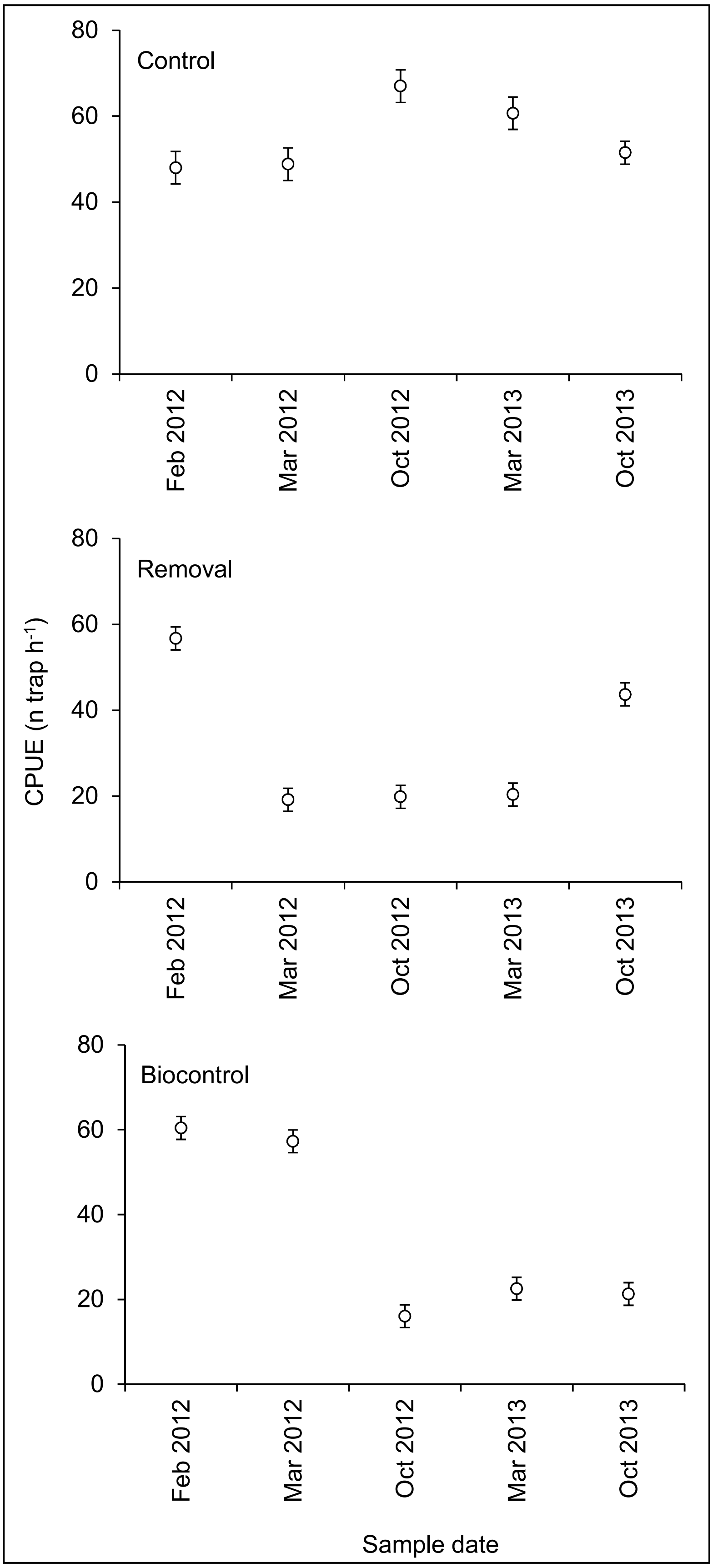

Figure 7 **Temporal changes in topmouth gudgeon catch per unit effort (CPUE) over the course of the trial.**

Conclusions and recommendations

1. Topmouth gudgeon show distinct habitat preferences in both their invasive and native ranges.
2. In ponds that are fished by anglers who introduce large amounts of bait then the probability of rapid topmouth gudgeon population establishment is significantly elevated.
3. In ponds where fish communities are reliant only on natural foods, the introduction of topmouth gudgeon might see their trophic niche divergence with native fishes as the species seek co-existence by avoiding inter-specific competition.
4. Population control of topmouth gudgeon is feasible through manipulation of their predatory fish populations, but removals of topmouth gudgeon alone run the risk incurring compensatory mechanisms that enables the rapid recovery of their population levels through high reproductive output of the surviving fish that results in high numbers of young of the year being produced that are then difficult to remove in traps due to their small body size (often <20 mm).

Deviations

There were no deviations in the trial.

Problems encountered

The ponds in the experiment on population control had to be monitored using fish traps rather than seine nets or electric fishing due to high macrophytes growth but this provided a standardized method for comparing relative abundance over time.

Lessons learnt

Ecological impacts of topmouth gudgeon might not always relate to competitive processes but might instead relate to changes in the trophic position and trophic niche size of native fishes as they seek to trophically diverge from topmouth gudgeon, rather than share resources. Chemical application by rotenone is the only apparent method that can quickly extirpate a pond population of topmouth gudgeon. Biocontrol can, however, be effective in significantly reducing population size, which could be an important method to reduce their risk of dispersal into the wider environment. As many managed fisheries in England do not allow the release of predatory fish such as perch, then this might inhibit the successful use of the method, and requires overcoming.

3.1.5 *Egyptian goose* Alopochen aegyptoacus *in Flanders*

Target species

This field trial targets Egyptian goose *Alopochen aegyptiacus*, one of several invasive goose species in Europe. Native to Africa, it was introduced into Western Europe for ornamental purposes in the 17th century and it is still increasing in numbers and range. Problems arising from their populations include damage to agriculture and sensitive vegetation types, eutrophication of water bodies, and nuisance through their faecal droppings, trampling and overgrazing. There is also anecdotal evidence for disruption of breeding native bird species through competition for nesting sites. Although rarely backed with scientific data, impact on local avifauna has also been suggested through competition for food and space. Nowadays, there is a growing demand for effective control measures of their populations. Management of invasive geese is generally done by egg pricking or oiling, shooting and/or trapping. Trapping efforts generally focus on moulting flightless geese, but due to their excellent diving capacities, they are not susceptible to the current moult trapping systems. In addition, the species does not generally nest in colonies and regularly uses nest sites in trees, making the nests less accessible for reproduction control.

Aim of the trial

To explore innovative options for the control of Egyptian goose, three objectives were set:

1. Establish if trap systems that deploy decoy birds are effective in trapping the species.
2. Determine the optimal season for the use of these trapping systems.
3. Compare different methods that all used decoy birds.

Target audience

The trials were primarily aimed at conservation managers, farmers, other RINSE partners, the recreational sector, hunters, and conservationists.

Economic and social benefits of management

Economic impact of geese occurs mainly through crop damage via consumption of crops combined with trampling of vegetation and soil. In Flanders, this is especially the case on parcels with winter wheat, maize and grasslands. In the Netherlands, agricultural crop damage by Egyptian and Canada geese together has been estimated at 870,000 Euro in 2010. If no population reduction of these geese was achieved in The Netherlands, the number of Egyptian geese is expected to increase from 10.000 to 28.000 breeding pairs by 2020. For Canada geese these numbers would go up from 5.500 breeding pairs up to 25.000. The damage to agricultural crops under this scenario was estimated to approach 3 million Euro.

Due to the experimental character of this field trial, a low number of animals were caught, thus no direct economic benefit resulted from this trial. The indirect benefit is that local managers in the field now have a clear knowledge on the optimal season to use these trap types. This way, actions can be targeted in time, increasing overall cost efficiency.

Cross-border Benefits

Results are applicable for the entire RINSE region, where similar management actions on Egyptian goose are performed. Therefore, a presentation and demonstration capture event was organised within a workshop on managing invasive mammals and birds. The results of the trials were also presented at the Benelux Congress on invasive alien species on April 2014.

Methods

The innovative management methods used in this trial include a specially designed floating trap with a live lure, a device that can also be put on land in the vicinity of breeding pairs, and a double clap net for larger geese concentrations. The floating cages were tested year-round on more than 20 locations throughout the RINSE area in a standardised design, investigating trapping success in time and efficiency of the device. During the breeding season, additional traps with different design were also placed in breeding areas close to nests on land. Also, a clap net was tested and technically optimised within the framework of the project. Floating Larsen traps, a land-based Larsen trap and clap nets were used in order to determine whether or not Egyptian geese could easily be caught. As this was the case, a separate experiment was then developed to determine the optimal catching season. For this, 19 floating Larsen traps were used for one week (Monday-Friday) in the middle of each month during one year, from February 2013 to January 2014. In 2014, based on the results of the experiment, additional field trials were performed in which the trap itself was altered and the different trap types were compared during the optimal catching season.

Parallel to this experiment, the land-based Larsen trap was also used *ad libitum* (until all present geese, usually one or two resident breeding couples, were caught) at various locations in west-Flanders, different from the field experiment locations, from February to June 2013 in order determine how many geese could be trapped using this type of approach. The factors to evaluate success were the average number of Egyptian geese caught per location, and the speed at which animals were caught (days to first capture in a given month at a given location, varying from 1 to 4).

Timetable

Summer 2012: Development and first trials of different trap systems

Autumn 2012: Development of the experiment.

Winter 2012-2013: Prospection of potential sites for captures.

February 2013 to January 2014: Field experiment floating trap types.

Spring to summer 2013: Field trial land-based Larsen trap.

Spring 2014: Analysis of experiment data.

Spring to summer 2014: Additional field experiments with other trap types.

Summer to autumn 2014: Analysis of experiment data.

Results

During the trial, 860 trapping days were realised with the *floating Larsen trap* distributed over 19 locations, during which 80 Egyptian geese were caught. At four locations, no geese were captured. In the most successful locations 7 or more Egyptian geese were caught. A total of 68 animals of non-target species were caught, mainly native water birds. The average number of Egyptian geese caught per location differed markedly between months. In the most successful months, on average 1 goose was caught per location over the course of four catching days. In the least successful month, virtually no animals were caught. Non-target species were caught more evenly throughout the year (Fig. 8), and the target/non-target ratio per month was highest in April - June.

The comparison of the speed at which animals were caught between months showed no clear period in which traps worked faster. If both evaluation factors are combined, the number of geese caught appears as the main parameter that can be used to discern trap efficacy in between months, and that spring is the most efficient season to deploy these

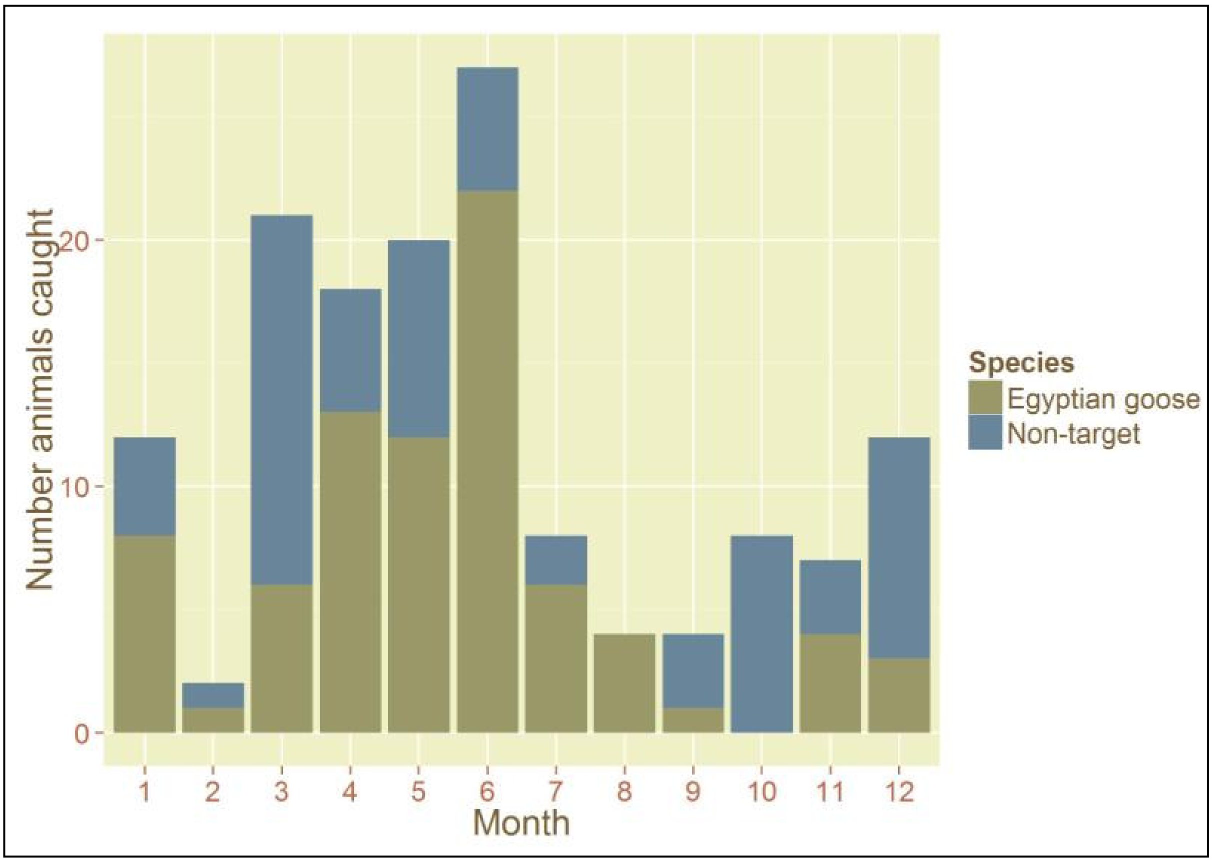

Figure 8 **Total number of Egyptian geese and non-target species per month.**

floating Larsen traps for Egyptian geese (Fig. 9). Contrarily, autumn (Fall) is the least preferable to deploy them.

Over the course of 89 catching days with the land-based Larsen trap, a single trap was placed for a period varying from 1 to 9 days at 27 different locations, and a total of 62 Egyptian geese were caught. It was confirmed that early in the year, during and before the breeding period, these traps with decoy birds work very well for Egyptian goose. Although the numbers are difficult to compare without a true scientific setup, the very high numbers per catching day (0.7 geese/day on average) indicate that a land-based approach targeting breeding pairs could be preferable to a floating system. Additional tests with floating traps and longer catching periods during spring are running in spring 2014 and will elucidate this further.

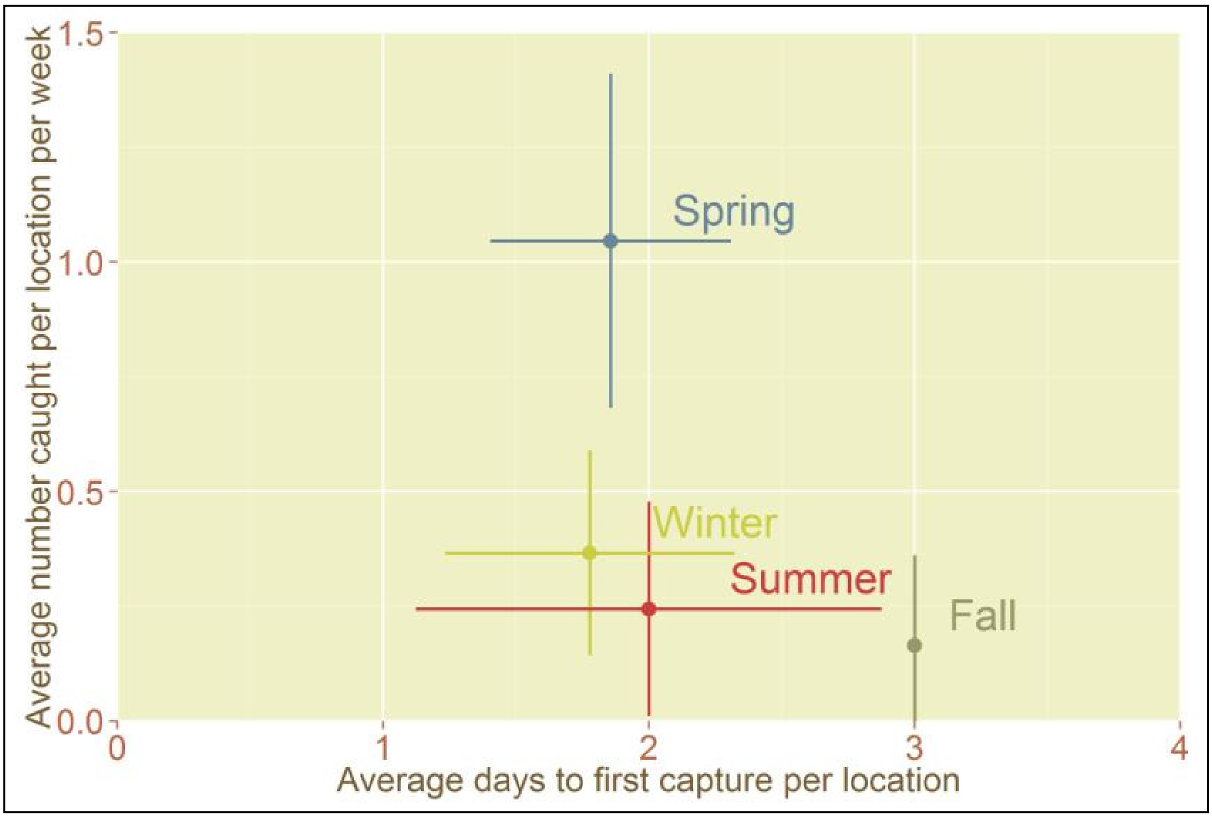

Figure 9 Average number and speed of Egyptian geese caught per location per season (error bars represent 95% CI).

