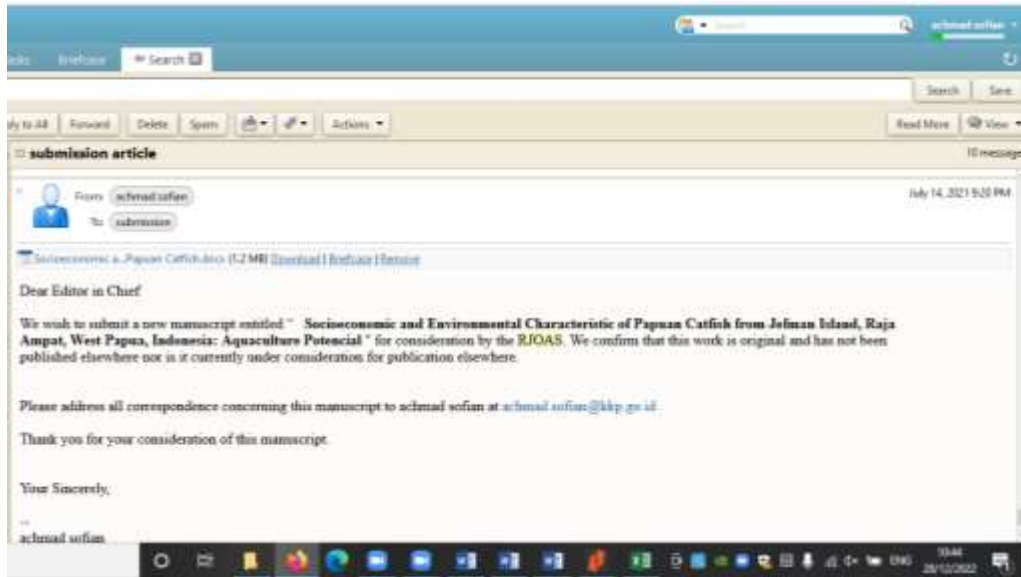
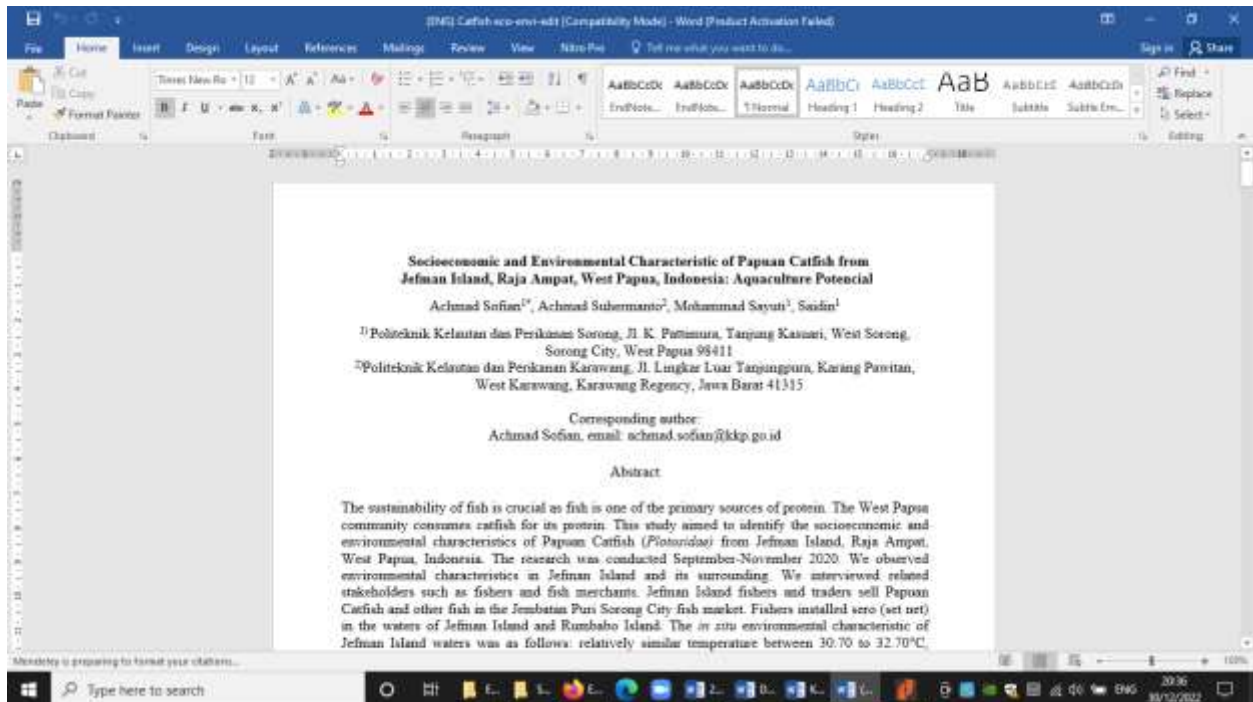


