The Philippine Journal of Fisheries 2026 NSAP Special Issue: 63-73
DOI: 10.31398/tpjf/33.3.2025C0007

September 2026

RESEARCH ARTICLE

Stock Status of *Coryphaena hippurus* (Common Dolphinfish) in Fisheries Management Area 1, Batanes Waters Sub-FMA

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ABSTRACT

Coryphaena hippurus, locally known as "*Arayu*," is a migratory fish of significant importance to Batanes Province, serving as a food source, livelihood, and cultural identity for *Ivatan* communities. This study assessed the stock status of the species in Batanes Waters (Fisheries Management Area 1) using standard National Stock Assessment Program (NSAP) methodology, analyzing data collected from 2014 to 2023. The results present a complex picture of the stock. Troll line is the dominant gear, contributing 97.1% of the total catch. Historical catch and Catch Per Unit Effort (CPUE) have increased steadily, while the Spawning Potential Ratio (SPR) was estimated at 43% in 2022 and 2023, indicating a healthy status. However, natural mortality (M), fishing mortality (F), and exploitation ratio (E) were estimated at 1.02, 5.89, and 0.85, respectively. This rate of F being almost five times M indicates high fishing pressure, and E suggests the stock is already beyond the sustainable level of exploitation. The disparity between the high exploitation estimates and the healthy SPR/CPUE metrics suggests that the initial conclusion of unsustainable exploitation may not fully reflect the species' population dynamics. This complexity likely stems from the highly selective nature and localized focus of the fishing gear used for the FiSAT analysis. To prevent stock decline, caution must be exercised against increasing fishing capacity. The study urgently recommends migration and connectivity studies to assess juvenile targeting by nearshore operations, and a reproductive biology study to confirm fish maturity.

*Corresponding Author: *len_calicdan@yahoo.com*
Received: *October 21, 2025*
Accepted: *June 29, 2026*

Keywords: *Mortality; exploitation rates, Coryphaena hippurus, LBSPR, Fisheries Management Area 1*

1. INTRODUCTION

Batanes Waters, a sub-Fisheries Management Area (FMA) of FMA 1 located at the northernmost tip of the Philippines, is considered a major fishing ground in the country (Morales et al. 2016). Its geographical area allows reliance on agriculture and fisheries to sustain the economy (Heyres et al. 2024). It is home to various commercially important fish species, including those in the family Coryphaenidae, or dolphinfishes, which are highly utilized in the area because of their fast growth rate and meat quality (Morales et al. 2016; López-Martínez et al. 2024).

The family Coryphaenidae is a large, migratory, and epipelagic family found in tropical and subtropical oceans (Roa-Ureta et al. 2024). It is composed of only two species within its genus: *Coryphaena equiselis*, or Pompano dolphinfish, and *Coryphaena hippurus* (Linnaeus, 1758), or the Common dolphinfish. Locally known as *"Arayu"*, the common dolphinfish is ranked seventh among commercially important fish species in Batanes from 2009 to 2013 (Morales et al. 2016) and ranked third from 2017 to 2021 (NSAP Data, unpublished). This species is crucial for the tradition and economy of the Batanes community, or the *Ivatans,* as it is a highly valued commodity for commercial, artisanal, and recreational fishing. The demand for the species makes it vulnerable to overexploitation. Therefore, continuous monitoring of the fishery and the implementation of

appropriate management guidelines and measures are essential for the conservation and sustainable utilization of the species.

Several studies have assessed the status of fisheries resources in Batanes. However, information specifically addressing the stock status of Coryphaena hippurus in the area remains limited. This information is necessary to provide policymakers and fisheries managers with a scientific basis for developing appropriate management measures and promoting the sustainable utilization of this stock.

Thus, this study assessed the status of the *"Arayu"* fishery in Batanes Waters and proposed management measures for its conservation. Particularly, it aimed to determine trends in catch and catch per unit effort for the past ten years (2014–2023), CPUE of the most commonly used fishing gears, length distribution, and population parameters.

2. METHODOLOGY

2.1 Study area

The assessment was conducted in Batanes Waters comprising 19 landing sites from the six municipalities of the province, namely: Chanarian, Baluarte, Manichet, and Valugan Port in Basco; Mauyen in Itbayat; Radiwan Port, San Vicente, and Tuhel Port in Ivana; Centro Port, Diura Port, Maratay Port, and Shelter Port in Mahatao; Centro Port, Chavayan Port, Nakanmuan, and Sumnanga in Sabtang; and, Centro Port, Imnajbu, and Itbud Port in Uyugan (Figure 1). The Map was generated using QGIS version 3.38, an open-access mapping software.

Located at 121° 53' East longitude and 22° 20' North latitude and considered the smallest province, Batanes forms the country's northernmost frontier (Morales et al. 2016). It covers about 23,000 hectares and is surrounded by approximately 45,000 hectares of territorial waters, which are abundant sources of fisheries and aquatic resources (DA-BFAR RO2 2006).

