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Proceedings of the 9th International Conference on Marine Bioinvasions (19–21 January 2016, Sydney, Australia)

Editorial

Keeping up with marine bioinvasions: Building bridges, crossing borders and moving forward at the International Conference on Marine Bioinvasions

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The National Conference on Marine Bioinvasions held on January 24–27, 1999 at the Massachusetts Institute of Technology, Cambridge, MA, USA, was the first of what we refer to today as the International Conference on Marine Bioinvasions (ICMB). It followed meetings, such as the "Zebra Mussel" conferences and the then separate "Aquatic Invasive Species" conferences (later combined into ICAIS, the International Conference on Aquatic Invasive Species), which were prompted by the invasion of the zebra mussel *Dreissena polymorpha* Pallas, 1771 into the Great Lakes in the 1980s. The ecological and economic impacts of the zebra mussels (followed by quagga mussels, *Dreissena bugensis* Andrusov, 1897) invasions had fuelled general public and political awareness in the U.S. and Canada on aquatic non-indigenous species, leading to funding for research and management. These meetings however, were focused on non-indigenous freshwater ("aquatic") species, and it was felt that it was time for a focused convocation on invasions in the marine environment.

Scientists were aware that non-indigenous species had long been altering the structure and function of many marine communities. Discussions and efforts to tackle marine bioinvasions were being fuelled across the world (Minchin 1996; Reise et al. 1998; Hewitt et al. 1999; Sliwa et al. 2009). New invasions were appearing on a steady basis: in January 1998 it was reported that an average of one new species had invaded San Francisco Bay, California, every 14 weeks between 1961 to 1995 (Cohen and Carlton 1998). With funding from the National Sea Grant Program, it was possible to pursue several initiatives to expand awareness of marine non-native species. Discussions and planning for an ICMB-I had begun in the summer and fall of 1997, and a steering committee was formed in February 1998. New USA non-indigenous species legislation was passed in 1990, in response to the introduction of zebra mussels in ballast water. This legislation was revised in 1996 and increased interest and urgency for a dedicated marine bioinvasions conference. At the time ICMB-I was convened, the field of marine bioinvasions had grown from a handful of experts just two decades earlier, to over 200 international and national researchers, managers, and others sharing insights on a recognised and growing worldwide issue (Pederson 1999). The work presented at ICMB-I fell under the three main topics: patterns of invasions, ecological and evolutionary consequences, and ballast water management. Four presentations addressed outreach and education.

The biannual conferences continued, with ICMB-II (2001, New Orleans, USA) and ICMB-III (2003, La Jolla, USA) growing in national and international participation and attention (Pederson 2003, 2005).

In 2005, ICMB-IV was held for the first time outside of the USA, across the globe to the Southern Hemisphere in Wellington, New Zealand. The ICMB then returned to the USA: Cambridge (2007) (Pederson and Blakeslee 2008) and Portland (2009). The last three conferences were held in Barcelona, Spain (2011), Vancouver, Canada (2013), and Sydney, Australia (2016).

ICMB grew in participant numbers but, most importantly, it grew in the diversity of supporting and participating countries, institutions and topics at the forefront of ecological research, education, management and policies tackling marine bioinvasions. The growth trend in global trade and anthropogenic activities has long been recognized as being related to the increase in transport and introduction of species around the globe (Elton 1958; di Castri 1989; Campbell and Hewitt 1999; Bax et al. 2003; Hewitt et al. 2004; Gollasch 2006; Minchin 2007; Occhipinti-Ambrogi 2007; Carlton 2011). In order to best utilise the limited available public funds to meet the scale of marine bioinvasions, environmental scientists, biosecurity managers and politicians are strategically investing energy and resources in prevention, prioritization, innovation and efficiencies (Darling 2015; Ojaveer et al. 2015; Seebens et al. 2017). Concurrently, the research community is critically advancing our understanding of the scale of invasions; the ecological, environmental, social, cultural, and evolutionary impacts of these invasions; creating tools to assess and statistically analyse impact; and developing innovative techniques to control and eradicate pest species. Collaboration is essential in achieving these goals (Lucy et al. 2016).

This editorial introduces the Proceedings of the 9th International Conference on Marine Bioinvasions that took place in January 2016, in Sydney, Australia. The 12 papers included in this special issue are a sample of the management focussed research presented within the four main themes and ten special sessions that occurred at ICMB-IX. The talks presented covered topics as diverse as non-indigenous species biology, ecology, incursions and impacts; native and non-indigenous species interactions and community ecology; inter regional and international species spread; challenges, governance and regulation in a connected world; and the trans-oceanic dispersal of species by the Japanese Tsunami Marine Debris (http://www.marinebioinvasions.info/previous-conferences). The 9th International Conference on Marine Bioinvasions proceedings starts with a timely reminder from Galil et al. (2017) that emphasises the constant challenges ahead within our discipline. Galil and colleagues (2017) raise awareness of the problems associated with the successive enlargement of the Suez Canal, despite scientific evidence on the impacts of the many hundreds of species that have invaded the Mediterranean, and the international treaties to protect the Mediterranean Sea. An important message from Galil et al. (2017) is that despite bioinvasion research, awareness often remains poor (or is ignored), and environmental treaties are often disregarded when political expediencies take priority to bioinvasion considerations.

