VALORISATION OF INVASIVE SPECIES: CASE STUDIES FROM **AROUND THE WORLD**

By Firoza Buranudeen

Global trade and human activities (intentional or otherwise) have resulted in the increasing presence of invasive alien species (IAS) which have impacted upon ecosystems, biodiversity and other sectors. Over time, several of these species (tilapias and carps being notable examples when well-managed) have contributed positively to local economies through their valorisation as food as well as utilisation of residues and byproducts; however, for some other IAS, their potential is not as clear for the moment. This article presents a global snapshot of IAS case studies which illustrate the complexities involved.

AFRICA

Nile perch (Lates niloticus)¹

The Nile perch, native to the Ethiopian region and commonly found in the major river basins such as the Nile, has had a devastating impact in East Africa where it was introduced in 1962. For example, in Lake Victoria, the Nile perch has driven more than 200 native species of fish to extinction, and now dominates the fishery together with Nile tilapia (Oreochromis niloticus), and the native silver cyprinid (Rastrineobola argentea). Nevertheless, an analysis of landings and fishing effort trends reveals that Nile perch in Lake Victoria is currently overfished.



Nile perch is the biggest freshwater fish species in the world

Upon processing, fillets account for 37-40% of the total Nile perch, with the remaining 60-63% being byproducts. Frames or skeletons with adhering flesh account for 40-43% of the byproducts' weight, followed by skin (8%), gut (5.7%), and swim bladder or fish maw (2.3%).









Fish leather products

Nile perch swim bladders (maws) constitute a major export item. Their processing is simple: the swim bladders are washed several times and dried in the sun several times over. They are then sold directly to traders or processed in preserved forms such as dried products. The international prices of dry maw per kilogram range between USD 450 and USD 1000 depending on size, product quality and market strength². The biggest market for fish maws is mainland China and Hong Kong as

Nile perch portions, steaks and fillets

The potential earnings from Nile perch byproducts could be two times more than those from the fillet. With appropriate technology and investment, these "wastes" can be transformed into premium products that attract high-end consumers.

For instance, when handled properly, fish skin can produce high-guality leather. In Kitale (Kenya), a company called Victoria Foods works with roughly 300 fishermen from Lake Turkana in Kenya's north, who provide it with Nile perch. The fish skin is put in a tannery machine after its scales are removed and soaked for an hour. They add banana extract to remove fish odour and salt to strengthen the fibres. It is then soaked for a further eight hours.

"Fish leather is considered exotic leather, like reptile leather, and you know the reptiles are endangered. We have crocodile leather or snake leather which is endangered, but fish leather, it's a good alternative to that. You don't require "CITES", you know, the permit that you use to export the leather for endangered animal species, you don't need that. So, I think very soon, as it gains popularity, there is going to be a lot of demand for it in the market", said James Ambani, CEO of Victoria Foods. Victoria Foods has been working with FAO as part of its Blue Initiative.



Nyamweya CS, Nyaboke HM, Aura CM, Momanyi KN, Mlaponi E, Odoli CO and Njiru JM (2022) Lake Victoria's bounty: A case for riparian countries' blue economic investment. Front. Environ. Sci. 10:952654. doi: 10.3389/ fenvs 2022 952654

² Bagumire, A., Muyanja, C. K., and Wabulya Kiboneka, F. (2018). The Value Chain Analysis of Nile perch Maw Trade in East Africa The Responsible Fisheries Business Chains Project of Deutsch Gesellschaft für Internationale Zusammenarbeit (GIZ).

they are regarded in traditional Chinese culture as one of the top marine delicacies alongside abalone, sea cucumber, and shark fin. It is generally believed that fish maws are good for health, possibly due to their high collagen content.



Dried Nile perch fish maws

Meanwhile, various studies have shown that viable quantities of oil can be extracted and refined from Nile perch viscera, belly flaps, and heads. These oils are rich in Omega-3 fatty acids.

ASIA

Possibly the most well-known IAS species in Asia is tilapia which has become so ubiquitous that its African origin is often forgotten. As there is a wealth of information on tilapia as a food fish and its utilisation in other ways, this article will look at a less familiar non-native fish species in parts of Asia.

Midas cichlid (Amphilophus citrinellus)³

Lake Sampaloc in San Pablo, the Philippines, glitters and gleams with golden fish introduced a decade ago. "I catch these wild golden fish and raise them in my bamboo fish pens. I sell them for PHP100 per kilogramme or PHP5 apiece. They are perfect for ponds because they look a bit like koi," explains Jepolo Austria, known as Mang Puloy to everyone in San Pablo. He used to raise only Nile tilapia (*Oreochromis niloticus*) and bighead carp (*Hypophthalmichthys nobilis*) in his floating fish pens, but his most colourful offering is now this golden fish, i.e. a hybrid of Midas cichlid (*Amphilophus citrinellus*).



