**The Impact of Aquatic Alien/Exotic Species on Fisheries and Aquaculture**

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**Abstract:**

Exotic species are imported to many countries for use in aquaculture, recreational fishing, wildlife enhancement and ornamental purposes, or for biological control (mosquito larvae, vegetables and phytoplankton). Although it has a positive impact on food production, its negative impact on ecosystems and biodiversity has attracted worldwide attention. The main concerns in introducing exotic fish are breeding, contamination of native seeds, disease, competition or rivalry with other species, economic loss, property damage, etc. This poses a threat to food security and impacts local ecosystems and biodiversity. The need for better research and more reliable estimates of the value of a particular aspect before implementing such strategies cannot be overemphasized. This review focuses on the introduction of exotic species, the reasons for their introduction, species suitable for introduction, the disadvantages and advantages of exotic species, and various fish lessons. Finally, recommendation a plan to control the introduction of exotic species is proposed.

**Introduction**

With 2936 fish species (11% of general fish species) and over 300 remarkable fish species, India has a diverse biodiversity. Aquaculture, as defined by the FAO, is "the cultivation of aquatic organisms such as fish, molluscs, crustaceans, and aquatic plant life." Farming, constant stocking, feeding, predator protection, and so on" comprises all actions in schooling to boost manufacturing. It is no longer limited to meal supplements, which are essential for human nutrition; instead, it now provides part-time and full-time work, particularly in rural areas (1). According to FAO (2), 60 million people are directly or indirectly associated with fisheries or aquaculture, which provides a living for 10-12% of the arena's population. Aquaculture also accounts for more than half of global fish consumption (3).

With freshwater aquaculture generating over 95% of the country's annual production, aquaculture is the fastest-growing industry in India, expanding at a rate of over 7% in just 356 days. Small-scale agriculture also serves as the main source of manufacturing in rural areas. Widespread aquaculture may lessen the movement of people from rural to urban regions because small-scale rural fisheries are the top suppliers of freshwater fish for food safety and revenue in developing countries (4). If the rural area is viewed as a lucrative agency alternative for experienced farmers and permits higher incomes for contemporary farmers, then this can be done.

Jayasankar and Das (5) cautioned that horizontal growth can grow fish production due to the fact that an impressive 50% of ponds out of 2,414 million hectares are currently used. Likewise, vertical growth offers species diversification and consists of breeding and the traditional generation of the same vintage diversification business agency for freshwater species. A survey on fish farming in rural areas found that fish farming is achieved as an income-producing organisation, and farmers are little by little increasing their enterprise organisation by acquiring more land to create watersheds. Each extraordinary study by means of the method of Duarah and Mall (6) on vertical diversification through the tradition of small indigenous fish species, which encompass carp in small-scale way of life ponds, has more than one hundred% cross-return on investment, enough to develop farmers' income. Similarly, amazing fish species are added to the cultivation device to improve aquaculture. In line with Kumar (7), the number one reason for introducing uncommon fish species can be: (i) to enhance the capability of neighbourhood fishing and to make the species larger inside the water gadget; (ii) game fishing; (iii) the reason of the aquarium; (iv) to manipulate weeds and unwanted organisms, which encompass flies.

Special fish are non-native species that come from other countries and have been added to Indian waters. They commonly establish cultural generation, manufacturing, and advertising abilities. Kottelat and Whitten (8) define added species (individual species) as species that are intentionally or accidentally transported and released via humans beyond their attainment. Consistent with Welcomme (9), unusual animals are species that arise outside their herbal variety. Likewise, the IUCN defines invasive alien species as alien species that arise in natural or semi-herbal ecosystems or habitats and threaten local biodiversity.

**Introducing exotic aquatic species**

The introduction of individual species has been practiced since the middle of the nineteenth century and is specifically utilized in aquaculture, recreation fishing, keeping ornamental fish, fly control, and so forth and in India, more than 3000 species were brought in (10). As noted above, exotic species are particularly useful for business functions.

