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Potential Hierarchical Interactions of Megafauna Species at a Cleaning Station

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Abstract

Cleaning stations on seamounts play a crucial ecological role in the health and behavior of marine megafauna, yet interspecific interactions at these sites remain understudied. This study investigates potential hierarchical dynamics between reef manta rays (*Mobula alfredi*) and pelagic thresher sharks (*Alopias pelagicus*) at two cleaning stations atop a seamount in the Philippines. Using over 960 h of autonomous video recordings across 119 survey days, we examined species-specific site preferences, visitation types, and behavioral responses to interspecific encounters. Results indicate that, while manta rays used both stations equally, thresher sharks showed a strong preference for the deeper, sloped station. Interruptions during cleaning suggest a hierarchy: all manta-to-shark interactions resulted in thresher sharks vacating the station prematurely, possibly before completing cleaning. In contrast, manta–manta interactions showed more balanced outcomes, with no significant impact on cleaning duration. Shark presence decreased as the flow speed intensified and was lowest during high tide, suggesting that sharks' decision to clean may be dictated by factors affecting the effectiveness of the cleaning process. These findings also suggest that manta rays may outcompete thresher sharks for access to cleaning services. Understanding such interspecific dynamics is vital for effective marine habitat management and the conservation of vulnerable pelagic species.

Keywords: cleaning stations; reef manta ray; pelagic thresher; interspecific interactions; remote autonomous cameras; hierarchy; seamount ecology

Key Contribution: Evidence of a hierarchy between reef manta rays and pelagic thresher sharks at cleaning stations, with manta rays displacing sharks during cleaning events.

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1. Introduction

Some pelagic and semi-pelagic species, including megafauna such as reef manta rays, *Mobula alfredi* (Kreft, 1868) and pelagic thresher sharks, *Alopias pelagicus* (Nakamura, 1935), frequent seamounts to use cleaning stations, which may otherwise be rare in the open ocean and are thought to greatly affect their health and well-being [1,2]. Moreover, reef manta rays likely use these sites as leks and are therefore essential for their reproduction [3], making seamount-based cleaning stations critical habitats for them.

Cleaning station clientele can be divided into two categories, i.e., residents and visitors, with pelagic and nomadic species belonging to the latter. While resident clients that inhabit the reef near the cleaning stations may have access to only a single station, visiting clients,

especially pelagic species, can choose from multiple stations [4,5] and therefore make decisions about which station to visit based on the quality of the cleaning service [6,7].

Both reef mantas and pelagic thresher sharks routinely visit the same locations at predictable times [8–10], and many individuals exhibit long-term fidelity (i.e., years) to the same station [11]. Manta ray visitation patterns to seamount-based cleaning stations have been correlated with environmental factors such as tide, sea state, moon illumination, and flow [6,10]. In contrast, the factors influencing thresher shark visits are still largely unknown.

Previous work has found that cleaners prioritize clients at cleaning stations according to their size and whether they are residents or merely visiting the reef [12,13]. However, it is not yet known whether relationships and interactions between the clients themselves influence their cleaning services, and whether a hierarchy exists among visiting clients.

Coral reefs are degrading globally, and consequently, unique sites such as cleaning stations are also under threat. Seamount-based cleaning stations are important for both resident reef-dwelling species and various pelagic and nomadic species, such as reef manta rays and the pelagic thresher shark. Therefore, understanding interspecific relationships and the spatio-temporal use of this habitat by different species may have implications for their protection and coral reef conservation.

In this study, we examine whether reef manta rays and pelagic thresher sharks use cleaning stations sympatrically in both spatial and temporal terms. We aim to shed light on the potential hierarchical relationship between the two species and the ecological consequences it may have. To this end, we compared their visitation patterns at two cleaning stations located at the top of a seamount in the Philippines. We analyzed their overall behavior (i.e., leaving the station or staying to be cleaned by cleaner fish, and the duration of cleaning), as well as their behavior in cases of interruption by another client. Specifically, we addressed two key questions: (1) Do the species exhibit sympatric behavior in terms of their spatio-temporal characteristics? and (2) In cases of overlap and interruptions, do they display signs of hierarchy?

2. Materials and Methods

The present study was conducted at a submerged reef known as "Manta Bowl" (12.6597° N, 123.7550° E), located on top of a seamount (ca. 0.4 km^2) near Ticao Island, the Philippines. The Manta Bowl reef lies approximately 8 km from Ticao and 12 km from Sorsogon (Figure 1) and covers an area of ~0.06 km^2. Its crest depth ranges from 20 m to 300 m.

