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Opinion paper

Current ideas on methodological approaches in European crayfish conservation and restocking procedures

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ABSTRACT

Key-words: *conservation, management, indigenous crayfish species (ICS), restocking*

The present paper deals with reintroductions or restocking as a management strategy for the indigenous crayfish species (ICS) in Europe. The suitability of the target habitat, the stocking material and the stocking procedure itself are paramount 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 and agricultural practices. Genetics of stocking material must be considered. However, it is first essential to make sure that the target habitat is free of crayfish plague. Analyses of experiences gathered in various European countries indicate how difficult it is to get the best information as a basis for successful restocking and consequently the discussions recently conducted among European researchers and managers were aimed at achieving consensus and common strategies.

RÉSUMÉ

Idées actuelles sur les approches méthodologiques des procédures de conservation et de réintroduction des écrevisses européennes

Mots-clés : *conservation, gestion, écrevisses indigènes (ICS), réintroduction*

Le présent article considère les réintroductions en tant que stratégie de gestion des populations d'écrevisses indigènes (ICS) en Europe. La qualité de l'habitat receveur, le matériel donneur et la procédure de la réintroduction en elle-même sont de la plus haute importance : à part une bonne qualité de l'eau et des paramètres structurels, un habitat convenable est idéalement isolé géographiquement des autres eaux de surface et des activités humaines telles que la pêche intensive et les pratiques agricoles. Le statut génétique doit être obligatoirement considéré en termes des animaux à introduire. De plus, il est essentiel d'être sûr que l'habitat choisi est exempt de la peste de l'écrevisse. L'analyse des expériences de réintroduction dans différents pays européens montre comme il est difficile d'obtenir une information sur la procédure la meilleure en termes de réintroduction réussie et les discussions récemment menées au sein des chercheurs et gestionnaires européens ont pour but d'accéder à des stratégies communes.

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INTRODUCTION

Among the European crayfish species (ICS) native to western Europe (*Astacus astacus*, *Austropotamobius pallipes* and *Austropotamobius torrentium*), *Astacus astacus* and *Austropotamobius torrentium* are listed in Appendix V of Habitat Directive (Annex E of DPR 357/97), while *Austropotamobius pallipes* is listed in Appendixes II and V (Annexes B and E of DPR 357/97). However, *Austropotamobius italicus* has only recently been accepted as a separate species distinct from *A. pallipes* (Fratini *et al.*, 2005), and so it is yet to be included. For all species protected under the Habitats Directive in Europe, each member state must submit regular "favourable status reports", based on an assessment of the species' current status; in decline, stable or increasing; with an assessment of the pressures and threats acting on it. Conservation measures may be required in case of declines; these include protection of the habitat and reintroductions to favourable areas within the broad range of the species. For example, measures to reintroduce native crayfish into surface waters have been suggested as a crucial part of management and conservation strategies in Europe (Schulz *et al.*, 2002). However, there is still considerable uncertainty as to how best to perform such actions and what questions should be answered related to reintroduction or restocking exercises ("reintroduction" is the deliberate release of crayfish to part of their range where they have become extinct, while "restocking" refers to repeated releases to boost an existing population). In the crayfish literature, "restocking" is used sometimes for actions that should properly be called reintroductions (Schulz *et al.*, 2002).

Based on the available data there has been a drastic reduction in distribution and abundance of the indigenous European crayfish species (ICS) and IUCN (2009) is looking at a rate of decline somewhere between 50%–80% over the last ten years due to the direct and indirect result of human activities (*e.g.* destruction and fragmentation of habitat, poaching, pollution, and introduction of invasive non-indigenous crayfish species (NICS) resulting in both competition and dissemination of crayfish plague caused by *Aphanomyces astaci*). This situation led to the inception of the EC thematic Network "CRAYNET" which brought together scientists and water managers from 11 European countries. Reintroductions or restocking are often emphasized as management strategies for the conservation of indigenous freshwater crayfish. Norway had especially good conditions for reintroduction of *Astacus astacus* after crayfish plague, because at the time there was no alien plague-carrying crayfish species in this country (Taugbøl, 2004).

Despite the many case studies of reintroductions across Europe, it is still proving difficult to understand the causes of success or failures. A round table discussion was therefore organized during the workshop "Future of native crayfish in Europe" (Pisek, September 2009, Czech Republic) to consider how best to progress towards optimum conservation strategies involving reintroductions at a European scale.

