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Temporal Comparison of Native and Introduced Fish Catches of Cirata and Jatiluhur Reservoir In 2021-2023

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ABSTRACT

The management of capture fisheries in Purwakarta Reservoir, including Cirata and Jatiluhur Reservoir through the identification of catch weights between native and introduced fish, is one indicator of whether the environment is ecologically stressed or not. The method used in this study is a comparative descriptive analysis between secondary data obtained from the Purwakarta District Fisheries and Livestock Service and previous studies in Jatiluhur Reservoir. The highest catch was in 2022 with a value of 1305.98 tons, followed by 2023 with a value of 1235.03 tons, and finally 2021 with 1186.152 tons. There are four native fish species still caught in Jatiluhur Reservoir, with a weight ratio of 8% for native fish and 92% for introduced fish in 2023. In 2022, the weight ratio of native fish was 5% compared to 95%, while in 2023, the ratio of native fish to introduced fish was around 6% and 94%. The data about fishing gear shows a consistent reliance on gillnets and fishing rods over the three years, with a notable decline in fishing rod usage by 2023. The slight increase in boat usage from 2021 to 2022 and its stabilization in 2023 suggests a shift toward more mechanized fishing methods.

***Keywords*:** Catch, Fish, Native, Introduced, Weight, Fishing, Gear, Vessel.

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1. INTRODUCTION

Reservoirs are one type of multipurpose inland water body. The existence of reservoirs can have both positive and negative impacts on the environment. The positive impacts of reservoirs include serving as a storage facility for floodwater, providing a source of electricity through hydroelectric power plants, and facilitating irrigation for fisheries and agriculture. Meanwhile, the negative impacts of reservoirs include a decline in biodiversity, a decrease in river water quality and sedimentation in the upper reaches of rivers due to damming, and the presence of KJA, which can reduce water quality (Nastiti *et al.* 2018)

The Ir. H. Djuanda or well known as Jatiluhur Reservoir, is located at an elevation of 110 meters above sea level with a flooded area of 8,300 hectares. The water level, according to the gauge (i.e., between the highest and lowest water levels) is 25 meters (Deswati and Adrison, 2019). The reservoir is used for fishing and aquaculture. Overfishing occurs during the dry season when the water level in the reservoir is very low. The Jatiluhur Reservoir is a multipurpose dam, with its main function being to meet the irrigation needs of approximately 242,000 hectares of rice fields, supplying raw water for drinking in DKI Jakarta and its surrounding areas, generating electricity with an installed capacity of 187.5 MW, controlling flooding in Karawang, Bekasi, and Jakarta Regencies, supplying water for industry and for 20,000 hectares of inland aquaculture, and for tourism and water sports (Prinajati, 2019). More than nine million residents in the Citarum River Basin utilize the Citarum River for their livelihoods, with most (87%) using it for irrigation and the rest for domestic and industrial water needs (Maarif *et al.* 2018)

Cirata Reservoir is one of the reservoirs in the Citarum River Basin that forms a cascade reservoir formation together with Saguling Reservoir and Ir. H. Djuanda Reservoir, Jatiluhur (Sentosa *et al.* 2022). The reservoir was constructed in 1987 at an elevation of 221 meters above sea level, with the primary purpose of generating hydroelectric power (PLTA). Over time, Cirata Reservoir has also taken on other functions such as tourism, water transportation, and fishing activities, both capture and cultivation in floating net cages (KJA) (Sentosa *et al.* 2022). The development of the fishery business in Cirata Reservoir is reported to be growing rapidly, with an average fish production of around 6,450 tons/month (Nastiti *et al.*, 2018). However, currently, the fishery business in the reservoir is threatened by several problems such as pollution, declining water quality, mass fish deaths, and the presence of alien fish species.

As the utilization of inland waters increases, the pollution load resulting from human activities will also increase. Environmental degradation in reservoirs occurs in all parts of the reservoir, including lacustrine, riverine, and transition zones, due to suboptimal management and utilization. Many large reservoirs have been built without considering interactions or conducting prior evaluations of long-term environmental, social, and economic interactions (Nastiti *et al.* 2018). Evaluations require key parameters to be measured through several studies conducted on reservoirs to be managed. One such study is related to ecological indices that measure the ecological health of a water body, including reservoirs.