This site is characterized by strong tidal currents, which support substantial fishing activity by local communities. The convergence of optimal plankton availability and water flow facilitates the regular occurrence of resident reef-associated fish, aggregations of semi-pelagic species such as jacks (family *Carangidae*), and large megafauna including manta rays and whale sharks.

A rectangular area (200 m × 150 m) at a depth of 22–28 m in the northernmost part of the seamount was chosen as the study site due to the frequent manta and shark cleaning activity observed there and because its depth allowed prolonged yet safe diving. The site contains several coral species, a range of reef, semi-pelagic, and pelagic fish species, as well as numerous 'Bluestreak cleaner wrasse' (*Labroides dimidiatus*; Valenciennes, 1839), which inhabit numerous cleaning stations. This study focused on cleaning times and locations of two megafauna species: the reef manta ray (*Mobula alfredi*), henceforth 'manta' and the pelagic thresher shark (*Alopias pelagicus*), henceforth 'shark'.

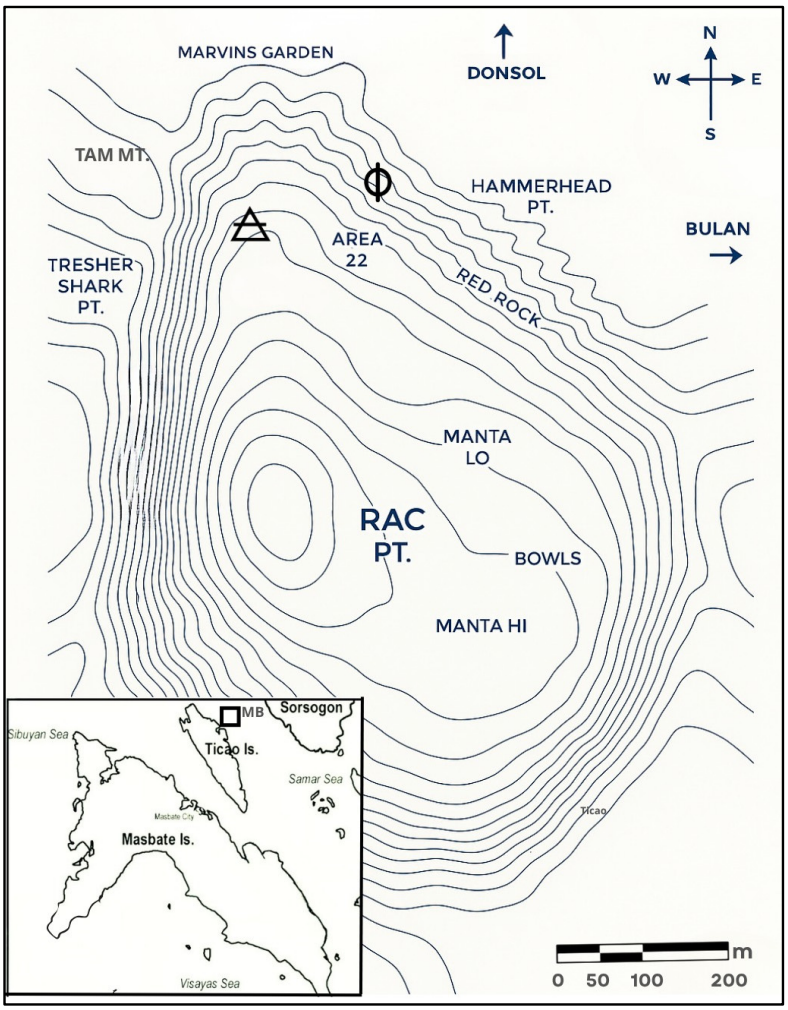


Figure 1. Map of the Ticao Island area (South Luzon, Philippines); the center of Manta Bowl's location is marked with a square and the letters MB at the top of the insert map (12.6597° N, 123.7550° E). A topographic representation of the Manta Bowl seamount top. The locations of the cleaning stations are marked with a Φ (Banger-II station) and a △ (Tamis Rock). The distance between the two stations is ca. 180 m.

Data were collected through diving surveys and the deployment of autonomous cameras (Midland XTC-400, Midland radio Corporation, Reggio Emilia, Italy) near cleaning stations. Each camera was weighted with 2 kg to prevent movement. All fieldwork was carried out by the same two-person team between July and December 2014. Cameras were positioned so that the field of view covered was ca. 140 degrees and about 12 m horizontal coverage, resulting in a cover area of about 50 m. In the case of a sloping terrain, the camera was positioned so that it aligned with the station for an ideal view. The cameras were activated as quickly as possible to minimize disturbance. When a station was occupied by visiting megafauna, the team waited at a distance of approximately 8 m until the animal departed before deploying the camera. Cleaning events observed during dives were excluded from analysis to avoid potential bias caused by diver presence. Each cleaning station was monitored by one camera at a time.

