CONTRIBUTION 4.2

Investigating the Economic Implications of Weather-Related Damages and Theft on Fishing Vessels: a Survey-Based Analysis in the Coastal Communities of Trinidad

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Abstract

The fishing industry on the northeast coast of Trinidad holds great importance as a major economic driver in the region, providing employment, income opportunities and supporting local businesses. Fishing provides a sustainable protein source for the community and is an integral part of cultural traditions and community life in these seven villages. However, the lack of safe ports for securing the valuable fishing assets has resulted in damage and destruction of vessels owing to harsh weather conditions and theft. Accordingly, Future Fishers investigated the economic impact of these events on the lives of fishers. The study aims to provide valuable insights into the potential consequences of the lack of safe ports for fishing vessels. Primary data were collected using a two-step process. First, fisherfolks registered in the Future Fishers database were contacted to identify those who were affected. Second, phone or in-person interviews were used to elicit information from those who were impacted. The information collected was the date and location of the events, the type and extent of damages, what caused the damage and the estimated cost and time to repair. The preliminary findings suggest that adverse weather conditions and theft have a significant impact on fishers and their fishing communities. The study has practical implications for multiple stakeholders, including local villages, government agencies, and fishers. They will gain insights into the economic impact of extreme weather events and the urgent need for safe ports and facilities that sustain the local fishing industry.

KEYWORDS: fishing industry, safe ports, economic impact, sustaining local fishing

CITATION: Sammy, D., V. Alexander, I. Khan and E. Douglas, 2026. Investigating the Economic Implications of Weather-Related Damages and Theft on Fishing Vessels: a Survey-Based Analysis in the Coastal Communities of Trinidad. Contribution 4.2, p288-298 *IN* CRFM, 2026. Volume I: Technical Papers. Presented at the CRFM 20th Anniversary Scientific Conference, 28-31 August 2023. CRFM Special Publication No. 37, CRFM Secretariat https://www.crfm.int/index.php?option=com_k2&view=item&id=922

1. INTRODUCTION

Coastal communities all over the world face significant challenges because of their vulnerability to natural disasters, climate change, and environmental degradation. These communities are at risk when it comes to climate related changes in the environment because they heavily rely on natural resources owing to their proximity to the ocean (Bennett et al., 2014). The increasing frequency and severity of bleaching events caused by global warming have had a major impact on coastal communities that depend on coral reefs (Cinner et al., 2018). Additionally, rising sea levels resulting from warming pose a threat to the infrastructure of communities during natural disasters (Sajjad et al., 2018).

Moreover, it is crucial for coastal communities to have the ability to withstand shocks and recover from disasters. The resilience of these communities plays a role in managing events and minimizing societal disruptions (Norris et al., 2007). Furthermore, in low-income countries, effective alert systems, shelter/evacuation plans, disaster risk reduction education programs and social unity can help enhance resilience against hazards and tropical cyclones (Lumbroso et al. 2017).

Coastal communities also depend on the resources found in the sea and coastal areas to support their way of life. The services provided by these ecosystems such as food, economic growth and natural protection against floods and storms play a role in the economic progress of coastal communities (Zain et al., 2022). However, these communities face challenges like erosion, overfishing and pollution. These issues negatively impact livelihood opportunities Marfai, 2012).

Coastal communities in the Caribbean are no different and heavily depend on the resources provided by marine and coastal ecosystems to sustain themselves and support their economic growth (Islam et al., 2013). The services provided by these ecosystems, such as food, economic opportunities and natural protection against floods and storms, are crucial for the well being and livelihoods of coastal communities (Idrus et al., 2022). However, there are various challenges that these communities face which threaten the long term sustainability and desirability of coastal living. These challenges include erosion, overfishing and pollution which not only limit livelihood options but also impact the overall appeal of living in coastal areas (Roy et al., 2021).

In Trinidad and Tobago, coastal communities have long relied on fishing for their well-being (Caribbean Natural Resource Institute [CANARI] 2020). They provide employment opportunities and contribute to the local and national economy (Reid et al, 2020, CANARI, 2020). However, the fishing industry faces challenges that affect its sustainability and economic viability. Many assets or fishing vessels within the sector are vulnerable to physical damage because of sea level rise and extreme weather, including fishing gear, vessels, piers, fish landing sites, processing facilities and markets (CRFM 2020). These circumstances, in turn, have broader environmental consequences for the fishing communities that experience these challenges.

