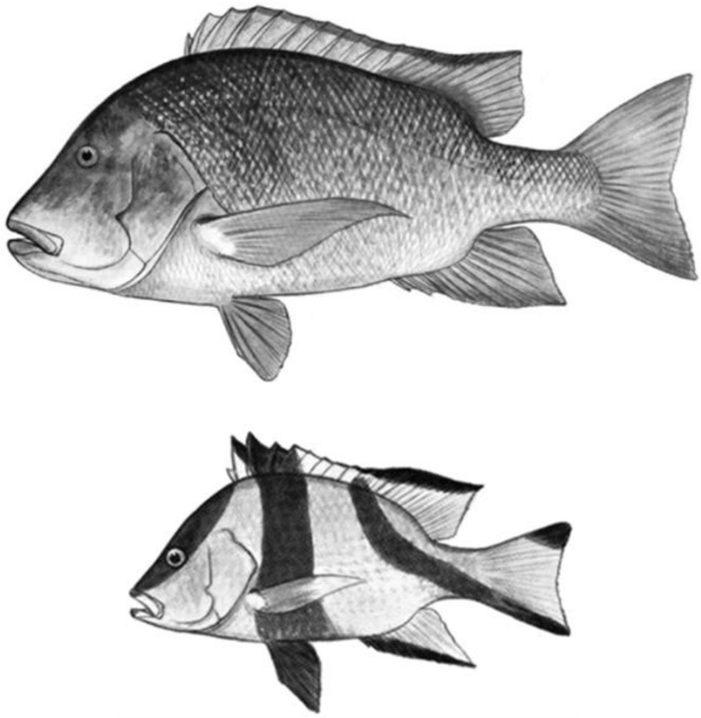
SEYCHELLES FISHERIES AUTHORITY

Investigating the spatial and temporal distribution of spawning aggregation and nursery areas for Lutjanus sebae (Emperor Red Snapper) on the Mahé Plateau

Interview-Based Report



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FISHERIES RESEARCH DEPARTMENT

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Contents

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1 Introduction

The Emperor red snapper (*Lutjanus sebae*), known locally as "Bourzwa", is a tropical and subtropical reef-associated fish that belongs to the Lutjanidae family. It is a large, slow-growing, and long-lived species that can reach a maximum length of 116 cm. It is known to inhabit reef habitats at depths ranging from 5 to 180 m (SFA, 2019), either in shoals or solitarily. Juveniles are commonly found nearshore in mangrove areas along the coast, as well as in offshore reefs (FishBase, 2026), and are usually observed swimming among sea urchins.

It is distributed throughout the Indo-West Pacific, with concentrations along the coast of Northern Australia, extending to Southeast Asia and the east coast of Africa (FishBase, 2026). *L. sebae* is known to be nocturnal and feeds on other fish, crustaceans, molluscs, and various other invertebrates (Bodin *et al.*, 2020). It is a gonochoristic species, reaching sexual maturity at about 40-50% of its maximum length. Adults exhibit batch spawning behaviour, with reproduction confined to discrete temporal windows depending on the region (Bodin *et al.,* 2020).

Observations indicate that juveniles associate with sea urchins, likely seeking shelter from predators among the spines (Allen, 1985), while adults are known to roam deeper waters. *L. sebae* is known to form spawning aggregations during lunar phases, specifically during new and full moons, as well as during spring tides (Masood & Farooq, 2011). Their spawning grounds are typically located in offshore areas near the ocean surface. However, there is limited information available about *L. sebae* in the Western Indian Ocean (Robinson *et al.*, 2004). Snappers and other lutjanids are also known to spawn at shelf edges and ridges adjacent to deep waters (Bezerra *et al.,* 2021), although their nursery areas remain largely unknown.

As with other aggregative species, accurate information about the population of *L. sebae* is essential for understanding and protecting their spawning aggregation sites (Robinson *et al.,* 2007). Spawning behaviours in *L. sebae* or other Lutjanidae species can vary. They are known to aggregate, forming groups at the bottom of the sea. Though forming aggregations does not necessarily indicate spawning, other behaviours observed can help determine whether the species is spawning or not. It is common for fish to form spawning aggregations in remote locations and often under challenging conditions (Domeier & Colin, 1997).

Similar species in aquarium settings have been observed to come together at the bottom to form a group prior to spawning and rise together during spawning (Suzuki & Hioki, 1979). Other observed behaviours include convergence at predictable locations, usually well-known to fishermen. Some Lutjanidae around Palau are known to spawn shortly before the full moon, while others are known to spawn around two days before the new moon. For example, *Lutjanus bohar* in the Palau is known to have spawning activity from April through July, mostly at night (Johannes, 1936).

The Seychelles Islands, with an Exclusive Economic Zone (EEZ) of 1.37 million square kilometres located off the east coast of Africa, rely on the fisheries industry as their second-largest economic pillar after tourism (Robinson *et al.*, 2007). On the Mahé Plateau, alongside other demersal species, *L. sebae* is targeted by the artisanal fishery and as well as recreational and sports fishers (Mees, 1992). *L. sebae* is a well-known delicacy, especially during special occasions, which gives it high commercial value both locally and internationally, leading to high demand.

As an important commercial fish species within the Seychelles artisanal trap and line fishery, the species is currently being managed under the “Mahé Plateau Trap and Line Co-management Plan”, by the Seychelles Fisheries Authority (SFA), which is mandated to oversee all fish stocks (SFA, 2020). The plan includes a regulation for immediate release of *L. sebae* below 32 cm fork length (FL) upon capture. Additional management measures are recommended to maintain a sustainable harvest of *L. sebae*, and further research is required to inform future implementation decisions.

However, within the Seychelles, there is a lack of information that can be used to improve its management. This includes behavioural and spatial information such as spawning months, spawning aggregation sites, and nursery areas. The population of *L. sebae,* like most important commercial species, is highly exploited (Robinson *et al.*, 2007). Even though they have low natural mortality rates, they may face stock collapse if not managed properly in the future as they are vulnerable to overfishing (Bodin *et al.,* 2020). Therefore, it is important to understand the species' spawning aggregation behaviours and other related information.

In 2004, a study assessed the spatial distribution of spawning aggregations for reef fishes, in which *L. sebae* was also recorded. However, after the completion of the interview-based phase of the project, the data collected were not further validated with field surveys, leaving a gap in the research on spawning aggregations. Thus, this research aims to obtain information on the spawning aggregation of *L. sebae*, along with other patterns and behaviours, which can be used for understanding their population dynamics and reproductive potential, with the purpose of influencing future management recommendations and decisions (Kadison *et al.*, 2006). Robinson *et al.* (2004) concluded from local knowledge that *L. sebae* spawn year-round, with peak months being March to May and October to November. It has been 20 years since this knowledge was shared, and globally, spawning aggregations are targeted hotspots. Further and updated information is required on the location and ecology of unregulated spawning and nursery areas of important commercial fish stocks (Kadison, *et al.,* 2006). A research project will be initiated in 2025 to investigate the spawning aggregation sites and nursery areas of *L. sebae*, using a methodology similar to the research conducted in 2004.

2 Methodology

The general aim is to determine and understand the spawning aggregation sites and nursery areas of *L. sebae* on the Mahé Plateau. Therefore, the primary goals are to assimilate local knowledge through interview-based surveys on spawning aggregation sites and nursery areas. The knowledge gathered from these surveys will be further used to investigate the spatial and temporal distribution of *L. sebae* spawning aggregation areas and nursery areas on the Mahé Plateau.

Figure 1: Interview-based survey taking place on La Digue, Mahé, and Praslin (From left to right)

2.1 Questionnaire Design

The survey was conducted using semi-structured questionnaires specifically designed to support the objectives of the data collection and ensure relevance to the research goals. It was structured to gather spatial (location, depth, habitat type, etc.) and temporal (seasonality, environmental conditions, tidal and lunar cycles, etc.) data on the spawning aggregations and nursery areas of *L. sebae* to guide field investigations. Some of the questions were adapted from a similar survey conducted by Robinson *et al.* (2004) and were further supplemented with additional questions tailored to the objectives of the present study.

2.2 Questionnaire Protocol

The sampling protocol for the survey focused on individuals who were currently active in fishing and diving activities across Mahé, Praslin, and La Digue. For fishers, some participants were targeted because they are or were directly involved in the species' fishery, while other participants were randomly selected using existing fisher registries and local contacts, with efforts made to include a diverse range of respondents based on geographic location, years of experience, and fishing methods (trap & line). For divers, sea cucumber fishers and dive centres were targeted, with efforts made to include a diverse range of respondents based on geographic location and years of experience.

The interviews were conducted in March and April 2025 on Mahé, Praslin, and La Digue. The initial sample size was 100, with the aim of ensuring representation across different targeted stakeholders, including current and retired artisanal fishers, recreational divers, and sea cucumber harvesters. A trial of both the diver questionnaire and the fisher questionnaire was conducted prior to the interviews. A total of 59 interviews were successfully completed. Of these participants, 47 identified as fishers and 12 identified as divers. While the final sample was slightly below the intended target due to the unavailability or non-responsiveness of some intended participants, it still provided a sufficient foundation for further investigations.

Prior to each interview, participants were provided with a consent form outlining the purpose of the study, their voluntary participation, and the confidentiality of their responses. The consent form also included permission for any photographic materials to be used strictly for research purposes. Participants were informed that they could decline to answer any questions or withdraw from the interview at any time without consequence. Only individuals who provided informed consent were included in the study, ensuring that all data collection adhered to ethical research standards.

Each questionnaire was administered face-to-face by members of the Seychelles Fisheries Authority (SFA) fisheries research team at various locations, including landing sites, participants' homes, and even at the SFA office, depending on accessibility and participant preference. The duration of each interview varied; some were completed relatively quickly, while others took longer due to the depth of discussion or interruptions. In certain cases, the interviews were conducted in multiple sessions to accommodate the participants' availability. Notes and clarifications were often written alongside responses to capture additional context or elaboration provided during the conversation.

Grid maps of the Mahé Plateau, divided into seven sections, were attached to each questionnaire to facilitate spatial identification. This allowed interviewees to identify, and mark suspected spawning and nursery locations directly on the map, based on their knowledge and experience. Printed photographs of common seagrass and seaweeds were used to support discussions and help clarify habitat references during the interviews.

Figure 2: Consent forms being signed and verified prior to interviews

3 Results and Findings

3.1 Socioeconomic Profile of Respondents

Among the 59 respondents, 47 were fishers and 12 were divers. 55 (93.2%) were currently active, while 4 (6.8%) were retired. Of the active respondents, 44 (74.6%) were full-time, 9 (15.3%) were part-time, and 6 (10.2%) were classified as recreational (Figure 3). The respondents had varying levels of experience in fishing and diving activities. As shown in Figure 4, the majority had over 25 years of involvement, while a small number had less than 5 years of experience.

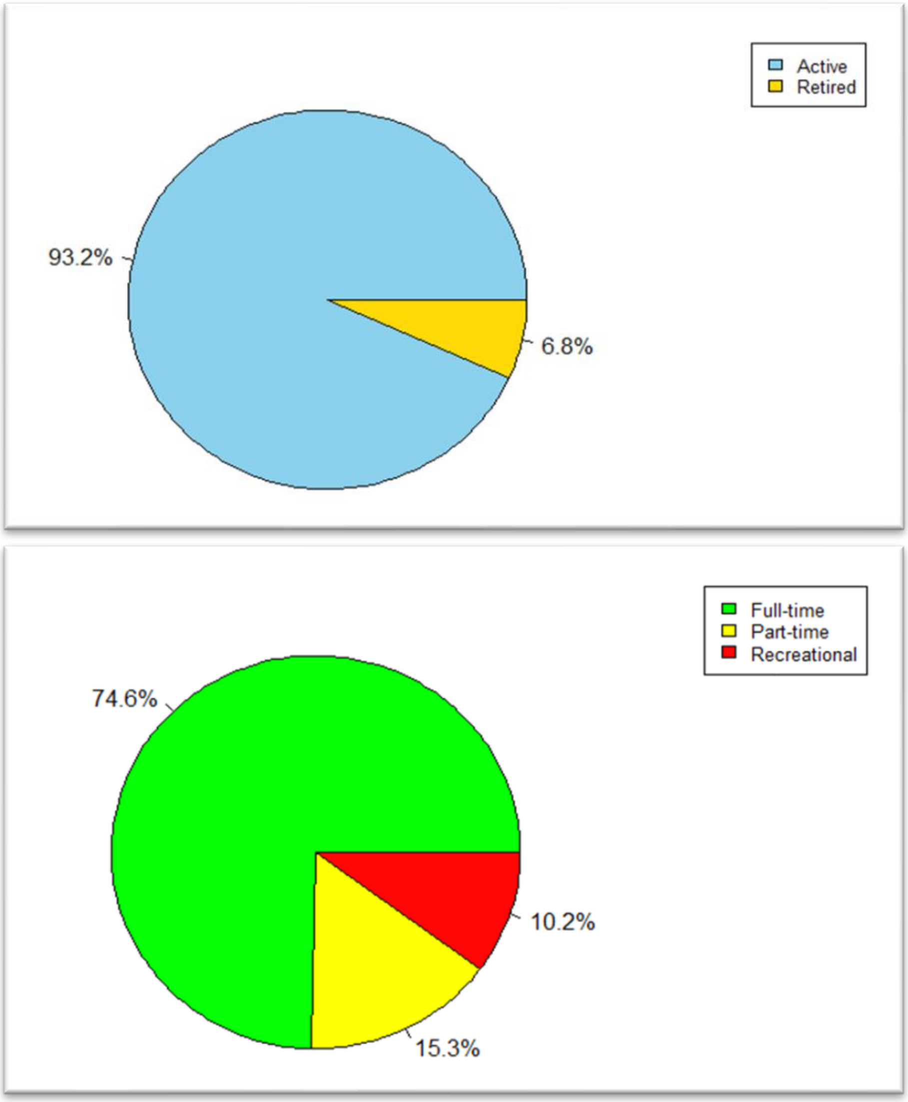

Figure 3: Respondents by activity status (Top), and respondents by employment status (Bottom)

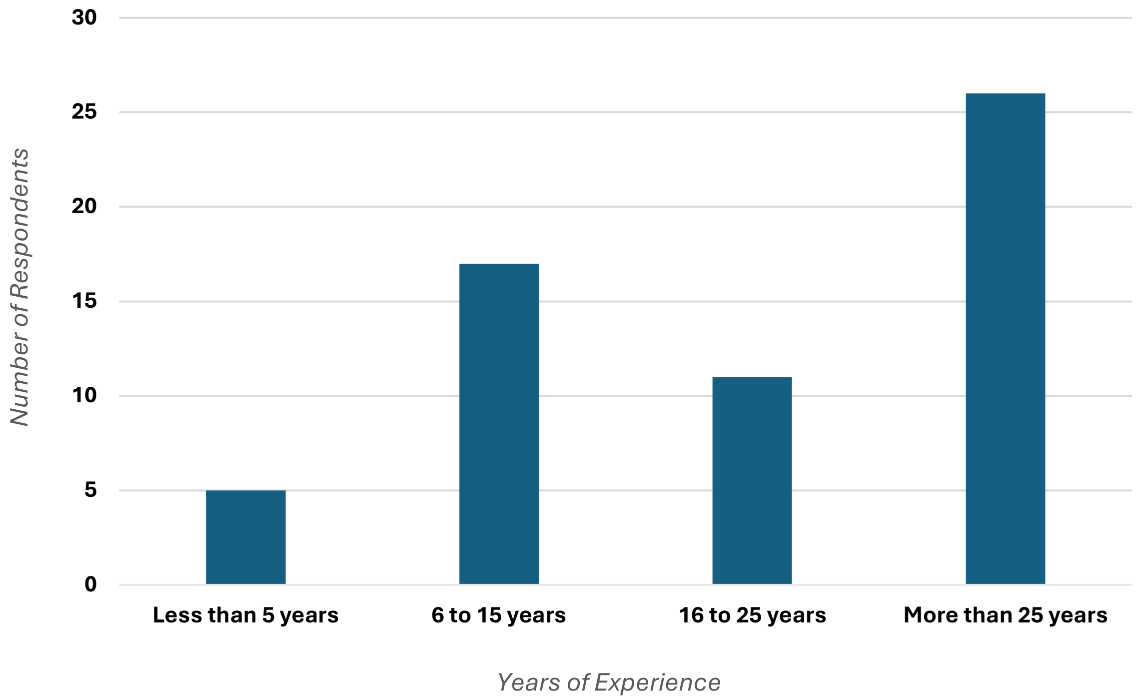

Figure 4: Years of experience in fishing and diving among respondents

3.2 Spawning Aggregations

3.2.1 Observations, Behaviours, and Indicators of *L. sebae* Aggregations

Out of the 59 respondents, 40 (75.5%) reported having observed aggregations of *L. sebae*, while 13 (24.5%) had not (Figure 5). Among those who had observed aggregations, 29 reported seeing More than 10, 4 reported seeing 5 to 9, and 7 reported seeing Less than 5 during their fishing and diving activities (Figure 6). A total of 44 respondents answered whether they believed these aggregations of *L. sebae* were spawning or not. Of these, 33 (75%) believed the *L. sebae* aggregations were spawning, and 11 (25%) did not (Figure 7).

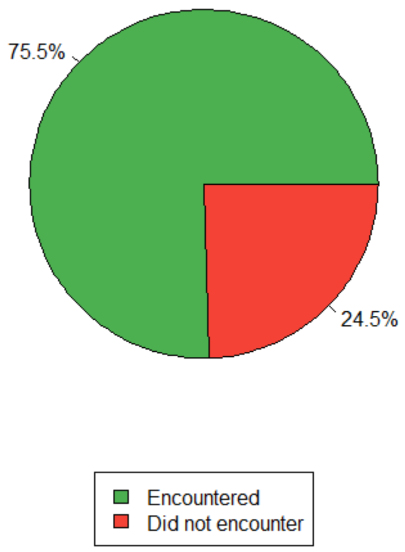

Figure 5: Respondents reporting *L. sebae* aggregations

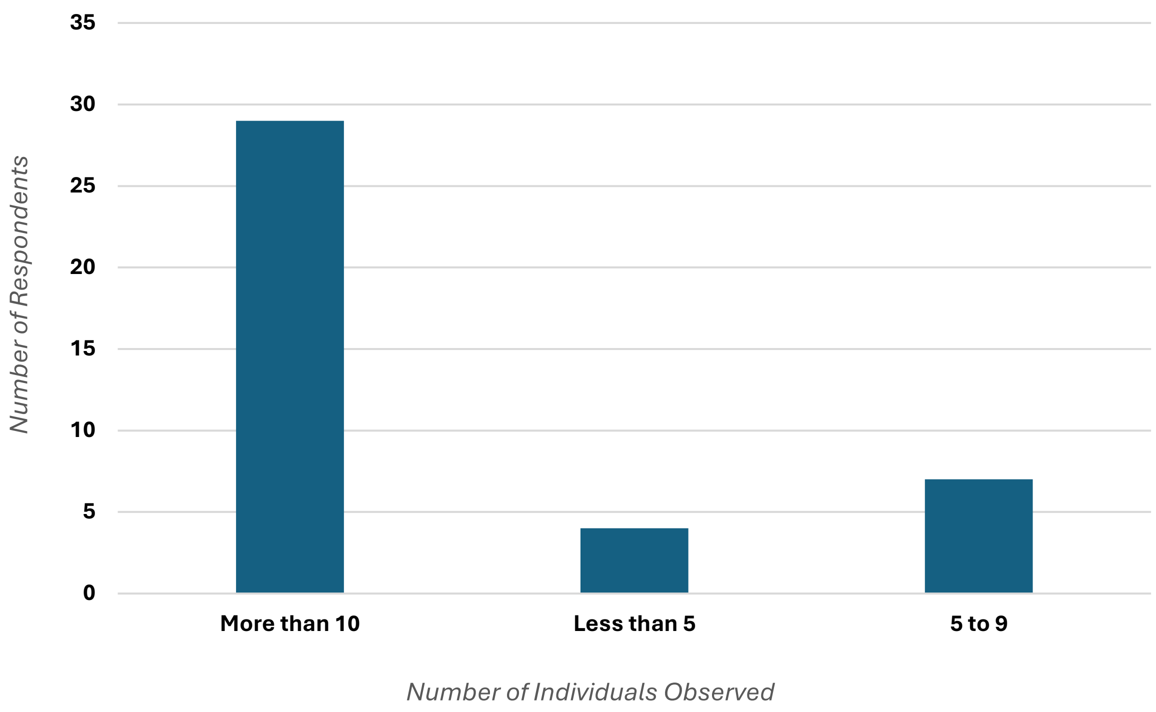

Figure 6: Number of *L. sebae* individuals observed during aggregations

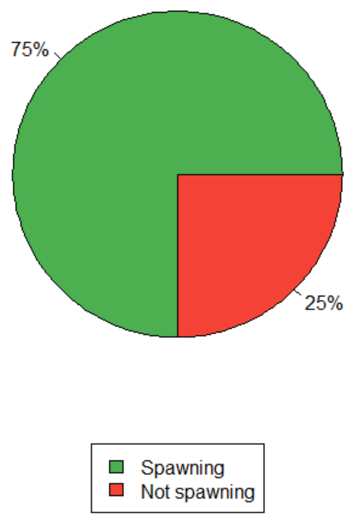

Figure 7: Respondent's beliefs about whether *L. sebae* aggregations were spawning

Respondents were asked to describe behaviours and other known factors they associate with spawning aggregations of *L. sebae*. Responses varied, with the most frequently reported observations being grouping behaviour (n = 22), mature gonads (n = 21), aggressive behaviour (n = 7), and habitat type (n = 3). Notably, 18 respondents either did not provide a response or were unsure of any specific behaviour (Figure 8).