2.2 Data collection

Data on *C. hippurus* were collected from the established landing sites in Batanes waters sub-FMA from 2014–2023. Data collection followed the standard methodology of the National Stock Assessment Program (NSAP) (DA-BFAR 2017). Collected data were submitted to the Department of Agriculture - Bureau of Fisheries and Aquatic Resources Regional Office 02 for evaluation, encoding, and analysis. Fork length measurement was used during the collection of length frequencies, where measurement started from the tip of the fish's snout to the center of the fork in the tail, since *C. hippurus* is an oceanic species and highly migratory.

2.3 Annual landed catch

Catch and CPUE trends were assessed by analyzing *C. hippurus* catch within the study period, using data gathered by NSAP enumerators in the fishing ground. The annual nominal CPUE was obtained by dividing the total annual catch of *C. hippurus* by the annual total number of boats landed catching *C. hippurus*.

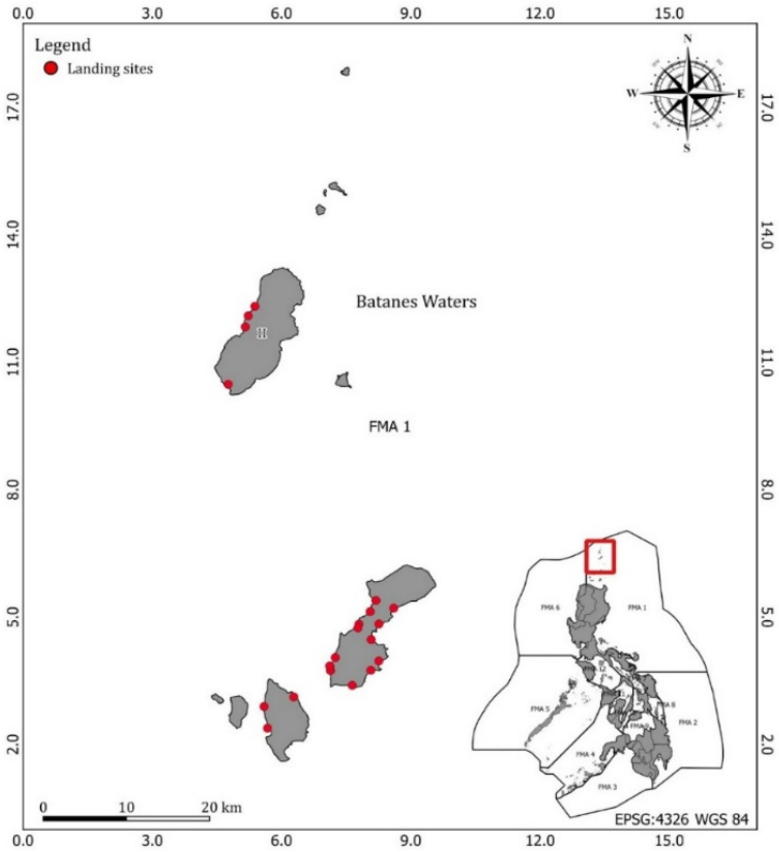

Figure 1. Map showing the landing sites in Batanes Province where the study was conducted.

2.4 Catch contribution by gear

Commonly used fishing gears catching *C. hippurus* were identified, and catch per fishing gear was calculated using an Excel spreadsheet. We estimated percent contribution by dividing the catch per gear by the total landed catch across all gears used, then multiplying by 100.

2.5 Catch per unit effort by gear

Nominal CPUE was computed by dividing the total catch by the fishing effort. We computed nominal data along with other collected data, such as fishing gear, fishing days, and fishing boats, and then processed and standardized them. CPUE standardization was implemented to filter biases in the computed CPUE, as confounding factors may affect the catch rate calculation. The CPUE was standardized as kilograms/boat.

2.6 Catch Maximum Sustainable Yield (CMSY)

The Catch Maximum Sustainable Yield (CMSY) method uses the formula (Palomares and Pauly 2019; Froese et al. 2017).

$$Bt + 1 = Bt + r\,Bt\left(\frac{Bt}{k}\right) - Ct$$

Where Ct was the catch in year t, B = CPUE / q, q was the catchability coefficient. If the CPUE is unknown, a prior range for r was derived from life history traits, a prior range for k was derived from the maximum catch, and the prior ranges for Bt/k (beginning and end of catch time series) were derived from expert knowledge. All r-k combinations that were compatible with the life history traits (r, M, K), catches (Ct), and the expert knowledge (Bt/k) were identified by a Monte-Carlo approach. These new stock assessment methods generate Reference points (RPs) such as biomass, Maximum Sustainable Yield (MSY), fishing maximum sustainable yield (FMSY), and others that fisheries managers highly value for decision-making. Running the data using various tools and models will give more confidence in the results of the data being processed and analyzed in the FiSAT software.

2.7 Population parameters

Population parameters (L_∞, K, M, F, Z, E) were computed and analyzed using length-frequency data grouped at 1 cm intervals and the FAO-ICLARM Stock Assessment Tool (FISAT) designed by Gayanilo and Pauly (1997).

