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Crayfish NEWS

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Inside this issue:

IAA Cruise, August 2017
Impressions and Reflections

Figure 1. Attendees of the IAA Cruise, held on board of m/s *Gabriela*, Helsinki, Finland.

The IAA 2017 Cruise was an extremely memorable conference; this was an additional European get-together, which supplements the biennial international IAA conference that will take place in Pittsburgh in July 2018. The IAA 2017 Scientific committee, led by our host **Japo Jussila**, came up with the novel idea of holding the conference on a Nordic cruise liner, with perhaps the slight ulterior motive of ensuring that the delegates would be captive for the essential pre and post conference session socialising. The setting was therefore perfect; cruising, aboard the *Gabriella*, between the spectacular backdrops of Sweden and Finland, whilst having the opportunity for some historical Stockholm sight-seeing, with our most able and capable hosts. Due to the conference delegates' enthusiasm for socialising, (and dancing), there was ample opportunity to continue discussions on the complexities of crayfish conservation and invasive crayfish control, way into the wee small hours.

The scientific content of the conference presentations was excellent, with a broad mix of topics covering subjects such as the status of European native and invasive crayfish populations and their genetic diversity; the specifics of crayfish plague strains; the use of environmental DNA as a survey tool; monitoring crayfish heartbeats as bio-indicators and the effect of environmental levels of antibiotics and antidepressant drugs on crayfish behaviour. Optimal aquaculture techniques for native crayfish captive-breeding were presented and invasive crayfish control methods were discussed, such as the use of barriers, male sterilisation and the efficacy of trapping techniques.

The scientific poster display was very interesting; all of the posters were produced at a high standard, presenting fascinating new and novel research. A diverse spread of

(Continued on page 3)

INTERNATIONAL ASSOCIATION OF ASTACOLOGY

Lennart Edsman, Ph.D.
IAA President *(Sweden)*

President's Corner

Dear Crayfish Enthusiasts,

Summer has passed hopefully with a good field season for most of us. In Europe, heated discussions continued about how to tackle the new EU regulation with signal crayfish classified as invasive and undesirable but present everywhere and in northern Europe the target of a fishery.

In mid-June a video about crayfish by "Coyote Peterson" appeared on YouTube. Coyote is an American wildlife educator mostly known for his wildlife videos. The clip showed Coyote trying to find a rare blue crayfish in West Virginia and finally finding one after turning a great number of stones. The taxonomic status, the name of the species, and its eventual novelty was totally confused in the video, since the recording team never checked back for correct facts. But regardless of this, the video was a great success when it went out. In a few days it had millions of viewers. A "Welcome to IAA" information page was sketched by **Mael Glon**, commented by some colleagues and processed and displayed on the IAA webpage by **Jim Fetzner**. Mael also convinced Coyote to put a link to the IAA webpage in the video. If only a minimal fraction of the millions of viewers went there, got interested, and eventually become members of IAA a lot has been won. In connection to this, the Board had a quick vote and was all in favour of letting anyone having *Crayfish News* for free if interested. A very good initiative for raising interest in crayfish and Astacology. We will see if this boasts the membership figures.

"The IAA cruise 2017" lead by the chief organizer, **Japo Jussila,** took place on a cruise ship on the Baltic Sea between Finland and Sweden in the middle of August. It was very successful both from a scientific and a social perspective and more can be read about the cruise elsewhere in this newsletter.

In Sweden, we actually still have a king and he celebrated his 70 year birthday recently. He is interested in hunting and fishing, so our university, SLU, decided to present him with a late evening trip with our small research vessel performing hydroacoustics on Lake Mälaren, on which our institute is situated. But before the boat trip in September, he was showed around our aquarium house. We had a small chat by the tanks where we have our crayfish. It turned out that he is an amateur crayfish farmer trying to culture our native noble crayfish in ponds by his summer

Figure 2. IAA president discussing crayfish farming with the Swedish king.

(Continued on page 3)

This issue formatted by Thomas Abeel (Belgium).
Edited by James W. Fetzner Jr., IAA Managing Editor.

(Continued from page 2)

mansion. Just shows that crayfish interest includes everyone! He also revealed that his farming efforts have been without much success so far. We are producing a basic manual for extensive culture of noble crayfish at the moment. I promised to send him one as an extra birthday present when it is ready.

In September, we met up with our Norwegian colleague **David Strand** from the Norwegian Veterinary Institute and the research group led by **Trude Vrålstad** there. Together with people from the county administration and the municipality, as well as local fishing right owners, we teamed up on the brink of a River Billan that starts in Norway and runs into Sweden. The noble crayfish is dying from crayfish plague in the lower Swedish parts of the river. The aim was to use filtering and environmental DNA to determine the position of the crayfish plague frontier and to detect the eventual presence of illegally introduced plague carrying signal crayfish. We wanted to find parts of the river that were not yet hit by the plague in order to remove and save noble crayfish for later reintroductions. Our Norwegian friends have shared their knowledge both on field work and the laboratory analyses since we are partners and now the Swedish Veterinary Institute did the analyses. Based on the results a few hundred noble crayfish were caught and transported to quarantine in a crayfish farm. They are still alive and healthy five weeks later so the effort looks like a success.