The presence of introduced fish in Cirata Reservoir and Jatiluhur Reservoir is believed to have existed since the reservoirs were first built. Fish farming activities in floating net cages (KJA) are suspected to be the cause of the introduction of fish species that are not native to the Citarum River, such as tilapia (*Oreochromis niloticus*), carp (*Cyprinus carpio*), and patin (*Pangasianodon hypophthalmus*) (Umar and Kartamihardja, 2006).

The native fish community in Cirata and Jatiluhur Reservoir was originally made up of fish from the Citarum River that had adapted to the lentic water habitat, but to date, many non-native fish have been introduced to the reservoir, both intentionally for aquaculture purposes in floating net cages (KJA) and unintentionally.

The presence of intentionally introduced alien fish species generally has a positive impact on increasing fishery production (Syafei and Sudinno, 2018). However, some accidentally introduced and invasive alien fish species tend to have a detrimental impact on aquatic ecosystems (Bounas *et al.* 2021). Some of these negative impacts include the loss of native fish species, increased ecological niche competition, predation, and the spread of fish diseases/parasites.

Capture fisheries are one of the activities that support the economy of the communities in the Jatiluhur Reservoir waters. Capture fisheries are a sector that is not expected to overlap with other activities (Windi *et al.*, 2021). Therefore, it is hoped that these capture fisheries activities will not cause a decline in the reservoir's function in the long term. The fishing gear used by fishermen to catch fish in the waters of Jatiluhur Reservoir are gill nets, fishing rods, cast nets, traps, and spears (Umar and Kartamihardja, 2006). Between 2000 and 2006, fishing activities by farmers yielded fairly high results. However, their profits tended to decline because the types of fish caught were not valuable and were less desirable to the community. This situation was the result of environmental degradation (Umar and Kartamihardja, 2006).

Based on the introduction described above, it can be said that the purpose of this study is to analyze the catch results for further analysis to compare the general composition between introduced fish and native fish caught in Cirata and Jatiluhur Reservoir.

2. METHODS

The research was conducted using secondary data obtained from the Purwakarta District Fisheries and Livestock Service. The data collected was fishing catch data from the Jatiluhur Reservoir for the period 2021-2023. Data analysis was performed to compare the catch data from ***the Purwakarta Fisheries and Livestock Service*** **(PFLS) or referred in local as** DKPP (2024)for the period 2021-2023 and recategorize it into native fish and introduced fish from the source of Setiadi *et al*. (2008). Then, data analysis was performed using a descriptive comparative method with previous studies on catch fluctuations referring to native and non-native fish. The author also add several data about fishing gear and vessel used by fishermen in both Cirata and Jatiluhur Reservoir to strengthen condition that still existing in terms fishing catch sector.

3. RESULTS

3.1. Total Catch Production

Fisheries catch results can be seen as an indicator of the existence of native and introduced fish. With this, we can see the composition of fish species, as well as their size and population. The following data on catches obtained from the Purwakarta Fisheries and Livestock Service (DPP) for 2021-2023 can be seen in **Figure 1.**

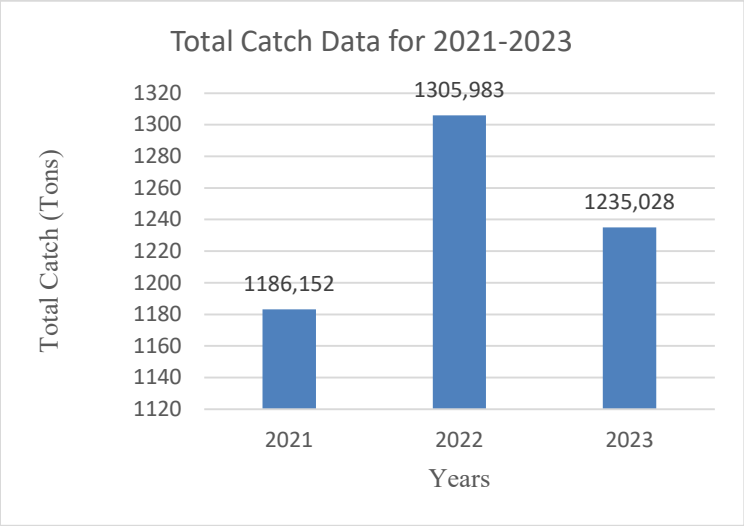


Figure 1. Total Catch in 2021-2023
Source: DKPP (2024)

