Supporting community-based mangrove forest management as Essential Ecosystem Area in Sungai Pakning, Riau

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Abstract. Out of fifty established Essential Ecosystem Area up to 2020, six are located on mangrove forest. To support the government target’s achievement of ecological representative protection, at once to enhance the conservation of coastal environment and resources, what has been initiated by Pertamina RU II Sungai Pakning, communities of seven coastal villages on Bukit Batu district, and various actors to rehabilitate and conserve the environment need to be supported through the improvement status as one of wetland type of Essential Ecosystem Area (EEA). Apart from its biological diversity and the carbon stock potentials, this 281.86 hectares of mangrove forest has been developed as an integrated coastal management site which is integrating coastal disaster risk mitigation, protection of mangrove-based biodiversity, wise utilization of wetland through inland aquaculture, education-purpose tourism, the environmental-based communities institutionalization, and as a coastal resources-based alternative livelihood. The result shows that Sungai Pakning Mangrove Forest meets the indication of the essential area from the uniqueness, biodiversity, existing governance, and utilization aspects. The improvement status as Essential Ecosystem Area expectedly also improve the quality of coastal management and promote the wider collaborative management, and encourage sustainable utilization by communities surround mangrove forest.

Keywords: Essential Ecosystem Area; integrated coastal management; mangrove forest; Sungai Pakning; wetland

1. Introduction
Based on the national norm in Indonesia, the Essential Ecosystem Area (EEA) is a protected area for life supporting systems (according to Law No. 5/1990 on Conservation of Living Natural Resources and the Ecosystems). This is also confirmed in Government Law No. 28/2011 on Management of Nature Reserves and Nature Conservation Areas, that EEA may be in the form of karst, wetland, mangrove and peat ecosystems that located outside the Nature Reserve Area and Nature Conservation Areas which previously categorized as Conservation Areas based on Law No. 41/1999 on Forestry. However, based on the decree of the Ministry of Marine and Fisheries No. 17/2008, mangrove forest located on the coastline are categorized as coastal and small island’s conservation area. This ministerial
decree is affirmed by Presidential Decree No. 73/2012 on National Strategy for Mangrove Ecosystem Management and Presidential Decree No. 51/2016 on Coastline as defined as far as 100 meters to inland area measured from the highest tide point. The coastline and mangrove areas are considered to be vital for many aspects of life, therefore they must be protected and highly-considered in the spatial management process. The dualism and the diversity of interests regarding the coastal area, especially mangroves, made the management is nationally coordinated by the Coordinating Ministry for People's Welfare to bridge the different nomenclature and regimes.

So far, the achievement of the establishment of EEA in Indonesia are 50 areas in a total area of ± 975,200 hectares [1]. The Essential Ecosystem Area consists of four categories, namely wetlands, wildlife corridors, biodiversity parks, and high conservation value areas [2]. One factor that is still experiencing obstacles to the initiation of EEA is regulation, hitherto the ministerial level regulations regarding the Essential Ecosystem Areas have not been issued. Regardless of the dynamics at the policy level, the EEA initiatives in various locations indicate the existence of many parties' initiatives to save ecologically important sites without questioning their administrative status. This is in line with the global tendency in which the conservation actors are local communities, leaving the old pattern where the government or donors were the dominant actors [3].

The EEA initiation itself is the answer to an ecological representation gap analysis compiled jointly by the Ministry of Forestry and the Ministry of Marine and Fisheries together with a number of non-governmental organizations that state that 80% of threatened wildlife is in fact outside the conservation areas [4]. In the same document, it is stated that the representation of mangrove forests in conservation areas is only 8.37% compared to 91.63% that are outside conservation areas. This means that the states of protection for important wildlife in mangrove areas are still in an uncertain condition due to a lack of firm management. Seeing the importance of mangrove forest, weak existing control, and high levels of pressure, it is still necessary to improve the governance of mangroves forest [5].

In an arbitrary manner, EEA defined as an area with important ecosystem values outside the Nature Reserve Area, Nature Conservation Area and Game Reserve, which ecologically supports the continuity of life through conserving biodiversity for the welfare of society and the quality of human life, which is determined as a protected area. This definition has three important nuances, namely: a) This area is not included as a conservation area that is absolutely in state forest which has been divided into Nature Reserve (KSA), Nature Conservation Area (KPA) and Game Reserve (Taman Buru); b) EEA is part of regional spatial governance and can involve local governments in its management; and c). This area is managed according to the principles of conservation as the primary purpose and other uses as secondary purposes. Therefore, there is a big room for local governments and other local actors to develop EEA based on their specific types so that they can provide benefits to the surrounding community.

A mangrove forest is a form of EEA that is included in the wetland ecosystem category with a river, swamp, peat, lake, karst and shallow water ecosystems. The Sungai Pakning mangrove forest has experienced degradation due to natural abrasion of the coast, pollution, and conversion to agricultural and estate crops. But in three years, this area was rehabilitated through a collaborative program between the state’s oil and gas company Pertamina RU II Sungai Pakning, the community and the village government. The purpose of this rehabilitation has various dimensions: for the purpose of preserving mangroves, utilization as a fishpond, local tourism, as well as alternative sources of income, and part of efforts to reduce coastal disaster risk from abrasion.

