Pak. j. life soc. Sci. (2025), 23(1): 1870-1893 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2025-23.1.00145

CASE REPORT

Domestication Management Model of Wader Fish (*Puntius binotatus*): As a Supporter of Freshwater Fish Biodiversity at DAS Brantas, East Java Province

Yunetta Ferawati[1*], Moh. Khusaini[2], Rita Parmawati[3], Anthon Efani[4]

[1,2,3,4] Graduate School, Universitas Brawijaya, Indonesia

ARTICLE INFO

Received: Nov 22, 2024
Accepted: Jan 13, 2025

Keywords

Dynamic System
Wader Fish
Domestication
Sustainability

***Corresponding Author:**
yunetta.ferawati@gmail.com

ABSTRACT

Wader fish is one of the freshwater fish species that is quite commonly found in river waters in Indonesia, including the Brantas River. The results of the analysis of influential factors show that the decline in the waterish population in this river is caused by 1) Water Pollution: Industrial, household, and agricultural waste dumped into the Brantas River results in the degradation of water quality. Hazardous chemicals and other pollutants can poison the wader fish habitat, significantly reducing their population; (2) Habitat Destruction: Changes in land use around the Brantas River, such as residential development, infrastructure, and intensive agricultural activities, have damaged the natural habitat of wader fish. Deforestation in the catchment area also has an impact on river flow and water quality; 3) Overfishing: Unsustainable fishing practices, including the use of destructive fishing gear and overfishing, have contributed to the decline in the wader fish population; 4) Climate Change: Changes in weather patterns and water temperatures due to climate change can also affect the wader fish population. Rising water temperatures can change the breeding patterns and survival of these fish. The Wader fish population needs to be preserved with integrated efforts such as improving river water quality, habitat rehabilitation, controlling fishing, and educating the public about the importance of preserving river ecosystems. The dynamic model of wader fish domestication can be used as a scenario to preserve the wader fish population in the Brantas River so that it is sustainable. Based on dynamic modeling simulations for 20 years (2020-2040), efforts to restock wader fish seeds and seedlings in the Brantas River Watershed as a result of domestication showed a significant increase of more than 7 million in 2040 for the moderate scenario and more than 10 million in 2040 for the optimistic scenario.

INTRODUCTION

The limitations of resources have made the study of environmental management a significant concern. This issue pertains not only to current environmental management practices but also to those in the future. Consequently, this highlights the importance of sustainable environmental management. This concept has been emphasized in various international agendas, such as the Sendai Framework for Disaster

Risk Reduction (United Nations, 2015), the Strategic Plan for Biodiversity (Secretariat of the Convention on Biological Diversity, 2010), and the 2030 Agenda for Sustainable Development (Faivre et al., 2017). In a specific context, the United Nations later established 17 Sustainable Development Goals (SDGs) as a framework for achieving sustainable development. Specifically, SDG 14 emphasizes the importance of protecting oceans, seas, and marine resources in order to attain sustainability (Cohen-Shacham et al., 2016)(Fang et al., 2019).

In Indonesia, sustainable environmental management has not received significant attention. Practical evidence shows that stakeholders' commitments to slow down, stop, and reverse the direction of environmental degradation are lacking. Development tends to prioritize economic interests over environmental concerns, posing future threats to many natural resources (Herlina, 2017). This situation is indeed highly contradictory to the natural wealth possessed by Indonesia. Specifically, the biodiversity of freshwater fish in the region faces significant environmental threats. This has led to a decline in biodiversity, particularly concerning local and endemic fish species. According to Reid & Miller (1989), the extinction of freshwater fish is primarily attributed to habitat alteration (35%), the introduction of non-native fish species (30%), and overexploitation (4%). The presence of imported or invasive fish in public waters, whether intentional or accidental, exacerbates the challenges to the preservation of local or indigenous fish. Invasive fish species typically exhibit superior adaptability to aggressive environmental conditions and predation, which can directly impact the native fish populations of Indonesia. Furthermore, the increasing intensity of fishing activities contributes to the growing number of local fish species at risk of extinction.

One of the local fish species facing threats is the Wader fish. The Wader fish usually inhabit lakes, rivers, and even clear-water sewers. They are often found living in groups at the bottom of small rocky rivers with calm to moderate flow, with temperatures ranging from 22 - 24°C and pH levels between 6.0 - 6.5 (Hartato, 1986 cited in Hartoto & Mulyana, 1996; Froese & Pauly, 2010). In East Java, there are two types of Wader fish, namely Wader Cakul (genus *Puntius*) and Wader Pari (genus *Rasbora*). Risjani et al., (1998) identified 50 local fish species in the Brantas Watershed (DAS) in East Java from the *Cyprinidae*, *Gobiidae*, and *Cluppeidae* families, including the Wader fish (*Puntius binotatus*) belonging to the *Cyprinidae* genus.

For the communities surrounding the Brantas Watershed, the Wader fish, specifically the *Puntius binotatus* species, holds significant importance. Due to the benefits it provides, the Wader fish is the most recognized and favored choice for consumption among local fish varieties. It is appreciated for its delicious flavor and savory taste, and it can be enjoyed without the need to remove its bones. Additionally, it boasts a high protein content of 14.8 g per 100 g (Setiyoko et al., 2022). Various processed Wader fish dishes are well accepted by the community and have even become a flagship product of the region (Retnoaji et al., 2022). The high demand and exploitation of Wader fish do not match the efforts in domestication and intensive cultivation. This imbalance may lead to extinction (Retnoaji et al., 2017; Rukayah & Lestari, 2021). The community is more accustomed to catching Wader fish in rivers rather than engaging in domestication and intensive cultivation. When engaging in fishing activities, people do not have a precise knowledge of fish species and their characteristics. They also do not understand whether their activities affect the existing fish stock, growth, and species sustainability (Iskandar et al., 2021).

In other instances, there are several factors contributing to the decline in the population of Wader fish in the Brantas River in East Java, including excessive exploitation through illegal fishing, water pollution, environmental degradation, unaccommodating environmental management, and the lack of techniques for sustaining its genetic resources. The introduction of imported or invasive fish species in public waters has also led to a decrease in the number of Wader fish juveniles. Some types of fish, such as Tilapia, Catfish, and Alligator gar, are among the invasive fish species found along the Brantas River in East Java, ranging from Kediri, Jombang, Mojokerto, Gresik to Surabaya. According to the Fish Census book from the Fishery Resources Administration Bureau (SDI), the Secretary of the East Java Provincial Government in 2011-2012 only found 12 local fish species, but Wader Cakul and Wader Pari are no longer found. This indicates that the Wader fish population in public waters is at risk of extinction.

Considering the crucial role of the *Puntius binotatus* species of Wader fish in the Brantas Watershed, East Java, it is imperative to take measures to conserve its population, one of which involves domestication. Thus far, there has been no literature review regarding research on domestication techniques for the *Puntius binotatus* species of Wader fish in the Brantas Watershed in East Java. Consequently, domestication techniques are expected to be beneficial academically, for practitioners, and for the fishing community, which can help support conservation efforts and preserve the original genetic resources of East Java, particularly in the Brantas Watershed in the province of East Java (Ahmad et al., 2019).

Furthermore, for the domestication of the *Puntius binotatus* Wader fish species, researchers have conducted a series of internal research trials to study the feed requirements, gonad maturation process, fecundity, breeding process, and cultivation of Wader fish that have been carried out at the Freshwater Cultivation Development Center (PBAT) Umbulan, East Java Province Fisheries and Marine Service since late 2017. The next step, which has not been implemented yet and is the next stage, is to conduct continuous advanced research by identifying, adapting to artificial cultivation environments and natural environments, and retesting Wader fish domestication techniques through mastering their reproductive biology until the evaluation of the post-domestication Wader fish life cycle can be known and ready for replication. The success of domestication will not only produce seeds for widespread fish farming by fish farmers but will also be carried out as an effort to restock Wader fish seeds in public waters while obtaining approval for release from the Minister of Maritime Affairs and Fisheries. This legality is required before the Wader fish domestication technique is socialized and replicated to the wider community as one of the new fish species whose supply and dissemination are monitored by the government. The success of domesticating Wader fish is expected to provide new scientific contributions that can be utilized and developed by the academic world, practitioners, fish farmers, as well as contribute to enriching East Java's original germplasm resources to help support the sustainability of Wader fish in East Java public waters to maintain biodiversity, especially in the Brantas Watershed, in a sustainable manner.

Generally, based on the above description, the novelty in this research is:

Several studies have indicated that the *Puntius binotatus* species of Wader fish in the Brantas Watershed exhibit genetic differences compared to other Wader fish species in Indonesia. The *Puntius binotatus* species of Wader fish are exclusively found in the waters of East Java, making them an endemic species. However, the *Puntius binotatus* species of Wader fish in the Brantas Watershed are facing the threat of extinction due to the deterioration of habitat quality. Therefore, researchers will utilize the *Puntius binotatus* species of Wader fish in the Brantas Watershed as the subject of their study.