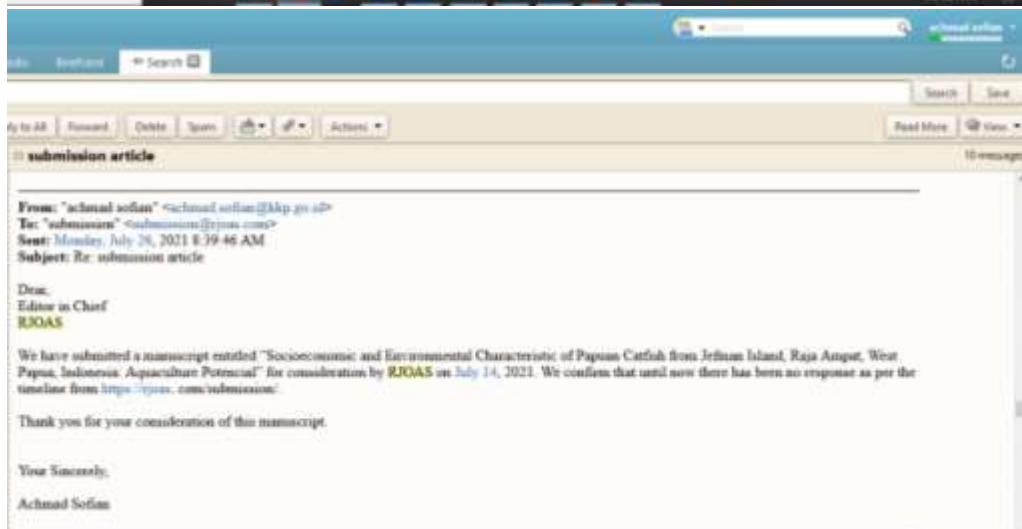
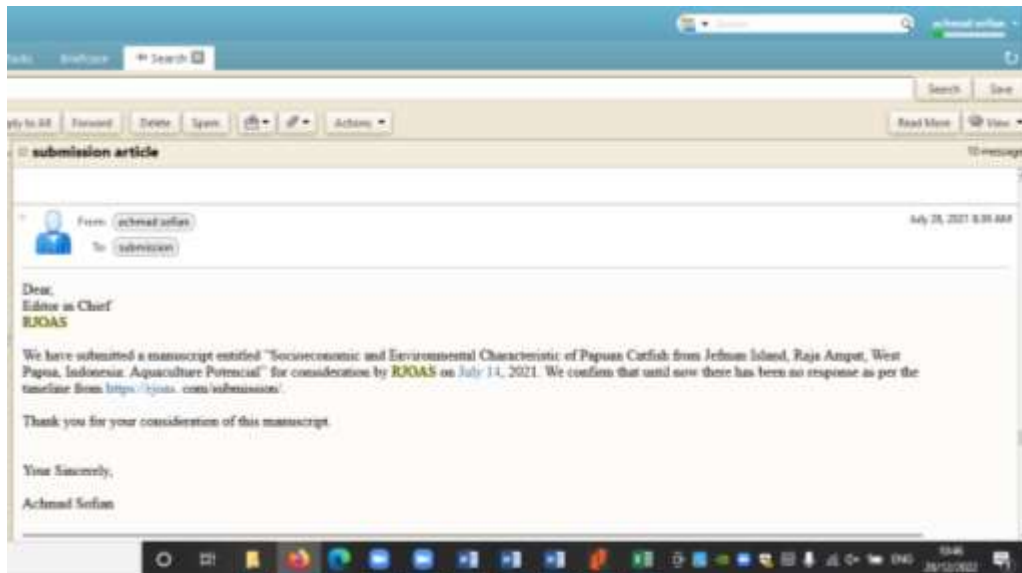
Socio-Economic and Environmental Characteristics of Papuan Catfish at Jefman Island (Raja Ampat, West Papua, Indonesia): A Study of Aquaculture

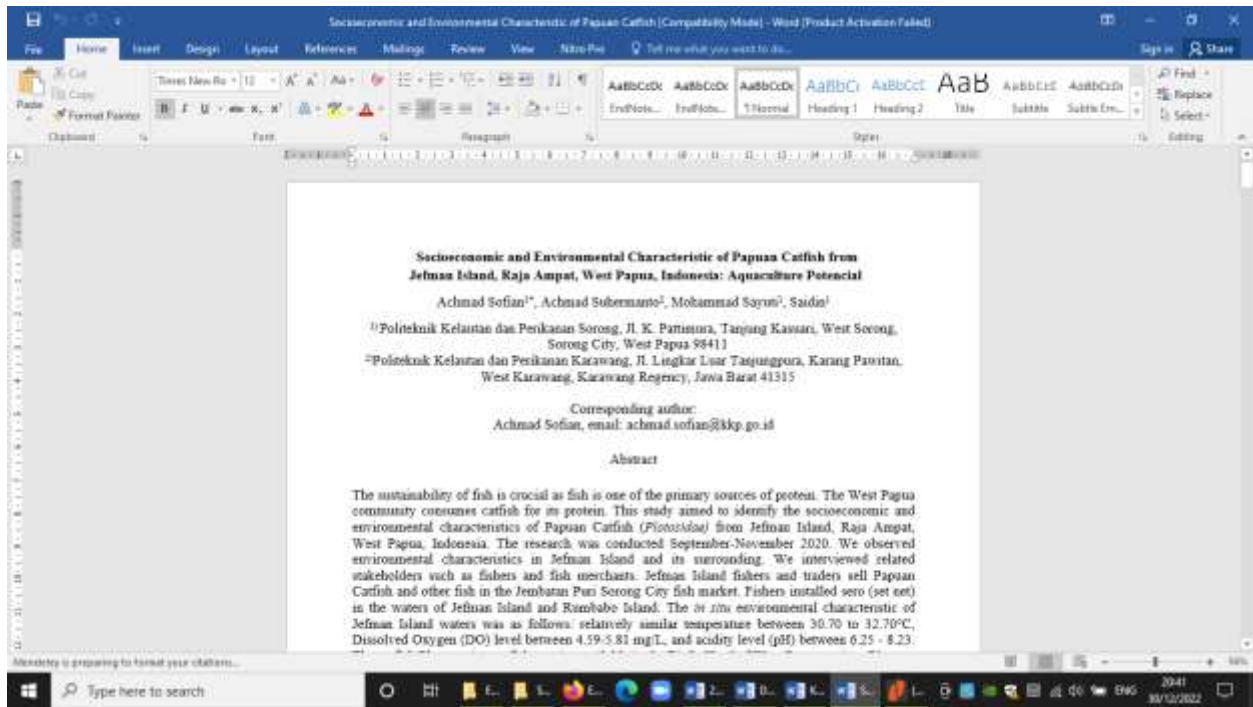
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Socioeconomic and Environmental Characteristic of Papuan Catfish from Jefman Island, Raja Ampat, West Papua, Indonesia: Aquaculture Potencial