Within three years, management of the mangrove area has been able to restore this degraded area. The quality and quantity of typical vegetation and fauna have increased, mangrove distribution areas have increased, and alternative sources of income through mangrove and fishery-based commodity production, inland fisheries and local tourism have begun to develop. Seeing these achievements, it is considered feasible to increase the protection status of this area. Therefore the efforts that have been made can involve more stakeholders, the area is designated as a protected area, and this community-based management will receive political recognition and support from the government.

The aim of this paper is to support the improvement of the status of mangrove rehabilitation areas as Essential Ecosystem Area for Mangrove Wetlands. For this reason, the problem that needs to be
formulated is: what extent the suitability of the Sungai Pakning mangrove forest to become EEA according to indicators based on existing regulations in Indonesia?

2. Methodology

The Ramsar Convention defines a wetland as areas of marsh, fen, peatland or water, whether artificial or natural, permanent or temporary, with static or flowing, fresh, brackish or saltwater, including areas of marine water which the depth does not exceed six meters at low tide [6]. The definition is suitable with the location of the study on Sungai Pakning, which is shallow marine water on the coast of the Bengkalis Strait. Based on indications of the potential mangroves in the Sumatra ecoregion, the mangrove forest in Riau Province is the largest which is 186,208 hectares [7], one of which is on the Bengkalis coast.

The study was carried out in seven villages in Bukit Batu District, Bengkalis Regency, Riau Province, which is known as the Sungai Pakning area (figure 1) where there are mangroves forest covering 281.86 hectares [8]. In order to obtain related information, the extraction of information is carried out in several ways: observing animals and vegetation, aerial photographs to see the extent and position of the landscape, interviews with communities that are managing mangrove forest, and interviews with CSR Pertamina RU II Sungai Pakning as a companion to the mangrove rehabilitation process. To support this primary information, a documentary study on environmental and institutional aspects related to the development of the Sungai Pakning mangrove area was also carried out as well as a review of other supporting documents related to EEA in Indonesia particularly the normative analysis.

![Figure 1. Map of study locations in the mangrove areas of Sungai Pakning, Bukit Batu, Bengkalis (source: KeSEMat, Pertamina RU II, PKSPL [10]).](image)

The findings and secondary data were analyzed using a normative approach to ensure conformity between indications in the area and the processes, procedures and criteria as the basis for determining the EEA of mangrove wetlands based on national norms. This paper will then describe all of the findings as a reference for the fulfillment of Sungai Pakning area as an Essential Ecosystem Area as well as recommendations for implementors, supporting private parties, and local governments to improve the quality of this Bengkalis coastal area.
3. Result

3.1. Biodiversity of the Sungai Pakning mangrove forest

According to the records in 2017 the mangrove area located on Sungai Pakning and the location of Pertamina RU II's assistance has an area of 281.86 hectares and a length of 20.24 km directly facing the Bengkalis Strait. Prior to the 2017 data collection, there was no record of the condition of this mangrove area, but the existing quality and quantity of mangroves in the area are quite threatened due to natural coastal dynamics such as abrasion and human factors such as mangrove logging and land conversion into estate crops. However, in 2017, through a cooperation program between Pertamina and the community in seven coastal villages in this area, the potential has begun to be studied, management institutions are built, and rehabilitated and utilized to provide use value to the surrounding community and the environment.

Out of the 157 species of mangroves that have been mapped in Sumatra [9], the Sungai Pakning mangrove forest has 14 species of true mangroves and 8 mangrove’s associated, so that a total of 22 species were found from 15 families. In the following studies conducted, several species of fauna and typical coastal vegetation indicated the presence of individuals as well as a diversity of vegetation and fauna. This indicates that the interventions that have been carried out are able to improve the quality of mangrove forests in this area. Even so, there are still challenges that must be resolved by the initiators of mangrove rehabilitation and conservation in ecological, social and economic aspects.

Table 1 shows a list of mangrove vegetation both true and associated as well as fauna in the coastal mangrove habitat of Bukit Batu Bengkalis in 2019 [10].

