Research article

Influence of Coral Nursery Units on Fish Assemblage

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Abstract Since 2012, the Department of Science and Technology-Philippine Council for Agriculture and Natural Resources Research and Development (DOST-PCAARD) has been funding a coral reef restoration project, conducted by different universities in the Philippines. As part of this project, coral nursery units (CNUs) have been deployed to supply high quality coral nubbins aimed at reducing the dependence of coral fragments from wild coral populations. Changes in the reef fish assemblage were assessed after four months to find out whether fishes are attracted to and produced at the CNUs. Six CNUs were deployed at 30 m apart from each other. Fishes were counted and identified using the fixed-point technique. Fish density and species richness were compared before and after CNU installation. Both production and attraction of reef fishes were evident, notably, by the abundance of Apogonidae. The high concentrations of secondary consumers are the main evidence for the attraction of the CNUs. Our results indicate that CNUs can be used as an effective management and restoration tool for improving the local fishing yields.

Keywords coral cover, fish assemblage, marine protected areas, nursery

INTRODUCTION

The Philippines is one of the world's centers of marine biodiversity and multi-taxa marine endemism (Roberts et al., 2002). However, the country's marine resources are also experiencing the highest level of anthropogenic and climatic threats. The anthropogenic threats include fishing overcapacity; overfishing and destructive fishing practices; increased domestic, agricultural, and industrial runoff from a burgeoning population; poor land use; and increased sedimentation from forest deforestation and un-regulated mining activities (Cabral et al., 2014).

One of the ecosystems in the Philippines that are in serious deterioration-suffering massive, long-term declines in abundance and diversity of species are the coral reefs. In order to save our reefs, the Department of Science and Technology-Philippine Council for Agriculture and Natural Resources Research and Development (DOST-PCAARD) provided funds for different universities in the Philippines to implement a coral reef restoration project which started in the year 2012. One of its objectives is to establish demonstration for coral nursery units (CNUs). The main purpose of establishing and deploying CNUs is to supply high quality coral nubbins for transplantation and to reduce the dependence of coral fragments from wild coral populations (Pub. Project 6: Pilot Testing, 2014). As the project proceeded, projects staff, volunteers, and project implementers observed fishes that were not around in the area in the past. CNUs have literally become an artificial reef for these species. In general terms, the artificial reefs are man-made habitats placed at the sea bottom that provide a framework for marine life to develop. Such habitats have several benefits including: providing food, shelter, protection, and spawning areas for fish and marine life, as well as, relieving natural reefs from user pressure by providing alternative recreational areas (Bohnsack and Sutherland, 1985). Intrigued by the observed fishes around the CNUs, we proposed this study in order to assess the influence of the CNU's on fish assemblage.

OBJECTIVES

This study investigated the influence of coral nursery unit (CNUs) deployed in the Roll-out Coral Restoration Project in Anda, Bohol on fish assemblage. Specifically, this study compared the fish abundance and species richness before and four months after installation of the CNUs by determining the occurrence, frequency, and abundance of fish species by trophic levels.

METHODOLOGY

This study was conducted in the Marine Protected Area (MPA) of Suba, Anda, Bohol (Fig. 1) to ensure safety of the CNUs. Six CNUs (dimension = 3 m L x 1 m W x 0.5 H), made up of ropes and reinforcing bars, were deployed in the sandy portion of the MPA at 30 m apart from each other to avoid overlapping. Fishes in the CNUs were counted and identified visually using the fixed-point technique (Hackradt et al., 2011) every month. Observations were made within an imaginary cylinder that has a radius of 3 m. There was a 5-min interval before and after census to minimize interference. The census was done for 10 minutes at each CNU. Monthly dive was done to remove fouling organisms (Aaron-Amper et al., 2015).

The fish assemblages were characterized in terms of: 1) fish abundance and species richness, 2) four classes of frequency occurrence of species (permanent 75-100%, frequent 50-75%, scarce 25-50%, and rare < 25%), 3) and trophic level of each fish species following the procedures described by Romanuk et al. (2011) wherein an omnivore was assigned to trophic positions between 2.2 and 2.79, secondary consumer to > 2.8, and tertiary consumer to > 4.

Statistical analysis was performed using Systat 12. The data were log transformed based on the paired t-test.

