

CORAL REEF CONSERVATION INDEX IN SAMALONA ISLAND, CITY OF MAKASSAR

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ABSTRACT

This study sought to evaluate the quality of benthic organisms and coral fish, as well as analyze the coral reef conservation index in the waters surrounding Samalona Island. The research was conducted in the northern, southern, and western waters of Samalona Island, encompassing five reef zones: reef flat, reef crest, upper and lower reef slopes, and reef base. The line intercept transect (LIT) method was employed in conjunction with the belt transect for the collection of benthic data, while the underwater visual census (UVC) was utilized for capturing reef fish data. Further assessments of the quality of benthic organisms and reef fish were conducted using the suspension technique outlined by McMellor (2007). The findings indicated that the quality of coral reef organisms on Samalona Island was suboptimal, with scores of 21, 19, and 28 for the southern, western, and northern sides, respectively. The quality of reef fish was categorized as moderate-low, with scores of 27, 31, and 33 on the southern, western, and northern sides of the island, respectively. Consequently, the coral reefs in the waters surrounding Samalona Island were evaluated using the D3–D4 conservation index for both the southern and western sides of the island. Although the northern side has a conservation index of E3 and includes degraded habitat, it is not recommended for designation as a conservation area.

Keywords: Conservation, benthic, reef fish, Samalona Island.

INTRODUCTION

The condition of coral reefs in Indonesia has changed significantly over time. Among the various influencing factors, anthropogenic activities have a notable impact on coral reef health in the region. As the population continues to grow, the demand for marine resources and utilization of coastal land are expected to increase, posing a threat to coastal ecosystems, including coral reefs (Hadi et al., 2018).

Coral reefs offer substantial benefits to millions of individuals living in coastal regions. This ecosystem serves as a crucial source of food and income, provides a breeding habitat for a diverse array of commercially traded fish species, attracts tourists and coral reef enthusiasts globally, facilitates the formation of sand on tourist beaches, and shields coastlines from storm impacts (Burke et al., 2012).

The Spermonde Islands are a significant center of coral reef distribution in the Makassar Strait. This region is characterized by considerable marine biodiversity; however, the condition of the coral cover is alarming. The intensive exploitation of these resources has led to a substantial decline in their natural populations (Jompa & Litaay, 2006).

The waters surrounding Samalona Island are part of the Spermonde Island group. This island serves as a snorkeling tourism destination for both domestic and international visitors. One of the island's advantages is its

proximity to the city of Makassar. The coral reefs encircling the island create an underwater park characterized by diverse coral formations of various shapes, types, and colors. However, over time, the coverage of living corals on the island has begun to decline due to anthropogenic and natural activities, leading to sustained and uncontrolled degradation of coral reefs (Kasman et al., 2018).

Enhancing the management and expansion of conservation areas amidst the constraints imposed by exploitation pressure is a crucial strategy for ensuring resource sustainability. There is a notable deficiency in coral reef monitoring programs that generate data and information pertinent to coral reef development (McMellor, 2007). As Karr and Chu (1999) asserted, a pertinent metric for monitoring is the biological condition that identifies changes in endpoints. It is imperative that the monitoring and identification of biological changes are effectively communicated to policymakers and other stakeholders.

Effective dissemination of information to stakeholders is essential for enhancing the management of marine and fishery resources, particularly in coral reef ecosystems. This necessitates the development of assessment methods that are accessible to local communities (Pretty, 2003). Consequently, straightforward, non-specialist approaches are needed to convey information on coral reef quality to stakeholders. These methods also offer a general overview that can be readily comprehended by

policy-makers and funding agencies. Numerous studies have highlighted the issues associated with habitat classification using single-factor indices. The creation of a comprehensible multivariate or multimetric index would be more advantageous than reports relying on multiple factor indices (Extence et al., 1987).

Effective management of coral reef ecosystems is essential for their preservation and sustainability. Consequently, it is imperative to conduct comprehensive studies and analyses of these ecosystems to safeguard the conservation areas. A fundamental aspect of this endeavor is the evaluation of conservation indices, which serves as an initial step in establishing a conservation area. This involves examining the community structure

of benthic organisms, including corals and coral-associated fish, that inhabit the waters surrounding Samalona Island. This study aimed to assess the quality of benthic organisms, evaluate the quality of coral-associated fish, and analyze the coral reef conservation index in the waters surrounding Samalona Island.

