JoAS Volume 9 No. 2 October 2024
DOI: https://doi.org/10.24073/joas.v9i2.56567

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

OPEN ACCESS

Journal of Aquaculture Science

Management Challenges of Marine Ornamental Fish and Their Utilization as The Sustainable Potential Marine Resources

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Article info:

Submitted: 14 May 2024
Revised: 9 October 2024
Accepted: 10 October 2024
Publish: 28 October 2024

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ABSTRACT

Coral ornamental fish become potential fishery commodities, providing opportunities and challenges in managing fishery resources in Indonesia. This activity has long been done and has become one cause of damage to coral reefs in Indonesia. Changes in paradigm and technology currently applied in Indonesia are expected to provide a gradual regulatory and coral reef ecosystem improvement. The commercial trade of ornamental fish requires attention and rigorous regulation. The marine ornamental fish trade activity is expected to improve and drive the coastal communities' economy. The significant increase in exploitation is expected to be controlled with the right regulations. This regulation must refer to the concept of sustainable development established through the Sustainable Development Goals (SDGs), especially SDGs number 14 concerning life underwater. The existence of reef fish is enough to provide economic movement, which continues to heat up, especially after the pandemic and the reopening of flights and export activities abroad. However, multi-stakeholders should ratify the concept of sustainability and environment-friendliness. Support from the government, academia, industry, and community groups must be aligned and in tune to achieve sustainable development goals. Providing accurate information related to the biological characteristics of reef fish is an essential contribution for researchers that can be used directly by the community. Thus, the exploitation of reef fish can align with efforts to conserve coral reef ecosystems closely related to global warming and climate change.

Keywords: coral ecosystem, diversity, Indonesia, ornamental fish, marine habitat

INTRODUCTION

As part of the countries that include the Coral triangle (White et al., 2014), coral reef ecosystems have provided various benefits to the community. Coral reef ecosystems have been felt to benefit the provision of goods and services. Ecologically, the services generated from these ecosystems are grouped into physical structure, biotic, bio-geo-chemical, information, and social/cultural services (Moberg and Folke 1999; Woodhead et al., 2019). From the economic value assessment, this ecosystem generated economic benefits for coastal communities, especially in Indonesia. This financial gain is generated from trading coral reef fish for consumption or as ornamental pet fish. This activity has become an activity of small-scale fisheries activities (Allison and Ellis, 2001). Associated with the increasing demand for ornamental fish, some negative impacts of this exploitation have begun to be felt. These also affect the pattern of marine fisheries resource management in Indonesia. This paper tries to

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

collect and review marine ornamental fish exploitation information on Java Island, the center of distribution and trade of ornamental reef fish in Indonesia. Moreover, we also identify problems that arise and several alternative solutions that can be done based on scientific information that can be applied in Indonesia.

Indonesian marine fishes in global trade marine ornamental fish

The activities of ornamental fish cultivation originated from the hobby of growing and becoming very interesting which gives hope to the fishery industry (Fabricio et al., 2022; Landis et al., 2022; Tran et al., 2022). The increase in this industry has been dramatically felt, which started in 1976 and was only done by 28 countries. Currently, more than 125 countries have engaged in training ornamental fish in 2016 (Naufal et al., 2022). This trade-in ornamental fish is not of little value; the report shows that it gradually increased its export value from US$ 177.7 million in 2000 to US$ 347.5 million in 2014. As the largest importing country, The United States import value was US$ 42.9 million (global) in 2014 and reached US$56.5 million in 2016, and the UK (EU region) reached US$ 23.1 million (www.factfish.com).

The export value indicates that trading fish and other coral reef-related biota becomes a profitable economic activity. However, most marine fish species that are collected from the coral reef in the tropical region are factors in the threat of degradation of coral reefs in Indonesia. The exploitation of fish as an economic commodity has been done in Indonesia from the 1960s until now (Ferse et al., 2014). The intensity of marine ornamental fish production increases with the higher selling price of this product. The export of marine ornamental fish until 2011 is lower than the export value of freshwater ornamental fish, which reaches 18,690 EUR for seawater and 38,163 EUR for freshwater.