Each camera was left to record for 3.5–4.3 h (until battery depletion) before being retrieved and replaced with a fully charged unit, resulting in ~7 h of daily coverage. The first deployment time each day was alternated between 07:00 and 10:00 to ensure adequate coverage of the day. In total, 119 survey days were conducted, with 263 camera deployments, yielding 960 h of footage.

2.1. Cleaning Stations Identification

Within the designated study site, we identified two independent cleaning stations—Tamis Rock and Banger-II (Figure 2)—which yielded the highest number of sightings. The stations are located approximately 180 m apart, oriented in different directions, and differing in bathymetric characteristics.

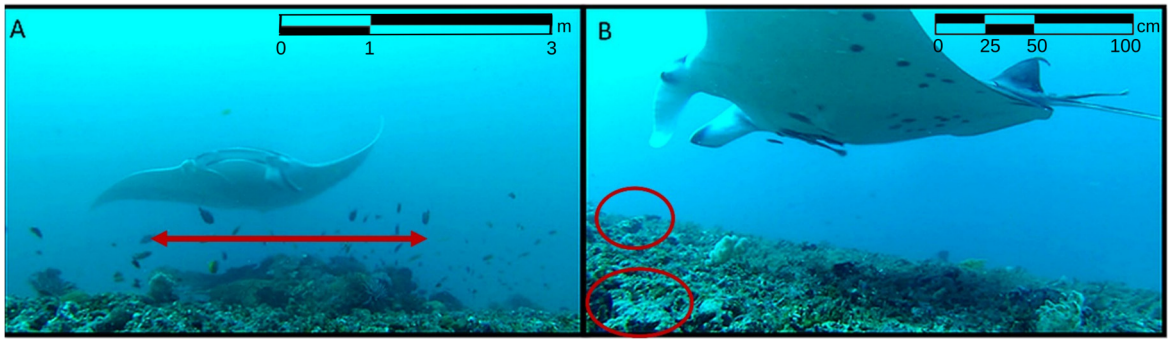


Figure 2. Tamis Rock (**A**) and Banger-II (**B**) cleaning stations. The red line over the cleaning station (**A**) represents a scale of ca. 3 m. Tamis Rock (**A**) is characterized by a rocky structure while Banger-II (**B**) is characterized by scattered small boulders (2 of which are circled red).

Banger-II is situated in the northeastern part of the seamount at a depth of 28 m, where the seafloor slopes at approximately 20° toward deeper, colder waters. This site frequently experiences down-currents and upwelling. Tamis Rock is located about 180 m to the west, toward the center of the seamount, where the seafloor is flat at a depth of 22 m.

Although both stations are subject to strong currents of around 3 knots, currents at Banger-II can be significantly stronger, reaching up to 4 knots. The stations also differ in structure: Tamis Rock is a rocky reef with a roughly circular shape, approximately 3 m in diameter and 1 m in height, while Banger-II consists of a scatter of five small boulders, each about 50 cm in both height and width.

2.2. Measurement of Environmental Factors

A suite of environmental factors was documented and analyzed as predictors of thresher sharks in the cleaning stations. Table 1 lists the factors, what type data they were as and their source.

Table 1. Environmental factors measured during surveys, with units, type of data, and source.

Environmental Factor	Units	Data Type	Source
Cloud coverage	0–8	Factorial	in situ (Okta scale, [14])
Sea state	0–6	Factorial	Measured in situ (Douglas scale)
Moon illumination	LUX (1 lux = 1 lumen per square meter)	Continuous	www.tide4fishing.com (accessed on 01 July 2018); LUX was estimated using 'clear sky standard scales', [15]
Flow speed	0–3 (in 0.5 increments)	Continuous	visually estimated using suspended particles calibrated against current-meter readings
Tide	Ebb, Flood, Slack	Categorical	www.tide4fishing.com
Cleaning station	Tamis Rock; Banger-II	Binomial; Used as random factor in model	Documented in situ

2.3. Data Processing

2.3.1. Events

Each survey day was divided into 1 h periods. The number of shark and manta arrivals at the cleaning stations was recorded for each period. Each sighting of an approaching manta or shark was considered an event. Events (Cleaning, Passing, or Low and Slow Pass; see below for definitions) were classified according to their time of onset as follows:

(i) A single event was defined as the time from the appearance of an individual until it left the cleaning station for at least 5 min.

(ii) A separate event was recorded if an individual could be uniquely identified by external features such as injuries or prominent markings (e.g., scars or, in the case of manta rays, ventral patterns [16]) and it revisited one of the two stations more than 20 min after leaving it.