Creed and colleagues (2017) present compelling evidence that it is important that research is topical and engaging, and is coupled with outreach and education, with management efforts to maximise efficiencies and outcomes. Their work presents an overview of ten years of the Sun-Coral Project (in Brazil) that was aimed at mitigating the impact of two invasive coral species introduced to coastal ecosystems in Brazil in the 1980s. Altvater and colleagues (2017) present further research on the sun-coral invasions in Brazil, evaluating the effectiveness of sodium hypochlorite as a control method for *Tubastraea coccinea* Lesson, 1829.

The utility of several existing control methods on notorious invasive species are also evaluated in the papers by Marks et al. (2017), Davidson et al. (2017) and Duncombe and Therriault (2017). These papers investigate the assessment of manual removal versus using a suction device for removal of the invasive seaweed *Sargassum horneri* (Turner) C. Agardh, 1820, from rocky reefs in southern California (Marks et al. 2017); present a cost-benefit analysis of treatment regimes for the removal of the tunicate *Ciona intestinalis* Linnaeus, 1767 fouling mussel farms in the Prince Edward Island province of Canada (Davidson et al. 2017); and evaluate four years of trapping of the green crab, *Carcinus maenas* Linnaeus, 1758 on the west coast of Canada (Duncombe and Therriault 2017). Best et al. (2017) provides further insight on the biology and management of *C. maenas* in Canada, by investigating the reproductive strategies of an invasive population of this species in Placentia Bay, Newfoundland.

New management platforms such as the Canadian Marine Invasive Screening Tool (CMIST) are presented and its efficacy evaluated in Drolet et al. (2017). CMIST is a decision-making tool to optimize screening-level risk assessment (SLRA) for non-indigenous species. The findings presented by Drolet et al. (2017) contribute towards improving the accuracy of risk models. Together, these papers illustrate how analysis and evaluations are an important part of moving forward, as they allow us to reflect and enhance capacity worldwide. Equally relevant is the ability to bridge areas of expertise and innovation, to keep abreast of trans-disciplinary innovations, that can be used in bioinvasions management.

Pande et al. (2017) demonstrate how the Analytical Hierarchy Process (Saaty 2008) can aid in decision making, using surveillance for the non-indigenous species *Sabella spallanzanii* (Gmelin, 1791) as a case study in New Zealand. Pande and colleagues (2017) demonstrate how the combination of hydrodynamic modelling and elicitation of expert knowledge can assist in the allocation of surveillance effort aimed at the detection of marine pests. Dafforn (2017) provides a review on the management and application of marine bioinvasion ecological theory within an eco-engineering context. Dafforn's (2017) viewpoint article highlights how future planning and design of marine infrastructure can be bought to bear to reduce the establishment of non-indigenous species. The combination of "green-engineering" and biosecurity management can be used to create effective barriers to invasive species. Dias and colleagues (2017) report on the establishment of a reference collection for the identification of species listed of concern and regulated in Western Australia. Such work aims to support the identification of pest species not only using taxonomic methods and DNA barcoding, but also sets the foundation for the development of environmental DNA (eDNA) detection methods for marine pests in Western Australia.

For marine bioinvasion response and management to be effective, it requires that knowledge is shared and countries are upskilled. Developed nations such as the USA, Canada, New Zealand, Australia, and European countries have in the past three decades been the main contributors to marine bioinvasions conferences. Marine bioinvasions research is not limited to these countries. Marine bioinvasions research however, often involve species from regions such as South East Asia, the Caribbean or South America: locations where an understanding of the scale and impact of bioinvasions is not well studied. In the hyperconnected world that we live in, these regions are also the recipients of non-indigenous marine species as evidenced by the research presented by Huhn and colleagues (2017). Huhn et al. (2017) examined how vessel voyages have the ability to stress biofouling species (specifically, *Perna viridis* (Linnaeus, 1758)) and as such, act as potential non-indigenous marine species "arrival" filters. Huhn et al.'s (2017) findings are used to infer how stressors may influence the movement of species within Indonesian bioregions and between neighbouring countries, such as Indonesia and Australia.

The 9th International Conference on Marine Bioinvasions that occurred in Australia included researchers and colleagues from countries such as Bangladesh, Sri Lanka and Indonesia. The success of ICMB-IX would not have been possible without the work and dedication of the local organization in Sydney and supporting committee members from Australia, New Zealand and beyond. The tenth anniversary ICMB will be hosted for the first time in South America, in Puerto Madryn, Argentina, in October 2018 (http://www.marinebioinvasions.info). It is exciting to see the ICMB continue to cross borders, providing opportunities for researchers from various corners of the world to dock at a new harbour, share their experiences, learn and sail forward, full steam ahead! We look forward to seeing you all in Puerto Madryn in 2018.

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