Finally, 2017 is soon coming to an end. Please do remember to pay the membership fee for next year since this is the only income for IAA. Please also encourage colleagues to become new members. Why not utilize the possibility to pay the IAA membership fee for more than one year. If the funds are available, it is a very good idea for people like me, since you do not have to keep track if you paid or not every year. It also gives more stability to the economy of the IAA. H

All the best until next,

Lennart Edsman

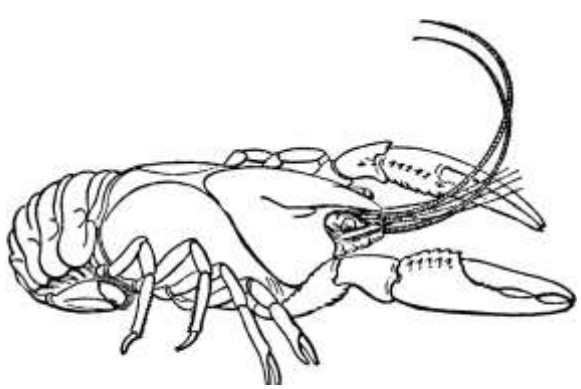

Figure 3. M/s Gabriela: a perfect setting for the European IAA conference

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topics was covered, including microsporidian infections and their potential spread during translocations; crayfish plague and plague resistance within native crayfish populations; diet, trophic level and resource competition between native and invasive crayfish species; terrestrial emigration, behavioural comparisons of natives versus invasive crayfish, and details of a new crayfish research centre in Turkey.

One of the most significant and important outputs from the conference was the resolve to work much more closely as a partnership. This was developed from the workshop sessions with productive dynamic discussions on how to develop solid partnerships working on key priority topics, such as invasive crayfish control methods. With 16 countries represented, this was a very positive step; the European IAA team will develop standardised control methodology and put together a LIFE+ bid to help raise awareness of invasive species. This would be one of the largest crayfish collaborations to date.

The main theme that ran through the conference was the passion, dedication, knowledge, enthusiasm and commitment from an eclectic group of talented crustacean scientists to halt the decline of Europe's native crayfish species. The organisation and hospitality was outstanding, as was the warmth and humour of the countries visited.

My sincere thanks goes to the IAA 2017 Scientific committee, the very humorous, kind and generous Japo Jusilla, our president Lennart Edsman and their dedicated colleagues Kathrin Theissinger, Riho Gross, Ivana Maguire, Javier Dieguéz-Uribeondo, Harri Kokko and Jenny Makkonen. Thank you for all your hard work in making the event so informative and unforgettable and one that marks the beginning of some very productive crayfish collaborations. H

Jen Nightingale
Bristol Zoological Society
University of Bristol, UK.

IAA Related News

Crayfish Meeting Summaries

IAA European regional meeting: The IAA Cruise 2017

The IAA European meeting was held for three days, from 16-18 August, onboard the *m/s Gabriella* travelling between Helsinki (Finland) and Stockholm (Sweden). The meeting was kindly attended by 53 people from 16 nationalities (including Gotland). During the meeting we had 22 talks and familiarised ourselves with 10 posters. In addition to these, we had lively scientific discussions during Thursday's second scientific session on topics related to the control of alien crayfish in Europe, genetic terms to be used for *Aphanomyces astaci* and the prospective future projects to boost both research and networking among European crayfish researchers, stake holders and crayfisheries managers. The scientific program and book of abstracts are both available on the 2017 IAA Cruise website.

According to the delegates attending the 2017 IAA Cruise, the control of alien crayfish requires swift, coordinated and efficient actions. It was suggested that we should draft of code of practice for the control of the alien crayfish, to be introduced to stake holders and crayfisheries managers. The code of practice would include at least the following principles of control, in order of significance: 1) strict control of live alien crayfish sale and marketing, 2) eradication of alien crayfish by the most efficient means, 3) prevention of further spread of the alien crayfish and 4) decreasing population density of existing alien crayfish populations. The control of live alien crayfish transport and sale is fundamental and crucial.

We also discussed a networking project initiative, with a EU funded COST action project suggested. The idea was to further develop the code of practice for alien species control and networking for further development of research projects among European research institutes. The people responsible for the COST action will be Javier Dieguez-Uribeondo (Spain) and Pavel Kozak (Czech Republic).

An awareness raising LIFE+ project was also suggested, with the aim to focus on informing the general public and stake holders on matters related to risks posed by alien crayfish and the possibilities offered by native crayfish. This idea would be largely based on EU Regulation 1143/2014 and the ever increasing need to protect the native European ecosystems including native crayfish. The information campaigning material could be unified throughout Europe, with a national twist added. Japo Jussila (Finland) introduced the topic and will be taking it further.

Figure 4. IAA cruise: group picture in Stockholm

The prices for the best talks went to Jen Nightingale (UK) and Jan Kubec (Czech Republic). Best poster prices went to Italy and were received by Daniela Ghia and Gianluca Fea. All the other presenters also did a fantastic job.