Given the significant ecological importance and benefit to the community of the Wader fish species *Puntius binotatus*, and the lack of research on the domestication of Wader fish in East Java, researchers are working to formulate a technology for domesticating the Wader fish species *Puntius binotatus*. Furthermore, researchers are also conducting tests on the feasibility of managing the domestication technology of the Wader fish species *Puntius binotatus* in the Brantas Watershed in East Java. Consequently, the benefits of managing the domestication technology of the Wader fish species *Puntius binotatus* in the Brantas River in East Java can proceed continuously.

Researchers are striving to model the dynamics of sustainable environmental management of the Wader fish species *Puntius binotatus* in the Brantas Watershed in East Java. The dynamic modeling conducted by the researchers integrates the domestication needs, carrying capacity, and community needs for consumption. From a theoretical perspective, dynamic modeling rarely extends to the level of household elements. In this context, households involve the community as active participants in creating environmental support and beneficiaries. Considering these practical and theoretical needs, the researchers incorporate several functions, including environmental function (preparing suitable carrying capacity for the Wader fish species *Puntius binotatus* in the Brantas Watershed in East Java, based on pollution load indicators affecting biodiversity processes); ecological function (examining the quantity and quality of the Wader fish population in the post-domestication habitat); technical function (related to the production limits of seedlings and consumable seeds post-domestication that can be utilized by the community); economic function (the benefits of Wader fish for the community); and social function (preparing environmental support by involving the community in habitat conservation and management in the Brantas Watershed area).

Based on the background previously described, the objective of this research is to formulate appropriate domestication techniques for the Wader fish species *Puntius binotatus* in the Brantas Watershed, East Java. Develop a sustainable management model for domesticating Wader fish in the Brantas Watershed, East Java. Demonstrate the feasibility of the sustainable management model supporting the biodiversity of the Wader fish species *Puntius binotatus* in the Brantas Watershed, East Java.

RESEARCH METHOD

Research Type

Based on the research objectives aimed to be achieved at the research locus being studied, this type of research can be categorized as development research or also known as research and development (R&D). This study will combine several research approaches including qualitative, quantitative, and system. The qualitative approach is a research approach carried out based on empirical conditions found in the field which describe a phenomenon in words, pictures, and not numbers, moreover, all collected information is likely to be key to what has been studied and has a connection to empirical data. Particularly regarding the determining factors of sustainable management of Wader fish domestication in the Brantas Watershed, East Java. Meanwhile, quantitative data in the study will be used to reinforce the qualitative data that will be used in formulating priority strategy analysis in the control of water pollution in the Brantas Watershed.

Population, Sample & Key Informants

The population in the study encompasses all aspects and stakeholders related to the domestication of Wader Fish and stakeholders influencing sustainable domestication management.

The subjects of the study are the sources of information or individuals of interest. The subjects of this research are the breeders of Wader fish/producers at the UPT PBAT Umbulan, along with their associated groups.

The samples in the research are a subset of the population that serves as the research subjects representing the population. Samples serve as a "sample" of the population, thus must reflect the characteristics of the population (Jannah, 2018). Samples are taken for 2 research objects. Samples test the quality of pollution load in river water in the Brantas watershed and stakeholder samples based on criteria set by the researcher as sample requirements. These include domestication actors, Wader fish breeders, fishermen, local community around the research site, farmers, and industrial players around the research sites.

The research object is the domestication process object, namely the Wader Fish species *Puntius binotatus*.

Data Collection Techniques

Data collection techniques in this study include:

Questionnaire Distribution

This study used a questionnaire method distributed to wader fish farmers and communities living in the Brantas watershed, East Java.

Documentation

Documentation is one of the qualitative data collection methods by looking at or analyzing documents made by the subject himself or by others about the subject. In particular, documentation is done on the data needed for dynamic modeling.

Observation

Observation is an activity of observation and then careful and systematic recording of the symptoms being observed. Observation techniques are also used to determine domestication techniques, contamination loads. Determination of sample points is the most important stage in efforts to monitor river water quality. According to Mahfud, et al (2014) the considerations used in river water sampling are: 1) natural water sources, namely locations that have never been or are still slightly polluted; 2) polluted water sources, namely locations that have undergone changes or are downstream from polluting sources; and 3) utilized water sources, namely tapping / utilization locations.

The determination of sampling points used in this research is purposive sampling at locations representing all characteristics of waste and possible pollution. Before determining the sampling points, a researcher must take into account various considerations that underlie the selection of a point deemed suitable for sampling. One of the researcher's considerations for selecting a point is the belief that the point is a waste discharge point from both domestic and non-domestic sources suspected to contribute to pollution in the Brantas Watershed.

Sampling was conducted using grab sampling method, where samples were taken at specific times to represent the overall waste or body of water. Three replicates of sampling were performed at three points on each sampling site, following the guidelines of SNI 6969.57:2008 by sampling on the left, right, and center of the river with a depth of 0.5 from the riverbed. Sampling for this study is scheduled to take place in September 2022, during the peak dry season when the quality and quantity of water in the Brantas Watershed are at their lowest point.

The aforementioned actions were carried out to gain a true picture of the river's condition. The sampling procedure followed the guidelines outlined in SNI 037016-2004, specifically focusing on the sampling technique for water quality monitoring in a river catchment area. Preservation treatment of water samples involved storing them in a cool box to shield them from external light and ensure the samples' characteristics remain intact. These samples were promptly delivered to an environmental laboratory on the same day. The sampling procedure was tailored for water samples intended for water quality testing, with the parameters of BOD and DO chosen for this research due to their significant impact on the growth and survival of the Wader fish.

The calculation of River Pollution Load based on Minister of State for the Environment Decree No. 110 of 2003 states that pollution load refers to the amount of pollutant element contained in water or waste. There is a limit to the amount of pollution load that a water body can tolerate or allow according to its designated class, also known as the maximum pollution load. This calculation is intended to determine whether the river can still accommodate pollution load or not.

The calculation of the maximum pollutant load can be determined using the following equation:

MPL = Q x CPM

Where:

MPL = the maximum BOD and DO pollution load (kg/day),

Q = measured flow rate (m^3/second), and

CPM = the concentration (standard quality standard based on Government Regulation No. 82/2001 regarding Water Quality Management and Pollution Control for Class I Water).

The actual pollution load refers to the pollution load present in a river under existing conditions. The formula for calculating the actual pollution load is as follows:

APL = Q x CM

Where:

APL = actual BOD and DO pollution load (kg/day),

Q = measured flow rate (m^3/second), and

CM = measured concentration (mg/liter).

Data Validity Test

Several criteria are set in checking the validity of qualitative research data, namely trustworthiness, generalizability, authenticity, accuracy, simplicity, consistency, and comprehensiveness (Klenke, 2016, p. 41).

RESULT AND DISCUSSION

Analysis and Discussion of the Sustainable Management Model for the Domestication of Wader Fish (*Puntius binotatus*)

The Sustainable Management Model of the Domestication of Wader Fish (*Puntius binotatus*) as a Biodiversity Supporter in the Brantas Watershed - East Java Province was developed using powersim studio 10 software. Dynamic system modeling integrates the domestication needs, carrying capacity, social aspects, economic aspects, and community consumption needs.

The Sustainable Management Model of Domestication of Wader Fish (*Puntius binotatus*) as Support for Biodiversity in the Brantas Watershed - East Java Province was created using Powersim Studio 10 software. The dynamic system modeling integrates the requirements of domestication, carrying capacity, social aspects, economic aspects, and community consumption needs.

Social Sub Model

The population around the Brantas watershed area based on time series data continues to increase, so it is predicted that it will continue to increase until 2040. This will have an impact on the amount of housing needed and the amount of domestic waste that will be generated. Fig. 1(a) and Fig. 1(b) shows the increasing population growth and the number of settlements that continue to grow until 17,592,762.3 people and 2,911,822.5 housing units in 2040.

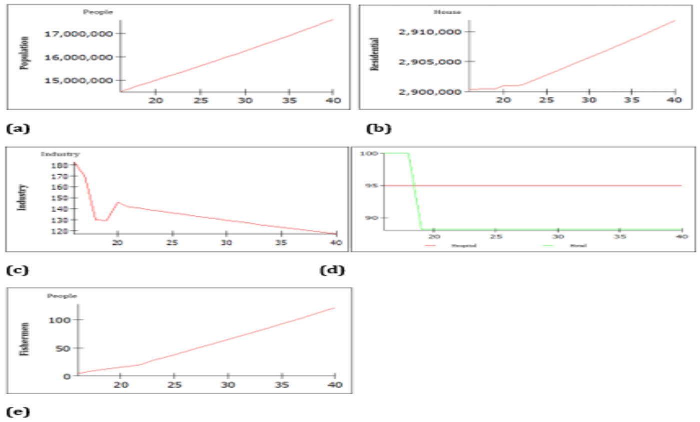


Fig. 1. Simulation Results of Social Sub Model

Description :

(a) Population Growth

(b) Residential Growth

(c) Industry Growth

(d) Hospital and Hotel Growth

(e) Growth of Fishermen

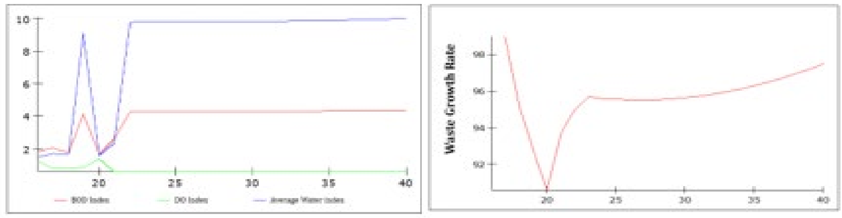
The number of industries around the Brantas Watershed shows fluctuations based on data from BPS, although it tends to decrease until only 117 industries remained by 2040 as shown in Fig. 1(c). This trend needs to be monitored to address environmental aspects impacting the Brantas River. The increasing number of industries will have an impact on the amount of waste produced.