The contribution of Indonesian marine ornamental fish is quite high compared with some Asian exporting countries. This sector has a positive impact on generating income; on the other hand, it also has a potential negative effect on the coral reef habitat. In general, ornamental fish are very common in various capture technologies, from simple to modern technology, which are used for capture with varied impacts.

Marine ornamental fish habitat

The world's coral reefs are only 0.1% of the world's oceans (Spalding et al., 2001). Although a tiny area, this region has an estimated 400 species in the ecosystem (Froese and Pauly, 2014). Currently, natural damage to coral reefs also occurs and cannot be avoided. Globally, estimated damage has occurred up to 19%. The current condition of the coral reef ecosystem is severely threatened harm for up to 10-20 years (15%), while the other is also in a threatening situation for up to 20 - 40 years (20%) (Wilkinson C, 2008). Damage to coral reef ecosystems as marine ornamental fish habitat occurs naturally and human activities such as overexploitation and coastal development (Wear, 2016), and pollution from the mainland (Lough, 2016).

Gradual seawater temperature changes also cause coral reef ecosystems to die and whiten. Changes in weather and climate in various parts of the world cause coral bleaching, such as in Indonesia, a tropical country with high coral cover. Research on coral reefs in Indonesia has been conducted since 1984, led by the Indonesian Center for Research and Development of Oceanology-LIPI, divided into several phases. The first phase of 124 stations started in 1987-1989, and

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

the next step was monitoring 217 stations from 1989 to 1994, which has 400 stations spread over 48 regions in Indonesia (www.reefbase.org). In a 2002 survey conducted by LIPI, 520 stations from 56 locations spread across Indonesia were measured by coral reef cover using the Line Intercept Transect (LIT) method with improved results compared to the previous years. The results show that 32.3% of coral reefs are weak, 5.5% are in good condition, and the remaining 6.7% are excellent (Chou et al., 2002). Several studies have also been conducted, in Pulau Seribu, Jakarta (Van der Meij and Hoeksema, 2010), the Spermonde archipelago, Sulawesi (Jompa, 1996), and Ambon (Lemmon).

In general, coral reefs in Indonesia are under pressure, and 70% were damaged to varying degrees. It is also reported that the western region of Indonesia is under considerable pressure with increasing population in the Jawa and Sumatra region, so the coral reef degradation in this region is affected by anthropogenic activity (Van der Meij and Hoeksema 2010), besides the significant change of forest land which also leads to high sedimentation and pollution (Wilkinson CR et al., 1993).

Exploitation and Economic Value

The exploitation of fish and coral reefs continues to this day. They use several methods, including gill net, fishing line, trap (trap), and fyke Net (Koeshendrajana and Hartono, 2006). Illegal fishing practices are also used discreetly, like cyanide fishing, because this method of arrest has been banned based on the Indonesian government's rules. Besides, bomb fishing was also reported in 1995-1997 in reef fishing (Pet-Soede C et al., 1999, Pet-Soede Lida and Erdmann, 1998). Environmentally friendly fishing methods are currently being developed to address the issue of the exploitation of reef fish. The process may not be widespread in Indonesia but is applied with several modifications. The ECOCEAN/ECOMAY has developed a friendly method, called CARE equipment associated with collecting, sorting, wearing, and growing procedures and has been patented by INPI (Institute National de la Proriete Industrielle) (Lecaillon, 2004).

Regulation of ornamental fish trade and management

The trading of coral reef commodities, including live reef fish, is subjected to the management policies and strategies set by the government in the Decree of the Minister of Marine Affairs and Fisheries. KEP.38 / MEN / 2004 on General Guidelines on Coral Reef Management. The principle of this policy is to manage the coral reef ecosystem based on the pattern of development between the utilization and sustainability process, which is developed and integrated between the Central Government, Local Government, Regency/City Government, and other supporting elements such as NGOs, academic, and private sector.