The delegates also had a wonderful walk around Old Town Stockholm guided by IAA President Lennart Edsman. To the amazement of all the participants of the historical walk, there was an exchange of the Swedish King's guards on the arrival to the Swedish King's castle. Surprisingly, the Swedish King was not available to greet us but was probably relaxing in his summer castle on the Island Öland. The Old Town is the point where crayfish plague entered Sweden from Finland 110 years ago, but despite this, the Swedish King is still enjoying his portion of 60 kg of noble crayfish every autumn. On behalf of the IAA Cruise 2017 scientific committee.

Japo Jussila
The University of Eastern Finland
Kuopio, Finland

IAA Cruise 2017 — Conclusions

We, the delegates of the IAA Cruise 2017 (representing 16 nations), have come to the following conclusions:

1. There is a need for a clear code of practice for the control of alien crayfish in Europe, to be used by fisheries administrators, fishing rights owners and other stake holders;
2. The following projects should be initiated:
    a. COST action for general crayfish research related networking, preparing the code of practice about

(Continued on page 5)

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alien crayfish control and planning for further research projects;

b. LIFE+ project on the European level aiming at raising awareness among the general public on the risks of alien crayfish and the benefits of native crayfish;

3. The genetic terms to be used for *Aphanomyces astaci* description (i.e., strain, lineage, haplogroup, haplotype, genotype) should be clarified for a consistent and consequent application;

4. The qPCR detection level A3 or higher should be used to confirm the presence of *Aphanomyces astaci* AND one should always try to sequence the A3 or above sample in order to make sure that *A. astaci* was actually amplified in the qPCR. In the case of donor populations for relocations, qPCR detection level A1/A2 or higher should still be used. H

Short Articles

Crayfish for Sale on Social Media

The excellent article 'Crayfish plague *Aphanomyces astaci* in Japan and the growing threat to Australia by Robert McCormack and Tadashi Kawai (*Crayfish News* 38(4): 5-8) describes an attitude by Australian officials horribly at odds with the country's vaunted preservation of native fauna and flora. I deplore strongly the introduction of alien American crayfish into such an important bioregion for native crayfish diversity.

However, on a smaller scale, something comparable is happening in Ireland, until now the only European country not invaded by alien crayfish. The widespread stocks of white-clawed crayfish across most of the country (protected under the national Wildlife Act 1976) are probably the largest in Europe, as the species is rapidly disappearing from its original range through crayfish plague and competition from alien crayfish (Souty-Grosset et al. 2006; Kouba et al. 2014). Scientists relied on Fisheries Legislation to exclude importation of alien crayfish, although many years ago this was shown to be faulty. The European Habitats and Species Directive 1992 was transposed into Irish law in 1997, but 20 years later it appears that it has still not been fully enacted.

A follow-on EU Regulation EU 1143/2014 deals with the import, breeding, etc., of alien species on the Union List, including four American species of crayfish (marbled, red swamp, virile and signal), a small subset of what is now in the wild in Europe. Some core provisions of this Regulation came into force one year ago, in 2016, but national legislation on penalties to deal with breaches of the regulation is still missing, with officials wringing their hands as further examples of illegal introduction come to light. Two articles by Zen Faulkes (Faulkes 2015, 2017) have highlighted the fact that Irish websites are offering at least four species of exotic crayfish for sale. The publications caused annoyance in official circles, but has led to no legislative action.

To bring the sorry saga up to date, although no alien crayfish have been detected in the wild, this year there have been at least four confirmed outbreaks of crayfish plague in different Irish river systems, including two of the main protected areas (Special Areas of Conservation). The loss of crayfish in these catchments is expected to be near complete, with resultant changes in river ecology. You can read a summary of information available to me on my webpage on ResearchGate, under the project "Progress and implications of crayfish plague in Ireland 2016". H

Julian D. Reynolds

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Information on the Japanese Common Name of the Alien Signal Crayfish, *Pacifastacus leniusculus*

The signal crayfish, *Pacifastacus leniusculus*, is one of the most important freshwater crayfish in terms of fisheries resources (Miller 1960; Miller and Van Hyning 1970), and its commercial trades have been practiced for many years across countries and continents (e.g., Holdich 2001). This has resulted in a rapid spread of this species in southern parts of California, USA, Europe, and the Japanese Archipelago (Abrahamson and Goldman 1970; Azuma et al. 2011; Hiruta 1998; Holdich 1988, 2001; Kawai et al. 2002b, 2004; Riegel 1959; Usio et al. 2016). It has been introduced to more than 20 European countries and Japan (e.g., Holdich et al. 1999; Kawai et al. 2002a), and this activity has negatively impacted the native ecosystem (e.g., Alderman 1996; Alderman and Polglase 1988; Füreder 2015; Holdich 1999; Nakata et al. 2010; Nyström 1999; Unestam 1969).