There's evidence of the success of the advent of a few distinctive species that might also be installed in Indian water bodies and offer economic blessings to farmers, but there are instances of the failed introduction of some unusual species that have adversely affected herbal biodiversity (11). Some important exotic species introduced in India are presented in Table 1:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SC. NAME** | **COMMON NAME** | **HOST COUNTRY** | **INTRODUCED TO** | **YEAR** | **PURPOSE** |
| **GAME FISHES** |
| *Salmo trutta fario* | Brown trout | England | Nilgiris(TN) | 1906 | In stream, lakes and reservoirs |
| *Salmo levensis* | Loch Leven Trout | England | Nilgiris(TN) | 1863 | In stream, lakes and reservoirs |
| *Oncorhynchus mykiss* | Rainbow trout | Sri Lanka, Germany | Nilgiris(TN) | 1907 | In stream, lakes and reservoirs |
| *Salvelinus fontinalis* | Eastern Brook trout | Canada |  | 1959 | In stream, lakes and reservoirs |
| *Salmo salar* | Atlantic Salmon | USA | Kashmir | 1968 | In stream, lakes and reservoirs |
| *Oncorhynchus nerka* | Socko-eyeSalmon | Japan | Nilgiris(TN) | 1968 | In stream, lakes and reservoirs |
| **FOOD FISHES** |
| *Carassius carassius* | Crucian Carp /Golden Carp | England | Nilgiris(TN) | 1874 | Experimental Culture |
| *Tinca tinca* | Tench/Doctor Fish | England | Nilgiris(TN) | 1874 | Experimental Culture |
| *Ctenopharyngodon idella* | Grass Carp | Hong Kong | Cuttack | 1959 | Experimental Culture and weed Control |
| *Cyprinus carpio communis* | Common Carp /Scale Carp | Bangkok | Cuttack | 1957 | Experimental Culture |
| *Cyprinus carpio specularis* | Common Carp /Mirror Carp | Sri Lanka | Nilgiris | 1939 | Experimental Culture |
| *Hypophthalmicthyes molitrix* | Silver Carp | Japan | Cuttack | 1959 | Experimental Culture |
| *Osphronemus goramy* | Giant Gouramy | Java and Mauritius | Tamil Nadu | 1916 | Experimental Culture |
| *Puntius javanicus* | Tawes | Indonesia | Kalyani(W.B.) | 1972 | Experimental Culture and weed Control |
| *Tilapia mossambica* | Tilapia | Bangkok,Sri Lanka | Mandapam (TN) | 1952 | Experimental Culture  |
| **LARVICIDAL FISH** |
| *Gambusia affinis* | Mosquito Fish | Italy |  | 1928 | Mosquito Control |
| *Poecilia reticulata* | Guppy | South America |  | 1908 | Mosquito Control and Aquarium |
| *Nothobranchus guentheri* | Red Tail Notho | Africa | TN |  | Mosquito Control |
| ORNAMENTAL FISHES |  |  |  |  |  |
| 27 Species | Live bearers | From various countries |  |  | Aquarium Keeping |
| 261 Species | Egg Layers | From various countries |  |  | Aquarium Keeping |
| **UNAUTHORIZE INTRODUCTION** |  |
| *Aristichthys nobilis* | Bighead Carp |  |  |  | Aquaculture |
| *Clarias gariepinus* | African Catfish |  |  |  | Aquaculture |
| *Oreochromis niloticus* | Nile Tilapia |  |  |  | Aquaculture |
| *Oreochromis* sp. | Red Tilapia |  |  |  | Aquaculture |
| *Serrasalmus nattereri* | Red Piranha |  |  |  | Aquaculture |

The freshwater pond cultivation gadget in India consists of three foremost species of Indian fundamental carp: Catla (*Catla catla*), Rohu (*Labeo rohita*), and Mrigal (*Cirrhinus mrigala*). Those species make up about 61% of the entire aquaculture industry. The freshwater aquaculture gadget in India incorporates three uncommon species: silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idela*), and commonplace carp (*Cyprinus carpio*), contributing about 9.5% of home manufacturing (12). These three wonderful Carps had been delivered to India from China. They have mounted themselves within the essential Indian industrial freshwater and carp aquaculture sectors. Every other example of a catfish species, Panagsius, was delivered to India in 1995 (13) from Thailand through Bangladesh. Despite the fact that, to start with, India banned tradition, throughout 2009, the government of India allowed its own lifestyle in cultivation. This species grows collectively with carps or as a monoculture. Due to its feed consumption and growth price, this species attracts many farmers for cultivation. In pond cultivation, the growth duration is restricted with the aid of environmental factors; therefore, farmers have to be advised to apply their ponds to develop a couple of crops in a year consistent with seasonal overall performance. Lately, pacu. (*P. brachypomus*) changed into illegally imported from Bangladesh in components of West Bengal and Assam.

**Choice of exotic species:**

Surely, the majority of the entries are associated with aquaculture or directed in the direction of aquaculture development. Turner (14) proposed a few criteria for introducing exclusive species. Below are a few homes that are suitable for introducing alien or unusual species.

(1) Need to be a quick grower to atone for the lack of protein.

