



## Invasive Fish Species in Indonesia: A Review

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### ABSTRAK

Penelitian ini mengkaji dampak spesies ikan invasif di Indonesia, yang menjadi isu penting dalam upaya menjaga keberlanjutan ekosistem perairan. Penelitian ini bertujuan untuk mengidentifikasi spesies ikan invasif yang ada dan mengevaluasi dampaknya terhadap biodiversitas lokal. Metode yang digunakan mencakup tinjauan literatur dan survei lapangan untuk mengumpulkan data mengenai distribusi spesies invasif. Hasil penelitian menunjukkan bahwa spesies invasif tidak hanya mengancam keberadaan spesies asli, tetapi juga mengganggu keseimbangan ekosistem secara keseluruhan. Temuan ini menyoroti pentingnya pengelolaan yang efektif untuk mencegah penyebaran lebih lanjut dari spesies invasif, serta perlunya peningkatan kesadaran masyarakat mengenai dampak negatif yang ditimbulkan. Penelitian ini diharapkan dapat memberikan kontribusi dalam pengembangan strategi pengelolaan sumber daya perairan yang lebih baik.

**Kata kunci:** biodiversitas, ekosistem, Indonesia, ikan invasif, manajemen

### ABSTRACT

This study examines the impact of invasive fish species in Indonesia, which is an important issue in efforts to maintain the sustainability of aquatic ecosystems. This study aims to identify existing non-native fish species and evaluate their impact on local biodiversity. The methods used included a literature review and field surveys to collect data on the distribution of invasive species. The results showed that invasive species not only threaten the existence of native species, but also disrupt the overall balance of the ecosystem. The findings highlight the importance of effective management to prevent the further spread of invasive species, as well as the need for increased public awareness of their negative impacts. This research is expected to contribute to the development of better aquatic resource management strategies.

**Keywords:** biodiversity, ecosystem, Indonesia, invasive fish, management

### INTRODUCTION

Fish are very popular aquatic species for general consumers and as

ornamental fish. Each fish species has a distribution range that is influenced by its biogeographic history (Aini *et al.* 2024).

Invasive species are generally very similar to native species and have the potential to become beneficial, dangerous, or neglected fish. Of these three, a species is considered invasive only if the non-native species has some adverse effect. In other words, an invasive species is non-native species that is considered dangerous because it has the potential to adversely affect the environment or have undesirable consequences for humans. These impacts can be classified into three categories: economically harmful, threatening to human health, and ecologically potentially destructive (Andriyono *et al.* 2021). Several authors have reviewed the negative impacts of non-native and invasive alien fish in general and specific species in Indonesia. The threat of invasive alien fish to native fish biodiversity and the status of invasive alien species (including ornamental fish traded in aquarium fish stores) in Indonesia have been generally discussed. The impact of the Red Devil fish (*Amphilophus citrinellus*) and the genus *Pterygoplichthys* has also been reviewed. Recently, the global distribution of the genus *Pterygoplichthys* and the suitability of *Pterygoplichthys pardalis* and *Pterygoplichthys disjunctivus* in Indonesia have been modeled and mapped (Dina *et al.* 2022).

Invasive fish in Indonesia are influenced by several key factors. Global trade and aquaculture significantly contribute to the introduction of non-native species, as the international trade of ornamental fish and seafood can lead to escapes from farms into local ecosystems. Climate change also plays a role, as rising temperatures and changing sea levels create favorable conditions for some invasive species to thrive. Additionally, habitat modification due to coastal development, deforestation, and pollution makes ecosystems more vulnerable to invasions. Increased maritime traffic further facilitates the unintentional transport of

invasive species through ballast water and biofouling on ships. Poor management practices, including inadequate regulation and lack of public awareness, exacerbate the problem. Natural disasters, such as tsunamis and flooding, can disrupt ecosystems and create pathways for invasive species to spread. Addressing these factors requires comprehensive management strategies, including stricter regulations on trade, habitat restoration, and public education to mitigate the impacts of invasive aquatic animals in Indonesia (Evan & Putri, 2021).

