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Population Status of Napoleon Wrasse (*Cheilinus undulatus*) at Bando Island, West Sumatra

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Abstract: The Pieh Marine Protected Area (MPA) in West Sumatra serves as a critical habitat for the endangered Napoleon wrasse (*Cheilinus undulatus*), a species listed under CITES Appendix II and nationally protected in Indonesia. Reports from local communities suggested the reappearance of this species at Bando Island after years of presumed absence. This study aims to assess the current status and potential recovery of Napoleon wrasse populations within the island's core conservation zone. Field surveys conducted in June 2024 used a GPS-based underwater visual census (UVC) to estimate population density and theoretical stock size. Two individuals a juvenile (~20 cm) and an adult (~60 cm) were recorded along a total transect area of 6.64 ha, resulting in a density of 1 individual/ha and a theoretical stock of 0.035 individual across the island's 28 ha coral reef area. Habitat assessment revealed moderate live coral cover (40%) and high substrate heterogeneity, including dead coral, rubble, and sand, which provide structural complexity, favourable for reef fish. However, the observed density falls within the "very low" category of the national conservation scale, indicating a severely depleted population. These findings suggest that despite suitable habitat conditions, the Napoleon wrasse population remains critically low and functionally vulnerable. Immediate conservation actions such as establishing no-take zones, restoring coral habitats, enhancing monitoring, and regulating the live reef fish trade are recommended to enable natural recolonization and recovery of this iconic species within the Pieh MPA.

Keywords: CITES; population density; marine protected area; theoretical stock

INTRODUCTION

The Pieh Island Conservation Area and its surrounding sea is an important habitat for marine resources. Apart from corals and other invertebrates fish is an important resource, also from an economical point of view. Previous studies (Kunzmann *et al*., 1999) how a wealth of different fish species in this area. However, over the years, fish populations decreased and there are a few species, that can already be categorized as rare and endangered fish. One of the most endangered species is Napoleon fish (*Cheilinus undulatus*). From an economic point of view, this fish has been extremely important as a leading commodity with high economic value. Unfortunately, the high demand in the live-reef-fish-trade in Hongkong, Singapore and other trading places, has led to uncontrolled use of destructive fishing methods (Barber and Pratt, 1997) directed at Napoleon and Grouper (various species of *Epinephelus* and others). Cyanide fishing in Southeast Asia, and particularly also in remote areas of Indonesia such as West Sumatra, has almost led to the extinction of Napoleon fish. While back in 1992/3 a resident pair of Napoleon from Pieh Island has been reported (Kunzmann, 1997) no occurrence has been reported after 1998.

Napoleon fish (*Cheilinus undulatus* Rüppell 1835) is a reef fish species that is distributed in the tropical Indo-Pacific. It belongs to the Labridae family, is long-lived can reach the age of 25 years for males and 32 years for females; measuring up to 2 m in length and a body weight of 190 kg

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Journal of Marine Research Vol 15, No. 1 Februari 2026, pp. 146-156

(Sadovy *et al.*, 2007). Adult fish tend to be in outer reef slope habitats, while juvenile-phase small fish generally reside on inshore coral reefs. The preferred diet is a variety of invertebrates, some fish, and the coral-eating starfish *Acanthaster plan*cii (Sadovy *et al.*, 2003). In addition, Napoleon fish are protogynous hermaphrodites and reach sexual maturity only at the age of 5-7 years (Rahman and Syam, 2015). Due to its slow growth, long lifespan and delayed reproduction, it is expected that a population increase of Napoleon fish would take many years.

In order to provide data on protected fish species, especially Napoleon fish, LKKPN Pekanbaru as the manager of the Pieh Island National Conservation Area has started investigations into potential recovery of fish populations. LKKPN has received reports from community groups regarding the presence of Napoleon fish in the Conservation Area, namely at Pulau Bando. There are no other studies about the Napoleon population in West Sumatra waters, studies from within the Pieh Conservation Area date back to 1992.