Based on the 2021 catch results, a total of 1186,152 tons were obtained, making it the year with the lowest catch among 2022 and 2023. This could be influenced by several factors, including the length of time fishermen spent fishing, the number of fishermen sailing in a given period of time, and the type of fishing gear used (Hafid and Abu, 2019). Considering that the COVID-19 pandemic was still ongoing during that period, limiting people's activities, these conditions would certainly affect fishermen's activities and ultimately lead to a decline in their catch (Nyiawung *et al.*, 2024). The catch in 2022 was the highest in the last three years, amounting to 1305.98 tons. In 2023, there were 13 main commodities caught, consisting of four native fish species and nine introduced fish species. This can be seen in **Table 1**. In 2023, there were 1235.03 tons of catch, which was the second highest catch after 2022. However, in 2023, there were more types of fish caught compared to 2022 and 2021, namely 13:15 types of fish caught with the addition of nilem and sepat siam fish.

Table 1. Catch per Species in 2021-2023

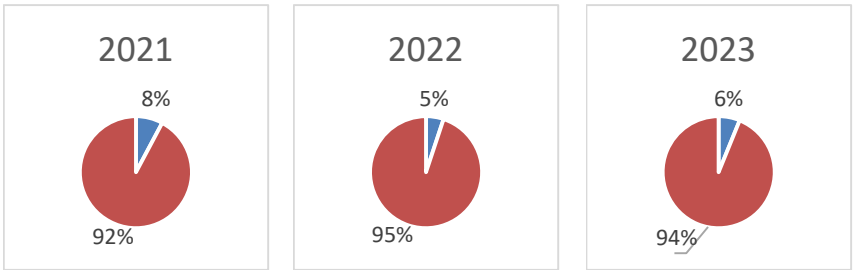
No	Local name	Scientific Name	Catch Result (Tons)			Category
			2021	2022	2023	
1	White Baung	*Hemibagrus nemurus*	15,38	2,95	11,08	Native
2	Freshwater Bawal	*Colossoma macropomum*	34,29	13,55	13,04	Introduced
3	Balidra	*Notopterus chitala*	2,44	15,57	16,61	Introduced
4	Betutu	*Oxyeleotris marmorata*	2,43	0,46	3,27	Introduced
5	Gabus	*Channa striatus*	56,51	61,03	54,36	Native
6	Hampala	*Hampala macrolepidota*	5,38	1,48	2,45	Native

7	**Lalawak**	***Barbodes bramoides***	**15,02**	**1,36**	**8,47**	Native
8	Freshwater lobster	*Cherax quaricarinatus*	0,33	1,97	2,77	Introduced
9	Carp	*Cyprinus carpio*	19,81	32,43	12,64	Introduced
10	Tilapia	*Oreochromis niloticus*	565,80	614,62	608,45	Introduced
11	Nilem	*Osteochillus hasselti*	-	-	0,142	Introduced
12	Patin siam	*Pangasius hypopthalmus*	464,12	559,81	502,79	Introduced
13	Sepat siam	*Trichogaster pectoralis*	-	-	0,194	Introduced
14	Sidat	*Anguilla sp*	0,54	0,025	0,53	Introduced
15	Tawes	*Barbodes gonionotus*	1,08	0,72	1,45	Introduced
	Total		**1183,155**	**1305,98**	**1235,028**	

Source : DKPP (2024) and Setiadi et al., (2019)

3.2. Introduced and Native Fish Comparison

From several catches described in **Table 1.** it can be seen that the dominance of introduced fish has become common in Jatiluhur Reservoir. This can be seen further in Figure **2.**



Description: Red = Introduced Fish; Blue = Native Fish
Sources : DKPP (2024)

Figure 2 . Comparison of the Weight of Native and Introduced Fish Catches 2021 - 2023

Data on catches in 2021 obtained from the Purwakarta Fisheries and Livestock Service shows that fishing in Cirata and Jatiluhur Reservoir is dominated by introduced fish species, which account for 93,66% of the total biomass of all catches in 2021-2023. The introduced fish species caught include Freshwater Bawal, Belida, Betutu, Freshwater Lobster, Mas, Nila, Nilem, Patin siam, Sepat Siam, Sidat, and Tawes. The total catch in 2021 was around 1186,152 tons, with 1093,85 tons of introduced fish and 92,30 tons of native fish from Jatiluhur Reservoir. In 2022, the total catch was the highest, ranging from 1305,98 tons, with 1239,166 tons of introduced fish and 66,817 tons of native fish.