PROCEDURES OF REINTRODUCTION

Three different phases were identified in the reintroduction process by scientists and managers in the thematic network CRAYNET: pre-introduction feasibility, implementation, and post-introduction monitoring. These headings were retained in analysis of 59 case-studies of reintroductions across Europe, below. Under each main heading are listed the stages identified in the reintroduction process, and the various situations or possibilities within each stage. These are further discussed where necessary.

STAGES IN PRE-INTRODUCTION FEASIBILITY PHASE

> *SUITABILITY OF TARGET HABITATS*

Several publications refer to the general water quality parameters and habitat requirements of native crayfish. For example, despite a growing acceptance that *A. pallipes* is not a strict bio-indicator of high water quality (Füreder and Reynolds, 2003), the heterogeneous nature of the habitat for crayfish must be maintained and enhanced, and water quality monitored in both rivers and lakes (Demers and Reynolds, 2002; Renai *et al.*, 2006). The bottom substrate and presence of morphological structures acting as hiding places, and the geographical isolation of the habitat seem to be of importance. Among some basic water quality aspects it was found that the white-clawed crayfish was able to tolerate wide ranges of values of some of the measured parameters, such as the range of water temperature. Principal component analyses (PCA) suggested that an increase of organic matter was a reliable indicator for the loss of *A. pallipes* (Trouilhé *et al.*, 2008).

1. Site is within natural range of species, but with no current populations and recolonization unlikely; streams which once held native crayfish will be prioritized.
2. No NICS within 50 km in adjoining waters (at least 20 km according to Peay (2003)).
3. Site meets ecological requirements for habitat and water quality (EU Framework Directive 2000/60/EC), including a low risk of pollution.
4. Suitable surplus habitat for population expansion (bedrock crevices, boulders, cobbles, gravel for adults; small roots, bryophytes, leaf litter, sand for juveniles).
5. Acceptable levels of predators (fish, mammals – mink, otter) (Peay, 2003).

> *CRAYFISH DONOR POPULATIONS*

1. Donor population sourced from same or adjacent catchment following precautionary principle (see also transport).
2. Donor stocks should be in high abundance (no more than 10% of the donor population must be removed).
3. Donor stocks free from plague; Thelohania $<$ 10% and health screening carried out.

Donor material originates either from existing stocks in nearby streams or ponds, or from crayfish farms. Legislative regulations should be considered, because the direct transfer of crayfish from one water body to another usually requires specific permits.

Four preliminary steps are required:

1. Government and stakeholders consulted,
2. Necessary permits obtained,
3. Pilot survey to ascertain if crayfish absent and no sign of plague,
4. Enhancement of habitat if necessary.

STAGES IN THE STOCKING PROCEDURE PHASE

> *IMPLEMENTATION: SUITABLE STOCK*

1. Use adults, or ideally a balanced donor population with all size classes, in several introductions over at least three years and during the period from August to October (Peay, 2003).

While adults have the advantages of good dispersal activity for rapid colonization and lower mortality than juveniles, they have the disadvantages of a lower life expectancy for oldest crayfish and male agressivity. The great problem with introduction of juveniles is that they are easily predated by fish but we could expect better adaptation to a new environment, and a higher number could be introduced. According to Taugbøl (2004), if the goal is to re-establish a population in a particular area, juveniles seem more appropriate as stocking material due to their stationary behaviour, which seems to persist as they grow larger, while extensive post-stocking movements were observed among adults.

2. Use suitable M: F ratio (1:1 to 1:3) among adults.
3. Use a range of size classes.
4. Use 50–100 individuals minimum.
5. Know genetic origin of donors (better than precautionary principle).