(2) They must to fulfil a need because there are no comparable ideal species available.

(3) Such species ought to be like-minded and no longer compete with treasured local species, which are causing their decline.

(4) Need to be propagated with local species and not produce undesirable hybrids.

(5 It needs to be free from pests, parasites, or illnesses in order not to attack local species.

(6) Ought to live and reproduce in stability with the brand new environment and no longer cause ecological troubles.

(7) Need to be long-lasting and smooth to work with other advantages.

(8) Tradition has to have verified technology and suitable monetary viability.

**Reasons for introduction**

There is no doubt that most of the introductions made were due to aquaculture activities or geared towards improving aquaculture. Below are the some reasons that makes an alien species suitable for introduction.

*1. for aquaculture purposes*

Aquaculture purposes were the most numerous reasons for introducing alien species. They have always been a significant part of the total, but in recent decades their importance has grown. The importation of foreign animals has led to an increase in the number of aquaculture species (15). The main reason behind this is the demand for special types and trade in the global market. Exotic species have played an important role in the development of aquaculture and trade in aquaculture products. As a result of this trend, in 1996 only nine species accounted for 78% of the total freshwater fish cultivation in the world. This key species for fish farming has been introduced to countries around the world. Current trends show more and more crustacean species being offered worldwide for freshwater shrimp farming which is growing rapidly. Regarding the introduction of shrimp, the introduction of Pacific white shrimp *Litopenaeus vannamei* in the Asian region is one of the important contributors to the extraordinary development of aquaculture in the region in recent times(16).

*2. Improving the condition of wild animals*

There are many motivations for stocking fish species to improve wild populations: establishing new food fisheries, filling "empty spots", stocking natural waters, providing food for predators, restoring fishing grounds, establishing wild stock, controlling stunted species. This applies especially in poor areas such as temperate zones, they were often introduced into artificial lakes, in which autochthonous species could not settle. In fact, all introductions of fish to improve wild populations more or less refer to the concept of a "vacuum" in the sense that there are resources in a body of water that are not being used effectively due to a lack of suitable native species. Alien species have the ability to fully utilize the available niche present in cultural facilities. An example is the polyculture of grass carps, silver carp, bighead carp, and other fish species (17; 16).

*3. for research purposes*

However, in recent years, many commercial farmers in Ghana have expressed dissatisfaction with the growth and survival rate of the Akosombo strain. As part of the development and validation of the Akosombo strain, the Ghana Government Aquaculture Research Center (ARDEC) imported the GIFT (Genetically Improved Farmed Tilapia) strain in 2012 to experiment with the Akosombo strain (18). A non-indigenous strain of tilapia (GIFT) managed to escape into the wild and efforts to reverse this action proved futile.

*4. Biocontrol substances*

Most fish species have the ability to help solve human-related environmental problems. Silver carp and bighead carp have the ability to feed on plankton and zooplankton. These carp can feed on harmful blue-green algae and are therefore suitable for combating algal blooms (eutrophication) of water and are therefore used for water purification.

Efforts were made to eradicate mosquito larva causing malaria, exotic fish species were introduced as early as in the 1920s. Twelve species are represented for mosquito control, but the most widespread introductions were made with 3 species: *Poecilia latipinna*, *Poecilia reticulata* and *Gambusia affinis*. Manage of mosquito larvae through those small larvivorous fish species had been very powerful and are changing greater steeply-priced ones and environmentally unfavourable control with insecticides. Introduced *Gambusia* sp. is now slowly being replaced by local larvivorous species. Also in some cases Molluscivorous fish were introduced to control the aquatic snail vector of Schistosomiasis (16).

*5. Recreational fishing*

The people who aim to be wild or manipulative changed stocks in natural water bodies are used for sports or for recreational fishing and a variety of fish food from recreational to commercial. Sport fishing provides the main reason for regular introductions per decade, but introductions for this purpose have declined in importance since the 1950s. By using 1988, seventy-8 species had been recorded as introduced for recreation around the world. Lots of these salmonids or large predators with preventing characteristics are well known with the aid of sports activities fishermen. In India also, salmonids have been introduced in upland areas to promote sport fishing (16). The fishing industry has recently been affected by the decline of fish populations in rivers, lakes, and dams. This has led to the introduction of fish species suitable for hunting into various freshwater systems (19).

*6. A casual introduction*

Ballast water can be sea water or fresh water added to the ballast tank to balance the water boat and the main source of casual dating, because the water is diverse. A place filled with ballast during the journey to a ship that can carry a lot plants and animals of different regions from where they are taken. One third of aquatic species have been reported to introduce to the Great Lakes of North America with ballast water (16).

