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Local Knowledge on the distribution, exploitation, and threats to *Centropyge* species (Pomacanthidae) in the Philippines

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ABSTRACT

The Philippines is a top exporter of marine ornamental fish in the world. Angelfishes (Pomacanthidae) are among the most valuable in the marine ornamental fish trade, particularly the species of *Centropyge*. Assessment of their conservation status is vital to regulate harvesting, prevent extinction, and sustain the ornamental industry. Critical information for their assessment is limited. Thus, this study used local knowledge to determine the distribution, exploitation, and threats to *Centropyge bispinosa*, *C. heraldi*, and *C. bicolor*. A total of 157 ornamental fish divers, 8 exporters, and 18 middlemen were interviewed from 12 municipalities covering eight provinces identified as major producers of marine ornamental fish in the Philippines. Results indicate a wide distribution of these species in the Philippines. These species were utilized for aquarium trading only. Zambales fisherfolk has the highest catch number for all three *Centropyge* species, with an average weekly catch of 72 pieces of *C. bispinosa,* 60 pieces of *C. heraldi,* and 36 species of *C. bicolor*. Their conservation status is Least Concern based on 2009-2010 IUCN assessments which are outdated. Illegal fishing, water pollution, natural disasters, and crown-of-thorns starfish infestation could drive them toward the threatened category. Information from this study will be used to re-assess the current conservation status using IUCN Red List Categories and Criteria. The result of this study will provide crucial information for advancing the conservation of marine biodiversity, sustainable management resources, and evidence-based policy formulation.

Keywords: Angelfish, *Centropyge bispinosa, Centropyge heraldi, Centropyge bicolor*, Philippines, IUCN Red List Categories and Criteria, Marine ornamental fish

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INTRODUCTION

The Philippines, an archipelagic country in Southeast Asia with 7,641 islands, is located within the Coral Triangle, a hotspot for coral reef biodiversity (Reyes and Licuanan, 2022; Sobha et al., 2023). This makes the country one of the most diverse in terms of marine life. The Philippines is a major player in marine ornamental fish exportation, offering promising livelihood opportunities for fisherfolk (Biondo and Burki, 2019; Priyashadi et al., 2023). An estimated 60% of marine ornamental fish traded internationally originate from the Philippines (Biondo and Burki, 2019; Mulyati et al., 2023; Pouil et al., 2019). Most of the marine ornamental fish are taken from the wild (Dominguez and Botella, 2014; Yan, 2016; Evers et al., 2019) and exported to different countries such as the United States, Europe, and Japan (Olivier, 2003; Leal et al., 2015).

The Family Pomacanthidae is one of the most popular marine ornamental fish harvested for the aquarium trade (Affonso and Galetti, 2007). According to the Global Marine Database, from 1997 to 2002, it was the second most imported family in marine ornamental trading (Wabnitz, 2003). Within the pomacanthid family, the genus *Centropyge* is one of the major highly traded marine angelfishes (Baensch and Tamura, 2009). This is due to its small body size and bright coloration (Olivotto et al., 2006; Baensch and Tamaru, 2009). However, collecting these species is challenging as some are usually found beyond conventional scuba depths (Gaither et al., 2014). The *Centropyge* genus is a territorial coral reef inhabitant that adapts well to aquariums over an extended period of more than 8 years (Bauer and Bauer,1981; Pyle, 2001; Pyle, 2003). Thus, this makes the genus *Centropyge* highly exported in the aquarium fish trade (Mendoca et al., 2020), particularly the *C. bispinosa, C. heraldi*, and *C. bicolor*. These species were included in the list of the highly exported species in the aquarium trade (Biondi et al., 2024), and their manageable size makes them excellent choices for aquarium enthusiasts (Bauer and Bauer,1981). In the recent evaluation, *C. bispinosa and C. bicolor* were included in the top 20 species imported into the European Union, highlighting *C. bicolor* as the top 3 and *C. bispinosa* as the top 11 between 2014 and 2021 assessment (Biondo et al., 2024). Moreover, *C. bicolor* was included in the top 10 most vulnerable fish species associated with its biological productivity and susceptibility to overfishing imported into the United States (Dee et al., 2019). Additionally, the Bureau of Fisheries and Aquatic Resource - National Fisheries Research and Development Institute (BFAR-NFRDI) conducted an assessment in 2017 showed that these three selected species were included in the top 30 most traded marine ornamental fish, *C. bispinosa* in the top 10 (28,053 pieces), *C. heraldi* as the top 21 (14,309 pieces), and *C. bicolor* in the top 27 (13, 231 pieces) exported in different countries (unpublished data provided by BFAR-NFRDI). Thus, the high market demand for these species may raise concerns about potential overharvesting in the wild, given that larval development for aquaculture is not yet available. The last extinction risk assessment of these species using the IUCN Red List Criteria and Categories was in 2009-2010 with the category Least Concern (IUCN, 2024), indicating that these species are less concerned than species in other threat categories. Given the outdated IUCN assessments and ongoing environmental pressure, this study provides critical updates needed for informed conservation planning.