In Japan, it is common for most organisms to list their Japanese names together with their scientific name. In

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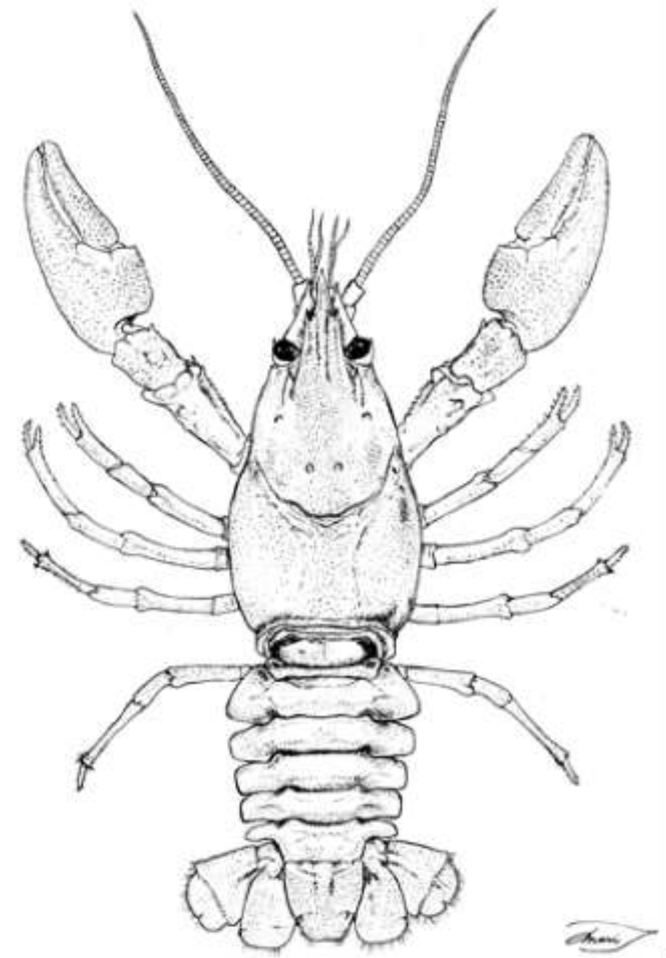

Figure 5. Adult female *Pacifastacus leniusculus* from Japan. The Japanese common name, Uchida Zarigani.

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addition, some animals can also have a local name. This system of using the Japanese name and a local name is often used to the exclusion of the Linnean names (Grygier 1993). In order to prevent possible ambiguity when using this system and to make it easy to incorporate taxonomic knowledge and information on the regional distribution, as well as to assist conservation activities in Japan, both the Japanese common and local names of *P. leniusculus* are given in this report.

One of the most popular Japanese common names for *P. leniusculus* is "Uchida Zarigani". The latter word "Zarigani" literally means "an animal that moves backward" (Ohtsuki 1817) as it has been mentioned in older papers (e.g., Kurimi 1811). Usio et al. (2007) have also suggest another common name, the "signal zarigani".

In the meantime, Randall (1840: 138–139, plate VII) described *Astacus oreganus* on the basis of specimens from the Columbia River, a drainage in the Pacific northwest of the USA, and this name is found in a lot of subsequent taxonomic papers; e.g., De Kay (1844: 23), Erichson (1846: 375), Stimpson (1857: 495), Hagen (1870: 95-96), Lockington (1878: 304), Faxon (1884: 152), Faxon (1885: 133), Underwood (1886: 365), Holmes (1900: 167), and Faxon (1914: 409). Faxon (1884, 1886) mentioned that the type of *Astacus oreganus* from the Columbia River was lost or destroyed while in the hands of the artist by whom the drawing was made, and no specimen answering to the figure or description has since been found. Faxon (1885) further noted that "I incline, nevertheless, to Dr. Hagen's opinion, that this specimen was no other than *A. leniusculus* Dana" (sic). Hobbs (1966: 351–354) submitted a report to the International Commission on Zoological Nomenclature, suggesting that it use its plenary powers to suppress the specific name "oreganus" Randall 1840, as published in the combination *Astacus oreganus* (International Commission on Zoological Nomenclature, 1965). Under a ruling, the members of Commission were invited to vote in 1968, and as a consequence, the specific *oreganus* Randall, 1840, as published in the binomen *Astacus oreganus*, was placed in the official Index of rejected and invalid specific names in zoology with the name number 896 (Melville and China 1968: 84–85). It is interesting that Dr. Uchida, who is a professor of Hokkaido University, Japan, was involved in the committee at that time, and we can see his name in the Japanese common name of the signal crayfish (*Pacifastacus leniusculus*), "Uchida Zarigani" (Tadashi Kawai, personal information).