MATERIAL AND METHODS

The study was conducted from January to July 2022, with data collection conducted on Samalona Island, Ujung Pandang, Makassar City, South Sulawesi (Figure 1). The research period encompassed the preparation phase, processing of field data, and compilation of the final report.



Figure 1. Research site in samalona island

Benthic Data Capture

The methodology employed for monitoring benthic communities integrates the Line Intercept Transect (LIT) technique (English et al., 1994) with belt transects (Loya, 1978). The transect extended up to 50 m, aligned with the depth contour, and was parallel to the coastline. Data collection commenced at zero meters depth for each substrate group on coral reefs, recording the cover length of each substrate component beneath the transect line in centimeters, and concluded at 50 m. The categorization of coral growth forms adhered to the framework established by English et al. (1994), while the identification of coral genera was guided by Veron (2000) and Russell-Kelley (2009).

The belt transect method was employed to observe benthic organisms, specifically *Acanthaster planci*, and to assess the condition of coral colonies affected by

Drupella predation, bleaching, and disease. The observation area measured 50 m in length and 5 m in width, with 2.5 m on each side of the transect line. The observation of *Acanthaster planci* involved counting the number of individuals. *Drupella* predation was assessed by counting the number of coral colonies exhibiting characteristic small white spots, indicative of predation. Coral bleaching was visually assessed by counting the number of colonies that bleached due to elevated temperatures. Coral disease was also visually assessed by counting colonies infected with diseases such as white band, white syndrome, white pox, white spot, black band, and dark spot, as described by Raymundo et al. (2008).

Coral Fish Data Collection

Fish populations on coral reefs were assessed at the same transect locations as in previous studies of coral reefs.

The Underwater Visual Census (UVC) method was employed to gather data on coral fish, utilizing an observation area measuring 5 m × 50 m. Within the transect area, all fish were enumerated, and data were recorded on the abundance of reef fish (tail/transect), species richness, and species richness of Chaetodontidae, Serranidae, Scaridae, Labridae, Pomacanthidae, Pomacentridae, and Acanthuridae. In addition, the proportion of herbivorous fish and corallivores was documented.

Data Analysis

Benthic Organism Quality

The parameters used to assess the quality of benthic organisms were derived from McMellor (2007). These parameters encompass 12 distinct factors: coral cover, which includes hard corals, soft corals, and coral fragments; macroalgae cover; live coral cover; the number of coral genera (general richness); colony size; the number of colonies; bleaching coral cover (coral bleaching); coral disease cover (coral disease); the abundance of *Acanthaster planci*; and colonies preyed upon by *Drupella*.

Percentage Coverage

The calculations for soft corals, coral fragments, macroalgae cover, overall coral cover (live cover), coral bleaching cover, and coral disease cover were derived from the percentage of hard coral cover using the formula provided by English et al. (1994):

$$C = \frac{a}{A} \times 100\%$$

Information:

- C = Percentage of closure
- a = Transect length of each category
- A = Total transect length

Abundance of Acanthaster planci

The abundance of *Acanthaster planci* was calculated using the following formula (English et al., 1994):

$$N = \frac{\sum n}{A} \times 100\%$$

Information:

- N = Individual abundance (ind/m²)
- ∑n = Number of individuals obtained per zone (ind)
- A = Observation area area (50 x 5 m²)

Coral Colony Predator

The percentage of colonies preyed upon by *Drupella* was calculated using the following formula:

$$\% = \frac{\text{Number of prey coral colonies}}{\text{Number of colonies}} \times 100\%$$

Coral Bleaching

The proportion of coral bleaching was determined using the following formula:

$$\% = \frac{\text{Number of bleaching coral colonies}}{\text{Number of colonies}} \times 100\%$$

Coral diseases

The proportion of coral disease was determined using the following formula:

$$\% = \frac{\text{Number of coral colonies infected with disease}}{\text{Number of colonies}} \times 100\%$$

The data were categorized by station and presented descriptively using graphs or tables.