| No | Family     | Local name         | Scientific name       | Status of protection |
|----|------------|--------------------|-----------------------|----------------------|
|    |            |                    |                       | IUCN     | CITES | PP 106 |
| 1  | Acanthaceae| Api-Api Putih      | Avicennia alba        | LC       | NE    | NPr    |
| 2  | Apocynaceae| Bintaro            | Cerbera manghas      | NE       | NE    | NPr    |
| 3  | Arecaceae  | Nipah              | Nypa Fruticans       | LC       | NE    | NPr    |
| 4  | Asteraceae | Beluntas           | Plachaea indica      | NE       | NE    | NPr    |
| 5  | Cactaceae  | Buah Naga          | Hylocereus undatus   | NE       | NE    | NPr    |
| 6  | Cactaceae  | Bogem              | Sonneratia alba      | LC       | NE    | NPr    |
| 7  | Combretaceae| Keduduk Bunga Merah| Lumnitzeria littorea | LC       | NE    | NPr    |
| 8  | Euphorbiaceae| Buta-Buta      | Excoecaria agallocha | LC       | NE    | NPr    |
| 9  | Fabaceae   | Gadelan            | Derris trifoliata    | NE       | NE    | NPr    |
| 10 | Malvaceae  | Waru               | Hibiscus tiliaceus   | NE       | NE    | NPr    |
| 11 | Meliaceae  | Nyaruah            | Xylocarpus moluccensis| LC       | NE    | NPr    |
| 12 | Meliaceae  | Nyirih             | Xylocarpus granatum  | LC       | NE    | NPr    |
| 13 | Primulaceae| Lempeni            | Ardisia elliptica    | NE       | NE    | NPr    |
| 14 | Pteridaceae| Paku Laut          | Acrostichum speciosum| LC       | NE    | NPr    |
| 15 | Rhizophoraceae| Tancang Putih   | Bruguiera cylindrica | LC       | NE    | NPr    |
| 16 | Rhizophoraceae| Tancang Merah    | Bruguiera gymnorhiza | NE       | NE    | NPr    |
| 17 | Rhizophoraceae| Tingi          | Ceriops tagal        | LC       | NE    | NPr    |
| 18 | Rhizophoraceae| Bakau Kacang    | Rhizophora apiculata | LC       | NE    | NPr    |
| 19 | Rhizophoraceae| Tancang         | Bruguiera sexangula  | LC       | NE    | NPr    |
| 20 | Rubiaceae  | Skiphora           | Scyphiphora hydrophylacea| LC       | NE    | NPr    |
| 21 | Rubiaceae  | Mangkudu           | Morinda citrifolia   | NE       | NE    | NPr    |
| 22 | Sterculiaceae| Dungun            | Heritiera littoralis | LC       | NE    | NPr    |

Source: Field observation (2019)

Notes:
- DD: Data Deficient
- LC: Least Concern
- NT: Near Threatened
- VU: Vulnerable
- EN: Endangered
- CR: Critically Endangered
- EW: Extinct in the wild
- EX: Extinct
- NE: Not Evaluated
- Pr: Protected
- NPr: Not Protected
In the following study conducted in 2018 and 2019, several types of fauna were identified. Observations of fauna in the mangrove forest in Pangkalan Jambi found 2 types of mammals and 25 species of birds from 14 families (table 2).

In particular, one issue to be highlighted is that the Bengkalis area has an iconic fauna, namely the Terubuk (*Tenualosa macrura*) (figure 2). This fish is endemic with limited distribution in the estuarine waters of Bengkalis, Meranti Island and Siak [12]. Currently, this fish is in an endangered state even though in the 60-70s era it was still abundant. This is due to the degradation of the quality of the waters in the Bengkalis Strait due to pollution and overextraction of its eggs [13]. Therefore officially through the Bengkalis Regent Law No. 15/2010, Governor of Riau Law No. 78/2012, and Marine and Fisheries Ministerial Decree No. 59/2011 the government seeks to protect this fish population by establishing a fishery reserve in Bengkalis Regency and limited protection for these fish [14]. Mangrove rehabilitation in Sungai Pakning area is part of an effort to restore the iconic Bengkalis fish population because the mangrove forest is the spawning area of *Tenualosa macrura*’s larvae [15].

![Figure 2. Map of Tenualosa macrura’s fishery reserve, processed (source: PKSPL [10]).](image)

The Sungai Pakning mangrove forest is unique because this area is a point for migratory birds from the Malay peninsula. Notes of Iqbal [16] found 1,080 individuals of the Sikepmadu Asia (*Pernis ptilorhynchus*) species crossing in the Rhu Bay, Rupat Island, Bengkalis Regency [16]. Higuchi et al. [17] also stated the same that Rupat Island, Bengkalis Regency, is one of the entry points for migration from the Malay peninsula to Indonesia. Pramono et al. [18] also more specifically states that one of the suitable habitats for migratory birds in Bengkalis Regency is a habitat in the form of mangrove forests. Therefore, it should be assumed that the Sungai Pakning mangrove forests are one of the stopover areas for migratory birds. Besides the migration period, Higuchi et al. [19] found that this migratory bird crossed the Malay peninsula to enter Sumatra Island in October - November and began moving to return to their breeding sites (China, Korea, Japan, Siberia) in February (figure 3).
Table 2. List of fauna observed in the coastal study area of Sungai Pakning, Bukit Batu, Bengkalis.

