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Research article

Water quality assessment of Dodiongan Falls in Bonbonon, Iligan City, Philippines

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Abstract: Water is an essential element that sustains life on this planet, yet it is threatened by human activities. With little attention paid to the waterfall as a source of a domestic water supply and a tourist spot for recreation, this study was designed to investigate one of the waterfalls in Iligan City, Philippines: Dodiongan Falls. The location of the study is a neighborhood of the city garbage dumpsite that due to an uncontrollable situation, releases dark-colored secretion from the treatment box as has been verified by the residents in the area; this posed a threat to their food security and livelihood. Assessing the physicochemical parameters, heavy metal concentration and *Escherichia coli* counts is very crucial in interpreting its water quality. All parameters such as the pH, alkalinity, turbidity, lead (Pb), mercury (Hg), and the E. Coli test were done following the standard procedures. The results revealed that the pH, alkalinity, turbidity, total lead (less than 0.01 mg/L) and total mercury concentration (less than 0.001 mg/L) at the three sites were in conformity with the guidelines of the World Health Organization and Philippine national water quality standards. However, the E. Coli count has increased downstream from 220 to 1,600 MPN per 100 ml, which exceeded the standard limit. With these findings, it is paramount that the creation of a management plan be initiated as soon as possible by the different governmental agencies in order to bring back the life of Dodiongan Falls.

Keywords: water pollution; environmental risk; health risk; water quality assessment

RESEARCH ARTICLE

Reproductive Biology of the Aquarium Marine Fish *Abudefduf vaigiensis* (Quoy & Gaimard, 1825) from Iligan Bay, Southern Philippines

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ABSTRACT

Abudefduf vaigiensis is one of the top ten aquarium reef fish in the world, but the supply of this ornamental fish species is mainly from the collection of wild populations. This current study investigated some aspects of the reproductive biology of Indo-Pacific sergeant *A. vaigiensis* (Quoy and Gaimard 1825) from Iligan Bay, Southern Philippines from August 2021 to August 2022. Monthly samples of 35 to 45 individuals per class size with a range of 6.8 to 15.3 cm (TL) were collected to examine the sex ratio, maturity stages and spawning period, gonado-somatic index (GSI), length at first maturity (L_{50}), and the batch fecundity (BF) of the species. The sex ratio showed female dominance (1:1.09) among size classes and across months. The spawning period displayed a peak during the inter-monsoon or warm month (April) and extends up to the beginning of the Southwest monsoon months (June and July). The higher GSI observed during these months clearly reinforced the occurrence of spawning. Histological investigation during this period displayed the existence of hydrated oocytes, tertiary vitellogenic ovaries, and post-ovulatory follicles (POF), which indicate the recent spawning event. Likewise, in males, numerous spermatozoa in the lumen of tubules in the testes were detected as well as the occurrence of remaining spermatozoa in the lumen of lobules in the sperm duct. The length at first sexual maturity of males (9.44 cm TL) was slightly shorter than females (10.32 cm TL). Batch fecundity significantly increased (p-value = 0.00) with body length and weight respectively.

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Keywords: *damselfish, fish stock management, ornamental fish, reproductive biology, sex ratio*

1. INTRODUCTION

Marine fauna such as fish and invertebrates are widely collected from the coral reef habitats throughout the Indo-Pacific but the exact number of species that are currently available in the trade is still difficult to estimate due to the unorganized, multifaceted, and fragmented supply system (Cohen et al. 2013; Rhyne et al. 2012; Larkin 2008; Prakash et al. 2017). The marine ornamental fish trade includes around 1000 fish species; the main supplying countries are the Philippines and Indonesia (Perera and Cumaranatunga 2009; Ochavillo et al. 2004; Muyot et al. 2019).