Conclusions and recommendations

The use of trap types that deploy decoy birds can be a useful tool for the population control of Egyptian goose. Throughout the year, geese can be caught fairly quickly, although spring is the optimal season for the use of similar trap types. The information provided here can be used by local managers to optimize the cost-efficiency of their actions. Knowledge on the optimal season is also very useful for future comparisons.

Deviations

No major deviations from the original set-up of the demonstrations to report.

Problems encountered

One of the main problems this approach had was the fact that a high number of by-catches occurred. In total, 68 non-target species were caught. Since traps were checked on a daily basis, all native species were released within 24 hours after catching. Non-target, non-native species and greylag geese were not released. In order to avoid vandalism, floating traps were used in the experiment, marked with a small sign explaining the field experiment and providing contact information. The same signs were also placed on the banks of the lakes involved. Consequently, no vandalism appeared.

Lessons learnt

The use of field trials within a framework like RINSE allowed successful testing of specific questions managers and field workers are faced with.

3.2 Demonstration projects

3.2.1 Overview

Eleven management trials were completed in sub-action 3.2, with the target species and RINSE partner responsible provided in Table 2.

Table 2 Summary of Demonstration Projects completed in RINSE sub-action 3.2

Section	Taxonomic group	Target species	RINSE Partner
3.2.2	Plant	*Crassula helmsii*	7, 9, 5
3.2.3	Plant	*Hydrocotyle ranunculoides*, *Impatiens glandulifera*	LP
3.2.4	Plant	*Impatiens glandulifera*	LP
3.2.5	Plant	*Impatiens glandulifera*	6
3.2.6	Plant	*Azolla filiculoides*	3
3.2.7	Plant	*Ludwigia grandiflora*	6
3.2.8	Plant	*Fallopia japonica*, *Solidago gigantea*	4
3.2.9	Plant	*Fallopia japonica*, *Solidago gigantea*, *Heracleum mantegazzianum*	4
3.2.10	Plant	*Heracleum mantegazzianum*	6
3.2.11	Bird	Non-native geese	7, 8, 9
3.2.12	Mammal	*Mustela vison*	LP

These are reported sequentially in the following sub-sections.

Target species

The present project targets Australian swamp stoncrop *Crassula helmsii*.

Aim of the demonstration

The aim of the demonstration was to complete a series of studies on *C. helmsii* in Flanders to identify distribution, seed viability, characteristics of invaded areas, and how management interventions can be used to manage its invasion.

Target audience

Natural resource managers, land owners, public sector organisations with responsibilities for managing public land.

Economic and social benefits of management

Please refer to Section 3.1.2.

Cross-border benefits

Given the considerable impact of *C. helmsii* in invaded areas across the Two Seas Area then its successful control has the potential to deliver considerable recreational, social and economic benefits across all of the Two Seas Area. Within the RINSE consortium, considerable cross-border benefit was realised through working with partners in the UK, Netherlands and Belgium in order to share experiences and deliver enhanced management, including attendance of workshops.

Methods

1. *Distribution.* Based on various information sources and corroborative field observations, the distribution of *C. helmsii* in Flanders was brought up to date. All distribution data were uploaded to the Q-bank data base (http:/q-bank-eu).

2. *Seed viability.* Although it is generally believed that *C. helmsii* in Europe merely reproduces by means of vegetative parts, a study from southern Belgium reported finding only aborted seeds in three populations. Thus, we collected mature seeds (c. 30 in 100 flowers) from *Crassula* growing in the Belgian coastal dunes to study the germination percentage.

3. *Characteristics of invaded habitats.* General site and vegetation characteristics of 47 sites with *C. helmsii* in Flanders were inventoried. More than 160 Braun-Blanquet type relevés of 0.5 x 0.5 m plots with *C. helmsii* were made to document the range of vegetation types where the species may be expected. Where possible, a relevé was also made of a comparable plots not yet occupied by *C. helmsii* to detect possible impacts on species composition.

4. *Interaction with characteristic species of the Natura 2000 habitat type 3130.* The amphibious pioneer communities of the protected N2000 habitat type 'Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoeto-Nanojuncetea*' (type 3130) are often assumed to be particularly vulnerable to the invasion of *C. helmsii*. Here, the competitive behaviour of selected characteristic species of this habitat type and *C. helmsii* was compared in controlled conditions. Effort concentrated on obtaining greater insight into the situations where negative interactions may be most prominent and which mechanisms may be involved. For that, an experiment was carried out in a controlled-climate facility, comparing the development of *Littorella uniflora* and *Hypericum elodes*, species differing in morphological and physiological traits as well as in environmental optima, in a replacement design with *C. helmsii* as an alternative competitor.

The species were grown in emergent conditions and watered regularly with artificial rain water where nitrogen was either at 'normal' concentrations, or at the more elevated level usually encountered in northern Flanders. Quantitative estimates of species cover were made every two weeks over a period of 30 weeks.

5. *Demonstration project Huis Ter Heide (Tilburg)*. A field experiment on management of *C. helmsii* in the nature reserve Huis Ter Heide (Tilburg, northern Netherlands) was executed. In this demonstration project, various control techniques were applied in an attempt to eradicate the species after its establishment in pools and developing wet heath. We documented the biomass development of *C. helmsii* and indigenous vegetation in one of the ponds where measures include mechanical removal, shading by means of dyes and light-blocking foil and frequent manual removal.

Results

1. The known occurrence of the species in Flanders now includes 66 km^2 throughout most of the region with at least 135 individual sites and c. 73 management units (Fig. 10). In addition, some reported occurrences along the border with the southern Netherlands were checked, resulting in 20 confirmations.

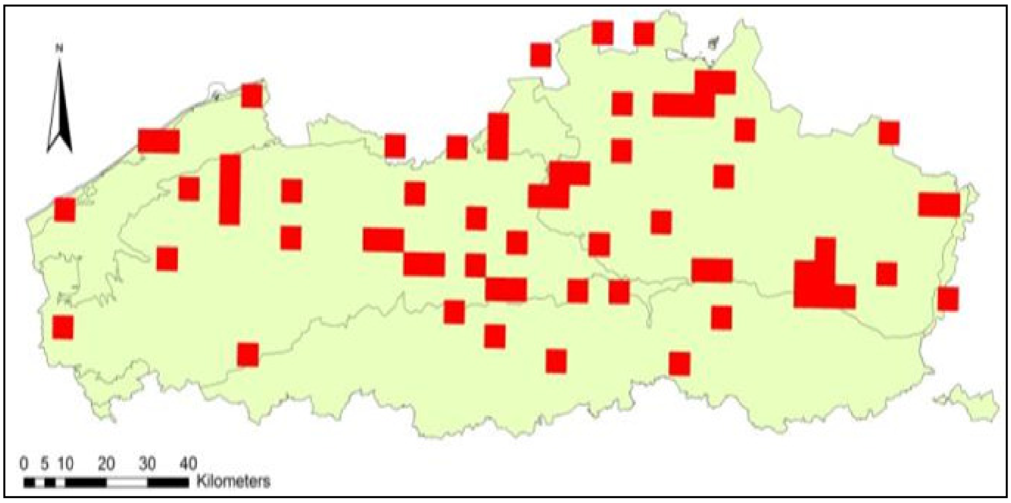

Figure 10 Distribution of *C. helmsii* in Flanders (2013).

2. From the mature seeds of *C. helmsii* collected and obtained a germination percentage of c. 18%.
3. There appears to be no consistent relation between *C. helmsii* cover and plant-species richness, the latter often not even decreasing with explicit *C. helmsii* dominance (Fig. 11).

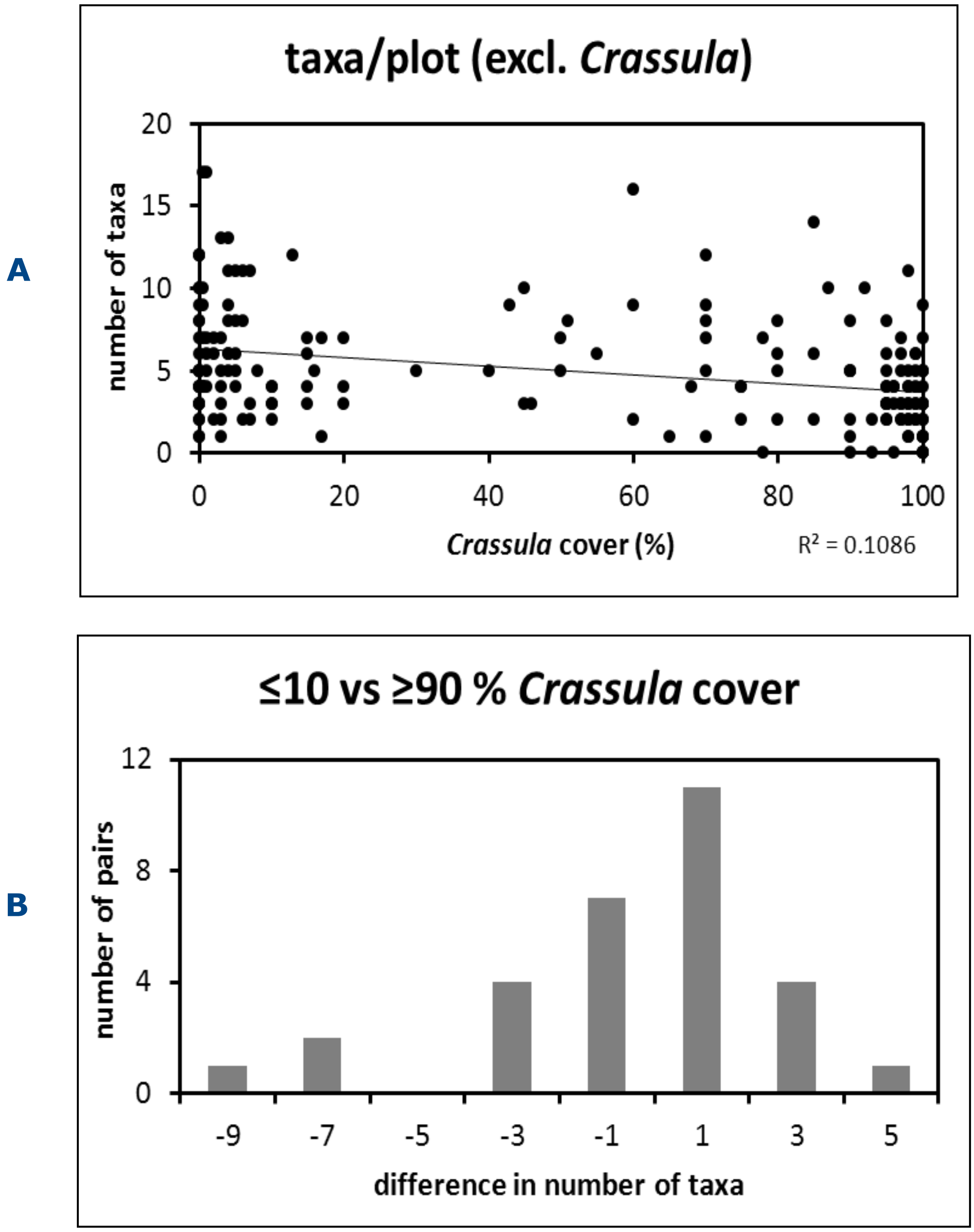

Figure 11 Plant-species richness in relation to *C. helmsii* cover. A) All plots (N=191). B) Difference in number of taxa between paired plots with at most 10% (reference) and at least 90% *C. helmsii* cover (29 comparisons).

4. The results of the experiment run to assess the interaction with species of the habitat type 3130 suggested that inter-specific competition between the native species was stronger than any inter-specific interaction with *C. helmsii*. Conversely, there was no indication of a negative response of *C. helmsii* to the presence of *Littorella*.
5. In the field experiment, measures carried out for the management of *C. helmsii* proved to be ineffective. The main reason for this was insufficient limitation of photosynthetically active radiation, due to the combination of shallowness and seasonal water-level lowering, in conjunction with dye concentrations being too low and variable. In addition, large parts of the foil surface became covered with a thin sediment layer in time, enabling establishment of *C. helmsii*. Where the foil was punctured above the water line in the course of the year, *C. helmsii* plants started growing again.

Conclusions and recommendations

- *C. helmsii* in Flanders has greatly increased its distribution area from 17 km^2 reported in 2006 to 66 km^2, with at least 135 individual sites and c. 73 management units.
- The seeds of the species are quite small and viability can have considerable implications for pathways of further spread and may challenge control measures (e.g. regrowth after removal of plants or covering with light-blocking material) and biosafety protocols based on the assumption of merely vegetative reproduction. So far, the distribution of populations able to reproduce by seed in Flanders and neighbouring regions remains unknown. Germination conditions as well as seed-bank characteristics in Europe also need to be determined further.

- The (presumably higher) possibility of dispersal by ingested seeds should be considered now that seed viability has been established. The potential distance of transport has to be worked out further. Nevertheless, the results add to the probability that especially sites with larger *C. helmsii* stands and visited by many water birds can serve as hubs for further spread.
- The apparent absence of relationship between *C. helmsii* cover and plant-species richness, suggests that, at least in earlier successional stages, exclusion may not be as prominent as often claimed. The data will be explored more fully at a larger stage. If time allows, a number of plots will be reassessed in 2014 to study the short-term succession that has occurred.
- Competition between *Littorella uniflora* and *Hypericum elodes* was stronger than any interaction with *C. helmsii* in controlled emergent conditions. A different response to changes in soil chemistry in leaching conditions is being examined further as a possible explanation. Based on field observations of apparent 'exclusion', allelopathy by *Littorella* has been suggested to occur in submerged conditions and consequently introduction of the latter is given consideration as a possible control measure. Allelopathic interactions are less likely to occur in emergent conditions and our results substantiate its absence. Given that permanent water, or at least a considerable period of submergence and strong development of *Littorella* would be required to influence the development of *C. helmsii* by means of allelopathy, if such were to occur, the possibilities for successful remediation by means of *Littorella* seem very limited. Building on the results of this experiment, a second experiment will be carried out.
- Insufficient limitation of photosynthetically active radiation drives to ineffective management actions. Specially, covering the ponds with light-blocking foil to control the species is fraught with difficulties.

Nevertheless, dye application at doses considerably above the minimum recommended by the supplier and other measures will be continued into 2014 and complementary observations will be made later this year.

Deviations

There were no major deviations in the work.

Problems encountered

When light-blocking foil is used to limitate photosynthetically active radiation reaching *C. helmsii*, large parts of the foil surface became covered with a thin sediment layer in time, enabling establishment of targeted the species. If these plants cannot be eliminated entirely in advance, removal of the foil without re-infecting the pond will probably be extremely difficult. Where the foil was punctured above the water line in the course of the year, *C. helmsii* plants started growing again.

Lessons learnt

C. helmsii is a highly invasive plant whose dispersal, colonisation and invasion present major challenges to natural resource managers.

3.2.3 Eradicating floating pennywort and controlling Himalayan balsam: River Waveney (UK)

Target species

Floating pennywort *Hydrocotyle ranunculoides* is a highly invasive aquatic plant that was first recorded in the UK in 1990. It is believed that the plant spreads primarily by vegetative means as very small fragments of the plant still have the ability to root. The plant can have very serious impacts on the ecology of infested waterways, and is also extremely costly to control and eradicate. This project also sought to control Himalayan balsam *Impatiens glandulifera*. This plant can quickly displace native vegetation, forming dense monocultures which can stretch many metres along riparian corridors. In the winter, the shallow root systems of the *I. glandulifera* stands leave river banks vulnerable to erosion, increasing the risk of flooding.

Aim of the demonstration

The aim was twofold: 1) eradicate floating pennywort from the River Waveney and its tributaries; and 2) significantly reduce the distribution of Himalayan balsam in the catchment, with a view to future eradication.

Target audience

This project involved working closely with landowners on the River Waveney. A Steering Group was established for the project, which comprised of staff from the Environment Agency, Broads Authority, Norfolk County Council and the River Waveney Trust (who joined the group in 2012).

Economic and social benefits of management

The River Waveney contributes significantly to the Broads landscape; an internationally important site for wildlife with over 90 SSSIs as well as Special Areas of Conservation (SACs), Special Protected Areas (SPAs) and Ramsar sites. This landscape remains an important tourist attraction for Norfolk, receiving 7 million visitors in 2013 alone, equating to £469 million for the local economy. Floating pennywort forms dense mats of vegetation across the top of an infested waterway, preventing the use of that area for recreational activities such as fishing and boating. Should floating pennywort become established in the Broads the social and economic impact of the species would be extremely large. Floating pennywort can also impede the flow of water and correspondingly increase the risk of flooding. Similar benefits accrue from controlling Himalayan Balsam given its impacts on native plant communities and propensity for increasing the risk of high riverbank erosion during flood events.

Cross-border benefits

This project has demonstrated an approach that can be used to successfully eradicate floating pennywort, which is a troublesome plant across the Two Seas region.

Methods

The river was split in to manageable chunks that were then surveyed in rotation. As the project developed it was clear that no floating pennywort was found at the lower end of the project area and so surveys were focused on the upper end. When floating pennywort was spotted it was recorded using a hand held GPS and a photograph was taken. Floating pennywort was removed by hand once it was recorded. Removed floating pennywort was placed in black plastic sacks in the boat and was spread out to dry in an area away from the bank of the river. Over the summer period, sites where floating pennywort had already been removed were re-visited. If patches proved to be difficult to eradicate by hand removal alone then a glyphosate based herbicide was used to kill the plant. The herbicide was mixed with an adjuvant, with Topfilm being the most commonly used chemical for this purpose. For Himalayan balsam, the river was surveyed for the presence of the plant and then hand-pulled to reduce its presence.

Timetable

May 2012 to June 2013: Surveys and hand removal of floating pennywort and Himalayan balsam.