| No. | Local name               | Family         | Scientific name          |
|-----|--------------------------|----------------|--------------------------|
|     | **Avifauna***            |                |                          |
| 1   | *Kuntul besar*           | Ardeidae       | *Egretta alba*           |
| 2   | *Kuntul kecil*           | Ardeidae       | *Egretta garzetta*       |
| 3   | *Perkutut jawa*          | Coulumbidae    | *Geopelia striata*       |
| 4   | *Walet sapi*             | Apodidae       | *Collocalia esculenta*   |
| 5   | *Walet sarang-putih*     | Apodidae       | *Collocalia fuciphaga*   |
| 6   | *Kirik-kirik senja*      | Meropidae      | *Merops leschenaulti*    |
| 7   | *Raja-udang meninting*   | Alcedinidae    | *Alcedo meninting*       |
| 8   | *Cekakak sungai*         | Alcedinidae    | *Todirhamphus chloris*   |
| 9   | *Pelatuk kijang*         | Picidae        | *Celeus brachyurus*      |
| 10  | *Layang-layang batu*     | Hirundinidae   | * Hirundo tahitica       |
| 11  | *Layang-layang loreng*   | Hirundinidae   | * Hirundo striolata      |
| 12  | *Cipoh kacat*            | Chlorophseidae | * Aegithina tiphia       |
| 13  | *Cucak katilang*         | Pycnonotidae   | *Pycnonotus aurigaster*  |
| 14  | *Merbah ceruckuk*        | Pycnonotidae   | *Pycnonotus goiavier*    |
| 15  | *Remetuk laut*           | Silviidae      | *Gerygone sulphurea*     |
| 16  | *Cikrak muda*            | Silviidae      | *Seicercus grammiceps*   |
| 17  | *Cinenen belukar*        | Silviidae      | *Orthotomus atrogularis* |
| 18  | *Kipasan belang*         | Muscicapidae   | *Rhipidura javanica*     |
| 19  | *Kekep babi*             | Artamidae      | * Artamus leucorhynchus* |
| 20  | *Burung-madu kelapa*     | Nectariniidae  | *Anthreptes malacensis*  |
| 21  | *Burung-madu sriganti*   | Nectariniidae  | *Nectarinia jugularis*   |
| 22  | *Pijantung kecil*        | Nectariniidae  | *Arachnothera longirostra* |
| 23  | *Cabai bunga-api*        | Dicaeidae      | *Dicaeum trigonostigma*  |
| 24  | *Pentis pelangi*         | Dicaeidae      | *Prionochilus percussus* |
| 25  | *Cabai jawa*             | Dicaeidae      | *Dicaeum trochileum*     |
|     | **Mammals***             |                |                          |
| 1   | *Bajing kelapa*          | Sciuridae      | *Callosciurus notatus*   |
| 2   | *Babi hutan*             | Suidae         | *Sus scrofa*             |
|     | **Fish in mangrove area***|               |                          |
| 1   | *Siput Tanduk*           | Potamididae    | *Telescopium telescopium*|
| 2   | *Kerang Lokan*           | Cyrenidae      | *Polymesoda expansa*     |
| 3   | *Ikan Buntal*            | Tetraodontidae | *Tetraodontidae*         |
| 4   | *Kakap Putih*            | Latidae        | *Lates calcarifer*       |
| 5   | *Ikan Biang*             | Coiliinae      | *Steppina breviceps*     |
| 6   | *Kitang*                 | Scatophagidae  | *Scatophagus argus*      |
| 7   | *Udang Pepai*            | Mysidae        | *Mysis sp.*              |
| 8   | *Ikan Lomek*             | Synodontidae   | *Horpodon nuherus*       |

Sources: *Field observation (2019) **Monitoring by Harapan Bersama P. Jambi [11].
Figure 3. Migration route on fall season (October – November) and summer season (February) of *Pernis ptilorhyncus* or Honey Buzzard (Higuchi *et al*. [19]).

In a study conducted at 5 sampling points, namely in Pangkalan Jambi Village, Dompas Village, Sejangat Village, Batang Duku Village, and Sungai Pakning Village in 2017 based on forest degradation standards (Environmental Ministerial Decree No. 201/2004) it was identified that the mangrove forests in 4 villages are in the Good and Dense categories with a cover value of 75% and a density between 2300-5600 individuals/hectare while 1 village namely Sungai Pakning is in the Good Medium category with 50%-75% cover and a density value of 1400 individuals/hectare [20].

The other important ecosystem services from mangrove ecosystems are the benefits of carbon sequestration which has large content. According to Donato *et al*. [21] stated that mangroves have high assimilation ability and carbon sink rates. By measuring the amount of carbon captured in the biomass in a land, it can describe the amount of CO$_2$ in the atmosphere that is sequestrated by plants.

The 2017 study identified the value of carbon capture and sequestration in five villages with the results as shown in table 3.

| No | Location          | Captured CO$_2$ (ton/ha) | Sequestration CO$_2$ (ton/ha) |
|----|-------------------|---------------------------|-------------------------------|
| 1  | Pangkalan Jambi   | 65                        | 238                           |
| 2  | Dompas            | 258                       | 946                           |
| 3  | Sejangat          | 135                       | 494                           |
| 4  | Sungai Pakning    | 273                       | 1001                          |
| 5  | Batang Duku       | 315                       | 1156                          |

Source: KeSEMat [8].
The biomass value is influenced by the stem diameter of a stand. Competition between individuals in utilizing solar energy, nutrients, and water will cause trees in a forest to form various diameter classes [22]. This is in line with the statement of Krisnawati et al. [23] that there is a correlation between tree measurement dimensions (tree diameter and height) and its biomass. This condition can be caused by the tree's diameter growing through continuous cell division and will be slower at a certain age. The larger the tree diameter, the biomass value will increase [24]. This allometric model has been widely used, but unfortunately it is only used for mature mangroves, while carbon storage is not calculated for the youngers [25].

Mangrove forests play a role in efforts to increase CO$_2$ sequestration with the help of sunlight and groundwater. Mangrove vegetation can absorb CO$_2$ from the atmosphere through photosynthesis. This means that the contribution of the mangrove ecosystem to air quality and control of climate warming also occurs around Sungai Pakning and is felt directly by the community and other living creatures.

