Red swamp crayfish
(*Procambarus clarkii*)

Experiments on controlling red swamp crayfish stocks using traps and natural predators
in the Brière regional nature park

The Brière regional nature park

■ The regional nature park was approved by the Ecology ministry and is run by a board, with representatives from the departmental council, the Pays-de-la-Loire regional council, neighbouring towns and stakeholders, that manages the marshes and works with towns, the marsh boards and private individuals.

■ One of the main objectives of the park is to preserve biodiversity and restore the wetlands (marshes, wet meadows, reed ponds, canals, etc.).

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Programme to preserve biodiversity from the invasion by red swamp crayfish

■ The programme included applied research from 2010 to 2012, managed by INRA and funded primarily by Onema.

■ The general objective was to identify the mechanisms involved in the successful invasion by red swamp crayfish (*Procambarus clarkii*) via a five-point approach:

- development of a monitoring method for crayfish populations and testing of new molecular techniques to detect crayfish in large aquatic environments;

- study on the population response of red swamp crayfish as a function of various environmental conditions (hydroperiod, salinity, etc.);

- study on trophic determinism in the invasive success of red swamp crayfish and the position of the species in the upper links of the food chain (with respect to fish);

- study on biodiversity patterns as a function of colonisation (or lack of colonisation) of pool networks by the invasive species;

- experiments on controlling red swamp crayfish stocks using traps and a natural predator, the European eel (*Anguilla anguilla*).

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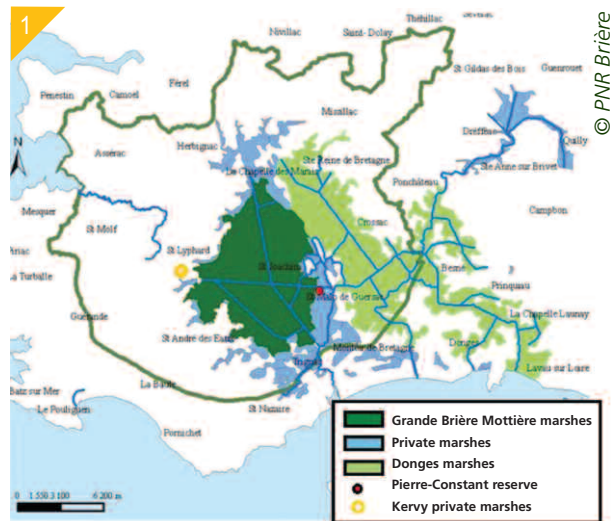
1. The Brière regional nature park and the different sectors.

Intervention site

■ Since 2009, attempts to draw down the stock of red swamp crayfish through continuous trapping have been undertaken in small ponds and lakes (isolated using a small-mesh barrier) in the Pierre-Constant reserve.

■ The reserve, owned by the park, is located to the east of the Grande Brière Mottière marsh among the Rozé private marshes in the town of Saint-Malo-de-Guersac (Loire-Atlantique department).

■ It covers a surface area of 25 hectares, of which 40% are ponds and lakes (some are watered year round, others are dry in the summer).

■ In 2009, the initial trials to regulate crayfish stocks were conducted exclusively in pond A. These initial experiments will not be discussed here.

■ In 2010 and 2011, trapping trials were carried out on two ponds (A and B, with respective surface areas of 225 and 715 square metres). In 2012, new trials to regulate the stocks were conducted on three ponds, including A and B:

- pond A, continuous trapping combined with the introduction of a natural predator, the European eel;

- pond B, continuous trapping with different types of traps to test their effectiveness (the results concerning trap effectiveness are not presented here);

- pond C, a new pond covering 680 square metres, served as a control environment.

■ These three ponds colonised by red swamp crayfish are good examples of the ponds in the Brière marshes. They are shallow (approximately 60 centimetres deep in April), generally dry from August to October, have slightly sloping banks and a peaty substrate.

Disturbances and issues involved

■ The presence of red swamp crayfish in the Brière marshes is thought to be due to the accidental dispersal of the species from a crayfish farm located near the marshes in the 1980s. Since that time, red swamp crayfish have colonised the entire wetland area (20 000 hectares), a situation that has had numerous impacts on the ecosystem:

- a significant reduction in aquatic plant beds to the point that some species have disappeared, e.g. water lilies, resulting in a proliferation of cyanobacteria;

- modification and simplification of the food chain. Crayfish are a highly consumed source of food for a wide range of predators (birds, fish, mammals, etc.);

- tunnels dug into banks degrade the water quality (increased turbidity) and damage the banks;

- given the lack of a baseline, it is difficult to assess the impact on fish populations. However, it is important to note a reduction in the carrying capacity of the environment for phytophilic fish species.