July to August: Re-visits and ongoing monitoring

Results

- Floating pennywort was not found anywhere on the River Waveney during 2013. It is hoped that the plant has now been eradicated from the river.
- The distribution of Himalayan balsam on the river has been significantly reduced.
- The 'Floating pennywort Eradication Steering Group' will remain in place but broaden its remit to encompass the control of all invasive species in the River Waveney catchment. The value of the group in coordinating activities to control invasive species on the river is well appreciated.

Conclusions and recommendations

- It is possible to eradicate floating pennywort once it is established in a major watercourse, but this requires concerted action over the whole of the plant's growing season and over a number of years.
- An integrated approach to eradicating floating pennywort, involving the removal of the bulk of the plant's biomass by hand or mechanical means followed up by numerous re-visits and the use of herbicide for particularly difficult areas seems to be effective.
- Infestations of floating pennywort should be tackled as soon as the

plant is identified. All those involved in the eradication on the River Waveney believe that if the infestation had remained uncontrolled for a longer period before being tackled it would have been much more costly and difficult to eradicate.

- Although it appears that floating pennywort has been eradicated from the river we recommend re-surveys of the affected stretch of the river to confirm that this is the case. These should be carried out during the plant's peak growth period (July-August). It is possible that small patches of the plant could still remain but be hidden by other bank side vegetation. There is no set number of years recommended for re-surveys to take place, but we believe 2-3 years would be appropriate.

Deviations

During the period of the project the approach was adapted according to the conditions on the River Waveney. During certain months excessive weed growth on the river prevented from carrying out waterborne surveys on certain stretches of the river. At other points waterborne surveys were still possible but the period of time that these surveys took was much increased. The work programme was also adapted to work around the Environment Agency's weed cutting schedule for the river. All deviations were discussed and agreed at meetings of the Floating pennywort Eradication Steering Group.

Problems encountered

Difficulties in managing invasive plants such as pennywort mean that it cannot be completed in one plant growth season and so a significant challenge is to complete management work over several years to complete its eradication.

Lessons learnt

- The project has demonstrated that floating pennywort can be eradicated from a major watercourse. It requires a concerted effort over a number of years, but eradication can be achieved using the methods and tools currently available.
- Although the methods to eradicate Himalayan balsam are well understood there are numerous practical difficulties associated with removing the plant. In particular, gaining access to land to remove the plant can be very time consuming. Surveying for the plant is also problematic, as it doesn’t just grow in the area directly adjacent to the river but can stretch inland for many metres. Indeed, it may have spread along the adjacent drainage network for many kilometres.

3.2.4 Assess the distribution of Himalayan balsam in the River Bure cCatchment (UK)

Target species

The target species was Himalayan balsam *Impatiens glandulifera*. This invasive species can quickly displace native vegetation, forming dense monocultures which can stretch for considerable distances along riparian corridors. In the winter, the shallow root systems of the *I. glandulifera* stands leave river banks vulnerable to erosion, increasing the risk of collapse during flooding. The plant can be dispersed passively downstream by the river flow establishing new infestations throughout a river catchment. The spread of Himalayan balsam throughout a river catchment is further exacerbated by recreational activity, with the seeds unintentionally transported between sites, for example, via anglers.

Aim of the demonstration

The project aim was to determine the distribution of Himalayan balsam within the River Bure catchment, identifying key areas of infestation for future control. A secondary aim of the project was to survey for five other invasive plants simultaneously within the same catchment:

- *Fallopia japonica* - Japanese knotweed
- *Heracleum mantegazzianum* - giant hogweed
- *Hydrocotyle ranunculoides* - floating pennywort
- *Crassula helmsii* - Australian swamp stonecrop
- *Myriophyllum aquaticum* - parrot’s feather.

Target audience

This project involved working closely with landowners on the River Bure, and required a significant number of volunteers to carry out the survey ‘on the ground.

Economic and social benefits of Management

The River Bure contributes significantly to the Broads landscape; an internationally important site for wildlife with over 90 SSSIs as well as Special Areas of Conservation (SACs), Special Protected Areas (SPAs) and Ramsar sites. This landscape remains an important tourist attraction for Norfolk, receiving 7 million visitors in 2013 alone, equating to £469 million for the local economy. An infestation of any of the invasive plants surveyed for in this project would reduce the amenity of the Broads and reduce its tourism value. The use of volunteers reduced the cost of the project considerably when compared with employing a full time surveyor.

Cross-border benefits

This project has demonstrated that the use of volunteers is a cost-effective and efficient approach to surveying a large area, such as a river catchment. It is possible that aspects of this approach could be adopted by other countries in the Two Seas area, although it is dependent on local land ownership and ability to access the river and its tributaries.

Methods

Potential volunteers were identified based on their personal motivation for the project. Volunteer advertisements were targeted to communities based along the River Bure and additionally local community groups with a keen interest in wildlife and walking. A number of online advertisements were posted, however the majority of volunteers were obtained by directly contacting the community groups themselves. In total 22 volunteers took part in the survey, equating to a total volunteer effort of 1064 hours. An Introductory Workshop was held addressed to the volunteers. This covered: an introduction to the RINSE Project; problems of invasive plants and how to identify them; the survey methodology, and rare native plants on the Bure. Volunteers were all issued with a Handbook detailing Health & Safety guidance and the methodology, a map of their river section and GPS units. The majority of the River Bure is publically accessible, with a Public Right of Way following the river bank allowing easy access for the volunteers. The upper stretches of the Bure are all privately owned and therefore, access permissions were required. Other than for some minor gaps in access, the River Bure was divided into manageable linear sections ranging from 2 km to 6 km across both public and privately owned land. Sections of the River Bure were walked by pairs of volunteers at a steady pace, recording sightings of Himalayan balsam on both sides of the bank. Where Himalayan balsam was sighted, volunteers recorded a six-figure grid reference using a GPS with an estimation of cover and photographed the plant for verification. Every 200m without a sighting was reported as 'none found' and recorded along with a six-figure grid reference. Any sightings of the other five invasive plants were recorded following the same method. The sections unsuitable for the volunteer survey due to accessibility and Health and Safety constraints were surveyed by boat by a RINSE contractor following the same methodology as above. All data collected was combined and a GIS map layer was created using MapInfo Professional 12.0.

Timetable

April 2013: Develop project plan. Contact landowners. Recruit and train volunteers.

May 2013: Introductory workshop.

June to October 2013: Survey.

November 2013: Results collated.

Results

The data collected from this survey has highlighted three significant infestations of Himalayan balsam on the River Bure: Corpusty (TG1130), Itteringham (TG1330 and TG1430) and Wroxham Broad (TG3116). Below Wroxham Broad, Himalayan balsam was absent from both sides of the River Bure (Fig. 12) suggesting the plant has yet to disperse this far downstream.

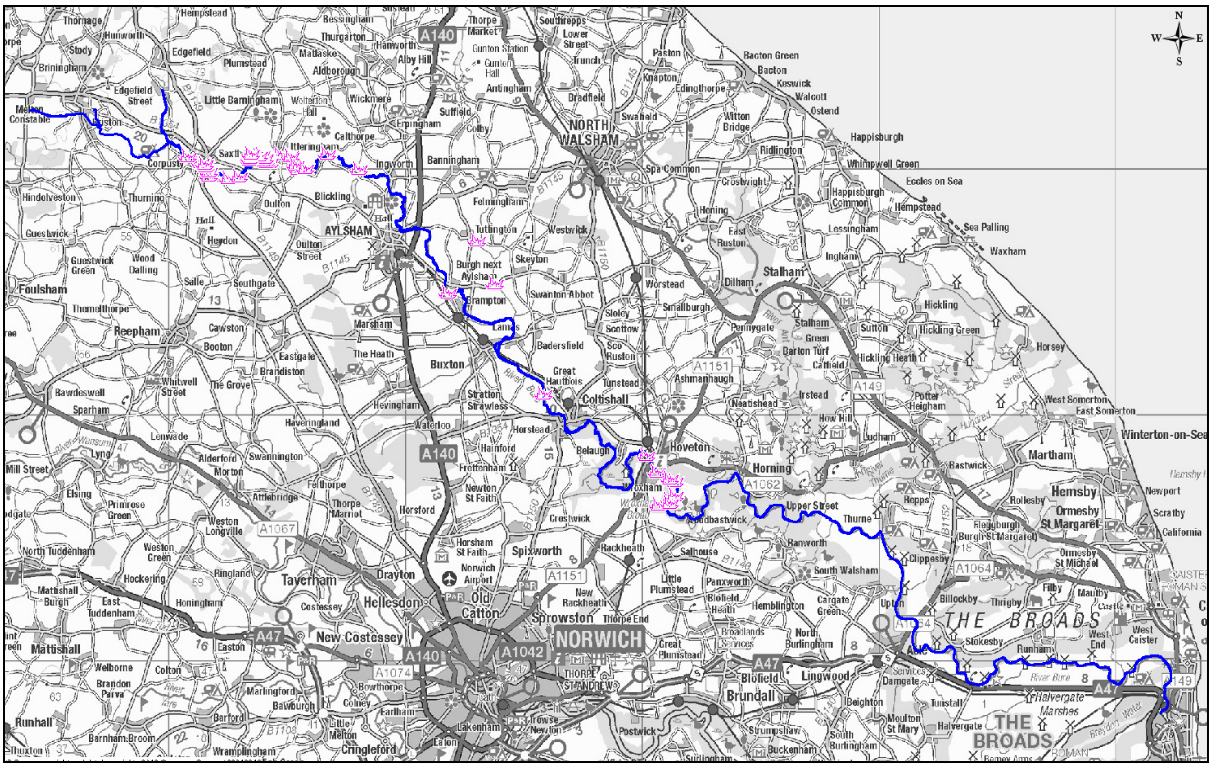

Figure 12 Results of the survey, with infestations of Himalayan balsam being shown in pink.

Contact has been made with several local community groups and landowners along the River Bure, all of which are now fully aware of the problems associated with invasive non-native species. Local groups have developed an interest in recording these on an *ad hoc* basis in their local vicinity. A number of landowners with Himalayan balsam on their land are keen to work with Norfolk County Council to begin management of the plant through volunteer action days. Additionally, many of the volunteers involved are keen to work in this removal.

Conclusions and recommendations

- It is feasible to begin the control and management of Himalayan balsam on the River Bure, starting at the source in Corpusty. A number of volunteer Action Days should be set up to target the three infestations, with participation advertised to the local communities nearby.
- A priority for future work should be to contain the infestation at Wroxham Broad preventing future colonisation. However, the possibility of independent introductions in this area should not be ignored, increasing the need for an improved recording network within the catchment. Given the likelihood that Himalayan balsam was introduced to the Bure from a local garden, an awareness campaign in the local vicinity could help reduce the chance of reintroduction.
- Raise awareness that Himalayan balsam can colonise new areas rapidly, and therefore continued monitoring will be vital following eradication.

Deviations

Although the majority of the River Bure is a public Right of Way, the upper reaches of the river are a jigsaw of small landowners and subsequently gaining access permissions for this section was both problematic and time consuming. For a total of four sections, full access permissions were not acquired from the necessary landowners and were therefore not surveyed by foot. These sites were visited by car, checking bridge sites for signs of Himalayan balsam on the main River Bure channel and surrounding tributaries.

Problems encountered

Due to a significant delay in receiving contact details of the landowners, the survey did not begin as early as was anticipated. Permission to access to some private lands could not be obtained.

Lessons learnt

- Contact with the local community at Corpusty suggests that Himalayan balsam has only established there within the last year. The implication of this would be a relatively limited seed bank making control efforts more effective in the short term.
- Community support is widespread and there is an interest from residents to become more involved in the protection of their local area. Given the importance of early detection, this could be a useful approach to adopt when monitoring invasive species at a regional level, where intensive localised monitoring is not feasible.

3.2.5 Mobilising volunteers to control Himalayan balsam across river catchments (UK)

Target species

Himalayan balsam *Impatiens glandulifera*.

Aim of the demonstration

The aim of this project was to demonstrate that volunteers can be mobilised effectively to contribute towards the successful control and eradication of Himalayan balsam at the catchment scale.

Target audience

The target audience was mainly organisations considering the use of volunteers in the control of Himalayan balsam.

Economic and social benefits of management

The control of Himalayan balsam by volunteers results in a number of social benefits. Questionnaires completed by volunteers to discover what motivated them to pull Himalayan balsam revealed what they most enjoyed was the opportunity for social interaction, with this highly valued. Volunteers also appreciated the opportunity to be outside and have some exercise, which improves their health, both mentally and physically.

Cross-border benefits

The use of volunteers has been presented as possible, and in this case the best approach, for stopping the spread of Himalayan balsam and other invasive non-native plants. Volunteers can play a vital role in surveying, performing removal actions, and subsequent monitoring. This fact and the proceedings presented here can be of relevance to organisations in other European countries.

Methods

This demonstration project focuses on the Beaulieu River, Hampshire, Southern England, as an example of successful control of Himalayan balsam. Volunteers were drawn from a range of sources. University graduates and a local resident surveyed the quantity and extent of Himalayan balsam. A volunteer at Hampshire and Isle of Wight Wildlife Trust mapped the results. Practical control of Himalayan balsam was undertaken by members of the Forestry Commission's 'Two Trees' Conservation Team and by the Forestry Commission's Voluntary Rangers. Since Himalayan balsam has short roots and is easy to pull up, method adopted by volunteers was hand-pulling Himalayan balsam plants. Finally, subsequent survey and monitoring was also undertaken by volunteers as Himalayan balsam is easy to recognise.

Timetable

2009-2010: Initial survey.

Summer 2010 to summer 2012: Practical control in the field.

September 2012: Subsequent monitoring

Summer 2013: Practical control of the remaining plants.

Results

Hand pulling of plants by volunteers has resulted in a large decrease in the amount of Himalayan balsam, particularly between 2009 and 2010, with much of this reduction sustained into 2013 (Fig. 13).

Conclusions and recommendations

- Volunteers drawn from a wide variety of sources and ages can be effectively mobilised to contribute towards the successful control and eradication of Himalayan balsam at the catchment scale.

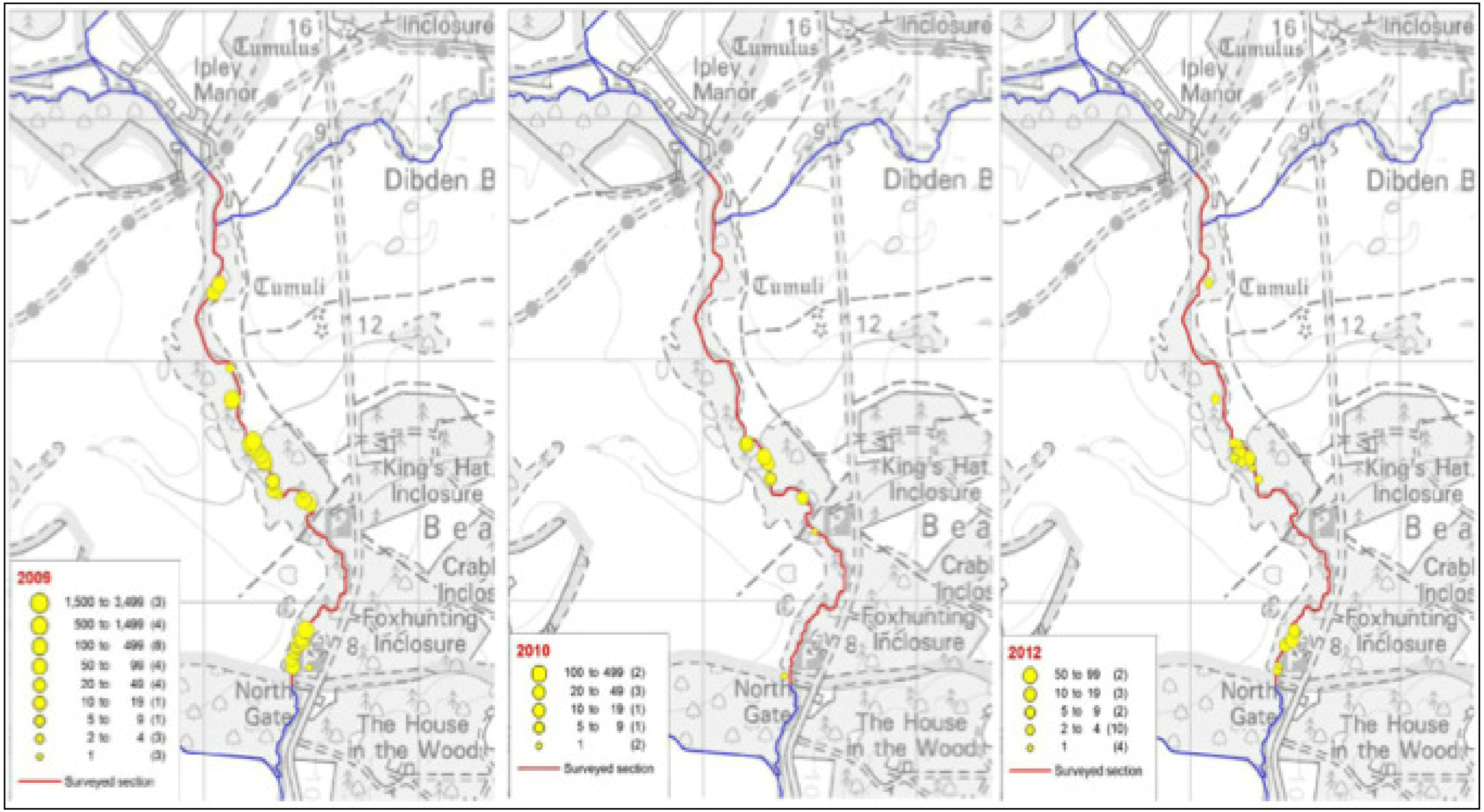

Figure 13 **Himalayan balsam plants recorded along a section of the Beaulieu River, Hampshire, Southern England, in 2009, 2010 and 2012.**

- Volunteers play an important role in a) surveying populations of Himalayan balsam and monitoring the effectiveness of control measures and b) undertaking practical control. They can also play an important role as 'river champions', patrolling a watercourse and liaising with landowners and Project Officer.
- Successful eradication is dependent on a co-ordinated and strategic approach to ensure that areas controlled by volunteers are not contaminated by seed shed from plants growing further upstream.
- Practical considerations including health and safety and insurance need to be addressed, and the Project Officer's role is critical in keeping volunteers well motivated. A flexible approach is required by the volunteers and the Project Officer.
- A strong commitment to partnership working between the Project Officer, volunteers, landowners, land managers and professional contractors combined with a strategic, co-ordinated approach to control can eradicate Himalayan balsam effectively at the catchment scale.