Local Knowledge (LK) is a breadth of knowledge that provides salient information, especially when scientific data is limited (Beaudreau and Levin, 2014; Lima et al., 2017; Pita et al., 2020; Truchet et al., 2019). The knowledge of fishers acquired over generations through hands-on experience and observation can shed light on fishing practices, distribution, species habitat, ecology, and threats (Ribeiro et al., 2021; Lima et al., 2017; Renck et al., 2023). Many studies have shown that Local Knowledge successfully provides conservation status data for endangered species such as sea lions, sharks, and sea turtles (Cook et al., 2015; Gallagher et al., 2015; Wedemeyer et al., 2021). Moreover, Local Knowledge (LK) helps to reveal unobserved declines in the species population, which is essential in developing effective fisheries conservation strategies and management plans for sustainability (Poissant et al., 2024). Thus, this study aims to determine the spatial distribution and exploitation of the three *Centropyge* species based on Local Knowledge and to determine threats to the population of the three *Centropyge* from the perspective of local fish divers, middlemen, and exporters involved in ornamental fish trading. The data obtained from LK will be used to assess the current conservation status of these three selected marine ornamental fish species of *Centropyge*. Involving fishers and integrating their knowledge into scientific assessments can help develop effective conservation strategies, ensuring the protection of fish populations and the communities that rely on them.

MATERIALS AND METHODS

Description of the study

The Philippines is one of the leading exporters of marine ornamental fish (Biondo et al., 2024). It has several key provinces actively involved in this industry. Pangasinan, Cagayan, Zambales, Quezon, Batangas, Eastern Samar, Cebu, and Davao del Sur were recognized as the major collection areas for marine ornamental species (Muyot et al., 2018; Muyot et al., 2019). These provinces are spread across different regions of the country and serve as centers for collecting marine ornamental fish species for international trade (Muyot et al., 2018). Therefore, interviews with ornamental fish divers, middlemen, and exporters were conducted in these identified areas (Figure 1).

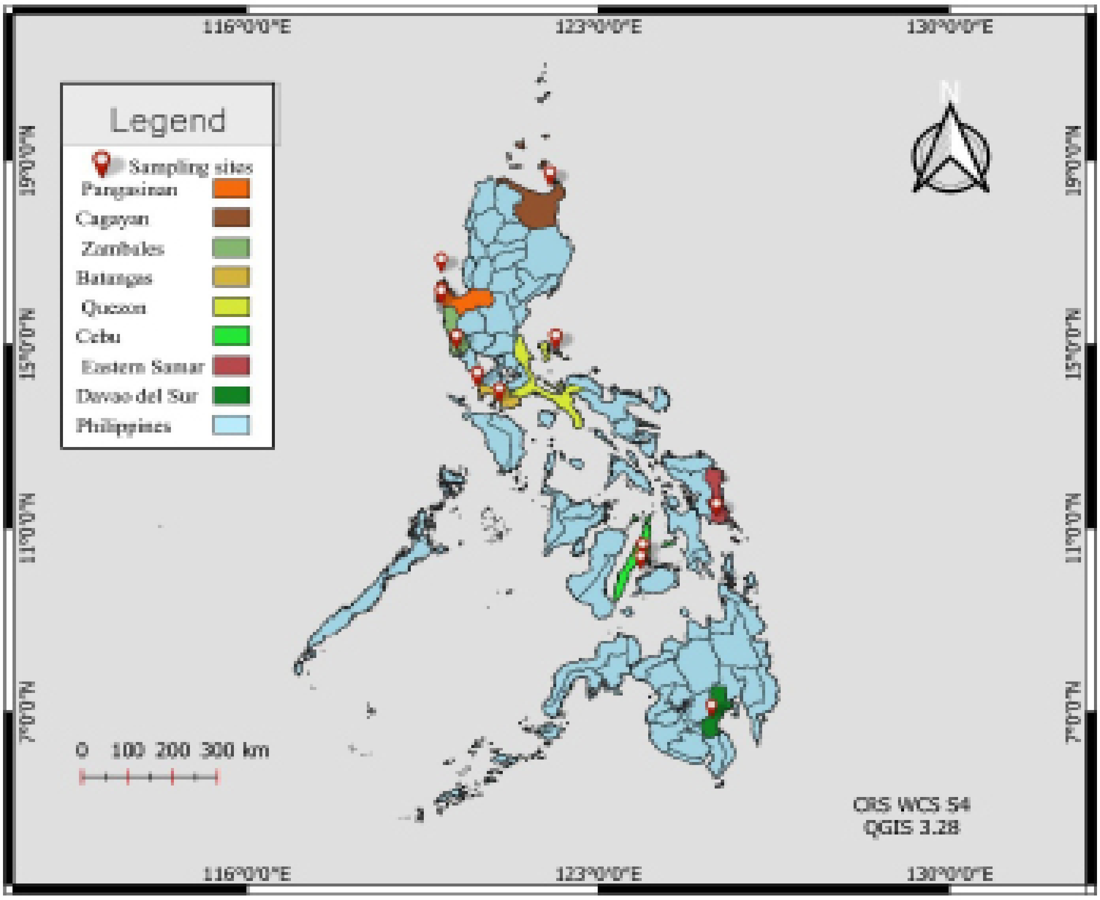

Figure 1. Map of major marine ornamental fish-producing areas in the Philippines.

