Fighting the invasion

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Fighting the Invasion

Today, invasive species are one of the most serious threats to aquatic ecosystems worldwide. ECO speaks with Kim Lundgreen, Ph.D. Student at the University of Southern Denmark, as he reveals the extent of this international problem as well as the steps being taken to reduce the spread and restore the balance in favor of native communities.

ECO: The spread of aquatic invasive species is a well-known issue impacting coastal ecosystems around the world. But how serious is the problem?

I would say it is very serious, and I don’t think many people are truly aware of the extent of the problem, or the huge economic costs when combining both aquatic and land-based invasive species. It was estimated some years ago, that the negative impact of all invasive species put together was equivalent to five percent of the annual world economy – something in the order of $1,400,000,000,000. This is a number that is hard to grasp; even if the costs are overestimated and it is perhaps half this value, it is still an astonishing number.

Todays’ economic burden of land-based invasive species is estimated to be much higher than for aquatic but the continuous introduction of new invasive species in aquatic environments means this will likely increase. A 2012 report from the United Nations Environment Programme estimated annual global costs to be in the order of $100 billion for controlling and preventing the spread of aquatic invasive species. I find this number to be frighteningly high.

I don’t think people had foreseen that “just” moving some organisms around a bit would have such severe consequences, not only economically but also regarding harmful effects on ecosystems and human health.

ECO: What are the main ways organisms are being transported?

Organisms can be transported via hull fouling, where they attach themselves on the outside of the ship’s hull, but the major transport occurs in the ships’ ballast water. Not many people know what ballast water actually is or what it’s used for, and that it is the most important player in the spreading of aquatic invasive species.

Ballast water is a necessity for all large ships for safety and economic reasons. It is used for reinforcement of the hull and for adjusting and trimming the position of the ship during voyage in relation to cargo load for better stability and fuel consumption. Some of the biggest ships out there can carry up to 100,000 m$^3$ of ballast water. That’s the same as 40 Olympic sized swimming pools.

In theory, there can be thousands of different species and billions of planktonic cells inside ships’ ballast water tanks during voyages.

ECO: Are there species that are more likely to spread than others?

To be acknowledged as an ‘invasive species,’ an organism must first survive the treatment process during intake. The ballast water is cleaned by treatment systems which are very efficient in removing the larger aquatic animals, but also costly for the ship-owners: the price for some of the treatment systems that can handle large volumes of water are within the range $1-3 million.

Some of the smaller and tougher species can potentially survive if treatment is not optimal, and they are therefore more likely to spread. This especially includes organisms with egg or larval stages such as crustaceans and mollusks, but some algal species have also shown to be robust towards treatment procedures.

Next, they must survive the potentially long passage in the dark ballast water tanks, and eventually a second treatment that happens before the water is discharged into a new environment.

Organisms must also be able to survive and overcome the new conditions where different ecological factors might dominate in relation to the area they originally came from. Finally, it must be able to adapt to a degree where it succeeds in reproducing and establish a population. Once an invasive species has established a reproductive population it can outcompete local species and multiply into pest proportions.

The damage invasive species exert on the environment and biodiversity is considered one of the most serious threats to aquatic ecosystems worldwide. These damages are often irreversible as it is almost impossible to eliminate an invasive species once a population has been established.

One of the most “successful” – and thereby least wanted – invasive species is the zebra mussel in the Great Lakes. It is native in Eastern Europe where the population is controlled by natural predators. Consequently, the absence of these predators in the Great Lakes and the perfect ecological conditions led to a population explosion after it was introduced via the discharge of ballast water. This caused the near extinction of some local species and, as the mussels consume large quantities of phytoplankton, there was a decrease in the food availability for commercial and game fish in the area. It is estimated that zebra mussels will outcompete 50 percent of the native
mussels, eventually causing extinction of more than 100 species. The major economic impacts include clogging the pipes of water treatment facilities and power plants, resulting in huge expenses and mobilization of resources in cleaning operations, as well as costly damages on boats and harbor areas.

Other successful invasive species that have caused major ecological and economic damage include the North American comb jellyfish, the European crab, and the North Pacific sea star which have all had devastating impacts on the fishing industry. The parasitic salmon fluke that infect salmon can cause catastrophic losses in aquaculture productions. And finally, toxic algal blooms can kill or harm other organisms – including humans – and blooms also cause huge economic losses for areas reliant on tourism due to the periodic damage and closing of beaches.

**ECO: How has this issue evolved with the growth of the shipping industry?**

Until the 19th century, ships’ ballasts were solid, typically rocks, but with the introduction of steel ships the solid ballast was replaced by water which was more flexible and could be adjusted according to cargo load.

The use of water as ballast introduced the transportation of unwanted organisms to different corners of the world. Later on, it was possible to establish stable populations and become the first harmful invasive species.

Shipping is the most cost-efficient way of moving goods and, for that reason, shipping accounts for about 80 percent of the global transportation of goods today. It has been estimated that between four and ten billion tons of ballast water is moved around the world annually. With the growing maritime trade caused by globalization, the demand for more and larger ships will, in my opinion, also increase the risk of transporting potential invasive species in ships’ ballast water.

One of the most recent concerns today in terms of invasive species is focused on the opening of Arctic Ocean shipping routes. The Arctic has, until now, been isolated from potential invasions due to its harsh climate but with the opening of the area for shipping, the pristine Arctic ecosystem will also become vulnerable.

**ECO: What is being done to reduce the spread?**

It is fair to say that the impact of aquatic invasive species was underestimated, and our efforts to implement control and prevention measures have been relatively late and too slow.

The “International Convention for the Control and Management of Ships’ Ballast Water and Sediments” was adopted by the International Maritime Organization (IMO) in 2004 – many years after it was globally accepted that this was a huge environmental and economic issue. It wasn’t until September 2017 that the convention was ratified. All ships are now required to have a ballast water treatment system on board that has been thoroughly verified by testing facilities approved by the IMO.

But many invasions have already occurred, and it seems like there is no saturation tendency in the accumulation of aquatic invasive species. However, it is important to keep complying with current regulations to ensure sufficient protection.

The use of standardized test organisms allows different nations to compare treatment systems, and it was accepted at the IMO conference. This means that testing procedures for organisms in the size class 10-50 µm need to be standardized.

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