Deviations

No deviations were apparent.

Problems encountered

- After a few years of balsam-pulling at a particular location it becomes increasingly difficult to predict how many balsam plants will germinate. It is also possible that there are insufficient balsam plants to justify a volunteer work party. It is therefore necessary for the work party leader to check the site a few days in advance and, if necessary, find an alternative site.
- The uncharacteristically wet summer of 2012 was a challenge to this project. River levels rose significantly and on some days the heavy

rain resulted in flooding which made it impossible for work parties to be held at the scheduled locations.

- The majority of the Himalayan balsam plants initially mapped coincided with extremely wet conditions under riparian woodland. Such areas are inhospitable to the commoners' grazing animals, which avoid such wet areas and the balsam plants can flower and shed seed in the absence of grazing pressure. Such wet woodlands are also inhospitable to people and it is important for the work party leader to ensure that the volunteers wear suitable footwear. A certain level of fitness and agility is required to negotiate unpredictable, wet, muddy conditions, often involving clambering over or crawling under fallen branches. It may be necessary to 'hand-pick' volunteers to ensure that they are physically capable of coping with such challenging situations, rather than 'advertising' a work party more widely.
- The Forestry Commission took the decision to cancel one of the work parties due to a weather forecast which predicted strong winds; the Beaulieu River is fringed by ancient woodland and it was considered too dangerous to hold a work party beneath the tree canopy.

Lessons learnt

- Flexibility is needed when planning volunteer work parties as it is difficult to predict how much Himalayan balsam will be growing at a particular site each year.
- Flexibility is also needed when high rainfall results in flooding, making the river bank inaccessible or when predicted strong winds means it is unsafe for volunteer to work at a site which is under trees.

3.2.6 **Azolla** ***weevil*** **Stenopelmus rufinasus** ***for the control of*** **Azolla filiculoides** ***in UK, Belgium, France and Netherlands***

Target species

Azolla filiculoides is a floating water fern native to the Americas that is invasive on a global scale, including across Europe. All RINSE regions are affected by this weed, which can impact upon water quality, submerged plants and animals, drainage, pumps and filters, leisure and livestock. Herbicide application for control of *Azolla* is not permitted in mainland Europe and is strongly discouraged in the UK, primarily due to environmental concerns, but also due to its expense and limited long-term effectiveness. Manual removal of *Azolla* is time-consuming, can require specialist equipment and usually results in only temporary reduction in *Azolla* density. Classical biological control of *Azolla* has been conducted in South Africa using the weevil *Stenopelmus rufinasus* which was found, through extensive safety testing, to be an *Azolla*-specialist. The weevil, although native to the Americas, arrived by accident in Europe and has probably done so on many occasions as a contaminant of plants for sale. *Stenopelmus rufinasus* has therefore been present in Europe for more than 100 years and has been resident in each of the RINSE countries since early in the twentieth century. In the UK, mass-rearing and redistribution of the weevil to control *Azolla* outbreaks has proven to be an effective management method. There is potential for this method to be carried out more widely across the RINSE region.

Aim of the demonstration

This study aimed to demonstrate that 1) the *Azolla* weevil *S. rufinasus* is present throughout all RINSE regions; 2) it can have a significant impact on *Azolla* populations; and 3) it can be mass-reared and relocated to treat *Azolla* outbreaks. Feedback from stakeholders that have used the weevil to treat *Azolla* in the UK was sought to assess the perceived effectiveness of the weevil and their opinions of it as a control agent.

Target audience

The target beneficiaries of this method of *Azolla* control are public and private water management authorities, as well as individuals who suffer from the impacts of this weed.

Economic and social benefits of management

The acceptance of weevil *S. rufinasus* as the best practice for managing *Azolla* will bring about ecological, social and economic benefits, with healthier, navigable, fishable and unclogged waterways that result from weevil application to *Azolla* infestations. The economic benefits of *Azolla* biocontrol are hard to quantify but could be worth millions of Euros across the RINSE region each year through reduced management costs and benefits to recreation (e.g. angling).

Cross-border benefits

Involved field staff and RINSE partners have been trained to identify and work with the weevil for *Azolla* control and can now add this management method to their repertoire and also inform land managers of the techniques and benefits. In France, networking has revealed a number of potential demonstration locations. Additionally, presentations to water managers in the Netherlands have provided knowledge of *Azolla* biocontrol to key stakeholders. As more people across the RINSE region are involved with or hear of *Azolla* biocontrol as a best practice management approach, the technique will benefit increasing numbers of land managers and the water bodies for which they are responsible. It is hoped they will be able to continue to share their experiences after RINSE is finished.

This method of weed control will contribute directly to achieving good ecological status of water bodies as required by the European Union Water Framework Directive (2000/60/EC). In addition, control of A.

filiculoides will very probably contribute toward the requirements of the new EU invasive species regulation that will come into force within the next year and will legislate for the management of invasive non-native species.

Outputs at international conferences, meetings, journals and blogs have provided the opportunity to describe the RINSE programme, highlighting the need to address invasive species in Europe and techniques with potential to aid management. Finally, opportunities to network with RINSE partners and key stakeholders will likely lead to future collaborations.

Methods

The methodology proceeded as the following:

1. A literature review was conducted to prove the presence of *S. rufinasus* in Europe.
2. For each RINSE country, permissions to conduct field demonstrations using the weevil *S. rufinasus* as a biological control of *Azolla* were sought at the highest level, namely the relevant national environmental authority.
3. Prior to initiation of RINSE demonstrations, releases were conducted in the UK where the methods of mass-rearing *S. rufinasus* for redistribution had been refined over several years. Weevil numbers required to provide control over a given area of *Azolla* cover were quantified, with fixed-point photography useful in tracking the progress of the weevil and its impact, along with overall levels of control achieved. Site monitoring and feedback from stakeholders were used to assess the efficacy of the technique.
4. In order to further assess stakeholders' views of the weevil's efficacy and also to quantify the impacts of the weevil, a questionnaire was

developed and sent out to 97 previous users of the weevil for biocontrol of *Azolla* in the UK. Feedback was requested regarding: the impact of the weevil; opinions of the weevil for *Azolla* control; alternate methods attempted for control of *Azolla*; and preferred methods for control of *Azolla*. The responses were analysed.

5. Suitable sites for release of the weevil in partner countries were selected through different methods, but in each there was a high level of RINSE partner cooperation. At the selected sites, controlled releases were carried out. Data for a 2-year period were gathered to assess the relative benefits of the technique vs current measures.

Timetable

2012: Literature review. Weevil releases in UK to perfect the technique. Questionnaires.

2012-2014: Identification of potential demonstration sites.

2013-2014: Weevil releases in other involved countries.

Results

The literature review confirmed the long-term presence of the weevil in all RINSE regions. Releases in the UK prior to initiation of demonstrations showed a high efficacy of the technique, frequently achieving local eradication of *Azolla* over a series of weeks. Thirty responses to the questionnaire about stakeholders' opinion were received, which was considered a good level of feedback, and their analysis revealed that most responders used weevils on 'pond' sites, which covers a diverse range of water body forms and sizes, most of which would be expected to be stationary. According to the questionnaires, the most frequent outcome resulting from weevil application was eradication of *Azolla* (Fig. 14A). Opinion of the weevil as a control option for *Azolla* was generally very positive, differing from feedback for other methods (primarily manual removal with one instance of chemical control) which were described as ineffective and short-term. The weevil was the preferred method for *Azolla* management (Fig. 14B). Due to very significant variation in the ease of obtaining permissions and/or sites for each country, timing and numbers of demonstrations have varied between countries. In the UK, releases have been made on three ponds, with a natural weevil infestation assessed on a fourth. Eradication resulted in three ponds, with good control apparent in the fourth (Fig. 15). A further demonstration is planned for a site in Norfolk in summer 2014.

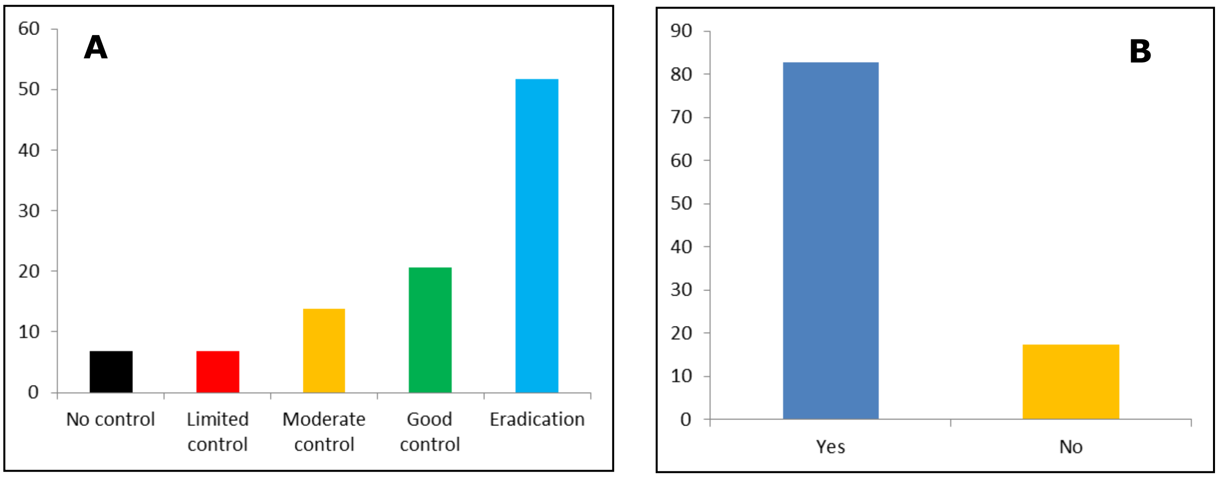

Figure 14 A) Effectiveness (%) of weevil in controlling *Azolla*; B) Preference for weevil in management of *Azolla*.

Figure 15 *Azolla* infestation on a SSSI pond with a natural *S. rufinasus* population (left) leading to eradication (right). Surrey, UK. (Photos: Corin Pratt; Sonal Varia).

Several potential demonstration sites were identified in Belgium in 2013. At three sites, however, the weevils were not released because they had natural weevil populations. These sites were monitored for impact. All *Azolla* populations succumbed to the impact of the weevil, with eradication apparent at two of the sites and high levels of control at the third. In 2014, a number of suitable sites were identified in Belgium. Six ponds were found to have weevils and will be monitored for impact. One site was free of weevils and a release of this species was made onto the *Azolla*. In the Netherlands, a waterway covered by *Azolla* was identified in September 2013 into which weevils were released with significant impact. However, due to the late timing in the season for application and the onset of cold and stormy weather unconducive to weevil activity, the remaining *Azolla* was manually removed by the site's managers before the conclusion of the study. Further demonstration sites are being sought for summer 2014. In France, trials are due to begin in 2014, with several potential release sites to be assessed. Several weevils must now be submitted for formal identification by experts in France and remaining individuals will be reared in the UK in order to establish a culture. Following this, and provisional to the identification of a suitable release site or sites there is a strong possibility of conducting successful demonstrations to exhibit the potential cost, time and effort benefits of using the weevil for *Azolla* control compared to manual removal, which due to herbicide regulations is the only management measure available in mainland Europe.

Conclusions and recommendations

Biocontrol of the invasive non-native water fern *Azolla filiculoides* using the weevil *Stenopelmus rufinasus* which is resident throughout the RINSE region is safe, effective, practical and financially viable. Demonstrations have shown that this method of control is scalable and results in good to complete control of outbreaks. The use of this method

The use of this method of control should be considered the best practice for *Azolla* management and utilised increasingly across the RINSE region and potentially more widely within Europe, for the benefit of land managers, the public and the environment. Additional demonstrations planned for 2014 should further support these findings and can be used to promote this method of management throughout the RINSE region and beyond.

Problems encountered

It took a great deal of time and networking to identify the competent individual/authority to grant permission for use of *S. rufinasus* to control *Azolla* in France, with a great number of unanswered requests making progress slower than expected. Difficulty in locating suitable *Azolla* sites and knowledgeable field-based contacts within the RINSE region meant that demonstrations were not possible in 2013.Limitations to the feedback received with the questionnaires were recognised, in that the response rate was not perfect; the questionnaire may have attracted responses from users with very negative (or very positive) outcomes; some of the prose based responses were harder to analyse; there was no feedback for control of *Azolla* on rivers; and application rates of weevils varied, commonly when users applied weevils at a lower than recommended rate giving potential for reduced levels of control.

Lessons learnt

Biocontrol of *Azolla* using weevils is an effective management method that can result in eradication.

3.2.7 Control of creeping water primrose Ludwigia grandiflora *at Breamore Marsh, in the New Forest District (Hampshire UK)*

Target species

The species targeted is creeping water primrose *Ludwigia grandiflora*.

Aim of the demonstration

The aim was to demonstrate the effectiveness of measures undertaken to eradicate creeping water primrose at Breamore Marsh Site of Special Scientific Interest (SSSI).

Target audience

Landowners, land managers or policy makers considering control of creeping water primrose.

Economic and social benefits of management

Creeping water primrose thrives in ponds, lakes, watercourses, wet meadows and other wetland habitats. It can root in water up to 3 metres deep, with its stems and leaves floating at the surface, forming dense mats, shading deeper water plants, reducing their photosynthetic rate and reducing the amount of dissolved oxygen in the water. As well as detrimentally affecting biodiversity, the dense mats of floating vegetation can quickly block waterways and interfere with navigation and fishing. Creeping water primrose has invaded 'Round Pond' at Breamore Marsh which is linked via watercourses to the River Avon which is designated as a Site of Special Scientific Interest (SSSI) and as a Special Area of Conservation (SAC) and Special Protection Area (SPA). If the creeping water primrose is not eradicated from Breamore Marsh there is a risk that it could colonise the River Avon. The cost of eradicating creeping water primrose from the River Avon would be highly significant. The eradication of creeping water primrose from Breamore Marsh is therefore of significant economic benefit.

Cross-border benefits

The results of this demonstration will be of interest to landowners, land managers and policy makers in other European countries where creeping water primrose is invasive.

Methods

Between 2009 and 2011, the water primerose had been treated with the glyphosate-based herbicide Roundup Pro Biactive with 'Topfilm' as an adjuvant in several occasions, and treatment completed with a volunteer working party in November 2010 to hand-pull remaining plants. The possibility of mechanical dredging of the pond to physically remove this invasive species was discussed, but this possibility was declined because it may lead to compaction on the sensitive SSSI. It was also considered that scraping out the pond would help increase the effectiveness of herbicide treatments, as a reduction in rush *Juncus spp* cover would increase the amount of chemical coming into contact with the *Ludwigia* foliage. The effectiveness of aquatic dye and 2,4-D amine ('Depitox') as possible methods to control water primerose in Round Pond had been also discussed in 2011, and decision to continue with the herbicide treatment followed by hand-pulling was made. Further herbicide treatments, combined with hand-pulling, were planned for 2012.

Timetable

2012: Practical work to control creeping water primrose.

Results

The attempts to eradicate creeping water primrose by a combination of herbicide treatment and hand-pulling have been ineffective. This is mainly due to Round Pond not drying out as anticipated during late summer / early autumn because of heavy rainfall. The effectiveness of the herbicide treatment is limited by the creeping water primrose being

being protected by other vegetation.

Conclusions and recommendations

The attempts to control creeping water primrose at Breamore Marsh using a combination of herbicide treatment and manual control have been unsuccessful due to a number of factors. Unseasonably high rainfall has resulted in high water levels in Round Pond which has delayed or prevented herbicide treatment being undertaken. The presence of taller vegetation has protected the creeping water primrose from herbicide applications. The eradication of creeping water primrose from the wild remains a top priority in the UK and Hampshire and Isle of Wight Wildlife Trust is considering alternative methods to eradicate this highly invasive species from Breamore Marsh.

Johan van Valkenburg (Netherlands Plant Protection Service) visited Breamore Marsh on 21 March 2013 to give advice on eradicating creeping water primrose at this site. His advice refers to a number of management techniques including mechanical excavation and dredging, chemical control, biological control and environmental control. He noted that although Breamore Marsh is grazed by domestic geese and cattle, grazing by cattle or wild geese elsewhere in Europe has not had an impact on creeping water primrose. Indeed, Johan recommended that successful eradication of the creeping water primrose at Breamore Marsh would necessitate dredging Round Pond to a depth of 30cm and disposal of the excavated material. It was concluded that dredging the entire Pond in a single operation would be preferable to a phased approach, with the following proceedings:

1. Remove bushes and brambles growing around the margin of Round Pond and spot-treat any creeping water primrose with herbicide.
2. Excavate Round Pond to a depth of 30cm during July (prior to

growth of creeping water primrose accelerating during August and September), taking extreme care to avoid inadvertently spreading fragments of creeping water primrose during the dredging operation.