Unfortunately, this rule does not specify the species that are allowed and prohibited from being traded. Regulations on the kinds of trade-in animals (animals and plants) are only carried out on organisms in the category of endangered or the status of protected biota from this Act. The conservation law of biological natural resources and their ecosystem (Law No. 5 of 1990) explains that biota use mechanisms are protected against government regulations. The rules and types of species that may be their trading products are regulated in the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

Management of ornamental fish sustainability in natural habitat

The effort of ornamental fish management is made by several mechanisms like conservation "*in-situ*" and "*ex-situ*", which generally pay attention to habitat suitability, ecosystem, and species (Groombridge, 1992). An in-situ conservation approach is undertaken at the site where the marine animals were found. Habitat was then identified with various terminologies such as natural reserves, wildlife sanctuaries, and national parks (Indonesia, 1990). Another approach is of protection for marine biota is through hatchery efforts on several species that have generally become commodities, such as various types of clown fish (*Amphiprion* sp.). These fish have made many hatchery efforts in Indonesia and other tropical nations (Gopakumar et al., 2001, Kumar TT et al., 2010, Kumar TT Ajith et al., 2012). Some species have been successfully cultured in both government and private hatcheries, such as leopard coral trout (*Plectropomus leopardus*), giant grouper (*Epinephelus lanceolatus*), orange-spotted grouper (*Epinephelus coioides*), camouflage grouper (*Epenephelus polyphekadion*), Pompano (*Trachinotus* spp.), Napoleon wrasse (*Cheilinus undulates*) - a species listed by CITES, and golden trevally (*Gnathonodon speciosus*) (Kongkeo et al., 2010).

The Government of Indonesia supports the development program of ornamental fish and corals (Johan et al., 2007, Prasetio and Kusrini, 2012). With the higher selling value of marine ornamental fish products, there is also a challenge in conserving marine areas. According to the IUCN's list, there are 596 species classified as threatened, but only a small portion of these are ornamental fish commodities (Andrews, 1990). Concerning the conservation of marine ornamental fish habitats, which primarily inhabit the coral reefs, it is mentioned that 48% of the coral reef ecosystem in Southeast Asia is in critical condition and 11% has already collapsed (Wilkinson CR et al., 1993). So, it is estimated that about 36% is expected to continue to decline with increasing exploration and exploitation if the practice of unsustainable fishing activities continues.

DISCUSSION

Sustainable use of marine ornamental fish resources should be part of managing Indonesia's coastal and marine areas, which are geographically composed of many islands (Dahuri and Dutton, 2000). Currently, managing a site using an ecosystem approach is essential because it offers several benefits. First, an ecosystem comprises the interaction of abiotic and biotic components. The processes within this ecosystem affect not only the biotic components but also include other elements such as water, soil, air, and humans. Second, the ecosystem approach is necessary because no ecosystem can stand alone; even a single ecosystem relies on surrounding ecosystems to maintain ecological balance. For example, coral reef ecosystems are affected by mangrove and seagrass ecosystems (Ogden and Gladfelter, 1983). The components in the ecosystem also exchange and interact with one another, creating a very balanced environmental unit in each region.

By paying attention to the area's management based on an ecosystem approach, managing marine ornamental fish is also very possible by controlling the coral reef ecosystem as its habitat. A healthy coral reef ecosystem will also produce other marine ecosystems in a healthier condition. The state of coral reefs in Indonesia is now gradually improving with the government and

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

researchers carrying out rehabilitation for conservation and protection. Some results of the rehabilitation process of coral reefs showed satisfactory results, which also impacted the improvement of the habitat of reef fish that live in this region (Fox HE et al., 2002, Fox Helen E et al., 2005).

However, the progress of this ecosystem should also pay attention to good restoration patterns and methods. The implemented restoration also integrates with management activities in important surrounding ecosystems (Moberg and Rönnbäck, 2003). On the other hand, the exploitation of marine ornamental fish is also increasingly intensive due to high economic valuation, which caught the attention of several stakeholders (Ferse et al., 2012). This activity becomes exciting for coastal communities to get alternative income besides commercial fish for consumption. Traditional fishing activities cannot be carried out in certain seasons due to bad weather conditions. However, this activity should not be permitted regularly, and arrangements must be made to realize the sustainable use of ornamental fish resources.