Fish play a crucial role in Indonesia's ecology, economy, and culture. The country is home to some of the world's most biodiverse coral reefs, which support a wide variety of marine life and help maintain ecosystem balance while protecting coastlines. The fishing industry is a significant economic contributor, providing livelihoods for millions and making Indonesia one of the largest fish producers globally. Additionally, the rich marine biodiversity attracts tourists for activities like diving and snorkeling, bolstering the tourism sector. Culturally, many Indonesian communities have deep ties to aquatic animals, integrating them into traditions, cuisines, and spiritual beliefs. However, environmental challenges such as overfishing and pollution threaten these ecosystems. To combat these issues, Indonesia has established various marine protected areas and encourages community involvement in conservation efforts. Overall, aquatic animals are integral to Indonesia's ecological balance, economic stability, and cultural identity, making their protection and sustainable management vital for the future (Evan & Putri, 2021).

The methods used in the article journals included a combination of literature review, field surveys, and regulatory analysis. The authors identified non-native and invasive fish species through surveys and gathered data on their distribution across various regions in Indonesia. They classified the impacts of these species on native ecosystems and analyzed factors contributing to their spread. Additionally, they reviewed existing regulations and management practices implemented by the Indonesian government to prevent and control invasive species. The study utilized mapping techniques to illustrate the distribution of invasive aquatic animals, providing a comprehensive overview of the situation in Indonesia.

This study aims to provide a comprehensive discussion about the impacts of invasive fish species in Indonesia, including their negative effects on biodiversity, the economy, and human health. The text also aimed to identify the factors that facilitated the spread of invasive species, explain their distribution in various regions, and highlight the importance of management strategies to address these issues. Additionally, the text emphasized the crucial role of fish and aquatic animals in Indonesia's ecology, economy, and culture, as well as the need for protection and sustainable management to maintain ecosystem balance.

## RESULT AND DISCUSSION

### a. Distribution of Invasive Fish in Indonesia

Non-native fish are species that live outside their natural habitat, while invasive fish are introduced non-native fish that have a negative impact on aquatic communities. The introduction of a species into the environment will go through several

stages, becoming an invasive species (Robin *et al.* 2023).

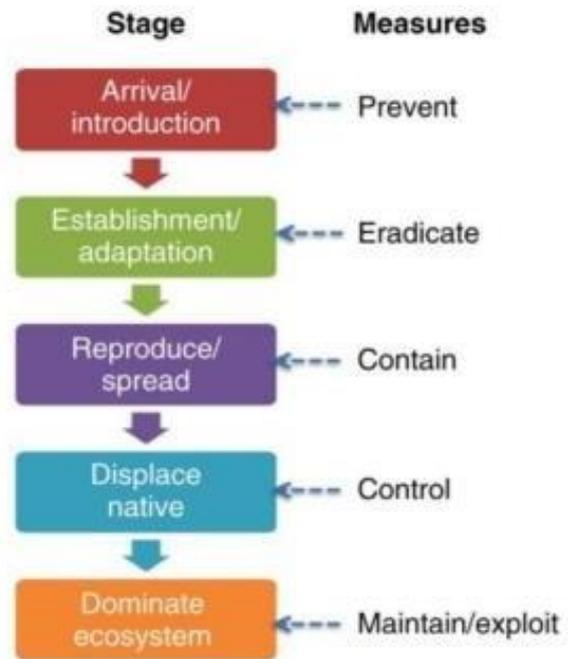


Figure 1. Stages of biological invasion (Andriyono & Fitriani, 2021).

Alien fish in Indonesian waters Indonesian waters, can be categorized into two parts, namely foreign fish that do not disturb the population of native fish in an aquatic ecosystem; and alien fish that disturb populations of native fish in an aquatic ecosystem. Generally, alien fishes that are not disruptive, even capable of increase total fisheries production, include catfish (*Pangasiadon hypothalmus*), goldfish (*Cyprinus carpio L.*), tilapia (*Oreochromis niloticus*); is considered not detrimental to the Indonesian fisheries sector. Including various alien ornamental fish species that increasing the production and business of Indonesia's ornamental fish production and business, among others: hyacinth fish (*Betta splendens*), chef fish (*Carassius auratus*) and koi carp (*Cyprinus carpio*) (Syafei & Sudinno, 2018).