Data collection

Face-to-face interviews from March 2024 to June 2024 in the selected villages of 8 provinces in the Philippines, where there is an active collection operation of marine ornamental fish were conducted (Table. 1). Snowball sampling was performed in selecting the respondents as there was no available information on the total population of fisherfolk engaged in marine ornamental fish in each province. The researcher obtained a list of accredited exporters from the Bureau of Fisheries and Aquatic Resource- Quarantine Division and employed it as a reference point in tracing the marine ornamental fish divers. Exporters were individually called by phone and asked for the details of their middleman trader posed in the villages. Subsequently, the middleman referred their ornamental fish divers for an interview. The networking and referral characteristics of the snowball sampling method are efficient in identifying the ornamental fish divers participants, especially in remote areas where it is hard to access information. However, snowball sampling has a limitation in selecting respondents, as it relies solely on the referred ornamental fish diver participants by the middlemen and exporters, which may result in a non-representative sample. Thus, it could exclude fishers who are not connected to the identified exporters or middlemen. Despite this constraint, this study can still provide reliable data on the distribution, exploitation, and threats that potentially affect the conservation status of these species.

A semi-structured interview was used to obtain the local knowledge (LK) on the habitat, abundance, distribution, uses and trade, and threats of the three selected species of genus *Centropyge* in their locality. Before the interview began, each respondent was asked for consent to participate in the activity. The questionnaire was pre-tested in the Municipality of Davao del Sur on March 2, 2024. This was done to test its validity and the respondents' time to answer questions (Macusi et al., 2017). Subsequently, it was modified based on the interview results. Additionally, a picture of the three *Centropyge* species was integrated into the questionnaire to guide the ornamental fish divers in identifying these species. During the interview, the researchers translated the questionnaire based on the local language of the ornamental fish divers, middlemen, and exporters (Tagalog in the Luzon areas and Cebuano in the Visayas and Mindanao areas) during the interview. This was done to prevent misinterpretation of the question.

Although a questionnaire was prepared, an open-ended question was allowed to encourage informants to share their knowledge and comments freely. Hence, this will elicit more information about the three *Centropyge* species. A total of 157 ornamental fish divers were interviewed in the provinces of Pangasinan (n= 8), Cagayan (n= 14), Zambales (n= 42), Batangas (n=41), Quezon (n= 12), Cebu (n=30), Eastern Samar (n= 6), and Davao del Sur (n= 4). Additionally, researchers conducted key informant interviews with exporters (n=8) and middleman traders (n=18) posed in the village sites (Table 1) to gather further data and validate the information obtained from the ornamental fish divers.

A grid map of each sampling site was included in the questionnaire to help the ornamental fish divers identify their usual fishing ground where the three *Centropyge* species frequently collected. The data points from interviews were transcribed by locating the sites on a Google Earth map, after which the coordinates were traced and recorded. In addition, occurrence data points from the Global Biodiversity Information Facility (GBIF) and Ocean Biodiversity Information System (OBIS) databases were gathered. The collected secondary data were combined with estimated data point coordinates provided by ornamental fish divers to collate all occurrence records of the three *Centropyge* species in the

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Table 1. Distribution of respondents by province and Municipality.

Provinces	Municipality	Fisherfolk diver respondents	Exporters respondents	Middlemen respondents
Pangasinan	Bolinao	8	-	2
Cagayan	Santa Ana	14	-	3
Zambales	Subic	8	-	1
	Masinloc	15	-	1
	Santa Cruz	19	-	1
Batangas	Calatagan Batangas	17	-	-
	Isla Verde Batangas City	24	-	5
Quezon	Patnanungan	12	-	3
Cebu	Olango Island	22	5	-
	Lapu-Lapu City	8	3	-
Eastern Samar	Giporlos	6	-	1
Davao del Sur	Santa Cruz	4	-	1
Total		157	8	18

Philippines.