Several approaches have been taken to improve habitats towards sustainable fisheries. The first approach can be made to business actors by socializing sustainable fisheries from fishing methods to the entire production process. This is done to increase the capacity of both the community and marine ornamental fish businesses. This capacity building can be harmonized with the decentralization program, which enables the role of the community in conservation activities as well as in the utilization of existing natural resources. Decentralization management of natural resources in Indonesia began, and several regions showed promising results. The key to successful management can be observed if the central government gives attention to the concept of sustainable management (Wever et al., 2012). The second approach is made by improving the environment and habitat, which can be done with the rehabilitation of coral reef areas and surrounding ecosystems such as mangroves (Andi, 2005; Brown et al., 2014; Field, 1999) and seagrass (Riani et al., 2012). The third approach that needs to be done is law enforcement and legal certainty so that all stakeholders can carry out their roles based on policies implemented for environmental preservation. Macro-view and site-specific enforcement are crucial to note.

In connection with the growing development of the ornamental fish business in Indonesia, several types of reef fish are also threatened to be exploited. Reef fishing has been done in various ways. Some records state that the fishing of coral ornamental fish is carried out using cyanide and it is possible to destroy the reef fish habitat by killing coral reefs. Additionally, an estimated 86.5% of reef fishing is carried out with explosives, while cyanide is used in small groups (10%) and the rest uses other methods (Ernaningsih, 2018). As a result, reef fishing activities stopped because the fish habitat was damaged and the ornamental fish did not reproduce.

Meanwhile, the impact of fishing with cyanide has also been reported in several studies, although it does not directly damage coral reefs it is reported that several fish species are hard to find which indicates a fairly high pressure with a low diversity index value (Budi Setiawan, 2010). The mechanism of action of cyanide poisons was examined on the performance of enzymes in the fish's body, and if exposed for a long time and at high concentrations it can cause death. Another study revealed that after exposure to cyanide, mammoth fish can live in a cyanide-free environment for 14 days (Muyassaroh and Salami, 2017). Even so, the use of cyanide is

pISSN 2550-0910; eISSN 2579-4817
Available online at https://e-journal.unair.ac.id/JoAS

still not recommended in reef fishing because the cyanide will kill coral polyps and damage coral reef habitat (Breen et al., 2018). With the intensive exploitation of reef fish, several NGOs and research centers are developing environmentally friendly fishing methods for these fish through fish traps (Kopp et al., 2020) and line fishing (Tupamahu et al., 2021). In addition, other institutions also support the trade in ornamental reef fish, including the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) (Rhyne et al., 2014, Vincent et al., 2014).

Thus, the attention of the government and all stakeholders becomes important in realizing integrated management of ornamental fish resources. Catch restrictions may be made for several reasons such as the use of environmentally friendly fishing gear and the suitable fishing season. Comprehensive research studies are crucial for providing accurate information on the biology, development, reproduction, and distribution of reef fish, which is expected to enhance the post-pandemic economy of local communities. Management for sustainable use is in line with the Goals of the Sustainable Development Goals (SDGs) number 14 concerning sustainable underwater life.

culture

CONCLUSION

The utilization of marine resources, especially reef fish, needs to get enough attention due to its high demand and direct economic benefits. Ecosystem balance in an exploited habitat is also a concern and needs attention. The health ecosystem supports the welfare of the coastal community that is still very dependent on these natural resources. Potential conservation areas that have been formed are expected to play a vital role with the support of the different stakeholders. The enforcement of the established legislation must be consistent, comprehensive, and revised under the latest conditions. The aspect of utilization must be aligned with management which refers to the concept of sustainable development with the support of all aspects from government, academia, industry, and community groups.

ACKNOWLEDGEMENTS

The authors would like to express our sincere gratitude for the initiation of collaborative research between Airlangga University (Surabaya), Udayana University (Denpasar), and Universitas Bangka Belitung (Pangkal Pinang), which have given great importance to the development of future fisheries studies between Jawa, Bali and Sumatera.

AUTHORS' CONTRIBUTIONS

SAN: ideas, draft manuscript, data analysis, manuscript finalization, and funding, GRA; data analysis, paper preparation and reference mining, AFS; data analysis, draft preparation and discussion, MJA; data analysis, manuscript preparation, and English proofreading.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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