*7. Decorative purpose*

Given the global demand for colourful fish and the growing aquarium trade maintain an aquarium at home and workplace, introduce exotic fish species all over the world. Large species introduced for stocking natural water or ornamental ponds, the main species used for this purpose is the gold fish *Carassius auratus* has spread widely outside the natural range and has frequently become wild. In other words, many species of tropical fish are widespread dispersed by the booming aquarium trade (16).

**Impacts of introduction of alien species**

In general, the introduction of an exotic aquatic organism can have a positive or negative impact on ecosystems and biodiversity. Effects are often recorded. Most of the alien species assessed were reported to affect more than one native species through different mechanisms, with 65% reporting negative impacts and 35% positive impacts on other species. In many cases, aliens have also affected keystone species or species of high conservation value. 49 assessed species are reported to be ecosystem engineers, creating or defining habitats by changing their physical or chemical characteristics (20; 21).

**Positive influence**

Although there are some negative effects of introducing alien fish, there are some positive effects of introducing alien fish. Here are the positive effects of introducing exotic fish species.

*1. It helps in genetic research*

Many alien species have been used as research material. Experiments are carried out to increase the production of biomass and lipids in bioreactors for the production of biofuels. The introduction of exotic species and their establishment in new areas and ecosystems opens up new opportunities for ecological research, as they can be used to study concepts such as adaptive strategies, land construction, land measurement, keystone species, niche relationships, trophic cascades, rapid evolution, reproductive pressure, ecosystem engineering, connectivity, and dispersal mechanisms.

*2. Improvement of fish inventory*

Some introductions aim to manipulate wild or changed stocks in herbal water bodies. This includes growing new food fisheries, 'filling the gaps', conserving natural water, feeding predators, restoring fisheries, creating flora and fauna reserves, and dealing with endangered species. That is specifically proper in fauna-bad areas inclusive of ice-age glaciers, islands east of the Wallace Strait, or high-altitude mountain waters.

*3. Organic regulation*

These include, specifically, the management of pathogens in aquaculture facilities, the position of cleanser fish in reefs, the biological control of the unfolding of vector-borne human illnesses, and the manipulation of invasive species. Natural enemies are an environmentally friendly opportunity for pesticides generally used to govern invasive species. Examples of such fish consist of *Gambusia affinis* and grass carp, which are broadly promoted as organic controls of flies and algae.

*4. Increase the manufacturing of cultivation*

Unique species have played a crucial role in the improvement of aquaculture. Before 1900, the first worldwide movement of species, in particular freshwater salmonids, which included *Oncorhynchus mykiss* and *Salmo trutta trutta*, was brought to temperate areas to help with sport fishing and aquaculture for food manufacturing. Since the Seventies, the introduction of salmonids (especially *Salmo salar* and *Oncorhynchus kisutch*) refers to anadromous species that are widely cultivated in cages.

*5. Symbolic and aesthetic value*

It's approximately the presence and beauty of habitats and charismatic species, together with beaches, habitats, or species, and the cost positioned at the herbal and cultural monuments of the coast, reefs, or marine mammals.

**Unfavourable reactions**

 *1. Adjustments in genetic variety and genetic pollutants*

Most research has concluded that the genetic consequences of alien transplants lead to a discount in the effective population size and a change or extinction of the gene pool of the species. The release of fish into the wild can also have genetic outcomes. Direct effects consist of the impact on a species via initiating modifications in gene flow through hybridization and development. The indirect impact is mainly the discharge of a small number of people or the effect on local species through ecological approaches including competition, predation, new illnesses, or parasites. Hybridization can result in hybrid energy, heteroticity, or genetic infection due to dominance and heterozygosity at multiple loci. This genetic development no longer only leads to genetic pollution; however, in some instances, it additionally leads to the extinction of species. In maximum research, a full-size discount in the variety of offspring because of genetic contamination and genetic barriers is the result of genetic development. Similarly, researchers have identified reproductive problems due to this transplant, which include frame deformities, stunted boom, behavioural adjustments, and even reproductive melancholy. Such genetic effects can lead to a lack of regionally adapted populations and genetic variety. The evolutionary outcome of direct effects can also strongly depend on whether the launched fish are taken from wild or cultured shares. Domestication, which entails adjustments within the range, range, or combination of alleles, produces results that include a lack of population diversity in nature. At the same time, loss of diversity through genetic glide is random, and variety is lost.