In marine ecosystem, the invasive species is not only belongs to Pisces class, but also other taxa. The distribution of marine

which thrive in Indonesia's freshwater ecosystems, mainly in lakes. Java Island has the highest number of alien and

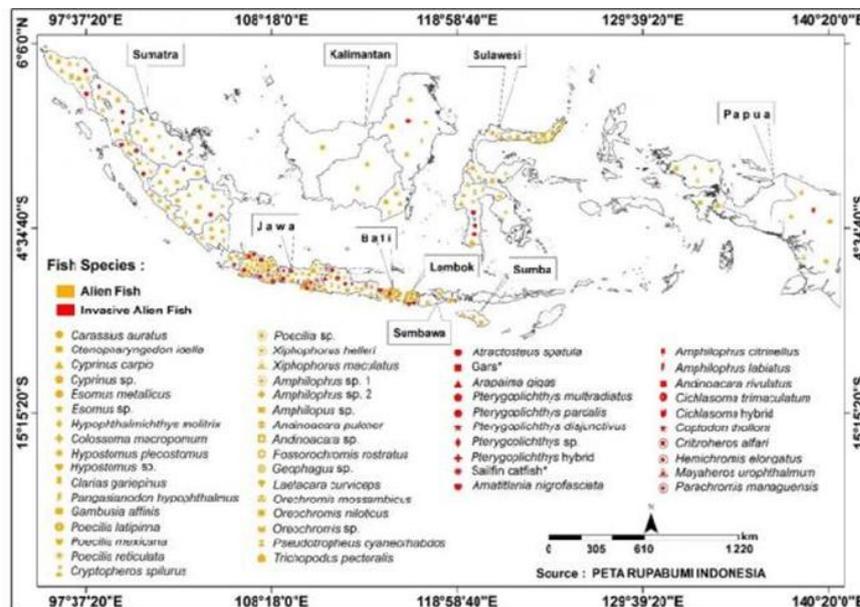


Figure 2. Map of alien and invasive alien fish distribution in Indonesia (Dina et al. 2022)

invasive species in Indonesia shows that the Mollusca phylum has the highest invasion rate at 27%, followed by Echinodermata 16%. Invasive species can significantly affect native species and ecosystems by acting as predators, competitors, pathogens and parasites. Rapid penetration can lead to the extinction of native species, highlighting the need for early detection and management strategies. Most invasive species are found in coral reef habitats, which are critical to marine biodiversity. Coral reefs serve as defense, protection, and breeding grounds for a wide variety of marine life. Most (64%) of the invasive species studied have a status of Not Evaluated (NE) according to the International Union for Conservation of Nature (IUCN), indicating that these species have not been thoroughly studied (Zalzabil et al. 2023).

There are an estimated 50 alien fish species in Indonesia, with 18 of them classified as invasive fish. These fish come from eight different orders and ten families,

invasive fish species, with 39 species, followed by Sumatra with 23 species, Sulawesi with 15 species, Bali with 11 species, Lombok in West Nusa Tenggara with 10 species, Papua with 8 species, Kalimantan with 7 species, and Sumbawa and Sumba in East Nusa Tenggara with 3 species. Foreign fish species most commonly found in lakes and rivers include *Oreochromis niloticus*, *O. mossambicus*, *Cyprinus carpio*, *Trichopodus pectoralis*, *Clarias gariepinus*, *Pangasianodon hypophthalmus*, *Poecilia reticulata*, and *Xiphophorus helleri*. For example, *O. niloticus* was detected in 73% of the sampled lakes and in 68% of the rivers (Dina et al. 2022).