Jepolo Austria, better known as 'Mang Puloy', has been raising fish in Lake Sampaloc for over 30 years. His floating fish pens hold tilapia, bighead carp and the golden Midas cichlids locally called 'flowerhorns.'

³ Yan, G. (2023). Golden Midas Cichlids Invade Laguna's Lake Sampaloc. Published in the Philippine Daily Inquirer, July 2023. Locally called "flowerhorns", the fish are most probably hybrids of Midas cichlids (*Amphilophus citrinellus*), which are native to South America, particularly in Costa Rica and Nicaragua. They are sought-after aquarium fish due to their bright and highly variable coloration, ranging from bright orange to jet-black, leading to some scientists to classify them as a "species group" instead of a single fish species. Highly aggressive, they grow about a foot in length and develop an impressive "nuchal hump", a ball-like organ on their forehead. They have become an invasive species in various waterways, from the United States to Singapore.

"Having Midas cichlids in our local lakes poses a threat to the continued existence of our economically-important native or indigenous fish species since cichlids are omnivorous and can feed on the larvae and juveniles of native fish species," explains Dr. Maria Rowena Eguia, Associate Professorial Lecturer at De La Salle University who has been studying aquaculture for the past 40 years.

"The ASEAN region is rich in freshwater biodiversity. This is due to the presence of a number of inland lakes with unique geological history allowing them to support species and subspecies endemic to these water bodies. Introducing alien species into these closed systems will greatly impact the native species inhabiting the lakes," explains Dr. Mundita Lim, Executive Director of the ASEAN Centre for Biodiversity. "Tilapia and the infamous knifefish for instance, are predators which can devour endemic fish species to extinction. Other invasive alien fish such as janitorfish can compete with local species for food and space, thus eventually displacing them."



Closeup of one of Lake Sampaloc's golden fish, possibly a hybridised Midas cichlid (Amphilophus citrinellus), named after the legendary king who could turn anything he touched into gold. Midas cichlids are one of several fish used to create hybrid 'flowerhorns.'



Similar cichlids are being sold in the markets of Laguna, Cavite and Batangas as 'golden tilapia' and retail for around PHP180 per kilogramme.

EUROPE

The blue crab (Callinectes sapidus)⁴

Originally from the western Atlantic Ocean, blue crabs are considered one of the hundred "worst invasive" alien marine species in the Mediterranean Sea, with a high impact on ecosystem biodiversity and human activities (fisheries, aquaculture, tourism) Despite the negative impacts, the blue crab could be considered a new source of income, considering its high nutritional value, its utilisation in local industries and the valorisation of byproducts.

The blue crab represents a double-edged sword for local ecosystems and economies. Ecologically, it can alter local marine life by preying on native species and competing for resources, reducing biodiversity and affecting fisheries. In addition, blue crab management is costly, as traditional disposal methods are expensive and laborious, with a low yield of usable meat.

By developing products such as crab patties, pasta sauces, and crab burgers, businesses can create economic value from what is otherwise considered a nuisance. This approach aligns with broader strategies seen in other regions, where invasive species are harvested for food, pharmaceuticals, or cosmetic products, thereby controlling their populations while generating revenue.

Possible byproducts

Globally, around 6-8 million tonnes of crab shells are produced each year, causing disposal problems and environmental concerns. Due to its low economic value and high disposal costs, most of this waste is actually disposed of in landfills.

Crab shells and other crab byproducts are an important source of proteins, lipids, chitin, minerals (mainly calcium and magnesium carbonates) and pigments that can be processed into high-value products. By deacetylating chitin, chitosan is obtained—a polysaccharide with many applications in different fields (clinical, cosmetic, food, pharmaceutical, agricultural, aquaculture and environmental) due to its non-toxicity, biodegradability, and adsorption and chelating ability. Chitosan can also be used as an alternative antimicrobial agent as it possesses antimicrobial activity against many bacteria, fungi and yeasts. Furthermore, chitosan has excellent film-forming properties, making it suitable for applications in the food industry to preserve the quality of various foods.

The exoskeleton and cephalothorax of the blue crab are composed of carotenoids, particularly astaxanthin, the major carotenoid pigment naturally occurring in marine crustaceans. The recovered astaxanthin can be used in various sectors, including food, pharmaceuticals and cosmetics, providing a sustainable and natural alternative to synthetic carotenoids.