Although data were collected from 2014 to 2023, we restricted the computation and analysis of population parameters to length frequencies collected only for 2022–2023. This limitation arose because the software (FiSAT) cannot process the data due to the limited number of length frequencies collected in the other years. Furthermore, the analysis was based exclusively on catch from troll line gear, as it was the only gear that provided a complete set of length data the software could process.

Length infinity (L_∞) and growth coefficient (K) values were estimated using the ELEFAN routine embedded in FISAT II, with the assumption that the body growth followed the von Bertalanffy growth equation (Gayanilo et al. 2005) using the formula below:

$$L(t) = L_\infty\,[\exp(-K(t-t0))]]$$

where L(t) is the length at age t, L∞ is the asymptotic length, K is a growth coefficient, and t0 corresponds to the theoretical age at which the fish length is zero. The growth curve that passes through the highest number of peaks in the distribution of length frequencies fits the ELEFAN routine (Pauly 1984). Gayanilo et al. (2005) reported that a computer automatically determined the goodness-of-fit index (Rn). The standard growth index (Φ), used in measuring the overall growth performance (Pauly and Munro 1984), is defined as:

$$\Phi' = \text{Log10}(K) + 2L_\infty g10(L_{oo})$$

Pauly's (1984) equation tmax = 3/K was used to calculate species longevity. The theoretical age at length zero (t_0) was estimated using Pauly's (1979) empirical equation:

$$\text{Log}_{10}(-t_0) = 0.392 - 0.275\,\text{Log}_{10}(L_{oo}) - 1.038\,\text{Log}_{10}(K)$$

The estimated total mortality from the length-converted catch curve using the growth parameters yielded by the von Bertalanffy growth (VBGF) equation. The formula below was used in constructing the linearized length-converted catch:

$$\text{Ln}(Ni/\Delta) = a + b\,ti$$

Wherein, Ni is the total number of individuals in length class i, Δ t is the period in which the fish grows through length class i, and t is the relative age (computed with $t_0 = 0$) which corresponds to the midlength of class i. The slope (b) of the curve, with its sign changed, gives Z. Extrapolate the regression lines to approximate the capture probability at a given natural mortality (M). The following empirical equation of Pauly (1980) provides an option to estimate this value using FiSAT II:

$$\text{Log10}(M) = -0.0066 - 0.297\,\text{Log10}(Loo) + 0.6543\,\text{Log10}(K) + 0.463\,\text{Log10}(T),\ SD(\text{Log}\,M) = 0.245$$

Where the annual habitat temperature (°C) was presented as (T), with a value equal to 27°C (Djidohokpin et al. 2017). Pauly (1980) suggested this method for estimating M, and it is widely used throughout the tropics, especially when reliable catch and effort data and several years of Z values are not available. Fishing mortality (F) was derived by subtracting M from Z. Exploitation rate (E) was derived using the formula E = F/Z. The recruitment pattern of the stock was determined by backward projection along the length axis of the available length-frequency data, as described in FiSAT II.

2.8 Length-Based Spawning Potential Ratio (LBSPR)

To verify the results obtained in the FiSAT, data were also run using the Length Based Spawning Potential Ratio (LBSPR) Tool in the Barefoot Ecologist toolbox designed by Hordyk et al. (2015).

3. RESULTS

3.1 Annual landed catch and CPUE

Figure 2 presents the annual catch and CPUE trend of *C. hippurus* in Batanes waters sub-FMA during the study period. Over the 10-year period, historical catch fluctuated, with abrupt declines in 2016 and 2020; however, catch and effort increased slightly.

3.2 Catch contribution per gear

Four (4) types of fishing gear were recorded as commonly used to catch *C. hippurus* in the area (Figure 3). Troll line (TL) was observed to be the most dominantly used fishing gear, contributing 97.14%, followed by simple handline (SHL) with 1.45%, gillnet (GN) with 0.87%, and multiple handline (MHL) with 0.55% catch contribution.

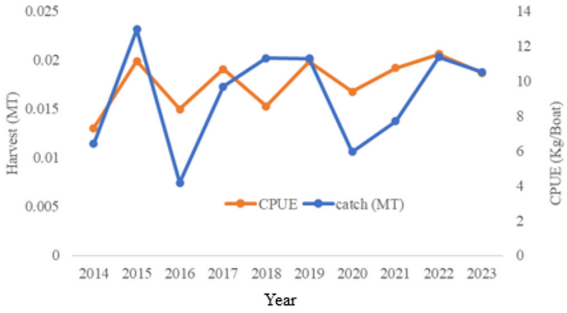

Figure 2. Annual landed catch and CPUE trend of *Coryphaena hippurus* in Fisheries Management Area 1 Batanes Waters sub-FMA (2014–2023).

