On Shared Waters

Where Livelihoods, Culture, and Giants Meet

Justin Funa

Masters of Advanced Studies Candidate, Marine Biodiversity and Conservation

Scripps Institution of Oceanography, UC San Diego

Capstone Advisory Committee:

Rory Driskell (Chair)
Office of Protected Resources, National Marine Fisheries Service

Signature: Signed by: [redacted] 1C758D22A65045A... 6/11/2025

Dr. Alessandro Ponzo
Large Marine Vertebrates Research Institute Philippines (LAMAVE)

Signature: Signed by: [redacted] 0299F3FAE3E54BA... 6/6/2025

Dr. David Shiffman
Arizona State University Washington, DC center.

Signature: Signed by: [redacted] FC17CCFAC92E4F7... 6/9/2025

1. Introduction

In the heart of the Philippine archipelago lies Ticao Pass, a biologically rich corridor between Ticao Island and the Bicol Peninsula. This narrow channel hosts seasonal gatherings of whale sharks (Rhincodon typus), pelagic thresher sharks (Alopias pelagicus), and reef manta rays (Mobula alfredi), three charismatic megafauna species that inspire awe and draw ecotourists from around the world. Despite their popularity, these species are not listed under the U.S. Endangered Species Act (ESA). Although they are protected nationally, they often fall outside of global conservation priority frameworks due to persistent data gaps, especially in the Global South (Foster et al. 2022; Dulvy et al. 2014).

This capstone project emerged from both scientific urgency and a personal desire to return home. As a Filipino and a graduate student in marine conservation, I wanted to reconnect with a region I care deeply about and contribute to locally driven stewardship. I do not approach this work as an impartial outsider. I am someone shaped by the Philippines, by time away from it, and by a responsibility to give back through science and service. Ticao Pass and Donsol are more than biological habitats. They are lived spaces where species presence directly shapes people's income, identity, and daily decisions. Whale sharks and manta rays are not only icons of conservation; they are also economic lifelines, supporting livelihoods through ecotourism and guiding work (Ziegler et al. 2012; O'Malley et al. 2013).

This project focuses on mapping those shared spaces where marine megafauna and people interact. It draws on community knowledge and local experience, combining data from the Large Marine Vertebrates Research Institute Philippines (LAMAVE), the National Marine Fisheries Service (NMFS), and local dive operators, fishers, and NGOs. At a time when sightings are less frequent and incomes more fragile, conservation planning must reflect both ecological realities and human needs. This StoryMap was developed to do exactly that.

2. Project Overview and Objectives

This project aimed to visualize the overlap between human activities and the presence of three key shark and ray species in Ticao Pass and Donsol. The StoryMap deliverable integrates dive log records, fisher GPS tracks, local ecological knowledge, and NGO datasets to inform conservation and marine spatial planning.

> Research Question:
> Where are the spatial overlaps between human activities (fishing and ecotourism) and sightings of whale sharks, thresher sharks, and reef manta rays in Ticao Pass, and how can these data support community-informed conservation?

Objectives:

1. Map the presence and sightings of focal species using dive logs, interviews, and partner datasets.

2. Integrate community-sourced and NGO data to identify spatial overlaps and usage patterns.
   Create an interactive StoryMap to support education, outreach, and spatial planning.
3. Highlight the socio economic relevance of species presence and promote participatory conservation efforts grounded in local livelihoods.

3. Methods

This project used a mixed-methods approach combining spatial analysis with stakeholder interviews and local data contributions. Data was collected over several months, with field presence in April 2025. The final StoryMap integrates GPS and geospatial data from NGOs, dive operators, and fishers, with support from community partners and the research institute LAMAVE.

3.1 Data Collection

1. Dive Logs from Local Operators
Dive logs from Fun Dive Asia and Ticao Island Resort, covering April 2024 to April 2025, were shared with the project to provide insight into species presence. Fun Dive Asia is a locally owned dive shop that has operated in Ticao Island, catering to both domestic and international divers. The shop typically manages three to four boats during peak season and offers daily trips to popular sites including Manta Bowl. Ticao Island Resort is a larger, long-standing tourism operation that hosts international guests and dive groups. Both operators contribute to regional ecotourism while relying heavily on healthy populations of whale sharks, manta rays, and other large marine species.

These logs offered temporal and site-level information on whale shark, manta ray, and thresher shark encounters and were used to help contextualize areas of interest in the StoryMap. While the sightings were plotted in correspondence to the dive site, they were used to cross-reference other datasets, particularly those from LAMAVE.

> Dive operator logs are recognized as cost-effective tools for species presence data, especially in areas with established dive tourism (Ward-Paige et al. 2014; Araujo et al. 2017).

