COMPARISON OF WHITE-CLAWED CRAYFISH POPULATIONS IN IRISH AND FRENCH STREAMS, WITH COMMENTS ON ITS FUTURE SURVIVAL IN EUROPE

J.D. REYNOLDS, A. DEMERS

Department of Zoology, Trinity College, Dublin 2, Ireland.
E-Mail: julian@thereynolds.com

Reçu le 24 juin 2005 *Received June 24, 2005*
Accepté le 22 août 2005 *Accepted August 22, 2005*

ABSTRACT

White-clawed crayfish *Austropotamobius pallipes* (Lereboullet) populations remain strong in Ireland across a range of river and lake habitats, but the species is in decline elsewhere in Europe where it is sympatric with alien species. From comparison of published French and Irish studies, we suggest that in the changed European context the long-term health and survival of this species requires the maintenance of Ireland's no-go status for non-indigenous crayfish.

Key-words: *Austropotamobius pallipes*, stream habitats, crayfish plague, Ireland, France, conservation.

COMPARAISON DES POPULATIONS D'ÉCREVISSES À PATTES BLANCHES DANS LES COURS D'EAU IRLANDAIS ET FRANÇAIS, AVEC COMMENTAIRES SUR LEUR SURVIE EN EUROPE

RÉSUMÉ

Les écrevisses à pattes blanches (*Austropotamobius pallipes)* sont encore présentes en populations abondantes en Irlande, dans une grande variété d'habitats de cours d'eau et de lacs, alors que cette espèce est en régression partout ailleurs en Europe, ou elle est confrontée à des espèces exotiques. En s'appuyant sur des études françaises et irlandaises, nous suggérons que, dans l'évolution du contexte européen actuel, la santé à long terme ainsi que la survie de cette espèce, passent par le maintien de la fermeture de l'Irlande aux écrevisses étrangers.

Mots-clés : *Austropotamobius pallipes*, biotopes de ruisseau, la peste, Irlande, France, conservation.

INTRODUCTION AND BACKGROUND

The threatened white-clawed crayfish *Austropotamobius pallipes* was the first European crayfish to be listed in Annex 2 of the EU Habitats Directive. Its range is broad, being found in some 18 European territories from Spain to Austria and the Balkans, and from Italy to the British Isles (HOLDICH, 2002, SOUTY-GROSSET *et al., in press*). However, the species is in decline, attributed to a variety of causes, including over-fishing, pollution

Article available at http://www.kmae-journal.org or http://dx.doi.org/10.1051/kmae:2006014

and disease. Non-indigenous American crayfish species are now sympatric across its range, except in Ireland (HOLDICH *et al.,* 1999) and crayfish plague is endemic wherever American crayfish occur.

Indigenous Irish white-clawed crayfish have a close genetic similarity to populations in western France (SOUTY-GROSSET *et al.,* 1999), and may be derived from them in historic or pre-historic times (REYNOLDS *et al.,* 2002b, GOUIN *et al.,* 2003). SWAHN (2004) indicates that the monastic orders in France were major users of crayfish in the tenth century, and it has been speculated that this might have been the origins of the Irish populations (REYNOLDS, 1997). A comparison of populations in the two countries, therefore, may indicate differences related to presence and absence of non-indigenous crayfish, with the attendant risks of crayfish plague, and could be useful in determining the survival prospects of this threatened species in Europe. However, differences in the size of water-body supporting crayfish populations often necessitated the use of different sampling methodology, so that population estimators cannot be directly compared.

White-clawed crayfish remain widely distributed across both Ireland (REYNOLDS, 1997, DEMERS and REYNOLDS, 2003, DEMERS *et al*., 2005) and France (CHANGEUX, 2003). Where geology is suitable, there are large populations of crayfish in many Irish rivers and some lakes, as well as headwater streams (REYNOLDS *et al*., 2002b, DEMERS *et al*., 2005). In France, however, while white-clawed crayfish are present in most Départements, many populations have disappeared and densities are diminishing (VIGNEUX *et al*., 1993; CHANGEUX, 2003). Ireland suffered one documented outbreak of crayfish plague in the 1980s. By contrast, France has had recurring plague outbreaks and alien crayfish are widespread (CHANGEUX, 2003).

