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ONEMA

Meetings

Invasive exotic crayfish: present situation and management approaches

Two days devoted to information and debate, organised by the INRA, the "Parc naturel régional de Brière", the "Forum des marais atlantiques", the Onema and the CNRS.

Nearly 120 managers and scientists gathered at Saint Lyphard (Loire-Atlantique) on the 19th and 20th of June, 2013, for the first "National meeting on invasive exotic crayfish". Overview.

Out of the nine crayfish species inventoried in France in 2013, six were introduced during the XXth century. Three of them are well-known invasive. The spiny-cheek crayfish (*Orconectes limosus*) has now spread across the whole French territory. In the 1970s, the same became true for the signal crayfish (*Pacifastacus leniusculus*) and the red swamp crayfish (*Procambarus clarkii*), whose rapidly expanding populations cause major disturbances to many aquatic environments. Other exotic species have been reported locally. The impacts of such a proliferation remained underestimated for a long time, but they now emerge as a central issue for many stakeholders ranging from fishermen's federations to local administrations. In response to an increasing need for more knowledge and solutions, an unprecedented research effort has been led in Brière since 2010, mobilising quite a number of partners around the INRA, the "Parc naturel régional de Brière", the CNRS and the Onema. All these studies, along with others led elsewhere in France, were presented during the first "French meeting on invasive exotic crayfish".

Distribution areas: a rapid colonisation

In his opening speech, M. Collas (Onema), gave an overview of the demography of the different species based on five national inventories led by the "Conseil Supérieur de la Pêche" and then the Onema since 1977 (cf. supplementary information about the distribution of species

across Europe in Figure 1, next pages). While the spiny-cheek crayfish, which was introduced in the Cher county as early as 1911, was found in all mainland counties except the Lozère county over the study period, the two "recent" invasive species spread quickly: in 2001, signal crayfish and red swamp crayfish were found in 61 and 49 counties, respectively, but in 2013 they were found in 71 and 73 counties. Meanwhile, the white-clawed crayfish (*Austropotamobius pallipes*), the best-represented native species in France, has severely declined: populations were still found in 78 counties, but they are more and more fragmented and confined to the upstream part of basins. An analysis of electrofishing results showed that their average

Inadequate regulations

Although introducing invasive species (all species included) into environments is forbidden by the environment code, live transport remains allowed for most crayfish species – among which spiny-cheek and signal crayfish. Authorisations are needed only in the case of the red swamp crayfish.

density plummeted between 1990 and 2009, while signal crayfish and red swamp crayfish densities soared.



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The red swamp crayfish is the spearhead of invasive species in France

Regional actions make it possible to refine the inventory. Thus, when red swamp crayfish populations were found in the Meurthe basin for the first time in 2008, “the Fédération lorraine des associations agréées pour la pêche et la protection des milieux aquatiques” led more than 400 investigations over the territory (*P. Pommeret, FDAAPPMA Lorraine*). “Exhaustive” (10 × 10 km-mesh) distribution maps were generated for each species and revealed the existence of numerous unheard-of populations – invasive ones, but also native ones. In the Parc naturel régional du Morvan, substantial inventory and data-updating work was done on the distribution of the signal crayfish, first found in 1990: the work (*L. Paris, PNR Morvan*) more particularly evidenced that the invasive species was making progress upstream, at a rate of 2 to 4 km per year in the mainstream, and 800 m in several tributaries.

Colonisation and impacts: new insights

The circumstances that led to the introduction of invasive crayfish in Europe are known (*M. Collas, Onema*): they were imported for breeding and repopulation purposes into a small number of lakes and drainage basins, and then they gradually gained neighbouring waters, quite helped by intentional introductions. But the way they naturally colonise aquatic environments remains fairly mysterious. At the scale of the Brière and Mès marshes (Loire-Atlantique), an *in situ* study (*A. Tréguier, INRA and Rennes Univ.*) aimed to understand the modes of propagation of the red swamp crayfish through two pond networks partly invaded by the species. Based on a survey of crayfish presence, the work characterised the chances for ponds to be colonised as

related to different topographic variables. In both case-studies, the preponderant factor appeared to be how close marshes (source environments) were: colonisation chances also increased with the number of neighbouring ponds and pond surface. Another *in situ* study (*F. Fonteneau, Rennes Univ.*) focused on red swamp crayfish movements between Grand-Lieu lake (Loire-Atlantique) and its floodplain meadows when floodwaters subside. Funnel-traps were placed at the inlet and outlet points of the meadows and lifted out daily from mid-April to mid-May 2012. They evidenced significant crayfish movements – up to 320 specimens at the outlets on the last day. Crayfish capture pattern was analysed regarding size structure as a function of date. It more particularly confirmed that meadows constitute favourite feeding environments for the species, especially for juveniles, down to the last moment before meadow floods subsided.