The number of hotels and hospitals around the Brantas Watershed remains relatively constant, with 88 hotels and 95 hospitals as shown in Fig. 1(d). The quantity of hotels and hospitals will affect the amount of waste discharged into the Brantas River, highlighting the need for these establishments to treat their waste properly and not contribute to river pollution.

The number of fishermen utilizing the Brantas River for catching Wader fish continues to increase, reaching 121 fishermen as shown in Fig. 1(e). However, unmonitored fishing of Wader fish by these fishermen could affect the Wader fish population. The Wader fish population is at risk of extinction if their catch is not regulated, which is also influenced by environmental factors polluting the Brantas River, as increased pollution levels in the river will reduce the Wader fish population.

Environment Sub Model

The number of industries or factories operating around the Brantas River are disposing of their waste directly into the river without adequate treatment. This waste contains hazardous chemicals that can pollute the water and damage the river ecosystem. The communities living along the Brantas River often dispose of garbage and domestic waste into the river, increasing the pollution levels and making the river more contaminated. Agricultural waste from the use of pesticides and chemical fertilizers in farming also contributes to the pollution of the Brantas River. These chemicals are often carried by rainwater into the river, resulting in water pollution and deteriorating water quality. Livestock waste around the Brantas river increases the number of pollutants, further worsening the pollution. The increase in population around the Brantas River has led to an increase in the volume of waste dumped into the river, aggravating the pollution conditions. Simulation results indicate that by the year 2040, the pollution index value and the flow rate of the Brantas River are shown in Fig. 2(a).



(a) (b)

Fig. 2. Simulation Results of the Environment Sub Model

Description:

(a) Pollution Index

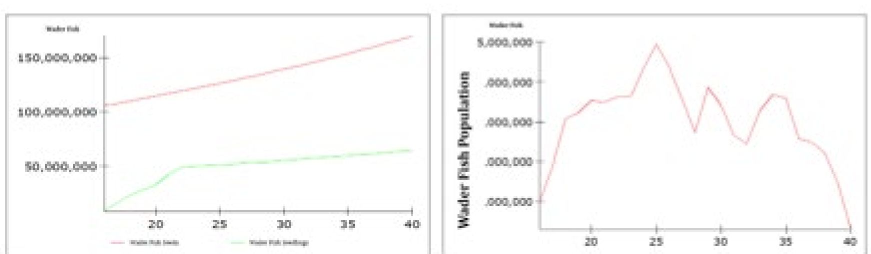
(b) Waste Growth Rate

The impact of this pollution is quite severe, including a decrease in water quality, loss of biodiversity in rivers such as the endangered Wader fish, and health problems for populations relying on river water for daily needs. Fig. 2(b) illustrates that by the year 2040, the growth rate of waste will be 0.98.

Ecological and Technical Sub Model

The seeding and seedling cultivation of Wader fish represent a crucial step in the conservation and management of freshwater fish resources, particularly in East Java, aimed at preserving the Wader fish population in the Brantas River. This process is designed to produce high-quality fish fry that can either be reintroduced into their natural habitat or further cultivated.

The development of Wader fish from seed to seedling is not without challenges, as some fish may not survive the process, resulting in a success rate of approximately 40%. According to the simulation results, the projected number of Wader seeds in 2040 is 169,564,671.7 and Wader fish seedlings are 63,917,858.2 in East Java, as illustrated in Fig. 3.



(a) (b)

Fig. 3. Simulation Results of Ecological and Technical Sub Models

Description:

(a) Wader seeds and seedlings

(b) Wader fish population

The seeding and seedling of Wader fish require special attention to water quality and environmental conditions to ensure high-quality seeds that can thrive when released into the wild or cultivated. The Wader fish population in the Brantas River, based on BPS data, has experienced a decline without domestication, although there was an increase from 2021-2025, but if projected until 2040, there will be a significant decrease of up to 345,955.7 individuals, as shown in Fig. 3.

Economic Sub Model

Economically, the seeding and seedling of Wader fish can be a profitable enterprise with potential for growth, particularly when managed effectively and supported by a stable market. The output of Wader fish seeding and seedling can be sold in local markets or between regions. The prices of Wader fish fry and fingerlings may vary depending on their size, quality, and market demand. The market for Wader fish fry and fingerlings includes fish farmers, hobbyists, as well as restocking programs by government or environmental organizations. Based on farmer income data and operational costs, Wader fish seeding shows a significant difference as depicted in Fig. 4. This indicates that the profits from Wader fish seeding are relatively high.

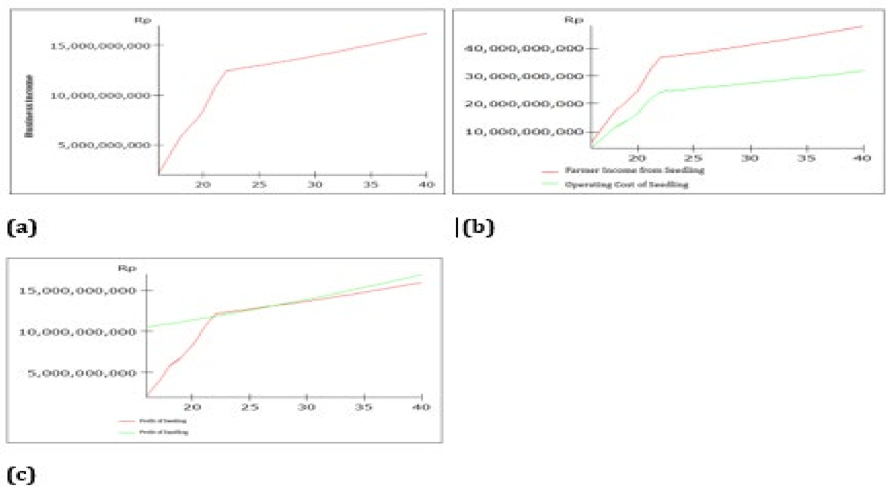


Fig. 4. Simulation Results of Economic Sub Model

Description:

(a) Graph of Farmer Income and Operational Costs of Wader Fish Seedlings.

(b) Profit Graph of Wader Fish Seeding and Seedling

(c) Graph of Business Income of Wader Fish Seeding and Seedling

Profit margins from the wader seeding and seedling process can be quite high, especially if seeding and seedling operations are conducted efficiently. Profits come from the difference between the cost of production and the selling price of the fry. Farmer profits from the seeding and seedling processes continue to increase up to IDR 15,979,464,540.02 per year for seedling and IDR 16,956,467,171.42 per year for seedings in 2024 as the graph of business income is shown in Fig. 4.

Risks and challenges in the process Wader seeding and seedling rely on good water quality making the business vulnerable to environmental changes or pollution that can affect production; Fluctuations in demand for fish fry can affect sales and prices. Farmers need to constantly monitor market trends and have strategies to deal with changes in demand. Fish diseases can be a major threat to wader populations, so fish health management is essential to minimize the risk of losses.

Performance Validation Test

Wader population data based on real data and simulated data is validated by comparing the two values to find the error value. Wader fish population data based on time series data from 2016 - 2021 is compared with Wader fish population data based on simulation results from 2016 - 2021 as presented in Table 1.

Table 1. Real Data and Simulation Results of Wader Fish Population

Years	Real Data	Simulation Results
2016	1010000	1010000
2017	1897596	1897663
2018	3072474	3072115
2019	3231936	3231096
2020	3533778	3533539
2021	3495773	3495651

Absolute Mean Error (AME) is the deviation (difference) between the average value (mean) of the simulation results against the actual value, based on the calculation results obtained AME value of 0.008576%. Absolute Variation Error (AVE) means the deviation of the simulated variance value from the actual, based on the calculation results, the AME value is 0.035%. This shows that the error value is very small so that the Wader fish domestication model is valid.