Crayfish populations have been studied in most major Irish river catchments, including the Corrib (McFADDEN and FAIRLEY, 1984), Liffey and Boyne (DEMERS and REYNOLDS, 2002), Nore (LYONS and KELLY-QUINN, 2003), Barrow, Suir, Munster Blackwater and Shannon (DEMERS and REYNOLDS, 2003). Water quality and Horton-Strahler stream order for crayfish sites in these rivers have been estimated conservatively from the 1: 440,000 map accompanying McGARRIGLE *et al.* (2002). Most studied stocks were in third to fourth order stretches, up to 100 km from the source, where water quality was often rated slightly or moderately polluted, based on invertebrate faunal samples. However, crayfish catches were good, with mean CPUE values from 2 to 24 crayfish per trap night.

In France, white-clawed crayfish populations have been studied, for example, in the Loire (BROQUET *et al.,* 2002), Maine (NEVEU, 2000), Corrèze (REYJOL and ROQUEPLO, 2002), and Poitou-Charentes: Vienne (GRANDJEAN *et al.,* 2000) and Deux-Sèvres (TROUILHE *et al.,* 2003). In contrast to Ireland, these stocks only occurred in first or second order streams a maximum of 10 km downstream from the source, and water quality was generally good. Crayfish densities were 2.5 to 26 per square metre, probably comparable to those seen in small Irish streams, but stocks were generally small and restricted in extent.

DISCUSSION

Crayfish streams in Ireland and northern and western France are broadly similar in type and water quality, although some French headwater streams are more forested. However, the largest Irish crayfish stocks occur in higher order rivers and moderately large lakes, while today French stocks are generally restricted to headwater streams. In Great Britain, also, most white-clawed crayfish populations are restricted to first or second order streams (e.g. SLATER *et al.,* 2004), although in northern catchments, particularly in the "no go" areas for alien crayfish, they may occur for long distances downstream (S. PEAY, pers. comm.).

The French situation has been interpreted as showing a demand by this species for high water quality (GRANDJEAN *et al.,* 2002), but mild or even moderate organic pollution *per se* appears not to be a limiting factor for this species in Ireland (DEMERS and REYNOLDS, 2002, 2003; GALLAGHER, 2002) or elsewhere (FÜREDER and REYNOLDS, 2003). In Poitou-Charentes (France), TROUILHE *et al*., (2004) have shown that the limiting factor seems to be some form of organic matter; sites without *A. pallipes* were distributed according to organic matter parameters.

The one documented Irish outbreak of crayfish plague in the 1980s decimated crayfish in the Boyne system and perhaps elsewhere (DEMERS and REYNOLDS, 2002), the spores of *Aphanomyces astaci* probably brought in accidentally with recreational fishing gear (MATTHEWS and REYNOLDS, 1990). Today, long stretches of the Boyne, although apparently suitable in habitat and water quality, remain devoid of crayfish (DEMERS *et al.,* 2005). The impact of alien American crayfish, through transmission of plague spores as well as direct competition, thus may be a major or perhaps even the main reason for the sporadic loss of native crayfish populations or for their restriction to isolated headwaters on the European mainland, and has serious implications for survival of native European species. Ireland then becomes a crucially important area for the white-clawed crayfish. How can its populations be protected?

Potential for Irish crayfish conservation has previously been discussed by REYNOLDS and MATTHEWS (1996) and REYNOLDS *et al.* (2002a). The first proposed a controlled relaxation of the ban on crayfish capture, to enhance public interest in its protection, while the second made management recommendations to protect the Irish stocks, so that they would be better protected for possible restockings in Ireland and elsewhere. These recommendations included preventative measures to exclude spores of the crayfish plague oomycete *Aphanomyces astaci* from entering Irish waters, and maintenance of the prohibition on imports of non-indigenous crayfish.