3. Bury contaminated soil and vegetation on site. However, it was noted that burying the excavated material on site might not be realistic due to the impact on the Site of Special Scientific, aesthetic considerations and the attitude of the landowner and local residents. Consideration would need to be given to identifying a suitable site to dispose of the excavated material.

Further action to be taken:

- Continue with herbicide treatment during 2013 (as feasible, depending on water levels in late summer/early autumn 2013);
- Investigate feasibility of dredging Round Pond during 2014;
- Explore proposals for dredging and disposal of arisings with landowner, local residents and relevant statutory authorities (Natural England, Environment Agency and local planning authority);
- Secure necessary permits, authorisations, consents from relevant authorities;
- Secure necessary funding.

Deviations

Round Pond is an ephemeral pond which, based on observations in previous years, could be expected to dry out by September each year. However heavy rainfall and high water levels in Round Pond resulted in herbicide treatment being delayed or having to be cancelled. The demonstration project highlighted the need to consider alternatives to herbicide treatment. Advice was therefore sought from Johan van

Valkenburg of RINSE partner PP5 during a site visit on 21 March 2013. Johan had knowledge of work undertaken to control creeping water primrose in The Netherlands and he recommended dredging to a depth of 30 cm and careful disposal of the excavated material.

Problems encountered

The main problem encountered was due to the heavy rain and high water levels which resulted in herbicide treatment having to be postponed or cancelled. Even when herbicide treatment was undertaken, its effectiveness was limited as some of the creeping water primrose was protected by other vegetation such as rushes *Juncus* spp.

Herbicide treatment did not occur until two months following its discovery at Breamore Marsh due to unforeseen delays in the Environment Agency's authorisation procedures.

Lessons learnt

- Using herbicide to control creeping water primrose is highly dependent on weather conditions. Heavy rainfall and high water levels can jeopardise attempts to use herbicide.
- Herbicide treatment is of limited effectiveness where the creeping water primrose is 'hidden' amongst other vegetation for example rushes *Juncus* spp.
- Hand-pulling of creeping water primrose is of limited effectiveness.
- Attempts to eradicate creeping water primrose at Breamore Marsh using a combination of herbicide treatment and hand-pulling has proved to be ineffective.
- More radical measures need to be considered, involving mechanical excavation to a depth of 30 cm and appropriate disposal of the excavated material, with effective biosecurity measures during

- disposal of cuttings to prevent fragments of vegetation causing further contamination.
- As stated by Johan van Valkenburg “a job half done is no good whatsoever; if you do anything you have to do it rigorously”.

3.2.8 Japanese knotweed Fallopia japonica *and early goldenrod* Solidago gigantean *in Auxi le Château (France)*

Target species

Two target species were selected: Japanese knotweed *Fallopia japonica* and early goldenrod *Solidago gigantea*.

Aim of the demonstration

The principal aims were: 1) implement management measures to control Japanese knotweed and early goldenrod from specific sites of Auxi le Château; and 2) compare the results of the different management measures used for early goldenrod. An additional aim was to raise awareness on the importance of controlling both species.

Target audience

The target audience was mainly municipal employees who manage communal green areas so that they can better understand the issues created by these plants and the actions that can be implemented against them. In addition, other RINSE partners were targeted in order to improve control methods.

Economic and social benefits of management

Both plants can have severe socio-economic impacts arising from both their impacts on native flora resulting in high management costs and for Japanese knotweed in particular, its propensity to grow in disturbed environments and cause building damage.

Cross-border benefits

As both plants are present across the Two Seas area then considerable cross-border benefits will be evident in their successful management. Cross-border benefit was also achieved within the RINSE project through liaison with project partners on management methods to control plant growth.

Methods

The management plan selected for Japanese knotweed was mowing followed by plantations, as this had previously been implemented on a different site with satisfactory results. In 2012 and 2013, the plant was mowed 6 times per year between April and September in 5 colonised areas, to reduce the vigour of the plant as much as possible. The residues were removed or chopped. After two years of mowing, it was planned to introduce woody plants in order to shade out the plant and hence to reduce its photosynthetic capacity. For early goldenrod, the first step was to map its spread in "Le Grand marais" in Auxi le Château. The inventoried area in 2012 was around 5000 m², where different sectors were delimited for different management, allowing comparison:

1. Pulling before flowering (June-July). Implemented on a site on the top of a bank (about 150m long and 1m wide) along the River Authie. This consisted of hand pulling at the base of the plant while trying to remove most of the roots just before flowering, when the plant has spent much energy on its flowers. It aimed to limit the risk of spreading through the watercourse.
2. Pulling after flowering (October-November). Also implemented on a site on the top of a bank (about 150m long and 1m wide) along the River Authie, consisting in hand pulling each plant of the delimited area. Nevertheless, as stems are drier at the end of the season and tend to break more easily, the ground was previously loosened.
3. Mowing several times a season (April-October). The mowing was implemented in the marsh, further away from the watercourse and on larger colonised surfaces. An area of approximately 400m² (20m x 20m) was slashed 3 times a year between April and October, by means of a brush cutter and as low as possible. The residues were raked and exported.

Timetable

April to September 2012: Mowing Japanese knotweed.

6 June 2012: Pulling goldenrod before flowering.

16 October 2012: Pulling goldenrod after flowering.

19 April, 18 & 20 June, and 17 October 2012: Mowing goldenrod.

April to September 2013: Mowing Japanese knotweed.

4 & 18 June 2013: Pulling goldenrod before flowering.

7 & 8 November 2013: Pulling goldenrod after flowering.

17 May, 23 July and 25 & 26 September 2013: Mowing goldenrod.

Results

Even though Japanese knotweed is still present, it has become sparse and has therefore enabled native vegetation to develop. The 'pulling before flowering' actions on early goldenrod did not have a marked effect as its density remained constant on the managed site. This may be because two years of management was not sufficiently long enough to have an impact. When 'pulling after flowering' early goldenrod, the density of regrowth between 2012 and 2013 was reduced, suggesting some promise. Nevertheless, as it is a perennial species, this method will require monitoring over a longer period to properly assess its relevance. The area mowed for early goldenrod management shows no significant reduction of its density. Compared to the area mowed monthly, or more often in summer by the municipality, and on which the early goldenrod does not seem to establish, this result can therefore appear to be discouraging. Nevertheless, it should be stressed that the area concerned is already kept at a low level of grass vegetation through active management, whilst the rest of the marsh is rather being occupied by high vegetation of diversified tall herbs. Thus, systematic gyratory crushing is not necessarily interesting from the biodiversity perspective.

Conclusions and recommendations

- The management of Japanese knotweed did show some success and did enable some native vegetation to develop.
- For early goldenrod, after two years of experiments, the pulling method in fall with spading forks appeared the most promising method. Nevertheless, this method is tedious to implement and should thus be reserved for small areas or areas that are particularly problematic in terms of dispersal. To get a more complete and transposable feedback, this demonstration should also be recreated on other sites.

Deviations

As the plantations of woody plants to shade out the Japanese knotweed could not be planted after two years, a third year of mowing is planned before the plantations during winter 2014. To be able to draw a final conclusion on the real impact of control measures on the particularly vigorous Japanese knotweed, we will have to wait several years.

Problems encountered

The main problem encountered with the management of early goldenrod was the fate of green waste produced. To solve this problem, the municipality made public land available for temporary storage on and under canvas cover. Pulling plants by hand is very tedious as shoots must be pulled out one by one but it enables to avoid that stems from the top of the bank get carried away by current. After flowering, the stems of early goldenrod are drier and tend to break more easily. So as an attempt to remove most of the roots, the ground was loosened beforehand with a spading fork in order to get the roots when pulling the stem. Mowing early goldenrod is a less selective method and does not protect non-target species.

Lessons learnt

Regular mowing (once or twice a month, particularly in summer) prevents early goldenrod from colonising. However, this management is hard to apply to riverine vegetation on the top of the bank and in the marsh area where diversified plantings have been made. It should be ensured that organisations undertaking the work implement a monitoring and evaluation protocol. It is important that local organisations and stakeholders become involved.

3.2.9 Japanese knotweed Fallopia japonica*, early goldenrod* Solidago gigantean *and giant hogweed* Heracleum mantegazzianum *in Auxi le Château (France)*

Target species

The project targeted 3 invasive non-native species: giant hogweed *Heracleum mantegazzianum*, early goldenrod *Solidago gigantea*, and Japanese knotweed *Fallopia japonica*.

Aim of the demonstration

The aim of this demonstration was to demonstrate whether it is possible to manage invasive plants in municipal areas using a variety of methods and using municipal staff to undertake these works.

Target audience

The target audience was mainly landowners and municipal employees, who manage communal green areas invaded by non-native plants. In relation to this, the awareness of the concerned municipalities has been raised during preparatory meetings and they have contributed to the demonstration.

Economic and social benefits of management

These plants can have severe socio-economic impacts arising from their impacts on biodiversity, on human constructions, on recreational use of land, and on human health (particularly in the case of giant hogweed). Their proliferation implicates high socio-economic costs, and their management also requires high expenditure.

Cross-border benefits

As these plants are present across the Two Seas area then considerable cross border benefits will be evident in their successful management.

Methods

Giant hogweed is a biennial plant that grows on a root of "carrot" type. To avoid sprouting, flowering and graining, and therefore spread, the root must be beheaded about 10cm below ground-level. Consequently, on three sites, it has been managed by cutting the root under the crown. The first site was located on a small tributary river (Gézaincourtoise) with an estimated surface of 500m² with unequal densities of plant cover. In May 2012 and again in May 2013, all the roots present along the watercourse were cut under the crown. A monitoring visit took place about 1-1.5 months later when any regrowth was cut. At the second site (Ramecourt), an old railway turned into a hiking trail estimated at 225m², the presence of ballasts required an adjustment of the method. This consisted of penetrating the soil along the roots with U-shaped metallic rods before being leaned in order to cut them. These management actions were conducted in June 2012 and again in May 2013, and were followed by two monitoring visits per year in order to cut potential regrowth. The third site was a roadside in the municipality of Humières, but this was extended to include a road bank inside the village and some plants along the road, representing about 100m². It should also be noted that a wooded area close to the road was also colonised (about 1700m²). Demonstrations were carried out on this station in June 2012 and in June 2013. All the colonised areas of the municipality were inventoried and were then submitted to the management method that consisted of cutting under the crown. The municipal staff carefully monitored the area throughout both years by cutting all the sprouts on a regular basis.

Early goldenrod has already been the subject of a management demonstration on a site (250m²) located in Auxi le Château, via the pulling after flowering method.

Japanese knotweed was used for a demonstrative project with the pulling method on a public land (80 m²) that had been used as a landfill. With spades, the plants were drained trying to remove most of the rhizomes. The residues were then stored under a canvas cover on the old landfill site.

Timetable

May & June 2012: Management of giant hogweed at the three sites (Year 1).

June 2012: Re-visits to Sites 1 & 2 to cut regrowth of giant hogweed (Year 1).

17 October 2012: Management of early goldenrod.

7 May 2013: Management of Japanese knotweed.

May & June 2013: Management of giant hogweed at the three sites (Year 2).

June, July & Sept 2013: Re-visits to Sites 1 & 2 to cut regrowth of giant hogweed (Year 2).

2012 & 2013: Periodic re-visits to Site 3 to cut regrowth of giant hogweed (Year 1, 2).

Results

Monitoring of the first site (Gézaincourtoise) revealed whilst the area of invasion remained relatively constant between 2012 and 2013 (about 3 km along the watercourse for 500m²), the density of plant decreased by approximately 50%. Monitoring of the second site (Ramecourt) revealed that the colonised area again remained relatively stable but that a lower plant density was achieved. Nevertheless, the presence of several outbreaks in private neighbouring areas and on which an intervention was only possible with the goodwill of the owner, may have an impact on the results of the management and the monitoring implemented on the

the public land i.e. despite some success in the demonstration area the plant was still able to disperse. At the third site (Humières), a significant decline of the colonised area and density has already been noticed since 2012, especially via the reduction of the isolated plants precursor to new sites and signs of colonisation expansion

Conclusions and recommendations

- At the first (Gézaincourtoise) and the second (Ramecourt) sites, the colonised area remained constant but the density decreased between 2012 and 2013. At the third site (Humières), a significant decline of the colonised area and density were noticed since 2012, especially via the reduction of the isolated plants that represent a precursor to dispersal to new sites and signs of colonisation expansion.
- The management of the three sites is expected to continue in 2014. This should allow confirming the decline trends observed and thus enable further promotion of successful management control methods.
- At least one monitoring visit should be realised after the first passage in order to recut potential regrowth. This intervention is known to be the most effective control method, especially given feedback from experience in Belgium, but it must be conducted meticulously on a multi-annual basis for between 7 to 10 years. It must occur at the beginning of the season before flowering. If it is not possible to act at that time, cutting the inflorescences should at least be considered to avoid graining. They will then have to be bagged to avoid seed dispersal.

Deviations

At the second site (Ramecourt), the presence of ballasts required an adjustment of the method.

Problems encountered

The main current problem encountered in the management of early goldenrod was the fate of green waste extracted from the control sites to prevent accidental dispersal of the plant, as there were no management structures in place for this kind of waste. For the large volumes of exported early goldenrod, the municipality made public land available for temporary storage on and under canvas cover.

Lessons learnt

Any management of these three invasive plants must always incorporate disposal of the cut plants to avoid subsequent dispersal. Invasive plant control can also be achieved but will require long-term investment of resources and effort to reduce plant density in affected areas.

3.2.10 *Control of giant hogweed* **Heracleum mantegazzianum** *along the Avon Water in the New Forest (UK): a case study controlling an invasive plant in a landscape characterised by fragmented landownership*

Target species

The species targeted is giant hogweed *Heracleum mantegazzianum*.

Aim of the demonstration

The aim was to demonstrate the challenges involved in the control of an invasive non-native plant in a landscape characterised by a highly fragmented pattern of land ownership.

Target audience

Landowners, land managers or policy makers considering control of giant hogweed at the catchment scale.

Economic and social benefits of management

In addition to its negative impacts on biodiversity, giant hogweed has economic and social impacts due its toxic sap which reacts with human skin, particularly in bright sunlight, to form 'burning' blisters and skin discolouration. Giant hogweed is therefore a risk to human health. As a result, when land is colonised by giant hogweed landowners are reluctant to manage the land for fear of being affected by the toxic sap; the land can become abandoned and its economic value declines. Furthermore, river banks infested with giant hogweed are inaccessible to walkers and other recreational user groups such as fishermen, thereby resulting in a negative social effect.

Cross-border benefits

The results of this demonstration will be of interest to landowners, land managers and policy makers in other European countries where giant hogweed is invasive. They have already proved to be of particular interest to land management advisers in the New Forest and beyond.

Methods

Having ascertained the extent of the giant hogweed population along the Avon Water (Fig. 16) all the relevant landowners had to be identified in order to secure their co-operation to implement a control programme with the aim of eradicating the giant hogweed at the catchment scale. This necessitated contacting all relevant landowners and agreeing a suitable treatment method.

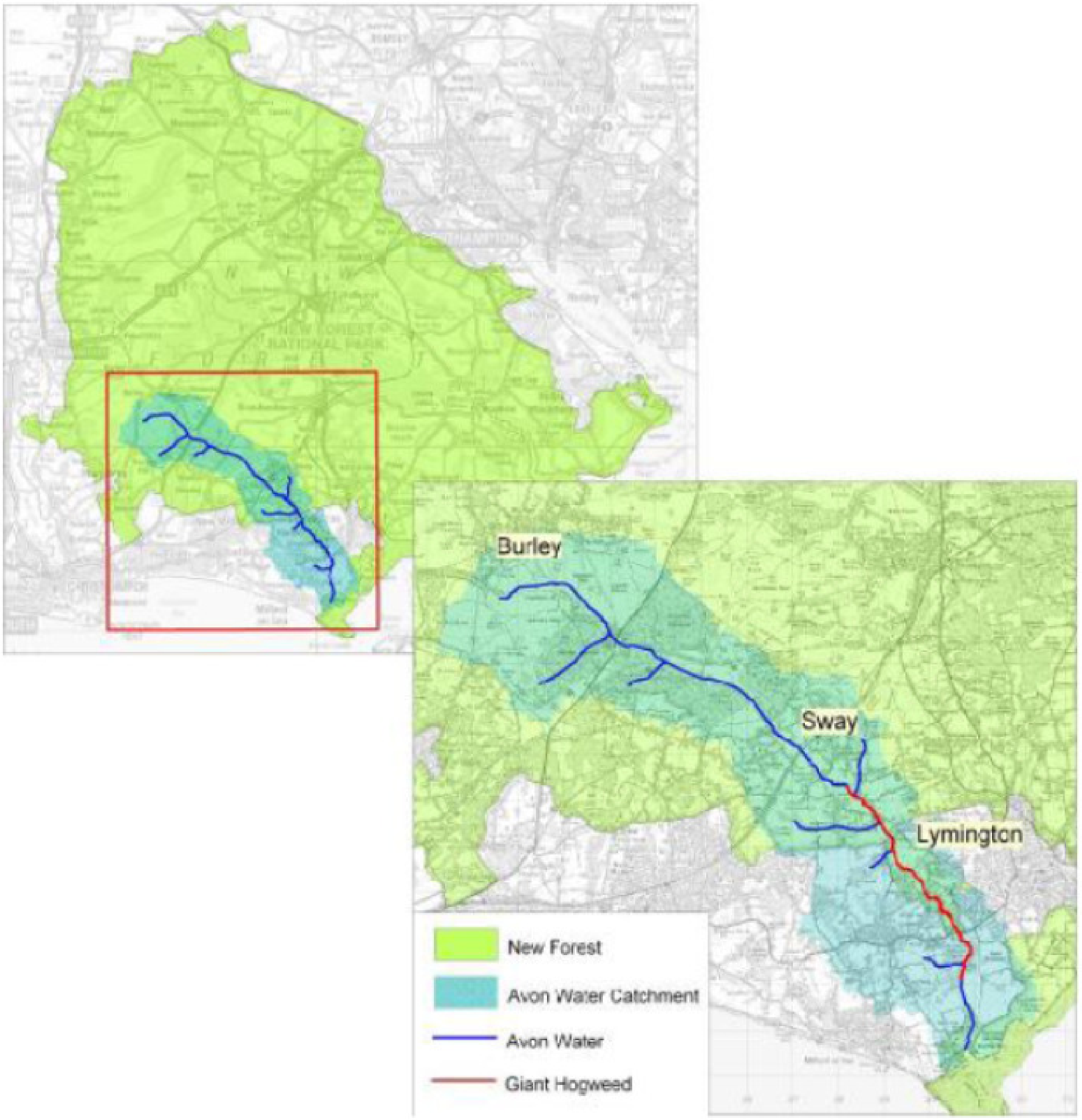

Figure 16 Distribution of giant hogweed on the Avon Water

To emphasize the extension of this fragmentation, the pattern of land-ownership along the Avon Water in the mid-nineteenth century was researched using historic maps and documents held at the Hampshire Records Office. This historic pattern of land-ownership was then compared with the current pattern of land-ownership and subjected to statistical analysis which revealed significant sub-division.