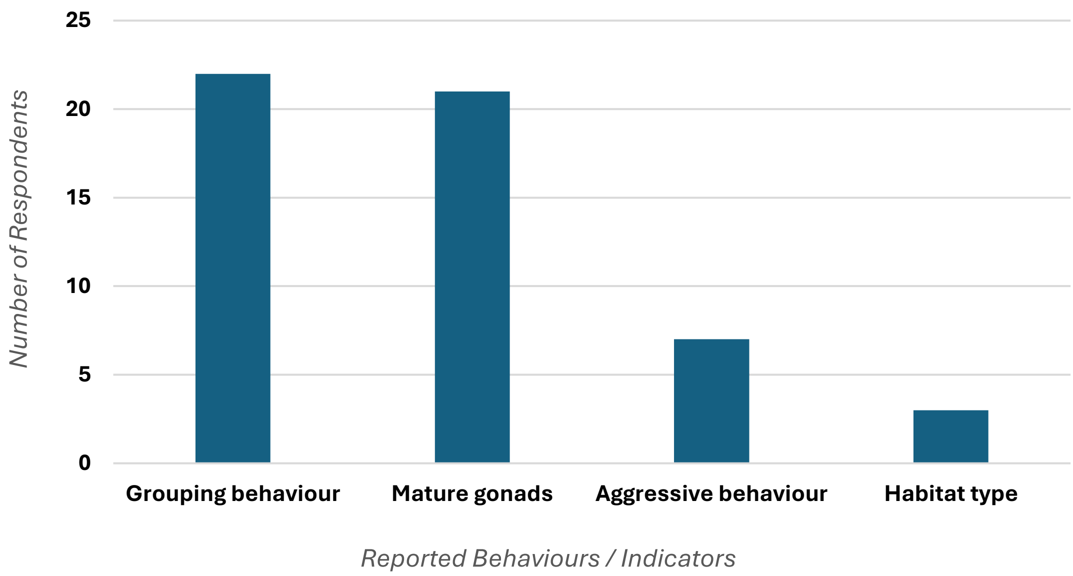

Figure 8: Reported behaviours and other indicators with *L. sebae* spawning aggregations during their activities

Respondents described a variety of benthic habitats associated with observed aggregations of *L. sebae*. The most frequently mentioned habitats were coral reefs (n = 22), followed by mixed habitats (n = 20), which are a combination of coral reefs, seagrass, sandy, and rocky habitats. Other habitat types included sandy bottoms (n = 2), rocky areas (n = 1), and seagrass beds (n = 1). A total of 13 interviewees either did not provide a clear answer, were unsure of the habitat, or referred to less common types not easily categorized (Figure 9).

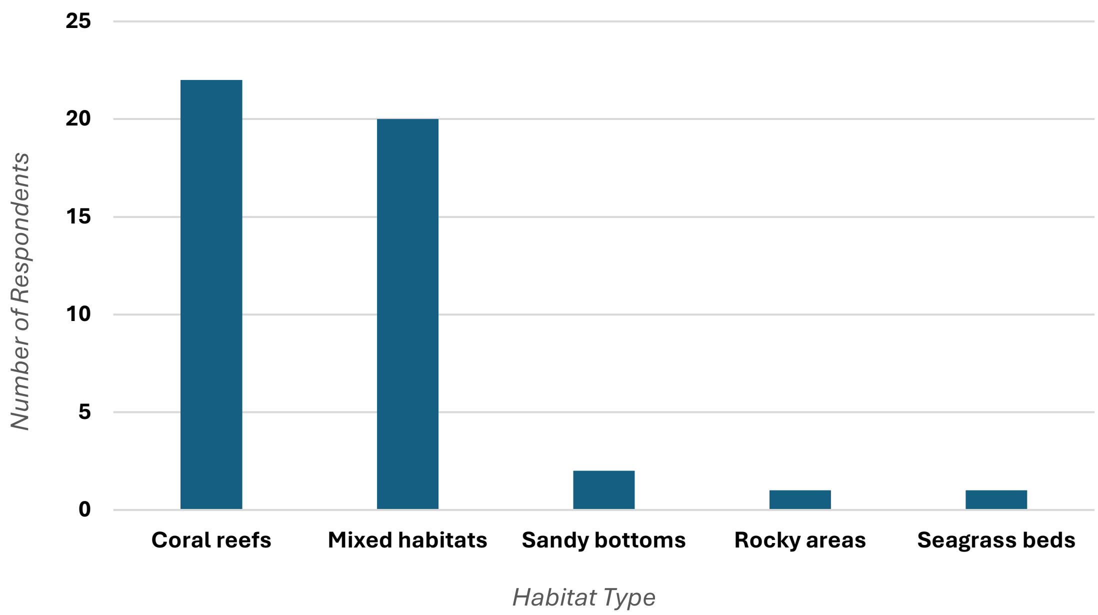

Figure 9: Benthic habitats associated with observed *L. sebae* aggregations

3.2.2 Temporal Patterns of Spawning Aggregations

Responses were analysed to determine the seasonal periods during which aggregations were most frequently observed or fished. Aggregations were most frequently reported between January and April, with 48 mentions. The second most frequently mentioned period was September to December, with 19 mentions. May to August was less frequent, with only 6 mentions. Five respondents mentioned that the aggregations could occur at any time during the year (Figure 10).

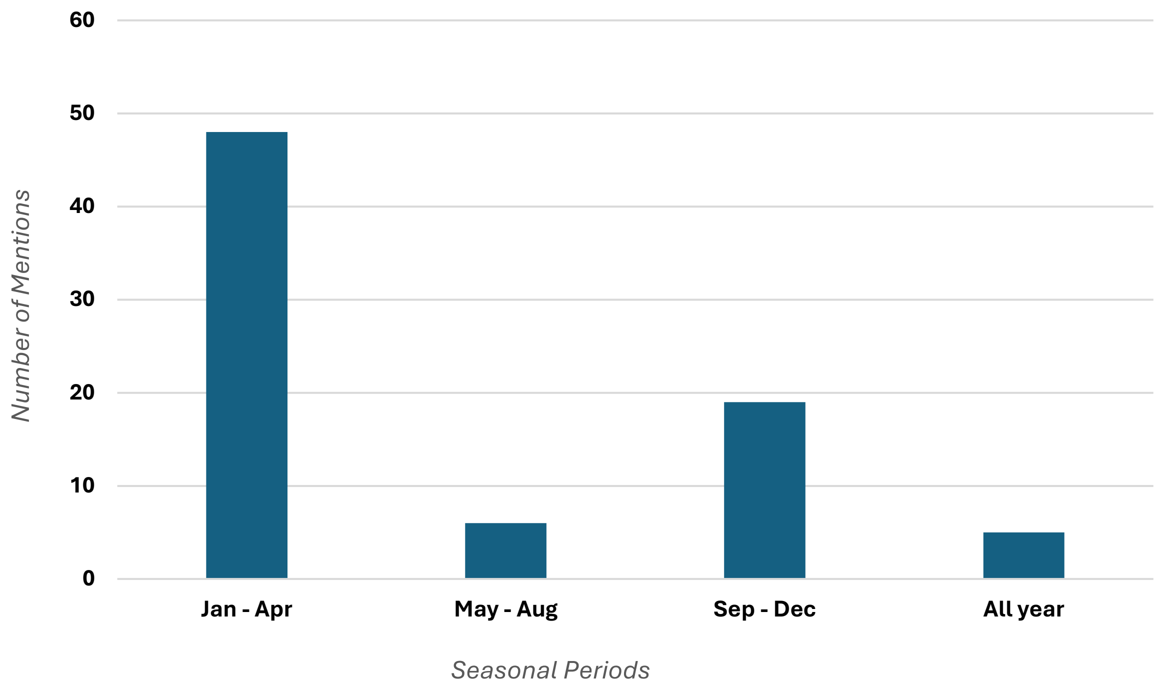

Figure 10: Seasonal periods during which *L. sebae* aggregations were reported to occur

When asked about the duration of observed spawning aggregations, 28 (63.6%) respondents indicated that aggregations typically lasted more than one day, while 16 (36.4%) reported durations of less than one day (Figure 11). Several participants (n = 15) did not provide an answer or were unsure of the duration. For the time of day when aggregations were observed, responses varied with most responses indicating aggregation activities in the morning hours (n = 32), followed by nighttime (n = 15), and afternoon (n = 13). A few mentioned that the aggregations occur at any time of the day (n = 10) (Figure 12), and a total of 7 respondents either did not provide any answers or were unsure of the aggregation times. Most respondents indicated that spawning aggregations varied in timing and occurrence from year to year.

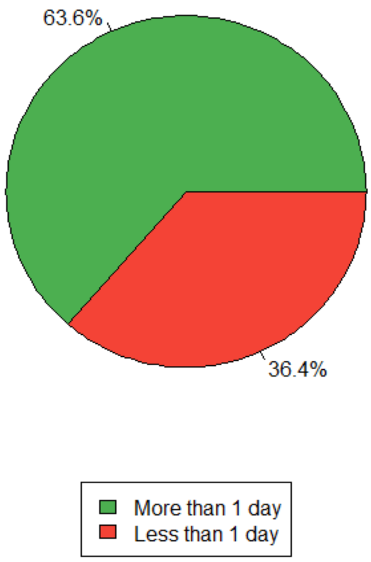

Figure 11: Reported duration of observed *L. sebae* spawning aggregations

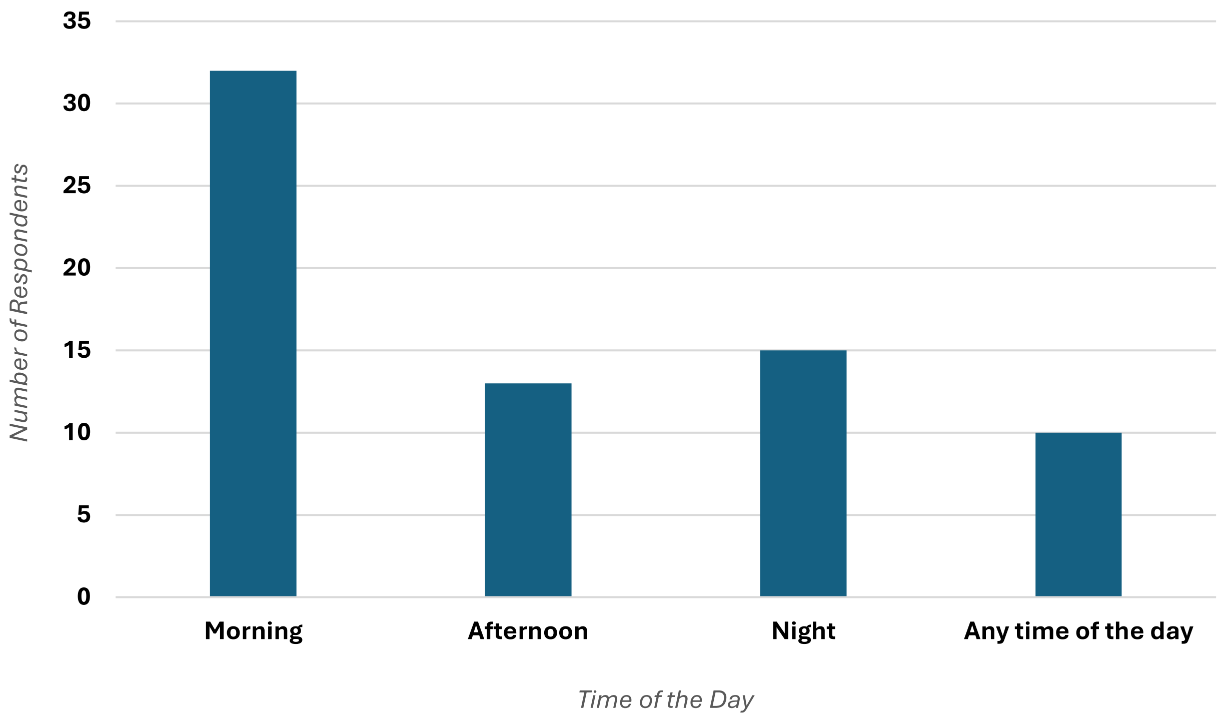

Figure 12: Reported time of the day when *L. sebae* aggregations were observed

3.2.3 Lunar Cycle & Phase

When asked whether the lunar cycle influences spawning aggregation, 50 respondents (94.3%) indicated that there is a connection, while 3 (5.7%) responded that there was not. A few (n = 6) respondents were uncertain or did not provide any information (Figure 13). Among the responses regarding whether the lunar phase influences spawning aggregations, the most common response was “both new moon and full moon” (n = 19), followed by “full moon” (n = 12) and “new moon” (n = 9). Additionally, 19 respondents either did not provide a response or answered no for the lunar phase influence (Figure 14).

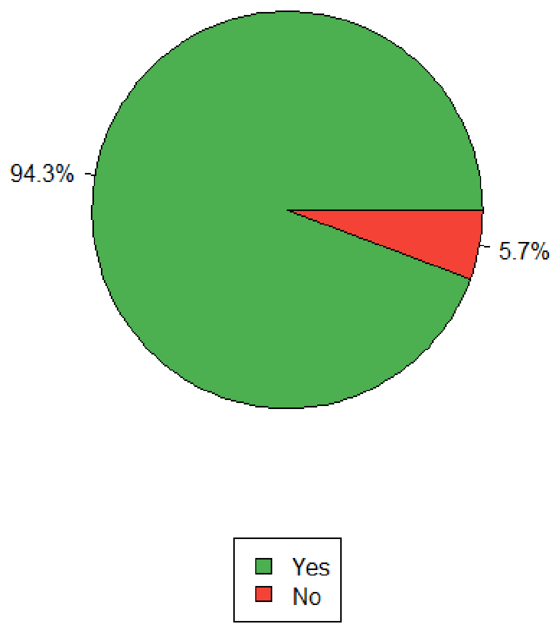

Figure 13: Respondent’s views on whether the lunar cycle influences *L. sebae* spawning aggregations

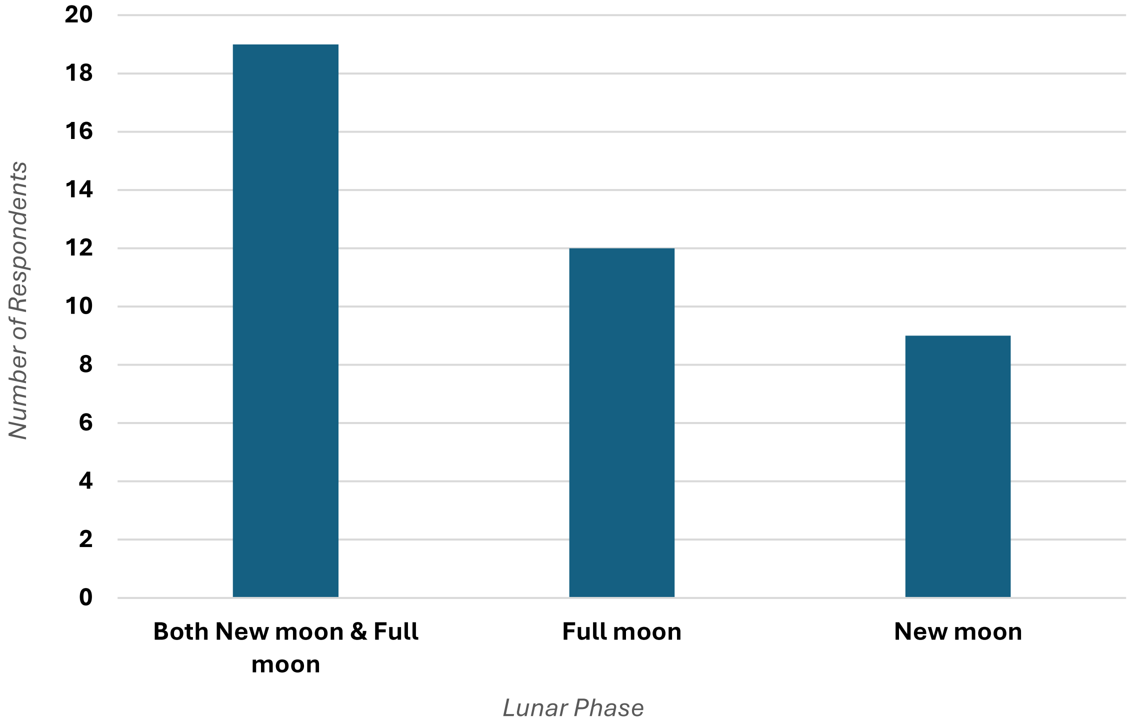

Figure 14: Reported influence of specific lunar phases on *L. sebae* spawning aggregations

3.2.4 Estimates of *L. sebae* Numbers from Divers Observations

Out of 12 divers interviewed, 7 provided estimates of the number of *L. sebae* observed during an aggregation. These estimates were recorded using categorical ranges: "less than 20", "25 to 50", and "more than 100". Five divers either did not know or chose not to respond. The most frequently reported range was "less than 20" individuals by 4 respondents, followed by "more than 100" with 2 mentions and "25 to 50" with 1 mention (Figure 15). While not precise counts, these estimates offer valuable insight into diver perceptions of *L. sebae* abundance during observed aggregation events.

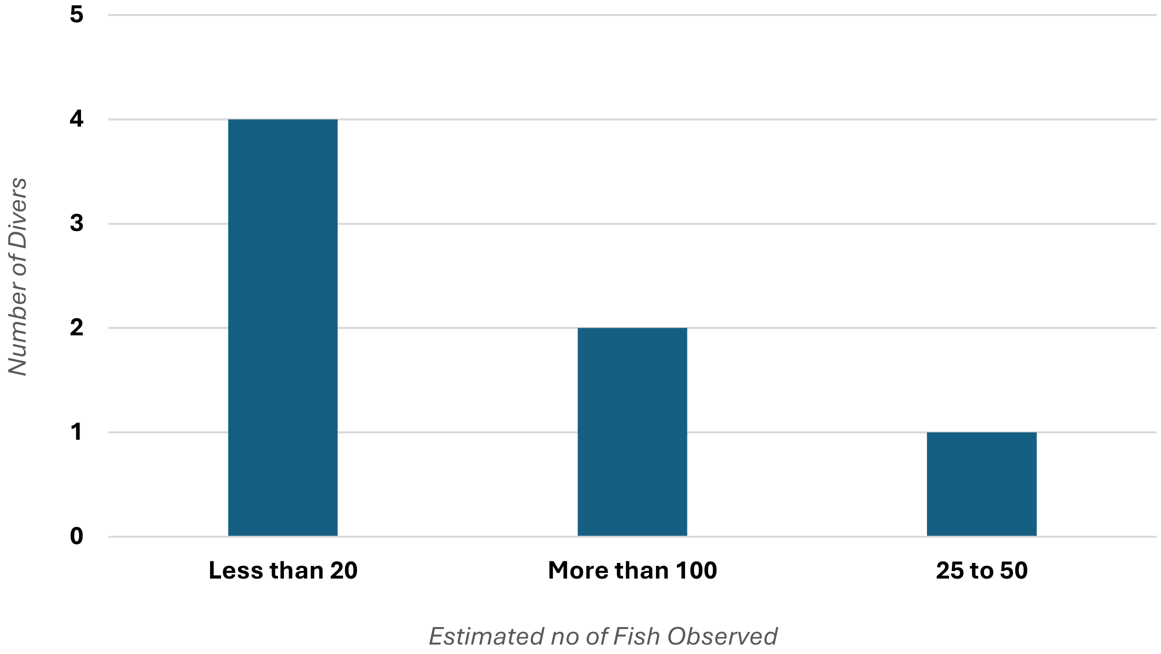

Figure 15: Reported number of *L. sebae* observed within an aggregation

3.2.5 Fisher-Reported Catch Estimates of *L. sebae*

Fishers were asked to estimate both the number of *L. sebae* individuals caught and the total weight of their catch during observed aggregations. All 47 fishers responded, but 14 fishers did not provide, or were unsure of weight and amount estimates. The responses were recorded in categorical ranges with some fishers providing both estimates, some providing only one, and others providing none. For total catch weight, the most frequently reported categories were "more than 500 kg" and "200 to 400 kg", each selected by 12 fishers, followed by "less than 200 kg" selected by 9 fishers (Figure 16). For total catch amount, most fishers (n = 24) reported catching "less than 100" individuals, followed by "100 to 300" individuals (n = 5) and "more than 300" individuals (n = 4) (Figure 17). These estimates provide a semi-quantitative view of the perceived abundance of *L. sebae* during aggregation fishing events.