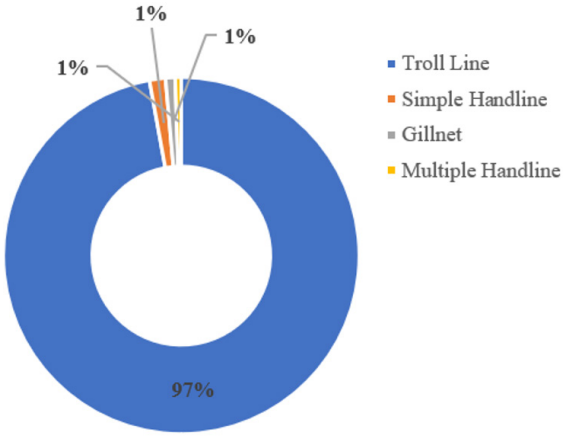

Figure 3. Catch contribution by gear catching *C. hippurus* in Fisheries Management Area 1, Batanes waters Sub-FMA (2014–2023).

3.3 Catch per unit effort of major fishing gears

Figure 4 shows that the majority of the reported catch of *C. hippurus* in the area was attributed to troll line and simple handline fishing methods throughout the study period. The troll-line-associated catch fluctuated. However, catch per unit effort peaked in 2016 and 2018 at 493 kg and 495 kg per boat, respectively, while CPUE was lowest in 2023 at 356 kg per boat. On the other hand, SHL showed an increasing catch trajectory from 2014 to 2022,

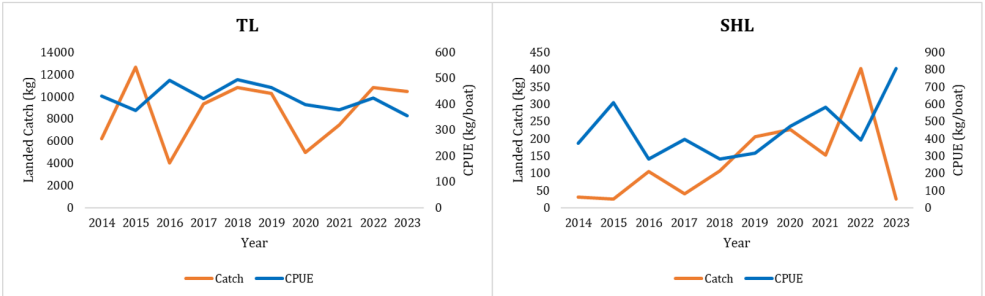

Figure 4. Annual catch and standardized CPUE (kg/boat) of dominantly used fishing gears catching *C. hippurus* in Fisheries Management Area 1 Batanes Waters sub-FMA (2014–2023).

followed by a marked decline in 2023. The CPUE for SHL was shown to fluctuate, with its peak recorded in the year 2023 (805 kg per boat) and the lowest in the year 2018 (281 kg per boat).

3.4 Catch Maximum Sustainable Yield (CMSY)

Ten (10) years of historical catch and CPUE data for all gears were also processed in CMSY to validate the results obtained from the FiSAT Software. The CMSY results (Figure 8) showed that the maximum sustainable yield for *C. hippurus* has not yet been met. Notably, the MSY (0.0107 MT) was met in 2015, then in 2017-2018 and 2022-2023. In contrast, biomass remains above the target reference point (B=1) and continues to increase. The biomass results also align with the CPUE results in this study. The CMSY results ultimately conclude that the stock status is still healthy, with a B/Bmsy of 1.46 in the last year, and report a 96.7% chance that the stock will remain healthy. This conclusion regarding stock health strongly contrasts with the high exploitation ratio (E=0.85) derived from the FiSAT length-based analysis.

3.5 Population parameters

This study assessed only the population parameters of the troll line, as it is the only gear that provides a complete set of length data the analysis software could process. Table 1 shows the growth parameters for *C hippurus,* which has an asymptotic length (L_∞) of 154 cm FL, a growth coefficient (K) of 0.85 in year$^{-1,}$ and a performance index of 4.28. The recorded length ranged from a minimum of 22.5 cm FL to a maximum of 142 cm FL.

3.5.1 Mortality estimates

The natural mortality rate (M) of *C. hippurus* in Batanes waters was 1.02 year^{-1} at an annual average temperature of 28°C. The fishing mortality rate (F) was 5.89 year^{-1}, with a total mortality rate (Z) of 6.91 year^{-1} (Figure 5).

Table 1. Growth parameters of *Coryphaena hippurus* in Batanes Waters sub-FMA.

Growth Parameters	Values Obtained
Length Infinity (L_∞)	154 cm FL
Growth Coefficient (K)	0.85 year^{-1}
Growth Performance Index (Ø)	4.28

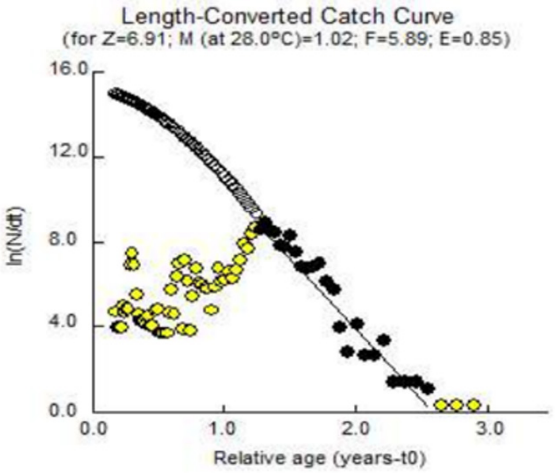

Figure 5. Mortality estimates of *C. hippurus* in Fisheries Management Area 1 Batanes Waters sub- FMA (2022-2023).