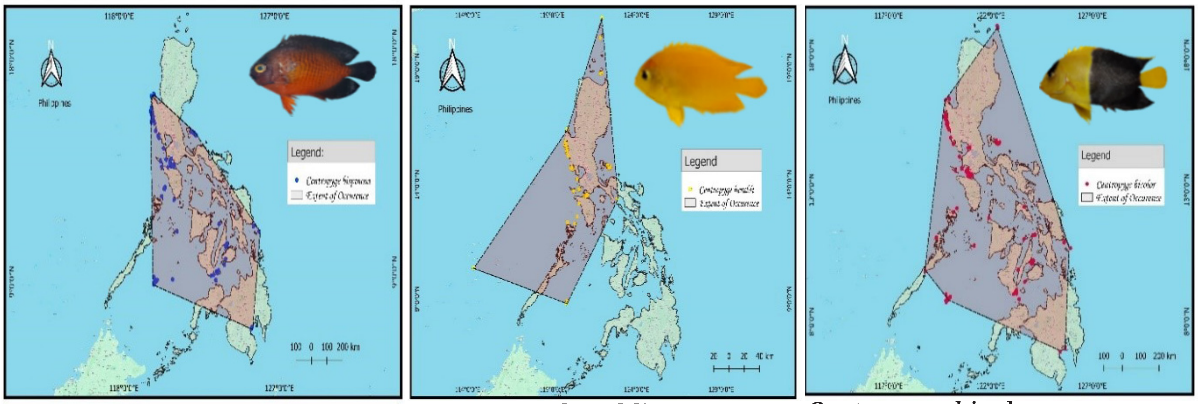
Data analyses

Researchers analyzed both quantitative and qualitative responses of the respondents. They were encoded and summarized using Microsoft Excel (2019). The quantitative data (utilization and threats) were analyzed through descriptive statistics, and the findings were visualized through graphs. The Shapiro-Wilk-Test was applied to determine the normality test of the gathered data. The Mann- Whitney U-Test was employed to determine the influence of gear type in the total weekly catch of the ornamental fish divers for the three *Centropyge* species. Kruskal Wallis Test was also performed to determine the threats affecting the total weekly catch collections of the three selected *Centropyge* species. A confidence level of 0.05 was set in all analyses. These statistical analyses were run through RStudio software 4.2.1. In addition, the Likert scale was used to analyze the observation of the occurrence of these species in each sampling area. Corresponding scores such as 1- Never, 2- Rarely, 3- Sometimes, 4- Frequently, and 5- always were set to measure the perceptions of fish divers. Subsequently, average scores were calculated and interpreted based on this mean range: 1.0 -2.9 – Low or Weak agreement, 3.0-4.4 Moderately agree, and 4.5-5 Strongly agree on its species occurrence. Moreover, the distribution data points were analyzed through Geospatial Conservation Assessment Tool software (GeoCAT) developed by Kew Garden (Batchman, 2011) as recommended software by the IUCN Red List Mapping Standards and Data Quality for the IUCN Red Spatial Data (IUCN 2024). This analysis was employed to calculate the extent of occurrence (EOO) using the minimum convex polygon method (IUCN, 2024). Subsequently, the Quantum Geographic Information System (QGIS) software version 3.36.3 generated the geographic distribution representation map of the three selected *Centropyge* species.

RESULTS

Distribution

The three marine ornamental species were widely distributed in the Philipines. *C. bicolor* species has the broadest distribution among the three species with an extent of occurrence of 664,637.562 km^2., followed by *C. heraldi* covering 601 983.961 km^2 concentrated in the Western and Central part of the country, and *C. bispinosa* with 457,189.338 km^2 (Figure 2). The *C. bicolor* species is present in all sampling sites and has a high occurrence in Zambales and Cagayan. Moreover, Quezon, Davao del Sur, Cebu, and Eastern Samar revealed moderate occurrence of this species in their areas (Table 4). Meanwhile, fisherfolk revealed the absence of C. heraldi in Cebu, Samar, and Davao del Sur provinces. This information was further confirmed by the exporters and middlemen, who said they never have a supply of C. heraldi coming from the these provinces. This species was consistently observed in Zambales, Cagayan, and Quezon provinces (Table 3). The rest of the fisherfolk in Pangasinan and Cagayan have low observation of *C. heraldi* in their fishing ground. The *C. bispinosa* species is highly presence in Zambales and moderately observed in Pangasinan, Batangas, Quezon,



Centropyge bispinosa
457,189.338 km^2 (EOO)

Centropyge heraldi
601,983.961 km^2 (EOO)

Centropyge bicolor
664,637.562 km^2(EOO)

Figure 2. Distribution of the three Centropyge species in the Philippines.

Table 2. Perceived occurrence for *C. bispinosa* fish species.

Sampling sites	Mean	SD	Interpretation
Pangasinan	4.0	1.15	Moderately agree
Cagayan	-	-	-
Zambales	4.7	0.67	Strongly agree
Batangas	3.67	1.03	Moderately agree
Quezon	4.08	1.08	Moderately agree
Cebu	3.77	1.08	Moderately agree
Eastern Samar	2.67	1.36	Low or weak agree
Davao del Sur	4.0	1.15	Moderately agree

Table 3. Perceived occurrence for *C. heraldi* fish species.

Sampling sites	Mean	SD	Interpretation
Pangasinan	2.81	1.57	Low weak agree
Cagayan	3.57	1.16	Moderately agree
Zambales	4.09	1.33	Strongly agree
Batangas	2.5	1.62	Low or weak agree
Quezon	3.92	1.62	Moderately agree
Cebu	-	-	-
Eastern Samar	-	-	-
Davao del Sur	-	-	-

Table 3. Perceived occurrence for *C. bicolor* fish species.

