

## Editorial

## Keep beating the drum: ICAIS confirms aquatic invasive species are of continuing concern

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The 18th International Conference on Aquatic Invasive Species (ICAIS) was held in Niagara Falls, Ontario, Canada, April 21–25, 2013 and hosted by the Invasive Species Forum, Canada (<http://www.invasivespeciescentre.ca>). This conference series is widely recognised as the most comprehensive international forum on aquatic invasive species and continues to evolve to address new and emerging issues. In recent years the conference has typically involved over 400 participants from over 30 countries, representing academia, industry, government agencies, NGOs and other stakeholders involved in the issues (<http://www.icaiss.org>).

Regional Euro-Regional Biological Invasions Centre (REABIC, <http://www.reabic.net>) has produced two special editions for the 18th International Conference on Aquatic Invasive Species. This edition of *Aquatic Invasions* contains eleven research papers. Its sister journal, *Management of Biological Invasions* (MBI), has published another twelve papers, more closely linked to the management of aquatic invasive species (reviewed in MacNeil and Campbell 2014).

The 18<sup>th</sup> conference covered a broad range of sessions on issues including early detection, case studies and monitoring of aquatic invasive species, shipping pathways, risk assessment, live bait pathways, control of aquatic invasive species, outreach and policy. Dreissenids appropriately dominated the sessions; this was not always the case at ICAIS, because although the conference series was originally set-up for the presentation of zebra mussel research in 1995, the development of invasion science over a short-period (see Richardson and Ricciardi 2013) resulted in the

evolution of research outputs on numerous other invasive species over the span of 18 conferences (Lucy and Muckle-Jeffs 2010). The resurgence of the focus on *Dreissena* developed in parallel with the introduction of zebra mussel, *Dreissena polymorpha* (Pallas, 1771) and quagga mussel, *D. rostriformis bugensis* (Andrusov, 1897) in the western United States and with the recent spread of quagga mussel in Western Europe (reviewed in Karatayev et al. 2014; bij de Vaate et al. 2014). Both *Dreissena* species are among the most aggressive freshwater invaders in the northern hemisphere, causing serious ecological and economic impacts (reviewed in Nalepa and Schloesser 2014; Karatayev et al. 2002). The 2013 Niagara ICAIS conference included varied dreissenid presentations on: *Dreissena* impacts on unionidae in North America and Europe (Lucy et al. 2014); modelling the occurrence of zebra mussel parasites in both France and the USA; the invasion and rapid range expansion of quagga mussel in Western Europe; analysis of impacts of zebra mussel invasions on Canadian lake fisheries (Nienhuis et al. 2014). This special edition includes a paper on the mass mortality of invasive zebra and quagga mussels by desiccation during severe winter conditions (Leuven et al. 2014). This novel research was carried out within impounded sections of the rivers Rhine and Meuse and indicates that sudden water level drawdowns during severe cold winter conditions could be used as a tool for temporary reduction of invasive mollusc density in impounded river sections. In this case, this involved examination of mortalities, increase in density and changes in size distribution over time within the impacted

population. Dreissenid population studies have a long established scientific track (reviewed in Nalepa and Schloesser 2014). Leuven et al. 2014 illustrate how this bank of prior research knowledge is a gold standard when testing new hypotheses. In fact, the MBI ICAIS edition also demonstrates this point in papers by Meehan et al. (2014), on testing the efficacy of the *Dreissena* control product Zequanox™ and by Prescott et al. (2014) on the use of the calcite saturation index as an indicator of environmental suitability for dreissenid mussels. The research undertaken is dependent on long-established literature about the life cycle, ecology and impacts of zebra and quagga mussels. Much of this research was presented during the history of the ICAIS conference series.

The ICAIS conference included presentations on other freshwater invasive molluscs including a session on *Corbicula fluminea* (Müller, 1774) Asian clam and four papers on *Limnoperna fortunei* (Dunker, 1857) golden snail. This special edition includes a paper on modelling the potential distribution of the native Chinese *L. fortunei* on a global scale (Campos et al. 2014). *Limnoperna* was discovered in Argentina in 1991 and has since extended its distribution over the South American continent. The Brazilian based authors of this paper have used four different algorithms to assess potential global distribution of this high impact invader. All the models predicted the invasion of the Southeast part of the USA. The paper indicates that *L. fortunei* has been indicated in the literature as an invasive species, more aggressive than *D. polymorpha* and could occupy southern regions of North America (Karatayev et al. 2007) not invaded by dreissenids.

Rewicz et al. (2014) profile the killer shrimp, *Dikerogammarus villosus* (Sowinsky, 1894) as the 'perfect invader', complimenting a paper by MacNeil (2014) on invasive amphipods in the special ICAIS issue of MBI.

Invasive fish presentations from North American scientist were very much focussed on Asian carps, in particular bighead carp *Hypophthalmichthys nobilis* Richardson, 1845 and silver carp, *H. molitrix* Valenciennes. These two species have been introduced intentionally and unintentionally throughout the world mostly for aquaculture purposes (Kolar et al. 2007). Bighead carp have invaded 74 countries and are reproducing in 19 and silver carp have invaded 88 countries and are reproducing in 23 (Kolar et al. 2007). Both species

are currently reproducing in the USA (Deters et al. 2003), are a major component of the Mississippi River basin and are considered to be at high risk of invading the Laurentian Great Lakes with significant ecological and economic consequences (Kolar et al. 2005; Cudmore and Mandrak 2011). In this edition, Hayer et al. (2014) present a paper on the population characteristics of bighead and silver carp on the north-western front of their North American invasion. This study examines both bighead carp and silver carp in three Missouri River tributaries over a four year period at the beginning of their invasion there. This study by Hayer et al. 2014 is an important contribution to Asian carp ecology in North American water, including basic spatial and temporal trends in population characteristics and impacts on native fish in a prairie stream ecosystem. Environmental DNA surveillance and more conventional electrofishing have been employed as an early warning/rapid response system for detecting Asian Carps in the Great Lakes and the MBI ICAIS edition includes a proactive Canadian research programme in the Ontario waters of Lake Erie (Wilson et al. 2014).