3.5.2 Recruitment pattern

Recruitment pulses indicate the frequency of young recruits available in the fishing ground within a year. In the present study, *C. hippurus* showed a bimodal recruitment pattern with almost equal peaks. The major recruitment peak occurs in the months of April-June, and the secondary peak occurs in September to October (Figure 6).

3.6 Exploitation rate and relative yield per recruit (Y'/R)

The Beverton and Holt model (Figure 7) calculated the maximum sustainable yield exploitation rate (E_{max}) at 0.405. The calculated current exploitation rate (E_{cur}) derived from the mortality estimates (Z=6.91, F=5.89, M=1.02) is 0.85. Despite

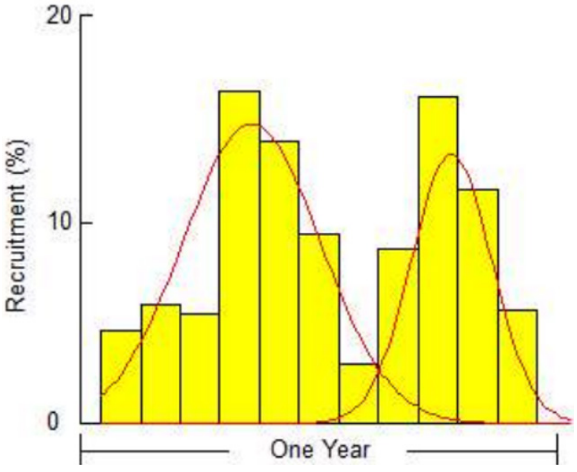

Figure 6. Recruitment pattern of *C. hippurus* in Fisheries Management Area 1 Batanes Waters sub- FMA (2022-2023).

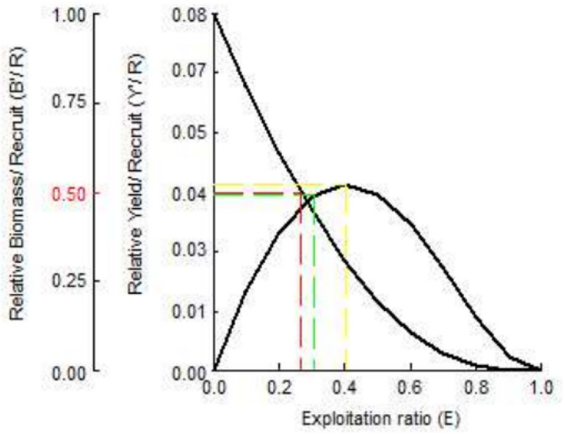

Figure 7. Yield per Recruit (Y'/R) of *C. hippurus* in Fisheries Management Area 1 Batanes Waters sub- FMA showing the E10=0.794, E50 =0.195 and Emax=0.403

the calculated E_{cur} (0.85) being more than double the E_{max} (0.405), which suggests severe overexploitation beyond optimal levels (E_{opt}=0.5 per Gulland (1971) and E_{opt}=0.4 per Pauly (1987), the current relative yield per recruit (Y'/R_{cur}) was 0.012, which is reported to be only 0.006 less than Y'/R_{max}. This small reduction in yield relative to the extreme exploitation rate warrants further investigation.

3.7 Length-Based Spawning Potential Ratio (LBSPR)

Using the Barefoot Ecologist toolbox, we also computed the LBSPR of C. hippurus to assess reproduction, recruitment, and stock sustainability. The length frequency distribution by year, with their corresponding LBSPR model fits, shows a modal length of 110-120. Figure 9 shows the four (4)- year maturity data and selectivity model. The results indicated that *C. hippurus* are harvested after they mature or after the species' spawning period. The M/K value (1.2) is higher than 0.53, indicating that the specimens used in this study are mature, with a length composition of widely varying sizes and near-asymptotic length. Fishing pressure (F/M) ranges 18.93-19.25 from 2020 to 2023. SPR values were 44% in 2020 and 2021 and 43% in 2022 and 2023 (Table 2). These values are already above the target reference point of 40%. The estimated SPR value based on length frequency in the current year was 43% (Figure 10).