Sampling sites	Mean	SD	Interpretation
Pangasinan	2.71	1.70	Low or weak agree
Cagayan	4.64	0.49	Strongly agree
Zambales	4.3	1.02	Strongly agree
Batangas	3.05	1.46	Moderately agree
Quezon	3.83	1.75	Moderately agree
Cebu	3.16	0.53	Moderately agree
Eastern Samar	3.33	0.82	Moderately agree
Davao del Sur	4.0	1.15	Moderately agree

Cebu, and Davao del Sur (Table 2).

Exploitation

The *C. bispinosa*, *C. heraldi*, and *C. bicolor* species are used only for commercial aquarium trading and are exported to different countries. Generally, ornamental divers carry out small barrier nets made of monofilament mesh nets (Figure 4a) to collect these species. The small barrier nets with a length of less than 5 meters and lead weights along the bottom were established in a 'V' shape. Then, ornamental divers carefully "drove" the fish into the center of the net and immediately collected the fish using a scoop net (Figure 4b). The collected fish were placed in the bucket with a zipper net (Figure 4c). The majority of the ornamental divers in Davao del Sur (100%), Zambales (70%), Cagayan (71%), and Quezon (58%) have employed compressors to supply air at depth. In comparison, in the provinces of Eastern Samar (100%), Cebu (60%), Batangas (61%), and Pangasinan (75%), most of the ornamental divers carried out skin diving or "mano-mano" (Figure 4f), which they only used improvised fins made of

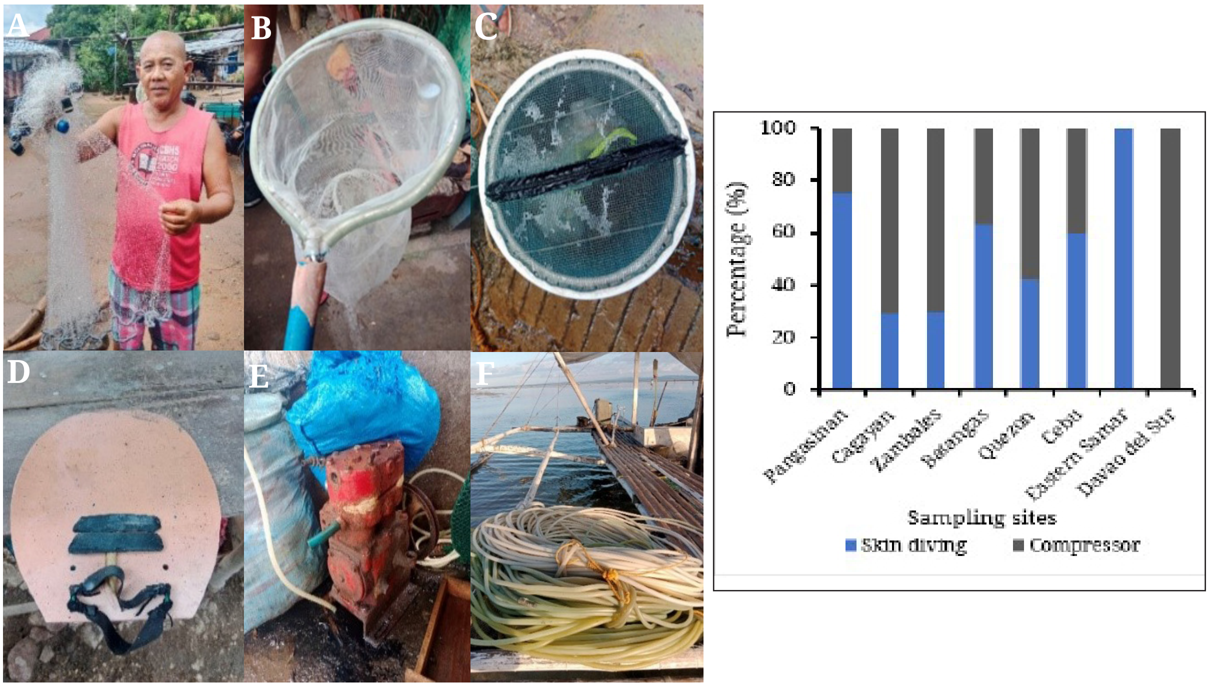


Figure 4. Gears used in collecting the three *Centropyge* species including mesh-size nets (A), scoop net (B), bucket with zipper net (C), improvised fins (D), compressors equipment (E), and percentage of ornamental fish divers employed compressors and skin diving (F).

plywood, PVC, or Fiber to dive (Figure 4d).