Like other assets, fishing vessels are expensive and represent the backbone of the local fishing economy. Unfortunately, these vessels are subject to weather conditions such as rough seas and heavy rainfall. Adverse weather conditions sometimes result in damages ranging from minor repairs to the loss of boats, engines and nets, and account for substantial financial setbacks in the case of the latter. Concurrently, theft of fishing vessels further increases fishers' vulnerabilities and jeopardises their livelihoods, while adding to existing economic pressures.

At present, there is limited knowledge regarding the extent of damages to fishing vessels caused by weather-related events. Jin (2014) explores the factors that contribute to the severity of fishing vessel accidents, with a particular focus on how weather conditions impact the level of

damage. Schnier et al. (2009) emphasize that weather related vessel instability is a primary cause of accidents and fatalities in the Alaskan crab fishery, highlighting the significance of weather related events for ensuring fishing vessel safety. In addition, Rezaee et al. (2016) examine Canadian fishing safety policies in relation to extreme environmental conditions and climate change effects, underscoring the importance of accurate weather forecasts and being prepared for extreme environmental conditions to ensure fishing safety. Furthermore, Wu et al. (2009) and Sainsbury et al. (2018) draw attention to how weather conditions influence both incident rates for fishing vessels and changing storminess impact on global capture fisheries respectively, thus emphasizing how crucial the understanding of weather patterns is for preventing incidents involving fishing vessels and safeguarding fisheries.

Collecting and aggregating data of weather related impacts in a systematic manner is not typically done, which makes it difficult to assess the broader impact of these damages on the fishing industry. In coastal regions and countries, especially those with small-scale or artisanal fishing practices, comprehensive data on vessel damage, including causes, frequency and economic impact, is often overlooked. As a result, there is a gap in the existing literature when it comes to understanding how fishing communities cope with disruptions caused by weather-related incidents. There are many studies focused on the impact of climate change on fishers by examining the vulnerability of marine ecosystems to climate change impacts. For example, (Paddack et al., 2009) highlighted the recent region-wide declines in Caribbean reef fish abundance, indicating profound ecological changes occurring on coral reefs throughout the tropics, with marked coral cover losses and concomitant algal increases, particularly in the Caribbean region (Paddack et al., 2009). Additionally, Blasiak et al. (2017) discussed the vulnerability of marine fisheries to climate change, defining vulnerability as the product of exposure to climate change impacts, sensitivity of an economy/community/country to changes in productive capacity associated with climate change impacts, and adaptive capacity to modify or adjust fisheries and livelihoods to cope with the negative impacts of climate change and pursue any emerging opportunities (Blasiak et al., 2017).

However, there were no detailed analyses specifically focused on vessel damages. The lack of data hinders the development of targeted strategies and policies that can effectively reduce risks and support affected fishing communities. Consequently, there is a need for more dedicated research in this area, which can provide valuable insights into the vulnerabilities faced by the fishing sector owing to changing weather patterns. Such research can contribute towards formulating effective measures for adaptation and mitigation.

The primary objective of this research is to conduct an exploratory examination of the socio-economic impact of weather-related damages and theft of fishing vessels in Trinidad Northeast communities through an exploratory analysis of data collected by Future Fishers. This study is important because it provides a data-driven understanding of the losses caused by weather-related damages and theft, offering insights into the financial burden faced by both individual fishermen and the local fishing sector as a whole. Additionally, the study provides an important contribution to the existing literature by highlighting the interaction between environmental forces , criminal activities and their impact on the sustainability of fishing communities. This is because there seems to be a scarcity of studies in the Caribbean on the socio-economic impacts of weather-related events and theft. As such, the findings from this research can inform policymakers, stakeholders and fishermen themselves about the need for strategies and interventions to address these challenges. This study has two delimitations: (1) the focus solely on quantifying the losses experienced by fishermen particularly related to repair expenses and revenue reduction, and (2) the focus on the operational range of Future Fishers—the Matura to Matelot (M2M) area. As such, findings may not necessarily be generalized to the entire country.