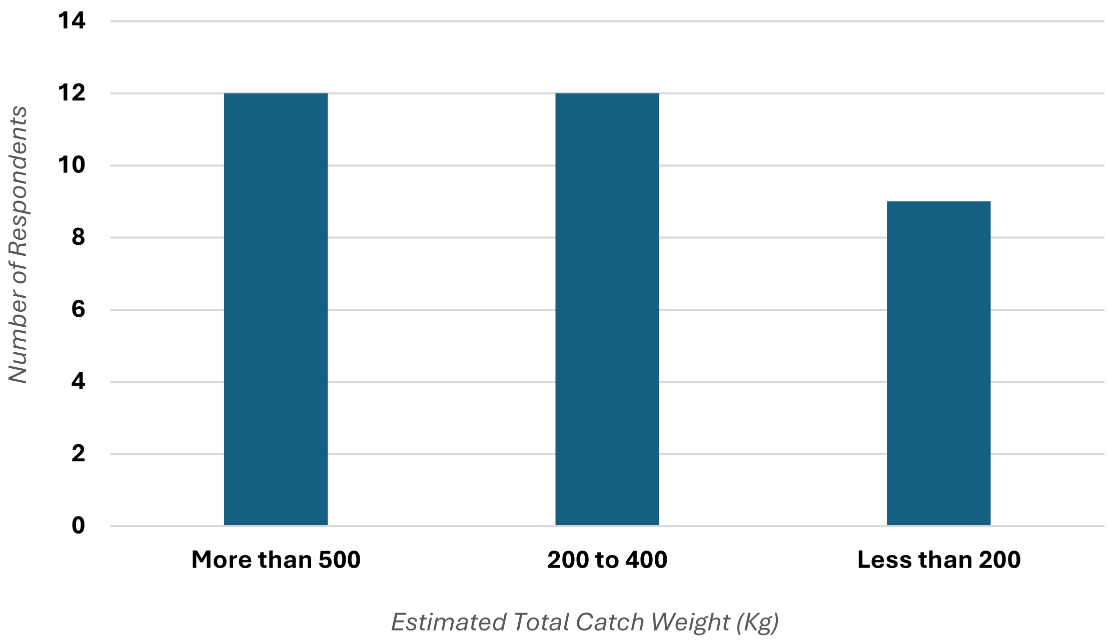

Figure 16: Estimates of *L. sebae* catch weight from fisher observations

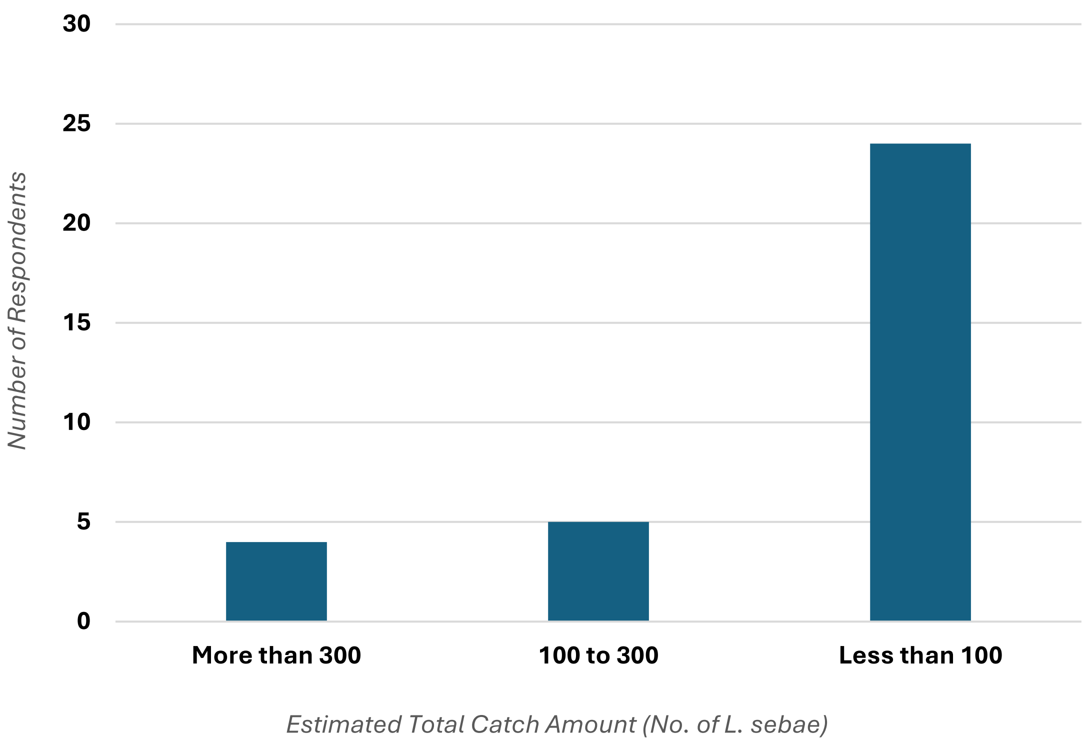

Figure 17: Estimates of *L. sebae* catch amount from fisher observations

3.2.6 Fisher-Reported Effort Estimates

Fishers were asked to estimate their fishing effort during *L. sebae* aggregation events, specifically in terms of time spent fishing and the number of individuals involved in each fishing trip. All 47 fishers responded, and the responses were recorded in categorical ranges with some fishers providing both estimates, some providing only one, and others providing none. For fishing effort (time spent), the most frequently reported category was “more than 5 hours” selected by 17 fishers, followed by “less than 3 hours” (n = 15) and “3 to 5 hours” (n = 12). Three fishers did not provide or were unsure of their effort estimates (Figure 18). For the number of individuals involved per trip, most fishers (n = 24) reported fishing with “3 to 5” men, followed by “less than 3” men (n = 17) and “more than 5” men (n = 1). Five fishers did not provide or were unsure of effort estimates (Figure 19). These estimates provide a semi-quantitative view of the perceived fishing effort associated with *L. sebae* during aggregation fishing events.

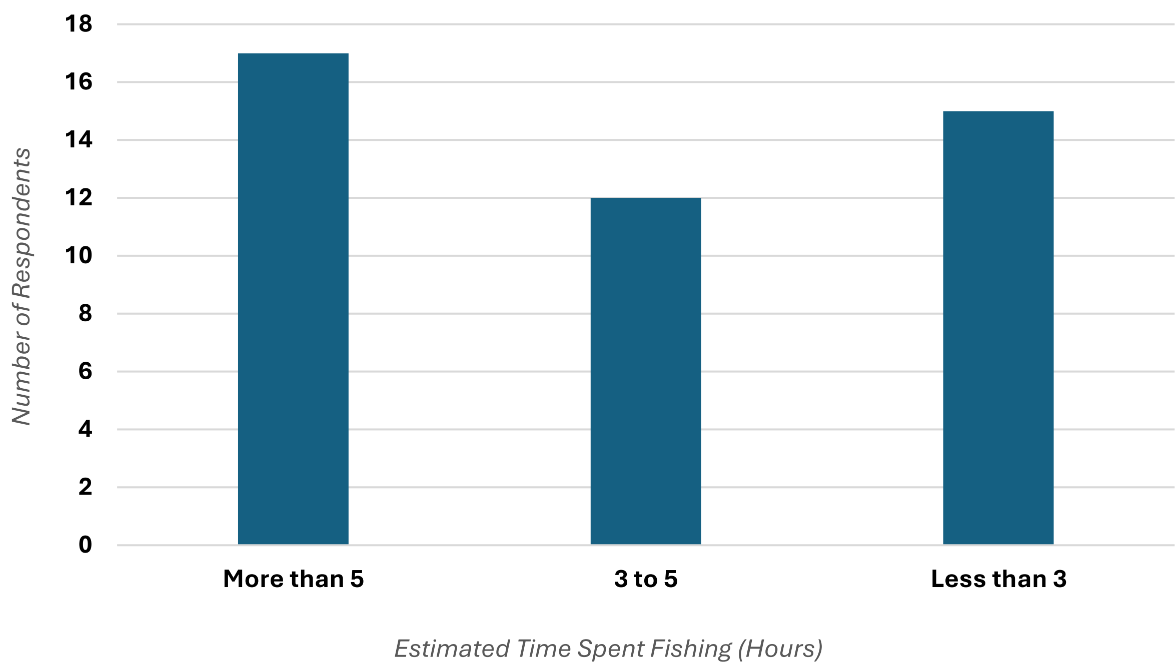

Figure 18: Estimates of fishing efforts during *L. sebae* aggregation events from fisher observations (Time spent)

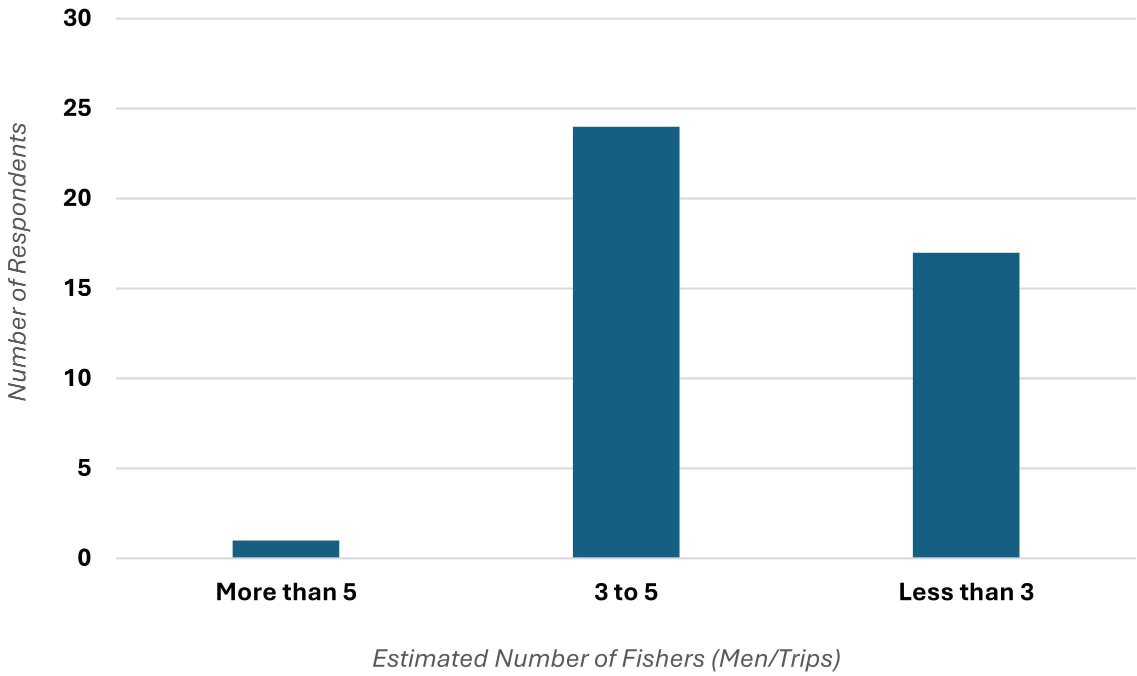

Figure 19: Estimates of fishing efforts during *L. sebae* aggregation events from fisher observations (Number of men per trips)

3.2.7 Perceived Changes in *L. sebae* Size and Amount Over Time

Fishers and divers were asked whether they had noticed any changes in the size of *L. sebae* over the course of their fishing or diving experience. 30 (51%) respondents reported a decrease, while 3 (5%) indicated the size had remained the same, and 2 (3%) reported that it had increased. 24 participants did not provide an answer or were unsure which accounted for 41%. They were also asked whether they had observed any changes in the amount of *L. sebae* encountered during their fishing and diving experience. The majority reported a decrease (n = 32, 54%), while a few perceived the amount had remained the same (n = 2, 3%) or had increased (n = 2, 3%). A substantial number of participants (n = 23, 39%) did not provide an answer or were unsure (Figure 20).

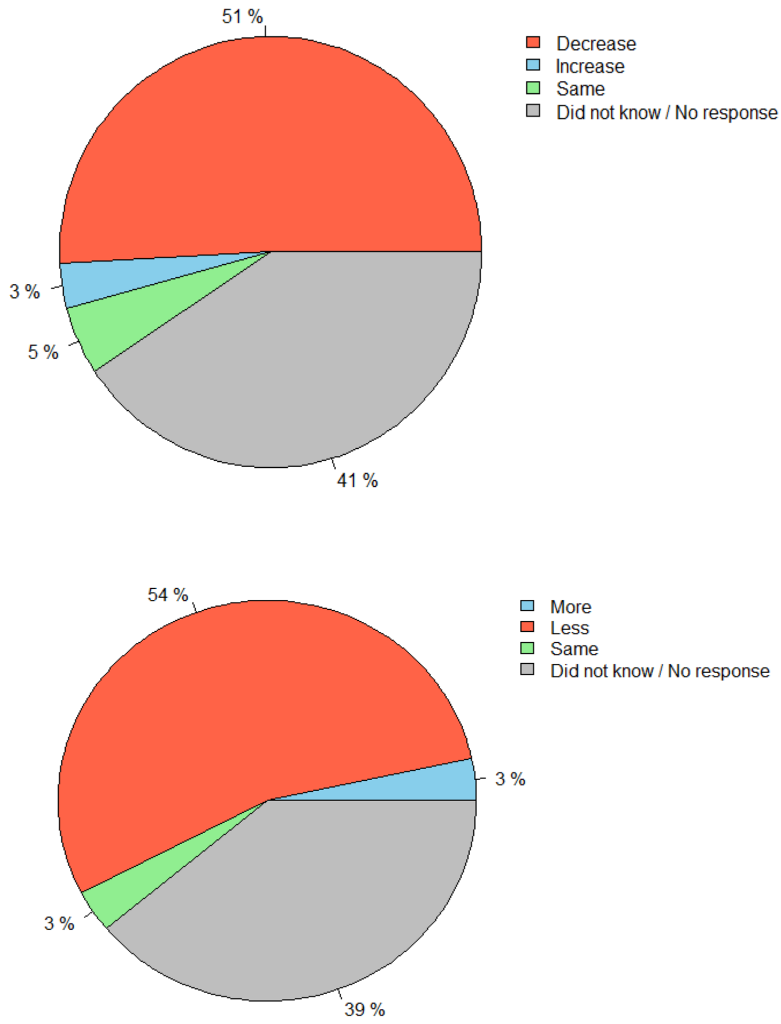

Figure 20: Responses from fishers and divers regarding perceived changes in the size (Top) and amount (Bottom) of *L. sebae* over time

3.2.8 Other Species Observed and Reported During *L. sebae* Aggregation Events

3.2.8.1 By-catch Observed During L. sebae Aggregation by Fishers

Out of the 47 fishers interviewed, the majority reported the presence of by-catch during fishing activities targeting *L. sebae* aggregations. Responses were categorized as "yes", "no", or "did not know/no response". A total of 43 (92%) reported yes, and 2 (4%) reported no, while 2 (4%) did not provide a response or were unsure (Figure 21).

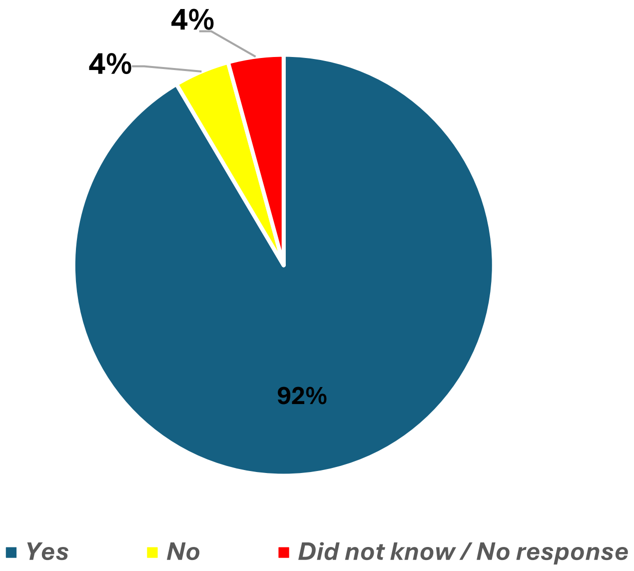

Figure 21: Presence of by-catch reported by fishers

Those who reported by-catch were further asked to identify the species involved and whether the individuals were possibly spawning. The species response categories included Humphead Snapper ("Bordmar", *Lutjanus sanguineus*), Groupers ("Vyey", *Epinephelidae spp*.), Two-spot Snapper ("Varvara", *Lutjanus bohar*), "mixed" (indicating a combination of the species mentioned above) and "others" (referring to by-catch species not specifically listed). Respondents who were unsure or did not provide species-level information were categorized as "did not know / did not respond". Table 1 shows the number of respondents reporting by-catch and those indicating possible spawning within each category. It is important to note that Two-spot Snapper was not reported individually as by-catch or as spawning and has therefore been excluded from the table. Of those who provided a response, 17 respondents (36%) reported that the individuals were spawning, 23 (49%) reported that they were not, and 7 (15%) either did not provide a response or were unsure (Figure 22).

Table 1: Respondents reporting by-catch and possible spawning per response categories

Response Categories	Numbers of Respondents Reporting By-catch	Number of Respondents Indicating Possible Spawning
Humphead Snapper	2	2
Groupers	3	1
Mixed	17	0
Others	21	4
Did not know / Did not respond	4	40

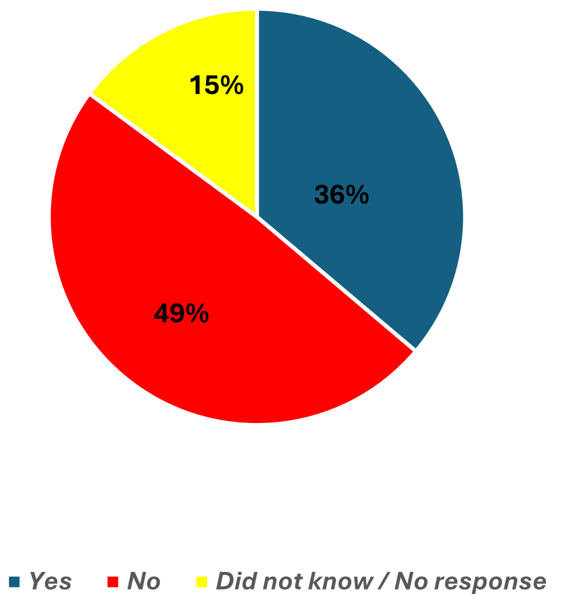

Figure 22: Fisher's report of by-catch spawning status during *L. sebae* fishing

3.2.8.2 Other Fish Observed During L. sebae Aggregations by Divers

Out of the 12 divers interviewed, the majority reported the presence of other fish species in association with *L. sebae* aggregations. Responses were categorized as “yes”, “no”, or “did not know / no response”. A total of 10 (83%) reported “yes” and none reported no, while 2 (17%) did not provide a response or were unsure (Figure 23).

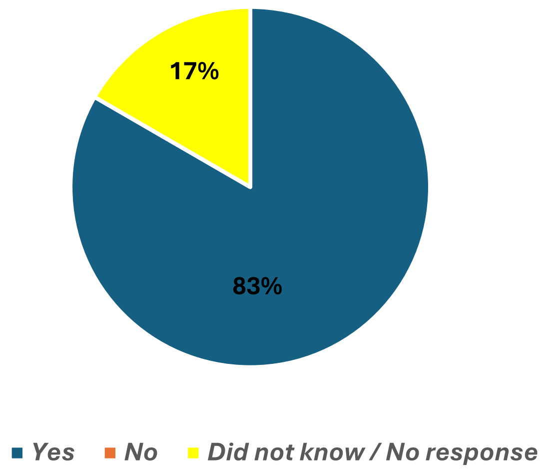

Figure 23: Presence of other species reported by divers

Divers reported observing several other fish species in association with *L. sebae* aggregations. These species or species groups were Humphead Snapper, Groupers, Two-spot Snapper, and several other lutjanids known locally as “Madras” mainly Bengal snapper (*Lutjanus bengalensis*) and Indian snapper (*Lutjanus madras*). Additionally, they were categorised as “mixed fishes” (indicating a combination of the species mentioned above) and “others” (referring to additional species not specifically listed). Respondents who were unsure or did not provide species-level information were categorized as “did not know / did not respond”.