The total weekly catch per species was 4 381 pieces for *C. bispinosa*, 3,192 pieces (*C. heraldi*), and 2,740 pieces for *C. bicolor*. The ornamental divers in Zambales stand out as the major collectors of the three *Centropyge* species, with an average weekly catch of *C. bispinosa* (72 pieces) *C. heraldi* (60 pieces), and *C. bicolor* (36 pieces), followed by Quezon ornamental divers, with 27 pieces (*C. bispinosa*), 44 pieces, (*C. heraldi*), and 45 pieces (*C. bicolor)*. Notably, there were no catches of *C. heraldi* in Cebu, Eastern Samar, and Davao del Sur. However, *C. bispinosa* and *C. bicolor* were collected in these provinces, and they had less than 30 pieces of average weekly catch. Batangas, Pangasinan, and Cagayan divers catch less than ten pieces of the three *Centropyge* fish species (Figure 5). The Mann -Whitney U test analysis revealed a statistically significant difference in weekly catch between those divers who used compressors and those who practiced skin diving. This implies that ornamental fish divers using compressors achieved higher catches than

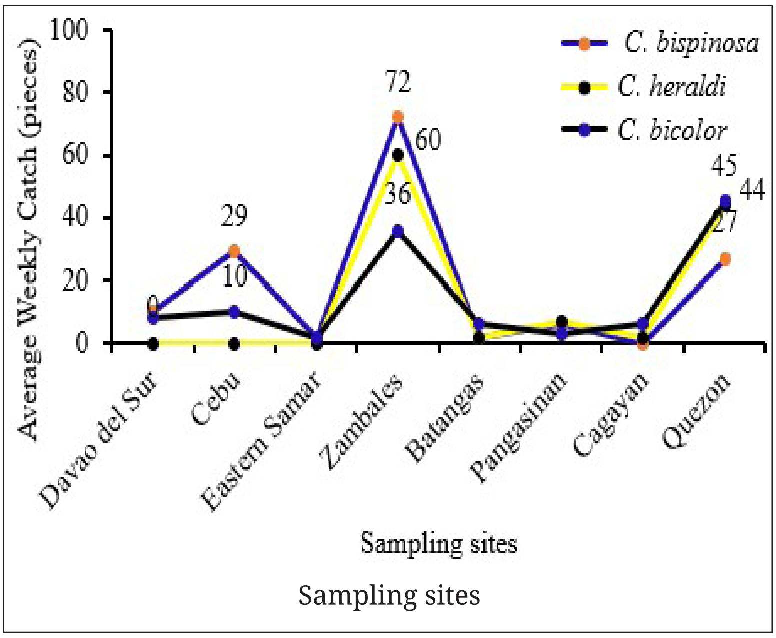


Figure 5. Average weekly catch of the *Centropyge* species within eight regions.

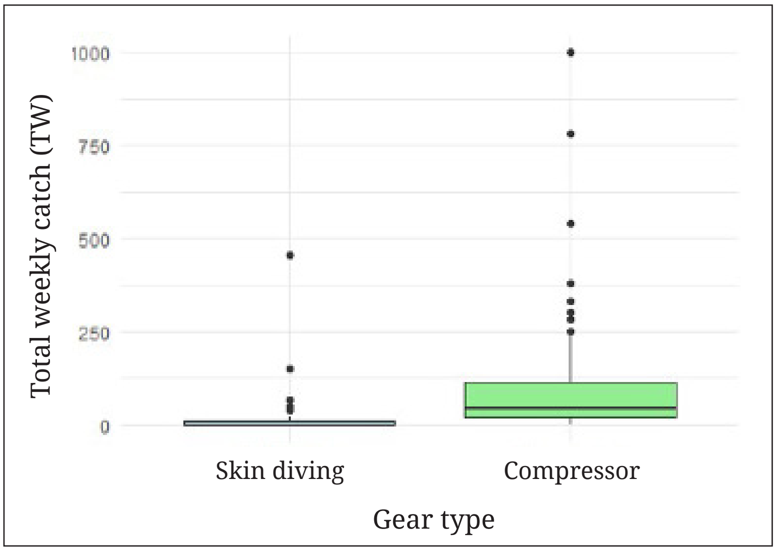


Figure 6. Total Weekly Catch (TWC) comparison between Skin Diving and Compressor gear types.

those who relied on skin diving (Figure 6).

Threats

Each sampling site faces different environmental threats that are perceived to damage the coral reef habitat and affect the population of the three *Centropyge* species. Ornamental divers in Davao del Sur (100%), Cebu (63%), Zambales (50%), and Pangasinan (50%) revealed that they were affected by the water pollution caused by anthropogenic activities (fish cages, garbage waste, siltation from mining activity), surrounded in their fishing areas. In addition, ornamental fish divers in Cebu (90%), Cagayan (100%), and Eastern Samar (33%) reported that natural disasters, particularly typhoons primarily the threats observed caused the reduction in the population of the three *Centropyge* species as typhoons significantly destroyed or damage the coral reefs structures according to the ornamental fish divers. Coral bleaching was also mentioned by the divers in Cebu (57%), Eastern Samar (33%), Zambales (24%), Pangasinan (38%), and

Cagayan (29%). Biological threats (Crown of Thorns starfish infestation) were reported in Davao del Sur (75%), Batangas (55%), and Cagayan province (29%). Zambales divers (28%), Pangasinan (13%), and Quezon (8%) also informed the presence of illegal fishing in their locality (Figure 7). In Kruskal-Wallis analysis, the findings showed that Illegal fishing (0.034), Water pollution (0.0003), Natural disasters (0.014), and Biological threats (Crown-of-thorns starfish infestation) (0.015) with p-values below 0.05 indicated that these threats significantly affect the total weekly catch of the three *Centropyge* species (Table 3). This implies that ornamental fish divers facing these identified threats tend to catch lesser number of the three *Centropyge* species.