Model Scenario Analysis

In 2024 Increase the control of residential domestic waste from 30% to 45%, increase the control of industrial waste from 40% to 55%, increase the control of livestock waste from 30% to 45%. Based on the simulation results the waste growth rate and pollution index value can be reduced. The graph of effluent growth rate and pollution index is shown in Fig. 5 below:

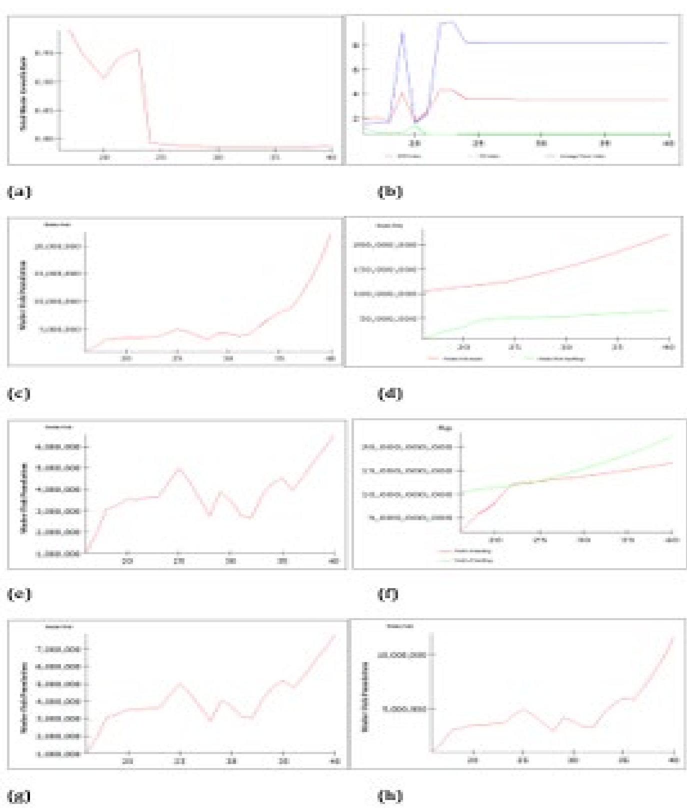


Fig. 5. Model Scenario

Description:

(a) Waste Growth Rate of the Increased Waste Control Scenario

(b) Pollution Index in the Brantas River

(c) Wader Fish Population with Increased Waste Control Scenario

(d) Graph of Wader Fish Seeds and Seedlings with Scenario of Increased Domestication by 40%

(e) Graph of Wader Fish Population with Scenario of Increasing Domestication by 40%

(f) Profit Graph of Wader Fish Seeding and Seedlings with a Scenario of Increasing Domestication by 40%

(g) Wader Population Chart under the Moderate Restocking Scenario

(h) Wader Population Graph with Optimistic Restocking Scenario

Based on the scenario of the Wader fish domestication management model by tightening or increasing waste control, the growth rate of waste and the value of the pollution index in the Brantas river can be reduced so that the Wader fish population in the Brantas river has increased to 20 million fish in 2040. This is in the same direction as the Wader fish conservation program so that it does not become extinct and is always sustainable. The graph of the Wader fish population in the Brantas river based on the scenario results is depicted in Fig. 5(c).

The management model for the domestication of Wader fish can be scenarized to sustain the Wader population in the Brantas River. The results of the model scenario indicate that increasing the domestication program to 40% would significantly enhance the production of Wader fry and seedlings, reaching approximately 169,564,671.7 fry and 63,917,858.2 seedlings by the year 2040, as illustrated in Fig. 5(d). This scenario suggests that by elevating the domestication program to 40% in 2024, the Wader population in the Brantas River could see substantial growth, thereby ensuring a sustainable population of Wader fish. The population graph reflecting this increase, with a 40% boost in the domestication program, is presented in Fig. 5(e), showing a total of 42,461,927.7 fish by 2040.

The domestication program, which was increased to 40%, also had an impact on the economic value of seeding and seedling. The Wader domestication program increased the number of Wader fry so that the economic value of Wader seedings increased higher than Wader seedlings to Rp. 16,956,467,171.42 per year for seedings and Rp. 15,979,464,540.02 per year for seedlings. This is because in the process of Wader fish seeds becoming seedlings, there are many deaths of Wader fish seeds. The profit graph of Wader fish seedings and seedlings is shown in Fig. 5(f).

Research and monitoring related to the population and health of Wader fish, as well as the environmental conditions of the Brantas River, are essential. Regular monitoring of fish populations and water quality is crucial for the preservation of Wader fish. Initiatives aimed at conserving and protecting Wader fish in the Brantas River can be effectively implemented through a domestication program. This domestication process involves adapting Wader fish from their natural habitat to a controlled or cultivated environment. The primary objectives of this process are to enhance productivity, manage their life cycle, and ensure a year-round supply of Wader fish for both consumption and conservation purposes. Findings indicate that conservation efforts for Wader fish in the Brantas River can be supported through a restocking program. This program should involve the introduction of high-quality seeds to achieve optimal results. Additionally, it is imperative that this initiative is accompanied by ecological studies to assess the success of the restocking efforts and their impact on the river ecosystem.

The dynamic model of domestication management of Wader fish with the scenario of moderate restocking in 2024 may enhance the population of Wader fish in the Brantas River. The restocking program scenario can aid in conserving sustainable populations of Wader fish in the Brantas River. The population graph of Wader fish with the scenario of moderate restocking is depicted in Fig. 5(g), showing a population of over 7 million individuals by 2040. The dynamic model of domestication management of Wader fish with the scenario of increased restocking optimistically in 2024 could significantly boost the population of Wader fish in the Brantas River, as demonstrated in Fig. 5(h). The optimistic restocking program scenario results in a population of over 10 million Wader fish by 2040, far surpassing the moderate scenario, thus aiding in the conservation of sustainable populations of Wader fish in the Brantas River.

Wader fish populations need to be conserved with integrated efforts such as improving river water quality, habitat rehabilitation, controlling fishing, and educating the public about the importance of preserving river ecosystems (Xiong et al., 2023). A dynamic model of wader domestication can be envisioned to conserve the wader population in the Brantas River for sustainability. Based on dynamic modeling simulations for 20 years (2020-2040), restocking efforts of Wader fish seeds and seedlings in the Brantas River watershed as a result of domestication showed a significant increase of more than 7 million fish in 2040 for the moderate scenario and more than 10 million fish in 2040 for the optimistic scenario. This is in line with the opinion of previous literatures (Brooker et al., 2020; Fabrice, 2019) that domestication of fish (native species), especially those that are endemic, is able to restore endemic native stocks to avoid extinction, while increasing the added value of endemic native fish species. This domestication process affects all organismal functions and, in particular, behaviors, such as swimming behavior, foraging, predator avoidance, social behavior (aggressiveness, competition, cannibalism), reproductive behavior, cognitive abilities, and even fish personality (such as stress levels experienced) (Teletchea & Fontaine, 2014).

Domestication initiatives are not only ecologically beneficial in terms of restoring native endemic wader stocks, but also provide benefits to surrounding communities (Cucherousset & Olden, 2020). In this case, the community around the Brantas watershed area, especially farmers who cultivate Wader to generate income. The simulation results show that Wader farmers' profits from seeding and seedling businesses can reach Rp. 42,939,486,008.06 in 2040. This finding is in line with the view of (Kwon et al., 2022) that the benefits of biodiversity can be in the form of consumption value, which is the direct benefit that can be obtained from biodiversity, such as food, clothing and shelter. Another benefit is production value, which is the market value obtained from processing and trading biological resources in local, national and international markets.

Feasibility Scenario of Sustainable Management Model for Domestication of Wader Fish *Puntius binotatus* in the Brantas Watershed Area, East Java

Economic Feasibility

Market Aspect Analysis

The market aspect is vital to demonstrate potential demand at favorable price levels. The market is one aspect of the feasibility analysis. The market aspect analysis is to look at demand, supply, and the marketing mix consisting of product, price, marketing location and location.

Demand

The Regulation of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia No. 1115/MEN/2009 on Fish species and restocking areas as well as cultivation-based fishing which states that only local fish species are used for restocking activities and prohibits restocking using invasive/outside fish, has increased the demand for wader fish seeds for restocking needs. The need for local fish seeds for restocking activities, especially in East Java, is at least 2 million fish per year.

Table 2. Projected Demand for Wader (*Puntius binotatus*) / year

No.	Wader fish demand	Individuals/ Year
1.	Trowulan, Mojokerto (for consumption)	24.525.000
2.	Ngantang, Malang (for consumption)	10.950.000
3.	Budidaya Jatim dan Jateng (for consumption)	2.000.000
4.	Restocking (Seed spread)	2.000.000
5.	Jakarta (for consumption)	360.000.000
	Total	399.475.000

Source: Secondary Data (processed)

Based on the projected demand data for Wader fish, it is anticipated that the requirement will reach approximately 399,475,000 individuals, with expectations of an annual increase. The demand projections outlined in Table 2 are specifically aimed at satisfying the consumption needs for Wader fish in Mojokerto and Malang districts, as well as for aquaculture and restocking purposes in East Java Province. However, the demand for Wader fish in other regions of East Java has not yet been documented.

The successful domestication and cultivation of Wader fish have garnered significant interest from both novice and experienced fish farmers, who are eager to learn the cultivation techniques due to the fish's high economic value and relatively elevated market price compared to other freshwater species. The selling price of fresh Wader fish varies by region, ranging from Rp. 25,000 to Rp. 35,000 per kilogram, in contrast to the more volatile market price of catfish, which fluctuates between Rp. 11,000 and Rp. 15,000 per kilogram.