Moreover, the impact of glide on genetic diversity is inversely proportional to the dimensions of the effective population, with genetic range misplaced through domestication related to genetic tendencies and the depth of selection. Therefore, if domestication permits culture to develop, it could also lead to reduced overall performance inside the wild because domesticated fish show worse effects than wild ones in terms of survival of fingerlings and adults, hiding behaviour, staying power, and migration. Because phenotypic and genetic characters can trade at some stage in captivity, they interact with every other neighbourhood populace or species, resulting in the dilution of domestically adapted gene swimming pools and a decline in the overall performance of local populations through the loss of species traits. Fish have a greater capacity for spontaneous hybridization than mammals or birds, which may cause complex evolution when domesticated fish meet wild stock. Consequentially, exotics can merge with local families or other aliens. Due to introgression pressure, conventional behaviour may be abandoned, and hybrids typically emerge from unrelated species.

*2. Habitat destruction or Alteration of Habitat*

The advent of wonderful aquatic species can adversely affect native species' habitats. Consumption of plant cloth by means of herbivorous fish, destruction of macrophytes by way of digging for meals or nesting web sites, and natural enrichment that will increase turbidity and reduce light penetration and photosynthesis can all make a contribution to the displacement of aquatic flora. The commonplace carp, *Cyprinus carpio*, is famous for muddying the water with its bottom-rooting dependency. It overshadows macrophytes, disturbs benthic invertebrates, and contributes to speedy eutrophication via speedy phosphate recycling. In India, the composition and abundance of the original fish fauna are changing, and the species of the genus *Schizothorax* have disappeared from the water, introducing goldfish and fisheries primarily based on it. *Ctenopharyngodon idela* has been introduced to many parts of the world to damage underwater plant life and emerge. It typically does the process well enough; however, by selectively feeding on milder species, it can increase the number of flowers, which is more than a nuisance.

The feeding behaviour of wonderful fish that damage flora and degrade sediments can have an effect on the predation of native fish that devour organisms in lakes or sediment streams. Substrate disturbance for the duration of feeding by European carp (*Cyprinus carpal*) is related to accelerated turbidity (22). This applies to different species that search for food visually and affect the photosynthetic potential of vegetation. Lack of plants in addition destabilizes benthic sediments, water clarity continues to decrease, and the whole gadget spirals down. Therefore, environmental degradation is associated with the loss of aquatic plant life, river erosion, water turbidity, and elevated nutrient availability. This could wreck local fish, invertebrates, and circulation habitats.

*3. Competition with native species*

Given the direct interplay among delivered and endemic species, organisms can change trophic relationships in at least three one-of a kind ways. Their presence can significantly increase the amount of prey available to local predators. Delivered fish-ingesting conduct can reduce the quantity of natural food available to local species through predation or opposition. Competition isn't always constrained to trophic consequences, but additionally to reproductive space, and so forth. Some brought species compete aggressively with local species for meals and area. Despite the fact that some introduced fish efficiently show common consumption behaviour and trophic opportunism (23, 24), in many systems there is huge similarity between the diets of introduced and endemic fish (25). Aggressive feeding of certain species on positive flora can lessen their availability for native species. A comparable mechanism has been identified in local species that cannot compete with delivered tilapia in a few parts of the United States. But a few other elements have been tested to play an essential role in the decline of neighbourhood species, such as the impact of human activities and changes in hydrographic parameters over time. Eutrophication and the advent of new fishing strategies have considerably contributed to the decline of the world fish fauna. The decline of endemic fish is often related to degraded and polluted habitats. The excessive productiveness of introduced species, including tilapia, can, without problems, lead to the stockpiling of available space and resources to be used by endemic species. This is a serious hassle, in particular in the course of the dry season, when the water usually reaches small ponds.

Eggs of *Gambusia affinis* or *Lepomis gibbosus* are reported to be eaten by other species. The excellent fish stocks within the surroundings can also be deteriorated by added species. Stunting is the manner by which a populace species expands unexpectedly, generating massive numbers of people that mature and reproduce in very small sizes, for that reason extensively reducing its recreational or business cost. Fish species that have been said to produce stunted populations encompass *Carassius* *auratus*, *Lepomis cynellus*, *L. gibbosus*, *L. macrochirus*, *Oreochromis mossambicus*, *O. niloticus*, *Tilapia rendalli*, and many others. Stunted populations suppress current and, in severe instances, can cause oxygen deprivation (16).