Pacifastacus leniusculus was introduced into Japan from northwestern North America during a period from 1925 to 1930, and they were released at two sites: Lake Mashu in eastern Hokkaido and Tankai Reservoir in Shiga Prefecture in the central Honshu mainland (Kawai et al. 2002b). Professor S. Miyake of Kyushu University gave the Japanese common name "Uchida Zarigani" for this crayfish released in Lake Mashu, and another "Tankai Zarigani" for that in the Tankai Reservoir (Kawai, 2010). The name "Uchida Zarigani" is a combination of "Uchida", a name associated with a famous Japanese zoological taxonomist, Professor T. Uchida of Hokkaido University who was one of committee members that issued the decision on *Astacus oreganus* Randall 1840 (see above). After that introduction, individuals of *P. leniusculus* in Lake Mashu have been transferred and released in many rivers and lakes, leading to a rapid spread of this species, especially in eastern Hokkaido and northern Japan (Usio et al. 2007, 2016). The Tankai Reservoir population, so far as currently known, has not been a subject of illegal release since it was first introduced (Kawai 2007). *H*

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Wakkanai, Japan

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A Large Scale Construction Project with a Benefit for Native Crayfish

White-clawed crayfish in England

The white-clawed crayfish *Austropotamobius pallipes* is the only native crayfish species in England. The species is under severe threat from a range of anthropogenic factors and from the widespread introduction of crayfish species from North America, especially the signal crayfish *Pacifastacus leniusculus*. Populations of white-clawed crayfish in England have decreased and become fragmented, while established populations of signal crayfish have expanded their range (Holdich et al. 2014). Since the 1990s, conservation efforts for the increasingly threatened white-clawed crayfish have included regulations to limit further introductions of non-native crayfish; encouraging public awareness about the need for biosecurity to prevent crayfish plague and accidental introduction of non-native crayfish; some re-stocking of white-clawed crayfish to replace losses due to crayfish plague, and by starting new 'ark site' populations in isolated sites which are not likely to be invaded by signal crayfish (Peay 2011). Resources for conservation of white-clawed crayfish are limited and are often heavily dependent on volunteer action and charitable funding. In this case study, benefit for white-clawed crayfish was obtained from a major infrastructure project, at minimal additional cost to the project.

Rugeley Flood Alleviation Scheme

The UK government is investing in flood alleviation schemes (FAS) in many areas that have been affected by flooding in recent years (Defra, 2016). One of these schemes is in Rugeley, Staffordshire, where low-lying areas of the town are at risk of flooding from the Rising Brook, a small tributary of the River Trent. To reduce this risk, the Environment Agency (the government agency responsible for implementing flood alleviation measures in England) developed a scheme for a flood storage reservoir adjacent to the watercourse.

During periods of high flow, an inlet from the watercourse will allow the reservoir to fill, while a control structure restricts the maximum flow down the channel. The floodwater in the reservoir will be released slowly back to the watercourse downstream via an outfall culvert. This diversion and storage of floodwater will reduce the peak flow and so reduce the likelihood of flooding occurring in the town. A

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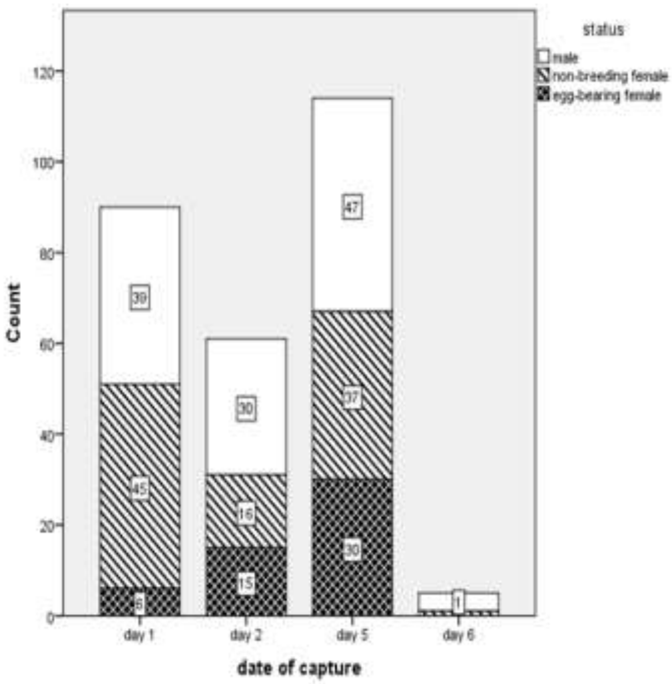

Figure 6. White-clawed crayfish caught at Rising Brook weir, Rugeley during dewatering of channel, y day of capture (days 3 and 4 were non-working days, but most of the flow remained diverted), n=270.

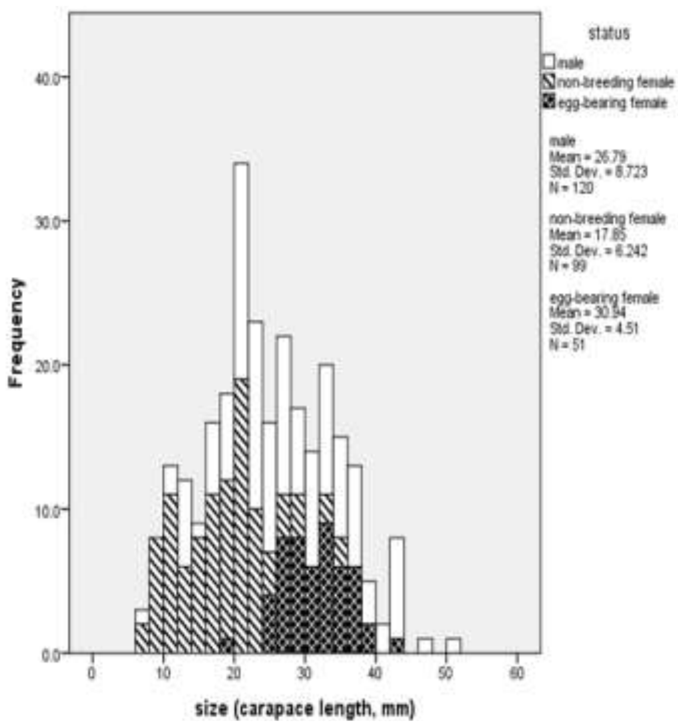

Figure 7. Crayfish size distribution, n=270, subdivided by sex and breeding status (non-breeding and egg-bearing females)