The manuscript adopts the following structure. The first part, titled 'Study Area,' provides a thorough overview of the geographical and environmental context relevant to the research. This introductory section aims to acquaint readers with the specific location and background of the study, providing necessary context and grounding the research in its unique environmental setting. The 'Methodology' section delves into the research design and methods used for data collection in the study. The 'Results section presents key findings obtained from the research supported by tables, graphs and other visual aids that effectively summarise data trends and significant discoveries. The 'Discussion' section of this paper offers a comprehensive interpretation and analysis of results.

Study Area

The fishing industry in Northeast Trinidad is characterised by small-scale operations. Predominantly, this sector involves artisanal fishers whose practices are entrenched in the historical context of the area's coastal settlements. In these areas, the focal point of fishing activities is concentrated in seven primary villages: Salybia, Balandra, Cumana, Toco, Sans Souci, Grande Riviere, and Matelot. These locations function as the epicenters of the industry, where expertise and fishing methodologies are passed down through generations. The significance of these villages extends beyond mere geographical importance; they serve as repositories of traditional fishing practices and indigenous knowledge, crucial for the sustainability of local fisheries. Furthermore, the sector contributes significantly to the local economy through the supply chain, impacting not only fishers but also related businesses such as equipment suppliers, fish processors, and market vendors. This symbiotic relationship underscores the sector's role in regional development and community livelihoods. Additionally, the fishing practices in these areas, while traditional, are increasingly influenced by environmental and regulatory factors, necessitating a balance between conservation efforts and the sustenance of the fishing community's economic needs.

The diverse marine landscape of Northeast Trinidad, encompassing both riverine and oceanic ecosystems, plays a pivotal role in shaping the small-scale fishing industry prevalent in the area. The interplay between the freshwaters of the Northeastern rivers and the saline waters of the Atlantic Ocean and Caribbean Sea creates a rich mosaic of habitats conducive to a variety of marine life, essential for artisanal fishing practices (French, 2002). Seasonal climatic patterns, particularly the wet season and the prevalence of hurricanes from August to December, introduce a level of unpredictability to the fishing yields. The frequency and intensity of these weather events not only influence the availability of fish stocks but also pose potential risks to the safety of fishers and the integrity of their equipment.

2. METHODOLOGY

The study utilised a survey design to collect information regarding the economic impact of the weather and theft-related damages and losses to the fishers in the designated area. This design allowed Future Fishers to gather a wide range of information in a cost-efficient manner. The survey was utilized with the understanding that it is limited self-reported data, which can lead to measurement error (Plugge et al., 2022).

Participants

The data collection pulled from a pool of over two hundred fishers utilising 105 pirogues, averaging 24 to 28 feet in size. Toco and Matelot stand out as the two largest ports, with 50% of the boats. This region boasts a diverse community of fishers, with 13 dedicated female fishers complementing the efforts of 189 male fishers. It's noteworthy that a significant portion, 62%,

of the fishers in this area are under the age of 50, signifying a dynamic and evolving industry. The main fishing methods employed by these fishers are white net (monofilament), multi-filament, trolling, banking, switching (dead bait), a-la-vive (live bait), and spear fishing.

Data Collection and Analysis

Data collection proceeded through a brief online questionnaire administered through a WhatsApp group dedicated to fishers in the region. The online questionnaire was followed up with phone calls to affected fishers to gather additional details and clarify information. This information included damage details such as location, a description of what was damaged and estimated costs.

These damages occurred while a broader baseline data collection survey was being conducted, encompassing a total of 76 boats, with the primary objective of collecting data such as catch details, species including non-fish species, quantity, weights, cost of fishing, and revenue estimates. The analysis proceeded in the form of an exploratory descriptive analysis of the economic impact of weather and theft on the lives of fishers.

3. RESULTS

Over the course of the 18-month study period, a total of 26 fishers and boat owners were impacted across seven ports, as detailed in Table 1. This accounts for 25% of the active vessels in the target area. This table categorises these individuals based on their fishing status, whether they fish full-time or part-time. And the specific port they are associated with. Out of these individuals, a significant number of 18 fishers operated full-time and solely relied on fishing as their livelihood without any other source of income. The remaining 8 were part-time fishermen. By examining the distribution of these fishermen across the ports in the study area, we were able to gain insight into how reliant each area's fishing community is on this industry. The table highlights that Toco had the highest number of impacted full-time fishermen, followed by Balandra and Matelot. The data suggest that fishing activities significantly influence rural dynamics, as evidenced by the observation from the Matelot community where reduced fishing activity correlates with a noticeable decrease in community engagement and local economic activities.