2. LAMAVE Ecotourism and Sighting Data
Through a partnership with LAMAVE, this project incorporated spatial datasets of whale shark and manta ray sightings from previous fieldwork in the Ticao-Burias Pass. These included ecotourism routes, GPS-tagged observations, and confirmed sightings. LAMAVE's contributions expanded the temporal scope of the analysis and provided a foundation for the mapping work. Their involvement highlights the essential role of collaboration between NGOs, researchers, and local communities.

3. WWF Fishing Hotspot Data
WWF-Philippines shared fishing points developed through past socioeconomic studies. These were mapped as areas of concentrated fishing activity and were key to identifying overlap with

species occurrence. Although not individual tracks, the data provided insight into human pressure zones that could intersect with conservation priorities.

4. Fisher GPS Track Collection
During April 2025, GPS devices were distributed to local fishers to capture real-time fishing routes. Though only 6-7 usable tracks were collected due to availability and holidays, they added firsthand, community-generated spatial data to the project. Tracks were digitized as polylines and color-coded by route.

> Participatory GPS mapping is an increasingly valuable tool in marine planning, especially in small-scale fisheries where formal data are limited (Gurney et al. 2019; Le Cornu et al. 2018).

5. Informal Conversations with Local Stakeholders
During fieldwork in April 2025, informal conversations were held with local fishers, as well as Butanding Interaction Officers (BIOs) and dive guides. These discussions, conducted in English, Tagalog, or Taglish depending on the individual, provided valuable anecdotal insight into shifting species presence, fishing pressure, and the fragile state of local livelihoods.

These conversations were guided by a set of informal questions focused on three themes: (1) observed changes in marine species presence over the years, (2) challenges or changes in fishing and tourism livelihoods, and (3) perceptions of conservation efforts in the region. While unstructured, each discussion aimed to understand how local stakeholders interpret environmental change and how it affects their work and sense of place.

While not part of a formal interview protocol, these conversations added depth and real-world grounding to the spatial data. One divemaster recounted cutting a line entangled on a manta ray at the Manta Bowl, a vivid example of how tourism and wildlife intersect in direct and sometimes harmful ways. Fishers spoke of fishing as a tradition passed down through generations, deeply tied to identity, yet increasingly unstable. Many shared that they now take on side jobs to make ends meet, citing unpredictable catch and declining fish stocks as growing concerns.

3.2 Spatial Analysis and Visualization

All data were cleaned and processed in ArcGIS Pro, using WGS 84 as the standard projection. Outputs were visualized and published through ArcGIS Online in the final StoryMap.

- Point data (dive logs, sightings) were categorized by species.
- Kernel Density (sightings and fishing hotspots) were calculated.
- Polyline and polygon data (fisher routes, hotspots) were layered and compared across species occurrence zones.
- Temporal attributes were retained when available to support seasonal interpretation.

3.3 Conservation Boundary Layer: ISRA

The Important Shark and Ray Areas (ISRA) shapefile for the Ticao-Burias Pass Protected Seascape (TBPPS) was incorporated to frame the analysis within a globally recognized

conservation zone. This provided additional relevance for policy applications and aligned the StoryMap with international frameworks.

3.4 Limitations and Adaptations

- Only 5–7 usable GPS tracks were collected from fishers, reflecting the logistical constraints of fieldwork during a short visit.
- Informal conversations with fishers and local tourism professionals supplemented the data, offering critical, if anecdotal, insights into community perspectives.
- The dive log dataset was biased toward tourist-accessible sites, but triangulated with LAMAVE data to improve depth and coverage.

4. Key Findings

The integration of dive logs, fisher GPS tracks, LAMAVE sightings, and WWF fishing hotspot data revealed notable overlap zones between human activity and the presence of whale sharks and reef manta rays. Though constrained by time and sample size, the data collectively offer a grounded understanding of ecological hotspots and human-use areas in Ticao Pass.

4.1 Species Sightings and Spatial Patterns

Whale Sharks (*Rhincodon typus*)
Sightings were concentrated near Donsol and the mid-channel zones of Ticao Pass. These areas, historically popular with tourists, align with known surface-feeding behavior in nutrient-rich waters. Both LAMAVE and dive log data indicate that encounters are becoming less frequent and involve fewer individuals, an emerging concern echoed in local conversations.

> Declines in whale shark encounters have been reported in Donsol and other areas, raising concern over ecological and economic impacts (Ziegler et al. 2012; Gonzales et al. 2021).

Thresher Sharks (*Alopias pelagicus*)
Recorded primarily in deeper offshore sites, such as Manta Bowl, thresher shark sightings were infrequent but spatially distinct. Their presence near cleaning stations aligns with behavior documented in other Philippine sites (Oliver et al. 2011).

Reef Manta Rays (*Mobula alfredi*)
Manta rays were logged both in nearshore and mid-channel areas, specially in and around the Manta Bowl. Observed behaviors included circling cleaning stations and gliding near boats, supporting findings that manta rays are frequently encountered during guided dives in the region (Araujo et al. 2017).