The strong decline of Napoleon fish populations has led the Indonesian government to restrict its utilization. The Ministry of Maritime Affairs and Fisheries (MMAF) issued the decree Number 37 of 2013 concerning the determination including the protection status of Napoleon fish. Therefore, in accordance with the mandate in Government Regulation No. 60 of 2007, LKKPN Pekanbaru as part of MMAF is obliged to collect data in order to protect animals included in the CITES Appendices, so that their utilization can be controlled. The potential existence and/or re-occurence of Napoleon fish in the area has an important value both in terms of conservation and economics. Up to date there are no detailed data about numbers, sex and distribution area. In order to obtain a more in-depth data collection, direct field observations were started (LKKPN Pekanbaru, 2024). Therefore, the major aim and objective of this study are to identify and quantify the status of Napoleon fish in the waters of the Pieh Conservation Area.

MATERIALS AND METHODS

The Napoleon fish data collection in the Pieh Island Conservation was carried out at Bando Island on June 26th, 2024 at high tide with beginning low tide conditions, using the GPS Density Survey. To minimize bias, surveys were conducted under clear-water conditions with a minimum visibility of 10 meters and during daylight hours between 08:00 and 14:00 local time. The collected data were then analysed to determine the density (individuals/ha) and encounter the frequency of Napoleon wrasse at each observation station. This data collection method refers to the density calculation method for reef fish. Collin (2005) modified the technique by sweeping a wider area and using a GPS-Floating Kit, where with this tool the determination of the transect area can be calculated based on the coordinates recorded by GPS and likewise the position of Napoleon fish encountered during the census can be determined according to the time (hour) the fish was found (Edrus and Sulman, 2013).

The GPS density survey method can be conducted using SCUBA diving equipment and performing an Underwater Visual Census (UVC). The UVC method is fast, accurate, effective and environmentally friendly and conducted in pairs (buddy system). The distance between the divers, along with the visual range of the first diver to the left and the second diver to the right, was used to determine the survey area. Thus, the surveyed area was calculated as the total transect width (the sum of the divers' visual ranges to both sides plus the distance between them) multiplied by the transect length. Each diver recorded the number of Napoleon wrasses observed within the census area, along with estimated total length and notable behaviours. Observations were conducted at depths ranging from 3 to 15 meters in coral reef habitats identified as potential areas for Napoleon wrasse occurrence. If the visibility of the observer on the left is 10 meters and on the right is 10 meters, the width of the census area is 25 m. The start and end points of the visual census are always determined and recorded in hours, minutes, seconds, to determine the length of the track (Edrus *et al.*, 2012) (Figure 1).

To calculate the density of Napoleon fish, data from field observations were recorded on a waterproof slate first in tabular form and then transferred into a spreadsheet using MS Excel. The fish density was then calculated using the formula from Edrus and Sulman (2013):

Journal of Marine Research Vol 15, No. 1 Februari 2026, pp. 146-156

$$Di = \frac{Xi}{ni}$$

Note: Di = Density of Napoleon wrasse (individual/ha) in the i-th surveyed area; Xi = Total number of Napoleon wrasse individuals recorded across all transect plots within the i-th surveyed area; ni = Total area of census transects observed in the i-th surveyed area (ha).

Assuming a more or less even distribution and similar habitat conditions, the theoretical Napoleon fish stock size can be determined if the density is calculated for the total area of the coral reef (N) (Edrus and Sulman, 2013), with the formula:

$$S = \frac{Di}{N}$$

Note: $S =$ Theoretical stock or total number of Napoleon wrasse individuals in the i-th area (individuals); Di = Density of Napoleon wrasse (individual/ha) in the i-th surveyed area; N = Total coral reef area of the i-th surveyed site (ha)

RESULTS AND DISCUSSION

The monitoring was conducted around Bando Island (Table 1) and divided into three survey tracks (Table 2; Figure 2) in accordance with the general guidelines for fish data collections (Edrus *et al*., 2012). The combined length of all three survey tracks is 2,656 m, covering 66407 m^2 (6.64 Ha). Along these three tracks only 2 individuals of Napoleon were counted, one juvenile estimated at 20 cm length and one adult estimated at 60 cm length. According the formulas above this results in a Napoleon density of 1 individual/ha. Consequently, the theoretical stock size of entire Bando island would be 0.035 individuals.