Initially, conservation programmes consisted of restoring the habitat and then translocating individuals without a detailed knowledge of their taxonomic status. Even if ecological managers wanted to be informed, the "traditional taxonomy" based on morphological characters could indicate several types of classification. Current priorities are therefore to provide taxonomic clarification. European crayfish have been subjected to a number of taxonomic revisions that have, at the simplest level, produced a system with one genus and 5 species and at the most complex, 5 genera and 19 species. This shows that classical taxonomic methods are sometimes not powerful enough to differentiate groups along phylogenetic lines and also to provide a precise delimitation of closely related species or intraspecific taxa. This is the case for *Austropotamobius pallipes*, now recognised as a species complex. Its classical taxonomy is a good example of the fact that the number of species, subspecies, or varieties may vary depending on the philosophical stance of authors: the taxonomy obtained by studying morphological characters revealed a complex species. As an endangered species, *A. pallipes* is subjected to a loss of genetic diversity. Consequently a certain degree of genetic variability must be maintained within the species because it governs the adaptation potential: the populations must be capable of responding to new environmental conditions.
The final step is to define management units within species. Since 2002, an important outcome has been this recognition of crayfish species complexes, as for example in the white clawed crayfish *Austropotamobius pallipes* which has gone through several taxonomic revisions that proposed different criteria for the classification of the various distinct morphological and genetic groups identified. At present, the species complex of *A. pallipes* is well recognised and the identity of the taxon *A. pallipes* is clear across its northern and western range (particularly in France, Great Britain and Ireland). The situation is more complex with *A. italicus* which is shared between three subspecies in Spain, Italy, Austria and the Balkans. Where there are subspecies and perhaps sibling species, conservation programmes cannot be undertaken without a thorough knowledge of taxonomic entities, particularly in zones where these overlap (reviewed in Souty-Grosset *et al.*, 2006). Concerning the other native species such as *Astacus astacus* and *Austropotamobius torrentium*, the genetic relationships should also be carefully considered. Nevertheless, it is still difficult to draw any final conclusions from the studies to date on the genetic structure of these crayfish stocks in relation to reintroduction measures. However, on the precautionary principle, it is recommended to use local populations whenever possible.

> *TRANSPORT*

1. Provide interim storage if time exceeds 18 h; it is thus useful to work at the level of the catchment to minimise the time of translocation.
2. Minimise aggression by providing ample hides, cool conditions, and water from the stream of origin.

Before release the crayfish may be acclimatized for one to four days in net cages supplied with adequate refuges; release must occur in areas with favourable physico-chemical conditions and with availability of natural and/or artificial shelters.

> *RELEASE*

1. Introduce to suitable refuges (natural or created).
2. Take appropriate measures to avoid spread of crayfish plague (*e.g.* disinfect boots and equipment).
3. Keep accurate records of reintroduction process.

Schulz *et al.* (2002) note that any habitat intended for a reintroduction exercise must first be shown to be free of crayfish plague arising from the fungus *Aphanomyces astaci.* According to Spink and Frayling (2000) the most effective test is the *in situ* exposure of native crayfish in the target habitat in an exposure cage during the summer period, when the potential of plague infection is highest due to the moulting of the crayfish. The *in situ* exposure period should last at least four to six weeks, however such captivity may lead to other unrelated mortalities, and it is only recommended where plague was known or suspected at the reintroduction site.

POST-INTRODUCTION STAGES

1. Annual or biennial monitoring for population presence and density estimates for at least five years.
2. If sites deteriorate, carry out management works.
3. Report all works and findings to statutory agency.

These are not always observed; where they are not it may indicate a lack of professionalism in the restocking process.

ANALYSIS OF REINTRODUCTION STUDIES

The final step is to analyse the reasons for success or failure and here we must state that there is still a considerable lack of consensus on how the reintroduction measure itself should be done. The authors attempted an analysis of 59 case-studies about reintroductions of the species complex *A. pallipes* across Europe (France, Ireland, UK, Spain, Italy and Austria) and while results indicated a wide range of methodology, no clear-cut optimal strategy emerged over this geographic range, indicating that more consideration of methodology steps and careful recording of their success are needed.
The process of reintroduction was analysed under three main headings; feasibility, implementation and post-introduction monitoring. Six stages were identified, involving some 25 possible decisions/situations, as described above: Each situation was codified for the 59 case-studies as positive, negative or unknown. In all, 26 reintroductions were successful and 33 unsuccessful. However, both regional and taxonomic differences are apparent. With *A. pallipes* in UK, Ireland and France, successful attempts had more positive scores (desired conditions complied with) during the reintroduction process than did unsuccessful ones. However, in studies with *A. italicus* in Spain and Italy, no clear-cut differences were seen either in positive or negative scores. Thus, in Spain, where 13 reintroductions were successful and 12 unsuccessful, in both cases there were on average about 4 positive scores and 0.7 negative ones, and in Italy, with 5 successful and 4 unsuccessful reintroductions, each averaged 15 positive scores – the higher number indicating closer attention to details but no greater success rates. Thus, the numbers of conditions or situations scored was not an indication of success or failure in most studies, but the number of positive scores was correlated with reintroductions of *A. pallipes* in several northern countries in which the taxonomy was clear.
From the 59 study findings, the conclusions for each phase were as follows:

> *FEASIBILITY PHASE*

Receptor site choice: Situations 1 (site is within natural range of species, with no current populations, and recolonization unlikely) and 4 (suitable surplus habitat for expansion) appear to influence success or failure.
Donor populations and site preparation: No clear pattern in most regions. More information would be needed on sites – *e.g.* whether they are in the same or different catchments.