*4. The creation of pathogens in new surroundings*

Most examples are taken from the United States of America's understanding that fish hygiene is superior and manipulation is implemented. However, sicknesses can also be introduced to different locations of the sector and have not been reported thus far. Especially because it is related to the introduction of pathogens. Due to its familiarity, tropical fish tradition is a well-studied topic. The introduction of invasive species is responsible for the advent of parasites and the unfolding of sickness. Even though a few parasites require intermediate hosts, many no longer affirm the host, and others have a more complicated existence cycle. While searching for the enjoyment of different species, there are examples of species migrating past clean barriers or causing surprising disorder issues while reintroduced. Atlantic salmon migrate from the Baltic Sea to Norway and infect Norwegian Atlantic salmon with parasites that Norwegian salmon are not resistant to.

Detrimental illnesses are also said to be mainly generic in the shrimp industry. White spot syndrome virus (WSSV) has been related to the emergence of distinguished species. A recent disease outbreak has prompted mass mortality among cultured penaeid beetles around the sector, in particular in Asian international locations. WSSV disorder brought on excessive mortality and excessive harm to the shrimp farming enterprise in China, Thailand, Japan, Taiwan, Indonesia, and India. The herpes virus is thought to be sexually transmitted and smuggled into India from Southeast Asian countries where the virus is endemic, as reported by a few authors (26). 1994–95, white spot virus disease caused intense mortality of cultured shrimp P. monodon and P. index from the east coast of India (27). Karunasagar *et al*. (28) found a scourge of WSSV on the west coast of India.

*5. Loss of surroundings offerings*

Adjustments in species and network shape can both directly and indirectly affect ecosystem offerings. Direct consequences include the discount of economically treasured species, especially those used for meals, fodder, fiber, gasoline, or medication. Aesthetic value is misplaced with the arrival of "nuisance species" such as invasive vines or floating plants. Disruptive invasive species threaten nature's offerings, especially pollination and pest management. The loss of genetic diversity and the extinction of species additionally affect the loss of selection fees. Indirect results encompass reduced atmospheric resistance and resilience to exchange due to the hypothesized hyperlink between resilience and biodiversity exchange (29). Consequentially, fantastic feedback because of invasive species interactions can cause accelerated vulnerability to further invasions and reduced atmospheric offerings (30).

 *6. Financial losses*

Invasive species of phytoplankton can cause great damage to aquaculture, aquaculture, or fisheries. *Alexandrium minutum* has brought on persistent blooms in northern Europe since 1985, inflicting considerable monetary losses to aquaculture (31). *Karenia mikimotoi*, called the fish killer, has induced a massive variety of deaths of fish and marine animals in north-western Europe, considering the fact that 1968, which included farmed fish and shellfish (32). *Gymnodinium catenatum* has become an abundant and benign species within the Alborian Sea and is frequently associated with poisonous events. At some stage in the past many years, the growth of *G. catenatum* has precipitated episodes of parasitic shellfish poisoning (PSP) on the west coast of the Iberian Peninsula (Portugal and Spain), which has caused excessive financial losses and reduced shellfish harvesting and commercialization (33). The ichyotoxic (34) flagellate *Pseudochattonella verruculosa* (E) killed 350 tons of farmed Norwegian salmon in 1998 and 1100 lots in 2001 (35) and wild fish (garfish, herring, sand eel, and mackerel) on the west coast of Denmark (36).

*7. Socio-financial effect*

The effect of inputs is not confined to biological and ecological parameters. It could, without delay or indirectly, have an effect on socio-monetary elements. Unwanted species can occur once they displace rather precious native fish. This case is determined in Europe (Lake Constance) and the United States (Laurentian extremely good lakes). When local economies depend upon fish farming for human intake, their financial vulnerability is considerable. Introducing extraordinary species can have negative influences and socio-economic results, specifically in the event that they include the emergence of new diseases or the genetic damage of cultivated seed shares. Aquaculture operators have to be cautious to decrease the risks concerned, as a lot depends on the change of genetic material in their inputs. In this case, the fishing industry cannot forget about the devastating impact of the whitefly disorder, which has shown severe mortality in *P. mondonda* and *P*. spp., endemic species of India. This induced a large financial loss to the farmers in addition to a social impact, as many farmers had been struggling for meals and work at that point.

**Merits and demerits of uncommon fish:**

In conjunction with anthropogenic activities, the depletion of freshwater aquatic biodiversity has also been stated to have been because of the introduction of special species. Added (distinguished) species are the ones that have been deliberately or by chance transported and launched via guy out of doors their present range.

It has been mentioned that 168 species of fish, representing 37 households, have been brought globally outside their natural distribution range. Of these, at the very least 67 species have turned out to be set up in special water in our bodies, and of these, 27 species have turned out to be actual pests.