Table 1 Fishing Status of Boat Owners at the seven Ports

Fishing Status	Balandra	Cumana	Grande Riviere	Matelot	Salybia	Sans Souci	Toco	Total
Full-Time Fishers	5	1	2	3		1	6	18
Part-Time Fishers	2	1	1	1	2	1		8
Total	7	2	3	4	2	2	6	26
%	27	8	12	15	8	8	23	100

Table 2 provides a breakdown of the types of damages incurred by various fishing assets across different ports, displaying the diverse range of challenges faced by fishermen in different areas. These include anchors, ropes, boats, engines, fish pots, iceboxes, nets, other equipment and propellers. A total of 67 instances of damage were recorded, affecting 29 boats. The damages caused by the events differ across the various ports. Balandra, Matelot and Toco stand out with notable impacts on boats, engines, nets and other fishing equipment.

Table 2. Damages to Fishing Assets by Port

Port	Anchor & Rope	Boat	Engine	Fish Pot	Ice Box	Net	Other	Propellor	Total
Balandra		4	3		1	4	3	1	16
Cumana		3	2			1	2		8
Grande Riviere		4	1			1		2	8
Matelot	1	6	3			4	1		15
Salybia				1		1			2
Sans Souci		1	2			1			4
Toco		5	4			3	2		14
Total	1	23	15	1	1	15	8	3	67
%	1	34	22	1	1	22	12	4	100

The most significant cost or expense was associated with damage to 23 boats (34%). This was followed by damage to 15 engines (22%) and nets (22%). Overall, these three fishing assets accounted for 78% reported damages. This underscores the role that boats, engines, and nets play in fishing operations and the substantial financial impact that ensues when they suffer damage.

Rough Seas & Heavy Rains were the greatest contributor to fishing asset damage, collectively contributing a staggering 79.13% of the total damage costs. This highlights the vulnerability of fishing assets to adverse weather conditions in the study area. “Theft” also represents a significant factor, accounting for 20.69% of the costs. Though “Heavy Rains” by itself contributed to a smaller percentage, it is important to note that these circumstances can still challenge the fishing industry, albeit to a lesser extent.

Economics

The economic analysis considered the repair time, loss of average number of fishing days and associated revenue. A substantial 73% of the cost associated with damages that occur at the fishing port amounting to US$92,104. This reveals that vessels are still prone to damage even when they are not actively engaged in fishing activities. Damages that occurred out at sea and “anchored outside the port” represent significantly smaller costs in comparison, with US$32,382 and US$1,045, respectively. Loss from theft amounts to US$24,925. This suggests that vessels may be relatively more vulnerable to damages and theft while in port.

In Table 3 Matelot stands out with the highest number of days where the assets were down (471). This suggests that fishing assets in Matelot experienced periods of downtime, which could have significant economic implications for the fishers in that area.

Toco has the highest average price per pound USD $2.67, which may suggest a stronger negotiating power with local vendors. Overall, Matelot incurs the highest accumulated losses in USD ($95,636.86), reflecting the substantial economic impact of asset damage in this area. The total loss across all locations is $192,884.62, emphasising the significant economic consequences of fishing asset damage in the entire study area.The overall loss of approximately USD$192,884.62 underscores the importance of addressing asset damage in the fishing sector. These losses can have a direct impact on the livelihoods of fishers and their families, potentially affecting their economic stability and well-being.

Table 3. Revenue Loss from fishing days down						
Row Labels	**# of boats**	**Days down**	**Avg of Value/Trip**	**Avg price per lb**	**Total Losses USD**	**100%**
Balandra	7	144	$ 123.12	$ 1.50	$ 19,054.60	9.88%
Cumana	2	48	$ 144.63	$ 1.76	$ 6,942.12	3.60%
Grande Riviere	4	63	$ 137.81	$ 1.65	$ 9,381.07	4.86%
Matelot	6	471	$ 194.60	$ 1.87	$ 95,636.86	49.58%
Salybia	2	48	$ 74.80	$ 1.57	$ 3,590.30	1.86%
Sans Souci	2	30	$ 272.08	$ 2.21	$ 9,980.29	5.17%
Toco	6	360	$ 170.30	$ 2.67	$ 48,299.39	25.04%
Grand Total	**29**	**1164**	**$ 1,117.34**	**$ 13.23**	**$ 192,884.62**	**100.00%**

Table 4 presents the results for the Time to Repair Fishing Assets. The majority of fishing asset damages (46%) fall into the category of "Still down," indicating that a significant portion of damaged assets remained unrepaired at the time of writing. This suggests potential challenges in accessing financing to restore fishing assets to operational status quickly. Only a small percentage of damages were repaired within one month (13%) or in more than two months (15%). This indicates that there might be delays in repairing damaged fishing assets, potentially affecting the fishers' ability to resume their fishing activities promptly.