Achmad Sofian^{1*}, Achmad Suhermanto², Mohammad Sayuti¹, Saidin¹

¹Politeknik Kelautan dan Perikanan Sorong, Jl. K. Pattimura, Tanjung Kasuari, West Sorong, Sorong City, West Papua 98411

²Politeknik Kelautan dan Perikanan Karawang, Jl. Lingkar Luar Tanjungpura, Karang Pawitan, West Karawang, Karawang Regency, Jawa Barat 41315

Corresponding author:

Achmad Sofian, email: achmad.sofian@kkp.go.id

Abstract

The sustainability of fish is crucial as fish is one of the primary sources of protein. The West Papua community consumes catfish for its protein. This study aimed to identify the socioeconomic and environmental characteristics of Papuan Catfish (*Plotosidae*) from Jefman Island, Raja Ampat, West Papua, Indonesia. The research was conducted September-November 2020. We observed environmental characteristics in Jefman Island and its surrounding. We interviewed related stakeholders such as fishers and fish merchants. Jefman Island fishers and traders sell Papuan Catfish and other fish in the Jembatan Puri Sorong City fish market. Fishers installed sero (set net) in the waters of Jefman Island and Rumbabo Island. The *in situ* environmental characteristic of Jefman Island waters was as follows: relatively similar temperature between 30.70 to 32.70°C, Dissolved Oxygen (DO) level between 4.59-5.81 mg/L, and acidity level (pH) between 6.25 - 8.23. The catfish *Plotosus* is a catfish species available in the Bird's Head of West Papua region. *Plotosus* is found in Sorong and Raja Ampat waters. Papuan catfish have socioeconomic and environmental potential. Therefore, it is necessary to conduct aquaculture development.

Keywords: catfish, environment, socioeconomic, Raja Ampat

Introduction

Indonesia is an archipelago country that has thousands of islands and abundant potential resources. These islands have high biodiversity, socioeconomic, and ecological functions. Papua Indonesia is located in the western part of New Guinea. Papua Indonesia has abundant natural wealth and high biodiversity. Papua Indonesia has two provinces, namely West Papua and Papua. The West Papua Province is about 120,777 km² divided into 12 regencies and one city, including Raja Ampat Regency (BPS Provinsi Papua Barat, 2017). The natural resources and biodiversity of the Raja Ampat Regency are essential assets for regional development. Biodiversity provides ecosystem services. Raja Ampat Regency has an abundant source of animal-based food such as fish. (Pal *et al.*, 2018). Good and sustainable management will benefit the island community and improve national welfare.

Fish is one of the primary sources of animal protein for the West Papua coastal community. Based on 2017 socioeconomic survey data, the national fish consumption was 32.36 kg/capita/year. On the other hand, West Papua fish consumption was 58.74 kg/capita/year (BPS 2017). The community relies on captured fisheries and freshwater aquaculture. Catfish is one of the fish species available in the Sorong region. In addition, there are saltwater catfish such as Papuan Catfish (*Plotosidae*). These fishes are sold in the fish market and consumed by the community.

There are a small number of studies on the socioeconomic and environmental characteristics of saltwater catfish in West Papua. The relationship between socioeconomy and environment may improve assessment and provide detailed information for the decision-maker (Galanidi *et al.*, 2018). This study aimed to identify the socioeconomic and environmental characteristics of Papuan Catfish

(Plotosidae) from Jefman Island Raja Ampat, West Papua, Indonesia. Papuan Catfish (Plotosidae) study aimed to improve the education sector and environmental management, conservation, and sustainability.

Research Method

The research was conducted from September to November 2020 in Jefman Island, North Salawati District, Raja Ampat Regency, and Sorong City. Jefman Island is located at 0°55'36.21" South Latitude and 131°7'14.15" East Longitude (Figure 1). We observed the environmental characteristics of Jefman Island waters and its surrounding. We interviewed relevant stakeholders such as fishers and fish traders. The research location covered the area around Jefman Island Raja Ampat and Sorong City. We used Global Positioning System (GPS), camera, and AM200 Aquaread Water Quality. We analyzed primary and secondary data descriptively.