The specific legislation under the Fisheries Acts, preventing the introduction of alien crayfish species into Ireland, was successfully invoked to resist attempts to obtain licences for importation of American signal crayfish *Pacifastacus leniusculus* in the 1990s and no introductions took place (REYNOLDS *et al.,* (2002a). While Northern Ireland is governed by UK Legislation, the authorities North and South have adopted a joint approach to restricting imports of alien crayfish, which so far has held. However, a new approach is required in the changed European context. There have been regular sightings in Ireland of captive crayfish in the aquarium trade; various crayfish species can now be purchased through the internet, and live crayfish are sometimes seen in Irish fish shops. The legislation to prevent distribution or sale of such imports appears deficient. In the UK, several pieces of legislation exist to protect the native crayfish (SIBLEY, 2003), but with alien crayfish already spreading across the country they are of questionable value in halting the continuing decline of native populations.

The current situation in Europe with the noble crayfish *Astacus astacus* is instructive. This indigenous species is the object of a profitable fishery in Scandinavia (TAUGBØL, 2004) which protects its stocks for exploitation (EDSMAN, 2004). However, legislation protecting the noble crayfish in the Czech Republic has had a negative impact, particularly because alien signal crayfish were not regulated and so became more prized (EDSMAN and ŚMIETANA, 2004). Protection of the Atlantic salmon in Poland is believed to have contributed to its eradication because anglers had lost interest in its conservation (EDSMAN and ŚMIETANA, 2004). The native white-clawed crayfish *Austropotamobius pallipes* was also formerly fished in the UK and elsewhere up to the 20th century, before stocks were decimated, perhaps by plague. As it is now legally protected across its range, with a ban on capture except under licence, this species is less visible to fishermen and the interested public than is the noble crayfish and is therefore in more danger of disappearing un-noticed.

Populations of *Astacus astacus* in Sweden are now reduced to a few percent of their earlier strength (EDSMAN, 2004). Their demise was certainly hastened by the government-sponsored introduction of the signal crayfish from western North America. Fishermen still frequently move signal crayfish from lake to lake in Sweden, with disastrous results, although there is now strong evidence that the early claims for the superiority of the signal over the noble crayfish in terms of growth rate were incorrect (EDSMAN, 2004).

It is heartening to note that after national and international consultation, the Swedish authorities have now banned any further live imports or movements of non-indigenous crayfish to their country, despite the presence of large populations of signals and other alien species. This has been notified to the European Commission. Estonia has followed suit (L. EDSMAN, pers. comm.). These courageous stances should be an inspiration to Ireland, which holds currently the only populations of *Austropotamobius pallipes* in Europe unchallenged by alien species. It is important that Ireland should now implement similar legislation, rather than waiting for their fisheries legislation to be challenged.

The public also has a role to play. As white-clawed crayfish cannot be fished except under licence, it is important to make them more visible and relevant in their Irish stronghold. A change in Irish regulations to allow some recreational fishing has been proposed (REYNOLDS and MATTHEWS, 1996), and their licenced use in field ecology studies and for other educational activities suggested (REYNOLDS and PUKY, 2005). One area where crayfish attract comment is in the diet of otters; their carapace and other remains encountered on river banks are an indication of the presence of crayfish populations and their importance in the food web. HOWELLS and SLATER (2004) note that the perceived value of crayfish in Wales increased when their conservation value was better understood in such ecological terms. In summary, we conclude that strong Irish legislation is vital for the protection of white-clawed crayfish in Europe, and this legislation should consider including ways of allowing greater visibility of this important heritage species to the public.

ACKNOWLEDGEMENTS

We thank Lennart Edsman, Stephanie Peay, Catherine Souty-Grosset and Marie-Cécile Trouilhé for valuable discussions and Sylvia Reynolds for her helpful comments on the manuscript.

REFERENCES

BROQUET T., THIBAULT M., NEVEU A., 2002. Distribution and habitat requirements of the white-clawed crayfish *Austropotamobius pallipes* in a stream from the Pays de Loire region, France: an experimental and descriptive study. *Bull. Fr. Pêche Piscic., 367*, 717-728.

CHANGEUX T., 2003. Changes in crayfish distribution in metropolitan France according to the national surveys performed by the Conseil Supérieur de la Pêche from 1977 to 2001. *Bull. Fr. Pêche Piscic., 370-371*, 17-41.