Addressing the invasion

The process of integrating blue crab into local economies is not without its challenges. The low meat yield and high processing costs can make it difficult to commercialise on a large scale. There is also a need for more efficient processing technologies and improved integration within supply chain and logistics frameworks. In addition, regulatory frameworks play a critical role in shaping the economic viability of utilising blue crabs. Until recently, the use of specific fishing gear and the classification of blue crabs as a marketable species were major regulatory hurdles. For instance, the Veneto Region in Italy received a special allowance to use dredges within three miles of the coast to prevent damage to mussel beds. Regulatory adjustments like these are crucial for enabling businesses to legally and efficiently harvest blue crabs.

Addressing the blue crab invasion effectively requires a balanced approach that combines economic utilisation with ecological management. Social innovation plays a critical role in this effort, with strategies such as community-based management programs, educational initiatives, and public-private partnerships being essential. Engaging local communities, fostering education, and promoting collaboration between various stakeholders can help develop sustainable solutions that not only mitigate the ecological impact of the blue crab but also enhance economic resilience.

NORTH AMERICA

The US Department of Agriculture's National Invasive Species Information Center estimates invasive species cost Americans at least USD 26 billion a year due to their impact on local environments and economies.

Asian carp (copi)⁵

In 2021, the Illinois Department of Natural Resources proposed a new name for the invasive Asian carp (bighead, black, grass, and silver carp), in order to make it sound more palatable to diners and supermarket shoppers. The fish was originally imported into the US in the 1970s to eat the algae from wastewater treatment plants and clean up catfish ponds, but they eventually found ways to swim out of those environments and into the Illinois and Missouri Rivers. Now called copi (short for copious), it is promoted as having a "light and clean taste, responsibly-



⁴ Arena, R. et al. 2024. Valorization of the Invasive Blue Crabs (Callinectes sapidus) in the Mediterranean: Nutritional Value, Bioactive Compounds and Sustainable By-Products Utilization. Mar. Drugs 2024, 22(9), 430

⁵ https://choosecopi.com

caught, and being a plankton eater, it does not accumulate heavy metals in its flesh". Following its rebranding, the fish has seen a remarkable rise in popularity and is now served in many ways in restaurants: pan-fried, steamed, broiled, baked, roasted or grilled; and processed into burgers, fish cakes, dumplings and tacos.



The Asian carp (comprised of four species) has been rebranded as "copi" by a US communications company called Span Studio



In addition, companies like Arch Pet Food and Chippin are using copi as a sustainable raw material for pet foods. Chippin promotes its product as "soft and chewy fish jerky and training treats featuring sustainable silver carp. These healthy dog treats are packed with all 10 essential amino acids and omega-3s for a shiny coat. USA wild-caught by local fisherfolk."



Northern snakehead (Channa argus)⁶

Native to China, Russia and Korea, the first sighting of the northern snakehead (*Channa argus*) in US waters was in 1997, probably introduced intentionally after having outgrown home aquaria or from the live food

⁶ US Fish and Wildlife Service

trade. The mainstream media at that time described it as frankenfish, fishzilla or devilfish, leading local residents to warn their children not to go near the water's edge for fear of this new "snake fish".



Snakeheads are now on the menu of ethnic restaurants in the United States.

Fast forward 30 years, and the fears of snakehead hordes overtaking native fish populations are lower; nevertheless, since 2002, it has been illegal to possess a live snakehead in the United States. The snakehead has now garnered support as a sportfish in its own right; anglers describe catching snakeheads as a "high-energy experience" due to their aggressive, predatory nature and willingness to bite a variety of live and artificial baits. In addition, it has also become widely popular in ethnic markets and restaurants over the last two decades.

Conclusion

The cost of biological invasions worldwide has recently been estimated at a total of USD1.288 trillion for the interval between 1970 and 2017, averaging USD 26.8 billion annually. However, traditional invasive species management strategies can be costly and yield limited success, leading to stakeholder frustration and deterring policy makers from future investments, affecting collaborative initiatives and engagement in resource management. In marine ecosystems, the knowledge gaps and difficulties in successful management are particularly pronounced⁷.

In recognition of these challenges, there is an increasing dialogue about the benefits of involving citizen and stakeholder engagement in harvesting IAS. This approach focuses on control through recreational and commercial utilisation of certain IAS, leveraging their potential recreational or commercial value where it exists. The outcome holds potential for positive contributions to the Blue Economy— sustainable use of marine resources, including fisheries, tourism, and renewable energy— and for meeting sustainability objectives.



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⁷ https://doi.org/10.1016/j.biocon.2024.110548