Two Napoleon individuals were found at Bando Island, within Track 1, with one juvenile specimen of 20 cm length on the reef roof, while the adult specimen of about 60 cm was found on the reef slope. This is in accordance with Edrus and Sulman (2013), who report that Napoleon fish have different habitats according to the age phase of this fish. The young and juvenile phase is more

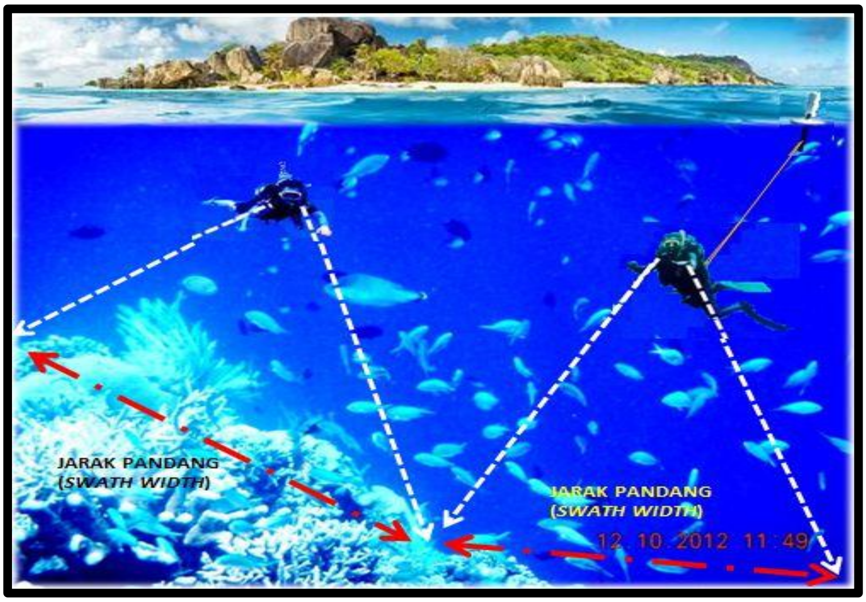

Figure 1. Underwater Visual Census method according to Edrus and Sulman (2013).

Table 1. Napoleon fish census at Bando Island

Category	Value
Start time 26.6.24	10:38:30 AM
End time 26.6.24	14:49:30 PM
Width of census	25 m
Combined length of census	2656.27 m
Combined area of census	66406.79 m^2 (6.64 Ha)
Total coral reef area	28.42 Ha

Table 2. Track data during Napoleon fish census at Bando Island, Pieh Conservation Area, West Sumatra. DC = dead coral, LC = live coral, R = rubble, SP = sponge, O = other biota

Track	Total length (m)	Total width (m)	Cumulative area (m^2)	Cumulative area (Ha)	Reef Position	Coral reef status	Fish count	Fish size (cm)	Fish density (In/ha)	Stock estimation
1	798.95	25	19973,64	1,9974	Reef roof & reef slope	30% DC, 40% LC, 10% R, 5% Sp, 10% S & 5% O	2	20 (cm) Juvenile and 60 (cm) Adult	1	0,035
2	1241.67	25	31041.80	3,1042	Reef roof & reef slope	25% DC, 55% LC, 5% R, 5% Sp, 15% S & 5% O	0	0	0	0
3	615.65	25	15391.34	1,5391	Shoreline & reef slope	45% DC, 30% LC, 5% R, 5% Sp, 10% S & 5% O	0	0	0	0

commonly found nearshore or in caves or cracks, while the older phase generally favours areas outside the reef, facing the open sea, or the reef slope. The difference is also a matter of the shallowness or depth of the waters of their habitat. The fingerlings live on reef tops, filled with hard

