An ecosystem services perspective for the economic value of seafood production supported by seagrass ecosystems: An exercise in Derawan Island, Indonesia

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Abstract: Seagrass meadows provide provisioning services that play a vital role in food security and human wellbeing, especially on the small island. However, the utilisation value is uncalculated as support for seafood production and livelihoods for the community, because they are considered as alternative uses, so that seagrass ecosystem services are underestimated and undervalued. This paper aims to show the economic value provided by seagrass ecosystem services in providing seafood, both as a primary or secondary source. Through field survey and effect on production (EOP) analysis shows that capture fisheries and other marine biota collecting, both crustacean and mollusc species associated with the seagrass ecosystem are utilised directly by coastal communities in Derawan Island, Indonesia. Estimates of the economic value of fish and marine biota employed in the seagrass ecosystem area are US$ 13,488.80 and US$ 35,744.69 per hectare per year, respectively, or a total of US$ 49,233.49 per hectare per year. This value demonstrates the potential importance of seagrass ecosystems. Unfortunately, these benefit values have not been fully understood by the communities, so that many people ignore the function of seagrass ecosystem services as provisioning services, although in the scarcity the utilisation of the seagrass ecosystem is quite intensive. Hence, the precautionary principle and suggesting conservation actions in a participatory manner is challenging to implement.

Keywords: seagrass; provisioning services; seafood production; economic value; ecosystem services; Derawan Island; Indonesia.

1. Introduction
Seagrass ecosystem has been proven to provide many benefits to humans and the environment, including ecosystem provisioning, such as fisheries [1, 2] and food security [3, 4], regulating, such as
carbon storage and climate change mitigation [5], cultural, such as tourism [6], recreational fishing [7], and supporting, such as habitat function [8], conservation function, especially for dugongs (*Dugong dugon*) as endangered species [9], etc.. Explicitly, the seagrass ecosystem services (SGES) also have a high economic value to the beneficiaries. Wahyudin, Kusumastanto, Adrianto and Wardiatno [7] stated that the economic value of seagrass for recreational fishing is averagely estimated at around IDR 351,179.56 per hectare per year. Arkham, Adrianto and Wardiatno [1] reported that seagrass ecosystem areas had supported the fisherman income from the fish catch, with total revenue IDR 202,124 per day or 12 kg per day in Malang Rapat Village and IDR 193,151 per day or 13.8 kg per day in Berakit village.

Seagrass meadows provide provisioning services that play a vital role in food security and human wellbeing, especially on the small island. However, the utilisation value is uncalculated as support for seafood production and livelihoods for the community, because they are considered as alternative uses, so that seagrass ecosystem services are underestimated and undervalued. This paper is a preliminary study and aims to show the economic value provided by seagrass ecosystem services in providing seafood directly, both as a primary or secondary source.

### 2. Materials and methods

This study was carried out with a case study in Derawan Island, Berau Regency, East Kalimantan, Indonesia (118° 14′35″ E and 2° 17′04″ N) (Fig. 1). Derawan Island has an area of 44.6 hectare and has a seagrass ecosystem of about 35 hectare [10].

Primary data collected using questionnaire and interview to fisher. Respondents are fisher or users in seagrass ecosystems, either fish or association biota that the community uses, such as shellfish, sea cucumbers, and other invertebrates. The data were analysed using the effect of production (EOP) method [11].
3. Result and discussion

In Derawan Island, dominant seagrass species is *Halodule uninervis*, *H. pinifolia*, *Cymodocea rotundata*, *Thalassia hempricii*, and *Syringodium isoetifolium*. The number of fishers who caught fish in the seagrass ecosystem was 173 persons, and the other marine biota collector, both crustacean and mollusc species were 20 persons. Fisher and biota collectors can get around 2-3 kg of fish/mollusc/crustacean per day. The most common types of fish and biota caught and taken are rabbit fish/baronang (*Siganus* sp.), jarbua terapon/kelong-kerong (*Terapon* sp.), sea cucumber/teripang (*Holothuroidea*), shells (*Anadara* sp., *Perna* sp., etc.), etc.

Fisher generally catches fish and collects biota in seagrass ecosystems at low tide, with an average total of 40 days in one year. Fish catches and biota collection are only for self-consumption, and only a few are sold. Based on local market prices, the selling value of fish ranges from IDR 16,667-30,000, or an average is IDR 23,542 per kg. This value is much smaller than the price of existing biota, which ranges from IDR 20,000-150,000, or an average is IDR 100,000 per kg. The average number of fish and biota catches reached 2,915 kg per year and 399 kg per year, respectively. Based on these values, the total income of fisher and biota collectors is IDR 26,991,750 and IDR 15,621,818 per year.

Based on the analysis, the utility value from fishing is IDR 396,667,091.00 (US$ 28,333.36) while for biota collection is IDR 330,475,710 (US$ 23,605.41), while for biota collection is IDR 330,475,710 (US$ 23,605.41). Thus, the total value of seagrass utilization utilities in Derawan Island is IDR 1,300,280,571.00 (US$ 92,877.18) with a CS value is IDR 1,206,220,514.00 (US$ 86,158.61). Therefore, the total economic value of fish and marine biota employed in the seagrass ecosystem area are IDR 188,843,262.94 (US$ 13,488.80) and IDR 500,425,602.56 (US$ 35,744.69) per hectare per year, respectively, or a total of IDR 689,268,865.50 (US$ 49,233.49) per hectare per year.

This value is quite significant, especially for the community on small islands. The real economic value also shows that the seagrass ecosystem is an important ecosystem that can become a source of food for the island community, especially during the difficult season for fishing. However, seagrass beds are under widespread pressure to decline with the main threats in Indonesia, i.e. coastal development, land reclamation, deforestation, seaweed farming, fishing, garbage dumping, oil pollution, run-off, marine culture and public awareness [12, 13]. In contrast, in some areas, the coastal communities and traditional fisherman are dependent on the existence of seagrass ecosystems [1, 2, 4, 7, 14]. The destruction of the seagrass ecosystem will change the SES of coastal areas, both ecological health, habitat function and human well-being [1-4, 7, 8, 15]. Moreover, some other pressures that threaten the seagrass are tourism, dredging, boating activities and sedimentation [6, 16, 17].

4. Conclusions

Seagrass ecosystem is an important ecosystem. It has a high economic value. However, the function of seagrass ecosystem services as provisioning services is ignored, and the benefit values have not been fully understood by the communities, although in the scarcity the utilisation of the seagrass ecosystem is quite intensive. Hence, community-based conservation requirements to be implemented.

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