In the Philippines, the marine ornamental fish sector mainly involved the gathering of wild, native, and endemic species from coral reef areas and traded mainly for the export market (Muyot et al. 2018; 2019). This bleak scenario puts strong pressure on the wild populations (Bruckner 2005). Despite its contribution to export trade, the marine ornamental fish sector has been criticized for an unsustainable harvest of fish from wild habitats and the illegal use of sodium cyanide, which has made a negative impression on the sector (Muyot et al. 2018). A substitute source of marine ornamental fish, captive-bred ornamental fish generated through aquaculture, is an evolving trend in the global marine ornamental fish trade (Swet and Pedersen 2018), but the Philippines has not made any attempt in this field. There is a wide-ranging opportunity for trade and livelihood for marine ornamental fish, but specific

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Original Article

Stock assessment of the marine ornamental Vagabond Butterflyfish *Chaetodon vagabundus* Linnaeus, 1758 (Pisces, Chaetodontidae) and the Indo-Pacific sergeant *Abudefduf vaigiensis* (Quoy & Gaimard, 1825) from Iligan Bay, Southern Philippines

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Abstract: The success of fisheries depends critically on the state of the fish stocks. In this study, a total of 1,188 fish individuals belonging to two species of *Abudefduf vaigiensis* (711), *Chaetodon vagabundus* (477) were investigated based on the samples collected from the waters of Iligan Bay, Southern Philippines. Population parameters were assessed using length-frequency data with FiSAT II software. The results showed positive correlations between length and weight. The values of *b* significantly ($P<0.000$) increased from 2.55 in *C. vagabundus* to 2.82 in *A. vaigiensis*. The growth and mortality parameters asymptotic length (L_∞), annual growth rate (K), annual total mortality (Z), natural mortality (M), fishing mortality (F) and exploitation rate (E) were 15.75 cm, 0.430, 1.60, 1.24, 0.28 and 0.18 for *A. vaigiensis* and 14.70 cm, 0.700, 2.60, 1.73, 1.09 and 0.39 for *C. vagabundus*, respectively. A bimodal recruitment pattern of unequal strength was observed for both species. The result of the virtual population analysis (VPA) routine showed that most of the small and young fish were prone to natural losses, while bigger fish were mostly caught by the fisherman. Finally, the maximum sustainable yield (E_{max}) for the two species was higher than the exploitation level, indicating that these two ornamental reef fishes were in good condition in Iligan Bay.

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Introduction

Ornamental fishkeeping is the second-largest hobby in the world, with the demand for ornamental fish steadily increasing annually (Muyot et al., 2019). Due to the considerable growth and diversification of the international ornamental fish trade, there is concern about its potential effects on the conservation of wild populations (Andrews, 1990; Domínguez and Botella, 2014), including its overall impact on the ecological balance of aquatic ecosystems. However, very little is known about the number or diversity of fish in commerce, and traded species are typically not traceable to their originating source because there has never been a proper monitoring system (Biondo and Burki, 2020). Available figures are based primarily on (often historical) estimates or are inferred using limited information from various formal and trade organizations. The data are also mostly based on the declared value of the ornamental fish trade and often fail to distinguish between freshwater and marine fishes (Monticini, 2010), sometimes including invertebrates (Dee et al., 2014). It is, therefore, challenging to find evidence to support the industry's claims that the ornamental fish trade is sustainable (Monticini, 2010; OATA, 2014). This market scenario may result in a sudden decrease in the marine ornamental fish stock. Thus, stock assessment is needed to provide important scientific information necessary for the conservation and management of fish stocks (Hoggarth et al., 2006; Gebremedhin et al., 2021). The assessment of a fish stock must consider all the relevant factors, especially the direct impact of a fishery on a single species (Halpern et al., 2015).

Growth, mortality, and recruitment parameters are essential for assessing and managing fish stocks (Kalhoro et al., 2017), as they determine catch and the

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Comparative Analysis of Bacterial Contamination in Three Species of Commercially Sold Oysters in Mindanao, Philippines

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Authors' contributions

This work was carried out in collaboration among all authors. Author Authors KMOL, MLPB, NAC and TBCN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author KMOL and NDC managed the analyses of the study. Authors MLPB, NAC, and TBCN managed the literature search. Author KMOL managed the editing and proofreading of the final manuscript. All authors read and approved the final manuscript.

