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Increasing the Survival Rate of Banggai Cardinal Fish by using the Artificial Sea Urchin method at Kilo 5 Beach, Luwuk, Banggai Regency

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Abstract
The Banggai Cardinalfish (*Pterapogon kauderni*) is an endemic species with high ecological and economic value, but faces the threat of population decline due to habitat degradation and fishing pressure. One important factor in the survival of this species is the availability of protective microhabitats, such as sea urchins, which serve as shelter from predators. This study aims to increase the survival rate of the Banggai Cardinalfish through the application of the Artificial Sea Urchin method introduced at the Coral Transplantation site at Kilo 5 Beach, Luwuk, Banggai Regency. The method used included the installation of 10 artificial structures resembling sea urchins at the study site, as well as monitoring the survival rate, behavior, and adaptation of the fish throughout the observation period. The results showed that the use of Artificial Sea Urchins increased the survival rate by 85%, indicated by the persistence of the number of surviving individuals and the tendency of the fish to utilize the structures as shelter. Furthermore, the artificial structures also contributed to reducing predation pressure and increasing microhabitat stability. Thus, the Artificial Sea Urchin method can be an effective alternative conservation strategy to support the sustainability of the Banggai Cardinalfish population in its natural habitat.

Keywords: Banggai Cardinal Fish, Artificial Sea Urchin, conservation, survival rate

1. Introduction

The Banggai Cardinalfish (*Pterapogon kauderni*) is an endemic reef fish naturally distributed within the Banggai Archipelago of Central Sulawesi, Indonesia. The species has attracted international attention due to its restricted geographic range, direct development reproductive strategy, and high demand in the marine ornamental fish trade. The International Union for Conservation of Nature (IUCN) categorizes *P. kauderni* as an endangered species because of habitat degradation and overexploitation [1].

Unlike many coral reef fishes, Banggai Cardinalfish lack a pelagic larval phase, resulting in limited dispersal and strong dependence on local habitats. Previous studies have shown that juvenile and adult fish rely heavily on benthic organisms such as sea urchins, sea anemones, and branching corals as protective microhabitats. The availability of these microhabitats directly influences recruitment success and population persistence [2].

Habitat degradation, coastal development, destructive fishing practices, and the decline of sea urchin

populations have significantly reduced the availability of suitable shelter for Banggai Cardinalfish. Several studies have reported that reductions in sea urchin abundance can negatively affect fish survival, particularly during early life stages. [3].

Artificial habitat enhancement has emerged as an important conservation strategy for reef-associated species. Artificial Sea Urchins are designed to mimic the physical structure and protective function of natural sea urchins, providing refuge from predators while increasing habitat complexity. However, information regarding their effectiveness in supporting Banggai Cardinalfish populations remains limited. [4].

Therefore, this study aimed to evaluate the effectiveness of Artificial Sea Urchins in increasing the survival rate of Banggai Cardinalfish at the coral transplantation area of Kilo 5 Beach, Luwuk.

2. Methodology

2.1 Study Area

The study was conducted at the Coral Transplantation Site located at Kilo 5 Beach, Luwuk, Banggai Regency, Central Sulawesi, Indonesia. The site is characterized by shallow coastal waters with coral reef habitats and serves as an environmental conservation area [6].

2.2 Artificial Sea Urchin Construction

Artificial Sea Urchins were constructed using durable synthetic materials designed to resemble the morphology of natural sea urchins. Each structure consisted of a central body with multiple flexible spines extending outward to provide shelter and protection for fish. A total of 10 Artificial Sea Urchin units were deployed within the coral transplantation area at depths ranging from 2 to 5 meters.

2.3 Data Collection

Monitoring was conducted through direct underwater observation using SCUBA and snorkeling techniques. Parameters recorded included Number of Banggai Cardinalfish utilizing each structure, Fish behavior around Artificial Sea Urchins. Survival rate of fish during observation. Presence of predators. Structural integrity of Artificial Sea Urchins. Observations were conducted periodically throughout the monitoring period.

2.4 Data Analysis

Survival rate was calculated using:

Survival Rate (%) = (Nt / N0) × 100

where:

Nt = number of surviving fish at the end of observation

N0 = initial number of fish

Descriptive analysis was applied to evaluate habitat utilization and behavioral adaptation [7].

3. Results and discussion

3.1 Utilization of Artificial Sea Urchins

Shortly after deployment, Banggai Cardinalfish were observed aggregating around the Artificial Sea

Urchin structures. Individuals frequently positioned themselves among the artificial spines, exhibiting behavior similar to that observed around natural sea urchins. The structures provided refuge from predators and served as resting areas during daylight hours. Juvenile fish showed particularly strong preferences for occupying the artificial microhabitats. These findings are consistent with previous observations that Banggai Cardinalfish depend heavily on protective microhabitats throughout their life cycle [8].

3.2 Survival Rate

The survival rate of Banggai Cardinalfish associated with Artificial Sea Urchins reached 85%. This relatively high survival rate compared to previous result that only reached below than 50% [9]. That indicates that the artificial structures successfully fulfilled the ecological function of natural sea urchins by reducing exposure to predation and environmental stress. The high occupancy rate observed during monitoring further suggests that the fish rapidly recognized and utilized the structures as suitable shelter.

3.3 Ecological Importance of Artificial Microhabitats

Microhabitat availability is widely recognized as a key factor regulating Banggai Cardinalfish population dynamics [10]. Previous studies have demonstrated that juvenile recruits are strongly associated with sea urchins and anemones, while adults utilize coral and sea urchin habitats [11]. Artificial Sea Urchins effectively increased habitat complexity within the coral transplantation site. Similar habitat enhancement approaches have been successfully applied in marine conservation programs to support recruitment and survival of reef-associated organisms [12]. The structures also contributed to reducing interspecific competition for shelter and may increase carrying capacity in areas where natural sea urchin populations have declined.

3.4 Implications for Conservation

The successful implementation of Artificial Sea Urchins at Kilo 5 Beach demonstrates the potential of habitat-based conservation strategies for endemic reef fish species. Given the ongoing degradation of coastal ecosystems throughout the Banggai region, Artificial Sea Urchins may serve as a practical and cost-effective management tool that complements broader conservation measures such as habitat protection, coral restoration, and sustainable fisheries management. Integration of Artificial Sea Urchins into coral restoration programs could enhance biodiversity outcomes while providing immediate shelter for vulnerable fish populations.

4. Conclusions and recommendations

The installation of Artificial Sea Urchins at Kilo 5 Beach significantly enhanced habitat availability for Banggai Cardinalfish and resulted in a survival rate of 85%. The artificial structures effectively functioned as protective microhabitats, reducing predation risk and promoting fish adaptation within the coral transplantation area. These findings indicate that Artificial Sea Urchins represent a promising conservation approach for supporting the recovery and sustainability of Banggai Cardinalfish populations in degraded coastal ecosystems.

Some recommendations such as expand the deployment of Artificial Sea Urchins in other Banggai Cardinalfish habitats, Conduct long-term monitoring to evaluate reproductive success and population growth, Integrate Artificial Sea Urchins into coral reef restoration and biodiversity conservation programs,

Encourage collaboration among government agencies, universities, local communities, and industry stakeholders, and Develop standardized guidelines for Artificial Sea Urchin design and implementation.

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