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broad spillway will release excess flood flow if the storage reservoir is full, to avoid the risk of damage to the long, low dam. Outside flood periods the reservoir will dry out and remain as an area of grassland for public amenity. The flood alleviation scheme also includes works on a historic structure adjacent to the impounding dam. A combined weir and footbridge had partly collapsed during a previous major flood and had been shored up with a pile of large boulders until a permanent repair or replacement during the scheme. In addition, the scheme includes work to enhance a section of the Rising Brook that had been straightened in the past, using large branches and tree-trunks to encourage new habitat features to develop, to produce a narrower, sinuous channel with some glides and small pools. This enhancement is intended to contribute to targets under the European Union Water Framework Directive to improve the environment of heavily modified waterbodies.

Rising Brook and white-clawed crayfish

The upper catchment of Rising Brook is in Cannock Chase, an area of heathland, woodland and farmland, which was originally a royal hunting area, but is now mostly a public country park. Before the Industrial Revolution in England, white-clawed crayfish were probably present throughout most of the watercourses in the catchment of the River Trent. However, during the 18th and 19th centuries many watercourses were modified to supply water for industries. Environmental legislation in the late 20th and 21st centuries led to improved water quality in the River Trent catchment, but many channel modifications remain. In the vicinity of the flood alleviation scheme the Rising Brook had been straightened historically, with an on-line mill pond and two weirs, plus a further series of old weirs, ponds and culverts in the stretch down to the River Trent.

A crayfish survey was one of the studies carried out to inform an ecological impact assessment of the flood alleviation scheme (Staffordshire Ecological Services Ltd. 2015). Crayfish survey by manual search of stony substrate and torchlight survey from accessible banks confirmed the presence of white-clawed crayfish in Rising Brook in the vicinity of the scheme. Most potential refuges for crayfish were in undercut banks or structures. The only area with a stony substrate was a broad shallow run downstream of the dilapidated bridge and weir. By contrast the online pond and widened channel upstream of the weir were heavily silted.

The Ark Site Plan

Due to the ongoing losses of white-clawed crayfish populations, the Rising Brook sub-catchment was considered to host one of the largest surviving populations in the Midlands (Mott 2015). Unfortunately, signal crayfish were

(Continued on page 10)

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discovered in an on-line fishing pond in the headwaters of the Rising Brook near Hednesford in 2014 (Mott 2015) and were likely to have been present for several years before detection. Regulations were introduced in England from 1992 onwards to try to prevent further introductions of signal crayfish, but there have been accidental and deliberate introductions at many sites in England since then.

With signal crayfish less than 3 km upstream and with limited scope to prevent their escape from the fishing pond into the watercourse, the white-clawed crayfish in Rising Brook are under threat. Loss of the whole population of white-clawed crayfish could occur at any time if the signal crayfish are carrying crayfish plague, or loss could occur over a longer period of years due to future invasion of the watercourse and competition.

Where authorised works are done in watercourses that support white-clawed crayfish, mitigation measures are used to avoid long term impacts on the population of this protected species (Peay 2003). Consent is required from Natural England, the government agency for biodiversity in England, which regulates activities that affect protected species. AECOM was appointed by the Environment Agency as scheme designer and to advise on and implement mitigation for white-clawed crayfish.

Instead of simply moving crayfish a short distance along the Rising Brook, out of the way of engineering works, AECOM recommended translocating all the white-clawed crayfish displaced by the works to a new, isolated 'ark' site, if one could be found. Fortunately, Staffordshire Wildlife Trust, a nature conservation charity, had already carried out appraisals of several potential sites as future ark sites for white-clawed crayfish. This work was part of a local initiative by the Wildlife Trust, the Environment Agency and other local partners.

One of the sites identified as potentially suitable is within Cannock Chase Country Park and is owned by Staffordshire County Council. It is an old, water-filled stone quarry 1.8 ha in size, fed by a couple of small springs, within an area of woodland and heathland (the location is confidential). The site has fish present, but it is not used for angling. Parts of the bed are sandy, with limited potential refuges for crayfish, but locally steep banks around the margins and submerged woody debris offer potential habitat.