A detailed case study focusing on South Sway Farm was undertaken to highlight the fragmentation which has occurred since the mid-twentieth century. This detailed case study was undertaken using information gleaned from sales particulars and discussions with local residents.

Timetable

2012: Practical work to control giant hogweed. Research into the historic pattern of land-ownership. Analysis of the historic and current patterns of land-ownership.

Results

The increasingly fragmented pattern of land ownership along the Avon Water between mid-nineteenth century and the early twenty-first century is vividly apparent. By 2012 the number of land ownerships along the section of the Avon Water subject to the study had more than doubled to a total of 40 ownerships since the 1840s and 1850s when the surveys revealed a total of 19 separate ownerships (Fig. 17). In relation to this, shorter sections are more frequently owned in present days (Mann-Whitney U statistical test: $Z = 2.63$, $P < 0.05$).

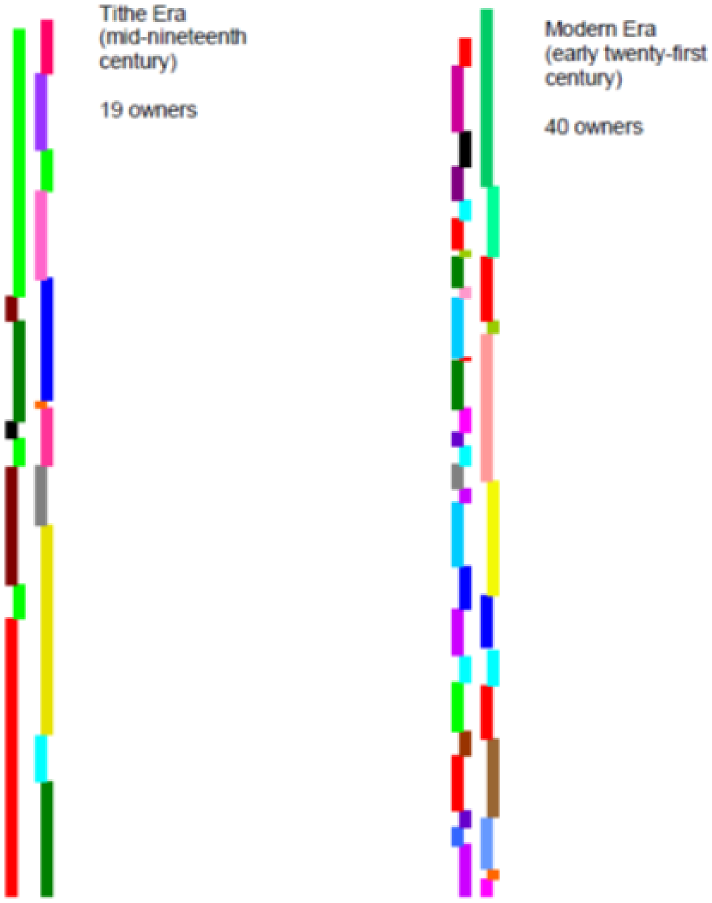

Figure 17 Abstracted, scaled representation of land ownership along the same length of the Avon Water in the 1850s (Tithe Era) and 2012 (Modern Era).

The detailed case study focusing on South Sway Farm revealed that following a period of consolidation between the mid-nineteenth century and the mid-twentieth century, the ownership this area has been subject to increasing fragmentation. A some stage between the mid-nineteenth century and the mid-twentieth century the case study area became a single holding of approximately 89 acres (36 hectares) known as 'South Sway Farm'. During the mid-twentieth century it was sub-divided and sold and, by the late 1950s, occupied three separate ownerships. By the 1980s the house of the property was split from the surrounding farmland and sold. By May 2009 the study area had been divided into four separate ownerships. By October 2009 the house called 'Yew Tree' and adjacent land (part of the green shaded land on Fig. 18A) had been sold. After a high activity during 2010 and 2011, by the end of 2012 the land to the west of the river had been split into two separate ownerships, while the land to the east of the river had been split into nine separate ownerships (Fig. 18B).

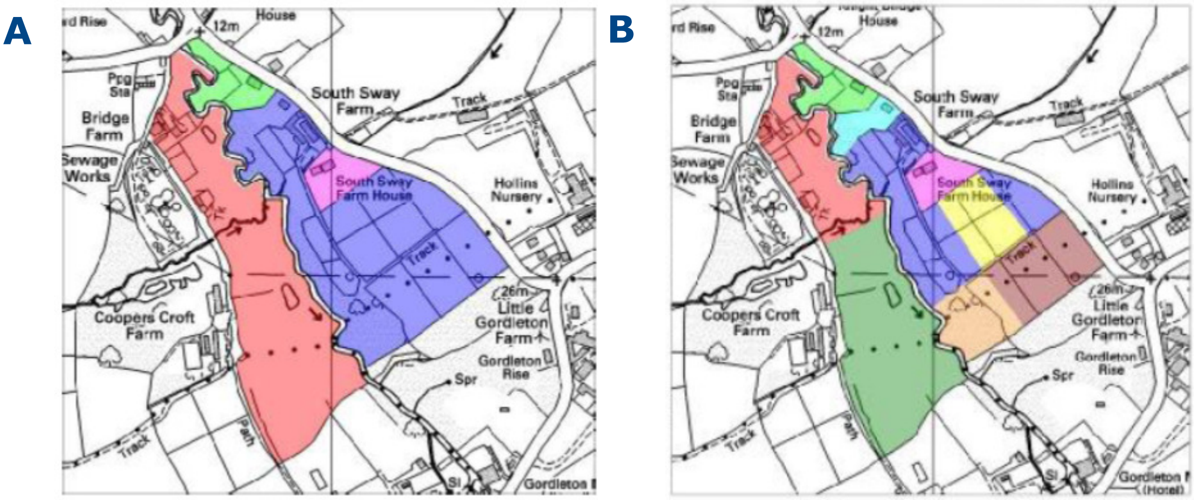

Figure 18 'South Sway Farm' in May 2009 (A) and in April 2013 (B).

Once contacted the 40 landowners of the invaded river section, the majority of them accepted to arrange a co-ordinated programme of chemical treatment by professional contractors using a herbicide which is approved for use near water. A handful of landowners who had small infestations of giant hogweed chose to undertake control themselves by digging or application of herbicide.

Conclusions and recommendations

The trend towards increasing sub-division of fields and fragmentation of land ownership has implications for the control of invasive non-native plant species at the catchment scale. An increase in the number of land owners/land managers necessitates additional work for the Project Officer co-ordinating a catchment-scale eradication programme, to ensure that all relevant landowners/managers understand the need for control and agree to co-operate in the eradication programme. The frequency of land sales requires constant vigilance by the Project Officer to ensure that contact is made with the purchasers. The sub-division and sale of land is often associated with a change of land use. Traditional grazing management by cattle is typically displaced by conversion to paddocks for recreational horse keeping. Alternatively land is converted to 'amenity' land or is left un-managed, facilitating the spread of invasive

invasive non-native species. Sub-division of land is often accompanied by erection of fences adjacent to the watercourse, resulting in a narrow strip of land which is difficult to manage and which is vulnerable to invasion by non-native species.

Deviations

There were no deviations from the original aim.

Problems encountered

During the preparation of the 'Partner Annexe' it became apparent that the identity of landowners would need to be protected. An appropriate way to present spatial information had to be devised. This problem was overcome by showing the pattern of land-ownership in diagrammatic form.

Target species

The target species were several non-native goose species, all of which have resident breeding populations in the project area in Flanders. Most species are year-round residents in the area, but often make (cross-border) dispersal movements over a wider area (e.g. dispersal from breeding grounds to moulting areas). The management actions particularly targeted invasive non-native greater Canada goose *Branta Canadensis*, feral domestic goose *Anser anser* f. *domestica* and a number of other non-native species including invasive non-native Egyptian goose *Alopochen aegyptiacus*, non-native bar-headed goose *A. indicus* and non-native Magellan goose *Chloephaga picta*. Also, hybrids were regularly present. To a lesser extent, locally, mixed populations of wild and domesticated barnacle goose *Branta leucopsis* (a protected species) were also targeted, as well as the breeding segment of the native greylag goose *Anser anser* population*.* About 75% of the birds managed by moult captures (4388 birds in total) in 2012-2013 were greater Canada geese, 10% were feral geese, 10% were greylag geese and 5% were other species.

Canada geese are listed among the worst invasive alien species threatening biodiversity in Europe. High geese densities can be responsible for overgrazing, fouling and trampling of vegetation. They can lead to a general deterioration of structure and quality of water bodies. Their vast quantities of nutrient rich faeces cause soil and water eutrophication and can have a severe impact on nutrient poor ecosystems. Impact on local avifauna, specifically other breeding bird species, has also been suggested through competition for food and space. In addition, hybridization with native geese species has been reported regularly. Finally, Canada geese in Belgium have been shown to be a vector of various wildlife diseases, such as *Batrachochytrium dendrobatidis*, the causal agent of the amphibian disease chytridiomycosis in Belgium.

Aim of the demonstration

The project aimed at reducing goose numbers, particularly of greater Canada goose, feral domesticated goose and Egyptian goose. The approach combined efforts on prevention with ethical management methods and a clear communication to the different stakeholders and the public.

Target audience

Conservation managers, farmers, other RINSE partners, the recreational sector, hunters, conservationists, and scientific community.

Economic and social benefits of management

Economic impact of geese occurs mainly through crop damage. In the Netherlands, agricultural crop damage by Egyptian and Canada geese together has been estimated at 870,000 Euros in 2010. If no population reduction of these geese was achieved in The Netherlands, the number of Egyptian geese is expected to increase from 10.000 to 28.000 breeding pairs by 2020. For Canada geese these numbers would go up from 5.500 breeding pairs up to 25.000. The damage to agricultural crops under this scenario was estimated to approach 3 million Euros. In addition, soil and water pollution cause management costs for maintaining areas suitable for recreation. Geese are also attracted by open expanses of grasses, such as runways of airports and flocks represent a human safety hazard by increasing the possibility of goose-plane collisions. Finally, the presence of geese can put interfere with the outcome of nature restoration projects. A decrease in the number of invasive summering geese is expected to bring down agricultural damages and create social benefits largely through reduced management costs on recreational facilities and in general reduced problems caused by geese for the recreational sector. Moreover, native biodiversity and related ecosystem services are expected to profit from the management actions.

Cross-border benefits

It has been shown that the summering goose population in Flanders shows exchanges over a larger region, notably with the southern part of The Netherlands (Zeeland). Therefore, benefits of this project can be considered significant in Belgium and neighbouring countries, and more extensively in a European context. Moreover, the results of this large-scale management effort were disseminated at a best practice workshop and several other international outreach activities.

Methods

A coordinated cross-border (Flanders, UK, The Netherlands) management of geese was performed. The project added value in enhancing coordination of already applied management measures (hunting and egg reduction) in the field. Importantly, moult (flightless period) captures of Canada geese were applied on a large scale. Substantial effort in communication was expended towards different stakeholders involved in geese management: hunters, farmers, conservationists and the public. Together with robust monitoring of geese populations, this investment in awareness raising and gaining public support was essential to the successful execution of the management. This included the regular organization of stakeholder meetings, workshops and the publication of a best practice for goose management.

Timetable

March-June (2012-2014): Site visits for egg pricking.

May-June (2012-2014): Prospection of potential sites for captures.

15 June-15 July (2012-2014): Performing moult captures.

20-21 July (2013), 19-20 July (2014): Goose survey with volunteers (simultaneous counts).

September-October: Data input, analysis and evaluation.

Results

On average, 2200 geese were removed from the population every year. The coordination and effort in egg reduction through shaking or pricking of eggs was further intensified during the project (Fig. 19).

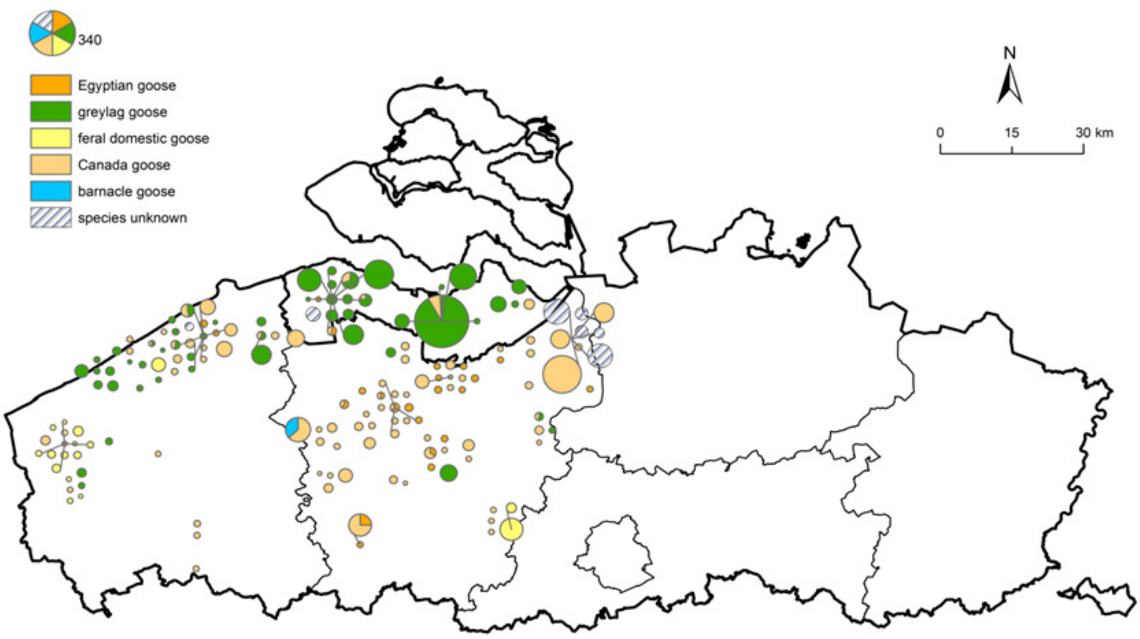

Figure 19 Egg reduction for the different species (period 2012-2014). The size of the circles is relative to the number of eggs treated.

Moult captures were very successful for Canada geese, with a total of 7829 caught between 2010 and 2013. A lower number of feral geese as well as native greylag geese were caught in 2013 (Fig. 20). Greylag geese, although comparable in density, tended to move away from catching sites during the moulting season. In relation to density, catch success for feral goose was high. Barnacle geese moult later and were therefore only caught in very low numbers. This protected species was only captured occasionally, with special permits and in case of immanent damage to vulnerable habitats. For Egyptian goose moult capturing is clearly not a good method, as these were only occasionally caught. Most birds tended to dive away during the captures.

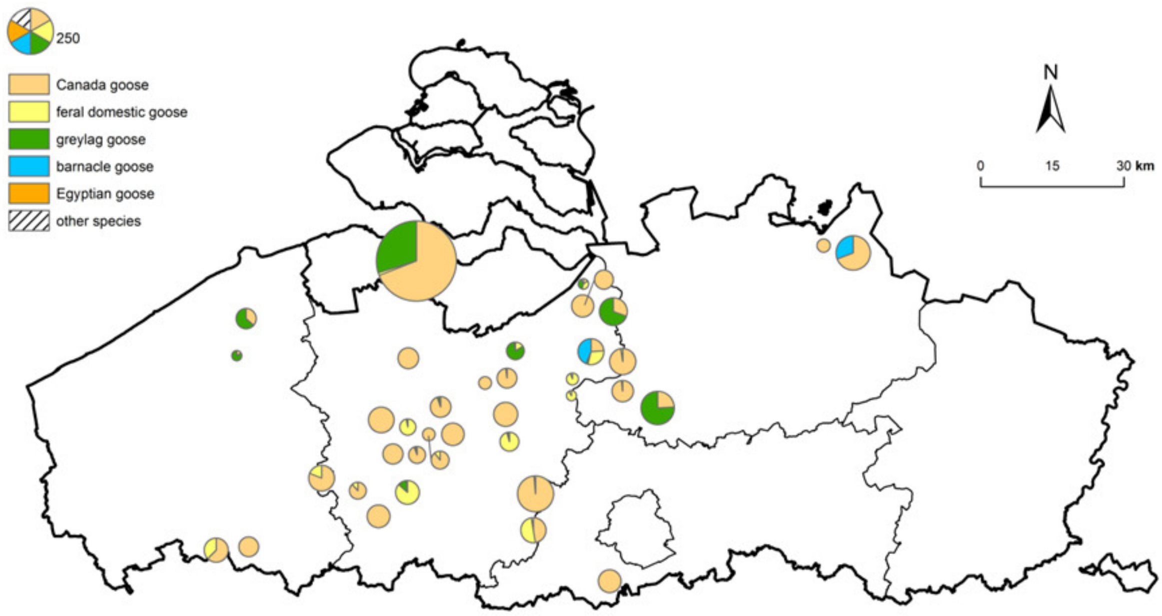

Figure 20 Moult captures performed within the RINSE area as demonstration projects in 2013. The size of the circles is relative to the number of captures.