Quality of Reef Fish

The data on coral fish species collected from each station were analyzed using 12 parameters. These parameters encompassed the abundance of reef fish, quantified as tails per transect, within the Shannon-Wiener diversity index, species richness, and species richness of specific families, including Chaetodontidae, Serranidae, Scaridae, Labridae, Pomacanthidae, Pomacentridae, and Acanthuridae. Furthermore, the analysis incorporated the proportion of herbivorous and corallivore fish, as delineated by McMellor (2007).

The abundance of reefs was quantified as the number of tails per transect, while the diversity index was assessed using the Shannon-Wiener diversity index, calculated according to the following formula (Krebs 1989):

$$H' = - \sum p_i \ln p_i$$

Where

- H' = Shannon-Wiener diversity index
- p_i = proportion of type i (n_i/N)
- n_i = The number of each type of fish (tail)
- N = Total number of fish of all types

The diversity of reef fish species, including several prominent families such as Chaetodontidae, Serranidae, Scaridae, Labridae, Pomacanthidae, Pomacentridae, and Acanthuridae, was assessed by documenting the species richness within each family across various transects. The distribution of reef fish was analyzed based on their dietary habits and categorized into specific trophic groups, namely herbivores and corallivores. The proportion of each group was calculated relative to the total fish population at each station. The classification of

these dietary groups adhered to the framework established by Munro (1983).

Benthic organisms and reef fish were evaluated using a scoring methodology. The parameters and their respective weight criteria, as delineated by McMellor (2007), are listed in Tables 1 and 2.

Quality assessment of benthic organisms and reef fish.

Table 1. Scoring criteria for benthic attributes (McMellor, 2007)

Attribute/Score	Score '5'	Score '3'	Score '1'	Score '0'	References
Live coral (%)	>85	>70	>55	<55	Gomez <i>et al.</i> , 1994; Wilkinson
Coral rubble (%)	<2	<5	<10	>10	Bowden & Coll, 1983; Fabricius & M'Corry, 2006
Hard coral (%)	76-100	51-75	26-50	0-25	Perry, 2001; Reigl, 2001
Macroalgae (%)	<5	<10	<20	>20	Liman, 2000; McCook, 1999
Soft Coral (%)	>30	>20	>10	<10	McField & Kramer, 2006
Generic richness	>20	>10	>5	<5	Borel-Best <i>et al.</i> , 1989; Comell & Karlson, 1996
Mean colony size (cm)	>25	>15	>10	<10	Birkland, 1999; Sakai, 1998
Number of colonies	>100	>75	>50	>50	Sukarno, 1977; Van Woesik & Done, 1997
Bleached (%)	<0.1	<1	<2	>2	Bellwood <i>et al.</i> , 2006; Jokiel, 2001
Diseased (%)	<1	<2	<5	>5	Bruckner, 2004; Goldberg & Wilkinson, 2004
<i>Acanthaster</i> abundance (ind/m2)	<1	<2	<5	>5	Endean, 1977; Goreau <i>et al.</i> , 1972
<i>Drupella</i> (%)	<1	<2	<5	>5	Cumming, 1999

Table 2. Scoring criteria for fish assemblage attributes (1250 m2) (McMellor, 2007)