Journal of Marine Research Vol 15, No. 1 Februari 2026, pp. 146-156

and soft corals and other marine life, such as macroalgae and seagrasses. Juvenile Napoleon live at a depth of ± 2-3 meters (Figure 2; 3). As they mature, young Napoleons can be found on the surface of branching corals. Adult Napoleons generally live in deeper places and are more easily spotted by divers on the edges of reef slopes or on steep reef walls.

The distinction between juvenile and adult reef fish habitat utilization has significant implications for marine conservation strategies. Juvenile reef fishes typically inhabit shallow reef flats or reef roofs characterized by high structural complexity, abundant shelter, and food availability, which serve as essential nursery and recruitment areas. These habitats provide protection from predators and promote early growth and survival (Moustaka *et al*., 2024). In contrast, adult individuals are often associated with deeper reef slopes, where they perform key ecological functions such as reproduction, territory establishment, and foraging (Costa *et al*., 2014; Hill *et al*., 2025). This ontogenetic habitat shift indicates that effective conservation planning, particularly in the core zones of marine protected areas, must encompass both shallow and deep reef habitats. Protecting only one depth range risks disrupting life-cycle connectivity and reducing the replenishment potential of reef fish populations. Previous studies have emphasized that multi-scale habitat protection covering diverse geomorphological and depth-related zones is essential for maintaining fish diversity and assemblage stability (Dahlgren and Eggleston, 2000; Sievers *et al*., 2024). Therefore, core zones should be designed to include shallow nursery habitats that support early developmental stages as well as deeper zones that sustain adult spawning stocks, ensuring full life-cycle protection and long-term population resilience.

Adult Napoleons can live up to 100 meters deep and occupy caves or cracks in the coral wall, when they feel threatened (Edrus and Sulman, 2013). Most of Bando Island's waters consist of extended reef tops and reef platforms and a steep reef slope. Surrounding Bando Island are three Conservation Area zones. Track 1, where the Napoleon fish were found, is a core zone area with fairly good coral reef conditions with a live coral cover (LC) value of 40% (Table 2). Using a rapid survey method for coral reefs, 30% dead coral, 10% rubble, 5% Sponge, 10% sand and 5% other biota were found. A mixture of sand, coral, other fauna and chunks of dead coral and broken corals are a typical Napoleon fish habitat. The most preferred reef pattern for napoleon fish is the reef slope that leads to the reef wall (drop off).

Napoleon fish swim between the reef crest and the reef wall, sometimes retreating deeper when facing threats (Syam, 2014). Although Track 1 exhibits a lower percentage of live coral cover (LC) compared to Track 2 and Track 3, it shows a more heterogeneous substrate composition consisting of live coral (LC 40%), dead coral (DC 30%), rubble (10%), sand (10%), and other organisms (5%). This substrate diversity creates higher structural complexity and provides multiple microhabitats for reef-associated fish. These microhabitats function as shelters for juvenile fish, foraging areas, and movement spaces for adult fish (Beese *et al*., 2023). Although having higher LC percentages, Track 2 and Track 3 display more homogeneous substrate conditions. Such uniformity leads to reduced topographic complexity and, consequently, fewer ecological niches for fish utilization. Structural complexity loss has been strongly correlated with decreased fish density and species diversity (Fakan *et al*., 2023).