DEMERS A., LUCEY J., MCGARRIGLE M.L., REYNOLDS J.D., 2005. The distribution of the white-clawed crayfish, *Austropotamobius pallipes*, in Ireland. *Biology and Environment, 105B,* 65-69.

DEMERS A., REYNOLDS J.D., 2002. A survey of the white-clawed crayfish *Austropotamobius pallipes* (Lereboullet) and of water quality in two catchments in Eastern Ireland. *Bull. Fr. Pêche Piscic., 367*, 729-740.

DEMERS A., REYNOLDS J.D., 2003. The distribution of the white-clawed crayfish, *Austropotamobius pallipes*, in eight catchments in Ireland in relation to water quality.

94-103 *In:* HOLDICH D.M., SIBLEY P.J. (Eds.), Management and conservation of Crayfish. Proceedings of a Conference held on 7th November 2002. Environment Agency Bristol.

EDSMAN L., 2004. The Swedish story about import of live crayfish. *Bull. Fr. Pêche Piscic., 372-373*, 225-232.

EDSMAN L., ŚMIETANA P., 2004. Exploitation, conservation and legislation. *Bull. Fr. Pêche Piscic., 372-373*, 457-464.

FÜREDER L., REYNOLDS J.D., 2003. Is *Austropotamobius pallipes* a good bioindicator? *Bull. Fr. Pêche Piscic., 370-371*, 157-163.

GALLAGHER M., 2002. The ecology and behaviour of the white-clawed crayfish, *Austropotamobius pallipes.* PhD Thesis, Queen's University, Belfast, 300 pages.

GOUIN N, PAIN S, REYNOLDS J, SOUTY-GROSSET C, GRANDJEAN F (2003) Origin and colonization history of the white-clawed crayfish *Austropotamobius pallipes* in Ireland. *Heredity, 91,* 70-77.

GRANDJEAN F., CORNUAULT B., ARCHAMBAULT S., BRAMARD M., OTREBSKY S., 2000. Life history and population biology of the white-clawed crayfish, *Austropotamobius pallipes pallipes*, in a brook from the Poitou-Charentes Region. *Bull. Fr. Pêche Piscic., 356*, 555-70.

GRANDJEAN F., JOUTEUX R., ROPIQUET A., BACHELIER E., BRAMARD M., 2002. Biological water quality assessment in running water sites harbouring the endangered crayfish, *Austropotamobius pallipes*, based on macroinvertebrates and its potential in habitat selection for restocking. *Freshwater Crayfish, 13,* 338-348.

HOLDICH D.M., 2002. Distribution of crayfish in Europe and some adjoining countries. *Bull. Fr. Pêche Piscic., 367,* 611-650.

HOLDICH D.M., ROGERS W.D., REYNOLDS J.D., 1999. Native and alien crayfish in the British Isles. 221-235, *In:* GHERARDI F., HOLDICH D.M. (Eds.), Crayfish in Europe as alien species. Balkema, Rotterdam.

HOWELLS M., SLATER F., 2004. Changes over time in perceptions of species value: the case of *Austropotamobius pallipes* in Wales. *Bull. Fr. Pêche Piscic., 372-373,* 329-332.

LYONS R., KELLY-QUINN M., 2003. An investigation into the disappearance of *Austropotamobius pallipes* (Lereboullet) populations in the headwaters of the Nore River, Ireland, and the correlation to water quality. *Bull. Fr. Pêche Piscic., 370-371*, 139-150.

McFADDEN Y.T., FAIRLEY J.S., 1984. Food of otters *Lutra lutra* (L.) in an Irish limestone river system with special reference to the crayfish *Austropotamobius pallipes* (Lereboullet) in Ireland. *Journal of Life Sciences, Royal Dublin Society, 5,* 65-76.

McGARRIGLE M., BOWMAN J., CLABBY K., LUCEY J., CUNNINGHAM P., MACCARTHAIGH M., KEEGAN M., CANTRELL B., LEHANE M., CLENAGHAN C., TONER P., 2002. Water Quality in Ireland 1998-2000, 2nd edition (revised). Environmental Protection Agency, Ireland.

