ROUNDTABLE SESSION 4A

MANAGEMENT: REINTRODUCTIONS AND RESTOCKING.

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ABSTRACT

The present paper summarizes the outcome of a roundtable discussion on reintroductions or restocking as a management strategy for native European crayfish, which took place during the European Crayfish conference in Poitiers, France in September 2001.

Aspects related to the suitability of the target habitat, the stocking material and the stocking procedure itself are important to consider during any reintroduction measure: Apart from general water quality and structural parameters, a suitable habitat is ideally geographically isolated from other surface waters and human activities such as intensive fishing pressure. However, it is of striking importance to make sure that the target habitat is free of crayfish plague, *e.g.* by experimental *in situ* exposure of native specimens. Over-exploitation should be avoided if the stocking material originates from other surface waters and genetic aspects should be considered in stocking material originating from both natural surface waters and crayfish farms. Information for the stocking procedure itself are summarized from experiences gathered in various European countries.

As an overall result of the discussion, the following three key questions related to reintroductions of native crayfish arised: 1. Why are the native crayfish not present (anymore) in the target habitat? 2. Do native crayfish survive *in situ* exposure as a test for crayfish plague? 3. Is the reintroduction or restocking measure successful in establishing a self-sustaining stock of native crayfish?

Key-words : conservation, freshwater decapod, management, native crayfish, reintroduction, restocking, restoration.

INTRODUCTION

Measures to reintroduce native European crayfish into surface waters have been suggested as a crucial part of management and conservation strategies in Europe (TAUGBOL *et al.*, 1992; REYNOLDS, 1997; DEHUS *et al.*, 1999). However, there is still a considerable uncertainty on how such actions should actually be performed and what questions should be answered related to reintroduction or restocking exercises.

In fishery science the term reintroduction refers to the deliberate release of fish by man into a geographic area in which it was indigenous in historic times, but where it subsequently became extinct, while stocking is rather used for the repeated injection of fish into an ecosystem in which a population of that species already exists (COWX, 1998). Here, I mainly use the term reintroduction, however in the crayfish literature, restocking is used sometimes for actions that should be called reintroductions according to the above-mentioned definition.

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The objective of the present paper is to summarize current information on reintroduction as a practical management strategy for native European crayfish in the view of a roundtable discussion on the same topic, which was held during the European Crayfish conference in Poitiers, France in September 2001.

SUITABILITY OF TARGET HABITATS

There are several publications referring to the general water quality parameters and habitat requirements of native crayfish (*e.g.* BOHL, 1999; GARCIA-ARBERAS and RALLO, 2000). Amongst some basic aspects such as the range of water temperature, the bottom substrate and the presence of morphological structures as hiding places, the geographical isolation of the habitat seems to be of importance. Recent stocks often occur in small isolated lakes (SCHULZ, 2000) or isolated stretches of small rivers (ALONSO *et al.*, 2000). Ironically, the presence of weirs and dams in running water habitats seems to be favourable for native crayfish stocks, because it prevents alien species or predatory fish from upstream distribution (BOHL, 1987). One general aspect, often associated with the geographical isolation of a surface water, is the absence or low amount of human impact such as fishing pressure by anglers or commercial fisherman, swimming activity or aquarium owners releasing alien crayfish (SKURDAL, 1995; DEHUS *et al.*, 1999).

Of striking importance is the test if a habitat intended for a reintroduction exercise is free of the crayfish plague arising from the fungus *Aphanomyces astaci* Schikora. The most effective test is the *in situ* exposure of native crayfish in the target habitat. Any kind of exposure cage (size: *e.g.* 60 x 60 x 30 cm containing up to 10 crayfish) is suitable as long as it prevents the crayfish from escaping and ensures an excessive water exchange. The cages should be exposed in the near-shore stretches of lakes and the use of three cages in lakes up to 5 ha and about 1 cage per 5 ha lake surface area in larger lakes is recommended. Each site of a running water habitat intended for reintroductions should be equipped with one test cage. However, the effectiveness of the *in situ* test is greatly dependent on the season and the duration of the exposure. It is strongly recommended to expose the test organisms during the summer period, when the potential of plague infection is highest due to the molting of the crayfish. The *in situ* exposure period should last at least four to six weeks, and covers ideally the whole summer period or even a whole year. SPINK and FRAYLING (2000) exposed ten white-clawed crayfish *Austropotamobius pallipes* (Lereboullet) in 46 x 46 x 31 cm canary cages for a period between six months and one year in two UK streams to test for crayfish plague prior to reintroduction.