2.3.2. Event Types

Events were categorized into three types: Cleaning, Low and Slow Pass, and Passing.

- **Cleaning events** occurred when either a shark or manta arrived at a cleaning station and cleaning took place.
- **Low and Slow Passes** were interpreted as exploratory approaches, in which an individual assessed whether to engage in cleaning. In these events, the animal approached the station close to the bottom at the depth where cleaning usually occurs, slowed to almost a halt, but then accelerated and swam away without cleaning.
- **Passing events** occurred when an individual swam over the cleaning station at a depth higher than the cleaning depth without altering its speed.

2.3.3. Interruption

An interruption was defined as an event in which one animal of either of the study species was undergoing cleaning, pausing, or stopping as a second animal of either species approached the station (hereafter termed the approaching client), with the apparent intention of getting cleaned (i.e., not merely passing through the area).

- **A successful interruption** occurred when the animal being cleaned left the station and the approaching client began being cleaned in its place.
- **An unsuccessful interruption** occurred when the animal being cleaned returned to the station after the interruption, and the approaching client left (Table 2).

Table 2. Number of events in which a second client approached the cleaning station while a client was already being cleaned, and the result of the incident. Data refer to Banger-II cleaning station only.

Animal Being Cleaned	Approaching Client	Animal Being Cleaned Stayed	Animal Being Cleaned Left	Total Interactions
Manta	Shark	1	1	2
Manta	Manta	18	12	30
Shark	Shark	2	2	4
Shark	Manta	0	9	9

2.4. Statistical Analysis

To account for small sample sizes and overdispersed count data, all analyses were conducted using non-parametric tests (Fisher's exact and Mann–Whitney) or a generalized linear mixed model (GLMM) with a negative binomial distribution, which does not assume normality.

All statistical analyses were performed using Python (v.3.11.2). Fisher's exact test was used to compare the number of visits and event types of manta rays and thresher sharks between the Tamis Rock and Banger-II cleaning stations. The Mann–Whitney test was applied to examine whether interruption events resulted in differences in event durations.

To assess potential effects of environmental factors on shark presence, we used a generalized linear mixed model (GLMM) with a negative binomial distribution. A suite of environmental factors (Table 1) served as predictors, and the number of sightings of the study species at the cleaning stations was used as the response variable. The factor 'Station' was included as a random effect. Two-way interactions were also analyzed to account for possible effects of tide on (1) flow speed, (2) sea state, and (3) moon phase (used in this model solely as a proxy for illumination).

3. Results

3.1. Cleaning Station Preferences

A total of 651 manta visits and 216 thresher shark visits were documented between the two cleaning stations (Figure 3).

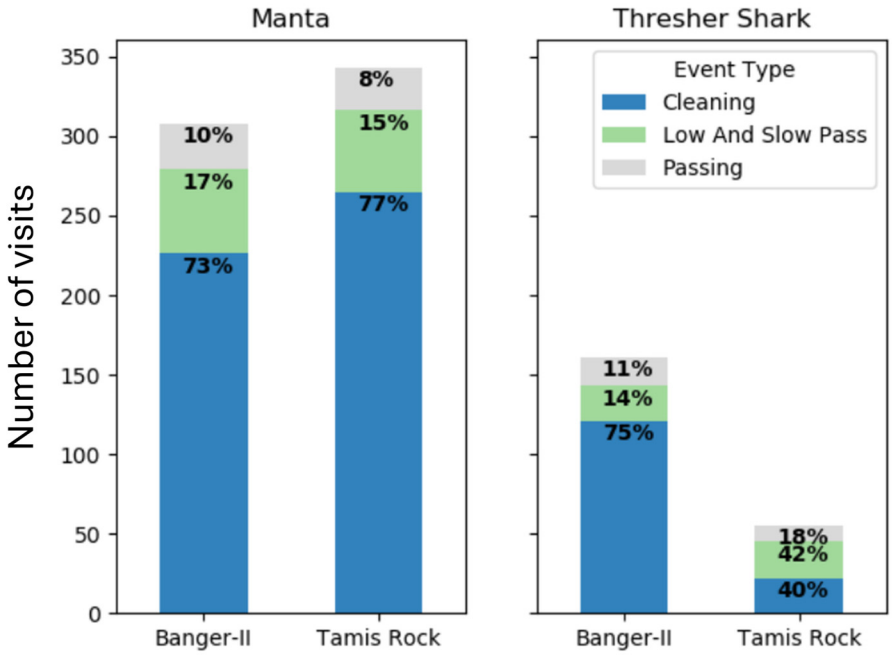


Figure 3. Types of visits of manta rays (**left**) and thresher sharks (**right**) in Banger-II and Tamis Rock cleaning stations. Visits at Banger-II comprise 47% of all manta visits (n = 651) and 75% of all thresher visits (n = 216). Bars represent the total number of visits per station and species.