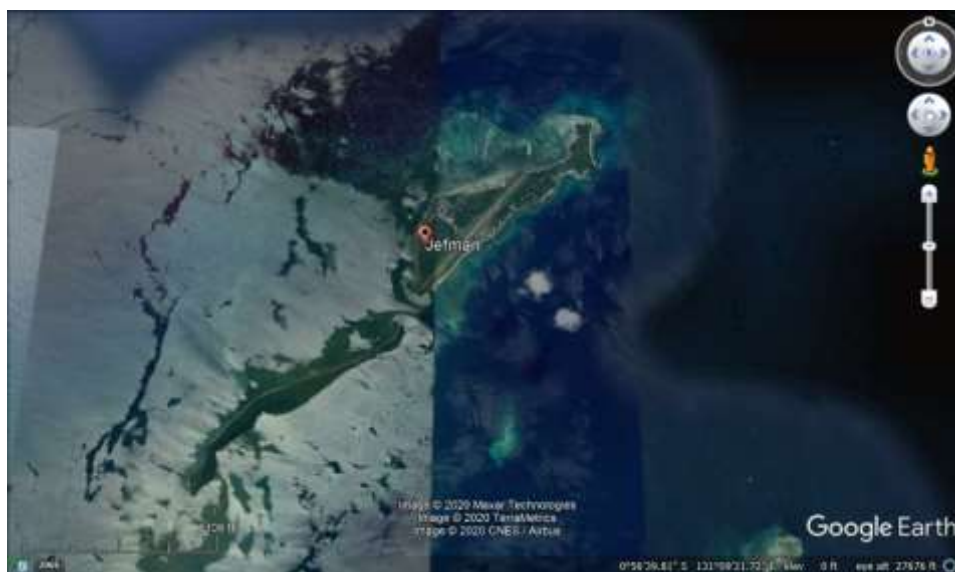


Figure 1. Map of Jefman Island (Google Earth)

Result and Discussion

Socioeconomy and Regional Overview

Raja Ampat Regency is located on the west side of Papua Island and is an expansion of Sorong Regency. Raja Ampat is famous for its high-biodiversity archipelago (Manuputty *et al.*, 2015; Cox and Bright, 2017; Asaad *et al.*, 2018). Wageo, Batanta, Salawati, Misool, and Kofiau Islands are the big islands in Raja Ampat (KKP and USAID 2018). A part of Raja Ampat waters is a marine conservation area. Raja Ampat waters have economic, endemic, and crucial marine biota species (Manuputty *et al.*, 2015). Jefman Island has fisheries potential and historical value. The following figure illustrates Jefman Island and its surrounding waters.

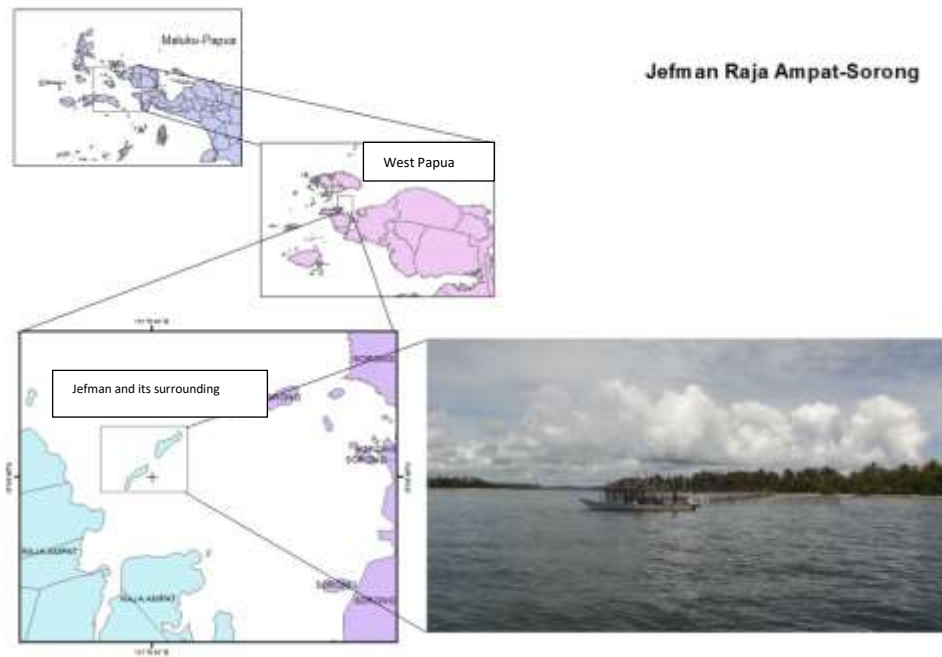


Figure 2. Waters of Jefman Island

Jefman Island has a land area of 416.42 km² and is part of the North Salawati District, Raja Ampat Regency (BPS Kab.Raja Ampat 2020). Jefman Island is located in the southern part of Raja Ampat. Jefman Island borders South Batanta District to the north, Sorong City to the east, Central Salawati District to the south, and West Salawati District to the west. Jefman Island is part of the North Salawati District. Jefman Island has two villages, namely Jefman Barat and Jefman Timur. The population of the North Salawati District in 2019 was 3,954 people, with a population density of 9.49 people/km². Jefman Barat has 299 families consisting of 976 citizens. Jefman Timur has 174 families consisting of 604 citizens (BPS Kab. Raja Ampat 2020).

Jefman Island was once the center of activities. Visitors traveled to Jefman Island by airplanes. The Jefman Island runway has historical value and is located in the middle part of the island. However, the activity stopped after the runway moved to Domine Eduard Osok airport in Sorong City. The community tends to build houses near the beach. The majority of the community members work as fishers. The activities of Jefman Island fishers are presented in Figure 3. The observation and interview process are shown in Figure 4.

The Jefman Island waters have marine fishery potentials such as grouper (*Epinephelus* sp.), rabbitfish (*Siganus* sp.), stingray (*Aetobatus narinari*), Lobster (*Panulirus* sp.), red snapper (*Lutjanus campechanus*), squid (*Loligo* sp.) and saltwater catfish. The Jefman Island fishers install *sero* gear (setnet) in Jefman Island and Rumbabo Island waters. The fishermen installed *sero* gear in shallow waters, with a 3-5 meter depth at low tide. The fishers catch fish and maintain *sero* gear daily. *Sero* gear may catch various fish such as demersal, crustacean, mollusk, Chondrichthyes, and saltwater catfish.