In India, several individual species of fish have installed themselves in herbal water bodies. Research on their impact in Indian waters has been accomplished, which has unequivocally discovered the devasting impacts of these exceptional fishes (including Tilapia, Silver Carp, *Gambusia*, not unusual carp, and so forth.) in Indian aquatic ecosystems. Some of their merits and demerits are discussed below:

*I. deserves unique fish:*

Despite the fact that India has an array of indigenous species (approximately 637 fish species), a number of amazing species were brought due to their notable merit, which is absent in the indigenous species, or to boom the splendour of aquariums.

Fish were brought mainly in two approaches:

(a) Scientists of the fisheries department, who often check out the pros and cons, found it suitable for creation, which could be beneficial to fishermen.

(b) Unauthorized creation, both with the aid of:

(i) The fishers who, to gain low-budget mileage, have added the fishes (evading the authorities definition), or

(ii) Via any small water outlet and unintentional release through the corporation of fish-eating birds and mammals.

*The beneficial effects of individual fish are summed up as follows:*

(1) The distinctive carps, due to their fast increase rate (excessive food conversion ratio), have turned out to be true candidates for the composite fish culture practice. They make handsome contributions to the yield and may resolve the scarcity of protein in India. Grass carp were pronounced to have attained a weight of five kg in a yr.

(2) Common carp can be made to breed in constrained waters of ponds, and consequently, the farmers need not visit the rivers for their seed series all through the breading season.

(3) Common carp, being omnivorous and a scavenger, maintain the water of an impoundment (pond) easily and pollutants-free.

(4) Silver carp in Indian warmer conditions mature at the age of 1, while in its native habitat it matures at the age of 5–6 years.

(5) Silver carp have the capacity to utilise the dense bloom of phytoplankton and assist in retaining it beneath the test.

(6) Grass carp can feed on a wide range of aquatic flora and are used for controlling weeds.

(7) The excreta of grass carp contain semi digested meals, which serve as food for omnivorous fish and additionally serve to fertilize the pond water.

(8) Approximately 288 species of fantastically coloured exclusive decorative fishes are very popular many of the aquarists.

(9) The larvicidal fishes (Guppy, *Gambusia affinis*) had been introduced for mosquito manipulate.

(10) The game fishes (trout and salmon) have been planted in hill streams, lakes and reservoirs for enjoyment time angling.

(11) *Puntius javonicus* become unauthorized introduced in India for culturing in rice fields.

(12) Tilapia, often called ‘brilliant'-fish' and categorised as ‘bird of water’, breeds without difficulty (has high fecundity), is reasonably-priced to feed, and can tolerate a extensive range of temperature and salinity. They’re comparatively free from parasites and illnesses. Because of their hardy nature, they're ideally suited for culture in sewage-fed ponds.

(13) Tilapia needs much less control for lifestyle as they can feed on a huge variety of meals, obtain adulthood within 2 months, breed in constrained waters, and have right parental care.

*II. Demerits of prominent fish:*

The indiscriminate creation of distinct fish has added to some problems. Not much research has been accomplished on the influences of unique species in Indian waters. But reviews from some other place provide a bleak state of affairs of the damages as a result of the sort of advent; that's the truth of Indian situations.

Some of the disadvantages encountered are listed underneath:

(1) The advent of African cichlids (Tilapia) in India has been claimed with the aid of many specialists as a successful event. But an unanticipated impact on each freshwater and brackish water fisheries has now been felt. Being a prolific breeder and hardy in nature, Tilapia has overcrowded many bodies of water, resulting in the prevention of the growth of IMC in pond waters.

(2) The advent of tilapia in Bharathapuzha (the longest river in Kerala) has resulted in the substitution of neighbourhood fish fauna in lots of regions. It has additionally been stated that common gill net fishing to acquire tilapia has resulted in the disappearance of freshwater turtles from our bodies.

(3) The appearance of *Cyprinus carpio* in Dal Lake and Loktak Lake has affected the indigenous fish population.

(4) Common carp have a dependency on sucking meal organisms in the dust on the pond bottom and margins, which makes the water muddy and weakens the base of the pond dyke, resulting in erosion. With the useful resource of anglers, *Cyprinus carpio* has been taken into consideration as a pest in game waters for making the pond water muddy.

(5) In Govind Sagar reservoir, the advent of silver carp has a terrible effect on fish variety.

(6) In India the way of life of remarkable carps is uneconomical due to its low fee. The flesh of those fishes are awful in pleasant or have unwanted grass-odour (grass carp).