Having obtained agreement for an ark site in principle, AECOM, the Environment Agency, the County Council, Wildlife Trust and Natural England arranged the necessary consents for the disturbance, removal and subsequent stocking with white-clawed crayfish. The Wildlife Trust and Council wildlife rangers prepared a receptor site for white-clawed crayfish in the quarry. A reef of perforated bricks capped with bundles of hazel and birch branches was placed in the pool around a small inflow, to provide abundant initial cover for introduced crayfish. AECOM worked with the Environment Agency and

(Continued on page 11)

Figure 8a. de-watered, section of Rising Brook immediately upstream of weir, the localised area where white-clawed crayfish were found

Figure 8b. de-watered, silted section of Rising Brook up-stream of weir, lacking white-clawed crayfish

Figure 8c. view of dewatered channel downstream from the bridge

Figure 8d. shallow pools where crayfish collected at the foot of boulders supporting the dilapidated bridge

Figure 8e. partially dewatered channel with searchable piles of stones placed for crayfish leaving the dewatered bridge zone (plus one of the bags of collected beer bottles)

Figure 8f. Inaccessible refuges for white-clawed crayfish exposed by removing the supporting boulders at the dilapidated bridge. The area was not safe for working, but as the area drained, crayfish moved down to areas where they were caught and translocated to the 'ark site'

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contractors to integrate the works for crayfish into the project programme.

Action in the Rising Brook

The mitigation plan for the flood alleviation scheme was to divert the flow of Rising Brook around each of the two sites of construction work consecutively, de-water the channel at each site and remove the crayfish.

On the Rising Brook at the upstream site for the inlet for the flood storage area, (Ordnance Survey grid reference SK037178) de-watering a silty 8 m long by 2 m wide section of channel upstream of the on-line pond did not yield any crayfish. At the downstream site (Ordnance Survey grid reference SK 040180) the flow was diverted around the area of works on 2nd March 2017 (day 1). The area above the weir and bridge, (approximately 15 m long, 3-4 m wide) drained quickly, which exposed extensive silty mud, much of it too soft for safe access. Approximately 40 crayfish found, but only in a narrow band (c. 3 m^2) along an old wall immediately upstream of old stop-logs in the weir, where flow kept the sand, gravel and concrete largely free of silt. Crayfish were found emerging from cracks in the previously submerged brickwork and by manual search of rubble, woody debris and litter. Another 50 crayfish were found in a manual search of approximately 50 m of channel downstream of the weir and boulders, mostly in or close to a bridge abutment with an un-mortared stone wall. The few fish present in the channel were caught by hand-net and moved upstream of the dewatered area. Inflow from a field drain meant the area downstream of the weir and bridge was not completely dried. With flow diverted, water slowly drained away from the weir, bridge and the supporting boulders.

By the second day, more crayfish had crept out from the bridge area and were found in a shallow pool at the foot of the boulders and in piles of previously searched stones left in the lower channel to provide easily searchable refuges for crayfish moving out of the drying area of the weir, bridge and boulders. During the weekend, when there was no work on site, the upper section and weir and bridge area continued to drain, while the lower section of the channel remained flooded. The lower section was re-drained on 6th March (day 5), by use of pumps at the downstream end of the section. More crayfish had moved out of the inaccessible weir and boulder area into the small piles of stones. Other crayfish were exposed later, in puddles on the bed, when the large boulders were moved individually using a hydraulic grab. This exposed a large quantity of urban rubbish (in addition to the three 1m^2 sacks of drinks cans and bottles already collected from the 50 m lower section).

A final pump-down on 7th March (day 6) and search of the lower section caught only a few juvenile crayfish, indicating removal was as complete as practicable. Egg-bearing females

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Figure 8g. white-clawed crayfish being introduced to ark site in a long-disused stone quarry

(Continued from page 11)

represented 12% of the catch of females on the first day, but 45% and 48% on days 2 and 5 respectively (Figure 6), which suggests egg-bearing females were more reluctant to emerge by day, or that they waited until conditions in exposed refuges became drier. The size distribution (Figure 7) shows a strong modal peak at 21 mm CL (carapace length). The median size for egg-bearing females was 31 mm CL, although a single 19 mm CL individual carried approximately 30 eggs, which is unusually small for a breeding female in England. Works on site are illustrated in Figure 8.

Crayfish were held in wetted tanks with abundant leaf litter, cooled by stream flow, until the working area had been searched, after which they were moved each day to the receptor (ark) site and released. Those showing visible signs of porcelain disease (thelohaniasis) were not translocated, but were released upstream of works. The founder stock obtained from the scheme was 259 (from a total catch of 270) including 51 egg-bearing females, which carried an estimated 1800 eggs. An additional stock of 127 white-clawed crayfish (including females with attached late-stage juveniles) was obtained by a team of volunteers from a nearby tributary of the Rising Brook in June 2017 (with support from the landowner, Forestry Commission England) and another stocking is planned in 2018 to help the population through the establishment phase in the ark site.