A significant difference was found in the proportion of total visits in made by each species to the cleaning stations (Two-tailed Fisher's exact test, $p < 0.0001$, Figure 3). Manta rays showed no significant bias for a specific station (Two-tailed Fisher's exact test, $p = 0.4$), with 47% of the visits (n = 308) occurring at Banger-II and 53% (n = 343) at Tamis Rock. In contrast, thresher sharks showed a significant bias towards Banger-II station (Two-tailed Fisher's exact test, $p < 0.00001$, Figure 3), with most visits, namely 75% (n = 161) occurring at Banger-II and only 25% (n = 55) at Tamis Rock.

3.2. Types of Visits

Three types of visits were defined—Cleaning, Low and slow pass and Passing. Manta rays showed no statistically significant difference in the proportions for each activity between the two cleaning stations (Two-tailed Fisher's exact test, $p = 0.5$, Figure 3). The

most frequent event type was cleaning, with similar relative occurrences in both cleaning stations (around 75%); followed by low and slow pass and finally passing event types (15% and 10%, respectively). Thresher sharks exhibited different behaviors between stations (Two-tailed Fisher's exact test, $p < 0.0001$, Figure 3), where 75% of the events at Banger-II were cleaning vs. the 40% of cleaning events in Tamis Rock. Low and slow passes and passing events were more frequent in Tamis Rock than in Banger-II station (42% and 18% compared to 14% and 11%, respectively, Figure 3).

3.3. Interruption Dynamics Between Manta Rays and Thresher Sharks

Throughout this study, no events of overlap, i.e., cases in which both species are simultaneously present at the same cleaning station, were documented at Tamis Rock; thus, the statistical analyses only refer to events at Banger-II station. The interactions between animals that were being cleaned and approaching clients are illustrated in Table 2. Notably, upon being interrupted by an approaching manta, 18 mantas (60%) that were being cleaned stayed and 12 (40%) left the station, 9 sharks (100%) that were being cleaned left the stations and none of them stayed.

Thresher shark cleaning being interrupted by approaching mantas is noted as manta-to-shark interruptions, and the same terminology is used for all other interaction (i.e., manta-to-manta, shark-to-shark and shark-to-manta). There were no differences in the duration of the event in shark-to-manta and shark-to-shark interruptions. Nevertheless, all manta-to-shark interruptions resulted in the shark leaving the station and a shorter than average cleaning duration (t = 3.93; $p = 0.0005$, Figure 4).

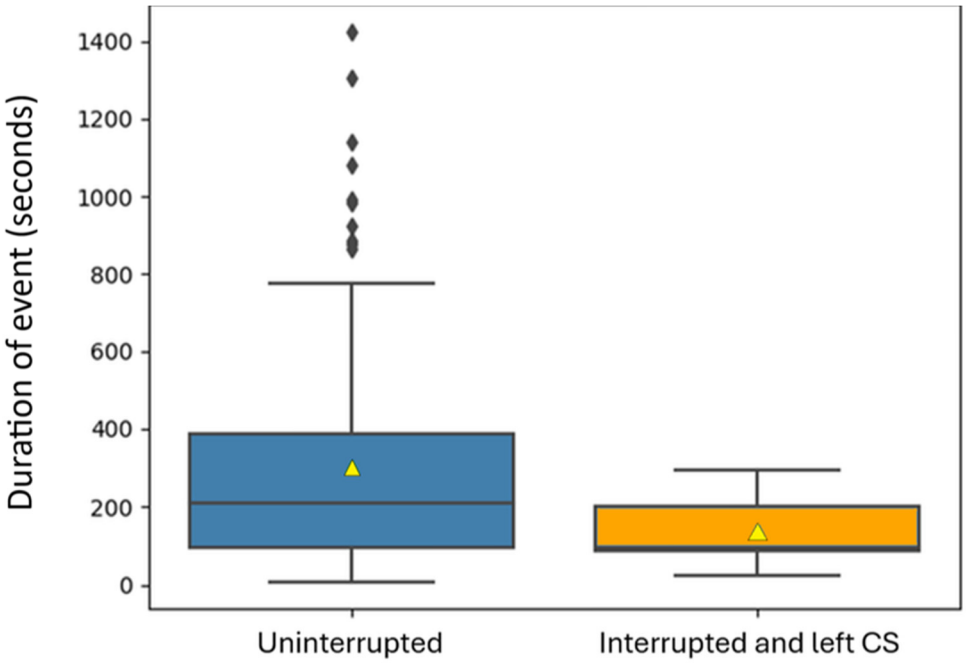


Figure 4. This figure shows the duration of thresher sharks cleaning events at Banger-II cleaning station (CS), when the event was uninterrupted or interrupted. There was no event where sharks that were being cleaned returned to the CS after the interruption. Average cleaning duration is marked by a yellow triangle and Median by the horizontal black line. The range of data is represented by vertical lines and outliers by diamonds.