The composition of native fish decreased in catch compared to the previous year, which had a value of 92,3 tons. The percentage of native fish catch also decreased to 5%, while the percentage of introduced fish increased to 95%. Furthermore, for 2023, the value is close to the median of the three total catches from 2021, 2022, and 2023, which is around 1235,028 tons, with a composition of 76.354 tons of native fish and 1118,674 tons of introduced fish. These figures indicate that the catch of native fish in 2023 will increase compared to 2022, which had a value of 66,817 tons. There will also be an increase in the percentage of the total catch from 6% to 94% between native and introduced fish.

The factor that influence in decreasing of native fish species is the degradation and loss of habitats for the native species, either from introduced fish or external factors such as antropogenic activities (Setiadi *et al*. 2019). The degradation and loss of fish habitats are mainly influenced by anthropogenic factors. The damming of the Citarum River for reservoir construction will result in the transformation of flowing water habitats into stagnant waters. Most of the fish in the Citarum River belong to the Citarum River Habitats. Fish in the Citarum River, most of which are riverine species, will experience disruption to their life cycles (Setiadi *et al.*, 2019).One of the effort to increase valuable catches in native fish is through restocking. The development of native fish hatcheries is necessary to ensure the availability of fry, especially for restocking. Several types of native fish that are rare in the Citarum River, such as arengan, jambal, tambakan, and gurame, can, in principle, be bred in hatcheries (Umar *et al.*, 2015). Fish restocking is carried out to increase fish renewal because natural fish renewal is limited. For restocking purposes, a study of reproductive biology and the characteristics of spawning habitats, nurseries, and breeding grounds is required. If a sanctuary for certain fish has been established, restocking by spreading fish fry can be carried out in the sanctuary area (Amoussou *et al.*, 2017)

Non-native species can act as direct triggers of change or as “passengers,” successfully forming populations but having little or no impact on ecosystems already affected by other non-interactive factors (Bounas *et al.*, 2021). In addition, according to Bernery *et al.*, (2024), it is not only determines the invasive status of a species, but also the profile of species that have the potential to invade large areas. This approach, which considers different invasion steps and pathways, can help identify the factors that determine the success of invasion in other taxa. The increase and decrease in the catch of native and introduced fish species can be caused by several factors, including differences in weight, total number, and length of fish caught (Bounas *et al.*, 2021). Another factor that affects the catch is the fishing gear used. At Jatiluhur Reservoir, the fishing gear used is gillnets with a mesh size of 3-4 inches. Based on the results of the study, it shows that differences in gillnet mesh sizes of 1 inch, 1.5 inches, and 2 inches have a significant effect on fish weight (kg), length (cm), and height (cm), as well as the total number (*tails*) of fish caught (Eli Nurlaela, 2023)

3.3. Fishing Gear Units

In the **Table 2**. categorization fishing activities based on vessel type and gear used in 2021 until 2023 were slightly not different. In 2021, a total of 2,667 units were recorded across various gear types, including gillnets, traps (Bubu), cast nets/trawls, and fishing rods, involving 2,667 fishermen. The majority of fishing activities were conducted without boats, particularly using fishing rods (1,294 units) and cast nets/trawls (142 units), while only 1,231 boats were used in total.