Another aspects that needs to be considered is the plant and animal assemblage of the target habitat before the reintroduction takes place. As it is well known that crayfish influence the aquatic community structure (HART, 1992; NYSTRÖM *et al.*, 1999), it is important to make sure that the introduction of crayfish is not causing any negative effects on any other protected species already occurring in the target surface water. It is recommended to undertake a full risk assessment for the effects of crayfish introduction, if a habitat did not contain crayfish for a period of five years or longer.

CRAYFISH MATERIAL FOR RESTOCKING

The stocking material either originates from existing stocks from other surface waters or from crayfish farms. Legislative regulations should be considered, because the direct transfer of crayfish from one surface water to another one usually requires specific permits.

To avoid an over-exploitation of existing stocks it is recommended to take less than 10% of the actual population size per year and to use only stocks with at least a few thousands of individuals. A quantitative survey (SCHULZ, 2000) of the stocks in the source-habitat *e.g.* by mark-recapture trapping is recommended to ensure that the taking of crayfish does not affect the population. Crayfish farming is generally considered to be a very suitable approach to produce material for reintroduction measures (HOLDICH, 1993; KELLER and KELLER, 1994).

In both cases, if the stocking material originates from surface waters or from crayfish farms, the genetic relationships of the crayfish should be taken under careful consideration. There are numerous studies reporting the genetic relationship of stocks at various geographic scales (AGERBERG and JANSSON, 1995; SANTUCCI *et al.*, 1997; SOUTY-GROSSET *et al.*, 1997; SCHULZ and SYPKE, 1999) and the whole issue of crayfish genetics is still developing. It has been shown, for example, that the *A. pallipes* populations in the UK are closely related to populations from Western France (GRANDJEAN *et al.*, 1997) and that *Astacus astacus* (L.) populations in lakes with a geographic distance as low as 20 km contain distinguishable populations (SCHULZ, 2000). Yet, it is difficult to draw any final conclusions from the studies on the genetic structure of crayfish stocks in relation to reintroduction measures, however, it is recommended to use local populations, whenever possible. If genetic analysis are undertaken, it is recommended to use a combination of different molecular methods and to carefully evaluate the results.

STOCKING PROCEDURE

There is still a considerable lack of generalized information on how the reintroduction measure itself should be done. Table I summarizes and compares experiences that had been gathered during various reintroductions using native European species. Some researchers recommend the use summerlings (length: about 30 mm), others prefer adult crayfish individuals for reintroductions to avoid substantial losses by fish predators. Generally, a mixture of different size classes is suggested and the male: female ratio is considered to be ideally up to 1:3. The timing of the reintroduction measure is another issue to be considered according to the water temperature, the molting and the mating period of the crayfish. Late autumn to early winter seems to be the best option for reintroduction measures and repeating the reintroduction during at least three years is highly recommended to ensure a long-term success. According to Table I, the total number of crayfish that had been used for successful reintroductions vary greatly from about 2.5 individuals per hectare (REYNOLDS, 1997) to about 230 individuals per hectare (L. Edsman, pers. comm.). Reintroduction and restocking programmes in North-Rhine Westfalia were performed using up to 1 000 summerlings per hectare lake surface area (C. Burk, pers. comm.).