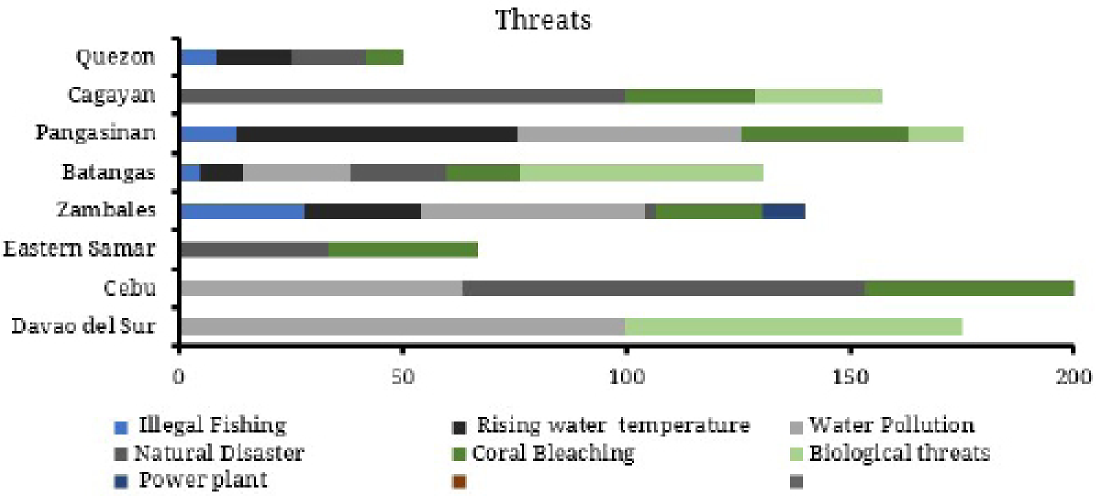


Figure 7. Threats identified by the ornamental fish divers.

Table 3. Kruskal-Wallis analysis results examining the effects of various threats on the total weekly catch for the three *Centropyge* species, displaying chi-square values, p-values, and the corresponding significance levels based on a 0.05 threshold.

Threats	X2	p-value	Interpretation
Illegal Fishing	4.4841	0.034	Significant
Rise in seawater Temperature	0.33914	0.560	Not significant
Water pollution	13.147	0.0003	Significant
Natural disasters (Typhoon)	6.0523	0.014	Significant
Coral bleaching	0.18097	0.670	Not significant
Biological threats (crown-of-thorns starfish infestation)	5.9301	0.015	Significant
Power plant	0.078056	0.779	Not significant

DISCUSSION

The local knowledge of ornamental fish divers is invaluable in uncovering the present status of the three *Centropyge* species. The three *Centropyge* species were widely distributed in the Philippines with an extent of occurrence of 457,189.338km^2 (*C. bispinosa*), 601,983.961km^2 (*C. heraldi*), and 664,637.562km^2 (*C. bicolor*). The good and fair status of coral cover in each study site (Licuanan et al., 2017) may contribute to the wide occurrence of the three *Centropyge* species in the Philippines. For instance, in Zambales province, the three *Centropyge* species were highly collected, particularly in the villages of Masinloc, Palauig, and Santa Cruz, which exhibit good and fair conditions of coral ecosystem (Paz-Albierto et al., 2021). Furthermore, *Centropyge* heraldi species were surprisingly not observed and collected in Cebu, Eastern Samar, and Davao del Sur provinces. The absence of *C. heraldi* in Visayas and Mindanao sampling sites is probably influenced by factors such as physical and chemical parameters requirement for this species. Similarly, these parameters are essential for species survival when keeping marine ornamental fish in an aquarium (Nair et al., 2020). In addition, substrate requirement may also contribute to its absence in several sampling sites. The study of Nanami (2023) emphasized that *C. heraldi* is mostly found in exposed reefs associated with substrates characterized by acroporid corals, specifically bottle-brush Acropora with greater coverage of rock. On the other hand, *C. bicolor* is found in all sampling sites, but fishers mentioned that they have a hard time collecting this species as they were mostly found in coral reefs with strong waves and currents. Thus, it reflects that the estimated total weekly catch (2 740 pieces) of this species was lower than the catch of *C. bispinosa* (4,381 pieces) and *C. heraldi* (3,192 pieces). Meanwhile, *C. bispinosa* was observed in all sampling sites except in Cagayan province, where all ornamental fish divers responded that they were unsure about the occurrence of *C. bispinosa* in their locality. This was because it was not included in their target species to collect due to the lower price value. Furthermore, ornamental fish divers use minimal equipment to catch these species, as they need to carefully collect the fish without physical damage and less stress to trade the species in the market. Several ornamental fish divers employed compressors to collect these species as they are depth generalist species (Bridge et al., 2016; Biondi et al., 2024). The Philippine Fisheries Code (Republic Act No. 8550), amended by Republic Act No. 10654, in section 6 stipulated that Local Government Units (LGUs) have the discretion to implement rules and regulations for fisheries activities in their municipal water areas in collaboration with the Fisheries and Aquatic Resources Management Council (FARMC). Hence, Pangasinan, Zambales, Batangas, Quezon, and Eastern Samar has implemented the ban on using compressor equipment for ornamental fishing. In addition, Memorandum Circular No. 2023, 012 by the Department of the Interior and Local Government in 2023 stipulated the unlawful use of this gear in fishing. Furthermore, inadequate compressor training, low equipment maintenance, and inspection may increase the likelihood of diving-related injuries like decompression illness and barotrauma (Kithome, 2021; Javier, 2022). Despite the legal and health risks involved, ornamental fish divers continue to engage in this practice as it allows them to collect a higher catch and earn enough income for daily sustenance.