4. DISCUSSION

Fluctuating catch and the increasing CPUE trend of *C. hippurus* in the Batanes Waters were affected by various factors, including environmental,

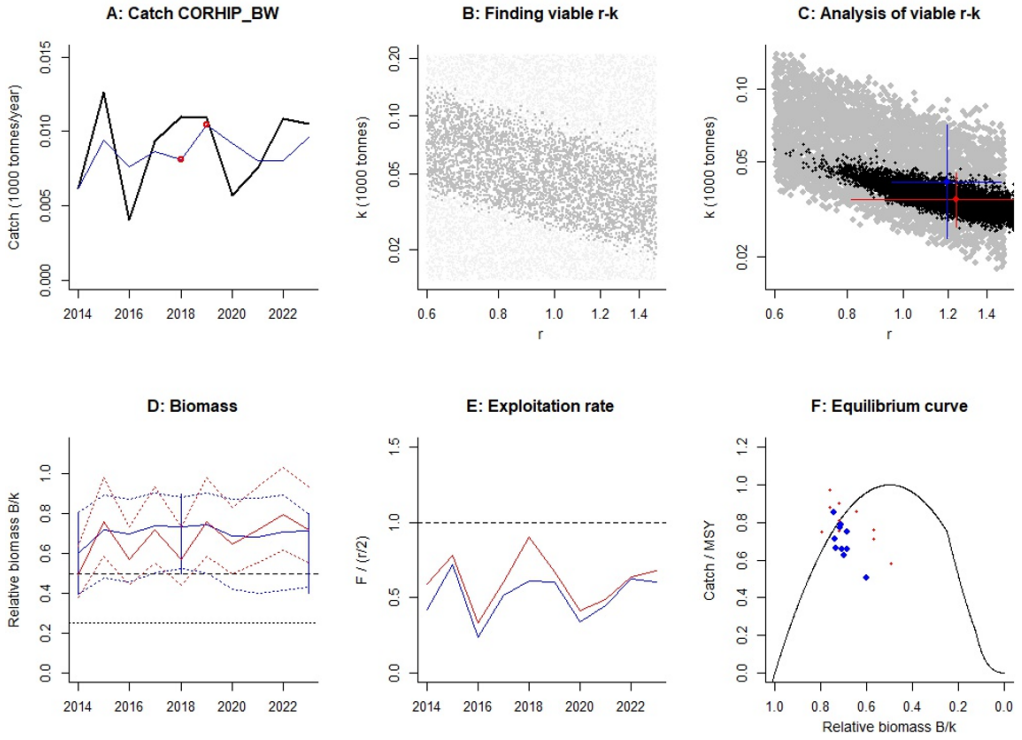

Figure 8. Result of Catch Maximum Sustainable Yield (CMSY) computation in Fisheries Management Area 1 Batanes Waters sub-FMA (2014–2023).

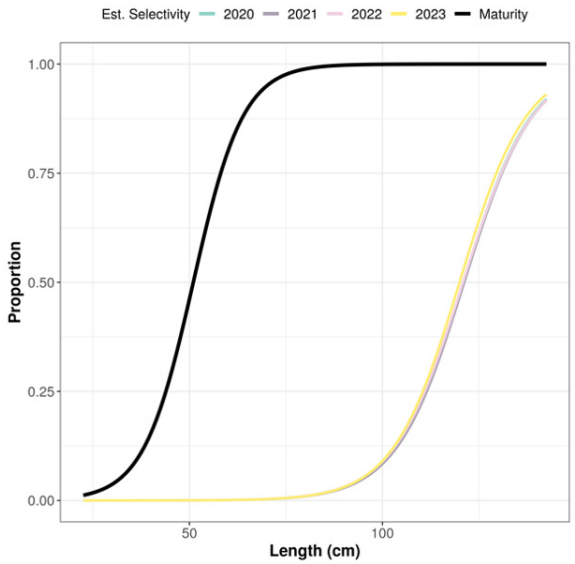

Figure 9. Selectivity size of fishing gears catching *C. hippurus* in Fisheries Management Area 1 Batanes waters sub-FMA in 2022.

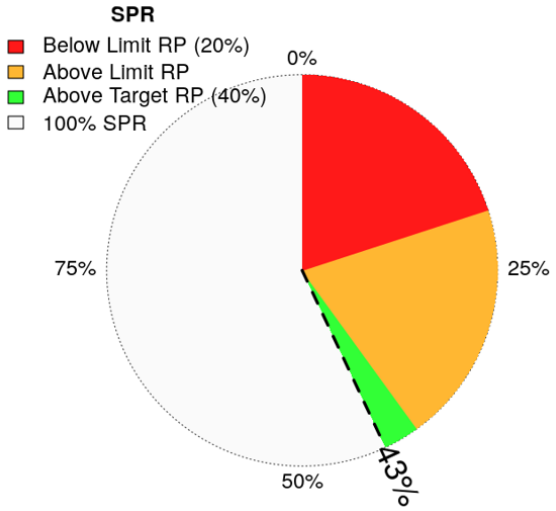

Figure 10. Percentage of *C. hippurus* spawning potential ratio (SPR) in Fisheries Management Area 1 Batanes Waters sub-FMA in 2022.

