Sea bunnies as a potential marine ecotourism in sumberkima, Buleleng Regency, Bali

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Abstract. The Sumberkima Village has a vital coral reef ecosystem since the ecosystem has become hometo some incredible marine biotas, including sea bunnies, a sea slug or Nudibranch species. The Nudibranchcommunity can indicate the health of the ecosystem from its diversity and structure. This study aims to determine the distribution and value of the Nudibranchia Ecological Index and provide an example informative infographic of sea bunnies to support marine ecotourism at Sumberkima Village, Gerokgak District, Buleleng Regency, Bali Province. The research method applied is observation by visual census with an underwater camera (underwater visual census) and SCUBA diving equipment at a depth range of5-25 meters. Observation data were collected in April 2021. A total of 15 species were found at ten dive sites.: *Chromodoris annae, Chromodoris magnifica, Goniobranchus reticulatus, Hypselodoris apolegma,Hypselodoris bullockii, Nembrotha cristata, Nembrotha kubaryana, Nembrotha sp, Notodoris serenae, Phyllidia elegans, Phyllidia varicosa, Phyllidiopsis pipecki, Phyllidiopsis shireenae*. The most dominant species was a member of *Phyllidia genus,* and an uncommon species is *Goniobranchus reticulatus*.

1 Introduction

According to the Geospatial Information Agency, The Center for Naval Hydrographs and Oceanography, and the Coordinating Ministry for Maritime Affairs, Indonesia has an area of 6,400,000 km^2 of water with a coastline of 108,000 km. It consists of 17,508 islands [1]. From this stretch of coastline, one of the "sea bunnies" creatures called Nudibranchia is one of the orders of the mollusk phylum that is interesting to observe because it has striking colors and varied shapes [2]. This organism is included in subclass Opisthobranchia marine with varying bathymetric range limits [3, 4]. The opisthobranch is a diverse group of sea slugs that are vulnerable to anthropogenic pollution, which has a negative impact on them [5].

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Previous studydemonstrated that anthropogenic activities reduce sea hares' individual fitness and impact theirpopulation dynamics and resilience [6].

Sea bunnies are a species of sea slug, or Nudibranch. In general, the morphology of Nudibranchs only consists of skin, muscles, and organs because they shed their shells millions of years ago [3]. Currently, there are more than 3000 species of Nudibranchs identified, both living in shallow waters, coral reefs, to dark seabeds with a depth of more than one kilometer and can even be found in various types of habitats ranging from soft mud sediment substrates to soft mud substrates rocky hard [4]. Morphologically, naked gills are one of the main characteristics that distinguish Nudibranchia from other gastropod snails (Nudibranchia: naked gills). In mostspecies of Nudibranchia, the gills appear like crests on the back slightly back [3, 5]. The morphology of the Nudibranchs consists of a mantle, rhinophores, gills, legs, and reproductiveorgans. Most Nudibranchs have a life span of no more than one year, then disappear without a trace due to their bodies lacking a calcareous skeleton. [5].

Nudibranchia habitat can be found in various habitats ranging from sandy substrates, mud, and algae to coral reefs [6]. These habitats are very close to food sources from Nudibranchs. Each type of Nudibranch generally chooses a distinctive type of food [7]. Almost all members of Nudibrancia are carnivorous as predators of sponges, soft corals, anemones, sea pens, bryozoans, ascidians, hydroids, and eggs of other Nudibranchs, and some species are parasitic.Some Nudibranchs are predatory (monophagous) and have a body shape adapted to eat their prey [8].

With large marine biological resources, one of which is the Nudibranchia marine biota presented in this paper, sustainable monitoring and management activities must be carried out continuously with the involvement of local communities along with central and regional stakeholders [9] so it can attract domestic and foreign tourists to increase the local economy tosupport food security in coastal areas [10].

This study aims to determine the distribution and value of the diversity, evenness, and dominance indices and provide an example informative infographic of sea bunnies for marine ecotourism in the waters of Sumberkima village, North Bali.

2 Materials and methods

2.1. Study area

The coastal waters of Sumberkima Village are located at latitude 8° S and longitude 114° E, an area in the northern waters of Bali Province, which is still included in Gerokgak District, Buleleng Regency, Bali Province. The width of this coastal area is 76.89 km. The community has used these coastal water areas for various fishery activities, capturing and cultivating. In addition to fishing activities, this location is also used or utilized by residents as a tourism area.