3.2. Developed governance

Table 4 shows an institutional development matrix that has been running for three years in Pangkalan Jambi:

| Institution               | Month/year | Objectives of activities                                      | Achieved outputs                                                                 |
|---------------------------|------------|---------------------------------------------------------------|----------------------------------------------------------------------------------|
| Harapan Bersama Group     | 2004–2019  | Mangrove conservation and ecotourism                          | Mangrove planting and financial outputs from ecotourism                          |
| Rizky Bersama Group       | 2018–2019  | Brackish water aquaculture                                    | Financial benefit from brackish water aquaculture                                |
| Jaya Bersama Group        | 2019       | Food processing from mangrove and fishes                      | Financial benefit from processing food based on mangrove and local fishes.       |
| Berkah Jaya Bersama Cooperative | 2019–present | Management of mangrove conservation, brackish water aquaculture, mangrove and fish-based food processing, and ecotourism | Conservation management, aquaculture, food production, and well-managed ecotourism management. Direct financial benefit and a better environment. |

Source: CSR Pertamina RU II Sungai Pakning 2020.

For its governance, the management system built is based on local communities with the establishment of a mangrove care group as part of a local fishers group. Initially, this group made mangrove rehabilitation the focus of its activities in order to develop it as a natural tourism area for the local public. During its development, other potentials were found in this area, namely the purpose of reducing the risk of abrasion and pollution on the coast, utilizing mangrove products as an alternative source of income, and utilizing coastal land around mangroves as piloting areas for saline tilapia ponds as other forms of coastal utilization.

Out of seven intervention villages, the institutional development in Pangkalan Jambi Village was the most advanced. This is indicated by the persistence of a group called the Harapan Bersama Group, and it can even develop its activities for women's groups as active actors in the production of local resources under the name Jaya Bersama Group. The Jaya Bersama Group is a group that is managed by women around the mangrove forest location with activities to process food made from mangrove and fishes. In 2020 the existing groups were merged into one Cooperative of Berkah Jaya Bersama and have initiated tourism objects that are open to the public, set entrance fees as payback for ecosystem management,
opened coastal resources-based culinary huts, and operated the Mangrove Information Center as a public education space about mangroves and coastal resources.

Therefore, it can be said that this cooperative is the center of institutional activities in mangrove management while fishers groups in other villages support and duplicate similar practices in their respective administrative locations. Thus, the integration of all institutional potentials and natural resources is considered to be able to strengthen the visibility and opportunities for the sustainability of the mangrove forest on the coast of the Bukit Batu District.

3.3. Cross-cutting issue
The nexus of various interests or cross-cutting issues in the management of the Sungai Pakning mangrove forest is an entry point for synergies efforts between environmental and ecological protection, utilization for the community's economy, as well as providing benefits and acceptance by the community because through the development of this mangrove area, the institutional formation, dialogical processes and education also take place. In the end, there is a perception and consciousness that environmental rehabilitation can mutually support the economy and support the institutional strengthening and capacity of village communities.

The Bengkalis coastal area is vulnerable to coastal abrasion as a combination of current dynamics and the reduction of coastal ecosystems as a buffer between sea and land. Fishing vessel traffic and marine debris are other pressures that make the Bengkalis coast vulnerable to pollution. From the risk map released by Regional Disaster Agency (BPBD) Riau Province in 2016, actually the level of abrasion and extreme waves hazard in Bengkalis coastal area is at Low-Moderate levels, but partially there are several points of coastal abrasion, one of which is in Pangkalan Jambi. Apart from abrasion, flooding is also another risk variable in Bengkalis. This risk is also related to land use practices that are less wise in coastal areas due to the pressure to expand monoculture or mix-crop estate that pushing away original coastal vegetation. The opening of land on the coast to some extent reduces the ability of the area to filter and hold water runoff from both sea and rain, so that water from the sea and rain will inundate coastal and urban areas that are not far from the shoreline.

From an economic perspective, the income of the people around Sungai Pakning mainly comes from the service and trade sectors, civil service, capture fisheries, and agriculture. The sub-sector that also growing in the area is oil palm plantations in coastal areas. Even though it is located in a coastal area, the development of the aquaculture sub-sector is still relatively small compared to capture fisheries. Capture fisheries themselves are still dominated by traditional scale capture fisheries (<5 GT) operating in artisanal areas, 0-4 miles from the coast using handlines, longlines, cast nets, trammel net, and filter net or locally called gombang.

This series of mangrove rehabilitation-based activities eventually helped shape a caring community, then shared the same vision and orientation, and encouraged a local cooperative association that involved women and men from the local village to encourage the use of the area while protecting it. The role of the private sector then strengthens the embryo of this organization with a series of training, facilitation, communication with other parties, including trying to build relationships with the market for the organization's products.