An important aspect of any reintroduction is the monitoring of the success rate in order to evaluate the procedure and to follow up the state of the stock and the surface water habitat. The monitoring should not be done directly following the first reintroduction, it is rather recommended to start three to five years after the first reintroduction depending on the size of the surface water and the amount of individuals used for restocking. According to ABRAHAMSSON (1966), densities of about 8 000 *A. astacus* per hectare lake area or about 2.5 adult individuals per meter shoreline represent natural stock densities in suitable habitats. About one *A. astacus* per squaremeter were reported from a study in a small stream in Western Germany (TREFZ and GROß, 1996). MATTHEWS and REYNOLDS (1995) documented about five trappable (adult) *A. pallipes* per squaremeter of suitable shoreline in Blessington lake, Ireland. A follow-up of the success of numerous reintroduction measures has been done *e.g.* in Finland (L. Edsman, personal communication).

Table I

Examples for reintroductions and restockings of native European crayfish.

Tableau I

Exemples de réintroductions et de repeuplements d'écrevisses natives en Europe.

Habitat type, location	Reason for lack of native stocks	Stocking material					Number of restockings	Follow up of success	Ref.[2]
		Species	Origin	Number of individuals	Size or age	Sexes[1]			
Streams and ponds, Czech Republic	Crayfish plague	*A. astacus*	Crayfish farm	100 to 1 000 per habitat	Adults, Juveniles	M: 33 to 50% F: 50 to 66%	Up to 3 times in 3 years	Partly investigated	a
River Sherston Avon, UK	Crayfish plague	*A. pallipes*	Same river	50 to 150 per site (8 sites)	Adults	M: 45% F: 55%	4 times (1986 to 1994)	1998 and 1999: proof of success	b
River Tetbury Avon, UK	Crayfish plague	*A. pallipes*	Mells River, Somerset, UK	61 to 127 per site (5 sites)	Adults	M: ≈ 50% F: ≈ 50%	2 times in 1987	1998 and 1999: proof of success	b
Lake, 59 ha, South Sweden	Crayfish plague in 1995	*A. astacus*	Island Gotland & Crayfish farm	13 615 in total	6 to 9 cm length	M: ≈ 50% F: ≈ 50%	4 times (1996 to 2000)	1997 to 1999: no records, 2000: 29 ind., 2001: 126 ind.	c
Stream, Aargau, Switzerland	Crayfish plague?	*A. pallipes*	From nearby surface waters	No data	Adults	No data	once	Yes: no success, (temperature?)	d
Lakes, Northwest Poland	Crayfish plague	*A. astacus*	##	##	##	M: 33% F: 66%	##	##	e
Lake Lough Lene, 440 ha, Ireland	Crayfish plague in 1987	*A. pallipes*	From nearby surface waters	1989: ≈ 50 1991: ≈ 60	Adults	M: 60% F: 40%	2 times	1996: proof of success	f
White Lake, 30 ha, Irleland	Crayfish plague in 1987	*A. pallipes*	From nearby surface waters	450 in total	Adults	M: 60% F: 40%	3 times (1999-2001)	2001: first indication of potential success	g
Lake Berezno, 72 ha, Russia	Crayfish plague in 1968	*A. astacus*	Lake Dolgoe	2 000 in total	Adults	M: ≈ 50% F: ≈ 50%	6 times (1986-1992)	1996 and 1997: proof of success	h
Bruchen Dam, 46 ha, Germany	Newly created dam	*A. astacus*	From nearby surface waters	93	Adults	M: ≈ 50% F: ≈ 50%	1 time 1976	1990: proof of success, more than 10 000 individuals	i

[1] M = Males; F = Females.

[2] a: Pavel KOZÁK, pers. comm.; b: SPINK and FRAYLING (2000); c: Lennart EDSMAN, pers. comm.; d: Thomas STUCKI, pers. comm.; e: Przemyslaw SMIETANA, pers. comm.; f: REYNOLDS (1997); g: REYNOLDS and MATTHEWS (1997); h: FEDOTOV *et al.* (1999); i: Gerhard FELDHAUS, pers. comm.

CONCLUSIONS

There are three key questions that should be answered as part of any reintroduction or restocking measure: 1. Why are the native crayfish not present (anymore) in the target habitat? 2. Do native crayfish survive *in situ* cage-exposure as a test for crayfish plague? 3. Is the reintroduction or restocking measure successful in establishing a self-sustaining stock of native crayfish?

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