One of the direct impacts of invasion by North-American crayfish is the decline of local species. More fecund, more aggressive, more tolerant to environment degradation, invasive species are moreover the vectors of the “crayfish plague”. This pathology is linked to the “mould” *Aphanomyces astaci*, it is generally lethal for native crayfish and still remains relatively poorly documented. A survey of the studies presently led across Europe was given during the seminar (*F. Grandjean, Poitiers Univ.*): they include a historical record of epidemics since the pathogen first occurred in the Po basin in 1895, detection methods, infestation rates of the French populations of signal crayfish...

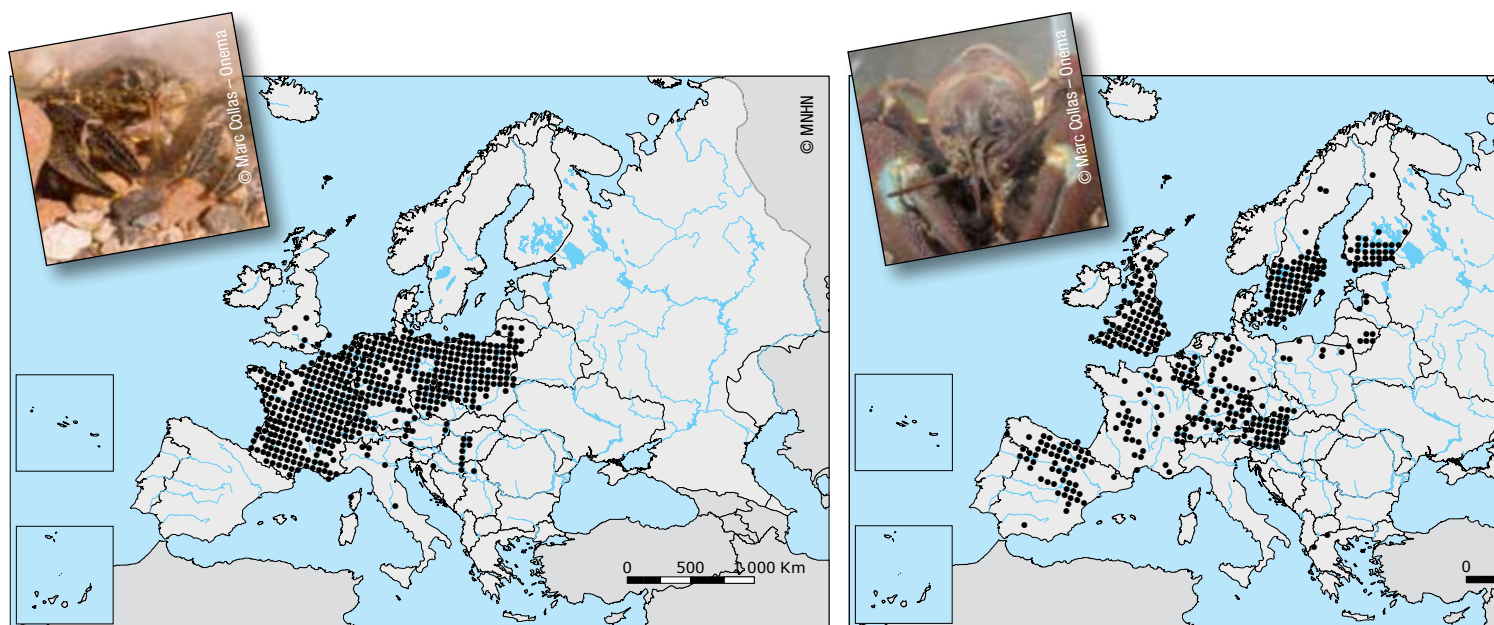
Beyond this interspecific impact, invasive crayfish can deeply affect environment functioning. Several studies highlight the

