Water fern

(Azolla filiculoïdes)

Experiments on biological control of water fern in the U.K., Belgium and the Netherlandss

Centre for Agricultural Bioscience International (CABI)

■ CABI is an international, non-profit organisation active in agricultural and environmental R&D work.

■ The organisation provides science advice in the fields of agriculture and the environment in view of improving food security worldwide and environmental protection via R&D projects addressing:

- efforts against crop pests and diseases;
- the development of management methods for invasive alien species (IAS);
- enhanced access to scientific knowledge concerning agriculture and the environment.

■ The organisation groups 48 countries with sites in 21 countries and its headquarters in the U.K. (Egham).

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RINSE project

■ The European RINSE project (Reducing the impacts of non-native species in Europe) attempts to determine the best management strategies for IASs in the Two seas region (along the English Channel and the southern section of the North Sea).

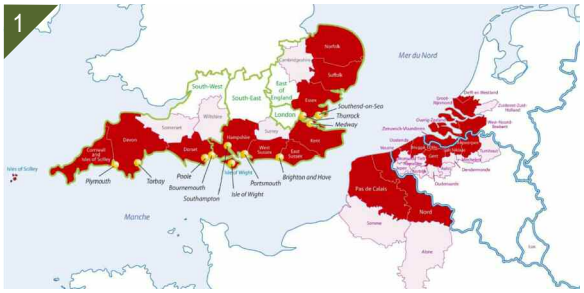
■ The objective of the project is to develop cross-border instruments to improve ranking and targeting of IASs in order to ensure that resources are effectively directed toward the most worrisome species and sites. Particular attention is paid to species in aquatic environments. New management methods are experimented in the field to develop the best practices and issue recommendations to managers.

■ The three-year project was launched in 2011 and is funded by the EU in the framework of the Interreg IVA Two seas programme. A total of nine partners from France, the U.K., Belgium and the Netherlands are involved.

■ The annual budget is 2.5 million euros.

Intervention site

■ The experiments on biologically controlling water fern were carried out in different coastal regions of the U.K., Belgium and the Netherlands.



1. RINSE intervention sites.
2. Study sites in the project on biological control of water fern.

United Kingdom	Cornwall, Hampshire, West Sussex, Surrey
Belgium	Assebroek, Kuurne, Kampveld, Wingene (multiple sites), Gistel, Geel
Netherlands	Rotterdam
France	No study sites.

Disturbances and issues involved

■ The plants develop thick mats that completely cover stagnant environments, provoking:

- a reduction in the light and oxygen available for other organisms;
- blocking of filters and pumps, which can result in flooding;
- risks of drowning for livestock because the mats can look like solid land;
- detrimental effects for recreational activities (fishing and boating).

Testing a biological-control method

■ Manual harvesting of water fern is possible, but complex in that the site is often recolonised by fragments left on site. Repeated harvesting operations have rarely succeeded in eradicating the plants over the long term and are very expensive.

■ Herbicides are prohibited in aquatic environments in France and therefore cannot be used to control water fern.

■ Biological control of water fern using a weevil, *Stenopelmus rufinasus*, was studied in 1990 in South Africa with positive results. The tests and monitoring revealed that *Stenopelmus rufinasus* is a specialised predator of water fern. The insect was released in number in South Africa in 1997.

■ In Europe, *Stenopelmus rufinasus* was accidentally introduced in 1901 in conjunction with water fern. The insect species established itself in Europe in spite of the harsh winters in the North that slow its reproduction and dispersal (winter diapause).

■ *Stenopelmus rufinasus* thus represents a potential means of biological control for water fern, particularly for major proliferations of water fern over large surface areas on sites where the insect is not already present.

■ The objective of the experiments was to:

- assess the impact of the *Stenopelmus rufinasus* weevils (bred specifically for the purpose or collected and transported from the natural environment) on sites colonised by water fern;
- determine whether the insect constitutes an effective means of biological control in managing water fern.

Interventions

■ During the first step, efforts were made in each of the regions in question to find proliferations of water fern.

■ A total of 15 sites were selected for the project, ranging from very small water bodies (1 square metre) to ponds covering several hectares.

■ Each site was then described in detail. The surface area colonised by water fern was estimated.

■ Once each site had been fully characterised, a search was made for the *Stenopelmus rufinasus* weevil.

■ On sites where the *Stenopelmus rufinasus* weevil was naturally present, the impact of the insect on water fern was monitored.

■ Specimens of *Stenopelmus rufinasus* were collected in each area and raised under confined conditions in specially equipped laboratories in the U.K. and the Netherlands.

■ The insects were then released, following authorisation, on the sites where water fern had been observed in the U.K., Belgium and the Netherlands. In France, the insect was not introduced because the administrative procedures were still under way.

■ In Belgium, adult insects were collected on one site and directly released on another, i.e. they were not bred in a lab.

■ Modifications in the colonisation of water fern were monitored on the sites over a number of weeks, notably using photographs taken from a fixed site.

3. Manual removal of Azolla filiculoides *in the U.K. (Sussex).*
4. 5. An adult Stenopelmus rufinasus *weevil on water fern.*

Results and assessment

Results of the on-site experiments

- The tests were conducted on approximately 15 water bodies of different types.
- The test results are summarised below.