4.2 Human Activity Overlap

Overlaying WWF's fishing hotspots and fisher GPS tracks with species sightings revealed consistent overlap:

- Whale sharks and manta rays were often sighted within or adjacent to fishing zones.

- These overlaps raise concern over bycatch, disturbance, and the potential impacts of unregulated tourism.

  Spatial conflict between marine megafauna and coastal fisheries is a growing issue in data-poor regions (Muallil et al. 2014; Ban et al. 2013).

4.3 Community Perspectives

Despite limited time in the field, conversations with community members highlighted conservation challenges from a lived-experience perspective:

- Whale sharks are appearing in fewer numbers, with some days seeing only a single individual. This scarcity leads to crowding by tour boats and raises concern over animal stress.
- Fishers described smaller, more unpredictable catches, and spoke of their reliance on supplemental jobs to survive. Fishing remains a tradition passed down through generations, but it no longer guarantees security.
- One divemaster recalled cutting a fishing line that had become entangled on a manta ray, a stark reminder of the invisible overlap between human and animal lives in the water.

Income among stakeholders varies widely:

- BIOs (Butanding Interaction Officers) earn approximately ₱900 per trip during peak season.
- Dive masters reported earning around ₱500 per tank and they normally use three tanks per day..
- Fishers, whose income is fully catch-dependent, shared that they sometimes make as little as ₱200/day. Current conversion rate is $1 USD = 55 Philippine Pesos.

These stories reflect a precarious economic balance, one tied closely to the health and visibility of marine species.

4.4 Gaps and Opportunities

- While direct GPS participation was limited, NGO and community-sourced datasets filled spatial gaps effectively.
- There is opportunity to expand GPS logging, tourism data standardization, and community-driven monitoring.
- Most stakeholders support conservation if it protects both biodiversity and economic opportunity which is a promising insight for future co-managed planning.

4.5 Socioeconomic Dimensions & Economic Value of Species

Whale sharks and manta rays are not only ecologically significant, they are economically critical. Studies have shown:

- Whale shark tourism in Donsol generates approximately USD $3.5 million annually, supporting BIOs, boat crews, and local businesses (Ziegler et al. 2012).

- Manta ray tourism in the Philippines contributes an estimated USD $3.4 million annually, often surpassing extractive fisheries in value (O'Malley et al. 2013).
- In contrast, most small-scale fishers in the Philippines earn less than USD $5/day, with incomes declining alongside fish stocks (Muallil et al. 2014).

Protecting these species is thus both a conservation and economic resilience strategy for the communities who rely on them.

5. Reflections and Implications

This project reaffirmed that effective marine conservation must look beyond ecological metrics and include social, economic, and cultural dimensions. By integrating community narratives, fisher routes, and partner datasets, the StoryMap evolved into more than a visualization. It became a platform for dialogue, collaborative planning, and the foundation for potential co-management.

5.1 Lessons in Data-Limited, People-Rich Contexts

In data-limited settings like Ticao Pass, local partnerships and community knowledge are essential. Collaborating with LAMAVE, along with local dive shops and fishers, allowed for the collection and curation of meaningful spatial data despite the short field window. The combination of NGO datasets, dive logs, and fisher GPS tracks created a diverse and complementary knowledge base that strengthened the final map.

While large-scale ecological datasets often dominate planning efforts, this project demonstrated that trust-based collaborations and participatory methods can produce results that are highly place-based and deeply grounded in lived experience (Aswani et al. 2018; Gurney et al. 2019).

> The lesson: You don't need years of data to make a difference, you need relationships, humility, and a willingness to listen.

5.2 Policy and Planning Implications

Findings from this project support several next steps for local marine spatial planning:

- The presence of ecological–economic overlap zones (e.g. whale shark hotspots inside fishing areas) signals the need for refined zoning, with active fisher and tourism operator participation.
- Fishing and tourism management should consider seasonality and species presence to avoid crowding, overfishing, or disturbance.
- NGOs and LGUs could use this StoryMap as a discussion tool during community planning sessions and zoning ordinance updates.

> Policy that emerges from community-grounded mapping is more likely to be accepted, effective, and equitable.

5.3 A Personal Reflection on Return and Responsibility

This project also represents a personal return. It was a reconnection to my roots and a growing sense of responsibility to contribute to marine stewardship in the Philippines. Although I am not originally from the Bicol region, spending time in Donsol and Ticao Island reminded me how much knowledge, care, and leadership already exist within our communities. Conservation is not something we need to bring in from the outside; it is already here. What we need is to listen, support, and amplify it.

As someone trained abroad, I felt grateful to collaborate with LAMAVE and work closely with local fishers and dive professionals. Their insight and generosity shaped this project in ways no dataset could. What began as a capstone evolved into something more lasting, a commitment to contribute meaningfully to conservation efforts grounded in both science and community leadership.