Attribute/Score	Score '5'	Score '3'	Score '1'	Score '0'	References
Fish abundance	>1000	>500	>250	<250	Hill & Wilkinson, 2004 McField & Kramer, 2006
Index of diversity	>3.00	>2.50	>2.00	<2.00	Jennings <i>et al.</i> 1995 Munday & Allen, 2000
Species Richness	>100	>75	>50	<50	Akala & Luchavez, 1993 Gratwicke & Speight, 2005
<i>Chaetodontidae</i> richness	>8	>6	>4	<4	Crosby & Reece, 1997 Allen & Werner, 2002
<i>Serranidae</i> Richness	>4	>2	>1	<1	Allen, 2000 Allen & Werner, 2002
<i>Scaridae</i> Richness	>6	>4	>2	<2	Allen, 2000 Allen & Werner, 2002
<i>Labridae</i> Richness	>15	>10	>5	<5	Allen, 2000 Allen & Werner, 2002
<i>Pomacanthidae</i> Richness	>4	>2	>1	<1	Allen, 2000 Allen & Werner, 2002
<i>Pomacentridae</i> Richness	>15	>10	>5	<5	Allen, 2000 Allen & Werner, 2002
<i>Acanthuridae</i> richness	>8	>4	>2	<2	Allen, 2000 Allen & Werner, 2002
Proportion of <i>Herbivores</i>	0.10-0.12	0.08-0.09 0.13-0.14	0.06-0.08 0.14-0.16	<0.06 >0.16	Bellwood <i>et al.</i> , 2003 Nystrom, 2006
Proportion of <i>Corallivores</i>	0.04-0.05	0.03-0.04 0.05-0.06	0.02-0.03 0.06-0.07	<0.02 >0.07	Bellwood <i>et al.</i> , 2003 Nystrom, 2006

The quality of benthic organisms and reef fish was assessed at various stations and subsequently compared

descriptively using tables and graphs. Each parameter was ranked according to its respective score, which

contributed to determining the conservation index. The classification criteria for the quality of benthic organisms were designated as categories A through E. Category A corresponds to a score of 50 or more, B to a score of 40-49, C to a score of 30-39, D to a score of 20-29, and E to a score of less than 20. These categories represent the following quality levels: very good (A), good (B), medium (C), poor (D), and very poor (E). The criteria for assessing the quality of reef fish were categorized using a numerical scale ranging from 1 to 5. Specifically, label 1 corresponds to a score of 50 or more, label 2 to a score of 40-49, label 3 to a score of 30-39, label 4 to a score of 20-29, and label 5 to a score of less than 20. Label 5 is classified as very poor, 4 as poor, 3 as moderate, 2 as good, and 1 as very good.

Coral Reef Conservation Index

Data from each zone (reef flat, reef crest, upper and lower reef slope, and reef base) were aggregated to evaluate the conservation index at each station. The conservation

index was determined using the scoring methodology outlined by McMellor (2007). Scores of 0, 1, 3, and 5 were deemed satisfactory, with the criteria for each score detailed in Tables 1 and 2, respectively.

The CVI category was established by aggregating the weights assigned to each of the parameters. Additionally, the assessment criteria for the quality parameters of benthic organisms were categorized into five groups labeled A-E, while the assessment criteria for the quality parameters of reef fish were categorized into five groups labeled numerically 1-5. The conservation index was determined by analyzing the intersection between the quality of benthic organisms (A-E) and the quality of reef fish (1-5) on the field graph (Figure 2).

For instance, a station is considered to be of high quality if the benthic habitat is classified as A and the coral fish quality is assigned a value of one (A1). In such cases, it can be asserted that the coral reef ecosystem remains in a natural (pristine) condition. Figure 2 illustrates the categorization of conservation index values..

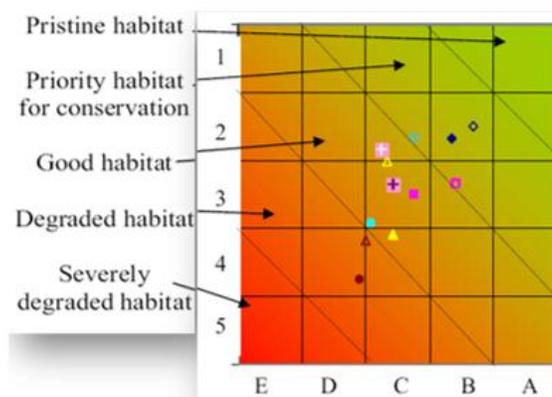


Figure 2. Grid-style output of CVI values; x-axis shows benthic component (A-E), y-axis shows fish component (1-5).