Divers also noted whether the observed individuals were possibly spawning based on visual cues. Table 2 shows the number of respondents reporting other species and those indicating possible spawning within each category. It is important to note that no respondents mentioned only one species; therefore, three categories were used. Of those who provided a response, 5 (42%) reported that the individuals were spawning, 1 (8%) reported that they were not, and 6 (50%) either did not provide a response or were unsure (Figure 23).

Table 2: Respondent reporting other species and possible spawning per response categories

Response Categories	**Numbers of Respondents Reporting Other Species**	**Number of Respondents Indicating Possible Spawning**
Mixed Fish	3	1
Others	7	2
Did not know / Did not respond	2	9

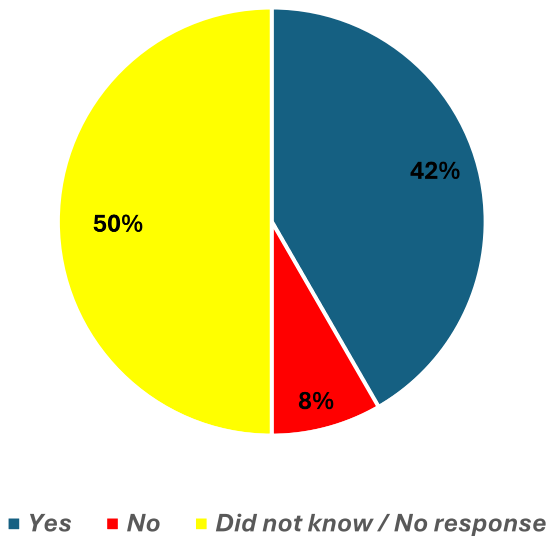

Figure 23: Diver's report of other species spawning status during *L. sebae* fishing

3.2.9 Environmental and Observational variables

To investigate further, a combination of environmental and observational variables was collected throughout the interviews with both fishers and divers. The key variables include sea temperature, depth, visibility, tide, and current. These variables were selected based on their relevance to conditions commonly observed during *L. sebae* spawning periods or typical aggregation events.

3.2.9.1 Sea Temperature

Reported water temperatures during observed aggregations were most commonly within the range of "25–30°C", accounting for 21 out of 59 responses. 14 respondents indicated temperatures "below 25°C", while only one reported a temperature "above 30°C". A substantial number of respondents (n = 23) did not provide information on temperature. These results suggest that aggregations are most frequently observed within the 25–30°C temperature range, although variability in reporting highlights potential knowledge gaps or observational limitations among respondents (Figure 24).

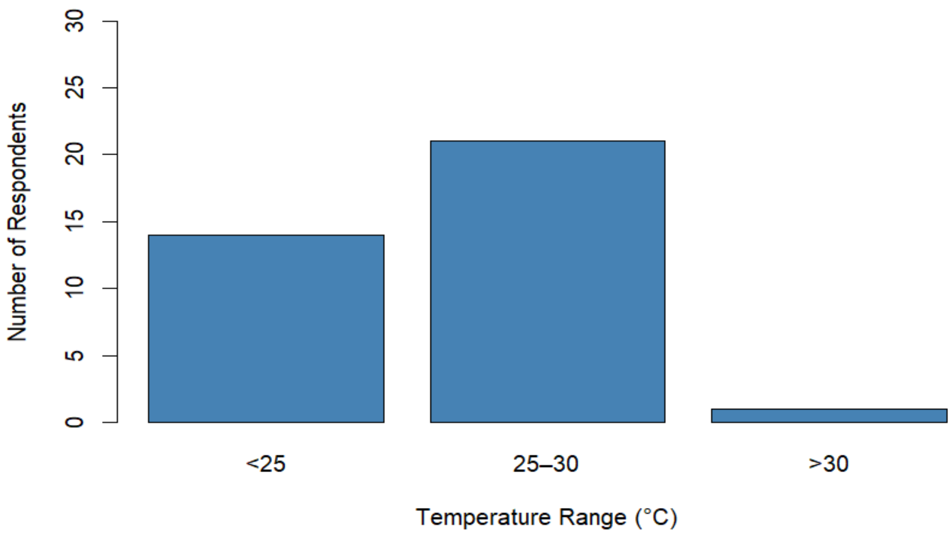

Figure 24: Fisher's and diver's reported sea temperature during *L. sebae* aggregations events

3.2.9.2 Depth

Aggregations were most frequently reported at depths "more than 30 metres", with 43 out of 59 responses indicating this category. Depths between "20–30 metres" were reported by 10 respondents, while only one individual observed aggregation in "less than 20 metres". 5 respondents did not provide depth information. These findings suggest a strong preference or association of aggregations with deeper reef or offshore habitats, predominantly at depths beyond 30 metres (Figure 25).

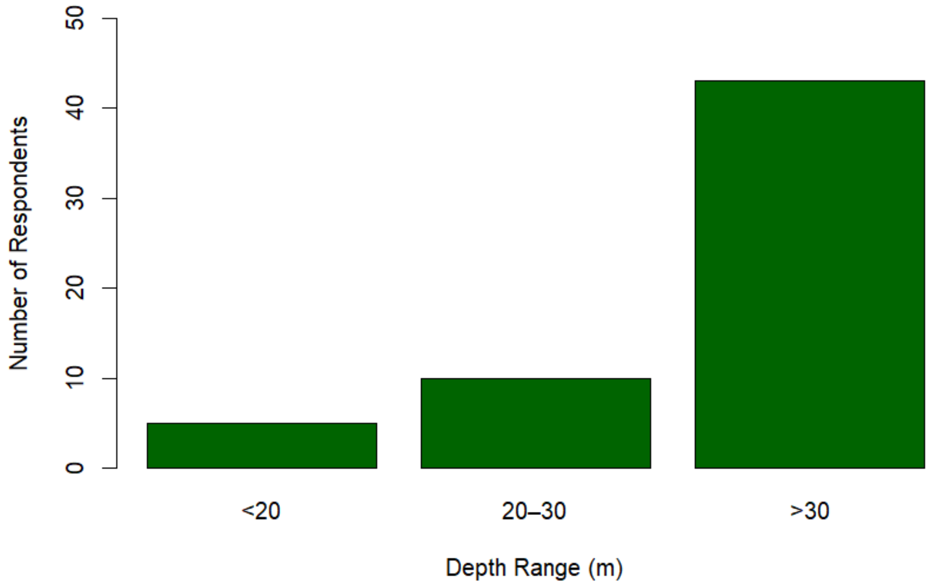

Figure 25: Fisher's and diver's reported depth during *L. sebae* aggregations events

3.2.9.3 Water Visibility

Water visibility during aggregations was most commonly described as "good" (n = 19) and "fair" (n = 17), followed by "excellent" visibility, which was reported by 6 respondents. No respondents mentioned "poor" or "very poor" conditions. 3 individuals selected all categories, possibly reflecting uncertainty or highly variable conditions, and 14 did not provide a visibility rating. Overall, the data suggest that aggregations are generally observed under moderate to high visibility conditions, with low visibility being rarely reported (Figure 26).

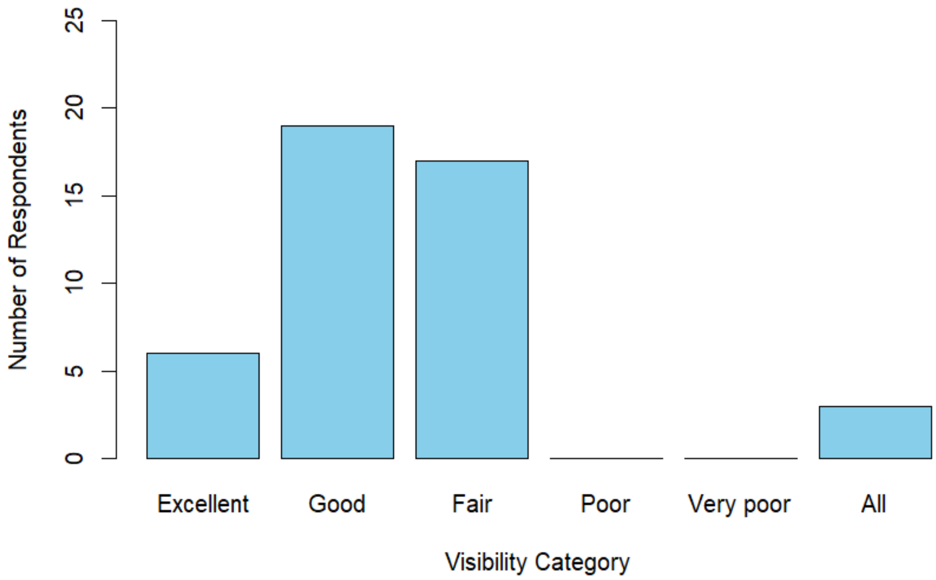

Figure 26: Fisher's and diver's reported visibility during *L. sebae* aggregations

3.2.9.4 Tide

Most respondents (21 out of 59) reported observing aggregations during "high tide" conditions. "Low tide" was mentioned by 5 respondents, while 7 respondents indicated that aggregations occurred during "both" high and low tides. A notable portion of responses (n = 26) were either uncertain or did not provide information on tidal conditions. These findings suggest a possible association between aggregations and high tide periods, though the relatively high number of non-responses indicates that tidal influence may not be consistently recognized or recalled (Figure 27).

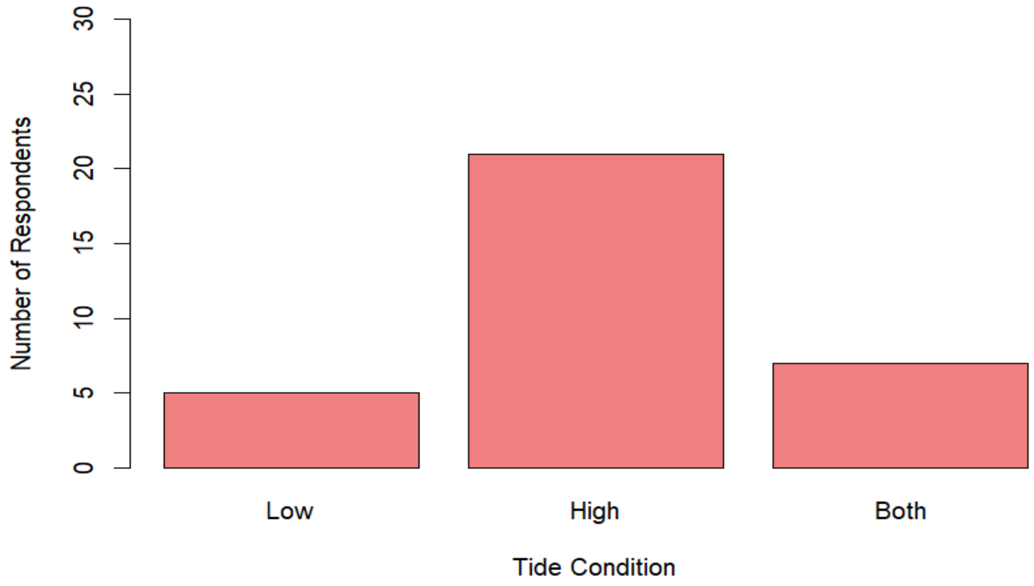

Figure 27: Fisher's and diver's reported tides during *L. sebae* aggregations

3.2.9.5 Current Strength

Aggregations were most commonly reported under "moderate" current conditions, with 19 out of 59 responses. This was followed by "weak" (n = 12) and "very weak" currents (n = 8). "No current" was noted in 6 cases, while "strong" currents were reported less frequently (n = 4). An additional 3 respondents selected all categories, and 7 did not provide information. These results suggest that aggregations are most often associated with low to moderate current flow, potentially indicating a preference for stable but dynamic water movement (Figure 28).

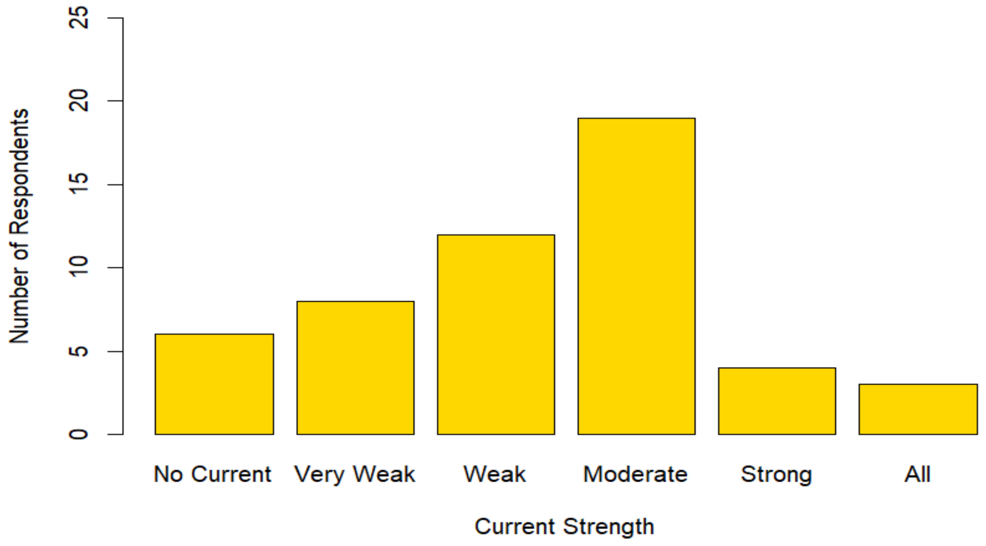

Figure 28: Fisher's and diver's reported currents during *L. sebae* aggregations

3.3 Nursery Areas

3.3.1 Juvenile *L. sebae* Identifications

All 59 respondents interviewed were able to identify juvenile *L. sebae* and were subsequently asked how they identify them. Their responses were grouped into the following categories: "32 cm" (SFA's current measure), "Colour," "Physical" (identification through visual cues or experience), "Size," "Mixed" (a combination of the criteria mentioned above), and "Others" (methods not specifically listed). The most frequently reported approach was the "Mixed" category, cited by 31 respondents. "Colour" and "Size" were each mentioned by 12 respondents. In contrast, identification based solely on a specific length (32 cm), physical characteristics, or other unspecified criteria ("Others") was reported by only one respondent each. One respondent did not provide a response (Figure 29).

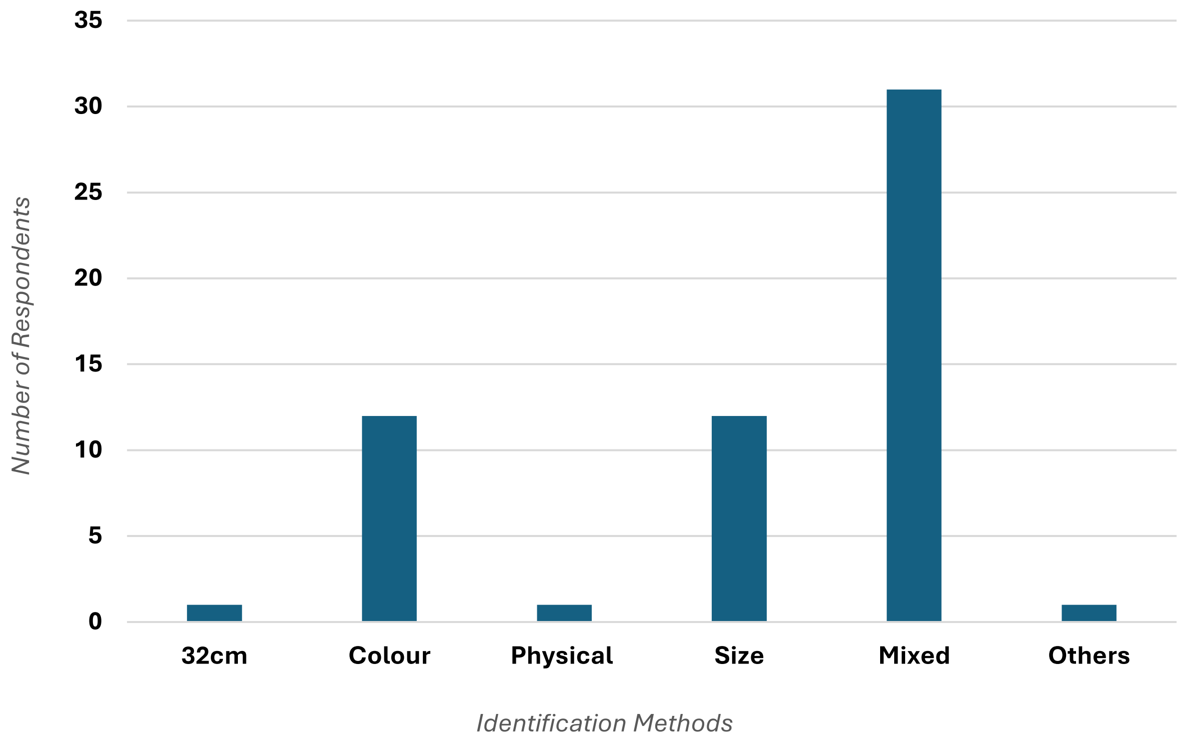

Figure 29: Reported methods used by respondents to identify juvenile *L. sebae*

3.3.2 Observations, Behaviours, and Indicators of *L. sebae* Nursery Areas

3.3.2.1 Diver Observations of Juvenile L. sebae at Potential Nursery Areas

Out of 12 divers interviewed, all provided estimates of how often they had observed groups of juvenile *L. sebae* and the number of individuals seen at potential nursery areas. The frequency of sightings was recorded using categorical ranges: “less than 5”, “5 to 9”, and “more than 10”. One diver did not respond to this question. Of the remaining 11, one reported “5 to 9”, while 5 divers each reported “less than 5” and “more than 10” (Figure 30). Regarding the number of individuals observed during these sightings, 7 reported “less than 5”, 3 reported “more than 10” and 2 reported “5 to 10” (Figure 31). While not precise counts, these estimates offer valuable insight into diver perceptions of juvenile *L. sebae* abundance during observed aggregation events.