Furthermore, half of the manta-to-manta interruptions ended in the original client's retreat. An unsuccessful manta-to-manta interruption prolongs the first manta's cleaning duration (t = 2.62; $p = 0.017$; Figure 5), and a successful interruption did not affect the duration of the cleaning of the already present manta (t = 0.67; $p = 0.515$; Figure 5).

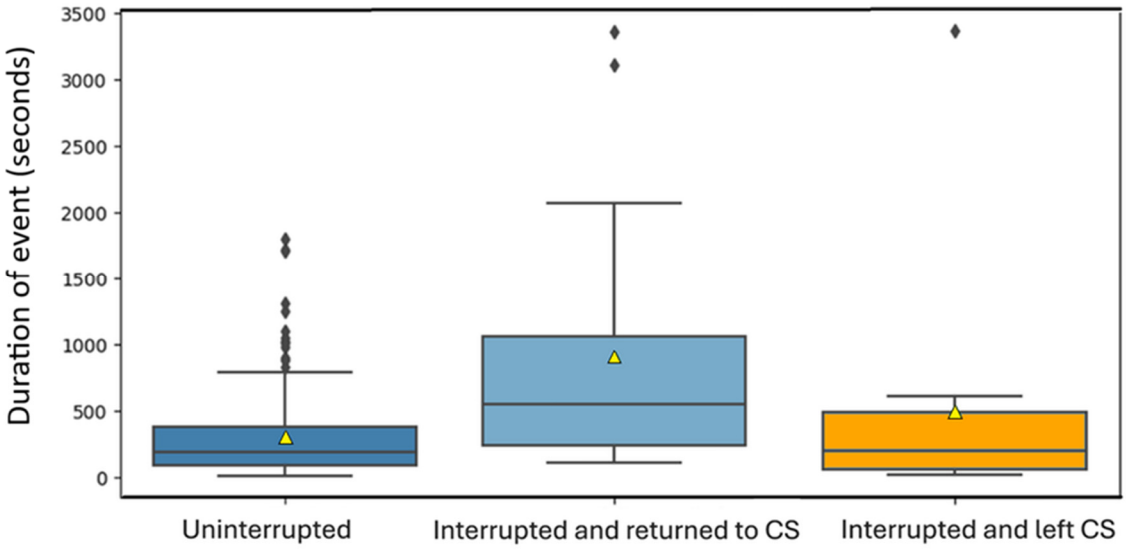


Figure 5. This figure shows the duration of manta ray cleaning events at Banger-II cleaning station (CS), when the event was uninterrupted or interrupted, and whether the animal being cleaned returned to the CS after the interruption or not. Average cleaning duration is marked by a yellow triangle and Median by the horizontal black line. The range of data is represented by vertical lines and outliers by diamonds.

3.4. The Effect of Environmental Factors

The model identified the flow speed and tide as significant predictors of shark presence in the cleaning stations. Shark presence decreased as the flow intensified ($p = 0.001$). Shark presence was also lowest during flood and slack tides and increased during ebb tide ($p < 0.0001$). The other variables tested (cloud cover, sea-state, and moon illumination) were not found to be statistically significant, as was the station factor, used as a random factor (Wald P = 0.48).

4. Discussion

Our observations suggest that manta rays do not exhibit a preference for a specific cleaning station, nor does their behavior (i.e., cleaning, low and slow passes, or passing) differ between the two stations. In contrast, thresher sharks show a clear preference—three times more visits—for Banger-II, as well as significantly different behavioral patterns: they clean far less and perform many more low and slow passes at Tamis Rock. In interactions involving both species at the same time and site, all manta-to-shark interruptions result in the shark leaving the station after a shorter-than-average cleaning duration. No such effect is observed for manta-to-manta interruptions.

4.1. Habitat Segregation and Station Preference and Avoidance

Our observations indicate microsympatric use [17] of two cleaning stations by manta rays and thresher sharks. Reef manta rays and pelagic thresher sharks share their habitat in the Philippines [10,18,19] and exhibit site fidelity [11,20].