RESULTS AND DISCUSSION

Bentic Organism Quality

Based on the observations of benthic organism components at each station in the waters of Samalona Island, the percentage of basic substrate cover is shown in Figure 3. The results indicated that live coral cover ranged from 37.2% to 49.8%, coral faults from 12.2% to 16.2%, hard corals from 24.4% to 43.6%, macroalgae from 0% to 0.1%, and soft corals from 0.7% to 20.5%. According to Decree No. 4 of the Minister of

Environment, the live coral cover around Samalona Island is categorized as medium. Luthfi et al. (2019) note that tourism activities can damage coral reefs, particularly when ship anchors are deployed in coral reef areas; the act of pulling anchors can lift and break corals, leading to coral mortality. In the waters surrounding Samalona Island, Acropora, Massive, and Mushroom corals predominantly constitute hard coral cover. Nurma et al. (2022) report that these coral types are commonly found from reef flat areas to reef slope areas, with the Acropora species being particularly prevalent in these regions..

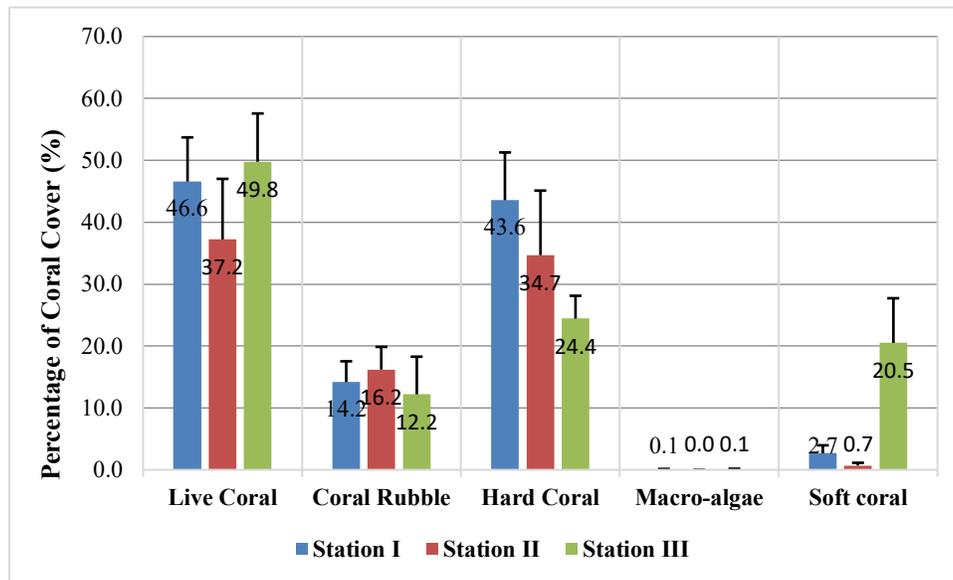


Figure 3. Percentage cover of base substrate

The research conducted at each station yielded the following findings: Station I recorded 19 genera of hard corals, Station II identified 18 genera, and Station III documented 22 coral genera. The average number of coral colonies observed was 65 at Station I, 25 at Station II, and 21 at Station III, respectively. Moll (1983) previously reported relatively high coral diversity in the Spermonde Islands, identifying 78 genera encompassing 262 species.

There was a notable variation in soft coral cover across the stations, with cover at station I, station II, and station III being 2.7%, 0.7%, and 20.5 %, respectively. As noted by Hamzah (2020), the absolute growth and growth rate of soft corals typically vary across different coral reef zones, such as the reef flat, crest, slope, and base. This variation is attributed to the differences in depth within each zone, which influences the intensity of sunlight penetrating the water.

Zurba (2019) posits that competition with macroalgae significantly influences coral reef growth rates. The rapid and unchecked proliferation of macroalgae adversely affects coral communities, resulting in deceleration of coral growth (Firdaus, 2018). Although macroalgae coverage is classified as low, at approximately 1% at each research station, it nonetheless impacts coral reef resilience.

Coral bleaching and coral diseases have also been documented at research stations. The incidence of coral bleaching at Station I was 4.4%, 54.6%, and 46.3%, respectively. According to Johan (2010), coral bleaching is attributed to both abiotic and biotic factors, including elevated temperatures, bacteria, fungi and worms. Large-scale coral bleaching is generally induced by an increase in sea surface temperature, whereas small-scale

bleaching events are typically associated with human activity and coral predator interactions. Research on coral diseases in Indonesia and at the current research sites remains limited in scope. Observational data collected from each station revealed the presence of coral diseases, including the white band, white syndrome, white spot, brown band, and black band. The prevalence of coral disease was 3.4% at station I, 39.9% at station II, and 7.9% at station III, with these diseases attributed to microorganisms. Coral diseases can be categorized into two types: pathogenic and non-infectious diseases (Siringoringo, 2007).