Figure 3 shows the distribution of invasive species in Wallace region. The map shows that Lake Matano joins Mahalona via the Petea river. Mahalona joins Towuti via the Tominanga river, and finally via the Larona river, which is the estuary of the Malili lakes, ending in the Gulf of Bone ending up in the Gulf of Bone. The

in Lake Batur. For Poeciliidae family, Bonylip barb (*Cyclocheilichthys apogon*) is clearly identified. The spotted barb (*Barbodes binotatus*) showed a species complexity that still needs to be resolved. Poeciliidae species were found in a shared habitats with small Midas cichlids (Gustiano *et al.* 2023).

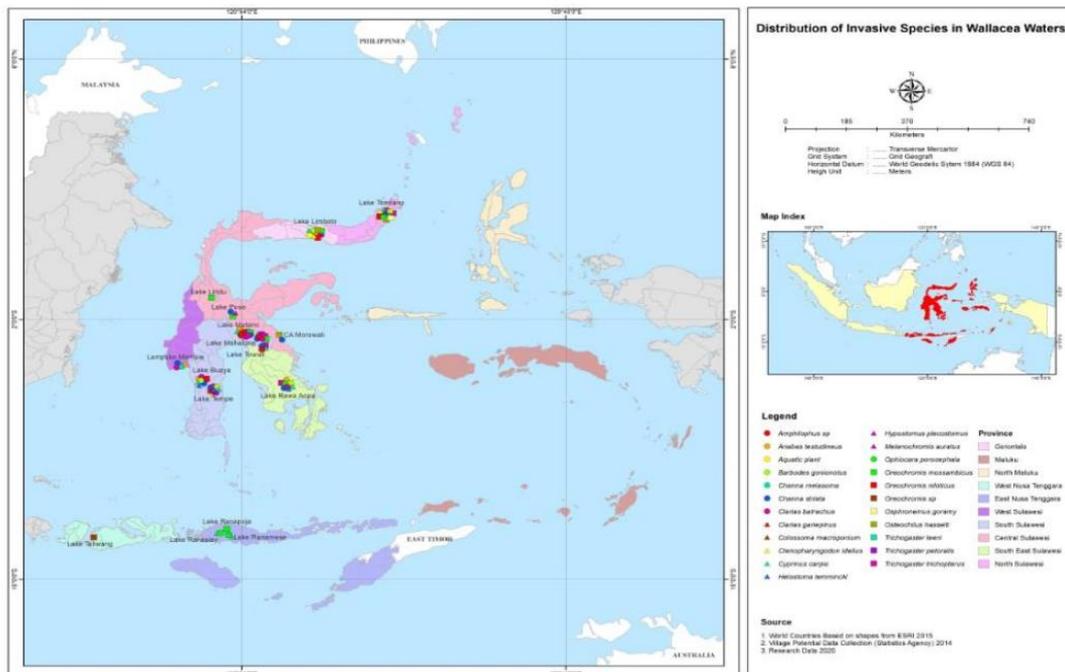


Figure 3. Aquatic invasive species distribution map within the Wallace region (Yanuarita *et al.* 2020).

interconnectedness of these three lakes may explain, in part, the number of invasive species recorded decreased from Matano with 9 species, Mahalona with 7 species and Towuti with 4 species. In addition, the establishment of an endemic species conservation zone in Lake Towuti may be effective in controlling the introduction of invasive species into the lake (Yanuarita *et al.* 2020).

In Lake Batur, Bali 17 species belonging to 8 families invasive fish were found. The most dominant fish family in Lake Batur is Cichlidae, represented by non-native species Nile tilapia and Midas cichlids. Furthermore, Midas cichlid become invasive with a very rapid increased number in population during last 10 years

The presence of invasive fish species in the Ciliwung River poses a significant threat to the local aquatic ecosystem. With 10 species identified across 5 families and 4 orders, including dominant species such as Plecostomus (*Pterygoplichthys pardalis*), Mosquito Fish (*Gambusia affinis*), and Guppy (*Poecilia reticulata*), the river faces a substantial challenge in maintaining its biodiversity. Moreover, the discovery of six new invasive species further exacerbates the situation, including Bristlenose Pleco (*Ancistrus temminckii*), Glossom (*Andinoacara rivulatus*), Carp (*Cyprinus carpio*), Red Devil (*Amphilophus labiatus*), African Catfish (*Clarias gariepinus*), and Guppy (*Poecilia latipinna*) (Ainy *et al.* 2024).