4. Discussion

4.1. National regulation on mangroves
Based on the Coordinating Minister for Economic Law No. 37/2015 on Strategies, Programs and Performance Indicators for National Mangrove Ecosystem Management, it is targeted that until 2045 there will be a rehabilitation of mangroves covering an area of 3.49 million hectares by mandating the Ministry of Environment and Forestry, Ministry of Marine and Fisheries, and the Land Agency to develop criteria for mangrove areas as protected/conservation or cultivation areas. Based on those norms, the formation of EEA for mangrove wetlands is one way to achieve this national target. Other regulations that support mangrove management are Law No. 27/2007 on the Management of Coastal
Areas and Small Islands which prohibits unsustainable conversion, Law No. 26/2007 on Spatial Planning which makes mangrove forested coast as a national protected area, Law No. 31/2004 on Fisheries which encourages mangroves as support for fishery resources, Government Law No. 26/2008 on the National Spatial Plan which prohibits the use of mangroves or activities that reduce and pollute mangrove forest, Presidential Law No. 73/2012 on The National Strategy for Mangrove Ecosystem Management, as well as Presidential Decree No. 73/2015 on Implementation of Regional Coordination of Coastal and Small Islands in single-hub coordination under the Marine and Fisheries Ministry [26].

There are several benefits of designating an area as an essential ecosystem area, namely: a) as a “protected” status in the regional spatial plan, the conversion for non-conservation purposes is relatively more difficult; b) political recognition from the central government in its contribution to national achievements at international conventions; c) improve the image of the area for many parties, especially those directly related to coastal conservation efforts and fishery resources; d) encouraging multi-stakeholder collaboration which opens up a bigger communication network and cooperation; e) provide opportunities for recognition of grassroots/community work to manage the area and utilize it; and f) increasing mangrove ecosystem services for the protection of important assets of the surrounding community.

Based on the existing norms regarding mangroves in the Regulation of the Director General of PHKA (Forest Protection and Nature Conservation) No. 151/ 2007 based on the Ramsar Convention, there are several ecological categories that are considered whether a mangrove wetland area has essential value or not. At least the area meets five criteria: criteria for representation and uniqueness as wetlands, criteria for the existence of flora and fauna, criteria based on the number of waterbirds, criteria based on the number and variety of fish, and criteria based on socio-cultural aspects.

The criteria for the uniqueness and representation of mangroves as wetlands can be seen from: a) natural or nearly natural wetland ecosystems; b) represents one or more biogeographic areas; c) has an important biological, hydrological, or ecological role in the natural functions of a coastal system or river flow; and d) the ecosystem is specific or rarely in suitable biogeography. From the criteria based on the presence of plants and animals, it is expected that mangrove areas: a) support a sufficiently large number of one or several rare, vulnerable, or threatened species; b) has particular value for maintaining the ecological or genetical diversity of flora or fauna; c) has special value as habitat for flora or fauna which is critical in the ecological cycle; and d) have a special value for endemic flora or fauna.

From the criteria for the presence of waterbirds, an area will be considered suitable as a EEA if: a) supports the presence of 20,000 individual waterbirds; b) support important avian individuals from certain waterbird groups as an indication of biodiversity; and c) support 1% of individuals among a population of waterbird species or sub-species. Apart from waterbirds, the presence of fish is also a consideration where: a) the ecosystem supports a sufficient number of native fish species, sub-species or families that provide benefits and value to global biodiversity; and b) the ecosystem is an important food source for fish, spawning, or fish migration routes. The last criterion is the existence of socio-cultural criteria. An ecosystem that can become an EEA is expected to: a) play an important role in supporting people's lives (both clothing, food, fuel and sources of livelihood); and b) the ecosystem has the potential for tourism, religious and traditional functions.

From the five existing criteria, the criteria for the uniqueness of wetlands can be found in their suitability for the biogeographical nature of Sumatra, which is natural and close to natural, the importance of this coast for protection from abrasion, as well as being a buffer area in case of sea water rising and preventing runoff from hinterland. As additional information, the average distance between the coastline at low tide and settlements is around 500 m–1 km, but in the middle between mangroves and settlements there are areas use as an estate crops land. From the three-year record since mangrove rehabilitation and hybrid engineering techniques were carried out in Pangkalan Jambi, which was experiencing abrasion, a 21 meter wide new land has been formed as a result of sedimentation. This gives an indication that efforts to reduce abrasion also occur during the area rehabilitation process.

From the presence of flora and fauna, this area is important to protect several species of mangroves, water birds and is a stopover location for migratory birds. The presence of fish in the location also
indicates that native fish species can breed well and make the mangrove forest a spawning location. From the socio-cultural criteria, the existence of this mangrove area is provenly encouraged the emergence of sustainable use of coastal resources through educational tourism, development of brackish tilapia aquaculture among mangroves (silvofishery) and supporting artisanal capture fisheries for the surrounding community.

4.2. Lessons from EEA mangrove management in Indonesia

In Indonesia, the EEA mangrove concept has been recognized by the formation of 6 Essential Ecosystem Areas of mangrove wetland types. The six locations are in Jaring Halus (Langkat Regency, North Sumatra), Cemara Beach (Tanjung Jabung Regency, Jambi), Mojo Village (Pemalang Regency, Central Java), Pangpang Bay (Banyuwangi Regency, East Java), Torosiaje (Pohuwato Regency, Gorontalo Province) and Sekotong (West Lombok Regency, West Nusa Tenggara Province). From the implementation of EEA in these six regions, there are several general conditions that are used as a comparison of the opportunities for the formation of the Sungai Pakning’s EEA. Table 5 shows a matrix of conditions for the EEA mangrove area in Indonesia.