MATTHEWS M.A., REYNOLDS J.D., 1990. Laboratory investigations of the pathogenicity of *Aphanomyces astaci* for Irish freshwater crayfish. *Hydrobiologia, 203,* 121-126.

NEVEU A. 2000. Étude des populations d'*Austropotamobius pallipes* (Crustacea, Astacidae) dans un ruisseau forestier de Normandie. II. Répartition en fonction des habitats; stabilité et variabilité au cours de cinq années. *Bull. Fr. Pêche Piscic., 356,* 99-122.

REYJOL Y., ROQUEPLO C., 2002. Répartition des écrevisses a pattes blanches, *Austropotamobius pallipes* (Lereboullet, 1858) dans trois ruisseaux de Corrèze: observation particulière des juvéniles, *Bull. Fr. Pêche Piscic., 367*, 741-759.

REYNOLDS J. D., 1997. The present status of freshwater crayfish in Ireland. *Bull. Fr. Pêche Piscic., 347,* 693-700.

REYNOLDS J.D., DEMERS A., MARNELL F., 2002a. Managing an abundant crayfish resource for conservation – *A. pallipes* in Ireland. *Bull. Fr. Pêche Piscic., 367,* 823-832.

REYNOLDS J., GOUIN N., PAIN S., GRANDJEAN F., DEMERS A., SOUTY-GROSSET C., 2002b. Irish crayfish populations: ecological survey and preliminary genetic findings. *Freshwater crayfish, 13*, 584-594.

REYNOLDS J.D., MATTHEWS M.A., 1996. Conservation strategies for the Irish freshwater crayfish. 151-155. *In:* REYNOLDS J.D. (Ed.) The conservation of aquatic Systems. Dublin, Royal Irish Academy.

REYNOLDS J.D., PUKY M., 2005. The importance of public education for the effective conservation of European native crayfish. *Bull. Fr. Pêche Piscic., 376-377,* 837-846.

SIBLEY P.J., 2003. Conservation management and legislation – the UK experience. *Bull. Fr. Pêche Piscic., 370-371*, 209-217.

SLATER F., ATKINSON M., ROGERS D., 2004. Environment Agency response to a crayfish mortality on the River Shep, Cambridgeshire. *Crayfish Conference Leeds 2004,* 1-6.

SOUTY-GROSSET C., GRANDJEAN F., GOUIN N., 1999. Molecular genetic contributions to conservation biology of the European native crayfish *Austropotamobius pallipes. Freshwater Crayfish, 12,* 371-386.

SOUTY-GROSSET C., HOLDICH D., NOEL P., REYNOLDS J.D., HAFFNER P., 2005. Atlas of crayfish in Europe. *Museum National d'Histoire Naturelle, Paris (Patrimoines naturels, 63)* (*in press*).

SWAHN J.-O., 2004. The cultural history of crayfish. *Bull. Fr. Pêche Piscic., 372-373,* 243-251.

TAUGBØL T., 2004. Exploitation is a prerequisite for conservation of *Astacus astacus. Bull. Fr. Pêche Piscic., 372-373,* 275-279.

TROUILHE M.C., RICARD F., PARINET B., GRANDJEAN F., SOUTY-GROSSET C., 2003. Management of the white-clawed crayfish (*Austropotamobius pallipes)* in Western France: abiotic and biotic factors study. *Bull. Fr. Pêche Piscic., 371-372,* 97-114.

TROUILHE M.C., PARINET B., GRANDJEAN F., SOUTY-GROSSET C., 2004. Qualité physicochimique et biologique de cours d'eau abritant l'écrevisse à pattes blanches (*Austropotamobius pallipes*) en région Poitou-Charentes. *Journées Information Eaux, 16°édition, 14,* 1-11.

VIGNEUX E., KEITH P., NOEL P., 1993. Atlas préliminaire des crustacés décapodes d'eau douce en France. Collections Patrimoines Naturels 14, MNHN, Ministère de l'Environnement Paris. 55 pp.