Country	Site	Type of site	Colonised surface area (square metres)	Date weevil introduced	Introduction method	Number of insects released	Results	Observation time
United Kingdom	Cornwall	Pool	6	July 2012	Breeding, then introduction	50	Elimination	10 weeks
United Kingdom	Hampshire	Pool	240	August 2012	Breeding, then introduction	3 000	Good control	6 weeks
United Kingdom	West Sussex	Pool	200	July 2013	Breeding, then introduction	1 000	Elimination	10 weeks
United Kingdom	Surrey	Pool	20 000	Species naturally present in July 2012	Naturally present		Elimination	15 weeks
Belgium	Assebroek	Pool	200	Species naturally present in April 2013	Naturally present		Elimination	10 weeks
Belgium	Kuurne	Pool	1 200	Species naturally present in July 2013	Naturally present		Excellent control	18 weeks
Belgium	Kampveld	Pool	360	Species naturally present in September 2013	Naturally present		Elimination	8 weeks
Belgium	Wingene	Ditch	50	Species naturally present in June 2014	Naturally present		Elimination (site flooded)	12 weeks
Belgium	Wingene	Pool	500	Species naturally present in June 2014	Naturally present		Virtually eliminated	Ongoing
Belgium	Wingene	Pool	15	Species naturally present in June 2014	Naturally present		Ongoing	Ongoing
Belgium	Wingene	Ditch	30	June 2014	Insects transported	300	Elimination (site flooded)	12 weeks
Belgium	Gistel	Pool and ditch	10 000	Species naturally present in June 2014	Naturally present		Ongoing	Ongoing
Belgium	Geel	Pool	1 000	Species naturally present in June 2014	Naturally present		Elimination	15 weeks
Netherlands	Greenhouse in Rotterdam	Basin	1	Since 2012	On-site breeding		Elimination	Not available
Netherlands	Rotterdam	Canal	500	September 2013	Breeding, then introduction	300	Project interrupted (water fern removed)	6 weeks

Assessment

- Biological control of water fern was effective on the study sites for a moderate cost and no observed negative effects on the environment.
- The main difficulties encountered during the project concerned regulations:

- it was not easy to find the cognizant authorities in each country for the introduction of a species that was already present in the country;
- the protocols required for the experiments had to be drafted.

- Time was also required to find the necessary experts and to set up a network for the project.
- A further difficulty lay in finding enough sites where water fern was present and where the insects could be introduced, particularly in the Netherlands and in France. This was due to variable seasonal weather and the short-lived nature of water fern meaning the species could not always be found on a site from one year to the next.
- The existence of regularly updated databases in Belgium and the U.K. made it much easier and faster to find sites, compared to France and the Netherlands.
- In addition to abiotic factors (harsh winters), the natural presence of *Stenopelmus rufinasus* on certain sites provoked the elimination of water fern even before the experiments could begin.

Outlook

- Additional experiments could be carried out in the exposed regions, particularly in France and the Netherlands where only a few or no sites could be monitored.
- The experiments could also be conducted on a larger area than that for the RINCE programme.
- Breeding and introduction techniques for *Stenopelmus rufinasus* could be improved and consolidated in view of continuous production of the species to improve management of sudden proliferations of water fern, as is the case in the U.K. (England and Wales).
- A genetic study on *Stenopelmus rufinasus* populations would be useful to define the relationships between the insects in the original area and those where the insects are released. If all European populations of the insects are genetically identical, it may be possible to transfer insects between countries rather than breeding them for introductions.

Information on the project

- Information was provided to the various stakeholders, e.g. public authorities, the managers of natural areas and the general public.
- Information was delivered via publications, an internet site, conferences, meetings, posters and various presentations.

Remarks

- In France, water fern has colonised a very small number of small water bodies and networks of stagnant ditches. In general, the colonisation lasts for only a few weeks. The species rarely reproduces sexually in France, however its vegetative multiplication is very dynamic.

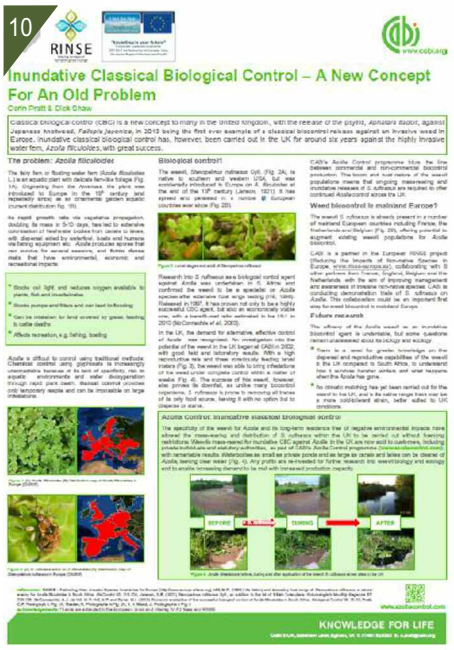
6. 7. A pool in England colonised by water fern before (a) and after (b) the introduction of Stenopelmus rufinasus.
8. 9. A pond in Belgium colonised by water fern before (a) and after (b) the introduction of Stenopelmus rufinasus.

■ The development of the plant is highly unforeseeable. It may undergo significant proliferation one year, completely disappear the next and then reappear a few years later on the same site or nearby.

■ Given the knowledge currently available on the species, it is not possible to determine the causes of this erratic behaviour in continental France. Possible causes include climatic conditions, physical-chemical conditions in the colonised biotopes resulting the the rapid growth and decline of populations, and control by *Stenopelmus rufinasus*. In any case, the insect would appear to be fairly widespread in continental France and could well play a role in the short-lived nature of certain proliferations.

■ For the above reasons, water fern is managed from time to time on certain spots, e.g. collected using dip nets or gathered using wooden logs and removed manually.

Authors: Corin Pratt, CABI, and Emmanuelle Sarat, IUCN French committee. September 2016.



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10. An example of posters presented during conferences on the biological control of water fern.

For more information

■ RINSE internet site: www.rinse-europe.eu
■ Internet site on controlling water fern: www.azollacontrol.com
■ CABI internet site: www.cabi.org
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