Benoît Thiébot,
Ministry for sustainable
development

“These two days made it possible to get a full view of the impacts of invasive crayfish and how hard it is to manage them. Biological invasions are quite a serious issue for the Ministry, and the present evolution of regulations must allow for a better handling of the risks related to invading exotic species. These meetings fit into scientists’ mission to provide information needed for public authorities to lead actions; prefects can act as relays to allow for regulatory developments. Besides, awaking the public’s awareness is essential. Opening the conference – which gathered people from highly diverse backgrounds - to the public the day before the seminar was to my mind an exemplary initiative”.

preponderant place taken by red swamp crayfish in the foodwebs within which they develop. A mesocosm study (*H. Rodriguez, Tour du Valat*) thus demonstrates how it reduces the diversity and density of benthic invertebrate communities and of vegetation in experimental systems (Figure 2). In the Camargue, stomach content analyses highlighted that they represent 80% of the food diet of glossy ibises, white spoon-bills and cattle egrets.

Omnivorous, opportunistic and detritivorous, this invasive species thus imposes itself as the central link in the food chain (*H. Rodriguez, Tour du Valat*); it creates a direct trophic link between the energy stored in debris and lower trophic links on the one hand, and upper predators on



Distribution areas of the spiny-cheek crayfish (left), the signal crayfish (middle) and the red swamp crayfish (right) across Europe. In Souty-Grosset *et al.*, 2006

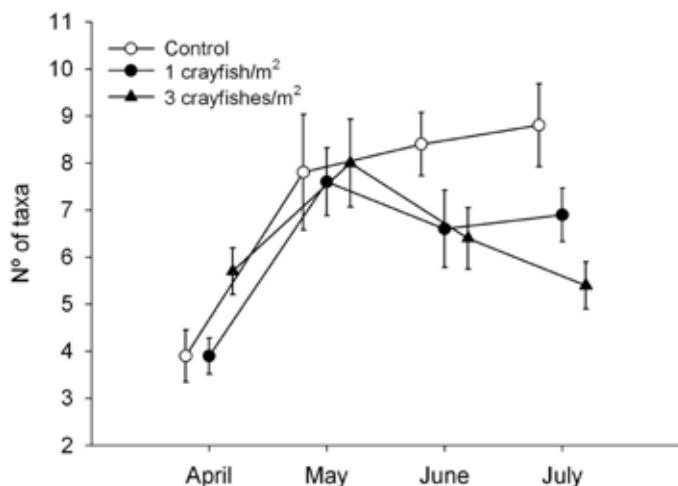


Figure 2. Evolution of the average numbers of macroinvertebrate species after one or three red swamp crayfish were introduced, as compared to the control tanks (mesocosm study). From H. Rodriguez, La Tour du Valat.

the other hand. Similar observations were made in the Brière marshes (J-M. Roussel, INRA); an analysis of stable isotopes as markers for mobilised energy sources shows that the red swamp crayfish constitutes the main food source of most fish. It is thus highly detrimental to aquatic environments, through biodiversity losses, foodweb levelling, and causing fish and birds to depend on a quasi-unique resource. In addition to these harmful ecological effects, its proliferation can locally affect socio-economic activity. In the Camargue again, a sociological survey was aimed at detailing, on the basis of interviews, how different stakeholders (rice-growers, canal rangers, fishermen...) perceived the species. That first approach (T. Prola, Tour du Valat) more particularly identified the potential impact of crayfish burrows as a concern for water management in rice fields.