Figure 3. Fishers of Jefman Island



Figure 4. Observation and Interview with fishers of Jefman Island

The fisherman gather and sell their catch in Jembatan Puri, the Sorong City fish market. Fish from Jefman Island are traded at the Jembatan Puri fish market by fish traders/fishers from Jefman Island. However, the availability of catfish depends on the season, such as the rainy season. Papuan Catfish is sold in a bundle. Fishers bundle the catfish using a bamboo rope. The fishers and traders sell a bundle of twenty Papuan Catfish for IDR 20,000.00 to 30,000.00. They sell the catch during the weekend due to many visitors. The fish trading activity is illustrated in Figure 5.



Figure 5. Jefman Island fish and catfish trader at the Jembatan Puri, Sorong City

Environment

The environment is related to socioeconomic characteristics. Damage to the ecosystem may reduce ecosystem goods and services. There is various research using environmental characteristics

to determine existing biota. However, the socioeconomic characteristic is equally crucial for stakeholders' decision-making. *Plotosus* was sold in the Jembatan Puri fish market at certain times. The waters of Sorong and its surrounding is the placed to catching the fish like catfish. Papuan Catfish has economic value as one of the animal-based food sources for the community. Papuan Catfish is available in Jefman Island, Raja Ampat, and Sorong. The anthropogenic pressure in Sorong waters influences the sustainability of Papuan Catfish.



Figure 6. Environmental Data Collection

The quality of the marine environment influences the distribution of marine biota (Gurning *et al.*, 2019). We performed in situ observation in Jefman Island to determine the marine environmental characteristic. We completed the observation in three posts near the sero (set net) (Figure 6). The measurement result of the marine environmental characteristic of Jefman Island is presented in Table 1.

Table 1. The average measurement result of water quality parameter in Jefman Island waters

Post	Latitude	Longitude	Temperature (°C)	DO (mg/L)	Salinity ‰	pH	TDS (ppm)
1	0°55'50"	131°7'11"	30.70	4.59	34.34	8.23	33.88
2	0°56'32"	131°6'32"	30.80	5.81	31.42	7.56	32.03
3	0°56'53"	131°6'31"	32.70	5.54	28.18	6.25	28.36

Water quality is determined by temperature, dissolved oxygen (DO), acidity (pH), salinity, and TDS. Temperature is an essential indicator in determining effects on other water parameters (Siburian *et al.*, 2017; Long *et al.* 2021). The water temperature ranged between 30.70 to 32.70°C. The temperature range was in normal condition, adhering to the natural temperature conditions of tropical waters (23 to 32°C). The temperature range was suitable for organisms to live (Siburian *et al.*, 2017). According to Gurning *et al.* (2019), the bottom of tropical waters should have a water temperature between 22 to 30°C (Fishbase). The temperature is suitable for eel-tail catfish (*Plotosus canius*). Dissolved Oxygen (DO) is crucial for aquatic biota and necessary for respiration, body metabolic processes. Furthermore, DO is essential for the oxidation of organic and inorganic materials in aerobic processes (Gurning *et al.*, 2019). Jefman Island waters have a DO level of 4.59-

5.81 mg/L. DO is essential for living organisms. DO fluctuates depending on temperature and salinity (Siburian *et al.*, 2017).

The acidity level (pH) affects marine biota as significant pH change may affect marine life. Jefman Island had a pH level of 6.25 to 8.23. Therefore, Jefman Island waters adhere to the Minister of Environment Decree Number 51 of 2004 quality standards. The seawater pH level should range between 7.00 to 8.5. The appropriate pH level for aquatic life is 6.5 to 8.5. Therefore, Jefman Island has a good pH level (Siburian *et al.*, 2017). Salinity is crucial in determining marine biota ecosystems. Jefman Island waters have a salinity level of 28.18 to 34.34. Hoek *et al.* (2016) found an average salinity of 29.1 to 30.0 ppt (good) in Jefman Island. The river water may influence the water salinity in the coastline (Siburian *et al.*, 2017). Jefman Island has a TDS value of 28.36 to 33.88 ppm. This research was lower than Erari *et al.*, (2012) in the Youtefa Bay, Jayapura, Papua (34.4 ppm). Weathering of rocks, soil runoff, and anthropogenic factors (domestic and industrial waste) influence the TDS level (Rinawati *et al.*, 2016). The measurement result showed that Jefman Island water quality adhered to the quality standards of marine biota.

The marine environmental condition around Jefman Island illustrates the existing ecosystem. Manuputty *et al.*, (2015) analyzed the environmental condition of Jefman Island. Jefman Island community build houses on the beach. Jefman Island seabed is sandy, overgrown with seagrass and coral. Furthermore, the stone coral cover is less than dead coral algae (DCA). Hoek *et al.*, (2016) stated that Jefman Island had 60% seagrass cover in healthy condition.

The catfish *Plotosus* is a species that lives in the Bird's Head West Papua region around the waters of Sorong and Raja Ampat (Allen and Erdmann 2009). The distribution of this species covers the Indo-Pacific region (Ali *et al.*, 2017). Their habitat is in coastal waters, reefs, and soft substrates (Edelist *et al.*, 2012). Sea catfish Plotosidae in other parts of Indonesia are the main catch targets, such as in the waters of Kolono Bay, Southeast Sulawesi (Asriyana *et al.*, 2020). Fish stocks and catches can be disrupted by overfishing and pollution of the marine environment (Cámara and Santero-Sánchez 2019). This will have an impact on the environment and socio-economic community.

Aquaculture Development Potential

The socioeconomic and environmental characteristic of Papuan Catfish illustrates the potential of the fishery as an animal-based food source. However, it is necessary to reduce the dependency to capture fisheries by developing aquaculture. The aquaculture sector fulfills global animal protein need. Indonesia also depends on the aquaculture sector to meet animal protein need. Environmentally friendly aquaculture may solve the stagnant production of capture fisheries (Guillen *et al.*, 2019). Aquaculture reduces capture fisheries activity and preserves natural resources (Longo *et al.*, 2019). Improving cultivated produce may increase global food security and nutrient quality (Guillen *et al.*, 2019).