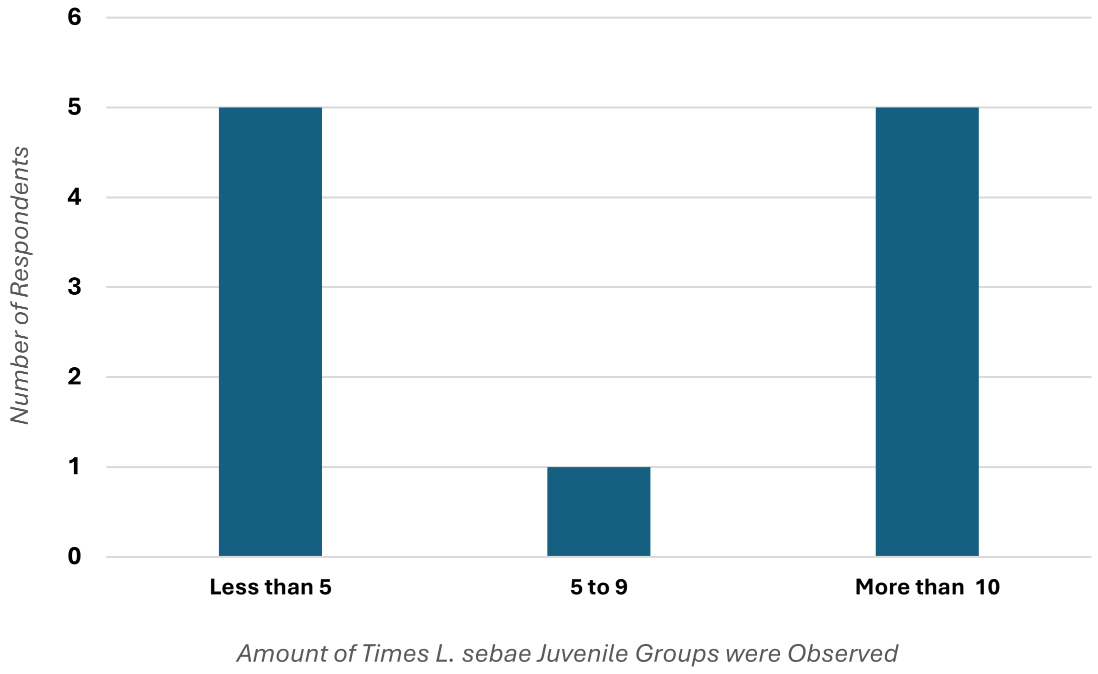

Figure 30: Respondents report on number of times juvenile *L. sebae* were observed in groups

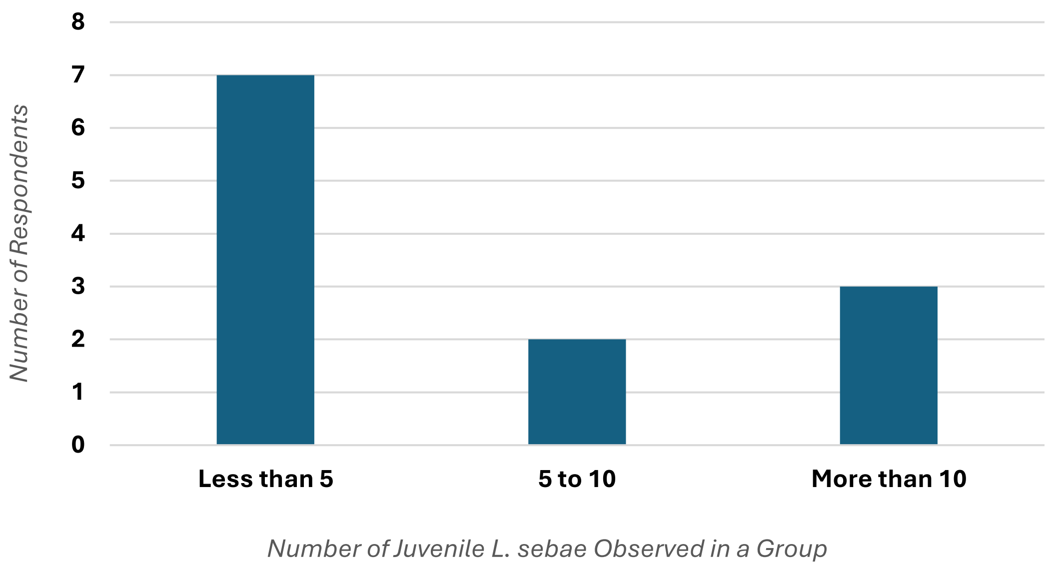

Figure 31: Respondents report on number juvenile *L. sebae* observed in groups

3.3.2.2 Fishing Methods Through Which Juvenile L. sebae are Caught

Fishers were asked to report the fishing methods through which juvenile *L. sebae* had been incidentally captured. Responses were categorized into three groups: "Traps," "Lines and Hooks," and "Both" (referring to the use of both methods). A total of 47 responses were recorded. Of these, 5 fishers reported incidental capture using traps, 32 through lines and hooks, and 10 through both methods. These findings indicate that juvenile *L. sebae* are most commonly encountered during line and hook fishing activities, despite not being the primary target.

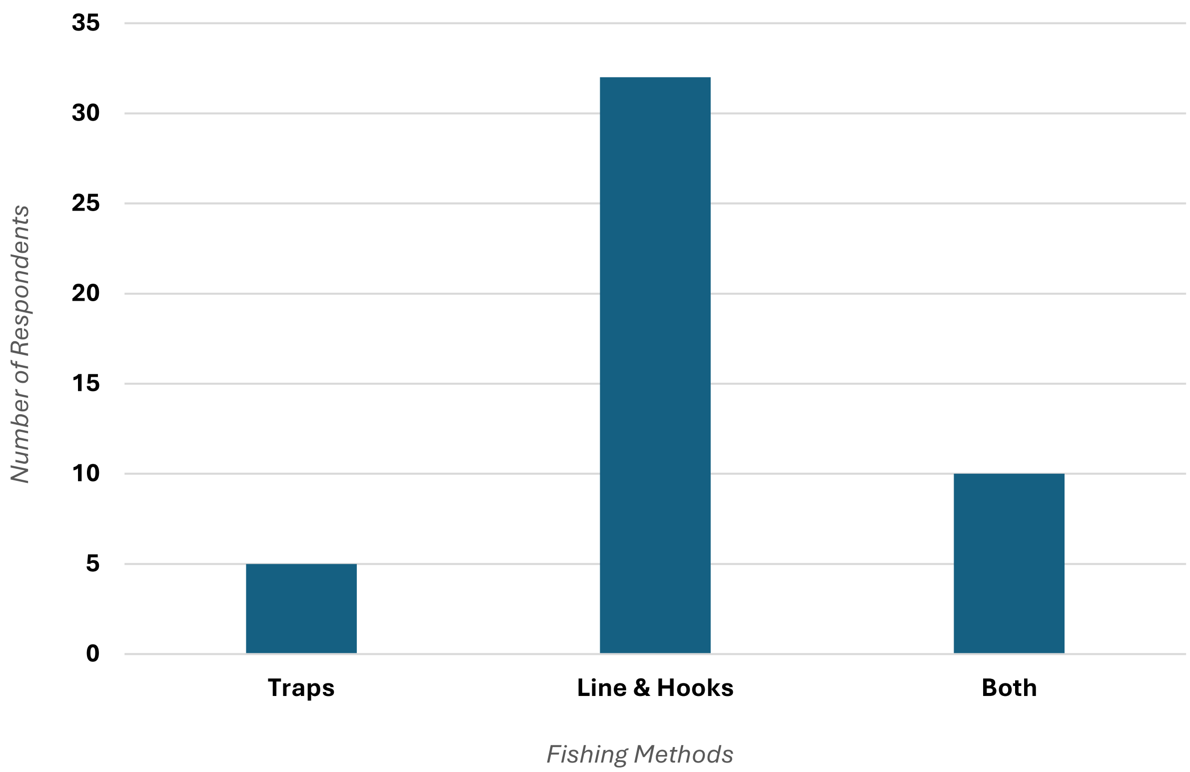

Figure 32: Respondents report on number juvenile *L. sebae* observed in groups

3.3.2.3 Types of Baits Used in the Traps and Line and hooks Fishing Methods

Fishers were asked to identify the types of bait used when juvenile *L. sebae* were incidentally captured using traps or lines and hooks. Responses were categorized as follows: "Squid", "Bonito," "Mackerel," "Both Bonito and Mackerel," "Mixed" (a combination of squid, bonito, and mackerel), and "Others." A total of 41 responses were recorded. Of these, 4 fishers reported using bonito, 6 used mackerel, 12 used both bonito and mackerel, and 19 reported using mixed bait. Although squid was listed as an option, it was never mentioned as the sole bait type and was instead included in mixed bait combinations. A small number of responses fell into the "Others" category, referring to bait types not specifically listed (Figure 33). These results indicate that mixed bait, particularly combinations involving squid, bonito, and mackerel, is the most commonly used during fishing activities where juveniles are incidentally captured.

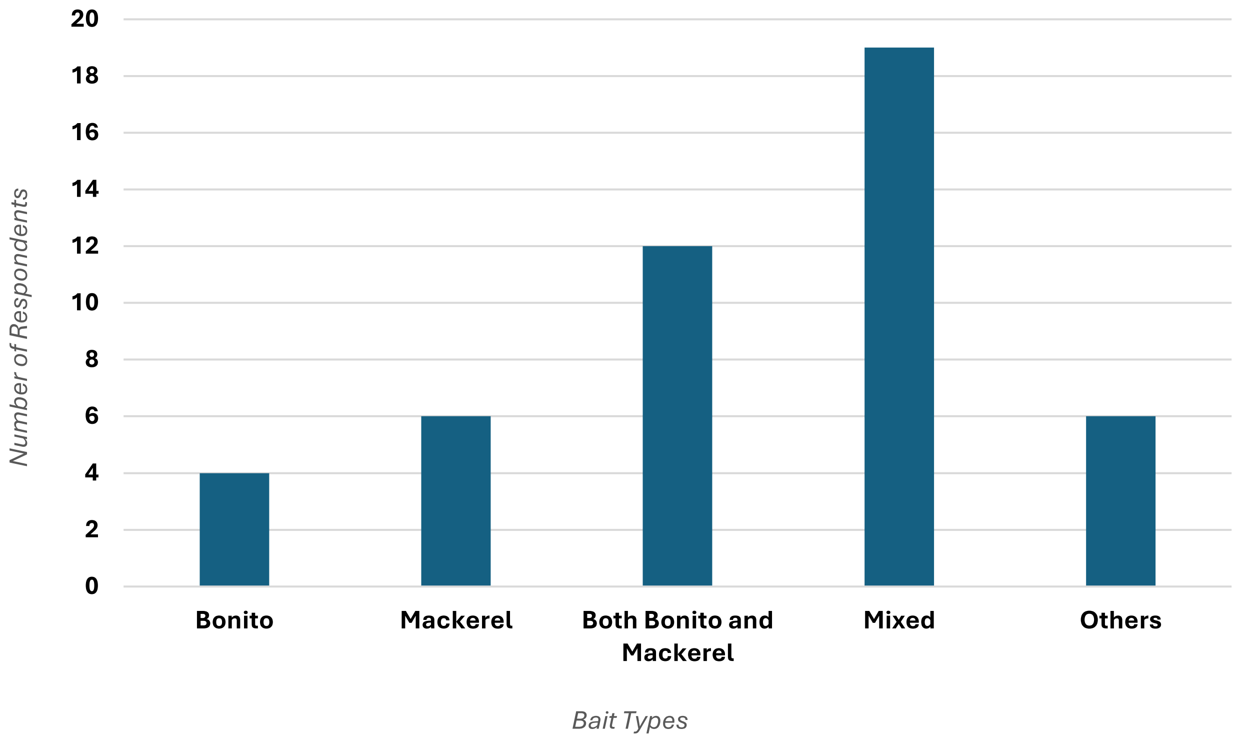

Figure 33: Respondents report on number juvenile *L. sebae* observed in groups

3.3.2.4 Fisher-report Catch Estimates of Juvenile L. sebae

Fishers were asked to estimate both the number of juvenile *L. sebae* individuals caught and the total weight of their catch during fishing using both traps and lines and hooks. 46 fishers responded. Of these, 30 either did not provide or were unsure of the weight estimate, and 7 did not provide or were unsure of the estimated number of individuals caught. The responses were recorded in categorical ranges, with some fishers providing both estimates, some providing only one, and others providing none. For total catch weight, the most frequently reported categories were "less than 100 kg", selected by 16 fishers, while the rest did not know or did not provide any answer (Figure 34). For total catch amount, most fishers (n = 38) reported catching "less than 100" individuals, while one fisher (n = 1) reported catching "more than 200" individuals (Figure 35). These estimates provide a semi-quantitative view of the perceived abundance of juvenile *L. sebae* in potential nursery areas.

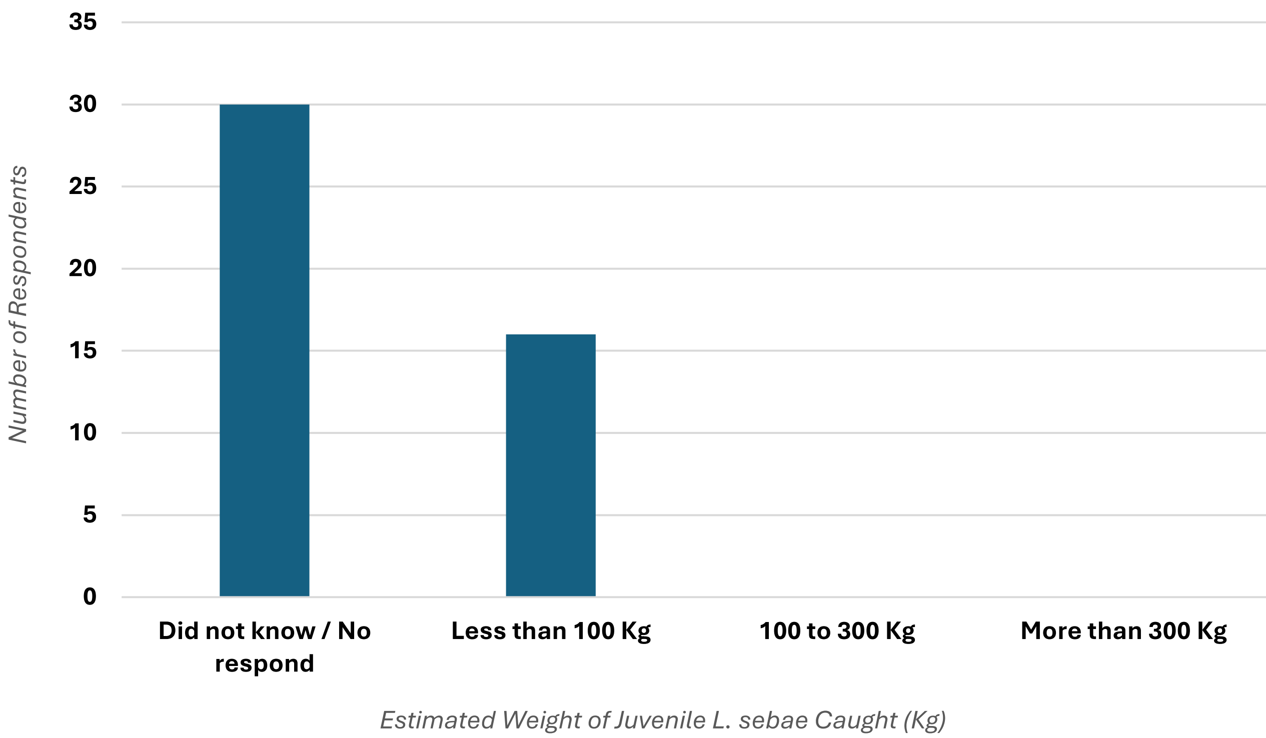

Figure 34: Estimated weight of juvenile *L. sebae* caught in traps or lines and hooks

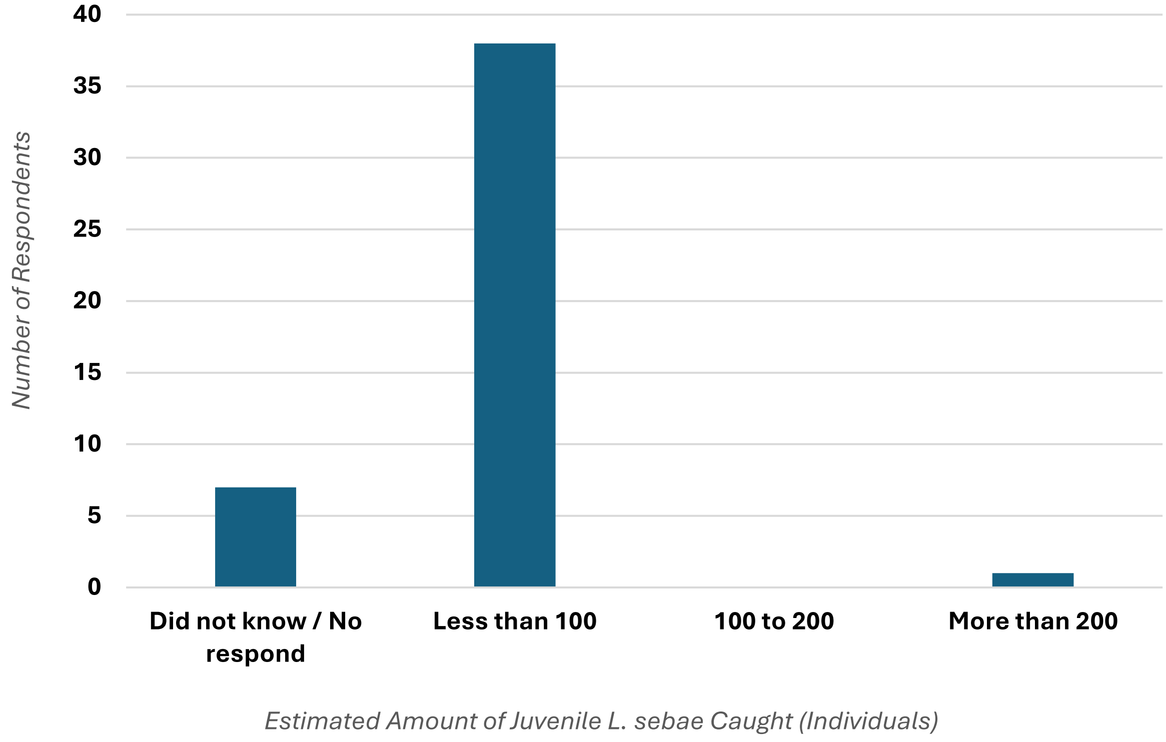

Figure 35: Estimated amount of juvenile *L. sebae* caught in traps or lines and hooks

3.3.2.5 Diver-report Observations of Juvenile L. sebae

All 12 respondents reported having observed juvenile *L. sebae* during their diving activities. Of these, 5 reported seeing "more than 10" individuals, 1 reported seeing "5 to 9", and 6 reported seeing "less than 5" (Figure 36). When asked how many juveniles were observed together in a single grouping, 11 respondents provided an estimate: 3 reported seeing "more than 10" individuals, 2 reported seeing "5 to 10", and 6 reported seeing "less than 5" (Figure 37).

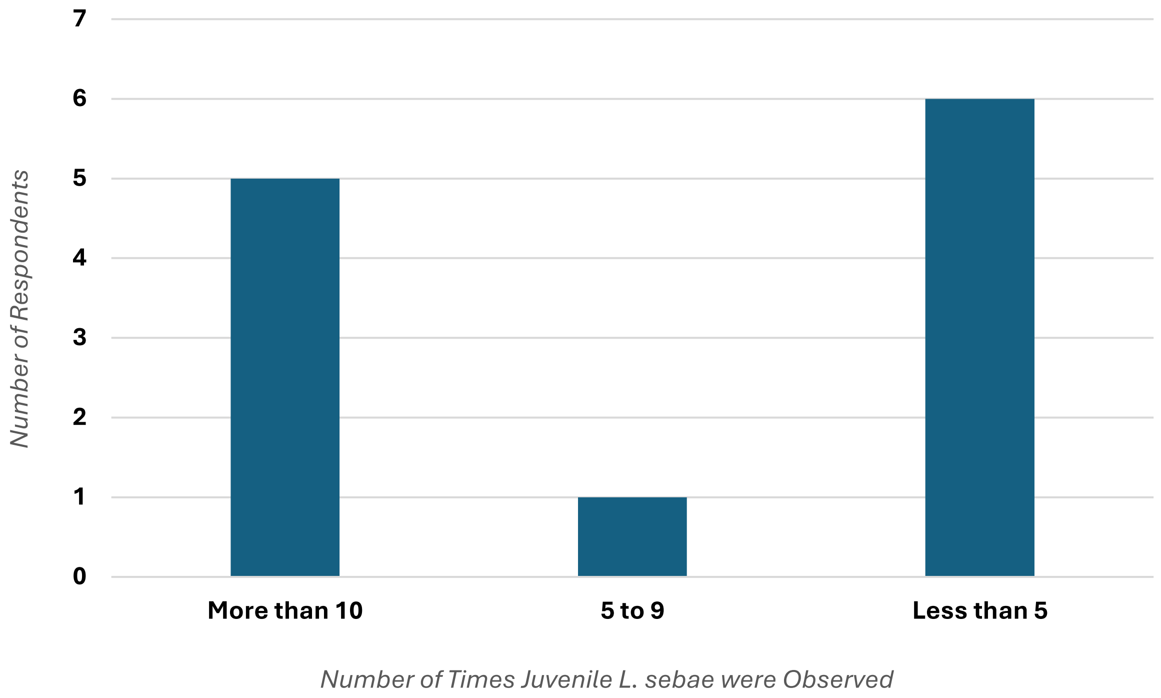

Figure 36: Number of respondents reporting number of times juvenile *L. sebae* were observed

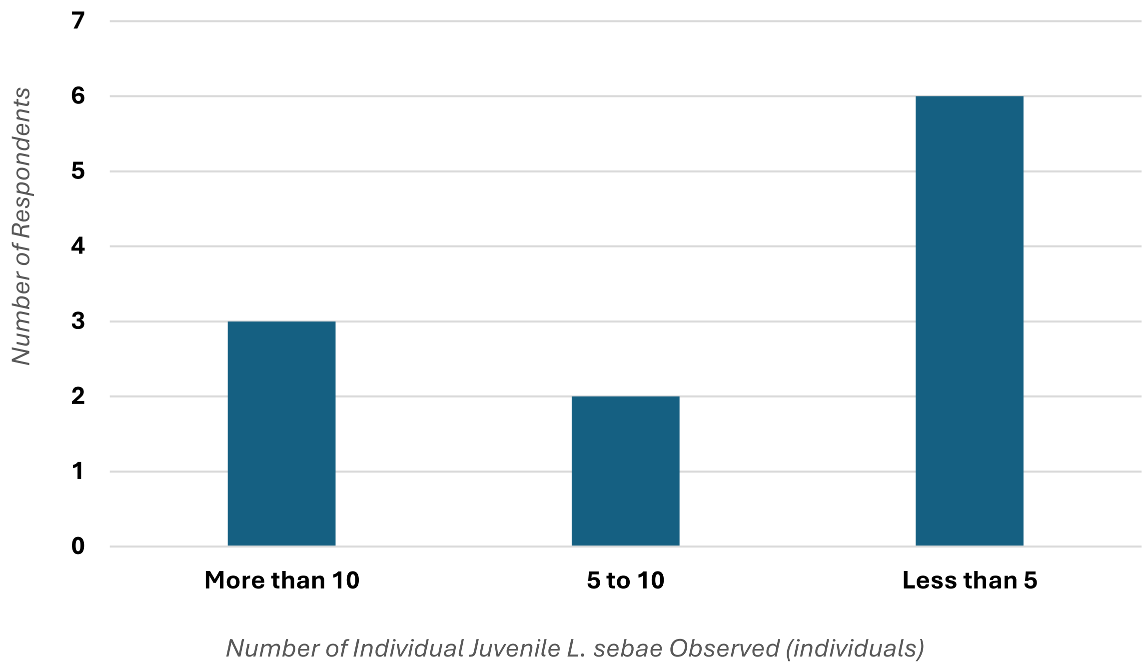

Figure 37: Number of respondents reporting number of individual juvenile *L. sebae* observed together

Divers who had observed juvenile *L. sebae* at potential nursery areas were asked to estimate the sizes of the juveniles and whether their presence in the water appeared to influence the behaviour or presence of the fish. Of the 12 divers interviewed, 2 (17%) reported that their presence appeared to influence the behaviour of juvenile *L. sebae*, while the remaining 10 (83%) observed no noticeable effect (Figure 38). The observed size ranges of juvenile *L. sebae* were as follows: "less than 25 cm" (n = 3), "20 to 35 cm" (n = 7), and "35 to 50 cm" (n = 2). No respondents reported observing individuals "more than 50 cm" (Figure 39).