(7) The introduction of Guppy and Mosquito Fish (*Gambusia*) in India has a poor effect on aquatic biodiversity. The Mosquito Fish are hardy and prolific breeders, and are able to stepping into the microhabitats of uncommon local species and have been said as predators.

The well-known Ichthyologist Mayer (37) labelled this species as a “fish destroyer”. IUCN has moreover said that the cause of extinction of some of species global has been due to advent of Guppy.

(8) Game fishes creation into Indian waters has been considered previously as non-intricate. At gift trouts were advised no longer first-rate to compete with neighbourhood stocks but additionally have been found to be a high predator (Rainbow Trout) on the eggs and young ones of neighbourhood species.

(9) The fishes illegally imported to India encompass the carnivorous and voracious feeders which includes the massive-head Carp (*Aristichthys nobilis*) and the African Catfish (*Clarius gariepinus*), and the aquarium fish, the red Piranha (*Serrasalmus nattereri*). The ones particular fishes in herbal water our bodies have end up a very crucial danger to the smaller indigenous fish species in addition to invertebrates.

The danger posed with the aid of these fishes has led the Union Agriculture Ministry to order the killing of those fishes en masse. But, such authorities order has did not have any effect. Even these days the African catfish and piranhas have been bred inside the farms of West Bengal and Kerala.

(10) On the aspect of the appearance of special fishes, transfer of parasites and illnesses has additionally been suggested from the Indian waters. This can bring about the formation of tons risky mutated bureaucracy.

(11) Introduction of one of a kind fishes to different habitats in India can also result in loss of biodiversity.

Because of this, it may be concluded that different fishes no longer most effective compete with indigenous species for food and habitat, they will additionally be preyed upon. The first-rate species introduce new parasites and illnesses, give up resulting the manufacturing of hybrids and causing genetic ‘erosion’ of indigenous species and degradation of the physico-chemical nature of aquatic environment.

Those types of ultimately will result in the lack of biodiversity. The capability threat additionally impacts the socio economic factors of the human community, as they depend upon the aquatic environment for their sustenance.

**Conclusion and recommendations:**

The following are the recommended plan for controlling alien species before species are allowed to enter.

o. Various nations have to have strict regulations for importing distinguished fish into their nations.

o. Simplest species that haven't any or much less poor impacts on the surroundings need to be imported.

o. Aquaculture of exclusive fish species inside the various international locations should be promoted however now not in proximity to herbal water our bodies.

o. Ministries of agriculture for various international locations have to prepare guidelines on the control and motion of fish and fish product.

o. Implementation of worldwide and regional codes of behaviour have to be undertaken

o. Extra research need to be performed at the influences of current unique species at the environment.

It’s far hard to evaluate the fulfilment of introductions for a spread of motives. The number one problem said by using Allendorf (38) is that fish introductions are frequently made without suitable mechanisms to assess if the desired objective(s) are done. Geographical and temporal scales of contrast had been used to assess successes however were found to present several troubles. As an instance, introductions in sure cases have improved the quantity of species current within a particular geographical place. Viewed on this slender scale, introductions may seem to boom biodiversity. But, these introductions have also caused the extinction of many species. Therefore, on a global scale, such introductions lessen biodiversity. The temporal scale is likewise very critical to bear in mind. Any useful outcomes of introductions normally occur right now, even as the damaging effects are frequently behind schedule. Thus, we are always faced with political and financial stress to embody short-term advantages at the value of the long-time period well-being of an ecosystem. Going ahead, the want to absolutely apprehend and limit the threats of introductions before such packages are carried out cannot be overemphasized. The introductions have to most effective be objective-driven, and suitable mechanisms of evaluation and tracking of the favoured objectives ought to be an integral part of this attempt. Tips display that education, cooperation, law, and studies are the key problems when coping with species introductions. A studies program to take a look at the long-term effects of distinct fish species at the environment and fisheries assets is very essential for herbal useful resource conservation and management. Man or woman nations and their people have a duty to assist guard neighbourhood environments from undesirable special fish species. Control selections as regards fish introductions should be completed by way of umbrella control agencies in preference to character states being allowed to pursue their personal agenda. Policies and guidelines ought to be developed and enforced to apprehend and encourage cooperation among accountable companies to protect the herbal surroundings. Many beyond and contemporary arguments in favour of introductions had been based totally on perceived societal needs. Society should understand that such introductions involve a "value," and we do no longer understand natural systems sufficiently to know what the value may be. There may be a want to increase efforts to teach the public and control companies on the limitations and dangers of fish introductions.

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