In addition, the ecological position of each habitat also plays a crucial role. Track 1 is located within a transitional zone between the reef roof and reef slope, an area characterized by stable hydrodynamics and enhanced nutrient availability. This transitional habitat serves as an ideal refuge for juvenile reef fish before they migrate to deeper areas (Bellwood *et al*., 2024). In contrast, Track 3, situated closer to the shoreline and reef slope, may experience increased sedimentation, variable salinity, and anthropogenic disturbances that decrease habitat quality (Moustaka *et al*., 2024). These findings emphasize that fish presence is not solely determined by the percentage of live coral cover, but also by the heterogeneity of substrate composition and ecological positioning of the habitat. This aligns with recent global research indicating that three-dimensional habitat complexity and substrate diversity (live coral, dead coral, sand, rubble) are key determinants of reef fish community structure (Ferreira *et al*., 2025). Thus, even though LC percentage in Track 1 is lower, the higher habitat heterogeneity makes it a more suitable environment for fish occurrence compared to the other tracks.

Journal of Marine Research Vol 15, No. 1 Februari 2026, pp. 146-156

Napoleon density on Bando Island was found to be only 1 individual/ha. The maximum density of adult Napoleon recorded so far is no more than 10 individuals per hectare (Sadovy, 2007). Naturally, Napoleon densities are low in all types of waters, whether in low, medium or high exploitation waters or in pristine waters, even in conservation areas and in their preferred habitat (Gillett, 2010). Many studies on the population and density of Napoleon fish have been conducted in various regions in Indonesia. Studies using the UVC method, such as in Raja Ampat Regency, Meos Mansuar Subdistrict in March 2012 and Misool Southeast Subdistrict in March 2013, have each found Napoleon fish with a density of 3.35 fish per hectare for a total UVC census track of 15.73 km and 2.8 fish per hectare for a total UVC census track of 26.1 km (PSPL Sorong Institute, 2013). In addition, there was also research conducted in South Sulawesi in the Sinjai and Bone regions in 2013 and found that the density of Napoleon fish in Sinjai ranged from 0-4 individual/ha (Syam, 2014). There is also research on the status (Table 3) of Napoleon fish populations in the waters of Buton and Wakatobi regencies, classified in the critical category with moderate density levels, respectively 0.76 and 0.93 individual/ha (Edrus and Handoko, 2017).

In the study conducted by Roe *et al*. (2022) in Laamu Atoll, Maldives, after nearly three decades of protection, a total of 3,211 individual Napoleon wrasses (*Cheilinus undulatus*) were recorded across approximately 1,203 ha of reef area, yielding an average density of 3.08 individual/ha. Habitat-specific densities were 6.02 ± 0.34 individual/ha in channels, 2.65 ± 0.20 individual/ha on outer reef slopes, 2.29 ± 0.23 individual/ha on inner reef slopes, indicating that channel habitats play a key role for this species. The authors noted that these densities are consistent with unexploited reefs elsewhere in the Indo-Pacific, demonstrating the long-term effectiveness of protection measures in Laamu Atoll.

Similar findings were reported by Suharti *et al*. (2023) in the Banda Islands, Indonesia, where densities reached approximately 7.14 individual/ha in well-managed reefs, while a survey in the Sembilan Archipelago, South Sulawesi recorded a total of 47 individuals, with an average density of