Interventions

Trapping experiments in 2010 and 2011

■ The objective of the tests to draw down the stock of red swamp crayfish is to determine the feasibility of controlling populations in small ecosystems and to assess the response of plant and animal communities to the expected drop in the pressures exerted by crayfish. In 2010 and 2011, the initial experiments consisted solely of trapping in the Pierre-Constant reserve.

Experiments in 2012 combining trapping and the introduction of a natural predator

■ Given the limited results of the experiments in 2010 and 2011, it was decided to attempt to regulate the stock of red swamp crayfish in 2012 by pursuing trapping, but also by introducing European eels.

■ Eels are a common, native species in the Brière marshes and a known predator of crayfish.

■ The objective of the experiments is to compare the impact on crayfish stocks of a method combining trapping and natural predation to the method tested in 2010 and 2011 involving only trapping.

■ The experiments were conducted on the three ponds from 2 April to 25 August 2012 and were organised as follows:

- pond A, continuous trapping and introduction of eels. 15 wire hoop nets were used, i.e. one for every 15 square metres of pond, and checked every 24 to 72 hours. On 11 April 2012, 31 eels (average length 550 millimetres and average weight 330.5 grams) were released, each with a PIT-tag;

- pond B, continuous trapping. A total of 70 traps of different types (traditional and wire hoop nets, large cage traps, experimental traps) were used, i.e. one for every 10 square metres of pond, and were checked every 24 to 72 hours;

2. A pond in the Pierre-Constant reserve with a barrier installed around it.

- pond C, a control pond where no trapping took place prior to 2012. Trapping was used to assess the crayfish population (density over time). It took place in two 24-hour sessions per week using 10 wire hoop nets installed at the start of the session (hour 0) and removed at the end (hour 24).

■ At the end of each session:

- the crayfish captured in each trap over the 24-hour session were counted and weighed;

- the crayfish from each trap were frozen.

■ The study took place in 3 phases, namely a phase prior to the introduction of the eels (sessions 1 to 3), a 3-month phase during which the eels were present (sessions 4 to 23) and a phase during which some of the eels were removed (sessions 24 to 28).

3- Red swamp crayfish (Procambarus clarkii).

Results of the interventions.

Year	2010	2011
Trapping period	14 April to 19 July	11 April to 22 July
Trapping organisation	• Pond A. 15 wire hoop nets in the water approximately 1 metre from the bank, 1 trap for every 15 square metres. • Pond B. 70 traps of different Types (traditional and wire hoop nets, large cage traps, experimental traps) in the water approximately 1.5 metres from the bank, 1 trap for every 10 square metres. • Bait (dog kibble) was placed in the traps each time they were checked.	• Pond A. Same as in 2010 + 7 additional traps starting on 4 July. • Pond B. Same as in 2010. • Bait (dog kibble) was placed from 24 June to 1 July in the traps in pond B and from 4 July onward in the traps in pond A, each time the traps were checked.
	• The traps were totally submerged (optimal capture conditions). • The traps were checked twice per week in both ponds.	
Handling after capture	• The crayfish in each trap were counted (except in 2010 in pond B). • The biomass in each trap was weighed. • The captured crayfish were frozen.	
Assessment	• A reduction in the numbers and total biomass captured from 2010 to 2011, but no significant reduction in spite of the relatively limited surface areas. • Trapping of red swamp crayfish requires significant human resources even for small ponds. It would be difficult to implement this technique in larger ecosystems.	

Results and assessment

■ Results

■ Total biomass captured:

- 2010. Pond A: 30 100 g (6 417 crayfish captured), i.e. 134 g per square metre. Pond B: 70 800 g, i.e. 99 g/m^2

- 2011. Pond A: 24 960 g (1 973 crayfish captured), i.e. 111 g/m^2. Pond B: 41 445 g, i.e. 58 g/m^2.
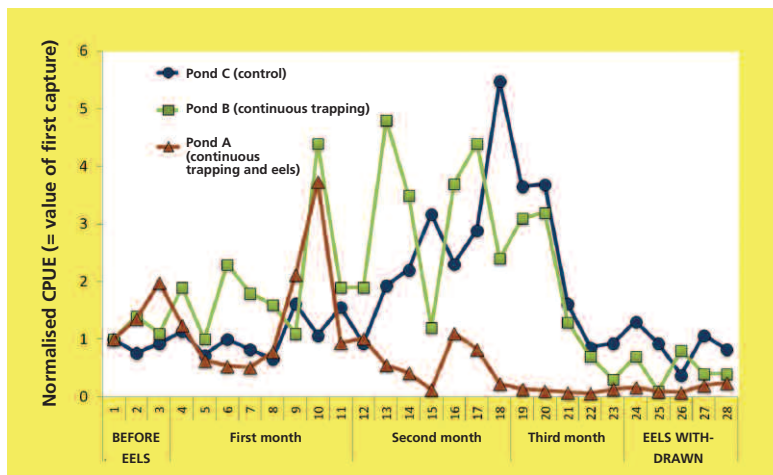
■ Experiments in 2012

■ The initial stock, measured in average captures per unit of effort (CPUE = average number of crayfish per trap per 24 hours), was higher in pond A (6.27 ± 1.18) than in ponds B and C (respectively 1.16 ± 0.46 and 2.60 ± 0.63).