The skew in thresher shark visits may reflect a preference for Banger-II, avoidance of Tamis Rock, or a combination of both. Banger-II and Tamis Rock differ in both location and structure. Banger-II lies in the northeastern part of the seamount at a depth of 28 m, where the substrate slopes at approximately 20° toward deeper, colder waters and is subject to down-currents and upwelling [20]. Tamis Rock is located ~180 m westward toward the center of the seamount, where the bottom is flat at a depth of 22 m. Both stations experience strong currents of around 3 knots, but currents at Banger-II can be considerably stronger,

reaching up to 4 knots. Previous work describing 7 more cleaning stations at the Manta Bowl seamount showed that the current tended to be stronger at cleaning stations nearing the slope of the seamount [20]. Likewise, the structure of Banger-II, as described in the Section 2, may provide better shelter for cleaners and serve as focal points for cleaning activity. Such conditions may be favored by the thresher sharks, which may explain their frequent visits.

Another explanation may be related to the preference of pelagic species to visit cleaning stations close to their foraging grounds [7]. Thresher sharks spend much of the daytime at depths of 200–300 m [21,22]—deeper than reef manta rays, which feed at various depths, with most daytime feeding in relatively shallow waters roughly between 5 and 30 m [7,23–25]. This may explain why sharks prefer the station near the slope of the seamount, whereas manta rays show no site preference.

Beyond station preference, the proportion of thresher shark cleaning events was higher at Banger-II than at Tamis Rock, where sharks engaged more frequently in low and slow passes that did not lead to cleaning. Such passes may represent exploratory behavior, allowing individuals to assess whether to initiate cleaning. The tendency to forgo cleaning at Tamis Rock may reflect avoidance of manta rays or, once more, indicate environmental niche preference [26] between the two species.

4.2. Interruptions and Dominance

The relatively low number of recorded events involving two individuals at the same station suggests that more such interactions may have occurred outside the cameras' limited field of view. Nevertheless, the available data reveal a clear pattern: manta rays appear dominant over thresher sharks at cleaning stations.

In all observed cases where a shark was being cleaned and a manta approached, the shark left, and cleaning was cut short. This is supported by the reduced duration of thresher shark cleaning events when a manta arrived. In contrast, only 40% of manta-to-manta interactions resulted in the replacement of the cleaning client, and in those cases, cleaning duration was unaffected. This suggests that many such encounters may not be interruptions but instead reflect queuing behavior or social interactions [6]. When the initial client was not replaced, event duration increased, likely because the cleaning individual had to chase away the approaching animal before returning, reducing cleaning efficiency.

For shark–shark interactions (n = 4), no consistent pattern in departure or cleaning duration was observed, although the small sample size limits interpretation.

It is suggested that body size may contribute to the observed dominance. Reef manta rays can reach disk widths of at least 490 cm [27] and weights of up to 700 kg, whereas pelagic thresher sharks reach a maximum length of ~365 cm [28] and ~130 kg [29]. This considerable size disparity may allow mantas to displace sharks with minimal effort, often by simply approaching. Aggressive behavior such as chasing thresher sharks away was occasionally documented in approaching mantas.

4.3. Effect of Environmental Factors

In accordance with O'Shea et al. (2010) [6], our study's results indicate that tide and current speed significantly influence cleaning station use. Shark presence decreased as flow intensified and was lowest during flood and slack tides, increasing during ebb tide. O'Shea et al. (2010) [6] reported a similar pattern for both manta rays and sharks, with a preference for ebb tides, and suggested that this may be due to reduced current speeds at their study site, which improve the ability of both clients and cleaner fish to maintain position, enhance cleaning efficiency, and improve visual communication between cleaners and clients. They also proposed that ebb tides may coincide with periods of lower plankton availability,

making cleaning more attractive relative to feeding for manta rays, which feed directly on plankton, and for thresher sharks, whose prey—small fishes and squid—depend on planktonic productivity.

The influence of flow speed observed in our study is also consistent with the feeding–cleaning trade-off described by Barr and Abelson (2019) [10], who found that manta rays were more likely to clean under calmer hydrodynamic conditions and shifted to feeding when stronger currents concentrated plankton. This trade-off provides a potential explanation for the reduced shark presence at high flow speeds in our dataset: under such conditions, cleaner efficiency may be reduced, while foraging opportunities increase, making cleaning less beneficial. Together, these findings suggest that both hydrodynamic conditions and tidal phase interact to shape cleaning station use, likely by modulating the relative benefits of cleaning versus feeding for pelagic megafauna.