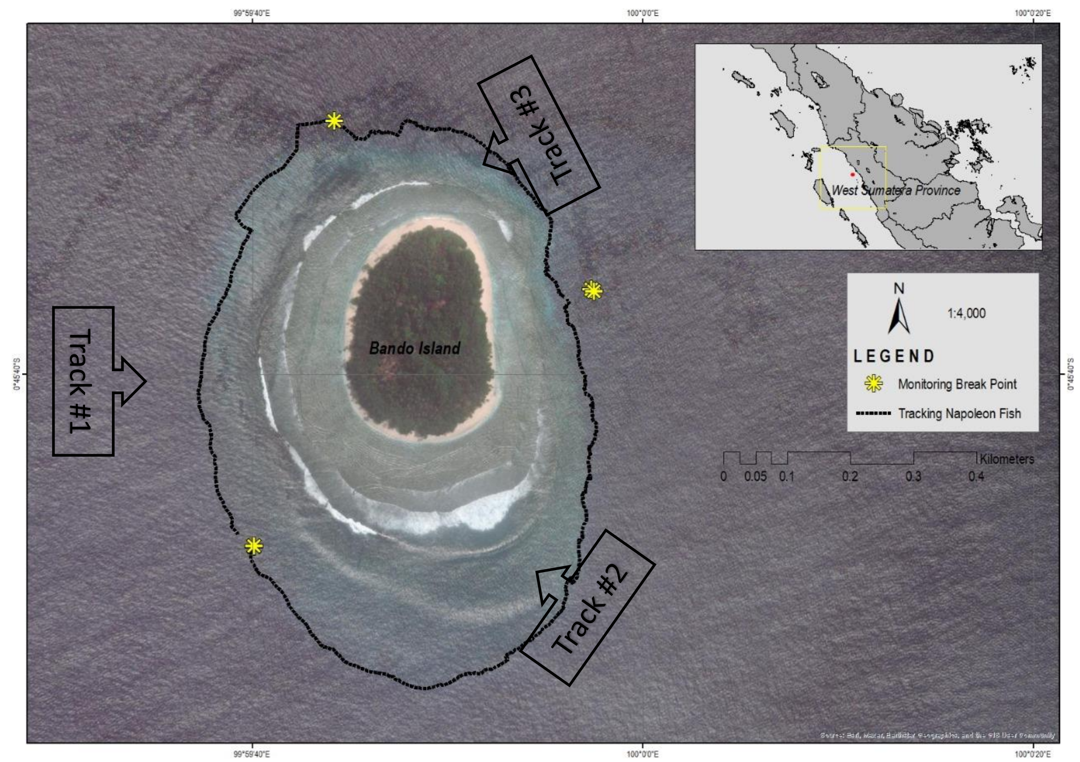

Figure 2. Birds view of three tracks and visual census area at Bando Island, Pieh Conservation Area, West Sumatra.

3.8 ± 0.6 individual/ha. The highest density was found on the reef slope zone with better live coral cover (approximately 5.2 individual, while the lowest occurred on the reef flat (~2.1 individual/ha) (Syam *et al.*, 2023). These comparative studies suggest that Napoleon wrasse populations respond positively to sustained protection and that areas with strong enforcement and habitat diversity maintain significantly higher densities than partially protected or exploited reefs (Roe *et al.*, 2022; Syam *et al.*, 2023).

The Napoleon fish density found on Bando Island in this study is in the category "very low". One clear, explicit guideline comes from an Indonesian synthesis that defines density categories for Napoleon wrasse, placing 0–2 individual/ha in the "very critical / very low" category (Edrus, 2012; Table 3). In addition, regional and review studies show that lightly-fished or unfished reefs typically record substantially higher densities (often ≥ ~4–6 individual/ha, and in some well-protected MPAs up to ~6–8 individual/ha or more), so values around 1 individual/ha are consistent with heavily exploited or depleted populations (Sadovy *et al.*, 2019). Therefore, the Pulau Bando result (1 individual/ha) fits the "very low" category per the Indonesian guideline and is much lower than densities reported from protected reference sites. These density data should be used as a warning indicator, that restrictions or licensing of utilization of Napoleon fish should be issued by the government. In addition, regular monitoring of Napoleon fish populations is highly needed.