Seafood is a crucial source of nutrition. Seafood provides animal protein for more than 3.1 billion people in 2013 (FAO, 2016). Seafood generally refers to grouper, snapper, shrimp, lobster, crab, tuna, etc. However, there is little mention of catfish. Indonesia has the highest production rate of freshwater catfish (*Clarias* sp.). However, Indonesia has not cultivated saltwater catfish. Irawan and Raza'i (2019) stated that saltwater catfish might be cultivated through crossbreeding eel-tailed catfish and *Clarias gariepinus*.

Papuan Catfish cultivation development is alternative resource management in Jefman Island. However, it is necessary to pay attention to socioeconomic and environmental conditions. Papuan Catfish cultivation may support community livelihood sustainably. The potential of Jefman

Island fisheries (catfish and other types of fish) is both an asset and a challenge. It is necessary to preserve the sustainability of Jefman Island's natural resources.

Conclusion

Papuan Catfish from Jefman Island, Raja Ampat, West Papua, provides ecological and socioeconomic potential in Sorong Raya. The fishers generally install *sero* (set net) in Jefman Island and Rumbabo Island waters. The marine environmental characteristic in Jefman Island waters is suitable for Papuan Catfish habitat. However, it is necessary to conduct further research on the potential and characteristics of Jefman Island's Papuan Catfish for aquaculture purposes.

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ФЕДЕРАЛЬНАЯ СЛУЖБА ПО НАДЗОРУ
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SOCIO-ECONOMIC AND ENVIRONMENTAL CHARACTERISTICS OF PAPUAN CATFISH AT JEFMAN ISLAND (RAJA AMPAT, WEST PAPUA, INDONESIA): A STUDY OF AQUACULTURE POTENTIAL

Sofian Achmad^{1*}, Suhermanto Achmad², Sayuti Mohammad¹, Saidin¹

¹Sorong Marine and Fisheries Polytechnic, Sorong, West Papua, Indonesia

²Karawang Marine and Fisheries Polytechnic, West Karawang, Indonesia

*E-mail: achmad.sofian@kkp.go.id

ABSTRACT

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METHODS OF RESEARCH

The research was conducted from September to November 2020 in Jefman Island, North Salawati District, Raja Ampat Regency, and Sorong City. Jefman Island is located at 0°55'36.21" South Latitude and 131°7'14.15" East Longitude (Figure 1). We observed the environmental characteristics of Jefman Island waters and its surrounding. We interviewed relevant stakeholders such as fishers and fish traders. The research location covered the area around Jefman Island Raja Ampat and Sorong City. We used Global Positioning System (GPS), camera, and AM200 Aquaread Water Quality. We analyzed primary and secondary data descriptively.

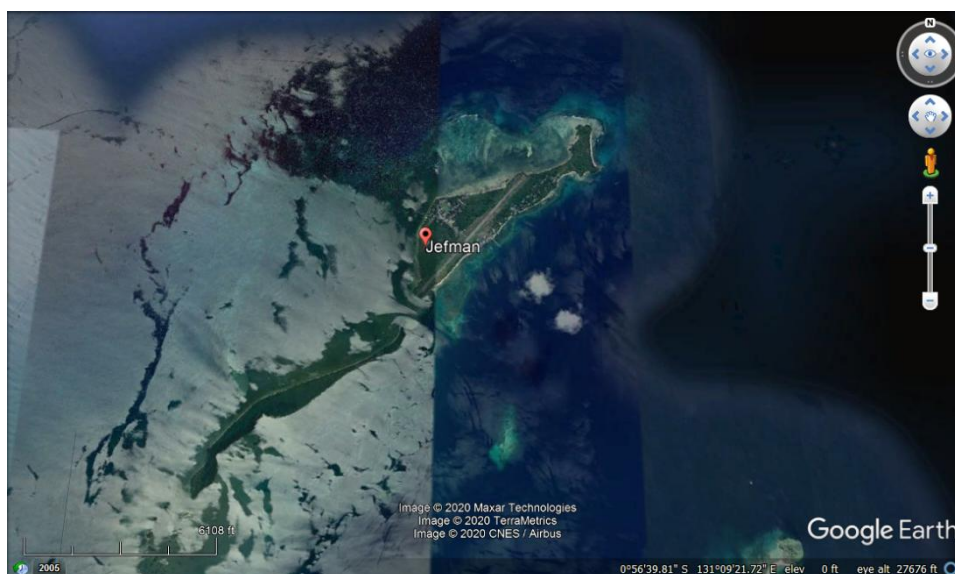


Figure 1 – Map of Jefman Island (Google Earth)

RESULTS AND DISCUSSION

Raja Ampat Regency is located on the west side of Papua Island and is an expansion of Sorong Regency. Raja Ampat is famous for its high-biodiversity archipelago (Manuputty *et al.*, 2015; Cox and Bright, 2017; Asaad *et al.*, 2018). Wageo, Batanta, Salawati, Misool, and Kofiau Islands are the big islands in Raja Ampat (KKP and USAID 2018). A part of Raja Ampat waters is a marine conservation area. Raja Ampat waters have economic, endemic, and crucial marine biota species (Manuputty *et al.*, 2015). Jefman Island has fisheries potential and historical value. The following figure illustrates Jefman Island and its surrounding waters.