cultural beliefs and norms, biological, and socio-economic factors, during the four-year study period. In addition, frequent typhoons and unfavorable weather that devastated the area, including the destruction of fishing boats and fishing gear used by fishers, may explain the decline in recorded landings (Casco et al. 2021) in some years. High fuel and other fishing input costs also affected fishing operations. The lowest catch observed in 2016 may be due to strong typhoons that greatly affected the province, damaging fishers' livelihoods, including their boats and fishing gear. In particular, Super Typhoon Ferdie (international name: Meranti) made landfall in the province in September 2016, causing estimated damage of PHP 244.6 million (NDRRMC 2016). Additionally, catch declined significantly in 2020 because the lockdown reduced boat landings in the province. In 2020, the World Health Organization (WHO) announced the progression of COVID-19, leading to a global pandemic that disrupted fishing operations. A slight increase in reported catch was observed in 2021 and 2022 after ECQ was lifted, showing that fisherfolk slowly resumed fishing after the restrictions were lifted.

Further, the geographic isolation of Batanes – composed of small, mountainous islands separated from mainland Luzon by the Balintang Channel and Bashi Channel – naturally limits access and shields local fisheries from large-scale commercial exploitation (Mangahas 2010). This is also coupled with the natural closed season occurring in the fishing ground. The province has limited market demand for marine resources, where most catch is locally consumed rather than exported; the isolation helps prevent overfishing and protects marine ecosystems. The small-scale, municipal handline fisheries operated by the *Ivatan* fishers primarily use simple gear like *"panayrin"* and *"payavayang"*, further reinforcing sustainability by keeping catch volumes modest and aligned with local ecological capacity (Obar et al. 2021). Additionally, traditional management practices, such as rituals, taboos, and seasonal constraints, could also help limit fishing pressure on *the C. hippurus* population.

The study reports a high Fishing Mortality ($F = 5.89$ year^{-1}) that is almost five times the Natural Mortality ($M = 1.02$ year^{-1}), leading to an exploitation rate ($E = 0.85$) that indicates the species is exploited beyond sustainable levels. However, this result must be viewed within the context of the increasing CPUE and biomass trend observed from 2014 to 2023, and the healthy Spawning Potential Ratio (SPR) of 43%, which stands above the 40% Target Reference Point (TRP).

The critical inconsistency between the high exploitation rate (E=0.85) and the healthy SPR (43%) is likely linked to the methodological limitations. The population parameters were based solely on troll line data. Troll lines are highly selective gear, and their catches, concentrated in nearshore fishing areas, predominantly consist of smaller individuals. This reliance on a size-biased sample from a restricted area means the high mortality and exploitation estimates calculated for 2022–2023 may reflect only the intense

pressure on the nearshore juvenile component of the stock and do not represent the entire species population.

The asymptotic length attained in the current study falls within the range of L_∞ values derived from Calicdan et al. (2018) in Babuyan Channel (140.7 cm to 225.75 cm), while a higher K value was obtained. Similarly, Benjamin and Kurup (2012) reported a higher L_∞ value for the same species in India (194.25 cm) but a lower K value of 0.40 $year^{-1}$. The growth performance index obtained in the current study is close to that in Fishbase. These variations in length infinity and growth could be attributed to environmental factors such as temperature, nutrient availability, and seasonality. Fishing mortality (F) values in this study were calculated to be almost five times the calculated natural mortality (M). This indicates that *the C. hippurus* species is experiencing high fishing pressure.

Meanwhile, the bimodal pattern of recruitment of *C. hippurus* in Batanes Waters is similar to the recruitment pattern observed in Babuyan Channel, wherein there were also two recruitment peaks recorded - a major pulse was recorded from March to May, while a minor pulse was also recorded from August to September (Calicdan et al. 2018) and April and August to September (Casco et al. 2021). Benjamin and Kurup (2012) showed that during a single spawning season, dolphinfishes are also capable of reproducing several times. Recruitment patterns commonly consist of two pulses because the Philippines lies in a tropical region, meaning two pulses of stock-recruit are equivalent to two different cohorts in a year. Each recruitment pulse is identified as weak, strong, or equal (Mesa et al. 2018).

The exploitation rate generally indicates that the species has been exploited beyond the sustainable level. The current exploitation (E_{cur}) is 0.85, which is higher than the optimum exploitation (E_{opt}=0.5) as in Gulland (1971) and E_{opt} =0.4 as in Pauly (1987).

The length data for individual specimens were sourced from catches obtained from troll lines. These gears are highly selective, resulting in catching size ranges predominantly between 22.5 cm and 142 cm fork length (FL). According to Alvarez (Pers. Com. 2025), the hook size utilized in troll line fishing ranges from 8/0– 11/0, typically operating in nearshore areas at depths of approximately 150–200 meters. This restricted operational range may help explain why the exploitation ratio in this study exceeds the sustainable level.