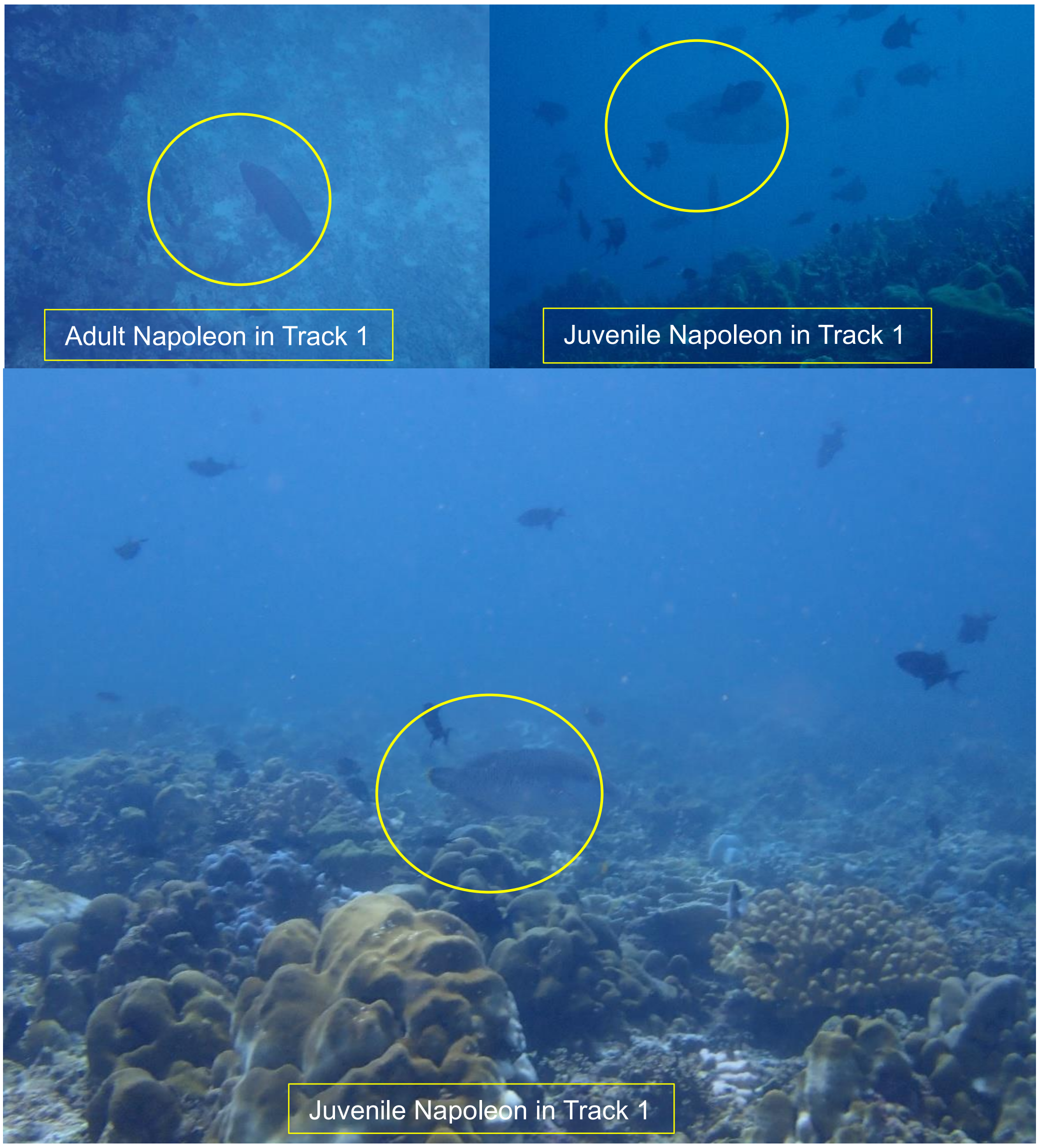

Figure 3: UW pictures of Napoleon individuals from Bando Island in 2024.

Journal of Marine Research Vol 15, No. 1 Februari 2026, pp. 146-156

Table 3. Status categories of Napoleon densities in Indonesian waters (Edrus and Sulman, 2013).