Jefman Island has a land area of 416.42 km² and is part of the North Salawati District, Raja Ampat Regency (BPS Kab.Raja Ampat 2020). Jefman Island is located in the southern part of Raja Ampat. Jefman Island borders South Batanta District to the north, Sorong City to the east, Central Salawati District to the south, and West Salawati District to the west. Jefman Island is part of the North Salawati District. Jefman Island has two villages, namely Jefman Barat and Jefman Timur. The population of the North Salawati District in 2019 was 3,954 people, with a population density of 9.49 people/km². Jefman Barat has 299 families consisting of 976 citizens. Jefman Timur has 174 families consisting of 604 citizens (BPS Kab. Raja Ampat 2020).

Jefman Island was once the center of activities. Visitors traveled to Jefman Island by airplanes. The Jefman Island runway has historical value and is located in the middle part of the island. However, the activity stopped after the runway moved to Domine Eduard Osok airport in Sorong City. The community tends to build houses near the beach. The majority of the community members work as fishers. The activities of Jefman Island fishers are presented in Figure 3. The observation and interview process are shown in Figure 4.



The Jefman Island waters have marine fishery potentials such as grouper (*Epinephelus* sp.), rabbitfish (*Siganus* sp.), stingray (*Aetobatus narinari*), Lobster (*Panulirus* sp.), red snapper (*Lutjanus campechanus*), squid (*Loligo* sp.) and saltwater catfish. The Jefman Island fishers install *sero* gear (setnet) in Jefman Island and Rumbabo Island waters. The fishermen installed *sero* gear in shallow waters, with a 3-5 meter depth at low tide. The fishers catch fish and maintain *sero* gear daily. *Sero* gear may catch various fish such as demersal, crustacean, mollusk, Chondrichthyes, and saltwater catfish.

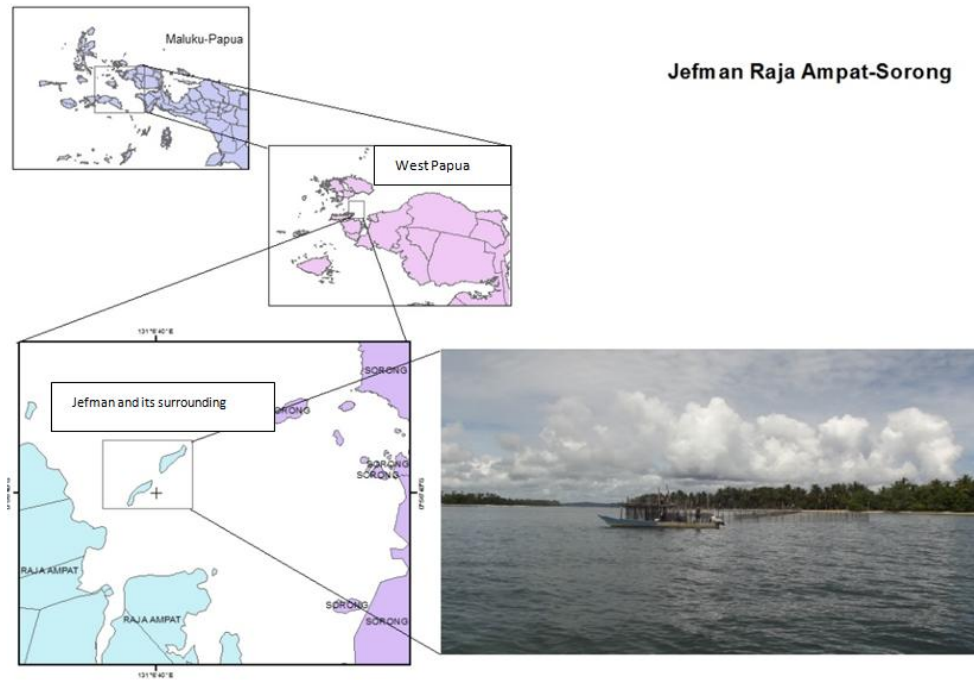


Figure 2 – Waters of Jefman Island



Figure 3 – Fishers of Jefman Island



Figure 4 – Observation and Interview with fishers of Jefman Island



The fishermen gather and sell their catch in Jembatan Puri, the Sorong City fish market. Fish from Jefman Island are traded at the Jembatan Puri fish market by fish traders/fishers from Jefman Island. However, the availability of catfish depends on the season, such as the rainy season. Papuan Catfish is sold in a bundle. Fishers bundle the catfish using a bamboo rope. The fishers and traders sell a bundle of twenty Papuan Catfish for IDR 20,000.00 to 30,000.00. They sell the catch during the weekend due to many visitors. The fish trading activity is illustrated in Figure 5.



Figure 5 – Jefman Island fish and catfish trader at the Jembatan Puri, Sorong City

The environment is related to socioeconomic characteristics. Damage to the ecosystem may reduce ecosystem goods and services. There is various research using environmental characteristics to determine existing biota. However, the socioeconomic characteristic is equally crucial for stakeholders' decision-making. *Plotosus* was sold in the Jembatan Puri fish market at certain times. The waters of Sorong and its surrounding is the placed to catching the fish like catfish. Papuan Catfish has economic value as one of the animal-based food sources for the community. Papuan Catfish is available in Jefman Island, Raja Ampat, and Sorong. The anthropogenic pressure in Sorong waters influences the sustainability of Papuan Catfish.



Figure 6 – Environmental Data Collection

The quality of the marine environment influences the distribution of marine biota (Gurning *et al.*, 2019). We performed in situ observation in Jefman Island to determine the marine environmental characteristic. We completed the observation in three posts near the sero (set net) (Figure 6). The measurement result of the marine environmental characteristic of Jefman Island is presented in Table 1.