Additionally, fisheries in Batanes predominantly exploit nearshore areas, where most catches consist of smaller individuals. It can be inferred that larger species of *C. hippurus* are primarily located in the high seas due to their migratory behavior, and the juveniles are found more frequently in the nearshore areas where fishers mostly operate. Likewise, the Kuroshio Current in the fishing ground may significantly affect the observed size distribution. Research on bluefin tuna, a similarly migratory species, shows that temperature fluctuations associated with the Kuroshio Current affect the habitat preferences of smaller bluefin tuna, which tend to inhabit coastal waters along the current's trajectory (Fujioka et al. 2018). Comparable patterns in size distributions have been documented in the Babuyan Channel fishing ground where fishing activities are concentrated in nearshore areas (Casco et al. 2021).

The SPR, on the other hand, is defined as the current egg production of the fished stock relative to the maximum potential egg production at unfished stock levels (Hordyk et al. 2015). It represents the proportion of the unfished reproductive capacity remaining at any specified level of fishing pressure. The SPR is widely acknowledged as an essential tool in fisheries management, addressing recruitment overfishing by ensuring that a sufficient number of individuals remain in the population to survive, reproduce, and replenish stocks at sustainable levels (Silvestre et al. 2020). The computed SPR for *C. hippurus* is 43%, which is 23% above the 20% limit reference point and exceeds the 30% precautionary threshold needed to maintain stock sustainability. This suggests that a substantial portion of the caught stocks had achieved reproductive maturity at least once and contributed to recruitment before being caught.

5. CONCLUSION AND RECOMMENDATIONS

Coryphaena hippurus in the Batanes waters sub-FMA is a commercially important species and is mainly exploited by artisanal fishers. Increasing catch and CPUE could be due to various factors (i.e., biological, environmental, health, socio-economic, beliefs and norms). While the current exploitation ratio (E=0.85) is calculated to be beyond sustainable levels based on localized length data, the increasing trend of CPUE and biomass, along with the healthy spawning potential ratio (43%), suggests there are complexities in the population dynamics of the species. The selective nature of the troll line gear and the concentration of fishing operations in nearshore areas resulted in a predominance of smaller individuals in the catch. Thus, these mortality estimates are heavily

influenced by the pressure on this localized component of the stock. The Kuroshio Current may also further complicate size distribution patterns, underscoring the need for a nuanced understanding of the species' behavior and habitat preferences.

Given that the calculated exploitation rate is already unsustainable, the recommendation to acquire larger fishing vessels to enable fishers to operate in offshore waters and target larger specimens should be approached with caution. While larger fishing vessels may provide access to offshore fishing grounds and potentially larger fishes, the sustainability of the fishery, the potential risk of increasing fishing pressure on the stock should also be considered. This potential increase in overall fishing capacity could negatively affect the entire stock if the high exploitation rate observed in nearshore areas reflects underlying stock vulnerability. Therefore, the traditional fishing practices (*Mataw fishing*) of *C. hippurus* should be encouraged, promoted, and preserved to ensure the sustainability of the resource. In addition, migration and connectivity studies should be conducted first to determine whether juveniles primarily inhabit the nearshore areas where current fishing effort is concentrated. This will enable the science managers to formulate better plans and policies for maintaining the population of *C. hippurus* in the fishing ground. Furthermore, a reproductive biology study should also be conducted to determine the species' maturity, as most captured individuals are only half the species' asymptotic length and may already contribute to the population at these small sizes.

Seasonal closure for the species is not a viable option since the fishing grounds have their natural close season where fishing days are only concentrated during summer months and limited to no fishing operations during colder months, particularly during the northeast monsoon. Enhance monitoring and data collection to improve the collected fisheries data that can be used to establish adaptive management strategies. Established Marine Protected Areas to protect the habitat to increase productivity, and ensure the long-term sustainability. Formulate a Harvest Strategy Plan to establish fisheries management measures for the protection and conservation of the *C. hippurus* population. Lastly, engage fishers and local communities, and stakeholders in raising awareness about the importance of sustainable fishing and conducting studies for dolphinfish.

ACKNOWLEDGMENT

The authors would like to acknowledge the technical and financial support of the Department of Agriculture - National Fisheries Research and Development Institute (DA-NFRDI) and the Department of Agriculture – Bureau of Fisheries and Aquatic Resources Regional Fisheries Office No. 2 (DA-BFAR RFO 2). The authors also extend their sincere appreciation to the technical data enumerators of Batanes Province for their dedication, diligence, and invaluable contributions in the collection of fisheries data essential to the successful completion of this research.

AUTHOR CONTRIBUTIONS

Villarao MC: Supervision, Conceptualization and design of study, Analysis and/or interpretation of data, and Revision. **Antonio LA**: Acquisition of data, Analysis and/or interpretation of data, Writing-Original draft preparation, and Revision. **Encarnacion AB**: Supervision, Conceptualization, and design of the study. **Flores NAL**: Analysis and/or interpretation of data and Revision. **Adversalo GB:** Acquisition of data, Analysis and/or interpretation of data, and Revision.

CONFLICTS OF INTEREST

The authors declare no actual, potential, or perceived conflict of interest for this study.

ETHICS STATEMENT

The authors affirm that all international, national, and institutional guidelines for the care and use of laboratory animals have been diligently followed and adhered to throughout this study.

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