Tourism activities at the research location as determined by the Buleleng Regency Governmentthat the coastal waters of Gerokgak Village to Sumberkima Village in Gerokgak District are included in the development area of the Batu Ampar Tourism Area in West Buleleng [11].

Data collection on the distribution of Nudibranchia was carried out on the coast of Sumberkima Village, Gerokgak District, Buleleng Regency, Bali Province (S 08°04'53.6"; E 115°07'08.8") (Figure. 1) in April 2021, a depth of 5-25 meters at ten dive sites on Sumberkima Bay.

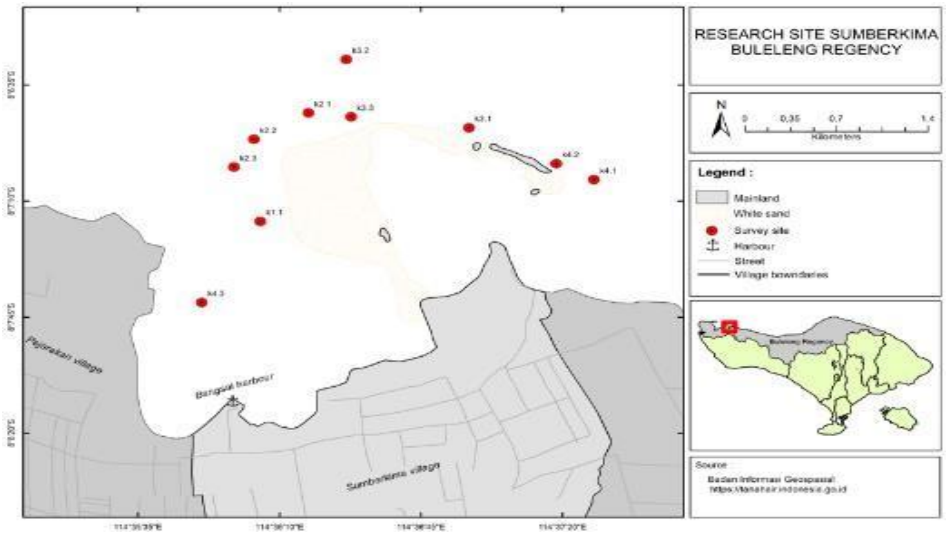

Fig. 1. The site of data collection

2.2. Sampling procedure

The data collection process uses photographic techniques and visual methods with time swim. This method is non-destructive because it does not require a direct sampling process by photo or video recording; the calculation is carried out directly underwater. Visual census techniques are divided into two main categories: 1) survey along a predetermined path (transect); 2) Specific and well-defined point sampling and use of underwater breathing equipment (SCUBA – *Self Contained Underwater Breathing Apparatus*) [12, 13]. This study applies the category two visual census technique. Photos or video recordings are taken at each dive site (Figure. 2).

2.3. Identification of species

Species identification is done by looking at the appearance of Nudibranchia on the substrate from photos using an underwater camera and directly identifying the species [12]. (Figure. 2), if unidentified and undescribed, explore the official website of *seaslugforum.net* [29] to determine the species.

2.4. Data analysis

Identification of the number and type of Nudibranchia species using the index value as follows: Biodiversity indices were calculated from the species count of Nudibranchia, which consist of Diversity Index (H'), Evenness Index (E') and Dominance Index (D):

- Shannon-Wiener Diversity Index (H') [14]

$$H' = -\sum_{i=1}^{n} pi\ Ln\ pi \quad (1)$$

H' = Diversity IndexPi= ni / N
Ni = number of individuals of type to i
N = total number of individuals of all types

Diversity Index range:
2,3026 = Low Diversity and Community Stability
2,3026 < H' < 6,9078 = Moderate Diversity and Community Stability
H' > 6,9078 = High Diversity and Community Stability

Fig. 2. The process of data collection by using SCUBA equipment and underwater camera (a), with target species of Nudibranchia (b)

- Evenness Index (E') [15]

$$E = \frac{H'}{H_{max}} \quad (2)$$

E = Evenness Index
H_{max} = ln S
S = species number

The value of the Evenness Index varies from 0 to 1, with a value near 0 showing the dominance of certain species and a value near 1 displaying community evenness.