Water quality is determined by temperature, dissolved oxygen (DO), acidity (pH), salinity, and TDS. Temperature is an essential indicator in determining effects on other water



parameters (Sibirian *et al.*, 2017; Long *et al.* 2021). The water temperature ranged between 30.70 to 32.70°C. The temperature range was in normal condition, adhering to the natural temperature conditions of tropical waters (23 to 32°C). The temperature range was suitable for organisms to live (Sibirian *et al.*, 2017). According to Gurning *et al.* (2019), the bottom of tropical waters should have a water temperature between 22 to 30°C (Fishbase). The temperature is suitable for eel-tail catfish (*Plotosus canius*). Dissolved Oxygen (DO) is crucial for aquatic biota and necessary for respiration, body metabolic processes. Furthermore, DO is essential for the oxidation of organic and inorganic materials in aerobic processes (Gurning *et al.*, 2019). Jefman Island waters have a DO level of 4.59-5.81 mg/L. DO is essential for living organisms. DO fluctuates depending on temperature and salinity (Sibirian *et al.*, 2017).

Table 1 – The average measurement result of water quality parameter in Jefman Island waters

Post	Latitude	Longitude	Temperature (°C)	DO (mg/L)	Salinity ‰	pH	TDS (ppm)
1	0°55'50"	131°7'11"	30.70	4.59	34.34	8.23	33.88
2	0°56'32"	131°6'32"	30.80	5.81	31.42	7.56	32.03
3	0°56'53"	131°6'31"	32.70	5.54	28.18	6.25	28.36

The acidity level (pH) affects marine biota as significant pH change may affect marine life. Jefman Island had a pH level of 6.25 to 8.23. Therefore, Jefman Island waters adhere to the Minister of Environment Decree Number 51 of 2004 quality standards. The seawater pH level should range between 7.00 to 8.5. The appropriate pH level for aquatic life is 6.5 to 8.5. Therefore, Jefman Island has a good pH level (Sibirian *et al.*, 2017). Salinity is crucial in determining marine biota ecosystems. Jefman Island waters have a salinity level of 28.18 to 34.34. Hoek *et al.* (2016) found an average salinity of 29.1 to 30.0 ppt (good) in Jefman Island. The river water may influence the water salinity in the coastline (Sibirian *et al.*, 2017). Jefman Island has a TDS value of 28.36 to 33.88 ppm. This research was lower than Erari *et al.*, (2012) in the Youtefa Bay, Jayapura, Papua (34.4 ppm). Weathering of rocks, soil runoff, and anthropogenic factors (domestic and industrial waste) influence the TDS level (Rinawati *et al.*, 2016). The measurement result showed that Jefman Island water quality adhered to the quality standards of marine biota.

The marine environmental condition around Jefman Island illustrates the existing ecosystem. Manuputty *et al.*, (2015) analyzed the environmental condition of Jefman Island. Jefman Island community build houses on the beach. Jefman Island seabed is sandy, overgrown with seagrass and coral. Furthermore, the stone coral cover is less than dead coral algae (DCA). Hoek *et al.*, (2016) stated that Jefman Island had 60% seagrass cover in healthy condition.

The catfish *Plotosus* is a species that lives in the Bird's Head West Papua region around the waters of Sorong and Raja Ampat (Allen and Erdmann 2009). The distribution of this species covers the Indo-Pacific region (Ali *et al.*, 2017). Their habitat is in coastal waters, reefs, and soft substrates (Edelist *et al.*, 2012). Sea catfish *Plotosidae* in other parts of Indonesia are the main catch targets, such as in the waters of Kolono Bay, Southeast Sulawesi (Asriyana *et al.*, 2020). Fish stocks and catches can be disrupted by overfishing and pollution of the marine environment (Cámara and Santero-Sánchez 2019). This will have an impact on the environment and socio-economic community.

The socioeconomic and environmental characteristic of Papuan Catfish illustrates the potential of the fishery as an animal-based food source. However, it is necessary to reduce the dependency to capture fisheries by developing aquaculture. The aquaculture sector fulfills global animal protein need. Indonesia also depends on the aquaculture sector to meet animal protein need. Environmentally friendly aquaculture may solve the stagnant production of capture fisheries (Guillen *et al.*, 2019). Aquaculture reduces capture fisheries activity and preserves natural resources (Longo *et al.*, 2019). Improving cultivated produce may increase global food security and nutrient quality (Guillen *et al.*, 2019).

Seafood is a crucial source of nutrition. Seafood provides animal protein for more than 3.1 billion people in 2013 (FAO, 2016). Seafood generally refers to grouper, snapper, shrimp,



lobster, crab, tuna, etc. However, there is little mention of catfish. Indonesia has the highest production rate of freshwater catfish (*Clarias* sp.). However, Indonesia has not cultivated saltwater catfish. Irawan and Raza'i (2019) stated that saltwater catfish might be cultivated through crossbreeding eel-tailed catfish and *Clarias gariepinus*.

Papuan Catfish cultivation development is alternative resource management in Jefman Island. However, it is necessary to pay attention to socioeconomic and environmental conditions. Papuan Catfish cultivation may support community livelihood sustainably. The potential of Jefman Island fisheries (catfish and other types of fish) is both an asset and a challenge. It is necessary to preserve the sustainability of Jefman Island's natural resources.

CONCLUSION

Papuan Catfish from Jefman Island, Raja Ampat, West Papua, provides ecological and socioeconomic potential in Sorong Raya. The fishers generally install *sero* (set net) in Jefman Island and Rumbabo Island waters. The marine environmental characteristic in Jefman Island waters is suitable for Papuan Catfish habitat. However, it is necessary to conduct further research on the potential and characteristics of Jefman Island's Papuan Catfish for aquaculture purposes.

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