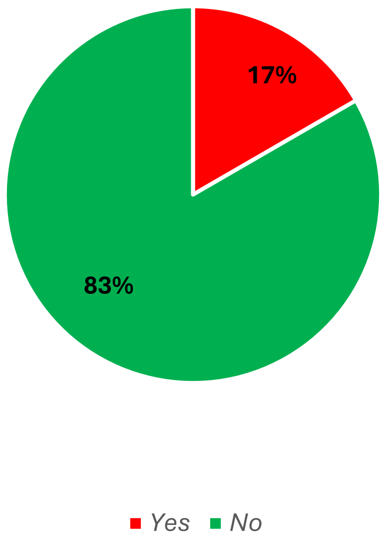

Figure 38: Perceived influence of the presence of divers around juvenile *L. sebae*

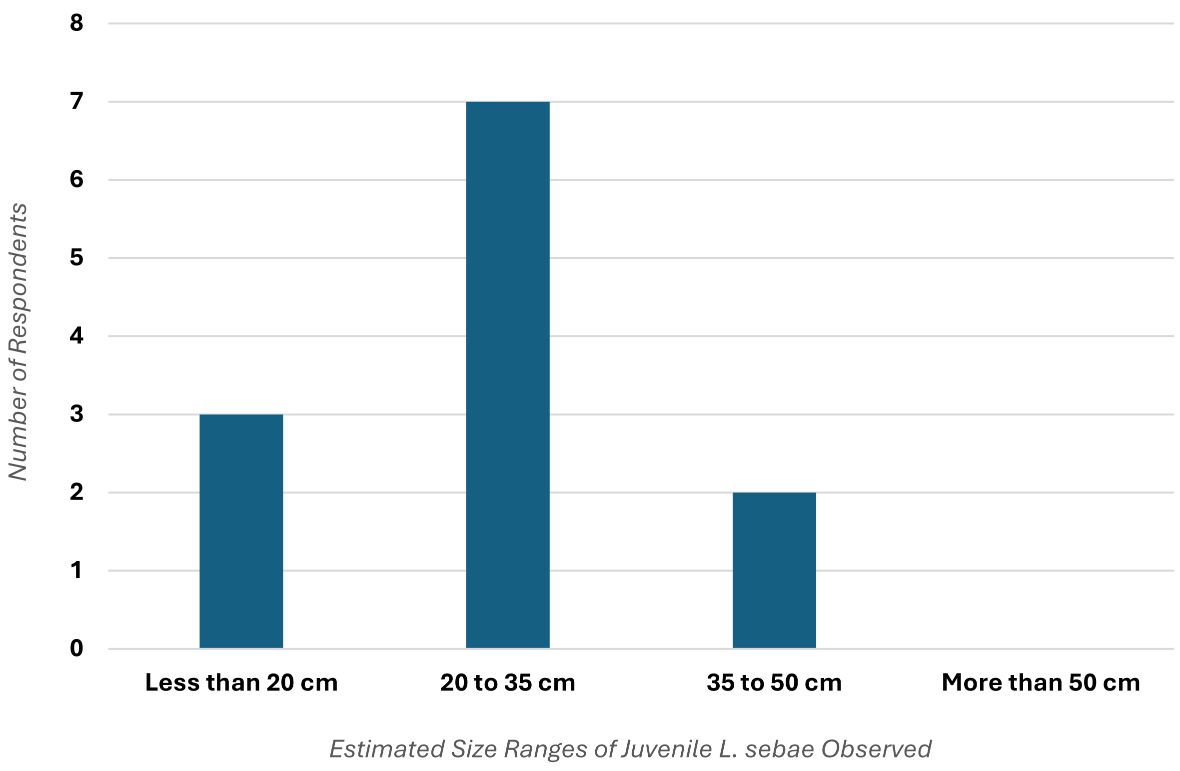

Figure 39: Estimated size ranges of juvenile *L. sebae in* potential nursery areas

3.3.2.6 Reported Habitat Types Associated with Juvenile L. sebae

Respondents described a variety of benthic habitats associated with observed nursery areas of *L. sebae*. The most frequently mentioned habitats were coral reefs (n = 25), followed by mixed habitats (n = 23), which is the combination of coral reefs, seagrass, sandy and rocky habitats. Other habitat types included sandy bottoms (n = 2), rocky areas (n = 1), and no respondents mentioned seagrass beds alone. A total of 8 interviewees either did not provide a clear answer, were unsure of the habitat, or referred to less common types not easily categorized (Figure 38).

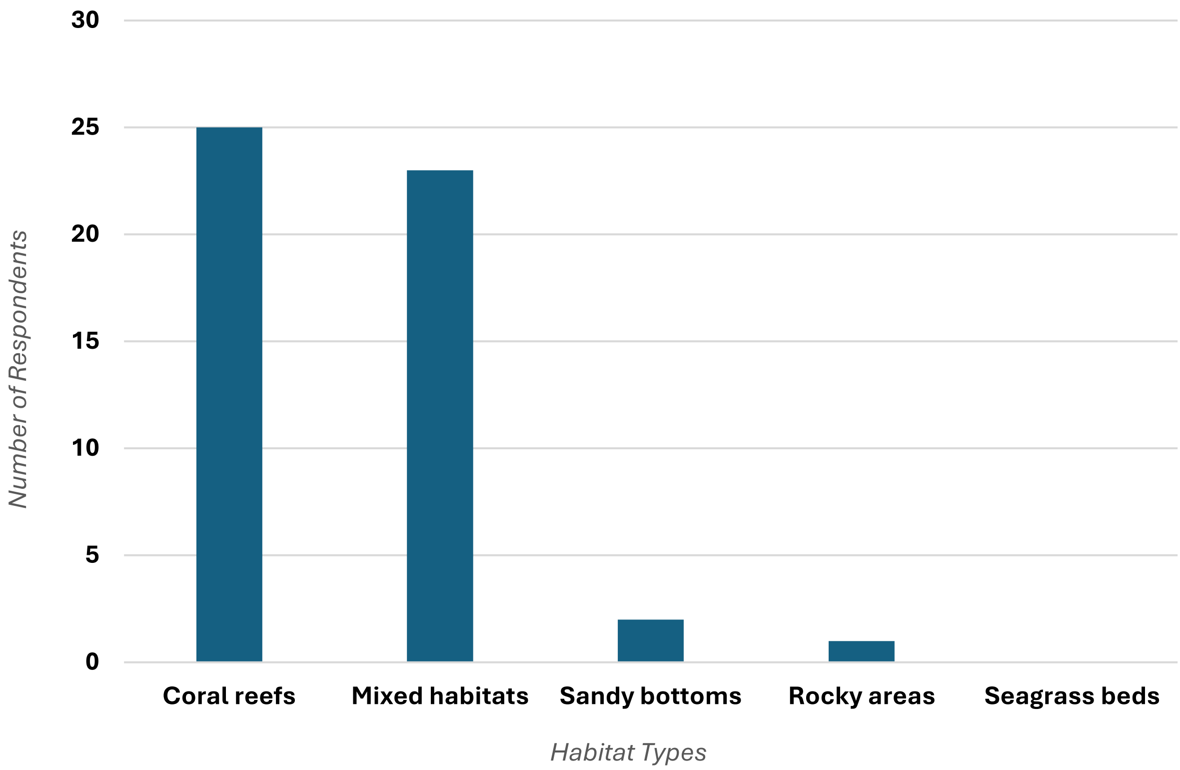

Figure 38: Benthic habitats associated with observed juvenile *L. sebae*

3.3.2.7 Seasonal and Daily Patterns of Juvenile L. sebae in Potential Nursery Areas

Responses were analysed to determine the seasonal periods during which juvenile *L. sebae* were most frequently observed or fished. Juvenile *L. sebae* were most frequently reported to be observed between "January to June", with 22 mentions. In contrast, observations from "July to December" were less frequent, with only 7 mentions. Additionally, 19 respondents indicated that juveniles could occur anytime during the year (Figure 39).

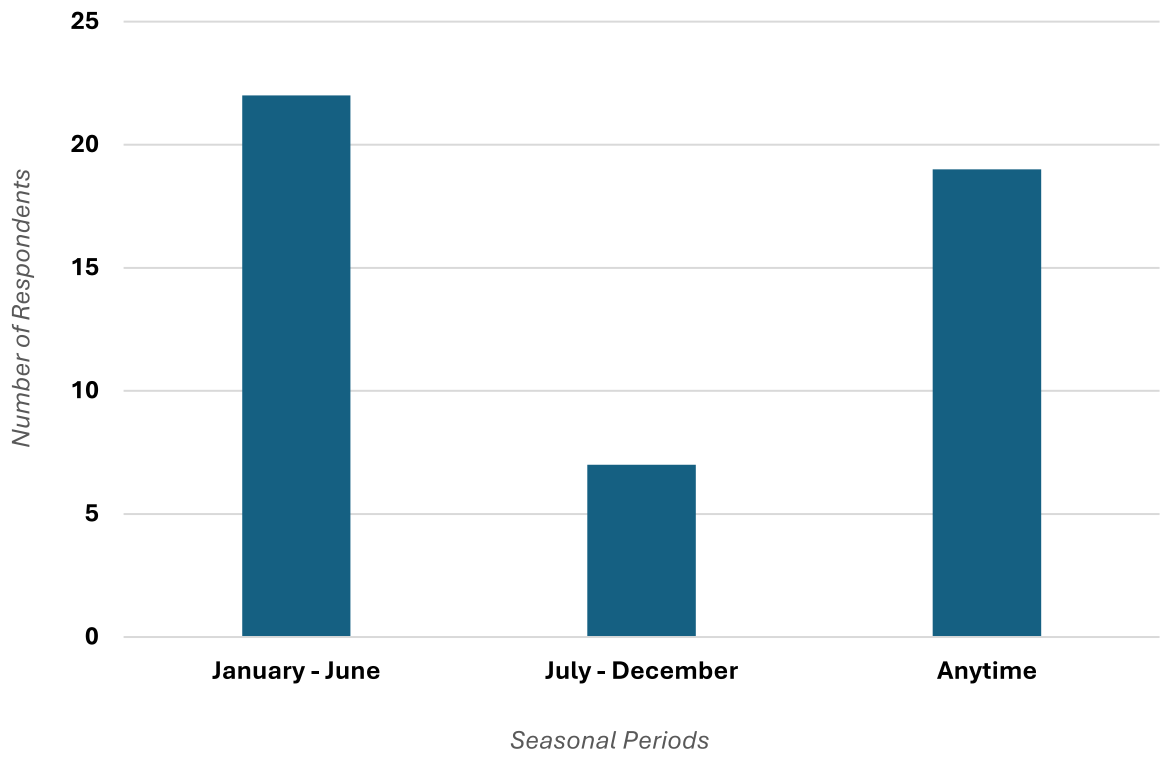

Figure 39: Seasonal periods in which juvenile *L. sebae* are observed

For the time of day when juvenile *L. sebae* were observed, responses varied with most responses indicate activity during morning hours (n = 25), followed by afternoon (n = 11), and night (n = 1). Some mentioned that the juveniles can be seen at any time of the day (n = 15) (Figure 40), and a total of 10 respondents either did not provide an answer or were unsure of the times. Most respondents indicated that spawning aggregations varied in timing and occurrence from year to year.

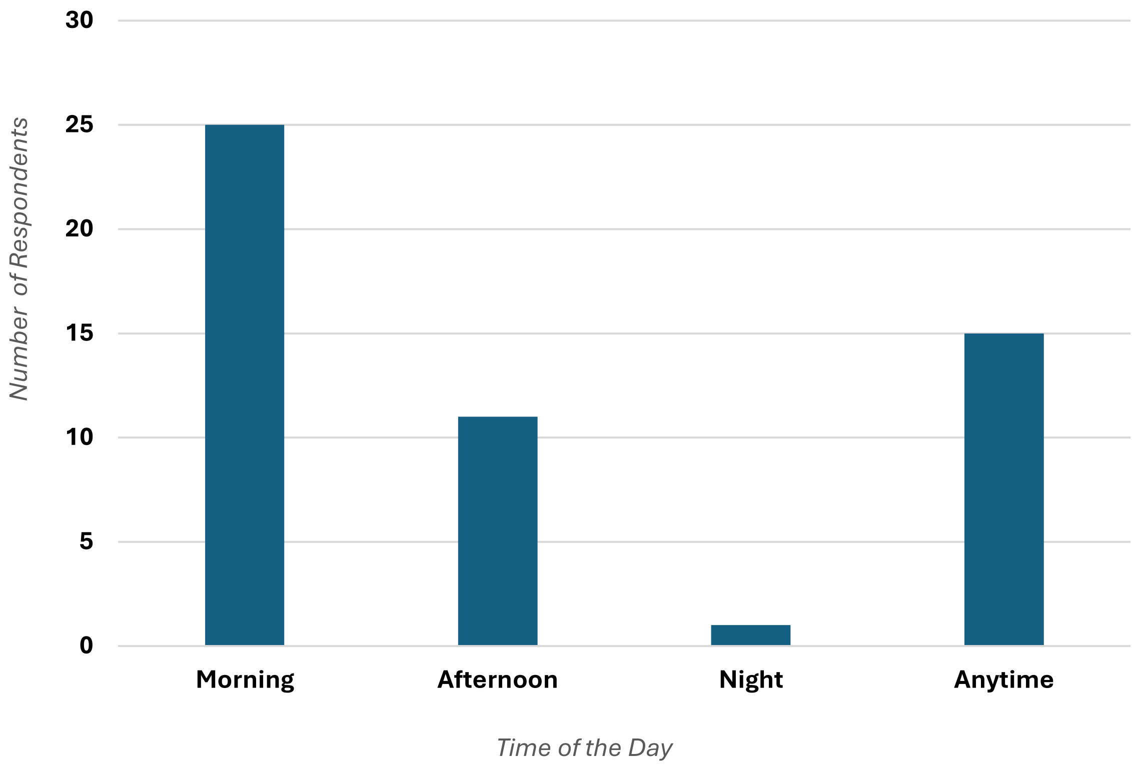

Figure 40: Time of the day in which juvenile *L. sebae* are observed

3.3.2.8 Perceived Changes in juvenile L. sebae Size and Number Over Time

Fishers and divers were asked whether they had noticed any changes in the number of juvenile *L. sebae* throughout their fishing or diving experience, and if so, in what way. A total of 32 (66.6%) reported noticing changes in the number of juvenile *L. sebae*, while 9 (18.8%) did not, and 7 (14.6%) were unsure (Figure 41). Of those who observed changes, 29 (70.7%) reported a decrease in numbers, 9 (22%) indicated that the size had remained the same, and 3 (7.3%) reported that it had increased (Figure 42).

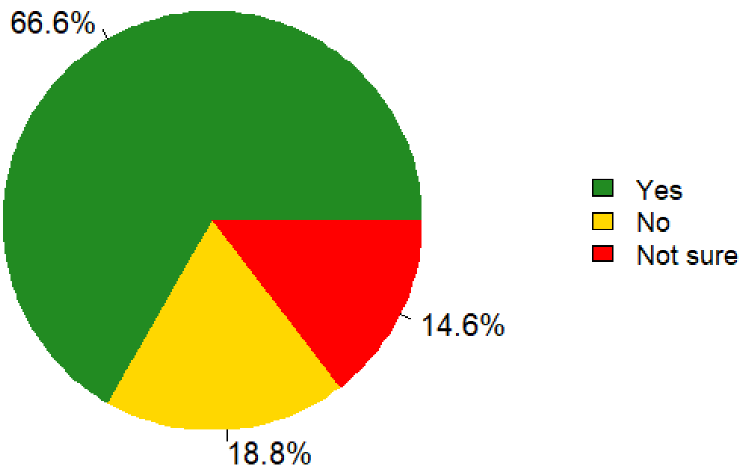

Figure 41: Perceptions of change in the number of juvenile *L. sebae* observed by fishers and divers

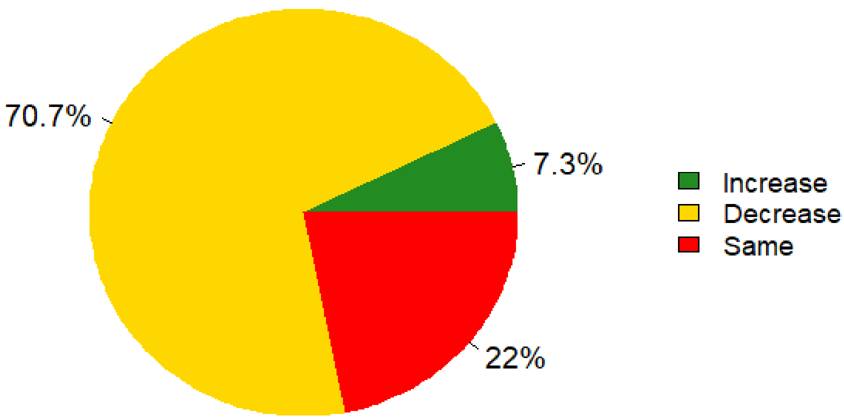

Figure 42: Direction of observed changes in juvenile *L. sebae* populations

3.3.2.9 Perceived Animal and Plant Associations in L. sebae Nursery Areas

Divers and fishers were asked about animals and plants potentially associated with *L. sebae* nursery areas. Of the 42 respondents, 32 mentioned animals, 2 mentioned plants, 3 mentioned both animals and plants, while 5 mentioned neither (Figure 43). The remaining respondents were either unsure or did not provide a response.