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Original Research Article

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Aspects of the reproductive biology of the marine ornamental Vagabond Butterflyfish Chaetodon vagabundus Linnaeus, 1758 (Pisces, Chaetodontidae) from Iligan Bay, Southern …

Authors Nelfa D Canini, Ephrime B Metillo, Cleto L Nanola Jr

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Description The reproductive biology of ornamental fish species from coral reefs is poorly studied despite increasing demand in the aquarium trade industry. Aspects of the reproductive biology of the Vagabond butterflyfish, Chaetodon vagabundus Linnaeus, 1758, from Iligan Bay, Southern Philippines were investigated from August 2021 to August 2022. Monthly samples of 30 to 45 individuals per class size with a range of 9 to 14.1 cm (TL) were collected to examine the sex ratio, maturity stages and spawning period, gonadosomatic index (GSI), length at first maturity (L50) and the batch fecundity (BF) of the species. The sex ratio showed female dominance (1: 1.42) among size classes and across months. The spawning period indicates a peak during the inter-monsoon or warm months (April and May) and extends beginning of the Southwest monsoon period (June and July). These were supported by the relatively higher gonadosomatic index (GSI) recorded during these months. Histological examination showed that the ovaries during this period had the presence of numerous tertiary vitellogenic and hydrated oocytes and post-ovulatory follicles. At the same time for testes, there are occurrences of dense spermatozoa in the lumen of tubules in testes. This served as confirmatory evidence in support of the spawning period. The length at first sexual maturity of males (10.58 cm TL) was slightly shorter than females (10.91 cm TL). Fecundity increased with the fish's total length and weight showing a non-linear relationship that was best described by a power function. This study highlighted the valuable data produced that are required for the management of the …

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Water Quality Assessment of Carangan Estero in Ozamiz City, Philippines

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Abstract

Water quality in Esteros is deteriorating due to pollution influx from various human activities. The water quality of Carangan Estero in Ozamiz City was assessed by conducting the physicochemical and bacteriological analyses of water samples. Water sampling from May to June 2013 was done upstream in Barangay Calabayan (Site 1), midstream in Barangay Lam-an (Site 2) and downstream in Barangay San Roque (Site 3). Results showed an increasing temperature downstream that was within the Department of Environment and Natural Resources standards for Class C waters. The low pH in Sites 1 and 2 that ranged from 6.0 to 6.3 did not fall within the standard which could be attributed to the presence of dam and quarry activity upstream and influx of organic wastes midstream. Dissolved oxygen was decreasing downstream and the lowest reading of 2.9 mg/L was below the minimum limit. Biological oxygen demand of 7.2 mg/L in Site 3 exceeded the maximum standard. Total alkalinity in all sites was below the typical level for fresh water and was limited to bicarbonate ions only. Total hardness was increasing downstream. Phosphate concentration did not exceed the standard. Fecal coliform count increased downstream ranging from 4600 to >11,000 MPN/100 mL that exceeded the standard limit. Overall assessment revealed that water quality was deteriorating downstream due to relatively high discharge of organic waste from toilets, kitchen, piggeries, laundry and commercial establishments associated with dense population. A collaborative and sustainable effort of the community is necessary to restore water quality.

Keywords: Biological oxygen demand, coliform, pH, phosphate, total alkalinity

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RESEARCH PAPER OPEN ACCESS

Macroinvertebrates as bioindicators of water quality in Labo and Clarin rivers, Misamis Occidental, Philippines

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Key words: Ephemeroptera, Organic pollution, Plecoptera, Pollution-sensitive, Trichoptera.

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Abstract

Aquatic macroinvertebrates are affected by physical, chemical and biological conditions of the stream. Some of them are pollution-sensitive while others are pollution-tolerant. They are good indicators of stream health. This study was conducted to determine the status of Labo and Clarin Rivers using macroinvertebrates as bioindicators. Dip-net and kick-net methods were employed. Results showed that sampling sites in forested areas in Labo and Clarin rivers had a higher macroinvertebrate taxa richness and abundance. Mayflies (Ephemeroptera) were the dominant macroinvertebrates. Ephemeroptera, Plecoptera, and Trichoptera (EPT) and %EPT indices were higher in Clarin than Labo River. Based on Family-level biotic index (FBI), the water quality of sampling site 1 in Clarin (forested site) was excellent (organic pollution is unlikely) and very good (possible slight organic pollution) for site 1 in the Labo River but decreased downstream (fair to good quality). MANOVA results revealed a significant difference in the macroinvertebrate abundance in the agricultural sites of Labo River and forest sites of Clarin River. Cluster analysis showed that among the macroinvertebrates, mayflies (Ephemeroptera) were distinct in the forest sites and bugs (Hemiptera) in agricultural sites on Clarin River. Fly larvae (Diptera) and beetles (Coleoptera) were distinct in agroforest sites of the Clarin River while abundant in agricultural sites on Labo River. Results indicate a need for monitoring and proper management of Labo and Clarin rivers to prevent increasing deterioration of water quality.