Supply

The number of parent Wader fish resulting from domestication is still limited. Parent Wader fish resulting from domestication in the UPT PBAT Umbulan (Generation 0) amount to 450 individuals and have been bred up to Generation 1 to 3 with a total number of male parents at 3,834 individuals and female parents at 2,166 individuals. The number of parents in each of the Partner Groups is 800 for the Rasbora 15 and 2,000 for the Mina Jam 3.

Table 3. Annual Production Targets for Wader Fish Larvae (*Puntius binotatus*)

No.	Name of Unit	Number of broodstock (fish)	Larval Production Target (Individuals/Year)
1.	UPT PBAT Umbulan	6.000	2.940.000
2.	Rasbora 15	800	336.000
3.	Mina Jam 3	2.000	735.000
	Total	**8.800**	**4.011.000**

Source: Primary Data (processed)

The limited number of Wader broodstock used for this Wader fish farming business has resulted in not being able to fulfill the very high demand for Wader fish seeds. Based on Table 3, the larval production target produced by UPT PBAT Umbulan is 4,011,000 individuals. This suggests that this Wader fish farming business is feasible and has a good opportunity to run due to the higher demand for seeds than supply.

Feasibility Analysis of Investment Criteria

In the financial analysis, the eligibility criteria used to assess the feasibility of the project are Net Present value (NPV), Net B/C Ratio, Internal Rate Return (IRR), and Payback Period (PP).

Table 4. Financial Feasibility of Cakul Wader Fish Enlargement Business (*Puntius binotatus*) at UPT PBAT Umbulan

No.	Investment Criteria	Results
1.	NPV	Rp. 109.256.722,-
2.	Net B/C	2,35
3.	IRR	30,16
4.	PP	0,77 Year

Source: Primary Data (processed)

Based on the results of the financial analysis of the Cakul Wader fish seeding business (*Puntius binotatus*) at UPT PBAT Umbulan, the NPV value is greater than zero, namely Rp 109,256,722, which means that the Cakul Wader fish enlargement business (*Puntius binotatus*) is feasible to implement. The NPV of Rp 109,256,722 also shows the net benefits received from the business over the life of the project against the prevailing interest rate. The Net B/C is greater than one at 2.35 which states that this business is feasible to implement. Net B/C equal to 2.35 means that every one rupiah spent during the life of the project produces a net benefit of 2.35 rupiah. The IRR value obtained from the financial analysis of the Cakul Wader fish enlargement business (*Puntius binotatus*) is 30.16 percent, where the IRR value is greater than the applicable discount rate of 4.75 percent. The IRR value shows the project's internal rate of return of 30.16 percent, and because the IRR value is greater than the discount rate, the Cakul Wader fish enlargement business (*Puntius binotatus*) at UPT PBAT Umbulan is feasible to implement. This business has an investment cost recovery period of 0.77 Period or 0.77 years.

Sensitivity Analysis

Sensitivity analysis calculations use substitute value or switching value techniques. The use of the replacement value technique in sensitivity analysis is performed by replacing several elements in the project analysis, until the project analysis touches the minimum number of feasibility.

The results of the sensitivity analysis with the assumption that a 25% increase in costs does not make the Cakul Wader fish enlargement business (*Puntius binotatus*) at UPT PBAT Umbulan unfit for business, because despite a 25% increase in costs the business sensitivity is quite high with an NPV value of Rp. 21,965,449, -; Net B / C = 1.27 and IRR = 10.75%, meaning that this business has a high enough tolerance to shocks due to a 25% increase in costs.

The feasibility indicators generated show that the NPV value is Rp 21,965,449, indicating that the fish breeding business of Wader Cakul (*Puntius binotatus*) managed by UPT PBAT Umbulan will generate a profit of Rp 21,965,449 over the project's lifetime. The Net B/C ratio is 0.98, meaning that every one rupiah of cost incurred will result in a profit of Rp 0.02 and an IRR of 10.75%, signifying that every cost incurred will benefit the business by 10.75% of that cost each period. However, under the second assumption of a 20.5% decrease in sales results, the NPV value is obtained as -Rp.1,253,000, Net B/C ratio = 0.98, and IRR = 4.35%, indicating that the fish enlargement business of Wader Cakul (*Puntius binotatus*) will incur a loss of Rp.1,253,000 over the project's lifetime. A Net B/C ratio of 0.98 means that every one rupiah of cost incurred will result in a loss of Rp 0.02 and an IRR of 4.35% means that every cost incurred will harm the business by 4.35% of that cost each period..

Based on the sensitivity analysis of the business of cultivating Wader Cakul fish (*Puntius binotatus*) at the Umbulan PBAT, it was found that the assumption of a 20.5% decrease in sales has a greater impact on the viability of the business than the assumption of a 25% increase in costs.

Feasibility of Technical Aspects

The technical aspect is the main aspect that needs to be considered, because in this aspect the calculation of project inputs and outputs in the form of goods and services is carried out based on the actual production flow, so that other aspects of project analysis will only be able to run if technical analysis can be carried out.

Some of the main questions that need answers from a technical aspect are:

Location of the Project

In considering project location in technical analysis, there are main variables discussed, namely: availability of raw materials, location of the intended market, labor supply and transportation facilities.

Availability of raw materials

The availability of raw materials referred to in the cultivation of Wader Cakul fish (*Puntius binotatus*) involves the availability of water with sufficient volume and quality. Wader fish are known to inhabit common water bodies such as rivers, reservoirs, lakes, and others, hence in their aquaculture efforts, they require adequate water volume and quality.

The location of the Wader Cakul fish (*Puntius binotatus*) cultivation business is at UPT PBAT Umbulan, Rasbora Fish Farmers Group 15, and Mina Jam 3 Fish Farmers Group, all of which have abundant and sufficient water availability. The water availability at UPT PBAT Umbulan never diminishes annually. This is because the water source used for aquaculture activities comes from the Umbulan Spring Water Source located approximately 500 meters from the Project site. This Umbulan Spring Water Source is a water source with the largest water discharge volume in Southeast Asia, with a water flow rate of 5,000 liters per second. Water is extracted from the Umbulan Spring Water Source for aquaculture activities in UPT PBAT Umbulan through a special channel measuring 300 meters in length, with a water flow rate of 50-75 liters per second.

For the Rasbora Fish Farmers Group, the water availability for Wader fish farming activities is highly sufficient. The water source used for Wader fish farming activities utilizes the overflow of artesian wells present at the project site. The overflow from the artesian wells is collected in a pond measuring 3 x 20 meters before entering the fish farming pond.

The Mina Jam 3 Fish Farmers Group utilizes the Tirta Berkah water source located in Sumber Gedang Village, Pandaan, which has consistent water availability throughout the year. The Tirta Berkah water source is not only used for fishing activities but also for agricultural activities.

Location of the targeted market

The cultivation of Wader fish is a relatively new venture with few fish breeders engaged in it, thus the targeted market location does not significantly affect the cultivation business. The production of Wader fish by the UPT PBAT Umbulan and the affiliated groups, namely the Rasbora 15 Fish Farmers Group and Mina Jam 3, is not sufficient to meet the demand for Wader fish consumption in the market. Wader fish has been scarce in both traditional and modern markets due to its diminishing presence in nature and declining catch. Consequently, all Wader fish produced by UPT PBAT Umbulan and affiliated groups can only be used for restocking purposes to replenish the Wader fish population in the wild, with very limited supply for consumer consumption. Current conditions indicate that consumers directly approach Wader fish producers/breeders to place orders or acquire products, hence the targeted market location does not hold much significance.

Feasibility of Domestication Technology

Transfer of domestication technology and Cakul Wader fish cultivation began in 2020 to the UPT PBAT Umbulan fostered group. The stages / guidelines in Cakul Wader fish cultivation technology have been outlined in the form of SOP (Standard Operating Procedures) Cakul Wader Fish Cultivation (*Puntius binotatus*). In the implementation of SOP Wader fish cultivation can be adjusted to the conditions of facilities and infrastructure owned by cultivation business actors.

Social Aspect Feasibility

The feasibility of social aspects is seen from the level of acceptance of farmers/fishermen towards wader domestication techniques obtained through the following perception survey:

Farmer/Fisherman Perception of Domestication Techniques

Data on Farmer/Fishermen Perceptions of Wader Fish Domestication Techniques (*Puntius binotatus*) were obtained by distributing questionnaires to farmers/fishermen sampled from upstream to downstream areas of the Brantas watershed, namely Batu City, Mojokerto, Sidoarjo, Pasuruan and Surabaya. The results of the research respondents' answers were then analyzed using the division of assessment levels according to Arikunto (2019) that the measurement results were categorized into; Less (<55%); Adequate (56-75%); and Good (76-100%).