- Dominance Index (D) [14]

Simpson's Dominance Index was calculated as follows:

$$D = \sum \left(\frac{ni}{N}\right)^2 \quad (3)$$

D = Simpson Dominance Index
Ni = number of individuals of type to i
N = total number of individuals of all types

The value of the Dominance Index is also varied from 0 to 1, with a value near 1 showing dominance of certain species.

3 Results and Discussion

In total, 15 Nudibranchia species were observed in Sumberkima from 7 genera with the length (cm) scale of each (Figure. 4): *Phyllidiopsis shireenae* [16], *Phyllidiopsis pipecki* (6cm) [16], *Phyllidia varicosa* [17], *Phyllidia pustulosa* [18], *Phyllidia ocellata* [18], *Phyllidia elegans* [19], *Notodoris serenae* [20], *Nembrotha sp* [21], *Nembrotha kubaryana* [21],

Nembrotha cristata [21], *Hypselodoris bullockii* [22], *Hypselodoris apolegma* per se Yonow, 2001 [23], *Goniobranchus reticulatus* [24], *Chromodoris magnifica* [24] and *Chromodoris annae* [21]. The species *Phyllidia pustulosa* had the highest species count (8 species), while *Notodoris serenae*,*Nembrotha sp., Hypselodoris apolegma,* and *Goniobranchus reticulatus* were only observed once (uncommon species) (Figure 3) and attractive underwater photos of 15 species of Nudibranchs (Figure. 4).