The mean density of *Acanthaster planci* observed at each research station was below 1 individual per square meter, indicating a relatively low abundance of *A. planci*. However, a high density of *Acanthaster planci* poses a significant threat to coral reefs. Additionally, *Drupella*, an invertebrate known to parasitize coral reef ecosystems, serves as a predator of the coral reefs. According to the analysis, the average predation by *Drupella* was relatively low, with station II exhibiting an average predation rate of 5%, station III at 7%, and no grazing observed at station I. As noted by Riska et al. (2013), the predation rate of *Drupella* is generally low because it does not attack healthy coral tissue, which is protected by the stinging cells.

Quality of Reef Fish

Based on the observational data regarding the quality of reef fish at each research station on Samalona Island, the abundance of reef fish was recorded over an area of 1,250 m². Specifically, Station I exhibited 929 individuals, Station II 862 individuals, and Station III 706 individuals. The diversity of coral fish was notably high, with diversity indices (H') of 3.46, 3.25, and 3.63 at Stations I,

II, and III, respectively. According to Ratnawati (2011), the abundance of reef fish can indicate the dominant species present in a given location, whereas a high diversity of reef fish species suggests that the aquatic environment is relatively stable (Fazilla et al., 2020).

Rumkorem et al. (2019) suggested that the characteristics of coral reefs in the waters of Samalona Island likely influenced the abundance of reef fish in the region. The study found a positive association between coral reef cover and coral fish communities.

Among the 24 reef fish families identified in the waters surrounding Samalona Island, the species richness at each station was documented as follows: 68 individuals at Station I, 66 individuals at Station II, and 54 individuals at Station III. The Pomacentridae family was the predominant family, comprising 26 species (Table 4). Observations by Ratnawati et al. (2011) regarding the Pomacentridae family in the Kayoa Islands indicated that this family exhibited the highest abundance among various reef fish types, accounting for 29% of the coral reef areas. This prevalence is attributed to the role of coral reef areas as foraging habitats.

Table 4. The Composition of coral fish in Samalona island

NO	Family	Station I	Station II	Station III
1	<i>Acanthuridae</i>	2	2	3
2	<i>Stuart O'Neill</i>	2		
3	<i>Aulostomidae</i>			1
4	<i>Balistidae</i>		1	
5	<i>Caesonidae</i>	3		2
6	<i>Chaetodontidae</i>	12	10	8
7	<i>Stuart O'Neill</i>	1		
8	<i>Haemulidae</i>	3	1	
9	<i>Holocentridae</i>			1
10	<i>Hybrids</i>	4	3	
11	<i>Labridae</i>	6	7	10
12	<i>Lethrinidae</i>	1		
13	<i>Lutjanidae</i>	2	2	2
14	<i>Mullidae</i>	1		
15	<i>Nemipteridae</i>			2
16	<i>Ostraciidae</i>			1
17	<i>Pemperididae</i>	1	1	
18	<i>Pomacanthidae</i>			1
19	<i>Pomacentridae</i>	16	16	26
20	<i>Scaridae</i>	9	6	6
21	<i>Scorpaenidae</i>			1
22	<i>Serranidae</i>	1	1	1
23	<i>Siganidae</i>	3	3	
24	<i>Zanclidae</i>	1	1	1

The proportion of herbivorous fish at Stations I, II, and III was 0.29 (39 %), 0.30 (41%), and 0.15 (20%), respectively. In contrast, the proportion of corallivorous fish in the coral reef waters of Samalona Island ranged from 0.05 to 0.16 (18% to 57%) of all reef fish (Figure 4). Corallivorous fish, a group of coral fish that prey on polyps, are predominantly composed of reef fish from the

Chaetodontidae family (Andrimida & Hardiyana, 2022). According to Vincent et al. (2011), the proportion of herbivorous fish is a subset of algae-eating fish. The high abundance and biomass of herbivorous reef fish are influenced by the extent of hard coral cover and distance from land.