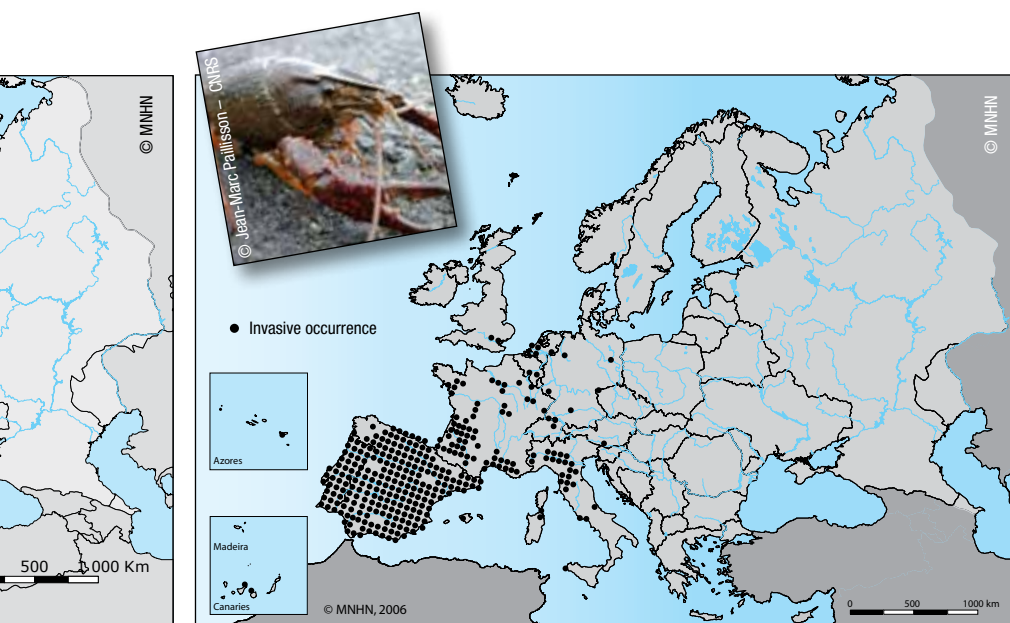
Managers face-to-face with invasions: feedbacks and questionings

Faced with these invasions and their impacts, what levers do managers have at their disposal? This was the subject-matter of the second day of the seminar, which was devoted to several feedbacks from experiments carried out in France. Regarding stretches of water, i.e. the starting points of most invasions, temporary draining is a well-tried option. For example, it was implemented in the Vosges, following a decision from the local authorities, in a dozen gravel pits and private ponds invaded by signal and red swamp crayfish (M. Collas, Onema). Habitat destruction via dredging and

quicklime treatment may prove necessary; crayfish are thoroughly got eradicated three years' drainage. The issue is of course more tricky for streams and open environments. Trapping has been used in many ponds of the Parc naturel régional de la Brenne (Indre) since 2007, the year when red swamp crayfish was found in its waters. A "crayfish brigade" composed of five agents operates 400 funnel-traps in link with rangers and local owners: altogether, more than 230,000 specimens have been destroyed since 2009. Catch records provide evidence for a sharp decrease of the invasion, but eradication appears to be out of reach due to the strong dynamics of the species. The limits of trapping alone have also been shown in a study led in two stretches of water of the Brière marshes that had a cumulated surface of about 1,000 m² (J-P. Damien, PNR de Brière). Following tests with different traps, a funnel-trap of the semi-cylindrical wired (GSC) type was identified as allowing for the best catch rate of all crayfish sizes. In addition, a highly selective trap that practically catches only crayfish has been developed. With one trap for 10 to 15 m², from April to July, the experiment made it possible to trap 38,000 individuals in four years... without depleting the stock. In parallel to trapping, the introduction of eels, which are well-known predators of crayfish, was tested in one of the stretches of water from 2012. The results are encouraging: in only one month, catches sharply dropped (Figure 3, next page). This result should be taken cautiously due to the inhibiting effect of the presence of eels on crayfish mobility, but it confirms the potential interest of biocontrol approaches using predators as complementary strategies.

Nicolas Cotrel,
Deux-Sèvres Nature Environnement

"The rise of red swamp crayfish in the South of the county and the recess of the last native populations are a major concern for us. The seminar, which was remarkable, answered many questions. But a lot remains to be done for such knowledge to get out of the scientific world. We must arouse the public's awareness to the issue: in the local press, I counted 150 articles on the Asian predatory wasp within 3 years, but not one line about crayfish! Besides, from a regulatory point of view, we suffer from public authorities' inertia. Can the scientists and naturalists' community write a motion to obtain significant advances on a national scale?"



For smaller-size environments, and depending on ecological stakes (e.g. the occurrence of a threatened native population upstream), different approaches were suggested. Saules et Eaux Co. (*T. Duperray*) thus developed a protocol to mechanically sterilise signal crayfish males, while trapped females and juveniles are destroyed. But *in situ* tests in several Cévennes and Normandie-Maine streams turned out to be disappointing: too many males escaped from the traps, despite an important catching effort. Other approaches are investigated. On the Sarthon, a Sarthe tributary, an apron was modified to stop invasive crayfish going upstream. Various tools, such as endoscopes for exploration, olfaction-led funnel-traps..., have been set up. In literature across Europe, various biocides and biological agents are also mentioned (*C. Souty-Grosset, Poitiers Univ.*). But in their present state, none of these approaches can be a magic remedy: depending on cases, the best results appear to be obtained by combining several strategies. As for the professional fishing sector, it poses itself as a regulating factor of populations through the setting-up of strictly supervised commercial channels in link with managers (*N. Stolzenberg, CONAPPED*): the option was discussed during the seminar, and several participants pointed that this might turn invasive crayfish into an item of our natural heritage.