> *IMPLEMENTATION PHASE*

Suitable stock and transport: No clear pattern seen in most regions.
Release: No clear pattern in most regions.

These findings are counter-intuitive but may suggest that if plague or other disease is perceived as a local problem, the outcome may be poor despite precautions.

Post-reintroduction monitoring: No clear pattern in most regions.

The conclusions are that *A. pallipes* and *A. italicus* may be fundamentally different in reintroduction success and explanations could be either that their climate and environment is different or methodology of reintroduction may not correspond in different studies, though coded the same.

It appears that the more meticulously planned and recorded is the process of reintroduction, the more chance there is of a positive outcome. However, donor populations and site preparation do not appear to influence results overall.

ROUND TABLE DISCUSSIONS ON REINTRODUCTIONS

Starting from this global analysis, discussions on native crayfish reintroductions among European scientists from Austria, Croatia, Czech Republic, England, Finland, Germany, France, Ireland, Italy and Spain were conducted during a round table of the Regional European Crayfish Workshop: Future of Native Crayfish in Europe in Pisek, Czech Republic (September 2009). The necessary phases of reintroduction – assessment of feasibility for reception sites and donor stocks, implementation and post-introduction monitoring – were outlined. The main questions which arose in discussion were as follows:

– Is it recommended to have general, Europe-wide guidance, for restocking?
– Is the 50 km isolation distance realistic?
– How important is the genetic variation at the proposed reintroduction site?
– What is the minimum number of crayfish that should be reintroduced to provide some genetic variability? Is a minimum of 50 needed?
– Is it better to restock with captive-bred donor stock or to harvest a threatened donor stock?
– What restocking situation is likely to lead to best survival of donor populations?
– What is the legal situation concerning sale and restocking? Is it better to grant permits to restock, *e.g.* from an approved aquaculture supply?
– Education of the public – Is it better to keep quiet about reintroduced populations in sanctuary sites, or publicise them?
– What aspects of ecology and climate change must be considered?

The results of the discussion are presented below according to the items needed for a common strategy.

> *THE NEED FOR GENERAL, EUROPE-WIDE PROTOCOLS FOR RESTOCKING*

Conclusions were that while there could be a general methodological framework, the finer details must depend on individual species, geography and available habitats. Base-line methodology could be helpful but this would require an analysis of successes and failures for each species and region. This was done for the *A. pallipes* species complex (see above), but few generalizations emerged from the analysis. Moreover, strategies applicable to streams will be different to those for ponds or lakes; in the latter it is recommended to restock from cages, where health checks can be implemented, but in streams this is seldom feasible.

> *WHAT IS A REALISTIC ISOLATION DISTANCE?*

CRAYNET scientists recommended that reintroduction sites be at least 50 km from a NICS site. However, participants noted that it would be difficult to find anywhere in Czech Republic at least 50 km from a NICS site and in UK Ark (sanctuary) sites are much less than 50 km from NICS stocks. Therefore, identifying the barriers to migration is essential. A stream is always a possible corridor, but an impassable waterfall or culvert can improve isolation. Crayfish may fall down an outflow, and return upstream by unknown means. They can also bypass barriers by land, or with human assistance. Target sites must thus be isolated from tourists and anglers. NICS such as *Procambarus clarkii* or *Pacifastacus leniusculus* show particular ingenuity in circumventing barriers. In the Czech Republic some new ponds in forest areas may appear safe, but most are stocked for fishing; thus only drinking water reservoirs would be safe reintroduction sites.