Coral Reef Conservation Index of Samalona Island

The conservation index was designed to evaluate the quality of benthic organisms and coral reefs in the areas surrounding Samalona Island. The data were presented on a station-by-station basis for each attribute.

Tables 5 and 6 present the evaluations of benthic organism parameters and reef fish quality for each of the attributes. The attribute values ranged from 0 to 5, with a score of 5 representing the highest possible score and a score of 0 indicating the lowest score for each attribute at each station.

The assessment of benthic organism quality at Stations I and II revealed that certain attributes, specifically macroalgae, average colony size, and *Acanthaster* abundance, scored 5. In contrast, at Station III, the attributes that achieved a score of 5 included macroalgae, average colony size, *Acanthaster* abundance and *Drupella* predation. Conversely, at Station I, attributes such as live corals, coral faults, soft corals, coral

bleaching, and coral diseases were assigned scores of 0. Similarly, at Station II, the attributes with a score of 0 were live corals, coral faults, soft corals, number of colonies, coral bleaching, coral diseases and *Drupella* predation. At Station III, the attributes that received a score of 0 included live corals, coral fractures, hard corals, colony count, coral bleaching and coral disease.

The evaluation of reef fish parameters at Stations I and II identified several attributes that achieved a score of 5, specifically the diversity index, Chaetodontidae, Scorpaenidae, and Pomacentridae richness. At Station III, the attributes that received a score of 5 included the diversity index, Chaetodontidae, Scridae, and Pomacentridae richness, and corallivore predation. Conversely, the lowest score (0) at Station I was associated with Pomacanthidae richness and herbivore and corallivore predation. At Station II, the attributes that received a score of 0 were Pomacanthidae richness and the proportion of herbivorous fishes.

Table 5. Scoring quality for benthic attributes

Attribute	Station I	Station II	Station III	Score		
				Station I	Station II	Station III
Live coral (%)	46.6	37.2	49.8	0	0	0
Coral rubble (%)	14.2	16.2	12.2	0	0	0
Hard coral (%)	43.6	34.7	24.4	1	1	0
Macroalgae (%)	0.1	0.0	0.1	5	5	5
Soft Coral (%)	2.7	0.7	20.5	0	0	3
Generic richness	19	18	21	3	3	5
Mean colony size (cm)	38	31	26	5	5	5
Number of colonies	65	25	21	1	0	0
Bleached (%)	4.4	54.6	46.3	0	0	0
Diseased (%)	3.4	39.9	7.9	0	0	0
<i>Acanthaster</i> abundance (ind/m ²)	0.2	0.0	0.1	5	5	5
<i>Drupella</i> (%)	5	7	0	1	0	5
Conservation Value Index scores				21	19	28
Conservation Value Index category				D	E	D

The total score obtained from the assessment of the quality parameters of the benthic organisms ranged from 19 to 28 (Table 5). Consequently, the quality of benthic organisms was classified as D – E, indicating a categorization of bad to very poor. In contrast, the total

score from the assessment of coral fish quality parameters ranged from 27–33 (Table 6). Therefore, the conservation index value for coral fish quality was classified within the range of 3 – 4, corresponding to a medium-low category..

Table 6. Scoring quality for fish assemblage attributes

Attribute	Station I	Station II	Station III	Score		
				Station I	Station II	Station III
Fish abundance	929	862	706	3	3	3
Index of diversity	3.46	3.25	3.64	5	5	5
Species Richness	68	56	66	1	1	1
<i>Chaetodontidae</i> richness	13	10	8	5	5	5
<i>Serranidae</i> Richness	1	1	1	1	1	1
<i>Scaridae</i> Richness	9	6	6	5	5	5
<i>Labridae</i> Richness	6	7	10	1	1	3
<i>Pomacanthidae</i> Richness	0	0	1	0	0	1
<i>Pomacentridae</i> Richness	16	16	26	5	5	5
<i>Acanthuridae</i> richness	2	2	3	1	1	1
Proportion of <i>Herbivores</i>	0.29	0.30	0.15	0	0	1
Proportion of <i>Corallivores</i>	0.16	0.07	0.05	0	1	5
Conservation Value Index scores				27	31	33
Conservation Value Index category				4	3	3