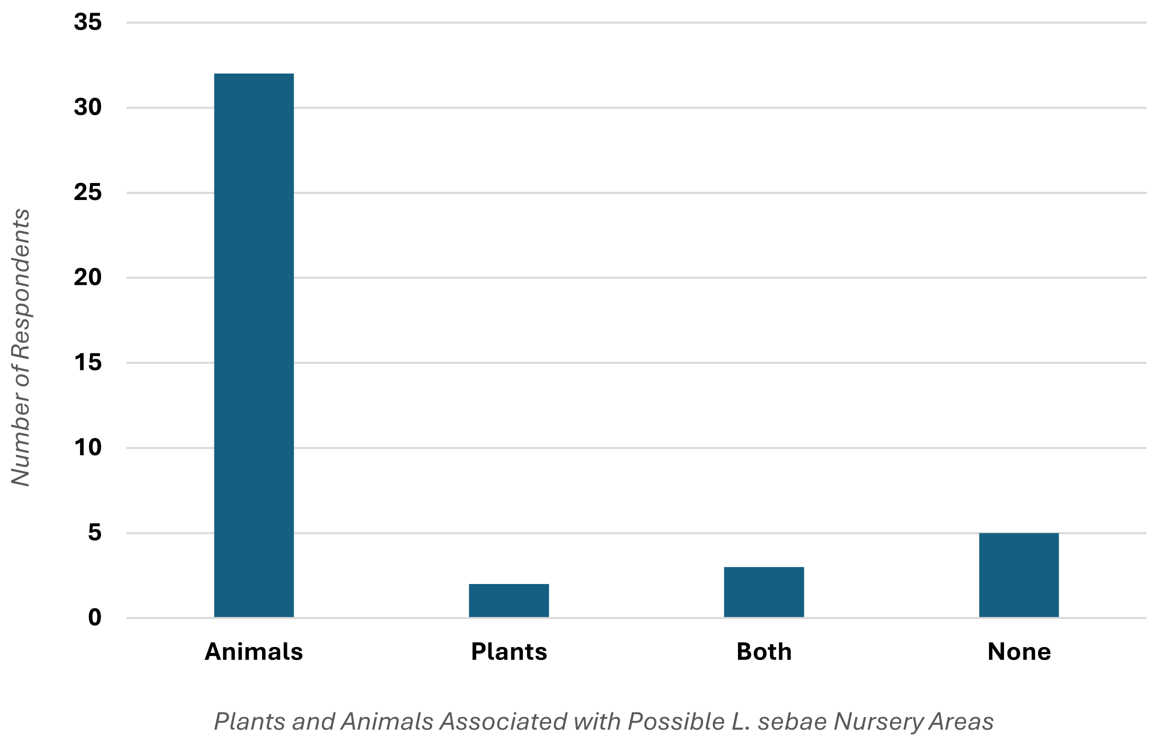

Figure 43: Organisms reported by respondents as associated with *L. sebae* nursery areas

Animals and plants mentioned were further identified and are categorized in Table 3. With more animal mentions overall, fish were the most frequently cited. The categories included fish, with the most commonly mentioned being the family *Lutjanidae* (n = 15), including Humphead snapper (n = 2), Jobfish ("Zob") (n = 2), One-spot snapper ("Semiz", *Lutjanus monostigma*) (n = 1), and "Madras" (n = 10). This was followed by sharks, which were mentioned 8 times. Other fish families included, *Serranidae* (groupers, n = 6), and *Lethrinidae* with Sky emperor ("Madanm beri", *Lethrinus mahsena*) (n = 2), Pink ear emperor ("Zekler", *Lethrinus lentjan*) (n = 2), Spot cheek emperor ("Baksou", *Lethrinus rubrioperculatus*) (n = 1), and Blackeye emperor ("Laskar", *Lethrinus enigmaticus*) (n = 1). *Echinoidea* (sea urchins) were mentioned 4 times and *Holothuroidea* (sea cucumbers) and *Brachyura* (crabs) were mentioned 2 times. The others mentioned once were *Haemulidae* (“Matongo”, Grunts & Sweetlips), *Caesionidae* (“Makro”, Mackerel), *Siganidae* (“Kordonnyen”, Rabbitfish), *Carangidae* (“Karang”, Jacks and pompanos), *Pomacentridae* (“Bweter”, Damselfish) *Mullidae” (*“Rouze”, *Goatfish)*”, and *Balistidae* (Triggerfish). Additionally, one mammal mentioned once was the dolphin, and corals (both soft corals and black corals) were mentioned once. As for plants, only seaweeds were mentioned with respondents identifying *Ulva (*Green algae*)*, and *Padina*, *Dictyota* and *Sargassum* which are all types of brown algae, each also mentioned only once *(*n = 1).

Table 3: Classification and frequency of animal and plants identified by respondents

<table>
<tr><td rowspan="17">Animals</td><td rowspan="11">Fish</td><td>Serranidae</td><td>6</td></tr>
<tr><td>Haemulidae</td><td>1</td></tr>
<tr><td>Caesionidae</td><td>1</td></tr>
<tr><td>Siganidae</td><td>1</td></tr>
<tr><td>Carangidae</td><td>1</td></tr>
<tr><td>Pomacentridae</td><td>1</td></tr>
<tr><td>Mullidae</td><td>1</td></tr>
<tr><td>Balistidae</td><td>1</td></tr>
<tr><td>Lutjanidae</td><td>15</td></tr>
<tr><td>Lethrinidae</td><td>6</td></tr>
<tr><td>Sharks</td><td>8</td></tr>
<tr><td rowspan="2">Echinoderm</td><td>Sea Urchins</td><td>4</td></tr>
<tr><td>Sea Cucumbers</td><td>2</td></tr>
<tr><td>Crustacean</td><td>Crabs</td><td>2</td></tr>
<tr><td>Mammals</td><td>Dolphins</td><td>1</td></tr>
<tr><td rowspan="2">Corals</td><td>Soft corals</td><td>1</td></tr>
<tr><td>Black corals</td><td>1</td></tr>
<tr><td rowspan="4">Plants</td><td rowspan="4">Seaweed</td><td>Ulva</td><td>1</td></tr>
<tr><td>Padina</td><td>1</td></tr>
<tr><td>Dictyota</td><td>1</td></tr>
<tr><td>Sargassum</td><td>1</td></tr>
</table>

3.3.3 Environmental and Observational variables

To investigate further, a combination of environmental and observational variables was collected during interviews with both fishers and divers. The key variables included sea temperature, depth, visibility, tide, and current. These variables were selected based on their relevance to the conditions commonly observed where juvenile *L. sebae* are present at potential nursery areas.

3.3.3.1 Sea Temperature

Reported water temperatures at potential nursery areas were most commonly within the range of "25–30°C", accounting for 27 out of 59 responses. 6 respondents indicated temperatures "below 25°C", while only one reported temperature "above 30°C". A substantial number of respondents (n = 25) did not provide information on temperature. These results suggest that nursery areas are most frequently observed within the "25–30°C" temperature range, although variability in reporting highlights potential knowledge gaps or observational limitations among respondents (Figure 44).

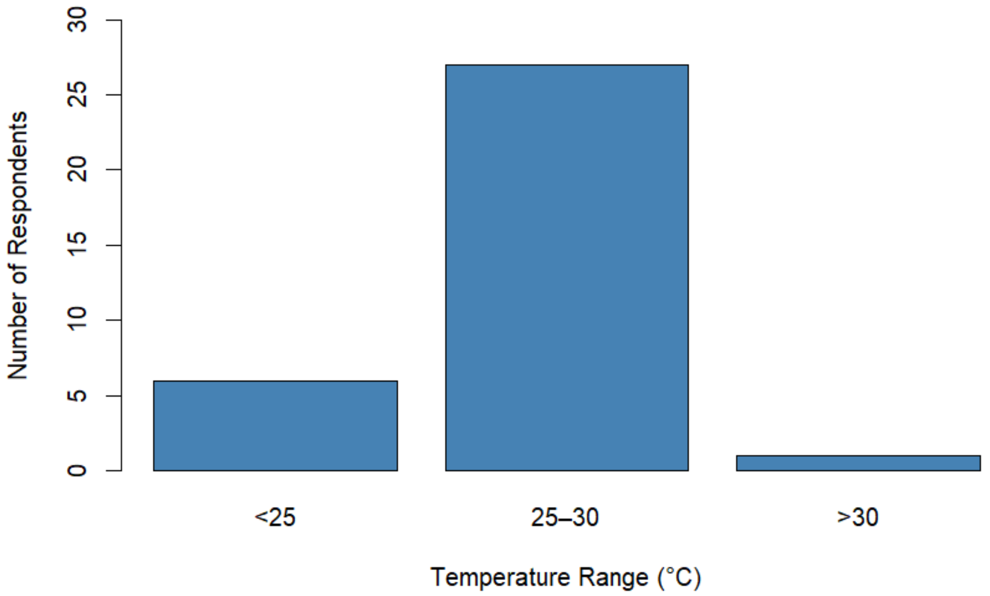

Figure 44: Fisher's and diver's reported sea temperature at potential *L. sebae* nursery areas

3.3.3.2 Depth

Nursery areas were most frequently reported at depths between "20–30 m", with 23 out of 59 responses indicating this category. Depths "more than 30 m" were reported by 20 respondents, while 12 respondents observed potential nursery areas at depths "less than 20 m". 4 responses did not provide depth information. These findings suggest a strong preference or association of nursery areas with deeper reef or offshore habitats, predominantly between "20–30 m" (Figure 45).

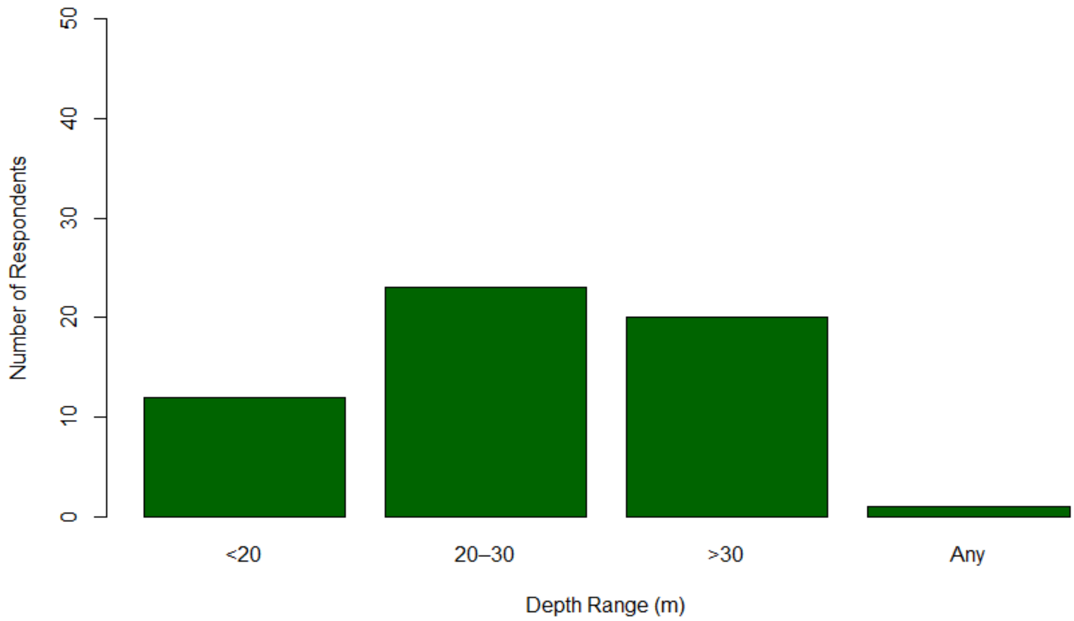

Figure 45: Fisher's and diver's reported depth at potential *L. sebae* nursery areas

3.3.3.3 Water Visibility

Water visibility at nursery areas was most commonly described as "good" (n = 20) and "fair" (n = 12), followed by "excellent" visibility, which was reported by 5 respondents. No respondents mentioned "poor" or "very poor" conditions. 5 individuals selected all categories, possibly reflecting uncertainty or highly variable conditions, and 17 did not provide a visibility rating. (Figure 46).

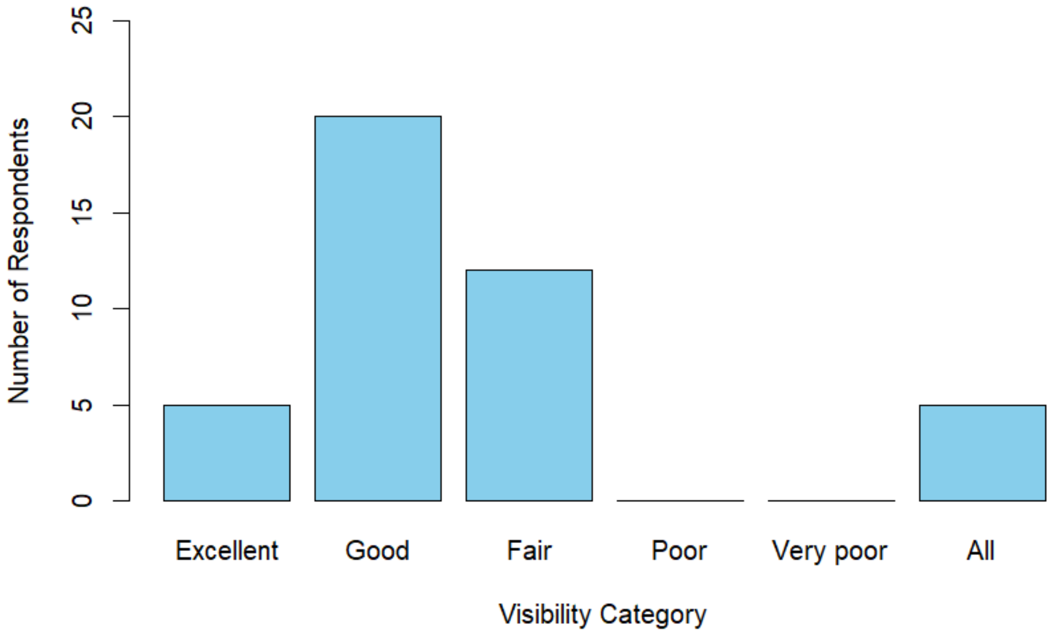

Figure 46: Fisher's and diver's reported visibility at potential *L. sebae* nursery areas

3.3.3.4 Tide

Most respondents (13 out of 59) reported observing potential nursery areas during "both" high tide and low tide conditions. "Low tide" only was mentioned by 8 respondents, while 8 indicated that "high tide" only. A notable portion of responses (n = 27) were either uncertain or did not provide information on tide conditions. This relatively high number of non-responses suggests that tidal influence may not be consistently observed or recalled (Figure 47).

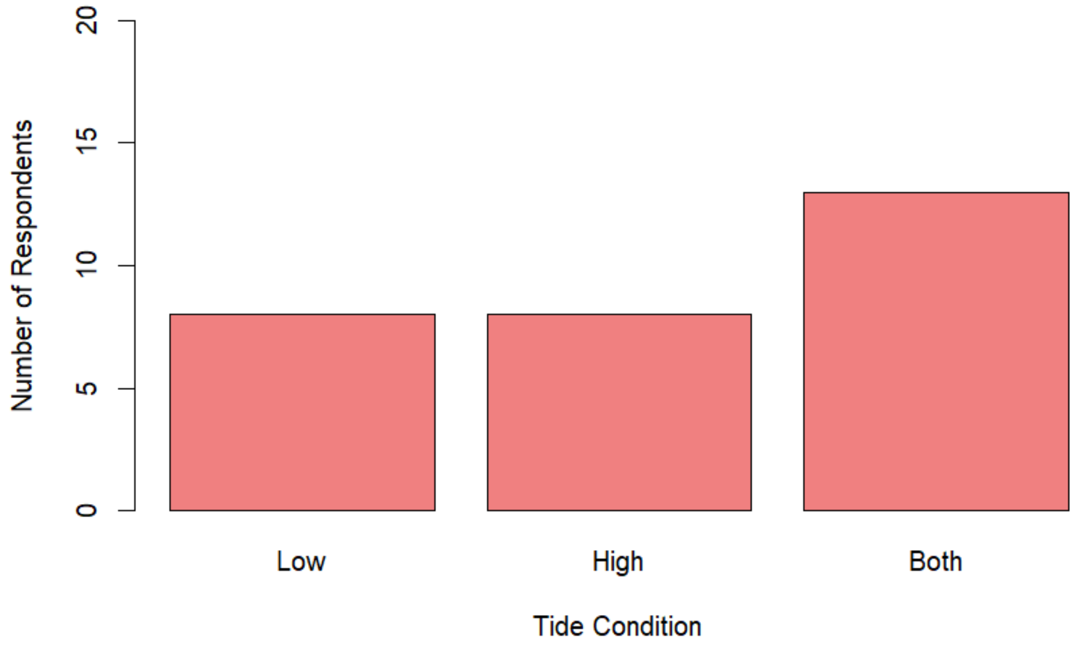

Figure 46: Fisher's and diver's reported tide conditions at potential *L. sebae* nursery areas

3.3.3.5 Current Strength

Nursery areas were most commonly reported under "moderate" current conditions, with 19 out of 59 responses. This was followed by "weak" (n = 12) and "no current" (n = 8). "Very weak" current was noted by 4 responses, while strong currents were reported less frequently (n = 1). An additional 4 respondents selected all categories, and 11 did not provide information. These results suggest nursery areas are most often associated with weak to moderate current flow, potentially indicating a preference for stable but dynamic water movement (Figure 48).

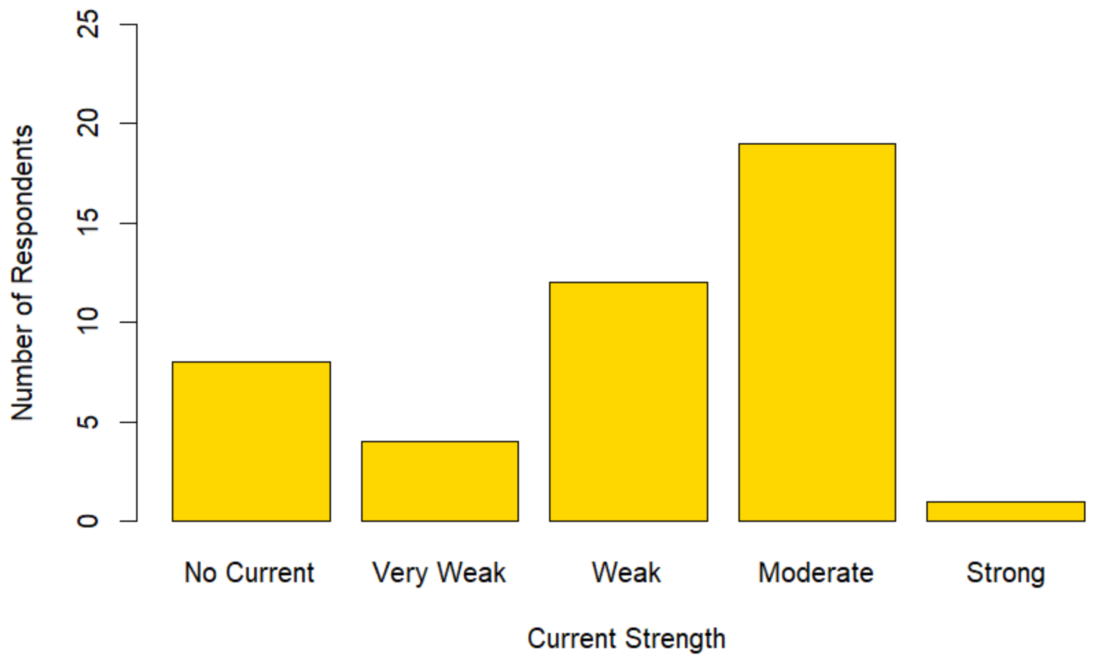

Figure 46: Fisher's and diver's reported current strength at potential *L. sebae* nursery areas

4 Spatial Data for Potential *L. sebae* Spawning Aggregations and Nursery Areas

One of the most important components for identifying potential spawning aggregation and nursery areas was the information provided by fishers and divers. Participants were asked to indicate locations not necessarily confirmed as spawning sites, but areas where *L. sebae* had been fished or observed in large groups, either through coordinates, points on maps, or verbal descriptions. Maps were then generated from these approximate locations. Figure 47 shows the potential spawning aggregation areas, while Figure 48 shows the potential nursery areas. The locations most frequently mentioned for spawning aggregations were Fregate Island (n = 10), followed by Denis Island (n = 6), with Constant Bank and North Island each receiving three mentions (Figure 49). Regarding potential nursery areas, the most commonly mentioned locations were La Digue Island (n = 9), Marianne Island (n = 6), Fregate Island (n = 5), and Ile aux Recifs (n = 5), followed by Felicite Island (n = 4), and Curieuse Island, Praslin Island, and White Bank each with three mentions (Figure 50). Additionally, five specific positions for spawning aggregations were reported by a fisher who did not participate in the interview-based survey (Figure 51).