The research findings indicate that the majority of farmers/fishermen express that their satisfaction with the domestication technique of *Puntius binotatus* fish is relatively good, as evidenced by statements such as the fish produced through domestication technique is beneficial for both themselves and the surrounding environment, it provides additional income for them and their community, the domestication technique improves the condition of the Brantas River environment, it supports the conservation of Wader fish in the Brantas River, they endorse the domestication technique of Wader fish in the Brantas River, utilizing the domestication technique of Wader fish in the Brantas River is a wise decision, if feasible, they would implement the domestication technique of Wader fish in areas with similar characteristics, and they would recommend supporting the domestication technique of Wader fish in the Brantas River.

The majority of farmers/fishermen have expressed that their Satisfaction with the Domestication Technique of Wader Fish (*Puntius binotatus*) is quite satisfactory, as indicated by statements such as the ease of implementing the domestication technique of Wader fish in the Brantas River, the minimal requirement of capital for domesticating Wader fish in the Brantas River, the simplicity of learning the standard techniques for domesticating Wader fish in the Brantas River, and the comprehensibility of the procedures for domesticating Wader fish in the Brantas River. In my opinion, the domestication technique of Wader fish in the Brantas River can be applied elsewhere. On average, farmers' overall Satisfaction with the Domestication Technique of Wader Fish (*Puntius binotatus*) is rated at 4.45, indicating a good level of satisfaction.

The results of a descriptive analysis on the Environmental Awareness of farmers towards the domestication technique of Wader Fish (*Puntius binotatus*) indicate that the statement of Respecting the river environment is carried out by not damaging it, Maintaining the river environment is done for the common welfare, Feeling proud when able to maintain the river environment well, Preserving the river environment as a form of gratitude for the blessings of Allah SWT, I strive to seek information on river management, I help to disseminate information on river management to people around me, I make an effort to participate in socialization on the importance of preserving the river environment, I also recommend programs aimed at preserving the river environment, A polluted river will have an impact on the quality of life for myself and those around me, The decrease in river quality poses health risks for myself and those around me, I support and encourage people to actively participate in river environmental cleanliness, If invited to clean the river environment, I will participate. Overall, the entire Environmental Awareness of farmers towards the domestication technique of Wader Fish (*Puntius binotatus*) has an average score of 4.93, which is classified as Good.

Domestication techniques also have benefits, including the increase of:

The number of locations where community outreach and education efforts were conducted increased from 6 in 2019 to 43 by July 2023.

The stakeholders involved in the observation and development of local fish in East Java increased from 120 individuals in 2019 to 840 individuals by July 2023.

The number of local fish species that have been domesticated increased from 12 species in 2019 to 16 species by the year 2023.

The number of local fish released into public waters increased from 592,000 individuals in 2019 to 12,239,665 individuals by July 2023.

The number of eco-tourism locations based on local fish in East Java increased from 3 locations in 2019 to 16 locations in 2023. This growth resulting from the research has directly impacted the community positively in terms of their environmental conservation awareness. Local fish species, once just a story, can now be found in various public waters where releases have been conducted. Moreover, the community is beginning to understand the proper methods of fish stocking in public waters according to existing regulations, ensuring the preservation and population growth of local fish in rivers, water sources, reservoirs, and other aquatic areas.

Feasibility of Environmental Aspects

The number of wader fish seeds restocked from 2018 to 2023 is approximately 5,000,000 seeds to all inland public waters including rivers, reservoirs and lakes in East Java Province. The positive impact of restocking is that the presence of wader fish in nature, which was previously difficult to find, is now widely found. The BAPPEDA JATIM report uploaded on the BAPPEDA website on September 28, 2015, states that "Dozens of Fish Species in the Brantas River Disappeared", including wader. It has changed its status according to Petrus (2019) in his report on the Mongabay Indonesia website, explaining that the results of the river census by ECOTON, show that local / native fish have begun to be found, because the condition of the Brantas river shows recovery. The BKIPM report (Fish Quarantine Agency, Quality Control and Safety of Fishery Products) on its website dated September 14, 2022 with the title "Mapping the Distribution of Prohibited, Protected and Invasive Fish Species (JADDI) in the Barantas River Watershed, East Java", has succeeded in mapping the types of fish in the Brantas river. Based on the mapping results, it shows that wader fish have been rediscovered.

Another positive impact on the community is the emergence of fish farmer groups engaged in the Wader fish farming business and becoming a fostered group of UPT PBAT Umbulan, namely the Rasbora 15 and Mina Jam 3 Fish Farmer Groups. For the fostered group, this Wader fish seeding business can make a good additional income for group members.

Based on the results of the social and environmental analysis, it shows that the Cakul Wader (*Puntius binotatus*) fish seeding business is very feasible to run as it has a positive impact on the community and preserves the natural environment around it.

The development of population activities in the Brantas River Watershed (DAS), such as the increase in residential settlements, household industrial activities and agricultural activities can affect the quality of Brantas river water. The input of dissolved materials produced by the activities of the population around the Brantas watershed to a certain extent will not degrade the quality of river water, however, if the input load of dissolved materials exceeds the ability of the river to clean itself (self purification), then a serious problem arises, namely water pollution, thus negatively affecting the life of aquatic biota and the health of the people who use the river water.

Wardhana (2006) stated that the quality of a body of water is influenced by the activities in its surrounding areas. Often, these activities can degrade the water quality, eventually disrupting the aquatic biota's life.

Additionally, the utilization of aquatic natural resources often impacts the existence of aquatic ecosystem components, both structurally and functionally. According to Odum (1993), biotic components can provide insights into the physical, chemical, and biological conditions of a body of water. Fachrul (2007) explained that environmental degradation and changes in water bodies resulting from human activities can be assessed by observing the aquatic biota present. High-quality water bodies typically host a variety of aquatic biota, while polluted water bodies do not. Changes in water conditions greatly affect the presence and ability of aquatic biota to survive in their habitats. The presence of biota is largely determined by the physical and chemical conditions of the water, leading to varying aquatic biota community structures based on these conditions. This allows aquatic biota to be used as bioindicators of water quality changes. The recent importance of using bioindicators lies in illustrating the relationship between the biotic and abiotic factors in the environment. According to McGeoch (1998), bioindicators are groups of organisms that are sensitive and exhibit symptoms of environmental stress due to human activities or damage to biotic systems. Monitoring the quality of river water is generally done using physical or chemical parameters, but recently, monitoring with aquatic biota has received more attention. Considering that aquatic biota are more effective in expressing river damage, including environmental pollution, due to their prolonged contact with rivers, while physical and chemical characteristics tend to inform about the river's condition only at the time of measurement. Furthermore, aquatic biota are more cost-effective, quick, easily interpretable, and sufficiently reliable in indicating environmental quality (Astirin and Setyawan, 2000).

Wader fish that have known habitat habits and their lethal limits in laboratory-scale research tests will provide environmental services as bioindicators of environmental quality in knowing the physical and chemical properties of river water, especially the Brantas River.

Feasibility of Ecological Aspects

Ecological aspects of domesticated wader fish can be measured by fish survival using multi-location tests in several areas in East Java. The multi-site test is expected to test the extent to which wader growth can be applied to different locations. This multilocation test is based on the altitude of the location of an area. It was conducted in Pasuruan (25-300 masl), Mojokerto district (120-600 masl) and Sidoarjo district (3 masl). Parameters measured in this multilocation test included: initial fish weight, final fish weight, biomass, survival rate, and FCR.

Table 5. Multilocation Test

No	Criteria	Umbulan	Pandaan	Mojokerto (Trawas)	Mojokerto (Dlanggu)	Sidoarjo (Tarik)
1	Site elevation (mdpl)	25	300	600	120	3
2	Average temperature (°C)	22-27	20-26	20-24	25-29	28-31
3	Pond Type	concrete base Soil	concrete base Soil	concrete base Soil	concrete	concrete
4	Pond area (m^2)	300	100	20	12	12
5	Stocking Quantity (individuals)	300,000	100,000	20,000	20,000	24,000
6	Stocking Density (individuals/m^2)	1,000	1,000	1,000	1,500	2,000
7	Initial weight Average (g)	0.025 ± 0.015	0.024 ± 0.018	0.024 ± 0.016	0.025 ± 0.011	0.027 ± 0.016
8	Final weight Average (g)	2.97 ± 0.35	2.92 ± 0.39	2.93 ± 0.37	2.99 ± 0.36	3.09 ± 0.37
9	Trajectories (%)	70	72	60	65	70
10	Raising period	100	100	100	100	100

	(days)					
11	Biomass (kg)	623,7	210.24	35.16	38.87	51.91
12	Feed (kg)	120	35	15	5	7
13	FCR	0.2	0.17	0.43	0.13	0.13
14	Productivity (kg/m²)	2.08	2.1	1.76	2.92	4.33

From Table 5 above, it can be observed that catfish can grow between elevations of 3 masl – 600 masl. The stocking density of these catfish in the nursery ponds until harvest ranges from 1000-2000 fish/m². Assuming a survival rate of 60-72% and an average harvest weight of 3 grams/fish, the productivity of catfish ranges from 1.76 – 4.33 kg/m².