The Coral Value Index (CVI) for Samalona Island was derived from the cumulative scores assigned to each attribute. Specifically, for the benthic component at Stations I and III, scores of 21 and 28 were recorded, corresponding to a label category of D, whereas a score of 19 was recorded with a label category of E. In contrast, the scores for the coral fish component at Stations II and III were 31 and 33, respectively, both of which were categorized under label number 3. Station I, however, received a score of 27, which falls under the label category number 4.

The benthic component exhibited the highest CVI score at Station III, registering a value of 28, while the lowest score was observed at Station II, with a value of 19. In

the coral fish component, Station III recorded the highest CVI score of 33, whereas Station I had the lowest score of 27.

The CVI scores are depicted in Figure 5 as a field graph, illustrating the position of each station. The analysis indicated that Stations II and III were classified as suitable habitats, whereas Station I was categorized as a degraded habitat.

The degradation of coral reefs on Samalona Island is significantly influenced by the island's designation as a tourist destination. Consequently, anthropogenic activities have a considerable impact on the condition of coral reefs in this area..

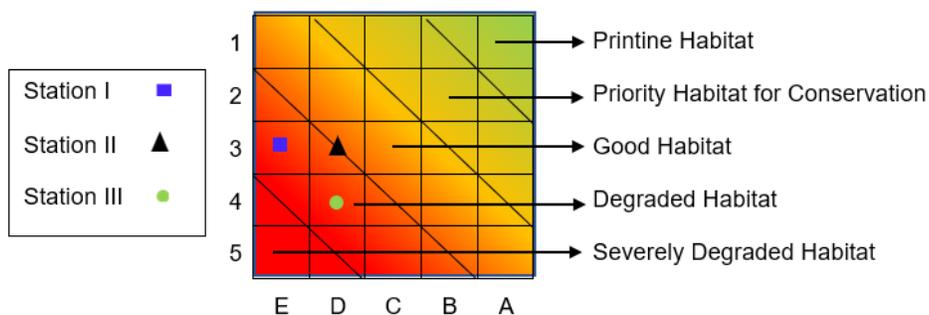


Figure 5. Grid style CVI output to show direction in index scores for the samalona island

This shows that the quality of coral reefs in the waters of Samalona Island in this category has been damaged and has a moderate-to-low conservation index value. Therefore, observational stations are not recommended as conservation areas.

However, management efforts need to be carried out immediately to prevent heavy degradation, especially for Station I. Therefore, there needs to be a policy to attract tourists who want to carry out underwater tourism activities so as not to carry out activities that can damage coral reefs and ships carrying tourists so as not to throw anchors in coral reef areas.

The CVI score can be used as baseline data to monitor future changes in coral reef quality in the waters of Samalona. According to McMellor (2007), these basic CVI values at each site allow for the monitoring of temporal changes while also providing an early warning of changes in community composition in a wider observation area. The CVI results can be used as a reference for stakeholders, such as the community, scientists, and the government.

The CVI score can also be used to distinguish between observation sites that show spatial variability, even if they do not show temporal changes at each site. CVI scores

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can also be presented in the form of maps that provide a clear representation of the coral reef conditions (McMellor, 2007).

CONCLUSION

The results of the research carried out in the waters of Samlona Island can be summarized as follows: The quality of benthic organisms in the coral reef area of the waters of Samalona Island obtained a score ranging from 19 to 28; therefore, it is included in the very poor category on the west side of the island, and the poor category is on the south and north sides of the island. The quality of reef fish in the coral reef area of the waters of Samalona Island obtained a score ranging from 27 to 33; therefore, it was included in the poor category on the southern side of the island and in the medium category on the western and northern sides. Coral reefs in the waters of Samalona Island have conservation index values of D3 – D4 and E3; therefore, they are included in the category of habitats on the South and West sides of the island, as degraded habitats are on the north side of the island, so they are not recommended for use as conservation areas

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