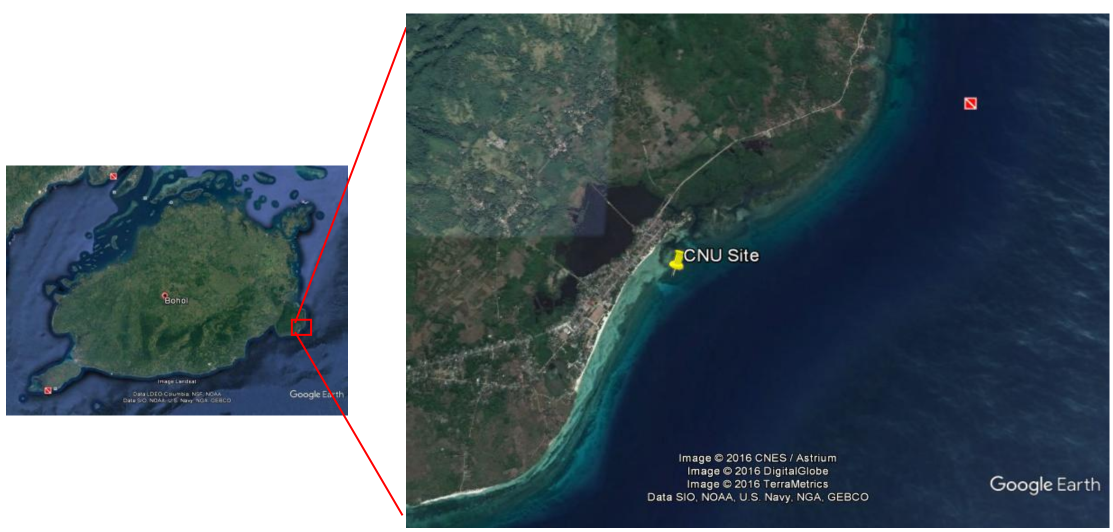

Fig. 1 Map of Bohol, Philippines showing the CNU site

RESULTS AND DISCUSSION

Overall, 41 species belonging to 12 families were recorded from the two sampling periods combined (Table 1). Of these, 38 (93% of the whole species pool) were recorded four months after deployment of the CNUs.

Table 1 Fish species composition, abundance, and richness before and four months after deployment of coral nursery units

Family	Species	Abundance	
		before	after 4 months
Acanthuridae	*Acanthurus grammoptilus*	0	2
Apogonidae	*Apogon bandanensis*	0	400
	Apogon griffini	5	0
	Apogon moluccensis	40	260
	Apogon monospilus	70	365
	Apogon perlitus	30	100
	Apogon quadrifasciatus	10	265
	Apogon sealei	110	380
	Archamia melasma	0	115
	Cheilodipterus singapurensis	0	40
Blenniidae	*Centropyge multifasciatus*	0	1
Chaetodontidae	*Chaetodon ocellicaudus*	0	2
	Chaetodon selene	0	1
	Chaetodon vagabundus	0	2
	Heniochus acuminatus	0	1
	Petroscirtes breviceps	70	16
Labridae	*Coris dorsomacula*	2	17
	Coris pictoides	0	1
	Halichoeres leucoxanthus	12	7
	Halichoeres scapularis	0	6
	Oxycheilinus bimaculatus	0	11
	Thalassoma lunare	0	12
Mullidae	*Upeneus moluccensis*	1	0
Ostraciidae	*Ostracion cubicus*	0	1
Pomacanthidae	*Genicanthus watanabei*	0	1
Pomacentridae	*Altrichthys curatus*	5	0
	Amblypomacentrus clarus	6	15
	Amphiprion polymnus	0	5
	Chromis analis	0	1
	Chrysiptera parasema	11	45
	Chrysiptera springeri	5	2
	Dascyllus aruanos	0	6
	Dascyllus reticulatus	1	6
	Dascyllus trimaculatus	5	11
	Dischistodus perspicillatus	1	1
	Pomacentrus philippinus	16	30
	Pomacentrus proteus	0	5
Serranidae	*Pseudanthias huchti*	5	70
Scorpaenidae	*Pterois volitans*	2	7
Tetradontidae	*Canthigaster solandri*	0	5
	Canthigaster valentini	0	2
Total abundance		407	2217
Total no. of species		20	38

Only 20 species were common and the Apogonidae dominated the community. During the second survey, four species were not found while 21 species were recorded. The total abundance of fish assemblage showed a highly significant increase ($p = 0.001$). The experimental results indicate the complex role of the CNUs as an effective way in increasing species richness and abundance of fish assemblage, and corroborate with the statement of Charbonnel et al. (2002) that habitat complexity has a prominent role on the ecological effectiveness of artificial reefs.