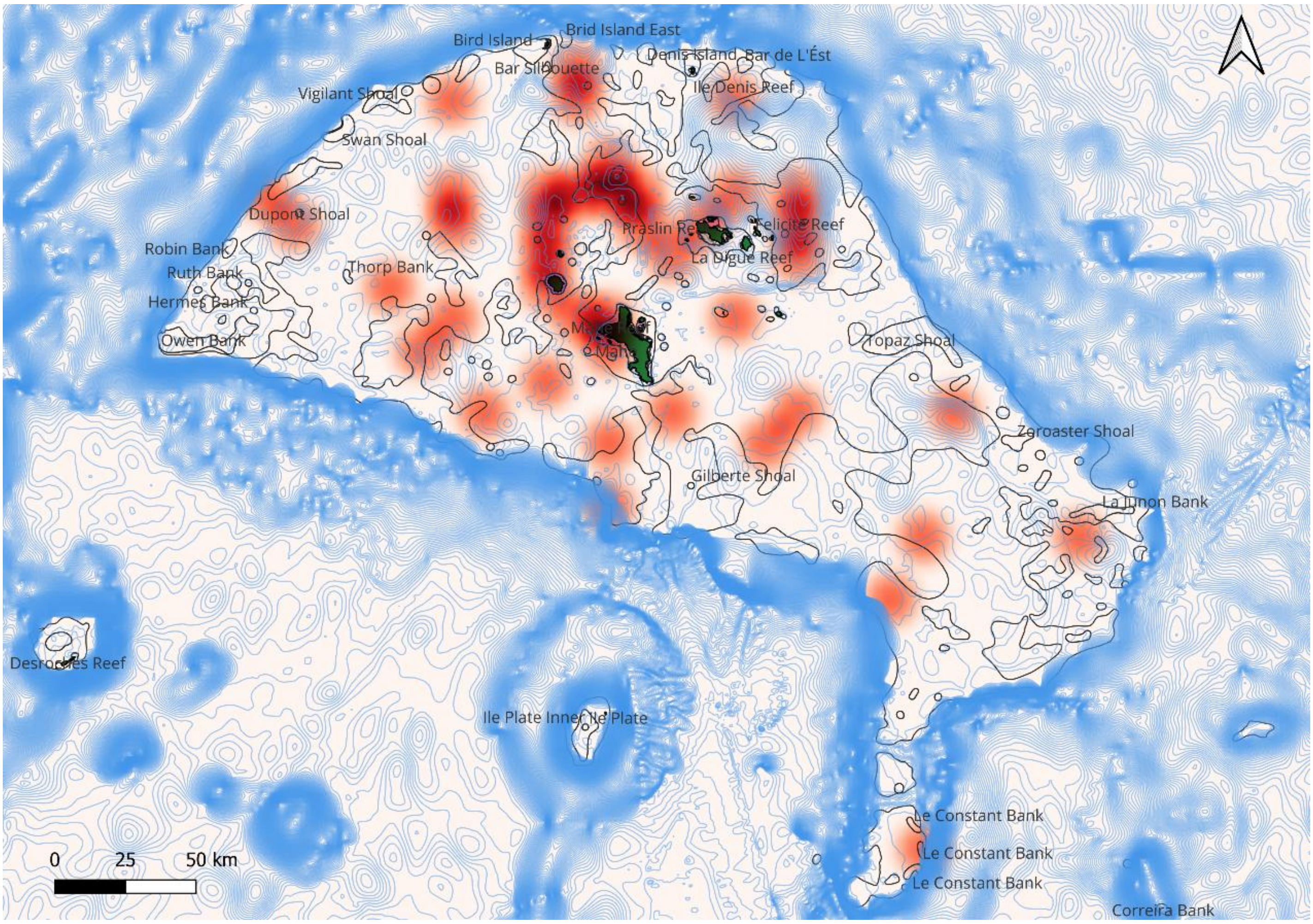

Figure 47: Heatmap of potential spawning aggregations areas of *L. sebae*

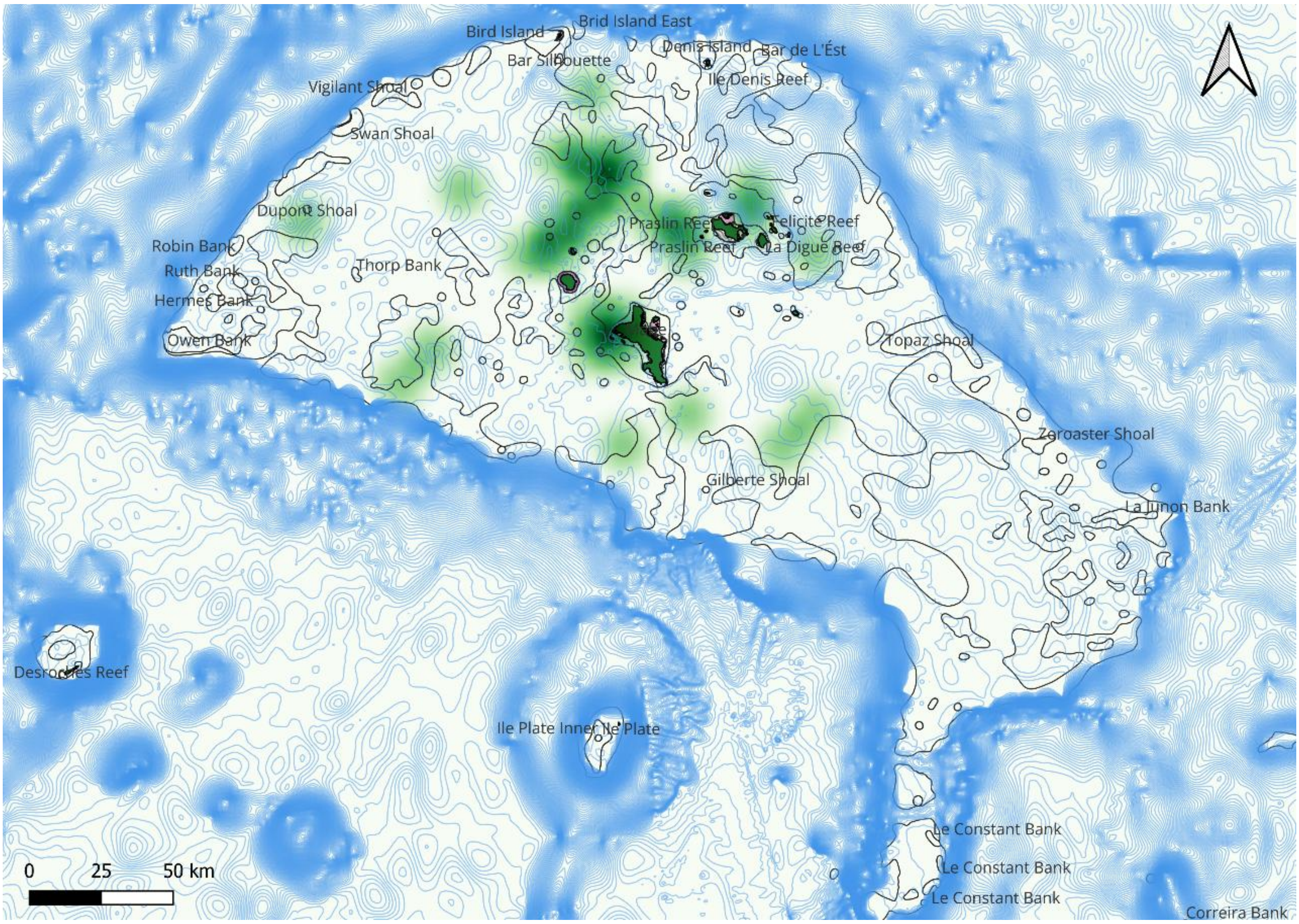

Figure 48: Heatmap of potential nursery areas of *L. sebae*

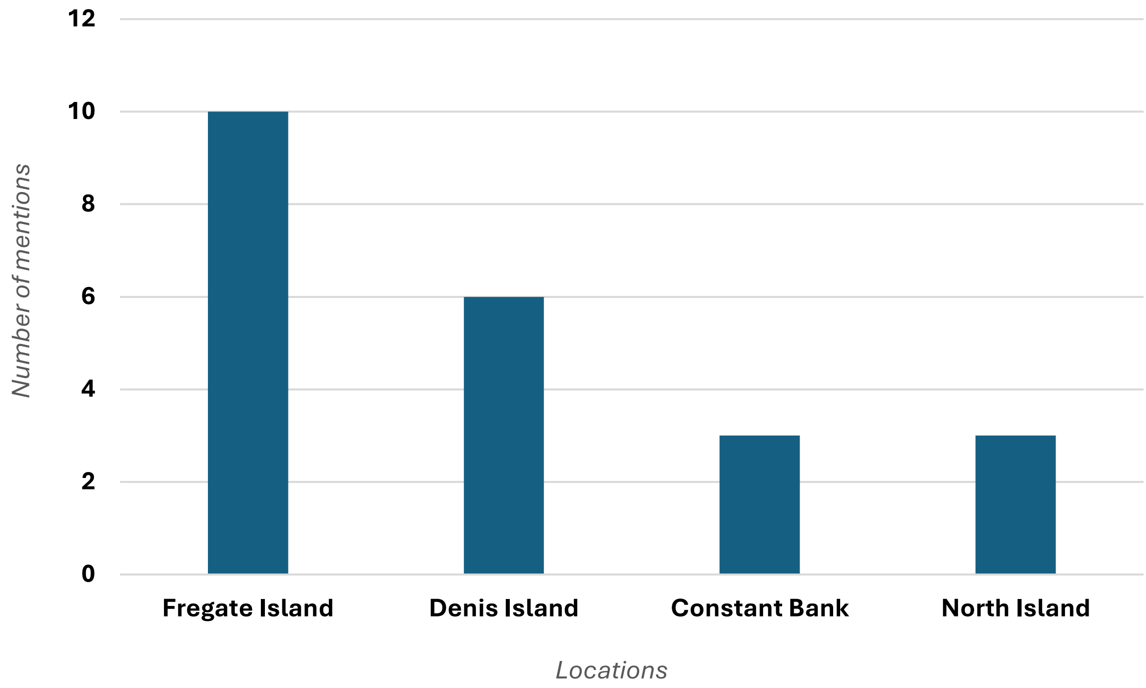

Figure 49: Most frequently cited spawning aggregation locations for *L. sebae*

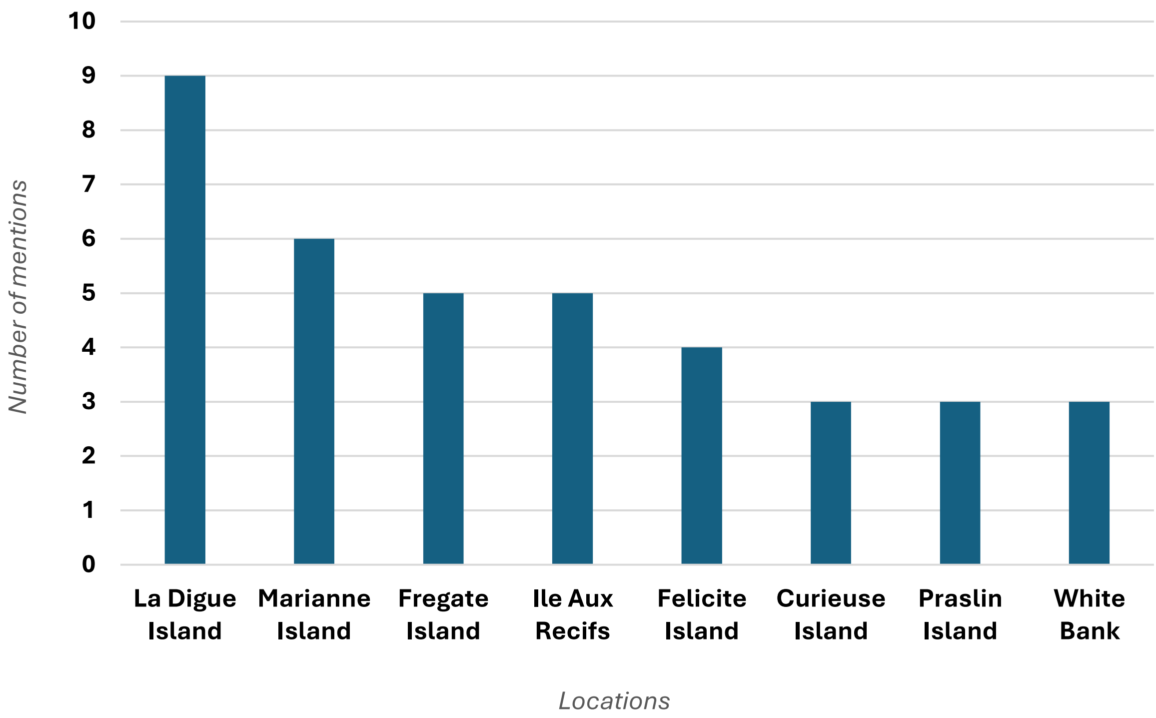

Figure 50: Most frequently cited nursery locations for juvenile *L. sebae*

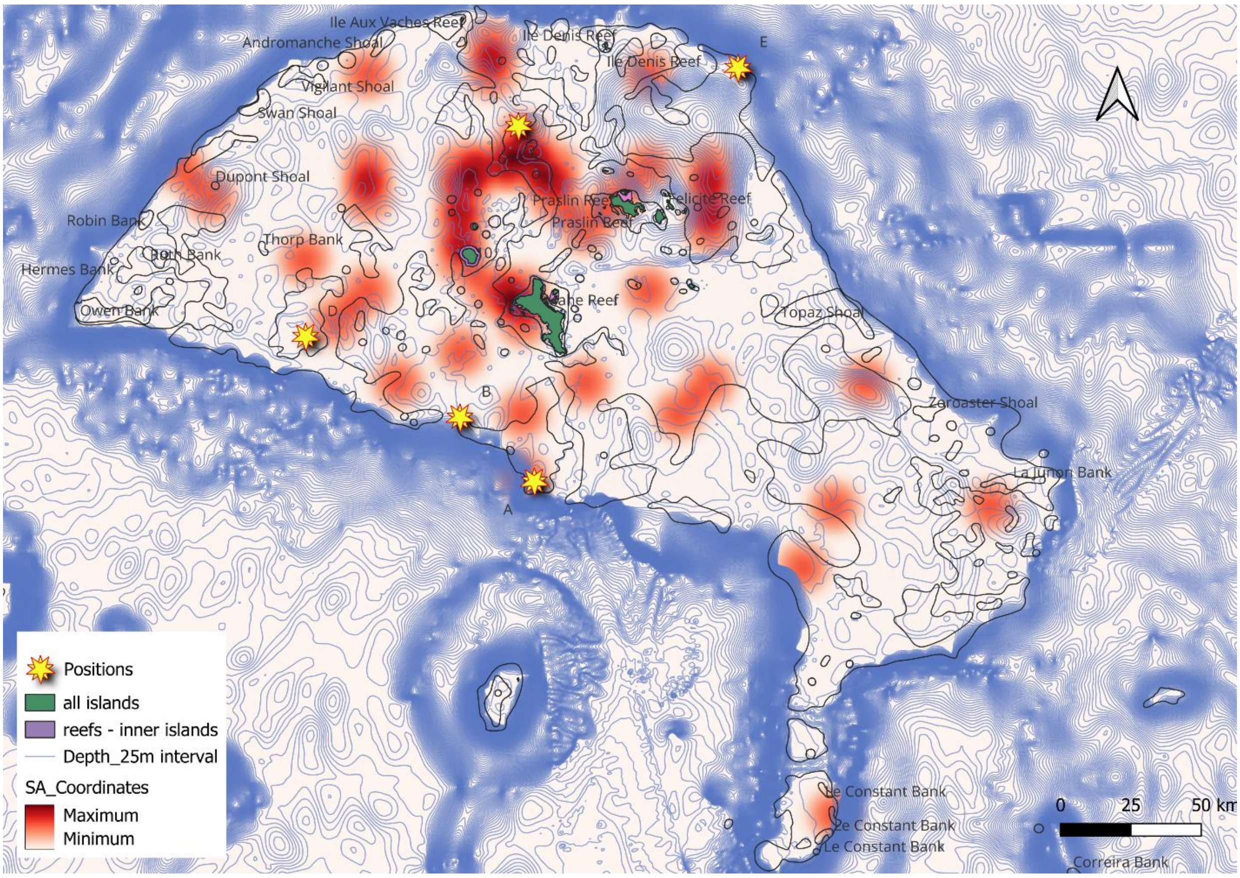

Figure 51: Heatmap showing specific spawning aggregation areas *L. sebae* provided by additional fisher

5 Discussion

Understanding the potential spawning aggregation and nursery areas of *Lutjanus sebae* is essential for informing effective fisheries management and supporting the implementation committee (ICCP) of the Mahé Plateau and line Co-management Plan. This study highlights the importance of local knowledge, the findings in this report will contribute to the investigation of *L. sebae* spawning aggregation and nursery areas on the Mahé plateau. The questionnaires provided responses from both fishers and divers, where there were total of 59 interviewees, 47 fishers and 12 divers. 93.2% of them are still active and 6.8% retired during the interview-based survey. They were a mix of full-time, part-time and recreational divers and fishers with a majority of them experienced more than 25 years.

5.1 Spawning Aggregations

Adult *Lutjanus sebae* have been reported to aggregate in large numbers, though these aggregations do not always necessarily indicate spawning. While not all respondents had personally observed *L. sebae* aggregations, much shared knowledge acquired from other fishers or through observations of similar species. A majority of respondents reported encountering aggregations and believed these to be spawning events, primarily occurring between January and April. Observed individuals in these aggregations displayed characteristic spawning behaviours, including grouping, aggressive interactions, and the presence of mature gonads. Spawning aggregations were most frequently associated with coral reef habitats, but were also observed in mixed habitats combining sandy, rocky, and seagrass areas.

Based on the respond obtained it can be concluded that spawning aggregations typically last longer than one day and occur during early morning or from dusk to night, often around three days before and three days after new and full moons. Additionally, fishing effort and methods can influence the number of *L. sebae* captured during aggregations. By-catch species were commonly reported, with some of these species observed or captured during spawning activity. Environmental conditions associated with *L. sebae* spawning aggregations included water temperatures of 25–30°C, depths greater than 30 meters, good to fair visibility, high tide periods, and moderate currents. These findings highlight the importance of both ecological and anthropogenic factors in shaping the timing, location, and intensity of spawning aggregations on the Mahé Plateau

5.2 Nursery Areas

All respondents were able to identify juvenile *L. sebae*, using criteria such as the 32 cm catch size limit, coloration, size, or a combination of physical traits. Divers reported observing juveniles both singly and in small groups, often consisting of five individuals or fewer. Juveniles are incidentally captured using both traps and line-and-hook fishing methods, with a variety of baits employed. Bonito and mackerel were the most commonly used baits. The individuals caught are generally larger juveniles, as smaller ones are rarely captured due to their size being unsuitable for consumption. With the current 32 cm size limit, juveniles up to this length are now mandated to be released. In one reported area, fishers using both fishing methods indicated that they typically caught fewer than 100 juveniles per site.

Divers who observed juvenile *L. sebae*, whether alone or in groups, noted that their presence did not appear to disturb or alter the behaviour of the fish. Observed juvenile sizes ranged mostly between 20 and 35 cm. Potential nursery areas were predominantly associated with coral reef habitats and mixed habitats comprising coral, seagrass, sandy, and rocky substrates. Respondents indicated that juveniles are present year-round but are most frequently observed or captured between January and June, particularly during morning hours. Other animals commonly associated with juvenile *L. sebae* include members of the Lutjanidae family, sharks, Lethrinidae, Serranidae, sea urchins, sea cucumbers, and crabs. Environmental conditions associated with potential nursery areas include water temperatures of 25–30°C, depths between 20 and 30 meters, good water visibility, both high and low tides, and moderate currents. These conditions highlight the ecological preferences of juvenile *L. sebae* and provide important guidance for management and conservation strategies.

5.3 Spatial Data

Based on interview responses, *Lutjanus sebae* are distributed throughout the Mahé Plateau. Spawning aggregations are relatively site specific, occurring in general areas rather than exact fixed locations each year. The mapped locations of reported spawning aggregations show a scattered distribution across the plateau, with a concentration in the north, and northeast of Mahé Island. The most frequently mentioned sites were around Fregate Island and Denis Island.

Potential nursery areas, as indicated on the map, are primarily concentrated around the inner islands, as well as in the north and northeast regions of Mahé Island and North Island. The most commonly reported nursery sites from the interviews included La Digue, Marianne Island and Fregate Island. Additionally, one fisher who did not participate in the formal interviews provided specific coordinates for spawning aggregations of *L. sebae* and *L. bohar*. These locations span the northeast, south, southwest, south-southwest, and northern edges pf the Mahé Plateau, further highlighting the spatial extent and variability of aggregation sites.

6 Conclusion

This phase of the study provided information relevant to the next phase of the research project. The interviews were conducted to obtain spatial and temporal information from local knowledge, which will be used to guide the investigation of *L. sebae* spawning aggregation sites and nursery areas. Data collected from the interview-based survey indicated where and when adults and juvenile *L. sebae* are most likely to be found, including preferred habitats, depths, and environmental conditions.

Overall, the information obtained through local knowledge forms a crucial foundation for the next phase of field-based investigations, supporting monitoring, conservation planning, and sustainable management of *L. sebae* populations on the Mahé Plateau.

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