Furthermore, the products of this domestication technique will be internally evaluated by the Cultivation Division of the East Java Provincial Department of Marine Affairs and Fisheries. The purpose of this internal evaluation is to assess the impact of post-domestication implementation related to the number of successful inventoried and collected local fish species, the number of species that have been domesticated, the number of local fish stocking/production, the number of local fish seedlings restocked into the wild until 2023, the amount of capture fisheries production in public waters in East Java, and the number of conservation areas preserving local fish species in East Java. This evaluation will be conducted annually. There are six indicators for internal evaluation: 1. The number of inventoried and collected local fish species; 2. The number of successfully domesticated species; 3. The number of local fish stocking/production; 4. The number of local fish seedlings restocked into the wild; 5. The amount of capture fisheries production in public waters of East Java; and 6. The number of conservation areas preserving local fish species in East Java. All these indicators are measured based on the number of species, stocking/production, restocking, capture production (tons), and conservation areas within one year.

This study highlights the importance of sustainable environmental management based on local wisdom with a holistic approach that considers various indicators. Theoretical findings have resulted in a new discovery, namely the domestication technique of the Wader fish species *Puntius binotatus*, which has been recognized by the government through the issuance of Ministerial Decree No. 62 of 2024 concerning the Release of Wader Cakul Fish (*Puntius binotatus*) Jatimbulan followed by the creation of its management model. This reinforces theories of balance and sustainability that emphasize the need for integration among environmental, social, economic, infrastructure, institutional, conservation, technology, and regulatory dimensions to achieve sustainability goals (Dynamic System Theory Model). Welfare economics theory involving subjective and objective welfare is also strengthened by the finding that the involvement of local farmers post-domestication in breeding or raising Wader fish can enhance their overall quality of life. Furthermore, this research emphasizes the importance of understanding the interdependence of variables in the context of biodiversity conservation in the Brantas Watershed, especially regarding locally endemic fish species on the brink of extinction, supporting the theory that a more integrated and systematic approach is essential in designing effective and sustainable policies.

Practically speaking, the findings of this research offer novel insights to the public regarding the discovery of a method for domesticating wild fish into cultured fish, as well as guidance for fisheries managers in general. Individuals who were previously more accustomed to catching Wader fish in rivers rather than engaging in domestication and intensive breeding will understand the implications of not implementing conservation efforts on the existing stocks of local endemic fish. The research results also serve as a reminder that preserving river environments is crucial in maintaining the ecology of Wader fish, which require a specific quality of habitat. Wader fish can naturally serve as bioindicators of their environment, ensuring their sustainability when their surroundings are clean and free of pollutants. Hence, to enhance the effectiveness of sustainable biodiversity management of Wader fish in the Brantas Watershed, it is essential to reinforce the social and environmental dimensions by involving local communities and industries around the Brantas Watershed, while ensuring fair economic benefits for all stakeholders, including local fishermen and farmers. Moreover, the development of technology and regulatory harmonization must be the primary focus to support more effective and sustainable management practices. The implementation of a sustainable management model utilizing dynamic system methods will provide a holistic understanding, especially when complemented by proper stakeholder grouping, ultimately improving the sustainability of Wader fish biodiversity in the Brantas Watershed. The success of this initiative in preserving the endangered local fish species of East Java, with the involvement of the government and community, has garnered positive responses from various stakeholders both domestically and internationally, including successes in discovering and mastering new technologies for local fish breeding, stocking and restocking activities. Currently, many organizations have adopted and made educational visits to learn about the initiative, including Neighborhood Watch Groups, Ecotourism Groups, Environmental Conservation Communities, Ministry of Marine Affairs and Fisheries, Domestic and International Educational Institutions, Provincial Fisheries Departments, Districts/Cities Fisheries Departments, and the General Public. Furthermore, the general public has been actively involved in releasing locally bred fish into public waters, evidenced by the high demand for local fish fry for restocking in water bodies across villages in East Java, especially during special events.

In the realm of policy, this research finding emphasizes the need for a holistic and integrated top-down policy approach. Policymakers should consider the interactions among various dimensions (environmental, social, economic, infrastructure, institutional, conservation, technology, and regulation) and ensure that each variable can optimally contribute to the sustainability and success of Wader fish biodiversity management in the Brantas Watershed. A number of factors have led to the decline in Wader fish populations in the Brantas Watershed in East Java, including overexploitation through illegal fishing, water pollution, environmental damage, unaccommodating environmental management, and the lack of preservation techniques for its genetic resources. The influx of imported or invasive fish in public waters also contributes to the decrease in Wader fish juveniles. Therefore, policies should focus on enhancing the sustainability of Wader fish, improving community welfare, increasing job opportunities in the aquaculture sector, boosting local business prospects, enhancing community participation, and reducing industrial/domestic pollution in the waters. Additionally, policies should support the development of various other dimensions to ensure optimal synergy among variables. Consequently, well-designed policies will be able to support more sustainable biodiversity management and positively contribute to the well-being of local communities and environmental preservation. Restocking Wader fish juveniles is an initial policy that is expected to have positive implications. The issuance of Minister of Marine Affairs and Fisheries Decision No. 62/2024 on the Release of Cakul Wader Fish (*Puntius binotatus*) Jatimbulan - Appendix 1 is the result of the successful Domestication Technique of Wader fish to enrich the variety of Wader fish circulating in the community as the basis for subsequent environmentally impactful policies.

CONCLUSION

The formulation of Domestication Techniques for the Wader fish (*Puntius binotatus*) species has been proven to be highly beneficial in supporting the fisheries biodiversity in the Brantas Watershed, East Java.

Domestication, in addition to preventing extinction, offers potential benefits in the field of fisheries. The objective of this process is to enhance productivity, regulate the life cycle, and ensure a year-round availability of Wader fish for consumption and conservation purposes. Ecologically, domestication involves inventorying and collecting wild fish species from nature to subsequently transfer them into controlled environments. During this phase, attention must be paid to the mortality factors of Wader fish due to the transition from their previous natural habitat to confined tanks of specific sizes. Key preparations for domesticating Wader fish include studying their biological characteristics (morphology, habitat, and distribution) and reproductive features (traits of males and females, gonad maturity, fecundity). Important considerations when relocating fish from natural habitats to controlled ponds for cultivation include:

Environmental engineering: This involves modifying the habitat to ensure that the water quality is suitable for the wild species intended for domestication.

Understanding feeding habits: This is achieved through surgical procedures on the digestive tract to collect stomach content samples, which are then analyzed to identify both microscopic and macroscopic food organisms (Rusmadania et al., 2023).

Feed engineering: This entails experimenting with the provision of pellets or manufactured fish feed with varying protein compositions. The aim is to ensure optimal growth by adjusting the feed to quantitatively and qualitatively support somatic growth, promote generative growth, and modify environmental and hormonal factors that influence vitellogenesis and ovulation processes.

Spawning engineering: This involves providing substrates in the spawning ponds, such as stones, coir, grass, and raffia.

Cultivating Wader fish until both males and females reach gonadal maturity.

On average, farmers/fishermen stated that satisfaction with the domestication technique of Wader Fish (*Puntius binotatus*) was classified as good, namely in the aspects of usefulness and attitudes towards Wader fish domestication efforts. While in the aspect of ease of implementation, on average, farmers/fishermen stated that satisfaction with the domestication technique of Wader Fish (*Puntius binotatus*) was quite good.

Sustainable management model of wader domestication in the Brantas watershed area of East Java.

Based on the results of the simulation model of sustainable management of the domestication of Wader Fish (*Puntius binotatus*), prioritizing key factors such as domestication, restocking, and waste control can enhance the population of wader fish, thus preventing extinction. This model can aid in predicting the population of Wader fish comprehensively by considering social, environmental, technical, and economic aspects. Various scenarios can be simulated in this model to formulate policy strategies in preserving Wader fish in the Brantas river.

Through dynamic modeling simulation over 20 years (2020-2040), efforts of restocking Wader fish seeds and fingerlings in the Brantas Watershed as a result of domestication show a significant increase of over 7 million individuals for the moderate scenario and over 10 million individuals for the optimistic scenario, along with the potential profit for Wader farmers from seeding and seedling efforts reaching Rp. 42,939,486,008.06 in 2040.

Wader populations need to be preserved with integrated efforts such as improving river water quality, habitat rehabilitation, controlling fishing, and educating the public about the importance of preserving river ecosystems. The results of the dynamic model scenario of Wader fish domestication can increase the Wader fish population, an increase in the Wader fish population can maintain the conservation of Wader fish in the Brantas river in a sustainable manner.

Feasibility scenario of domestication sustainable management model supporting biodiversity of *Puntius binotatus* wader in the Brantas watershed area, East Java.

Based on the results of the analysis, the discus wader seeding business at UPT PBAT Umbulan obtained a profit value of Rp. 2,632,067, - / cycle with a B / C ratio value of 2.81. A positive B / C ratio value indicates that this cakul wader seeding business is feasible. This seeding business has a return on investment period of 4.3 cycles. With a break-even point or BEP value for seed production of 96,689 seeds or a seed selling value of Rp. 5/head. Based on the results of the analysis, the cakul wader farming business at UPT PBAT Umbulan obtained a profit value of Rp. 7,639,667, - / cycle with a B / C ratio value of 1.96. A positive B / C ratio value indicates that this cakul wader seeding business is feasible. This business has a return on investment period of 2.7 cycles. With a break-even point or BEP value for consumption fish production of 318 kg or the selling value of consumption waders of Rp. 12,751/kg.