6. Conclusion and Recommendations

This project set out to map where marine megafauna and human activities intersect in the Ticao-Burias Pass, and to create a visual decision-support tool that could inform conservation and community planning. The resulting StoryMap reveals the complex geography of coexistence; where whale sharks, manta rays, and fishers share the same waters, sometimes in harmony, sometimes in conflict.

By combining field-collected GPS tracks, dive operator logs, LAMAVE and WWF datasets, and community narratives, the map offers a rare, locally grounded look at a globally significant seascape. And it tells a simple but urgent story: species are declining, livelihoods are fragile, and the time for collaborative marine spatial planning is now.

Recommendations: Pathways Forward

1. Deepen LAMAVE Collaboration and Expand Monitoring

LAMAVE was instrumental to this project. Continuing to support their local presence and outreach in Ticao Pass can improve data continuity and offer training opportunities for dive shops, fishers, and youth. Annual data-sharing and community presentations could help democratize information.

2. Use the StoryMap for Local Zoning Workshops (LGUs)

LGUs can use the StoryMap to co-host participatory planning sessions, inviting fishers, tourism operators, and NGOs to discuss zoning updates. This could include proposing seasonal limits, designated wildlife interaction zones, or no-take areas.

3. Formalize Data Collection with Dive Shops

A simple protocol or shared platform for logging manta, whale shark, and thresher sightings could improve long-term tracking. Local shops like Fun Dive Asia already have informal logs and standardizing these would enhance the science without requiring major new resources.

4. Refine Fishing Pressure Data with WWF and Fishers

WWF's hotspot data served as a strong base. Future work could include validating these zones with local cooperatives, gathering more GPS tracks, or layering in gear type and effort to improve resolution.

5. Invest in Livelihood Diversification

Species decline and tourism uncertainty make income diversification critical. NGOs and government partners should explore:

- Conservation stipends or cash-for-data programs
- Eco-certification for tour operators
- Skills training for BIOs, dive guides, and fishers in sustainable livelihoods

6. Empower Tourism Partners like Ticao Island Resort

As both contributors and stewards, resorts play a key role. Ticao Island Resort can be a leader in hosting training sessions, piloting best practices, and linking science to guest education.

This StoryMap is just a beginning. Conservation will only succeed here if it is built with the people who know these waters best, fishers, BIOs, dive professionals, and community leaders. Their voices are not just data points; they are decision-makers. This project is for them.

7. Acknowledgments

This project was only possible because of the generosity, trust, and collaboration of many individuals and organizations. I am deeply grateful to my Capstone Committee, Rory Driskell, Dr. Alessandro Ponzo and Dr. David Shiffman for their guidance and feedback throughout this process.

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I also extend my gratitude to WWF-Philippines for providing fishing hotspot data, and to the Donsol Tourism Office and Local Government Units (LGUs) in Sorsogon and Ticao Island for their openness to research partnerships. I'd like to acknowledge ISRA for providing the conservation shapefiles that helped frame this project in a broader international context.

Thank you to Fun Dive Asia and Ticao Island Resort for sharing dive logs, insights, and site knowledge, and for modeling sustainable tourism in practice. Special thanks to the BIOs, fishers, and community members who welcomed me, shared their stories, and offered their time. Your voices are the heart of this project.

This project is a shared effort, made meaningful by the people and places it represents.

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Institutional and Community Data Sources

LAMAVE. *Whale Shark and Manta Ray Sighting and Ecotourism Track Data for Ticao Pass Region*. Internal dataset shared with permission, 2024.

WWF-Philippines. *Fishing Hotspot Maps and Socioeconomic Data for the Ticao-Burias Pass Region*. Internal dataset, 2022.

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9. Appendices

Appendix A: StoryMap Link

The interactive StoryMap produced for this capstone project can be accessed at: https://arcg.is/0Tiz9D0

Appendix B: Map Metadata Summary

To promote transparency and reproducibility, metadata for all spatial layers used in the StoryMap is compiled in a separate document. This metadata includes source information, collection dates, coordinate systems, data formats, and key attribute fields for each map layer.

> A metadata table is available upon request or will be included in the project archive submitted to eScholarship.

Appendix C: Data Archive and Access

Raw and processed datasets used in this project include:

- Species sighting summaries and tracklines from **LAMAVE**
- Fishing hotspot polygons from **WWF-Philippines**
- Anonymized GPS tracks from local fishers
- Dive log summaries from **Fun Dive Asia** and **Ticao Island Resort**
- ISRA boundary shapefiles
- Local zoning data from LGU offices

Due to the sensitivity of GPS-based and community-derived data, full access is restricted. A **redacted, non-sensitive version of the dataset** (suitable for academic use) is available upon request. Please contact the author or relevant partner organization for access.