> IMPORTANCE OF GENETIC VARIATION AT THE PROPOSED REINTRODUCTION SITE

It makes sense to consider between-watershed genetic differences, developed over hundreds of generations. Variation can also arise quite fast. In the Liffey catchment (E. Ireland), *A. pallipes* stocks in the Blessington reservoir created 80 years ago now show genetic variation different from that in the tributary Brittas Stream, presumably through adaptation to a lake habitat (Reynolds *et al.*, 2002). However, Irish crayfish stocks are relatively very uniform (Gouin *et al.*, 2003), and differences between Blessington and Brittas crayfish are well within this range. The discussion is what levels of variation are acceptable when restocking, or even recommended. Genetic screening is essential, including determining what alleles are present. With *A. italicus*, a good example of the importance of genetic information is given by Bertocchi *et al.* (2008): Using a fragment of the mitochondrial DNA 16S rRNA gene, they identified eight haplotypes, six corresponding to *A. i. italicus* and two to *A. i. meridionalis*; the two clades were found in syntopy in one stream. Eight populations of *A. i. italicus*, analyzed for their microsatellite loci, showed a low intra-population genetic variability and a high inter-population genetic divergence. Populations sampled in one basin showed no heterozygotes and a high level of inbreeding. Thus a knowledge of the genetic structure of studied populations, combined with information on their ethology, ecology, and demography, is an essential prerequisite for any action aimed at reintroducing this threatened species.

> MINIMUM NUMBERS OF CRAYFISH THAT SHOULD BE REINTRODUCED TO PROVIDE GENETIC VARIABILITY

Round table participants agreed that for a fragmented population the best approach is to restore the environment. Where you wish to restock, be careful about existing small, fragmented populations, *i.e.* first maintain existing populations and their range, preventing further fragmentation and loss. Perhaps a bigger impact can be made through restoration of parts of such a stream, leading to an expanded population, rather than restocking.

Some population mixing is inevitable with restocking but genetic variability or mingling of donor stocks may not be a major problem. For example, a project to increase alpine populations of brown trout involved adding both Atlantic and Danube stocks to increase variation. However, information from molecular monitoring indicated that after catastrophic events such as floods, only the well-adapted local stocks survived (Medgyesi *et al.*, 2009).

> IS IT BETTER TO RESTOCK WITH CAPTIVE-BRED DONOR STOCK OR TO HARVEST A POSSIBLY THREATENED DONOR STOCK?

There were many responses covering *Astacus astacus*, *Austropotamobius pallipes* and *A. torrentium*, including the following: It is important to know the source of donor stocks; the problem is that this may not always be possible with reared crayfish. It is preferable to use a good donor stock and harvest it heavily, than to take a few crayfish from a feeble population. Successful captive breeding is best; but it is necessary first to ensure that aquaculture has a local (genetic) basis, or use local stocks reared at a regional farm. The use of small donor populations is questionable, and it can be difficult to decide where to stock them. Also, in the Czech Republic at least, there is a problem with legal stocking permits. Finland and Sweden will soon stop stocking from wild harvests, only allowing stocks from aquaculture (with known genetics, large numbers available and complete control of disease status possible). It is now known that wild *A. astacus* stocks can "hide" plague for several years, but this does not happen in culture where stress will bring it out. Different stocks can be maintained separately in a modern hatchery. Aquaculture is the best supply for restocking. In Spain, native white-clawed crayfish populations are now too small to risk harvesting for stocking, with too few donors available. The optimum strategy seems to be that if you know the local genetic strains, you should stick to them. However, up to date this has not happened with *A. astacus* across Europe, since many stockings or reintroductions are of the Augsburg selected strain

> *WHAT REINTRODUCTION SITUATION IS LIKELY TO LEAD TO BEST SURVIVAL OF DONOR POPULATIONS?*

Preferably reintroduce at least 50 crayfish each year, in three annual sessions to ensure a range of ages in the new population. Survival is best if you stock juveniles in autumn, when crayfish stop feeding, and they will survive better in spring when algae and zooplankton foods increase. If using water-filled quarries (recommended as ark sites) it is necessary to control access by SCUBA divers to protect implanted crayfish.

> *THE LEGAL SITUATION ABOUT SALE AND RESTOCKING*

The legal situation is quite variable across Europe, and there are often local and bio-political problems involved with restocking. In the Czech Republic it is not legally possible to buy crayfish for restocking. Local farmers, who build small ponds and seek to stock them, are not allowed legally to restock crayfish, even near native crayfish sites. This leads to a risk that they will bring in non-natives illegally. In Spain, there are currently three native crayfish farms, run by the state. They produce crayfish for restocking, but these crayfish cannot be bought. The risk is that the public will buy NICS in pet stores. In one Basque province there is a new project for white-clawed crayfish rearing, for restocking only. Crayfish projects in Granada are still ongoing, but currently lack funds. Some other EU countries permit sale of live crayfish. In Croatia, *A. leptodactylus* are imported from Armenia, semi-frozen but some are viable, or their eggs. In France, *A. leptodactylus* is legally considered "native" as it reproduces naturally. Therefore, uniform, Europe-wide legislation is needed to protect native stocks, and it may be best to provide restocking materials legally from an approved aquaculture supply.