GSC-type funnel-trap in fishing situation

Monitoring populations: toward a standardised method

In this context, setting up standardised methods for monitoring invasive populations appears indispensable for management. This objective was reached for red swamp crayfish, within the framework of the programme led by the Parc naturel régional de Brière. Thanks to systematic comparative tests, along with sampling effort assessment, a protocol for optimal passive trapping was defined (*J-M. Paillisson, CNRS*) to estimate crayfish abundance - expressed as CPUE (catch per unit effort) - reliably within a given environment. It relies on the use of GSC traps

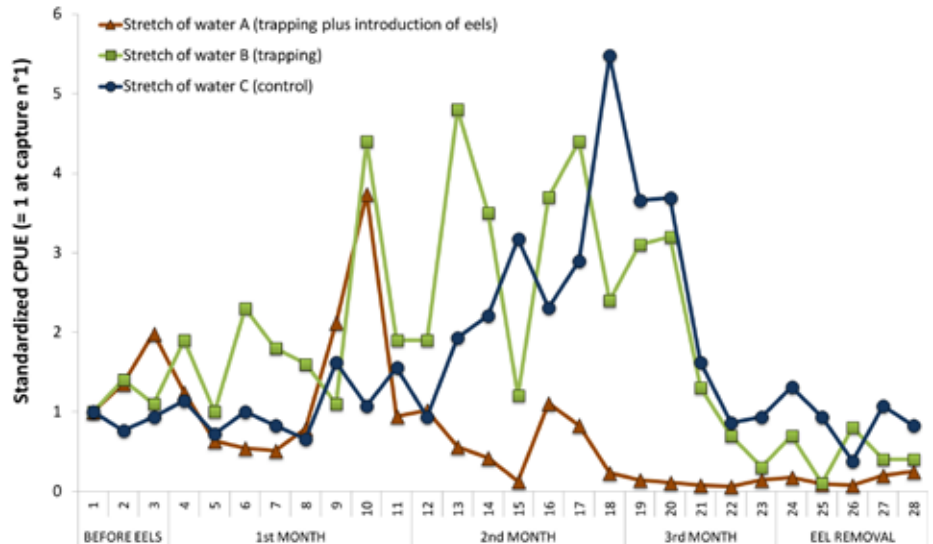


Figure 3. Effect of the introduction of eels on red swamp crayfish catches (per unit effort, CPUE) in a stretch of water. From J-M. Paillisson, CNRS.

mentioned above set every 10 m within a wide range of habitats. Baits should not be used, as they are likely to lead to over-estimating the numbers of large-size crayfish. Daily records lower the risk of trapped crayfish « vanishing » and therefore provide a closer-to-truth picture of population composition. The ability to transfer that protocol to other aquatic habitats now has to be validated by implementing it on a broader scale. In parallel, another study tested the suitability of the environmental DNA method for detecting crayfish (*A. Treguier, INRA and Rennes Univ.*), as compared to trapping, in 158 ponds close to the Brière marshes. Results are contrasting. While the two methods yielded converging results for 110 ponds, they yielded contradictory results for 30% of the studied ponds. In certain ponds, crayfish were caught but their DNA was not detected, whereas in other ponds it was the reverse: DNA was detected, but there were no catches. These differences suggest that the methods are complementary: the environmental DNA technique, whose development is still in progress, could offer better detection efficiency, while traps provide data about population abundance and age structure.

At the end of the two days, a set of new data had been brought that made it possible to understand and monitor exotic crayfish invasions and manage their impacts. However, from an operational point of view, the speeches highlight that fighting against their proliferations is a no less than true challenge. The prevention of new invasions, which includes regulatory measures as well as making stakeholders (managers, fishermen, owners, aquarists...) aware of the issue, appears more than ever as an essential condition for preserving aquatic environments. ■

For more information:

Seminar overview, in press:

<http://www.onema.fr/collection-les-rencontres-syntheses>

Proceedings, to be published in the journal *Aestuarina* – “Paroles des Marais Atlantiques” collection

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