In contrast to previous studies on reef manta rays, factors such as sea state, cloud cover, and lunar illumination did not significantly influence shark presence in our dataset, suggesting that thresher sharks may be less sensitive to these variables at seamount cleaning stations. This difference may reflect the distinct feeding ecology of the two species: such environmental processes are believed to affect manta rays primarily through their influence on plankton availability and feeding efficiency, whereas thresher sharks, which feed mainly on squid and fish, are likely less affected by these factors.

This correspondence suggests that comparable environmental mechanisms may shape the cleaning behavior of different pelagic species. However, the extent to which these relationships vary between seamount-associated and coastal cleaning stations remains insufficiently understood, where factors such as water temperature and upwellings may have a more prominent effect. Further comparative studies across both settings could clarify whether the environmental drivers of cleaning activity are consistent or context dependent. It should also be noted that our observations were limited to a single half-year period, and longer-term data would be needed to assess possible seasonal or interannual variation in cleaning station use.

4.4. Conservation Implications

Globally, coral reefs are experiencing degradation, with their capacity for recovery steadily diminishing [30]. Reef degradation may limit the availability of suitable sites for cleaning stations, potentially increasing competition among client species and resulting in adverse effects for individuals unable to access adequate cleaning services. Such impacts can affect overall health and well-being of both resident and visiting species. The findings of this study suggest that thresher sharks may be particularly vulnerable to these changes, as they exhibit selectivity in choosing cleaning stations and are more likely to be displaced by other arriving clients. These vulnerabilities could influence their habitat selection and general fitness. Understanding these dynamics is critical for informed decision-making in habitat management and restoration whether through the protection of existing cleaning stations or, where necessary, the selection of sites suitable for artificial reefs designed to support these functions and accommodate pelagic and semi-pelagic species that frequent seamount environments.

4.5. Study Limitations and Future Directions

Due to technical and funding constraints, this study was limited to two cleaning stations. However, these sites represent typical seamount-based habitats that are increasingly exposed to adverse human activities such as destructive fishing, over-fishing and diving tourism. Understanding how pelagic species share and compete for cleaning services at such remote locations is essential to inform site management and impact-mitigation strate-

gies, including the designation of protected areas, and fishing and diving management in the vicinity of cleaning stations. Future comparable studies across multiple seamounts and reef systems are required to strengthen the broader applicability of these behavioral and ecological insights to conservation and marine spatial planning.

5. Conclusions

This study demonstrates that manta rays and pelagic thresher sharks use cleaning stations in distinct ways, with differences in site preference, the proportion of cleaning-related visits, and their interactions at these sites. Our findings suggest a potential hierarchical relationship, with manta rays generally displacing thresher sharks when overlap occurs. While manta rays exhibited greater flexibility across station types, thresher sharks appeared more selective, which may render them more vulnerable to ecological changes such as reef degradation and the loss of suitable cleaning habitats.

These findings highlight the importance of recognizing species-specific needs and interspecific dynamics when managing cleaning stations as critical microhabitats within reef ecosystems, notably reefs of seamounts. Conservation efforts should also consider how tourism pressure at such sites may exacerbate competitive hierarchies. Effective management is therefore essential to minimize disturbance and maintain the ecological functions of cleaning interactions. Future research should further investigate how environmental conditions and anthropogenic pressures interact with these competitive dynamics to shape habitat use by these iconic endangered species.

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Institutional Review Board Statement: Regarding ethical approvals and legal framework for our work, our research consisted of non-invasive, observational methods only. Animals were neither captured, handled, tagged, fed, nor otherwise disturbed. Observations were conducted while SCUBA diving and by using remote cameras, ensuring that manta rays and thresher sharks were not influenced beyond the normal presence of tourist divers. All dives were conducted under the permission and supervision of Fun Dive Asia, a licensed dive company operating in the region. In the Philippines, manta rays (Mobula alfredi) and pelagic thresher sharks (Alopias pelagicus) are protected under several national regulations and international agreements. The overarching framework is provided by the Wildlife Resources Conservation and Protection Act (Republic Act No. 9147). Specific aquatic species, including manta rays, are regulated by the Department of Agriculture (DA) and the Bureau of Fisheries and Aquatic Resources (BFAR). In particular, manta rays are covered under Fisheries Administrative Order (FAO) No. 193, Series of 1998, which prohibits their capture, sale, and transport. Furthermore, both manta rays and thresher sharks are listed in Appendix II of CITES, and thus receive national protection through the Amended Philippine Fisheries Code (Republic Act No. 10654). As our study involved passive observation only, no special permit or ethics approval was required. For reference, details on FAO No. 193 can be accessed via BFAR: https://www.bfar.da.gov.ph/wp-content/uploads/2021/04/FAO-No.-193-s.-1998.pdf (accessed on 15 June 2024).

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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Conflicts of Interest: The authors declare no conflicts of interest.

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