> *EDUCATION OF THE PUBLIC*

When establishing new populations or sanctuary areas, as in the UK Ark programme; participants differed over whether these should be indicated to the public, *e.g.* with a sign, *e.g.* "Protection Area, No Fishing" or their location be kept secret?

Public access to land is a key to any education policy; however, ownership of land and of water varies across the EU. Round table participants agreed that education is essential and it is absolutely necessary to involve local people and stakeholders: Fishermen were formerly proud of their ponds, although now somewhat secretive in reaction to many regulations. It is therefore better to make positive suggestions than provide restrictions. Education must explain the role of crayfish in the freshwater ecosystem, and the wider focus – their value as sentinels for water quality, and their disappearance as alarm signals that other fauna, *e.g.* trout, are also in danger of extinction.

> CONSIDERING ECOLOGY AND CLIMATE CHANGE

Climate change is a longer-term consideration, but one which must influence choice of reintroduction site. In France and Italy, high temperatures (heat waves) in recent years have been the main cause of extinction of white-clawed crayfish populations, except where hyporheic flow or percolating cool ground-waters are suspected (Renai *et al.*, 2008). Stocks are in particular danger when fragmented and restricted to headwaters with small flows. Not just temperature extremes, but also local flooding and droughts are envisaged. Climate change anticipates perhaps a 10% increase in such events in future. Climate change may also lead to sudden flooding, perhaps resulting in a wash-out of introduced stocks.

CONCLUSIONS

According to Taugbøl and Peay (2004), a reintroduction is particularly appropriate for a population recently lost, for extending the distribution of an indigenous crayfish species into its historic range (however, historical data are often lacking and surveys must be systematically conducted), or for creating new or isolated populations to conserve genetic diversity or the species. The experiences in European countries advise that crayfish reintroductions are acceptable only when they are preceded by a feasibility study in order to (a) verify the taxonomic status of the species and identify genetically the management unit that was originally present in the area of reintroduction, and (b) choose the area of reintroduction.

The adequacy of the area to be repopulated is assessed according to: (1) general characteristics of the catchment, (2) its physico-chemical and ecological particulars, (3) absence of and preventing of access by non indigenous crayfish species, and (4) absence of *Aphanomyces astaci* and other potential pathogenic agents. General recommendations are to use both adults and juveniles as available, to stock as many crayfish as can be afforded and over several seasons, and, if short of stock, to boost with hatchery rearing. Projects which were successful in establishing stable and self-sustaining white-clawed crayfish populations had reintroduction numbers of at least 100–200 sexually mature individuals of various size classes, with a ratio of 1 male to 3 female crayfish. Harvesting from a donor population should always be carried out in summer, after females have released young and before mating. Before their release the crayfish can be acclimatized for one to four days in net cages supplied with adequate refuges. The release must occur in areas with favourable physico-chemical conditions and with availability of ample natural and/or artificial shelters. After the reintroduction (to be repeated annually in the same watercourses for three years at least), regular monitoring of the reintroduced population and checking of the physico-chemical and biotic parameters of the habitat of reintroduction are essential.

Main topics discussed in the Pisek round table were: what is the safe distance of reintroduction site from NICS populations and are there positive implications for stocking from aquaculture of donor stocks? Round table participants considered that, in general, major constraints in a reintroduction project are money and availability of stocking material. The current UK focus on Ark Sites – new, isolated sites, such as abandoned quarries, where populations can be established in relative safety from the widespread Signal crayfish – is now backed by a stage-by-stage methodology for site selection (available to download from www.buglife.org.uk). Positive approaches are needed in both education of the public and in developing uniform legislation to protect European native stocks. Rules are necessary; but they should reflect common sense in their implementation. While fishermen may transfer plague, even more dangerous are uninformed people who give a child a crayfish as a pet and later dispose of its offspring into fresh waters. Concerning the exploitation of NICS, Europe is now more amenable to broad-scale protection of native stocks, and it is hoped that there will be a decision for common harmonization of rules.

Round table participants expressed their concern about the aquarium trade for NICS, particularly through internet access, and finally participants recommended that a resolution on control of trade in live crayfish be considered for submission to the International Association of Astacology.

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