Research related to the domestication of Cakul wader fish has been successful and proven by the release of the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 62 of 2024 concerning the Release of Jatimbulan Cakul wader fish (*Puntius binotatus*). Domestication of Cakul Wader fish produces Cakul Wader broodstock that can be cultivated in the community. Trials, application, and development of Cakul Wader fish farming technology both seeding and seedling have obtained technological results that are easy to apply in the community. Domestication is proven to produce biological offspring in the form of broodstock and Cakul Wader fish seeds of the G0, G1, G2 offspring to be developed outside the UPT PBAT Umbulan environment and have been utilized by people in the Sidoarjo, Pandaan and other areas in East Java. Apart from cultivation activities, Cakul Wader seeds can also be used as restocking fish in lakes and rivers to prevent the existence / biodiversity of Cakul Wader fish which is increasingly limited.

REFERENCES

Baderan, D. W. K. & Utina, R., 2021. *Biodiversitas Flora dan Fauna Pantai Biluhu Timur (Suatu Tinjauan Ekologi-Lingkungan Pantai).* 1st ed. Yogyakarta: DeePublish.

Bala, B. K., 2022. *Energy Systems Modeling and Policy Analysis.* 1st ed. Boca Raton, FL & Oxon: CRC Press (Taylor & Francis Group).

Bala, B. K., Arshad, F. M. & Noh, K. M., 2017. *System Dynamics: Modelling and Simulation.* Singapore: Springer Science+Business Media.

Balon, E. K., 1995. Origin and Domestication of the Wild Carp, Cyprinus Carpio: from Roman Gourmets to the Swimming Flowers. *Aquaculture,* Volume 129, pp. 3-48.

Darajati, W. et al., 2016. *Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2015-2020.* Jakarta: Kementerian Perencanaan Pembangunan Nasional/BAPPENAS.

Ditya, Y. C. et al., 2022. Assessing the Ecosystem Approach to Fisheries Management in Indonesian Inland Fisheries. *Polish Journal of Environmental Studies,* 31(3), pp. 2579-2588.

Dumas, M., La Rosa, M., Mendling, J. & Reijers, H. A., 2021. *Fundamental Manajemen Proses Bisnis.* Yogyakarta: Andi Offset.

Fabrice, T., 2018. Fish Domestication: An Overview. In: *Animal Domestication.* London: IntechOpen, pp. 1-15.

FAO, 2019. *The State of the World's Biodiversity for Food and Agriculture.* Rome: FAO Commission on Genetic Resources for Food and Agriculture Assesment.

Fauzi, A., 2019. *Teknik Analisis Keberlanjutan.* Jakarta: Gramedia Pustaka Utama.

Gorshkov, S., 2010. Long-Term Plan for Domestication of the White Grouper (Epinephelus Aeneus) in Israel. *The Israeli Journal of Aquaculture - Bamidgeh,* 62(4), pp. 215-224.

Hutubessy, B. G. & Mosse, J. W., 2015. Ecosystem Approach to Fisheries Management in Indonesia: Review on Indikators and Reference Values. *Procedia Environmental Sciences,* Volume 23, p. 148 – 156.

Indarjo, A. et al., 2021. *Domestikasi Udang Galah (Macrobrachium Rosenbergii) Estuaria.* Banda Aceh: Syiah Kuala University Press.

Indrawan, M., Primack, R. B. & Supriatna, J., 2012. *Biologi Konservasi.* 3rd ed. Jakarta: Yayasan Pustaka Obor Indonesia.

Jannah, M., 2018. *Metodologi Penelitian Kuantitatif untuk Psikologi.* Surabaya: Unesa University Press.

Juliana, Koniyo, Y. & Lamadi, A., 2018. *Domistikasi dan Aplikasinya Terhadap Ikan Manggabai.* Gorontalo: Ideas Publishing.

Juwono, P. T. & Subagiyo, A., 2019. *Integrasi Pengelolaan Daerah Aliran Sungai dengan Wilayah Pesisi: Keberlanjutan Pengelolaan DAS untuk Menjamin Kelangsungan Sumber Daya Pesisir.* Malang: UB Press.

Kementerian Lingkungan Hidup dan Kehutanan, 2017. *Petunjuk Teknis Restorasi Kualitas Air Sungai.* Jakarta: Kementerian Lingkungan Hidup dan Kehutanan.

Klenke, K., 2016. *Qualitative Research in the Study of Leadership.* Bingley, UK: Emerald Group Publishing

Limited.
Kristanto, A. H., 2022. *Domestikasi Ikan Air Tawar Asli Indonesia Mendukung Produksi Perikanan.* Jakarta: Badan Riset dan Inovasi Nasional.
Latuconsina, H., 2021. *Ekologi Ikan Perairan Tropis: Biodiversitas, Adaptasi, Ancaman, dan Pengelolaannya.* Yogyakarta: Gadjah mada University Press.
Liao, I. C. & Huang, Y. S., 2000. Methodological Approach Used for the Domestication of Potential Candidates for Aquaculture. In: *Recent Advances in Mediterranean Aquaculture Finfish Species Diversification.* Zaragoza: CIHEAM - Cahiers Options Méditerranéennes; n. 47, pp. 97-107.
MacLaurin, J. & Sterelny, K., 2008. *What Is Biodiversity?.* Chicago & London: The University of Chicago Press.
Marimin, 2017. *Sistem Pendukung Pengambilan Keputusan dan Sistem Pakar.* Bogor: IPB Press.
Mukhlis, I., 2009. Eksternalitas, Pertumbuhan Ekonomi, dan Pembangunan Berkelanjutan dalam Perspektif Teoritis. *Jurnal Ekonomi Bisnis,* 14(3), pp. 191-199.
Pasquet, A., 2018. Effects of Domestication on Fish Behaviour. In: *Animal Domestication.* London: IntechOpen, pp. 91-108.
Price, E. O., 2002. *Animal Domestication and Behavior.* Wallingford, UK: CAB International Publishing.
Puryono, S., Anggoro, S., Suryanti & Anwar, I. S., 2019. *Pengelolaan Pesisir dan Laut Berbasis Ekosistem.* Semarang: Badan Penerbit Universitas Diponegoro.
Putra, D. F., 2021. *Dasar-dasar Budidaya Perairan.* Banda Aceh: Syiah Kuala University Press.
Rathoure, A. K. & Patel, U. R., 2020. Climate Conditions and Biodiversitty Decline: Impact Assesment. In: A. K. Rathoure & P. B. Chauhan, eds. *Current State and Future Impacts of Climate Change on Biodiversity.* Hershey PA, USA: IGI Global, pp. 79-94.
Retnaningdyah, C., 2019. *Blooming Microcystis di Ekosistem Perairan Tawar dan Cara Pengendaliannya.* Malang: UB Press.
Rusmadania, R., Putri, R. F., & Istyadji, M. (2023). The Effect Of Feeding From Fermented Rice Bran At Different Doses On The Growth Of Koi Fish Seeds. *Transpublika International Research In Exact Sciences*, *1*(2), 43–52. https://doi.org/10.55047/tires.v1i2.527
Salim, G. & Anggoro, S., 2019. *Domestikasi Udang: Prospek Masa Depan Sumber Pangan Dari Laut.* Yogyakarta: DeePublish.
Saputro, B., 2017. *Manajemen Penelitian Pengembangan (Research & Development) bagi Penyusun Tesis dan Disertasi.* Yogyakarta: Aswaja Pressindo.
Saraiva, J. L. et al., 2018. Domestication and Welfare in Farmed Fish. In: *Animal Domestication.* London: IntechOpen, pp. 109-135.
Soegianto, A., 2010. *Ekologi Perairan Tawar.* Surabaya : Airlangga Universiry Press.
Solberg, M., 2021. *A Cognitive Ethnography of Knowledge and Material Culture: Cognition, Experiment, and the Science of Salmon Lice.* Switzerland: Palgrave Macmillan.
Supriatna, J., 2008. *Melestarikan Alam Indonesia.* Jakarta: Yayasan Obor Indonesia.
Supriatna, J., 2021. *Pengelolaan Lingkungan Berkelanjutan.* Jakarta: Yayasan Pustaka Obor Indonesia.
van Zeben, J. & Rowell, A., 2021. *A Guide to EU Environmental Law.* Oakland, California: University of California Press.
Wulan, S. & Astuti, T., 2018. Analisis Kelayakan Bisnis Rencana Pendirian Usaha Butik Busana Lady Center Di Pringsewu. *Jurnal FEB,* p. 5.
Yahya, H. S. A., 2010. *Biodiversity Conservation Ethics in Major Religions.* 1st ed. Bloomington, Indiana, America: AuthorHouse.