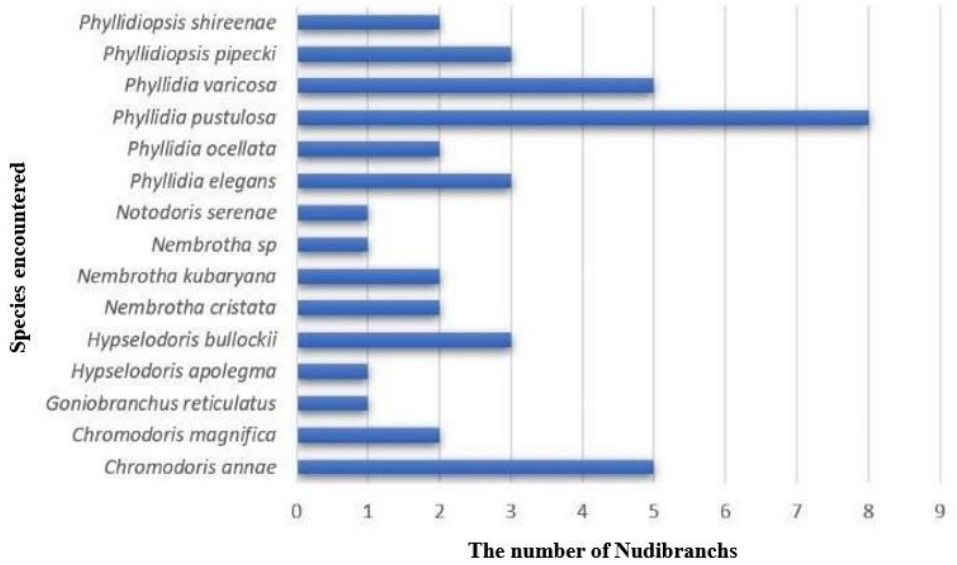

Fig. 3. Species encountered and the total number of Nudibranchia in Sumberkima

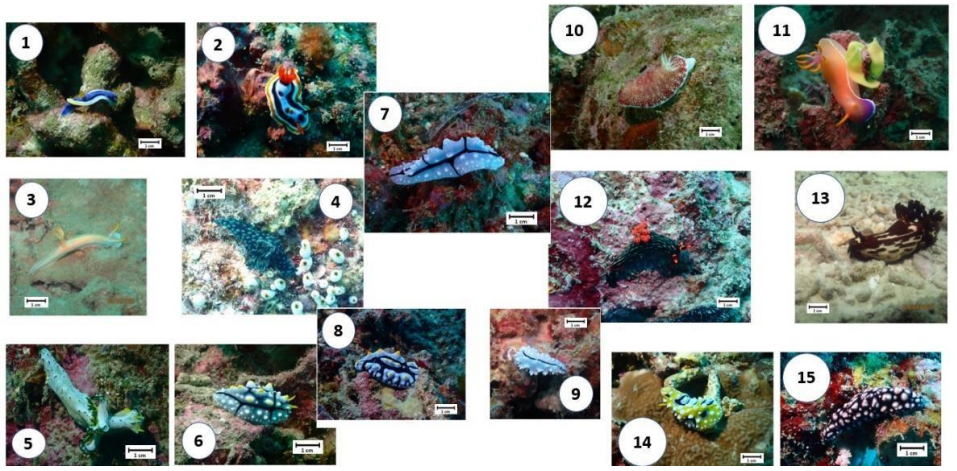

Fig. 4. Nudibranchia photos using an underwater camera with macro settings: **1)** *Chromodoris annae*; **2)** *Chromodoris magnifica*; **3)** *Hypselodoris bulockii*; **4)** *Nembrotha cristata*; **5)** *Notodoris serenae*; **6)** *Phyllidia elegans*; **7)** *Phyllidiopsis shireenae*; **8)** *Phyllidia varicosa*; **9)** *Phyllidiopsis pipecki*; **10)** *Goniobranchus reticulatus*; **11)** *Hypselodoris apolegma*; **12)** *Nembrotha kubaryana*; **13)** *Nembrotha sp*; **14)** Phyllidia *ocelata*; **15)** *Phyllidia pustulosa*

Shannon-Wiener's Diversity Index (H') of Sumberkima Nudibranchia revealed that this community has Moderate Diversity and Stability. This index is a widely used Diversity Index,in which the value increases as both the richness and the evenness of the community increase [27]. Evenness Index (E) and Simpson's Dominance Index (D) showed that the community composition of Nudibranchia in Sumberkima was relatively similar and did not display any dominance (Figure 5).

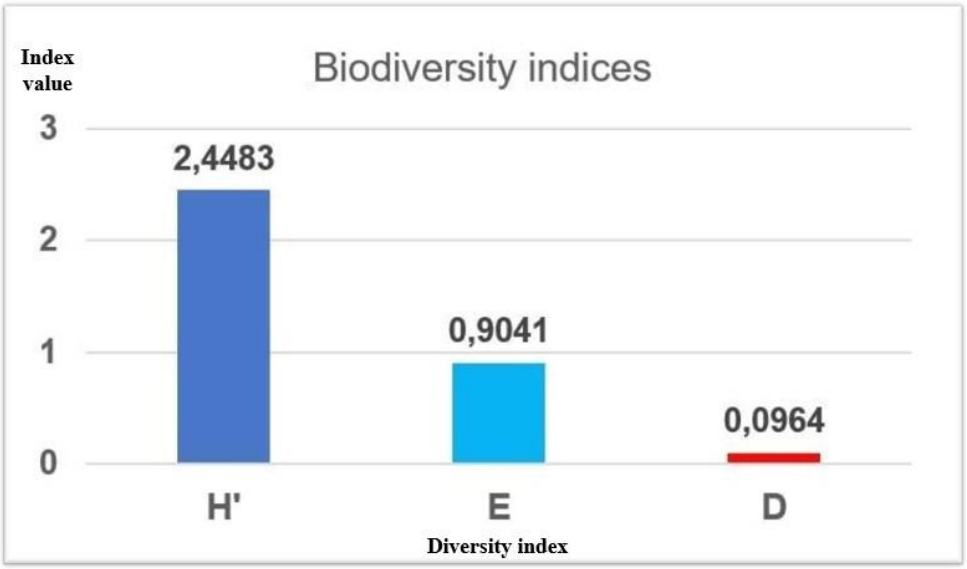

Fig. 5. Total value of Diversity Index (H'), Evenness (E), and Dominance (C)

The coastal area of Sumberkima is a part of the Northwest Coastline of the Bali Province. The main uses of fisheries and pearl cultivation using floating net cages called *Keramba Jaring Apung*. Aside from fishing, this location is also used or utilized by residents as a tourism area. The Buleleng Regency Government determined that the coastal waters of Gerokgak Village to Sumberkima Village in Gerokgak District are included in the Batu Ampar Tourism Area. In West Buleleng. Sumberkima, as part of coastal waters, has a rich biodiversity in the form of various types of marine organisms typical of coastal ecosystems. Nudibranchia is a type of organism found in these waters.