While the repair time "Still down" has the highest percentage, it's noteworthy that it also accounts for a substantial proportion of the total repair cost (79.85%). This reveals that even though these assets are not yet repaired, they contribute significantly to the overall cost (estimated).

Table 4. Time to Repair Fishing Assets

Repair Time	**Damages to various Fishing Assets**									
	Anchor & Rope	Boat	Engine	Fish Pot	Ice Box	Net	Other	Propellor	Total	%
More than 2 months		2	2		1	2	3		10	15
Still down	1	10	8	1		7	4		31	46
Within 1 Month		2	4			2	1		9	13
Within 2 Months		9	1			4		3	17	25
Total	**1**	**23**	**15**	**1**	**1**	**15**	**8**	**3**	**67**	**100**

The trends suggest that Matelot experienced the most extended downtime and highest total losses, while Sans Souci had higher-value fishing trips. Toco had the highest average fish price per pound. These variations in data highlight the cost of repair and the loss of revenue of asset damages across different fishing communities in the study area.

4. DISCUSSION

Asset damage, primarily caused by rough seas and heavy rains, resulted in over USD $125,531 in damages to fishing assets. This included boats, engines, nets, and other essential equipment. The economic losses extended beyond the cost of repairs, with an estimated USD 192,884 in revenue losses, highlighting the significant financial implications for fishers. Full-time fishers bore the majority of the economic burden, accounting for approximately 84.27% of the total losses. Part-time fishers also faced substantial financial setbacks, emphasising the widespread impact of asset damage. These losses threaten fishers' livelihoods, particularly full-time fishers who rely solely on fishing income. While theft accounted for a smaller percentage of total damage costs, it remains a concern. Addressing theft-related issues, such as improving security measures for fishing assets, should not be overlooked, as it can still impact the livelihoods of fishers.

Weather-related factors, such as heavy rains and rough seas, were identified as the primary causes of asset damage. Climate variability and changing weather patterns in coastal communities expose fishers to increased risk and vulnerabilities. The data expose significant disparities in the economic impact of asset damages. While Matelot and Toco experienced the highest total losses, other communities like Cumana and Salybia faced relatively lower losses. These disparities could be attributed to variations in the quantity of fishing vessels and the ease of securing the boats on land. The location of damage varied, with significant damage occurring at sea and in port areas. This suggests the need for targeted strategies to protect assets both in transit and at rest. Seasonal variations in asset damage were observed, with some areas experiencing more damage during specific times of the year. Understanding these patterns can inform proactive measures.

Policymakers and stakeholders must recognise the unequal distribution of losses between full-time and part-time fishers and tailor support mechanisms accordingly. Investment in resilience-building measures, including improved asset security, proper port development and disaster preparedness, can help mitigate the economic impact of asset damage. The study underscores the value of collecting and analysing data to inform decision-making in the fishing sector. Data-driven insights are essential for resource allocation and targeted interventions.

Since the study reveals that coastal communities, particularly those reliant on fishing, are economically vulnerable to weather-related damages and theft, this vulnerability can lead to substantial financial setbacks for both full-time and part-time fishers. Coastal communities must acknowledge and address this economic risk. Given the significant impact of weather-related events on fishing assets, coastal communities should prioritise climate resilience initiatives. This may involve infrastructure improvements, early warning systems, and community-based disaster preparedness programs.

Coastal communities play a crucial role in supporting fishers during difficult times. Strengthening social networks, establishing small businesses for repairing boats, engines and nets and sharing best practices can enhance community resilience and response to asset damages. The use of technology, as demonstrated by WhatsApp groups, can facilitate rapid communication, data collection, and response during asset damage incidents. Coastal communities should explore and adopt such technologies to enhance community resilience. Collaborative efforts with governmental agencies, NGOs, and research institutions can yield valuable support, resources, and expertise to address the economic implications of asset damage in coastal communities. Recognising seasonal variations in asset damage is crucial. Communities should develop seasonal preparedness plans that include asset protection measures and contingency strategies for periods of increased risk.

