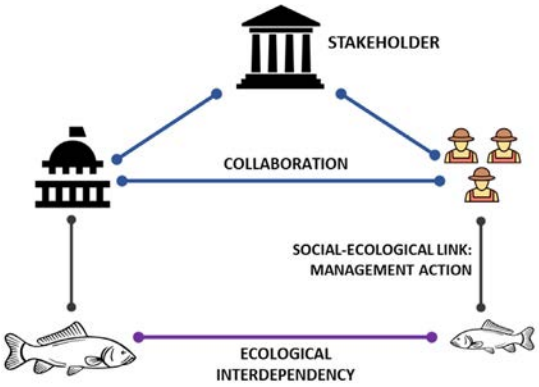
How an ecosystem approach can accelerate socio-ecological systems mapping and management of aquatic invasive species in the Great Lakes

Successful invasive species management depends on far more than the biological conditions of a given system. It also depends on human interactions with the ecosystem, and coordination and cooperation among interdependent stakeholders (Lubell et al. 2017, Bodin 2017). To fully understand the complexity of aquatic invasive species (AIS) management, we must consider all the interconnected elements, both ecological and social. This is where the idea of social-ecological systems (SES) comes into play and exemplifies an ecosystem approach. The SES framework attempts to address the complex interdependent relationships between humans and the natural environment, supporting a systems perspective in which the relationships between multiple social and ecological components are at the center (Sternlieb et al. 2013).

In AIS governance, management actions taken by myriad actors (governments, NGOs, researchers, corporations, etc.) create mutual interdependence, where actions and outcomes in one component of the SES can lead to outcomes in another (either intentionally or unintentionally) (Bodin et al. 2019). Our project focuses on AIS governance in the Great Lakes, understood as an SES. We seek to understand the patterns of social interdependencies between actors, and how well they reflect the existing interdependencies in the ecosystem. For example, if two actors are managing two interconnected elements of the ecosystem (such as one species that preys on another), we would expect that these actors collaborate in some form to "internalize" or reflect the existing ecological interdependence (see illustration).



To "reconstruct" the social and ecological subsystems, we rely on existing food web models to understand the ecological components, and on stakeholder surveys to understand the social system. We are currently analyzing survey data and will present our initial results at the 2022 ICAIS Conference in April. This project has the potential to shape our understanding of complex freshwater governance systems as well as meaningful implications for the development of a cohesive management approach for AIS in the Great Lakes.

By Federico Holm, University of Michigan, Ramiro Berardo, The Ohio State University, and Steven Alexander, University of Waterloo.

Participatory, holistic management of great lakes: Experiences from Lake Vättern, Sweden

Participatory, holistic management of ecosystems and water resources has been practiced in traditional cultures for millennia. The need to balance exploitation with nature's resilience and biodiversity is often more imminent in such cultures, since livelihoods are closely connected to nature there.

New inventions during the Industrial Revolution made life easier in many other societies. More efficient production could feed more people and provide more jobs. Concurrently, industrialization, urbanization, and changes in land use put increasing anthropogenic pressure on ecosystems, often leading to undesired ecological states. Environmental management gradually became more centralized, with the aim to focus protective action first where it is best needed.

During the past few decades, however, there has been an increasing scientific, management and policy interest in what is called the *ecosystem approach*, or, when applied to fisheries, *ecosystem-based fisheries management*. In a nutshell, it's about managing ecosystems and resources in a more participatory and holistic manner while using new, low-impact techniques.



Studying Arctic char migration in Lake Vättern. Photo courtesy of the County Administrative Board Jönköping.

In 2019–2021, our research team investigated the way the management of Lake Vättern, Sweden, works in relation to ecosystem-based fisheries management. Management tends to work with the whole lake ecosystem in focus and involves stakeholders quite extensively. Some notable progress has been made; eutrophication has been reversed and the iconic fish species Arctic char has been brought to a more sustainable population level. However, there are many remaining challenges to management, such as climate change, pollution, and invasive species. Participatory structures have been in place for many decades, which we saw as instrumental for this type of management. If other great lakes are to be managed in similar participatory, holistic ways, Lake Vättern is definitely an example worth learning from.

By Andreas C. Bryhn, associate professor at the Swedish University of Agricultural Science.