Phyllidiidae is a Nudibranchia family commonly found in the Indo-Pacific region [25], including Sumberkima coastal waters. Community empowerment based on integrated coastal zone management and a socio-cultural approach is needed to promote a certain area that is a target for marine ecotourism. One example of related activities is to develop a good management pattern to provide interesting information to the public with interesting characteristics such as exotic marine life [26], in this case Nudibranchia as the one peculiar marine biota.

Several supporting factors in the process of triggering tourist visits include qualified maps of tourism potential, recommendations, and improved implementation [28], in this case massive socialization (examples of online promotions) (Figure. 6).

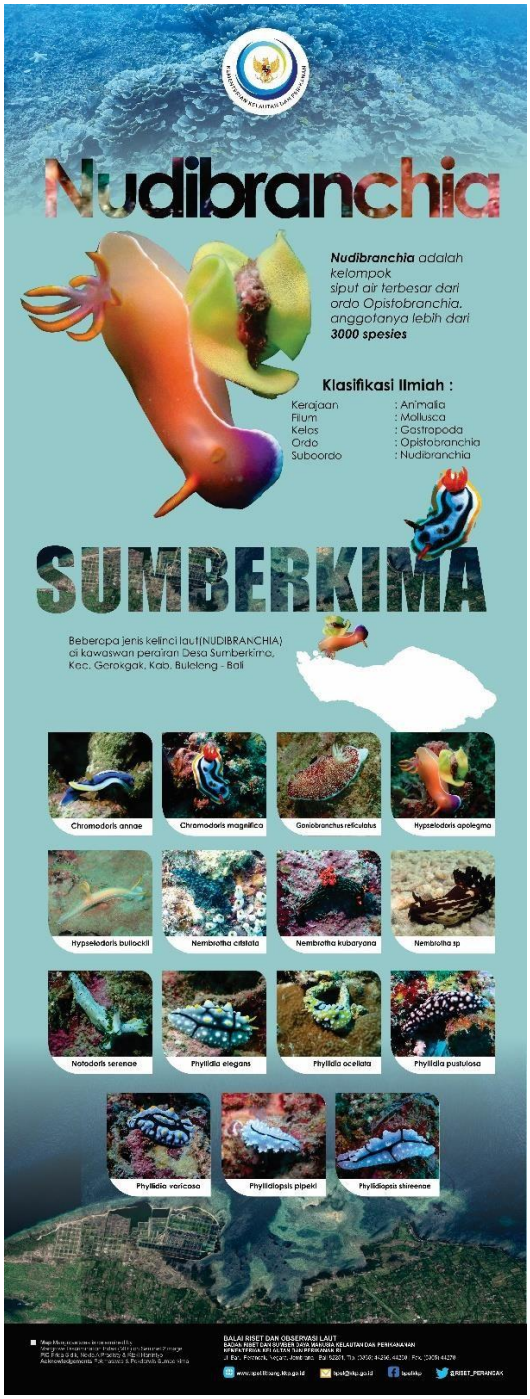

Fig. 6. An example of a standing banner that can be placed in local offices, inns/hotels, and other related stakeholders to trigger visitors' curiosity to explore directly is the hope it can increase residents' income regarding marine ecotourism.

4 Conclusions

Based on Nudibranchia's diversity and evenness index value in the coastal area of Sumberkimavillage, it is relatively stable, and there is no dominance in the distribution composition. This shows that the Nudibranchia biota in the Sumberkima waters can adapt to their environment. Furthermore, it is hoped that this result will not only be a scientific study but can make one of the data and information on the potential of exotic underwater biota that are interesting for marine ecotourism to increase economic value in Indonesian tourist areas (Figure. 6) in particular Sumberkima village and its surroundings. How informative infographic of sea bunnies contribute to marine ecotourism management in Sumberkima village, North Bali. Sustainable monitoring and ecotourism management activities must be synergized with the involvement oflocal communities and central and regional stakeholders. It can attract domestic and foreign tourists to increase the local economy.

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