Status	Explanation
A	Very low (0-2 individual/ha)
B	Low (2.1–4 individual/ha)
C	Moderate (4.1–6 individual/ha)
D	High (6.1–8 individual/ha)
E	Very High (8–10 individual/ha)

A theoretical stock size of Napoleon fish on Bando Island, with a total coral reef area of 28 ha would predict 0.035 individuals for the entire island. Such an extremely low value indicates a severely depleted or functionally extinct local population. There is no study that specifically assessed the density and theoretical stock size of the Napoleon wrasse (*Cheilinus undulatus*) in the waters of West Sumatra. Considering the extension of coral reefs in the western hemisphere of Indonesia, these important reef habitats for Napoleon fish need to be included in future research. Most previous research in Indonesia has focused on abundance and distribution patterns in eastern regions such as the Sembilan Archipelago (Syam *et al*., 2023).

However, a study that integrates field-based density estimation with theoretical stock calculation to evaluate the actual population condition of the Napoleon wrasse in West Sumatra has not yet been conducted. Therefore, this research provides the first baseline information on the theoretical stock estimation of *C. undulatus* in this region, serving as a valuable reference for coral reef fish resource management and local conservation policy. Furthermore, the findings reinforce global studies indicating that Napoleon wrasse stocks across the Indo-Pacific have dramatically declined and require immediate conservation measures (Roe *et al*., 2022; Friedlander *et al*., 2023; Houk *et al*., 2024).

Structured research on stocks of Napoleon fish in Indonesian waters only began around 2005, following alarming publications (e.g. Johannes and Riepen 1995, Barber and Pratt, 1997, Lee and Sadovy 1998, Schmidt and Kunzmann, 2005) and on the initiative of "grouper & wrasse specialist" experts. An IUCN program, including research on Napoleon fish in Indonesian waters, covers the areas of Madura, East Nusa Tenggara, Bunaken and Raja Ampat (Sadovy *et al*., 2003; 2007; Gillet, 2010). Unfortunately, West Sumatra, or even the entire western area of Indonesia is not included.

Given this result (0.035 individual/28 ha), the population on Bando Island is likely ecologically insignificant and unable to maintain natural reproduction. This implies a collapse of the local stock, meaning that recruitment is either extremely low or absent, and the area no longer serves as a viable habitat for Napoleon wrasse. In summary, the predicted theoretical stock (0.035 individual) reflects an alarmingly depleted population. Therefore, without immediate management intervention, the species may be functionally lost from Bando Island's reef ecosystem.

Based on previous research findings, the recommended actions include implementing immediate conservation measures to prevent further decline of the Napoleon wrasse (*Cheilinus undulatus*) population in the waters around Bando Island. Establishing the island's coral reefs as no-take zones could promote recolonization from nearby source populations (Roe *et al*., 2022). In addition, habitat restoration and protection should be prioritized, as coral cover and reef structural complexity are key factors influencing the species' occurrence and survival (Syam *et al*., 2023). Continuous monitoring using non-destructive census techniques, such as photo-identification and AI-based tracking, is also advised to detect early signs of recovery. Furthermore, enhancing awareness and regulation of the live reef fish trade remains essential, since illegal or unregulated harvesting can hinder any potential for natural stock recovery (Hau *et al*., 2025).

CONCLUSIONS

The present study provides the first quantitative assessment of Napoleon wrasse (*Cheilinus undulatus*) populations in West Sumatra, Indonesia. Only two individuals were detected at Bando Island, yielding a density of 1 individual/ha and a theoretical stock of 0.035 individual for the entire 28 ha coral reef area. This value indicates an ecologically insignificant population that is unlikely to sustain natural reproduction without external recruitment. Although coral reef conditions remain favourable, the extremely low abundance suggests that the species is locally depleted and requires urgent protection. To facilitate population recovery, Bando Island's coral reefs should be designated as strict no-take zones, complemented by habitat restoration and continuous population monitoring using non-destructive methods. Furthermore, regulation and public awareness of the live reef fish trade must be strengthened to prevent further exploitation. This study establishes a critical ecological baseline for future conservation planning and long-term management of / within the Pieh Marine Protected Area.

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