The reported numbers of Canada geese culled by hunters also increased in the same period with over 7000 birds shot per season. For greylag goose, over 2000 birds were shot in 2012. The overall impact of the combined management efforts was assessed by annual simultaneous counts of the geese populations in the region using a fixed sample of counting areas. Based on these simultaneous counts, Flanders hosts a resident population of over 10,500 summering geese, 50% of which is present in the provinces west and east Flanders (RINSE region). East Flanders holds the highest number of birds with 2000 greylag geese, 1000 Canada geese and 1000 Egyptian geese. Antwerp (RINSE adjacent area) is however gaining importance in terms of the number of Canada goose.

In absolute numbers, the results of the monitoring show a reduction of 40% in the number of greater Canada goose in east Flanders and a 38% reduction in feral domesticated goose in the RINSE region since 2010. Models using gee-GLMs showed a significant decrease in the number of Canada and feral goose per municipality and per year since the beginning of the project (Fig. 21). The other species showed no clear population trends. The absolute number of geese in the entire area hardly decreased in the last year. Recent research indicates that Canada geese disperse over large distances within Europe, blurring effects of a local action over the years.

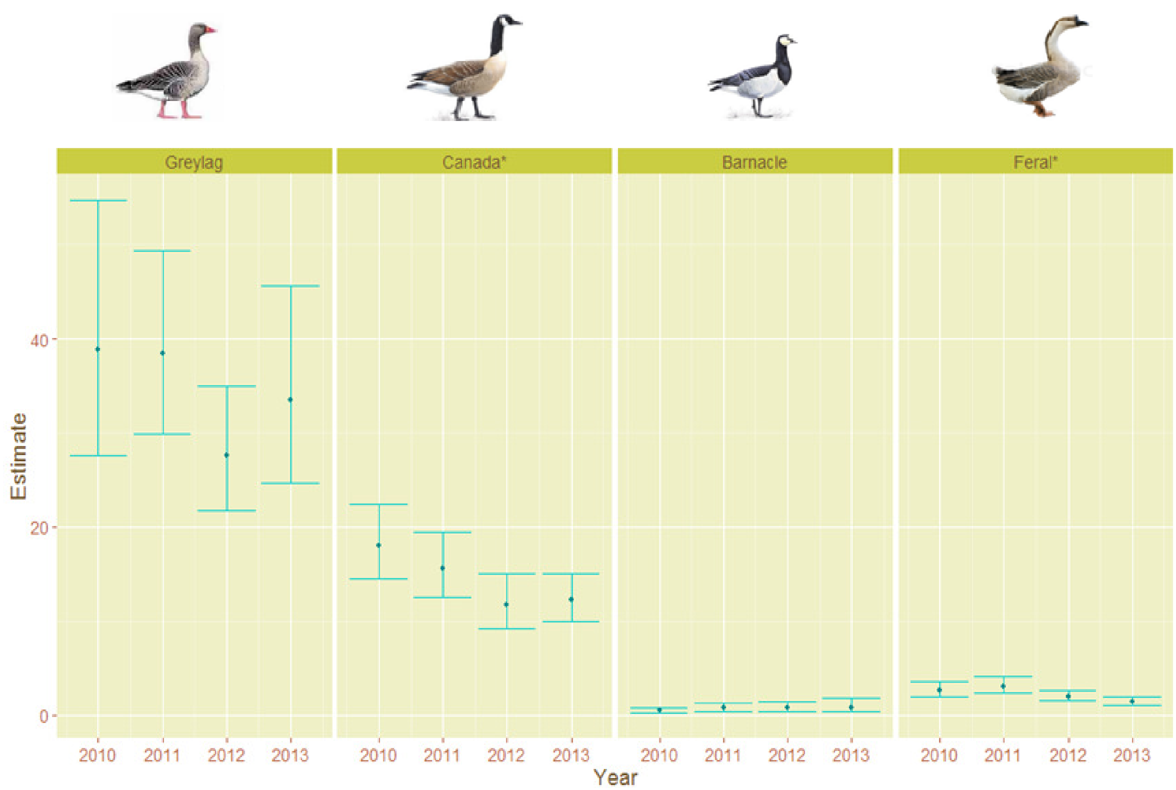

Figure 21 The modelled average number (+/-SD) of the different geese species per municipality per year.

Conclusions and recommendations

Management measures intervened on reproduction and on the number of birds. Measures were implemented opportunistically in space and time, resulting in a mixed and diffuse deployment throughout the project area. Limitations in the scientific follow-up did not allow robust quantification of the effectiveness of separate management measures. However, the combined management efforts were closely monitored. Trends in the average number of geese per municipality and per year showed a significant decrease in the number of Canada goose since the beginning of the captures. Future work will have to include dynamic population modelling to estimate the combined effect of management measures, as well as thorough monitoring of geese populations as the basic elements of a sound adaptive management plan for geese in the region. In addition, a continuous effort in communication towards different stakeholders was instrumental in creating support as well as policy initiative for further measures. It is advisable that, besides the culling, further ways of preventing damage are explored in the future.

Deviations

No major deviations from the original set-up of the demonstrations to report.

Problems encountered

Many of the sites where Canada geese occur are publicly accessible lakes and ponds in parks and green areas. In these areas, hunting is often difficult to apply and other methods of culling are needed that can be applied in areas where recreational pressure is substantial. Moult capturing of Canada geese provided a good alternative as many individuals could be caught simultaneously, the effect is immediate and public opinion was considered more positive. A general management plan for summering non-native geese was lacking. Clear management

Objectives with differentiated goals for the different species, and consensus amongst stakeholders are needed. The lack of studies on the impact of exotic geese and/or summering geese was still a bottleneck for public acceptance of the objective and corresponding measures.

Humane despatching of birds after capture was a critical factor in gaining public support for management measures. Throughout the project, a vet euthanized the geese, which was relatively costly. Moreover, because of food safety regulations, and unlike hunted birds, this prevented captured birds from entering the food chain, hampering public support. During the RINSE project, steps were taken to overcome this problem by liaising with relevant authorities and exploring possibilities for a short chain marketing strategy for the geese culled through moult captures. In the Netherlands, animal welfare issues were hampering execution of management in the field.

Lessons learnt

- To continue management of widely established non-native species like Canada goose in an adequate and evaluable way in the future, an adaptive management strategy is preferred. Such management is based on pre-defined and widely accepted operational goals. Management measures should thereby be continuously evaluated for adjustment. This approach requires continuous dialogue between partners and stakeholders and sound scientific monitoring.
- The debate on management choices needs information regarding expected population trends and what measures would have the most impact. A modelling approach may constitute an objective justification for an integrated management plan and will be explored in the future. Population models should be informed with data on breeding success, recruitment, mortality, survival, and high-quality data on the applied management e.g. the number of culled birds

through shooting and moult captures.

3.2.12 Establishing a mink trapping network to control American mink in North Norfolk (UK)

Target species

This project referred to the specific non-native invasive species North American Mink *Mustela vison*.

Aim of the demonstration

The project aim was to establish a network of volunteers who would monitor for, and if necessary remove, mink from the catchments present in the project area. This should reduce and maintain the mink population at a very low level. The assessable characteristic of a very low population is determined as: 'the negative impact of mink on other fauna within the target catchments is not significant' and 'the probability of finding signs of the species whilst monitoring to be rare, less than one sign/sighting per quarter'.

Target audience

Owners and managers of land that held habitat that was attractive to mink were the highest priority for recruitment. The project results will be of interest to conservation and biodiversity managers throughout the RINSE Area, especially those in which the water vole *Arvicola amphibious* is present and threatened, as mink are recognised as an invasive predator on their populations.

Economic and social benefits of management

1. The project area lies in North Norfolk, a landscape of considerable importance to biodiversity containing more than 40 SSSI sites, 5 National nature reserves, the North Norfolk coast RAMSAR site and the Norfolk coast Area of Outstanding Natural Beauty. Wildfowl migrate to and or breed in the area in nationally or internationally important numbers.

Tourism that is directly associated with the abundance and diversity of wildlife is important to the local economy. Quantifying the financial value is difficult however the 2006 assessment was that the figure of c. £163 million would be a reasonable estimate of the total value of tourism to the local economy. It is likely that thriving populations of native species are an important component to attracting tourists interested in wildlife.

2. The project has also aided the development of communication between individuals and organisations, between nature reserve staff and game managers.
3. The construction of rafts was undertaken at a local prison. Work of this nature provides opportunities for developing the practical skills of individuals through training with the trainee able to recognise that their effort is valued and worthwhile. There is an added benefit of the possibility raising an interest in the trainee for wildlife and conservation.
4. The use of a largely volunteer group of field workers reduced the cost of the project considerably when compared with employing full time trappers.

Cross-border benefits

1. Cross-border benefit has been realised by 'importing' successful techniques and strategies developed by other mink control initiatives operating within the county, from other parts of England and from Scotland.
2. Lessons learnt by this project may assist project development in other countries where invasive non-native species especially mink, become problematic. Other countries may not have a game keeping tradition like the one present in the UK but their awareness of the experience gained in North Norfolk that an experienced core group is an asset in helping them achieve their project aims.

Methods

Potential volunteers were identified based on their experience and potential motivation for working for the project. The main groups were:

1. Gamekeepers and shoot owners. They are highly experienced in trapping techniques, very well motivated to control predators and equipped to kill any mink caught.
2. Conservation organisations (RSPB, Natural England, Norfolk Wildlife Trust or National Trust) with professional field staff. They have a high understanding of the complexity of habitat and species conservation, are versed in the importance of safe working and have well developed species identification skills. Conservation organisations are also very aware of the need to have public support for the work that takes place on their property and the importance of explanation as a tool to reduce conflict.
3. Amateur conservation groups with enthusiastic membership. Members of local conservation groups are arguably the most motivated monitoring volunteers and highly committed to the areas of land that they manage. They are frequently receptive to guidance and advice. These characteristics can make these volunteers very reliable site-monitors. In most cases, the Catchment Co-ordinator was required to kill trapped mink by the approved technique.

A further group became apparent during the active period of the project, being managers of fisheries, who often owned and managed targeted sites. The group is enthusiastic to control mink and shares the experiences/considerations of the gamekeeper sector.

The project used techniques developed by The Game and Wildlife Conservation Trust (GWCT) to monitor for and control American mink. The system has undergone scrutiny by the UK government and been found to be lawful and as humane as can be determined based on animal welfare research prevalent at this time. The technique employed a raft tethered in a watercourse that has box tunnel covering a moist, clay pad. A wick system ensures that the clay remains damp whilst the raft is in position. The raft and tunnel are camouflaged with large quantities of cut vegetation, which are attractive for minks and other predatory aquatic animals. All animals passing through the tunnel will leave footings in the clay pad that can be investigated by the site monitor. The pad can be 'cleared' by smoothing the damp surface thereby giving a print free pad for further monitoring activity. In the event that mink prints are found a cage type, live catch trap can be inserted into the tunnel allowing captures to be made. All non-target catches can be released unharmed.

When a mink was captured the project followed the guidance for mink dispatch advised by GWCT - two shots to the head from a .177 calibre air rifle. All volunteers were given explanatory guidance documents regarding correct procedure. It was particularly stressed that drowning was a totally unacceptable means of dispatch.

All participating monitoring volunteers were contacted by telephone each month to collect information regarding raft locations, signs and sighting of mink or any capture information. The Catchment Co-ordinator visited volunteers either as requested or as part of a routine series of support visits.

Timetable

January 2013 to September 2014: Project duration

2012: Project plan developed. Tender for contractor circulated

November to December 2012: Development of mink-trapping network

January 2013 to September 2014: Mink survey

Results

- Data showed that the objective of achieving a situation where 'the negative impact of mink on other fauna within the target catchments is not significant' has been met. Reports of the sighting of live mink or signs of their presence have been very rare. Information recorded over 18 months suggests that mink are at very low densities and probably highly localised in North Norfolk.
- A co-ordinated group of 20 farms, estates nature reserves and other land holdings have been recruited as mink monitoring volunteers, and 38 locations are in use at the time of writing. A further 18 individuals who are working within the catchment have been recruited to report any mink related information that they are made aware of. The network will continue to operate after the formal closing date of the project.
- The project has increased intensity of species monitoring and targeted predator control within the project area.
- Liaison between conservation practitioners has increased allowing for greater co-operation between game shooting and wildlife conservation managers.
- Participation as a project volunteer has given an opportunity to shooting landowners to demonstrate commitment to the conservation of non-game species.
- The project received a great deal of goodwill from stakeholders in general and has a legacy of enthusiasm to participate in a co-ordinated conservation project in the future. The network established is capable of becoming the base for other landscape scale exercises if required.

Conclusions and recommendations

- It is feasible to consider controlling an invasive predatory mammal in the wild by intervention of monitoring sites operated by volunteers.
- The costs of a volunteer based system are significantly lower than one involving a significant number of employed staff.
- It is recommended to identify threats to the project during the planning phase and develop strategies that reduce the threat including finance, public perception and legal requirements.
- Be aware that mink populations can colonise an area rapidly and that monitoring is the most effective means of identifying mink activity.
- Newsletters help maintain group cohesion and motivation.
- Volunteers with limited access to land but with relevant experience can provide very valuable information as 'report only' volunteers, and greatly increase the reporting cover of the network. Having a 'report only' group also encourages participation from individuals with limited time to devote to monitoring or are reluctant to be involved in trapping activity.

Deviations

- Due to the close negative correlation between the presence of water voles and American mink within a catchment, from winter 2013/14 volunteers were asked to comment on water vole activity on the site. The project has been able to increase understanding of water vole populations that may be used by other organisations or projects.
- The monitoring system had to be modified to suit narrow and shallow watercourses. There, an alternative system based on a clay

pad with a wick and water reserve container located in a conventional trap tunnel was used. The 2 litre container was dug into the ground to be flush with the soil surface and a clay pad inserted over the wick. This system had a number of other advantages over the raft approach:

1. All the costs associated with raft construction were saved
2. Transport and storage was easier due to the less cumbersome equipment
3. The monitoring site was more discreet reducing the probability of interference or theft
4. Monitoring equipment was less likely to be lost in floods

Problems encountered

- The project was aware that monitoring effort and volunteer perseverance might reduce when signs of mink or catch rate are low. Strategies that encourage perseverance were developed to counter the problem:

  1. Co-ordinator support visits included time devoted to reporting catch rates on other catchments in Norfolk
  2. Discussing from examples elsewhere how reduction in monitoring can allow rapid increases in mink immigration or population increase
  3. Explanation that null catches were a sign of success
  4. Reminding volunteers that information gathered by monitoring regarding species other than mink was very informative
  5. Production and issuing of mink project information letter

- The severity and duration of the winter storm events was an unexpected problem, especially on salt marshes and coastal locations where flooding was widespread, damaging and persistent. Monitoring rafts in these situations were vulnerable and 2 lost. One was subsequently recovered and repaired. In the future, it would be advisable for the Catchment Co-ordinator to remind volunteers to move rafts to storage during the period of severe weather. Other less exposed locations were supplied with new materials (clay, sand etc.) as requested.
- There is a belief among some stakeholders that American mink are in decline due to an increase in otter population in the project area. The impact of this concept led some participants to regard monitoring as less important.
- Some managers of fisheries, in spite of being largely supportive of the project, showed considerable antipathy to otter. This should be of concern to those who are working to protect and aid the recovery of this species.

Lessons learnt

- The mink population in North Norfolk is at a low density and fragmented. This is possibly influenced by the fact that game shooting has been a high priority in the area ensuring that predator control has been carried out with considerable vigour for many years.
- Public support is widespread and there is an understanding of the ecological advantages of controlling American mink.
- It is practical to operate a wild mammal monitoring and control scheme at the landscape scale based on volunteer operatives.
- Adaptations to a raft based monitoring system can be implemented that retain the advantages of rafts but are compact and less costly.

3.3 Evaluation of INS management measures: the management toolkit

The trials and demonstrations completed in Activity 3 provide a wealth of information on the management controls that can be used to manage non-native species in Europe and reduce their impacts. The purpose of sub-action 3.3 was to evaluate these in the form of management toolkits. Consequently, the management toolkit for each taxonomic group is provided in Table 3. Should managers of non-native species in Europe want to identify the potential effectiveness of each of these options then an evaluation of their effectiveness, as revealed in the RINSE trials and demonstrations, is provided in Table 4. Note the only method that provided a relatively quick eradication of an established species was the use of a classical biocontrol agent (weevil) against *Azolla filiculoides*. Although the use of rotenone is an effective treatment for eradicating non-native fish, it is not species specific and can only really be used in tightly controlled environments; it was not tested in RINSE as Partner 2 has already revealed its effectiveness in previous work. In addition, managers should be aware of options using volunteers for some methods (Table 3). Subsequent, additional work for the closing conference will involve the development of management flowcharts outlining decision-making processes for non-native species, a development process involving multiple cross-border RINSE partners.