Changes in the frequency of occurrence demonstrate the relationship between habitat complexity and temporal variability in the fish assemblage (Fig. 2). Four months after the deployment of CNUs, the contribution of the permanent species (11% vs. 5%), frequent (13% vs. 10%), and scarce (50% vs. 26%) increased while the rare species decreased (26% vs. 60%). The "new" frequent species included *Oxycheilinus bimaculatus* and *Thalassoma lunare* of Labridae. This result may suggest higher temporal stability of the species assemblage.

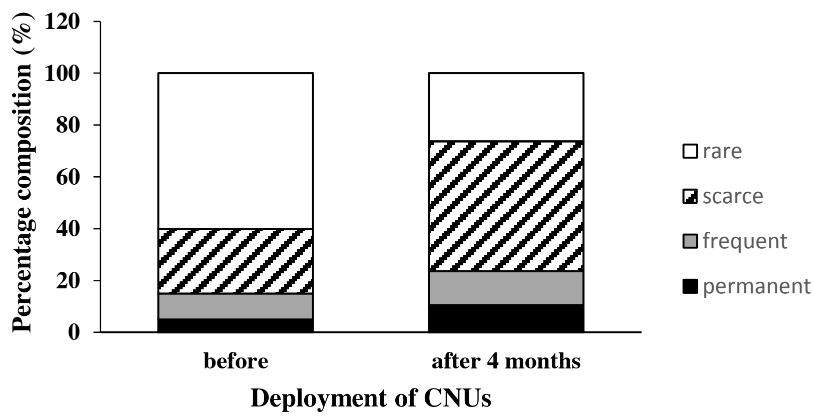

Fig. 2 Percentage composition of frequency of occurrence classes of the fish species before and four months after deployment of coral nursery units

Regarding the trophic levels, secondary consumers represented the greatest part of species composition and have increased after deployment of the CNUs (Fig. 3). Food availability, one of the main constraints to the optimal foraging of the predators (Simon et al., 2011) will not become a limiting factor within the CNUs, at least for some species. This may explain the increase of tertiary consumers during the second survey because these predators can encounter food at lower cost of search.

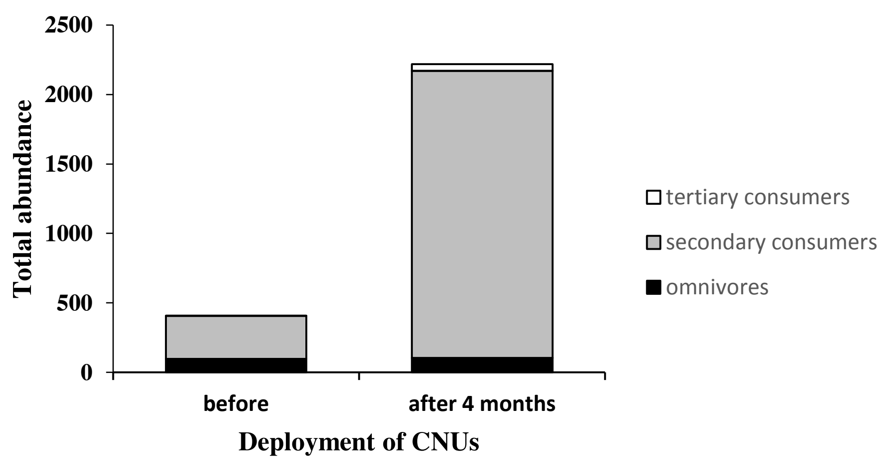

Fig. 3 Total abundance of fish species by trophic levels

CONCLUSION

The deployed CNUs undoubtedly offer suitable habitats to a number of fishes. In such habitats, these fishes can find food in abundance and this hypothetically would benefit their reproductive output and spillover. The sea is continuously subjected to stressors. Thus, even if the CNUs have not been planned for sustaining fisheries, they still need shelter and protection against undesirable impacts.

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