In Europe, meanwhile, there is heightened concern over the range expansion of Ponto-Caspian fish species, particularly round goby (*Neogobius melanostomus*) (Pallas, 1814) and tubenose goby (*Proterorhinus semilunaris*) (Heckel, 1937), which are rapidly expanding throughout Europe (Copp et al. 2005). Instead of concluding that the pathway to Belgium was simply via shipping or natural migration from interconnected European waterways, Mombaerts et al. (2014) initiated phylogeographical and parasitological studies on both species to gain insight into the introduction pathways and also to identify potential source populations. They concluded that the round goby was probably introduced via ballast water, whereas the tubenose has spread via natural active migration from Eastern to Western Europe through the southern corridor (Bij de Vaate et al. 2002). The contrasting results highlight the need for us not to make blanket assumptions about pathways of introduction. In fact such case studies must be researched and adequately funded, in order to steer invasive species management and policy on a national and European level.

In another European contribution to ICAIS fish papers, Van Kleef and Jongejans (2014) identify drivers of pumpkinseed, *Lepomis gibbosus* (Linnaeus, 1758) invasiveness using population models.

Goldsmith et al. (2014) presented at ICAIS on establishing a baseline for early detection of non-indigenous species in ports of the Canadian Arctic where changes are occurring in the macroinvertebrate fauna. There is a risk of exotic species introductions there in the near future due to a combination of global warming, resource exploitation and the resulting increase in Arctic shipping activity.

Impacts of aquatic invasive plant species on native macrophyte biodiversity were highlighted at ICAIS and are presented here in two geographically divergent studies. Chatterjee and Dewanji's (2014) study is on the effect of varying *Alternanthera philoxeroides*, alligator weed cover on the macrophyte species diversity of pond ecosystems in India. In a Belgian study, Stiers et al. (2014) examine how the invasive aquatic plant *Ludwigia grandiflora*, water primrose affects pollinator visitants to a native plant at high abundances. In addition, the MBI ICAIS edition includes a risk assessment paper by Champion et al. (2014) on a proactive management strategy for aquatic weeds in New Zealand.

The involvement of stakeholders in invasive species management has evolved internationally, particularly since the start of this century. The developments of voluntary codes of conduct are seen as important policy instruments in the management and control of aquatic invasive species. In this edition, Verbrugge et al. (2014) evaluate stakeholder awareness and involvement in risk prevention of aquatic invasive plant species by a Netherland's national code of conduct. This voluntary agreement between the government and horticulture sector has the objective to ban the sale of invasive species and to increase public awareness and stakeholder involvement in measures to prevent new introductions of potential invaders. The results indicate that while stakeholder compliance to species bans showed 'promising results', there were issues with correct labelling of species. This paper shows that for codes of conduct, stakeholder involvement, at every stage and process, needs to be ring-fenced by robust science inputs and that scientific post-evaluation of code effectiveness is vital for the process to be dynamic and targeted in its use.

Public awareness and media attention on the global spread of infectious diseases is heightening in recent years. An innovative ICAIS keynote presentation given by Conn (2014) is presented in this special edition. 'Aquatic invasive species

and emerging infectious disease threats: A One Health perspective', is a critical perspective paper that briefly reviews selected previous cases in which aquatic invasive species have contributed to infectious disease emergence, re-emergence, or increase, and proposes One Health strategies for integrating human, animal, and environmental monitoring and surveillance, to better prepare for or prevent geographic spread of major human health threats associated with aquatic systems.

While some of the papers (Conn 2014 and Campos et al. 2014) in this ICAIS are written at a truly global level, there is little doubt that national case studies, monitoring programmes, risk assessments, codes of practice and other policies and management practices presented at ICAIS, are appropriate in an international context. Many ICAIS attendees are seeking opportunities for international cooperation and collaboration to address aquatic invasive species issues from a global perspective and this has always been one of the central tenets of the conference series. Indeed international networking on invasive species has ramped up in the last two years, with for example the development of the Alien Challenge EU COST Action (<http://www.brc.ac.uk/alien-challenge>) and the 2013 international Freshwater Invasive Networking Strategy conference (Caffrey et al. 2014).

It is of real concern that the ecological and economic importance of invasive species can be undermined, both by quasi-scientific approaches and due to current international recessionary budgetary constraints. The opening keynote speaker at ICAIS, Dr. A. Ricciardi, responded to this in a presentation entitled, 'Why invasions matter: a response to recent criticisms of invasion biology' (see Richardson and Ricciardi 2013). Unfortunately, a number of high profile North American scientists and regular ICAIS attendees could not attend the Niagara conference, as they received notification of budget cuts from their various environmental organisations' employers, within days of the 2013 conference date. In Europe, the new EU Regulation on Invasive Species (European Commission 2013) will advocate targeting of national resources for invasive species management and scientists are cautiously optimistic about future prioritised funding. Of course in order to increase the level of awareness, it is up to all of us to keep aquatic invasive species issues at the frontline of our own organisations and to keep beating the drum!

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