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Open Access Research Article

Water quality assessment of Labo and Clarin Rivers in Misamis Occidental, Philippines

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Full Text

Abstract

Labo and Clarin rivers are very important to many communities in Misamis Occidental, Philippines. Hundreds of people living near the two rivers depend on these waters for domestic and industrial purposes. This study was conducted to assess the water quality of two major river systems, Clarin and Labo rivers in Misamis Occidental, Philippines. Physico-chemical and biological parameters were assessed in three different sampling sites in each river. Results showed that dissolved oxygen, biological oxygen demand, total dissolved solids, nitrate and phosphate along the forest and agro forest sampling sites were at levels that fall within the standards set by the Department of Environment and Natural Resources (DENR) in the Philippines. However, the sampling station in Labo River located along the agricultural area showed values that are non-compliant with the DENR standard. The water temperature and pH range in sampling stations along the forest were within the tolerable range that will not cause stress to the aquatic organisms. Bacteriological analysis showed that all sampling stations were positive for coliforms (Enterobacter aerogenes and Escherichia coli). The sampling stations along the agroforest and agricultural areas had high total fecal coliform load. Results indicate the need to have proper environmental management program in Clarin and Labo rivers.

Key words: Aquatic, bacteriological, coliforms, physico-chemical, river systems..

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Effects of Anthropogenic Activities on Physicochemical Characteristics and Macroinvertebrate Distribution in Riverine System of Misamis Occidental

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Abstract

Rivers are exposed to high human pressures with apparent effects on riparian organisms and other biological entities. This study was conducted to determine the effects of anthropogenic activities on the physicochemical characteristics and the distribution of macroinvertebrates in the riverine system of Misamis Occidental. Standard methods were followed to measure water temperature, water pH, and relative humidity. Macroinvertebrates were sampled using a handheld dip net and a one-meter kick net. Results showed that human activities were evident in all sampling areas. A total of 8 orders with nine families of macroinvertebrates were recorded. Among the macroinvertebrates, the Leptophyphidae family of the order Ephemeroptera (Mayflies), a good indicator of water quality, was the most abundant. Based on the Family Biotic Index, sampling site two has excellent water quality, which means organic pollution is unlikely. The findings of this study can be utilized as a basis for developing a protection and management plan for the river.

Keywords: Coleoptera, dip net, family biotic index, temperature

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Valuing the Water Ecosystem Services of Mount Malindang Range Natural Park: An Application of Contingent Valuation Method

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A crucial watershed in the Philippines, Mt. Malindang Range Natural Park (MMRNP; 8°15'34"N, 123°39'55"E) is located in the province of Misamis Occidental. It provides essential ecosystem services (ESs) to the communities around MMRNP. Despite its critical role, there is an increasing need for sustainable management and conservation to maintain these services. The purpose of this study was to evaluate the willingness -to -pay (WTP) of households in urban barangays (communities) close to MMRNP for the conservation and sustainable management of MMRNP's water ESs using the contingent valuation method. The findings showed that the average monthly WTP of PHP 35.01 (USD 0.60) per household has a potential yearly contribution of PHP 17,698,395.24 (USD 303,043.90). Factors such as bid amount, civil status, homeownership, household size, length of residency, and perception of MMRNP's ESs significantly influenced WTP. These insights underscore the possibility of household contribution through payment for ecosystem services for environmental conservation, sustainable financing, and the development of MMRNP's resources, providing valuable guidance for stakeholders in the region.

Keywords: ASEAN Heritage Park, conservation, sustainable financing mechanism, payment for ecosystem services, protected area, contingent valuation method