The economic vulnerabilities underscored by the study demonstrate a pressing need to enhance the financial resilience of fishers. Access to finance and the development of robust financial capabilities are not merely facilitative measures; they are critical lifelines that can buffer the fiscal shocks incurred from asset damage. Full-time fishers, who disproportionately shoulder these economic burdens, particularly stand to benefit from improved financial services tailored to their unique needs and the cyclical nature of their income. Such services could include savings and credit options designed with flexible repayment schedules to accommodate the seasonality of fishing revenues. Furthermore, building financial capability—through literacy programs specifically targeted at fishers—can empower them to make informed financial decisions, manage risks more effectively, and invest in more resilient fishing assets. Strengthening these economic safeguards is pivotal in ensuring that fishers can weather the storms brought on by both literal and figurative tides and continue to sustain their livelihoods and communities. The significant revenue losses experienced, amounting to approximately USD 192,884, punctuate the critical role that financial preparedness and accessible financial tools play in fortifying fishers against the inevitable challenges posed by their trade.

The study opens avenues for future research, including exploring the social and environmental dimensions of asset damage, assessing the effectiveness of recovery measures, and investigating long-term trends in the fishing sector.

5. CONCLUSION

In conclusion, this study provides valuable insights into the economic implications of weather-related damages and theft on fishing vessels in Northeast Trinidad. It underscores the need for proactive measures, collaborative efforts, and data-driven decision-making to safeguard the economic well-being of fishers and coastal communities in the face of climate variability and asset vulnerabilities.

The findings from this study reveal several key takeaways:

- Weather-related damages, primarily caused by rough seas and heavy rains, resulted in substantial financial losses exceeding $192,884 USD. These losses encompassed repair costs and revenue reduction, affecting both full-time and part-time fishers.
- Full-time fishers bore the majority of the economic burden, with approximately 84.27% of the total losses, emphasising their vulnerability to asset damage.
- Theft incidents, though contributing to a smaller percentage of total damage costs, remain a concern and can impact the livelihoods of fishers.
- The study highlighted variations in economic impacts across different fishing communities, with Matelot and Toco experiencing the highest total losses, while others faced relatively lower losses.
- The location of damage varied, with significant damages occurring both at sea and in port areas, emphasising the need for targeted protection measures.

Other Recommendations

The implications of this research extend to policy and practice:

- Policymakers and stakeholders should recognise the unequal distribution of losses between full-time and part-time fishers and tailor support mechanisms accordingly. Investment in resilience-building measures, including improved asset security, proper port development, and disaster preparedness, can help mitigate the economic impact of asset damage.
- Coastal communities should prioritise climate resilience initiatives, including infrastructure improvements, early warning systems, and community-based disaster preparedness

programs, to address the significant impact of weather-related events on fishing assets.
- Collaborative efforts with governmental agencies, NGOs, and research institutions can yield valuable support, resources, and expertise to address the economic implications of asset damage in coastal communities.
- The study's findings also highlight the importance of collecting and analysing data to inform decision-making in the fishing sector. Data-driven insights are essential for resource allocation and targeted interventions.
- Future research should explore the social and environmental dimensions of asset damage, assess the effectiveness of recovery measures, and investigate long-term trends in the fishing sector to enhance the resilience and sustainability of coastal communities.

ACKNOWLEDGEMENTS

We would like to express our appreciation to the Green Fund of the Ministry of Planning and Development for their support and funding, without which this research would not have been possible. Their commitment to promoting research has allowed us to explore and provide insights in this field.

We extend our thanks to the fishers who generously shared their valuable data, time and experiences with us. Their collaboration not only provided a perspective for our study but also exemplified the spirit of cooperation that drives scientific discovery and community engagement.

We would also like to acknowledge the Fisheries Division of the Ministry of Agriculture, Land and Fisheries for their assistance and support and leadership throughout this study. Their expertise and guidance were instrumental in navigating the complexities of the fishing industry and understanding the dynamics of ecosystems.

This research represents an effort, made possible by these organizations and individuals, to whom we are profoundly thankful.

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