Conclusions

This case-study shows the benefits of catchment-scale planning for conservation of white-clawed crayfish (Peay et al. 2011). There would not have been time to carry out a catchment-scale search for potential ark sites during the Rugeley scheme, nor could screening for sites have been included as part of the funded flood alleviation scheme. Nonetheless, the previous appraisal of potential ark sites gave a short-list of options. In response to the opportunity offered by the scheme, an option was brought forward that could be made ready quickly and cheaply, with the cooperation of the landowner and other stakeholders - within the timescale needed for the scheme. At the donor site, the use of dewatering provided donor stock more easily than would be the case with manual searching alone. Manual survey in Rising Brook prior to works yielded two crayfish in 1 hr 25 minutes searching (three surveyors), whereas similar effort in the same stretch after the channel was de-watered yielded 90 crayfish, most of which were caught in the first 1 to 2 hours.

It is difficult to make comparisons between sites during mitigation works, because sites vary in the proportion of the population in refuges in the channel that are suitable for manual search and those that are inaccessible the banks or channel. In practice, it is usually difficult to tally the numbers of crayfish that emerge from refuges, compared to those found by manual search of exposed areas, which tends to be started soon after exposure. Making the mitigation as efficient as practicable helps to minimise the time required during the construction work and its associated costs.

The work in this case confirms that variations in habitat within the channel can lead to highly patchy distribution of crayfish, with more than 90% found in about 10% of the channel. The best areas for crayfish were as predicted from prior habitat appraisal, although the yield was higher than expected. This shows the importance of careful appraisal of habitat both during surveys and when planning the details of works. If it had not been necessary to deal with the collapsed bridge, the works for the reservoir dam and its outfall could have been carried out in two subsections of the channel, avoiding nearly all the crayfish habitat.

It is generally assumed to be better to remove white-clawed crayfish out of the way of construction works during the summer, on the assumption that crayfish will leave their

Figure 9. Site manager with a crayfish.

(Continued on page 13)

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refuges more readily during warm conditions. In this case, however, works in winter were driven in large part by the overall programme for the scheme, but the greatest benefit of this was the yield of egg-bearing females for the ark site, with young-of-year expected to hatch there in late June 2017. Delaying construction by about four months would have set back the first brood in the ark site to summer 2018. Furthermore, previous studies (e.g., Holdich et al. 2006,) indicate that the efficiency of manual removal of young-of-year is lower than for larger size classes, whether dewatering is used or not, as young-of-year would be expected to be the most abundant size class in summer, but this is not usually reflected in the catches. There are potential benefits for the efficiency of mitigating the loss of individual crayfish during works if the young-of-year can be translocated as attached eggs rather than waiting until after release of young during the summer. In most infra-structure projects the programming of works will be determined by a range of other constraints, environmental, operational, regulatory and contractual.

This case confirms that it is not necessary to limit mitigation for white-clawed crayfish to the usual survey season (July to early September in most of England). Nonetheless, areas containing white-clawed crayfish should not be left de-watered overnight if frost is expected, as this could be fatal for exposed crayfish. At least one night will be needed to allow crayfish to emerge from refuges that are inaccessible, preferably two or three nights, although this period may be shortened if the works incorporate careful destructive search of the all the potentially occupied refuges that will be lost due to construction works. In the case at Rugeley, it is likely that most of the catch obtained on day 5 could have been obtained on day 2 or 3, if materials and equipment had been available and there had not been the interruption of a weekend. Even so, the works with crayfish did not delay the project overall.

After the works involving crayfish a dilemma arose regarding the European Union Water Framework Directive and modified watercourses. This was whether to incorporate a structure to allow passage of eels (*Anguilla anguilla*) through the replacement structure at the old weir and bridge. If Rising Brook had already been invaded by the signal crayfish, works to allow the passage of eels would not exacerbate the situation (although other structures downstream would also need modifications for eels to benefit). If the white-clawed crayfish population was relatively secure in Rising Brook, i.e., it was an existing ark site, the likely priority for nature conservation would be to protect the population of the endangered species by maintaining a physical barrier to upstream invasion of signal crayfish from the River Trent. With an interim situation, stakeholder views differed, but the Environment Agency opted for an eel pass in support of objectives under the Water Framework Directive. It is hoped that future surveys at the new ark site will confirm the legacy of the Rugeley flood alleviation scheme for white-clawed crayfish. The population in Rising Brook could be used as a source of donor stock for other ark sites - while there is still time. During low flows in late summer a small pump or two would probably be sufficient to partly de-water a short section of channel for a couple of hours and hence access crayfish without a constructed dam or flume, with relatively little impact on other fauna.

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Further information

A 2015 booklet which describes headwater ark site work at Cannock Chase can be downloaded from Staffordshire Wildlife Trust's website: Native Crayfish & Small Streams - www.staffs-wildlife.org.uk.

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(Continued on page 15)

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Meeting Announcements

The IAA22 Organizing Committee, on behalf of the International Association of Astacology, invites you to attend its 22nd International Crayfish Symposium, which will be held in Pittsburgh, PA, USA. The event will be hosted by the **Carnegie Museum of Natural History** and will commence with a crayfish identification workshop on the Sunday afternoon before the meeting (July 8), followed by 4 days of talks/posters, a 1-day field trip (mid-week), and will wrap up with a 2-day post-conference tour (limited availability). Details on the submission of abstracts, meeting program schedule, and registration fees will appear on the IAA website as the meeting approaches.

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(Continued on page 15)