**b. Management Status**

The Indonesian government, through relevant ministries, has issued several regulations to help prevent the introduction of invasive fish species into Indonesian waters. The first regulation, through the Minister of Agriculture Decree

health certificate issued by the competent authority in the country of origin and an entry permit from the Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries. Imports are further restricted to certain designated points and contact must be made with designated officers immediately upon arrival to fulfill

Table 1. List invasive fish species according to Number 19/PERMEN-KP/2020 (KKP 2020

Common Name	Scientific Name	Origin
Arapaima	<i>Arapaima gigas</i>	Amazon River, South America
Piranha	<i>Pygocentrus sp.</i>	South America
Alligator Gar	<i>Atractosteus spatula</i>	North America
Snakehead Fish	<i>Channa sp.</i>	Africa and Asia
Nile Tilapia	<i>Oreochromis niloticus</i>	Africa
Red-bellied Pacu	<i>Piaractus brachypomus</i>	South America
Peacock Bass	<i>Cichla sp.</i>	South America
Suckermouth Catfish	<i>Pterygoplichthys sp.</i>	South America
Red-eared Slider	<i>Trachemys scripta elegans</i>	North America
Clown Knifefish	<i>Chitala ornata</i>	Southeast Asia

179/Kpts/Um/3/1982, prohibits the entry of seven harmful fish species from abroad into the territory of the Republic of Indonesia from abroad into the territory of the Republic of Indonesia. In terms of regulation, through Law No.16/1992, animal, fish and plant quarantine was established under the Agricultural Quarantine Agency, Ministry of Agriculture. In 2009, the Ministry of Marine Affairs and Fisheries No. 17/2009 (Permen 17 KKP/2009) prohibited the entry of "dangerous" fish species in Indonesia. In 2014, the Ministry of Marine Affairs and Fisheries through Ministerial Regulation "Permen KP No. 41/PER/2014" enacted regulations to control 152 invasive and harmful species in waters, of which 79 species of Pisces have the potential to become invasive in Indonesia, and most recently Number 19/PERMEN-KP/2020 (KKP 2020). A total of 71 invasive fish species are banned by the latest Ministerial regulation. The import, cultivation, distribution, and export of these species are all restricted. In addition, imported fishery commodities must meet applicable regulatory requirements, including having a

quarantine measures (Haryono, 2016).

If foreign fish penetrate Indonesian aquatic habitats, management measures must be implemented. The first step is to identify whether the foreign fish in the water body are invasive. Standardized operational procedures should be developed to make field identification easier. There are numerous methods of control, including chemical control with insecticides, herbicides, and fungicides. The drawback is that it may kill non-invasive species. Mechanical management involves physically removing foreign species or modifying habitat conditions. This is often effective, although it can be expensive and time-consuming. Biological control refers to the introduction of natural enemies, predators, or parasites. This treatment aims to protect the environment. If these steps are unsuccessful, "removal" is required and should be monitored on a regular basis. Following these efforts, the next stage is to implement recovery 11 steps. Recovery is an effort designed to reduce the likelihood of non-native species infiltrating the aquatic ecosystem. To

ensure the long-term viability of all invasive fish management activities, the government, business sector, and non-governmental organisations must build institutional capacity (Syafei & Sudinno, 2018).

## CONCLUSIONS

The conclusion of this study emphasized that invasive fish species had significant impacts on aquatic ecosystems in Indonesia. The research successfully identified various invasive species and analyzed their implications for local biodiversity. The findings underscored the urgent need for immediate action in managing aquatic resources to protect native species and maintain ecosystem balance. Additionally, the study highlighted the importance of collaboration among the government, researchers, and the community in controlling invasive species. Therefore, collective efforts were necessary to ensure the sustainability of aquatic ecosystems in Indonesia.

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