**Table 5.** Matrix of mangrove’s EEA condition in Indonesia up to September 2020.

| No | Locations            | Area (hectares) | Highlighted issue                                                                                                                                                                                                 | Institutional/governance                                                                                     |
|----|----------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| 1  | Jaring Halus, Langkat | 57.8            | Wildlife Reserve buffer area, habitat preservation, and the protection of the iconic endangered freshwater dolphin (*Orcaella brevirostris*) or pesut.                                                      | Has been managed traditionally, dominant use as a fishing ground [27].                                       |
| 2  | Cemara Beach, Jambi  | 2,284.12        | Habitat and migration destination for water birds. This area also buffers zone of Berbak National Park. Has 26,000 birds [28].                                                                                     | Determined by a 2019 Governor Decree as a conservation value area for waterbirds, migratory birds, and the community's economy. Management is carried out by the Collaboration Forum under the coordination of the Jambi Provincial Forestry Office. |
| 3  | Mojo, Pemalang       | 14.5            | Area of rehabilitation of community cooperation and OISCA as mitigation of abrasion that threatens ponds [29] although small in size, this area is home to 19 species of mangroves, 46 species of birds, and 7 migratory birds. | Enacted by the Decree of the Pemalang Regent in 2017. Independent management by the community and farmers in Mojo Village with guidance by the Central Java BKSDA (Conservation of Nature and Biodiversity Office) and DLH (Environmental Office) Pemalang [30]. |
| 4  | Pangpang Bay, Banyuwangi | 2,926.6     | Multi-functional area for economic use of fisheries, tourism and protection of mangrove and waterbird biodiversity [31].                                                                                      | Initiated by the government but managed through KUB (communal business unit) and Pokmaswas (Community-based Monitoring group), has unique waterbird biology and fishery activities (capture and aquaculture) and nature tourism. Currently under the assistance of the BBKSDA of East Java. |
| 5  | Torosiaje, Pohuwato   | 124.5           | Mangrove area is adjacent to the settlements above the sea of the Bajo tribe. Density up to 6000/hectare and adjacent to seagrass and coral reef ecosystems.                                                           | Independent management by the Environmental Awareness Group accompanied by DKP (Fisheries Office) Pohuwato and NGOs, there is still a threat due to the expansion of fish pond and on land settlements. |
| No | Locations                  | Area (hectares) | Highlighted issue                                                                                       | Institutional/governance                                                                 |
|----|---------------------------|-----------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 6  | Sekotong, Lombok Barat    | 86.46           | Existing rehabilitation areas as a buffer against currents from the Bali Strait, preventing abrasion, and reducing the potential impact of a tsunami. | Located in the non-state forest and its management is carried out by community groups with the support of the West Lombok regional government. Collaboration forum formed in 2017. |

Based on a comparative analysis with other EEA Mangrove implementations in Indonesia, there are several similarities and differences compared to Sungai Pakning. What they have in common are: a) the initial motivations for establishing EEA are for the preservation and conservation of existing mangrove habitats, unique biodiversity, and ecosystem services as voluntarily; b) limiting or controlling the area like a conservation area (there is governance at the local level) applied; c) based on multi-stakeholder involvement or collaboration in area management; d) not detaching local economic functions from the area; and e) open up opportunities for broad funding sources. Meanwhile, some differences exist in the various size of areas, the content of biodiversity, the highlights of various uses, the legal determination can be by province or district, and the source of the initiative can be from the government and the community.

The similarities and variations that emerge indicate challenges and further homework for initiators and managers of the Sungai Pakning mangrove area. Several issues that are further homework for proposing the Sungai Pakning mangrove forest as an EEA are as follows: a) Standard and digital delineations are still needed as a clear mark for the area to be intervened; b) species, variety, and amount of biodiversity need to be reviewed for detail throughout the mangrove forest of Sungai Pakning; c) collaborative forums need to be improved in quality and formation, both between villages that have mangrove forest, local governments, NGOs, and the private sector; d) utilization and development plans based on medium-term local interests need to be clearly formulated, and e) advocacy is needed for the integration of EEA development as regional protected areas in regional spatial plans.

4.3. Other contributing factors: towards collaborative management

Lessons learned on collaborative management in Pangpang Bay show that simultaneously, mangrove forest conservation carried out together with participatory community empowerment has a positive impact on awareness and mangrove-based economic improvement initiatives [32]. The forms of collaborative management at EEA that have been formed also indicate a transfer of resources in the form of human capital, funding, supervision, and have a positive contribution to building trust between actors (mutual trust).

At EEA which functions as a buffer for conservation areas, EEA is considered to have contributed to the protection of conservation areas such as what happened in Jaring Halus, Cemara Beach, and Pangpang Bay. Another important aspect is that the preservation of the mangrove ecosystem also contributes positively to the economic income of the community through eduturism and ecotourism as well as the use of ecosystem services as a disaster mitigation tool such as in West Lombok [33] or the main livelihood supporters such as in Torostaje, namely fisheries [34].

From the study of other EEA locations above, mangrove management of Sungai Pakning can also be aimed at achieving ecological, social and economic goals. In the collaborative model that has emerged, one of its main strengths is the formation of mangrove-based community organizations in Pangkalan Jambi Village and surrounding villages through partnerships with national oil and gas companies. A series of training to strengthen group capacity have also been carried out. Until now, the Harapan Bersama Group has made this area a mangrove-based educational area called the Mangrove Education Center.