The ornamental fish divers reported several threats that were perceived to affect the coral reef habitat of the three *Centropyge* species in their locality. Environmental threats, such as illegal fishing, water pollution from aquaculture, mining siltation, and garbage; natural disasters, particularly typhoons; and biological threats, like crown-of-thorns starfish infestation, were reported to threaten their marine ornamental operation, affecting their total weekly catch. These threats are recurrent problems in the Philippines that contribute to the depletion of marine resources, leading to broader environmental and economic repercussions. For instance, a study conducted by Paz-Alberto et al., 2020 found that illegal fishing activity in Zambales caused a 50% reduction in fish caught in the areas based on the local ecological knowledge of fishers. This threat contributed to the decline of the coral ecosystem in the region (Paz-Alberto et al., 2021), thereby supporting the results of this study. Further, the case study in Santa Cruz, Zambales, where mining activities destroyed the marine ecosystem of the locality due to the siltation of the river system that exacerbates flood problems during typhoons (Migo et al., 2018). The excessive nutrient loading due to aquaculture effluents indirectly affects the coral settlement as it promotes the growth of another biota, leading to

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reduce availability of suitable substrate (Quimpo et al., 2020) and a prevalence problem of marine litter that may have extensive effects to the marine ecosystem (Dey et al., 2024; Razzaq et al., 2024). In addition, natural disasters such as typhoons have frequently increased, devasting the coral reef ecosystem, particularly in Cebu (Esteban et al., 2022). Ornamental fish divers emphasized that typhoon Odette wiped out an estimated 80-90% of their corals, which they said was the cause of the reduction in their collection of the *Centropyge bispinosa*, *C. bicolor*, and other marine ornamental species. This is similar to the case in Northern Palawan due to typhoon Odette in 2021, where there was a reduction in the coral cover that significantly affected the species richness and abundance of macroinvertebrates, particularly small giant clam species in the area (Dolorosa et al., 2023). The Crown of Thorns starfish infestation is a biological threat, significantly contributing to biodiversity and coral reef crises (Hillberg, 2024; Uthicke et al., 2023). Ornamental divers, particularly in Batangas, Pangasinan, Cagayan, and Davao del Sur, reported that crown-of-thorns starfish species outbreaks led to coral losses as they fed on corals. Similarly, the study by Deaker and Byrne (2022) explained this observation that these species are known for their destructive consumption of coral reefs. Additionally, ornamental divers faced difficulties in collecting marine ornamental fish because they had to avoid the harmful spines of the crown-of-thorns starfish. For instance, Acanthaster solaris found in the country have severe toxicity to humans, causing permanent abscesses, apoptosis, hemolysis, and bone-destroying processes (Birkeland and Lucas, 1990; Haszprunar et al., 2017). This reduces the overall weekly catch. Thus, reported threats have a substantial impact on the health of the coral reef ecosystem. These should be addressed immediately to prevent a decline in the populations of marine ornamental species, particularly the three *Centropyge* species.

CONCLUSION AND RECOMMENDATION

The findings of this study provide valuable insights into assessing the conservation status of the three *Centropyge* species (Pomacanthidae) in the Philippines. Local knowledge from ornamental fish divers has emphasized that these three species are widely distributed in the country. The current exploitation of these species is for marine ornamental trade only, and fish divers use minimal equipment to collect them. Being inhabitants of deep water has added extra protection for these *Centropyge* species from overfishing. Reported threats to these species include local illegal fishing, water pollution, natural disasters, and predation of crown-of-thorns starfish, which may lead to the decline of these species' populations. Results from this study support the need for stricter regulation of ornamental fish collection in areas where *Centropyge* species are vulnerable to overexploitation, particularly in Zambales, where occurrence was highest. Additionally, it emphasizes the need for further investigations into exportation activities and the species' ecological habitat requirements to ensure sustainable utilization and conservation. Indeed, the findings of this study are essential baseline data required for assessing the conservation status of these species using IUCN Categories and Criteria. It is crucial in guiding conservation actions and policy formulation for the long-term protection and sustainability of *Centropyge* species in the Philippines.

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