In 2022, the total number of fishing units increased slightly to 2673, with the same number of fishermen 2673 people, and boat usage rose to 1237 units. The number of fishing rods remained unchanged at 1,294 units, while gillnet usage on non-mounting machines increased from 187 to 190 units. By 2023, the total number of fishing units dropped significantly to 2,204, with a corresponding decrease in fishermen to 2,204. Notably, the use of fishing rods sharply declined from 1,294 to 825 units, indicating a reduction in single-target fishing methods. Boat usage remained at 1,237, consistent with 2022 levels. The number of gillnet units on non-mounting machines stayed at 190, while other gear types remained stable

Catch composition is the variety of fish that fishermen catch, and it is mainly influenced by the type of fishing gear used. As evidence, previous studies have found that catch composition varies between different types of gillnets (Hidayati and Mohamad, 2024). Moreover, the capture mechanisms in gillnets can vary greatly for different species based on their morphological and behavioral characteristics. For fish species, the individuals are often caught in gillnets by gilling, wedging, entangling, and snagging, depending on how the fish are enmeshed in the gillnet netting(Yu *et al.*, 2024)

According to research output provided by Eli Nurlaela (2023) Fishermen in Jatiluhur and Cirata Reservoir mostly having gillnets with a mesh size of 3-4 inches. Based on the results of the study, it shows that differences in gillnet mesh sizes of 1 inch, 1.5 inches, and 2 inches have a significant effect on fish weight (kg), length (cm), and height (cm), as well as the total number (*tails*) of fish caught. Using large mesh sizes can potentially capture large non-targeted fish, including threatened species, while using small mesh sizes may result in the capture of juvenile target- and small bycatch species. It is, therefore, essential to assess the catch composition of different mesh sizes for various fish species that are abundant in the fishery. In this study, we found that altering the gillnet mesh size did not show any significant differences in catch composition regarding the bycatch species observed.

Table 2. Fishing Gear Units in 2021-2023

Common Pool Resources	Type of fishing Vessel	Typer of fishing gear	Total Units	Total of Fishermen (person)	Number of Fishing Vessel (Units)	Number of Fishing Gear (Units)
2021						
Both Cirata and Jatiluhur Reservoir Combined	Mounting Machine	Gillnets	917	917	917	917
		Traps (Bubu)	1	1	1	1
	Non Mounting Machine	Cast Net/Trawl	106	106	106	106
		Gill Net	187	187	187	187
		Traps (Bubu)	20	20	20	20

	Without Boats	Cast Net/Trawl	142	142	0	142
		Fishing Rod	1.294	1.294	0	1.294
Total			**2.667**	**2.667**	**1.231**	**2.667**
		2022				
Both Cirata and Jatiluhur Reservoir Combined	Mounting Machine	Gillnets	920	920	920	920
		Traps (Bubu)	1	1	1	1
	Non Mounting Machine	Cast Net/Trawl	106	106	106	106
		Gill Net	190	190	190	190
		Traps (Bubu)	20	20	20	20
	Without Boats	Cast Net/Trawl	142	142	0	142
		Fishing Rod	1.294	1.294	0	1.294
Total			**2.673**	**2.673**	**1.237**	**2.673**
		2023				
Both Cirata and Jatiluhur Reservoir Combined	Mounting Machine	Gillnets	920	920	920	920
		Traps (Bubu)	1	1	1	1
	Non Mounting Machine	Cast Net/ Trawl	106	106	106	106
		Gill Net	190	190	190	190
		Traps (Bubu)	20	20	20	20
	Without Boats	Cast Net/ Trawl	142	142	0	142
		Fishing Rod	825	825	0	825
Total			**2.204**	**2.204**	**1.237**	**2.204**

Source : DKPP (2024)

4. CONCLUSIONS

Several conclusions from the research conducted by comparing the catch of native and non-native fish in the Jatiluhur Reservoir are as follows.

- There were 4 types of native fish caught and 11 types of introduced fish caught in 2021-2023 and The total weight in 2021 was 1186,152 tons, in 2022 it was 1305,98 tons, and in 2023 it was 1235,028 tons.
- The majority of commodities were found in introduced fish, with weights ranging from 92%, 95%, and 94% of the total catch in 2021, 2022, and 2023 respectively. The proportion of native fish in the catch has markedly decreased—from 8% in 2021 to only 6% in 2023 highlighting ongoing habitat degradation, competition, and predation by invasive species, likely driven by anthropogenic activities such as dam construction and water pollution.
- The data of Fishing Gear Unit shows a consistent reliance on gillnets and fishing rods over the three years, with a notable decline in fishing rod usage by 2023. The slight increase in boat usage from 2021 to 2022 and its stabilization in 2023 suggests a shift toward more mechanized fishing methods, while the overall reduction in total units may reflect changes in fishing effort or regulatory measures.

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