In their daily activities, there has been a division of group work such as financial management (from entrance fees), mangrove guides, boat services for mangrove scouting, as well as the development of mangrove culinary by women's groups, and development of brackish tilapia aquaculture in mangrove
areas (silvofishery). Until September 2020, the average visit was 2000 people per week, with an average income of 10-15 million/month. This indicates that in real terms, local communities have benefited directly from the rehabilitation and conservation efforts of Sungai Pakning mangroves. The Acting Regent of Bengkalis officially inaugurated the mangrove area of Pangkalan Jambi Village as a Mangrove Ecotourism Area on September 27, 2020 [35].

Thus collaborative relationships that are centered on the community can be realized in this location because the involvement of other actors can improve the quality of the mangrove area as well as improve the quality of the resources of actors and groups. The company still provides technical assistance and training support, the local government provides legal support and development study support, the village government may integrate it with village development plans, and NGOs and CSR help to expand information, scientific studies and other information networks to improve the quality of this area.

4.4. The conformity as wetland type EEA

Normatively, there is conformity if the Sungai Pakning mangrove forest is upgraded as an Essential Ecosystem Area of Mangrove Wetland. The results elaborated from the study can be seen in Table 6. From several points of conformity indication, points regarding detailed data for the type and amount of biodiversity need to be further verified to obtain more accurate data. Meanwhile, the points that are still a challenge for improving the status of EEA are the formalization of institutions and their governance regarding the collaboration model and the sharing of responsibilities between actors. The formulation of work plans, development plans, agreed on norms, and allocation of responsibilities need to be carried out immediately and formalized so that they are more measurable for inclusion in regional development plans and determination of spatial protection.

Table 6. Indication of the conformity of the Sungai Pakning Mangrove as EEA Wetland Mangrove.

| Area size (hectare) | Typical/unique condition | Biodiversity/carbon stock | Existing governance | Utilization |
|--------------------|--------------------------|---------------------------|---------------------|-------------|
| 281.6 covering 7 coastal villages | 1. Rehabilitation of threatened species, Terubuk (Tenualosa macrura). | 1. Habitat of 14 true mangroves and 8 species of associations. | 1. Community organizations active since 2018, in present in the form of Cooperative. | 1. Location of coastal ecosystem rehabilitation. |
| | 2. Stopover locations for migratory waterbirds. | 2. There are 25 types of birds. | 2. Support from 7 village government. | 2. Location of coastal abrasion mitigation. |
| | 3. Maintain water circulation (coast-land). | 3. There is 1 protected bird species. | 3. Support from partnership with Pertamina RU II Sungai Pakning. | 3. Locations of mangrove eco-tourism. |
| | 4. Bengkalis coastal green belt. | 4. There are 8 species of fish in the mangrove forest. | 4. Political support from Regent, Env. Office, Tourism Office, and Marine and Fishery Office of Bengkalis Regency. | 4. Artisanal fishing locations. |
| | | 5. There are 2 types of mammals. | | 5. Mangrove culinary center |
| | | 6. A large deposit of carbon and potential sequestration. | | 6. Brackish water Tilapia aquaculture (silvofishery). |

Back to the genealogy of EEA which comes from voluntary-based conservation, the application of EEA in Sungai Pakning is also expected to be one model of alternative conservation compared to the classical conservation (by the central state on defined conservation area) [36]. As a voluntary, the location of EEA do not merely pledge on the state land under classical bureaucracy but applied on public land or private land by private or collective management. The indication of biodiversity is also less rigid as conservation forest. This condition enables any parties including public, private, local government, even individuals to participate in the management of the EEA [37]. Another issue that needs to address is, the regime that will be applied by the state on the EEA should be facilitation instead of regulation
because the EEA not always operated on state-land, initiated and managed voluntarily, and do not oblige the central state to take full authority and control the area including the financial support.

5. Conclusion

Based on the Ramsar Convention adopted by Indonesia in 2007 and the National Mangrove Ecosystem Management Strategy (SPEMN) in 2012, the Sungai Pakning mangrove forest meets several indicators in terms of: a) representing hydrologically important wetland uniqueness in a coastal system; b) criteria for the existence of flora and fauna, especially those that are endemic and threatened; c) there is an adequate number of waterbirds and fish which are important for biodiversity and become fish spawning area. The last criterion that is fulfilled is the use as a support for the livelihoods and lives of the surrounding community and has a tourism function.

Those indicators above do not refer to existing law on EEA development which has not been issued yet by the national government, thus the definitive benchmark has not been decided yet. Besides the SPEMN norm, the lessons and practices from various established EEAs in Indonesia become the references for the governance of the proposed EEA in Sungai Pakning. First of all, the need for the protection of remaining mangrove forests is the main reason to improve the status while waiting for the definitive law is issued.

Increasing the status will also add the benefits that will be received, namely the protection of mangrove areas as protected areas in regional spatial planning, the integration of local efforts with the national target, building a positive image for actors involved, both the community, local government, and supporting private sectors, expanding the area's publicity and community works, improve the quality of the area's biodiversity, and strengthen protection from the threat of abrasion and floods. In the end, it is hoped that all these efforts will lead to community welfare and environmental sustainability of the Sungai Pakning coast.

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