■ Trapping had little effect on the crayfish stock in pond B. The drop at the end of the period was due to the drop in crayfish activity at that time of year.

■ The combined action of continuous trapping and the introduction of the predator produced a significant reduction in pond A (3 070 crayfish were removed from the pond, i.e. a density of 13.6 per square metre).

■ The major reduction in the numbers of crayfish in pond A was due to the high level of predation by the eels, probably in conjunction with a change in behaviour on the part of the crayfish (drop in activity) due to the presence of the eels.

■ This hypothesis is supported by the CPUE results in pond C.

Normalised captures per unit of effort (CPUE) in the three ponds. (The CPUE values were normalised to the initial CPUE value in each pond in order to take into account the differences in the initial stocks in the ponds.)

■ Assessment

■ Experiments in 2010 and 2011:
- a reduction in the numbers and total biomass captured from 2010 to 2011, but no significant reduction in spite of the relatively limited surface areas;
- trapping of red swamp crayfish requires significant human resources even for small ponds. It would be difficult to implement this technique in larger ecosystems.

■ Trapping in 2012 in the Pierre-Constant reserve produced limited results:
- densities dropped significantly from 2009 onward, but remained at high levels;
- the variations in biomass between 2011 and 2012 may indicate changes in the population structure (the studies on the population structure are not discussed here). Strong increases in the numbers of juveniles may be observed the year following large reductions in the crayfish stock.
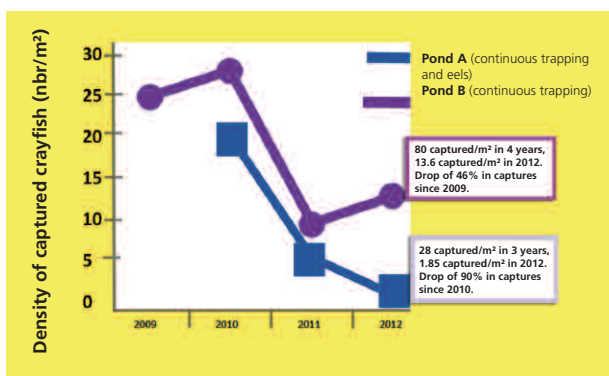
■ The presence of the predators has a significant effect that is however difficult to interpret (direct predation and/or effect on the activity of the crayfish).

■ A significant reduction in the population of red swamp crayfish becomes difficult once it has reached high density levels.

■ Total results since 2009: 10 371 traps checked, 138 "sessions", 580 man-hours in the field, 3 408 hours to lay the traps, 38 000 crayfish captured, i.e. 40.4 per square metre and approximately 120 kilograms of biomass captured, i.e. 128 grams per square metre.

■ The effort made for continuous trapping would be difficult to extend to a large, open environment.

Density of captured crayfish in ponds A and B.

80 captured/m² in 4 years, 13.6 captured/m² in 2012. Drop of 46% in captures since 2009.

28 captured/m² in 3 years, 1.85 captured/m² in 2012. Drop of 90% in captures since 2010.

Overall captures in ponds A and B.

	2010	2011	2012
Density (nbr/m²)	28.5	10.2	13.6 (↗)
Biomass (g/m²)	133.8	128.1	60.6 (↘)

Outlook

■ Efforts will be made to perfect the combination of captures and predation over the long term:
- selective trapping will be implemented if a major trapping effort is made and/or if emblematic species are present. Tests on selective trapping were run during the experiments and proved the effectiveness of the technique. An assessment of the technique in terms of the applicable regulations is in progress;
- the stock of predatory fish will be optimised to enhance their impact on the population of red swamp crayfish;
- particular efforts will be made for sites in the early stages of colonisation.

Information on the project

■ The first national meeting on invasive alien crayfish, held from 18 to 20 June 2013 in Saint-Lyphard (Loire-Atlantique department), was organised by INRA Rennes, the Brière regional nature park, the Forum of Atlantic marshes, the CNRS Rennes and Onema:
- a paper was presented on the trials to draw down the stock of red swamp crayfish *Procambarus clarkii* using trapping and biocontrols;
- the project results were published in an *Onema Meetings* document and in the *Aestuaria* collection of documents.

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For more information

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■ Soudieux A. 2010. Restauration de la biodiversité par épuisement de stock de *Procambarus clarkii*. Mémoire de fin d'étude d'école d'ingénieurs. ESITPA, Rouen, 58 pp.
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Parc naturel régional de Brière