Table 3 Toolkit for managing invasive non-native species and reducing their impact in Europe

Taxonomic group	Toolkit options	Example of RINSE target species	Suitable for volunteers
Plant	Herbicide	*Crassula helmsii*	No
	Hot foam	*Crassula helmsii*	No
	Aquatic dye	*Crassula helmsii*	No
	Light blocking foil	*Mahonia aquifolium*	No
	Stem treatment with saline solution	*Mahonia aquifolium*	No
	Manual removal	*Impatiens glandulifera*	Yes
	Mechanical removal	*Mahonia aquifolium*	No
	Biocontrol	*Azolla filiculoides*	No
	Mowing	*Fallopia japonica*	No
Fish	Chemical treatment	*Pseudorasbora parva*	No
	Biocontrol	*Pseudorasbora parva*	No
	Removal by cropping	*Pseudorasbora parva*	Only with training
Birds	Trapping	*Alopochen aegyptiacus*	No
	Hunting	*Alopochen aegyptiacus*	Yes
	Egg reduction	*Alopochen aegyptiacus*	Yes
Mammal	Trapping	*Mustela vison*	Yes

Table 4 Evaluation of the effectiveness of each management option per taxonomic group and target species within the non-native species management toolkit outlined in Table 3.

Taxa	Target species	Toolkit option	Likely outcome	Effect on non-target species	Caveats on effectiveness	Section
Plant	*Crassula helmsii*	a) herbicide; b) hot foam; c) aquatic dye	12 months after treatment, *C. helmsii* cover was back to pre-treatment levels across all treatments	No adverse effect on the cover or composition of native plant and macroinvertebrate communities	Require re-treatments; These treatments are weather-dependant	3.1.2
Plant	*Mahonia aquifolium* and *Rosa rugosa*	a) stem treatment with saturated salt solution; b) stem treatment with herbicide (glyphosate); c) manual removal; d) leaf treatment with glyphosate; e) mechanical removal	Leaf spraying with glyphosate seemed by far the most effective way to remove isolated *M. aquifolium* individuals; Large patches of *M. aquifolium* and *R. rugosa* can be removed with heavy machinery	Visual inspections showed very little collateral damage of glyphosate leaf-treatment	Chemical treatments require re-treatments to obtain complete removal; Mechanical removal requires re-visits to hand-pull regrowths	3.1.3
Plant	*Crassula helmsii*	a) mechanical removal; b) shading using dyes and light-blocking foil; c) manual removal	So far, these measures proved to be ineffective	Not analysed	Removal requires re-visits to eliminate regrowths	3.2.2
Plant	*Hydrocotyle ranunculoides*, *Impatiens glandulifera*	Manual removal	It is possible to eradicate *H. ranunculoides*, but difficult in the case of *I. glandulifera*	No adverse effect detected	Requires re-visits to hand-pull regrowths; If difficult to eradicate by hand removal alone then a glyphosate based herbicide was used	3.2.3

Plant	*Impatiens glandulifera*	Manual removal	A large decrease in the amount of *I. glandulifera*	No adverse effect detected	Successful eradication is dependent on a co-ordinated and strategic approach	3.2.5
Plant	*Azolla filiculoides*	Biocontrol (*Stenopelmus rufinasus*)	Biocontrol is an effective management method that can result in eradication	No adverse effect detected	Season dependant	3.2.6
Plant	*Ludwigia grandiflora*	A combination of glyphosate-based herbicide and manual removal	Unsuccessful	Not analysed	Dependant on weather and covering vegetation	3.2.7
Plant	*Fallopia japonica, Solidago gigantea*	Mowing *F. japonica*; For *S. gigantea*: a) manual removal b) mowing	The management of *F. japonica* showed some success; Pulling *S. gigantea* in autumn appeared to be promising	The management of *F. japonica* enabled some native vegetation to develop; But mowing is a less selective method and does not preserve the non-targeted species	Mowing should be done once or twice a month	3.2.8
Plant	*Fallopia japonica, Solidago gigantea, Heracleum mantegazzianum*	Cutting the root *of H. mantegazzianum*; Manual removal of *S. gigantea* and *F. japonica*	Decline of *H. mantegazzianum*	Not analysed	Requires re-visits to hand-pull regrowths; Season dependant; Long-term management	3.2.9
Plant	*Heracleum mantegazzianum*	Manual removal; herbicide	Not analysed	Not analysed	Difficulted by fragmentation of land-ownership	3.2.10
Fish	*Pseudorasbora parva*	a) biocontrol (predator) b) removal (traps) c) rotenone	Predators are a feasible method to control *P. parva*. Rotenone is the only apparent method that can quickly extirpate a pond population of the species	Not analysed	Restrictions on the release of predatory fish	3.1.4

Bird	*Alopochen aegyptiacus*	Specially designed traps	The use of traps with decoy birds can be a useful tool for population control	A high number of by-catches occurred, although released unharmed	Traps should be checked on a daily basis, to release non-target individuals	3.1.5
Bird	Non-native geese	Hunting; egg reduction; captures	Trends in the average number of geese showed a significant decrease	A high number of by-catches occurred, although released unharmed	Humane despatching of birds after capture is a critical factor; Hunting is difficult to apply in publicly accessible areas	3.2.11
Mammal	*Mustela vison*	Trapping	The negative impact of mink on other fauna within the target catchments has been reduced to non-significant	By-catches occurred, although released unharmed	Mink populations can colonise rapidly, so that continuous monitoring is essential	3.2.12

3.4 Establish an informal cross-border experts advisory service

3.4.1 Introduction

This sub-action aimed to provide technical advice to RINSE partners on INS management, the design of field projects, monitoring and evaluation. The sub-action was due to involve the lead partner Bournemouth University providing a "match making" service, by serving as a central point for partners' queries and providing email and Skype linkages to appropriate experts. Initial difficulties in establishing the network involved the discrepancies in protocols, policies and in some cases, legislation, on non-native species between RINSE countries that inhibited experts being unwilling to provide advice across national boundaries. Consequently, it was decided within a work package partner meeting that the service be focused on RINSE partners, with an informal network involving meetings, email and video-calling (e.g. Skype) used to enhance partner cooperation in order to improve the design of studies in sub-actions 3.1 and 3.2.

3.4.2 Implementation

The advisory service was used successfully throughout the project as highlighted by the following demonstrations and trial:

1. Non-native goose control: Originally, three project partners, 7, 8 and 9, were working on non-native goose management but it was apparent at Work package partner meeting 1 (Section 3.5) that it was highly challenging. By the three partners working together and designing their studies in tandem via regular meetings and video-conference, an enhanced demonstration design was achieved that met RINSE objectives and revealed the difficulties of managing large invasive birds in small areas when their populations are highly mobile and occupy large spatial areas (*cf*. Section 3.2).

2. Biocontrol of *Azolla*. Considerable cross-border benefits were delivered through the biocontrol of Azolla using weevils. This benefit was only able to be achieved through the partner concerned, partner 3, exploiting the RINSE expert so that work could be completed across the different RINSE countries. Moreover, it culminated in an Azolla-weevil partner workshop on the 17th April 2013, held prior to the Activity 3 partner workshop at Egham, Surrvey, England, at which all interested partners were able to learn more about the use of weevils in plant biocontrol. This would have been without the establishment of this informal network.
3. 3. Ecological impact of topmouth gudgeon: The use of the network enabled Partner 2 to work together with Partner 7 through the provision of topmouth gudgeon samples from Flanders (plus other fishes and their putative food resources) that were then integrated into the topmouth gudgeon trial (Section 3.1). This was an important component of the trial and so it was significantly enhanced through the network.

3.4.3 Enhanced progression of Activity 3

The effectiveness of the informal and internal network facilitated the establishment of the work-shadow exchanges, as it enhanced the ability of the LP to liaise with Partner 7 and 9 to organize an exchange within sub-action 3.7.

3.4.4 Conclusion

Following a difficult start, the use of this network of RINSE experts within the consortium provided considerable added-value to the work of each partner, and strongly facilitated the delivery of a series of enhanced cross-border benefits, as outlined in Section 3.4.2 and 3.4.3.

3.5 Partner workshops

Three partner workshops for the Activity were held over the duration of the project (Table 5).

Table 5 Partner Workshops held in RINSE Activity 3

Meeting	Date	Location	RINSE partner host	Number of participants
1	24/04/2012	Bournemouth, England	2	17
2	17/04/2013	Egham, England	3	10
3	10/04/2014	Arras, France	4	13

Evidence that each meeting was held is provided in subsequent pages, using the front page of the each meeting's agenda one document per meeting (Fig. 22 to 24). Representatives of all work package partners were present at each meeting.

Key outputs of these meetings were that they enabled the joint working by partners in the field trials and demonstrations, with this reinforced by cross-border interactions completed in sub-action 3.4. Completion of this joint development of trials and demonstrations is through the topmouth gudgeon trial, involving partner 2 and 7, demonstrations on non-native geese, involving partners 7, 8 and 9, demonstrations on *Crassula* management, involving partners 4, 5 and 7, and the demonstration on *Azolla* biocontrol, involving partner 3 with multiple borders in all countries of the Two Seas Area.

Reducing the Impacts of Non-native Species in Europe (RINSE)

Tuesday 24th April, Bournemouth University, England

09.45 to 16.45

Meeting Title - Agenda

Item No.	Time	Item	Duration
1.	9.45	Welcome & Introductions	15
2.	10.00	Structure of Work package 3	30
3.	10.30	Group session: Defining 'reducing impacts of non-native species' (includes coffee break)	90
4.	12.00	Introduction to the afternoon session	15
5.	12.15	Lunch	45
6.	13.00	Partner presentations on their field trials/ case studies on 'Reducing impacts of non-native species' Approx. 20 minutes per partner (includes coffee)	180
7.	16.00	Open question & answer between all partners	30
8.	16.30	Any other business (inc. date of next workshop)	15
9.	16.45	Meeting close	

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Figure 22 Front sheet of the agenda from Activity 3 Workshop 1, 24/04/2012.

Reducing the Impacts of Non-native Species in Europe (RINSE)

Thursday April 18 2013, 09:30 to 16:00
CABI, Egham

Work Package 3 Workshop 2 - Agenda

Item No.	Time	Item	Duration
1.	09:30	Sign-in and Welcome	5 minutes
2.	09:35	Apologies and previous meeting notes	10 minutes
3.	09:45	Overview of WP3	5 minutes
4	09.50	Reporting requirements of WP3	10 minutes
4.	10.00	Progress reports of each partner Each partner has a maximum of 30 minutes to discuss: - Partner commitments on the application versus actual work-package being completed - Progress on trials/ demonstrations to date, to include design, data collected, any preliminary findings, difficulties encountered (etc) - Details of cross-border working - Forward look on work remaining in work-package and projected timescales Presentation with slides preferred Pre-lunch session: 4 partners (+ 30 minute coffee break at approximately 10.30).	2.5 hours

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Figure 23 Front sheet of the agenda from Activity 3 Workshop 2, 17/04/2013.

Reducing the Impacts of Non-native Species in Europe (RINSE)

Thursday April 10th, 10:00
Room "Lys", Conseil Général, Arras

Joint Work Package 2 and 3 Partner Workshop - Agenda

Item No.	Time	Item	Duration
1.	10:00	Apologies and sign in	5 minutes
2.	10:05	Project Partner updates on Work Package 3 progress - 10 minutes per partner	90 minutes
3.	11:35	Review of outputs against Application - Are we missing any actions?	30 minutes
4.	12:05	Project Partner updates on Work Package 2 progress - 10 minutes per partner	30 minutes
	12:35	LUNCH	
5.	13:30	Continued Project Partner updates on Work Package 2 progress - 10 minutes per partner	60 minutes
6.	14:30	Review of outputs against Application - Are we missing any actions?	30 minutes
7.	15:00	Opportunities arising through Work Package 3 actions to assist Work Package 2 outputs	30 minutes
8.	15:30	Summary from Work Package Leads	20 minutes
9.	15:50	Final Best Practice Workshop; 24 April 2014	5 minutes
10.	15:55	Any Other Business	15 minutes

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Figure 24 Front sheet of the agenda from Activity 3 Workshop 3, 10/04/2014.

3.6 Management Workshops

Three management best-practice workshops for the Activity were held over the duration of the project (Table 6).

Table 6 Management Best Practice Workshops held in RINSE Activity 3

Meeting	Date	Location	RINSE partner Host	Number of participants
Invasive mammal and birds	3-4/07/2013	Gent, Belgium	2	78
Invasive aquatic plants	17-18/10/2013	Norwich, England	LP	71
Catchment scale management	24-25/04/2014	Montreuil-sur-mer, France	4	39

Literature from each Workshop is provided in subsequent pages (Fig. 25 to 27).

Figure 25 **Literature advertising the Invasive mammal and bird workshop.**

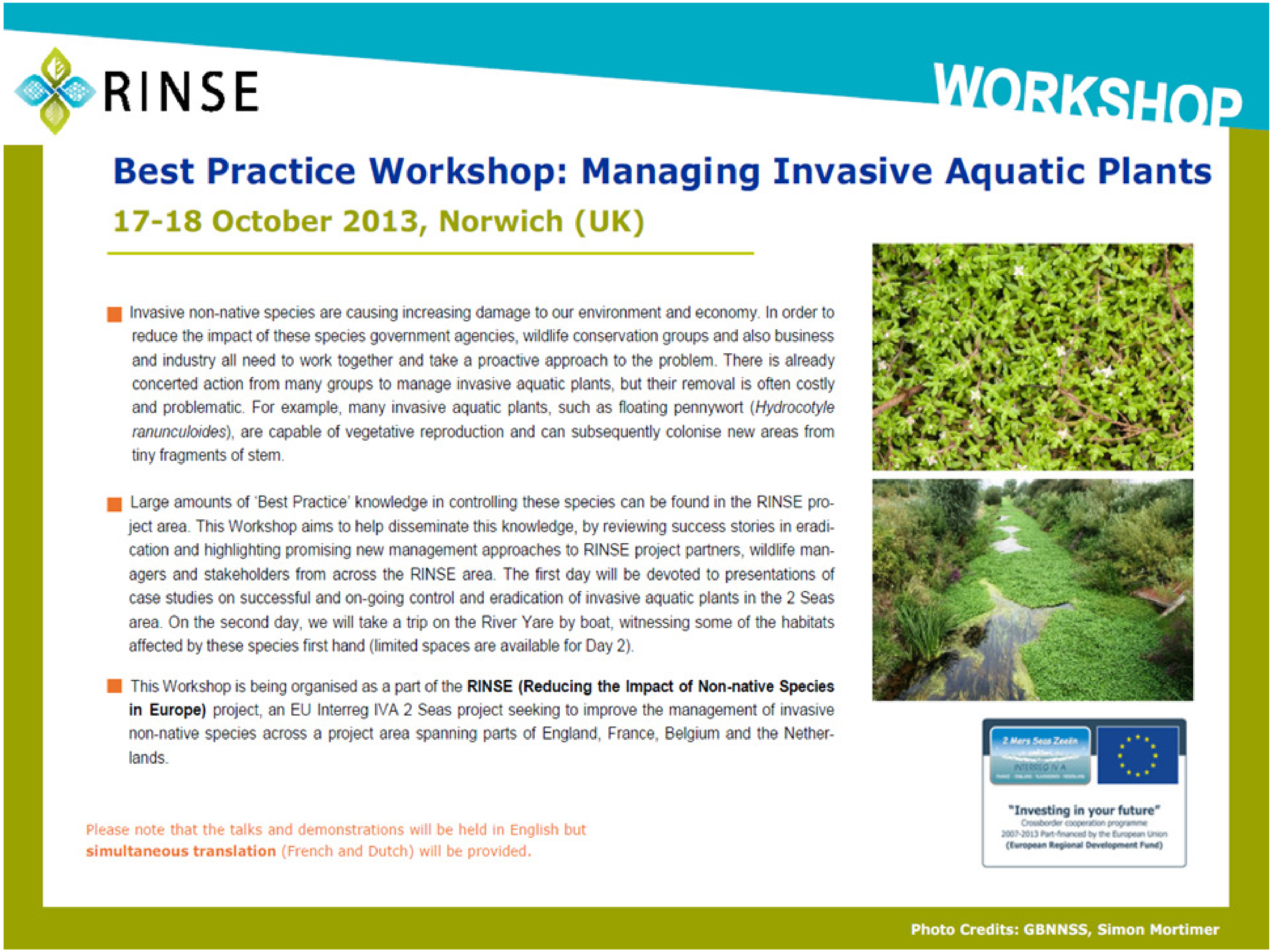

Figure 26 Literature advertising the Managing invasive aquatic plants workshop

Figure 26 **Literature advertising the managing invasive aquatic plants workshop**

3.7 Identify opportunities for work shadow exchange

The rationale of the sub-action was to provide project partners with in-field experience of management techniques so these experiences may be taken back to partner organizations and disseminated.

The most appropriate partners for this were identified as the LP (Norfolk County Council) and partner 7 (INBO) in relation to Muntjac deer *Muntiacus muntjak*. These are a well-established invasive species in the UK, including Norfolk, but have only recently been found in Flanders. In order to share management experiences and strategies, these two RINSE partners facilitated an exchange inviting a group of Belgian stakeholders to the UK to meet experts in deer management and control. In total, six delegates from Belgium attended the exchange, representing three organisations, of which two were RINSE partners.

The first day of the exchange was hosted by the Forestry Commission at Santon Downham, where presentations were given by three experts in this field: Trevor Banham (Head Wildlife Ranger at Thetford Forest), David Hooton (Deer Initiative) and Dr Kirstin Weber. This was followed by an evening of deer stalking in Swanton Morley. The following day the visitors were taken out on site to learn how to recognise the presence of Muntjac deer. This concluded the exchange visit, leaving the Belgian visitors with the knowledge and tools to tackle their populations effectively in Flanders, and hopefully avoid the establishment of large populations such as those in Thetford Forest.