Advancing Marine and Coastal Spatial Data Curation and Management in Belize

Ocean Country Partnership Programme (OCPP)

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MARFISHECO
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Executive Summary

High-quality marine and coastal data are critical for effective environmental management, sustainable development, and informed decision-making in Belize, a country with a rich marine ecosystem and an extensive coastline. Inconsistent data formats, limited metadata, and challenges with data sharing and storage have constrained the country's ability to fully leverage spatial information for marine spatial planning and resource management. To address these gaps, the Joint Nature Conservation Committee (JNCC), through the UK Government's Ocean Country Partnership Programme (OCPP), partnered with MarFishEco Fisheries Consultants (MFE) and the Coastal Zone Management Authority and Institute (CZMAI) to strengthen geospatial data curation and management in Belize. The project focused on developing geospatial data curation guidelines, building capacity through a hands-on workshop, and curating existing datasets to assess data formats and quality and identify areas for improvement. The initiative successfully delivered practical tools and recommendations to improve data formatting, curation, and management. Despite ongoing barriers related to infrastructure and technical capacity, this work provides a strong foundation for advancing Belize's marine data governance and lays the groundwork for a more integrated, reliable, and sustainable geospatial data curation system in support of long-term ocean management and conservation.

Acknowledgements

We are deeply grateful to Israel Correa (CZMAI GIS Technician) and Delwin Guevara (CZMAI MSP Spatial Analyst) for their unwavering support throughout the project, particularly in the lead-up to the workshop. Their efforts in facilitating communication, assisting with workshop planning, and ensuring the content was both relevant and effective were invaluable to the success of this initiative. Their coordination on the day of the workshop also played a crucial role in keeping everything running smoothly. We also extend our thanks to Arlene Young (CZMAI Director) for her guidance and support in the execution of this project.

Special appreciation goes to Andrea Grinage and Carlie Gillett at the Ministry of Blue Economy and Marine Conservation for helping to promote the workshop, engage with stakeholders, and secure the venue.

We are also grateful to the staff at the Biltmore Best Western Plaza for their hospitality and professionalism in managing the technical setup and catering, ensuring a seamless experience for all attendees.

Finally, we sincerely thank all the workshop participants who took time out of their busy schedules to engage in meaningful discussions on data curation. Your insights and contributions made the session both productive and impactful. This project was generously funded by the Ocean Country Partnership Programme (OCPP), whose support made this initiative possible.

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List of Acronyms

Acronym	Full Term
BSOP	Belize Sustainable Ocean Plan
CBWS	Corozal Bay Wildlife Sanctuary
CODATA	Committee on Data of the International Science Council
CGIAR	Consultative Group on International Agricultural Research
CRS	Coordinate Reference System
CZMAI	Coastal Zone Management Authority and Institute
FAIR	Findable, Accessible, Interoperable, and Reusable
GIS	Geographic Information System
ICZMP	Integrated Coastal Zone Management Plan
ISO	International Organization for Standardization
JNCC	Joint Nature Conservation Committee
KML/KMZ	Keyhole Markup Language / Compressed KML
MBEMC	Ministry of Blue Economy and Marine Conservation
MEL	Monitoring, Evaluation, and Learning
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MFE	MarFishEco Fisheries Consultants
NGO	Non-Governmental Organization
OCPP	Ocean Country Partnership Programme
OGC	Open Geospatial Consortium
PSC	Project Steering Committee
QGIS	Quantum Geographic Information System
R	Open-source programming language for data analysis
SACD	Sarteneja Alliance for Conservation and Development
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984
XML	Extensible Markup Language

Introduction

High-quality marine and coastal data are essential for effective environmental management, conservation planning, and sustainable development. Belize is a country with an extensive coastline and a rich marine ecosystem and therefore depends on standardised, reliable and accessible spatial data to support decision-making in areas such as marine protected area (MPA) management, fisheries, coastal resilience, and climate adaptation. Inconsistencies in data formats, gaps in metadata, challenges in data accessibility, and a lack of harmonisation between datasets can limit the effectiveness of data collection efforts, hindering their ability to effectively inform marine spatial planning and support sustainable resource management. To address these issues, a standardised approach to data curation, ensuring proper organisation, documentation, harmonisation storage, and sharing is critical for enhancing data integrity, usability, and long-term accessibility.

Recognising the importance of robust data management in marine ecosystem management, the Joint Nature Conservation Committee (JNCC), acting as a delivery partner for the UK government-led Ocean Country Partnership Programme (OCPP), has engaged MarFishEco Fisheries Consultants (MFE) to collaborate with the Coastal Zone Management Authority and Institute (CZMAI) in Belize. This collaboration aims to improve data accessibility, integration, and consistency, ensuring that high-quality datasets effectively support marine spatial planning and marine resource management efforts.

This project specifically aimed to:

1. Develop a Geospatial Data Curation Guideline for CZMAI's Coastal and Marine Data Centre, outlining best practices for data formatting, quality control, metadata management, and data organisation, storage, security, and sharing, all of which help to ensure enhanced accessibility, integrity, and long-term usability of spatial datasets.
2. Enhance capacity through a stakeholder workshop that introduces the Geospatial Data Curation Guidelines to CZMAI and its partners, providing hands-on training to apply these standards in practice and strengthen data curation skills.
3. Implement a data call campaign to gather spatial datasets from governmental agencies, non-governmental organisations (NGOs), universities, and research institutions, expanding Belize's spatial data inventory to support marine spatial planning and effective resource management.
4. Assess CZMAI's existing data, along with datasets received from stakeholders through the Data Call Campaign, against the Geospatial Data Curation Guidelines to ensure accuracy, consistency, and compliance with standardised data management practices, ultimately enhancing the quality and usability of spatial data in Belize.

By improving data governance and technical expertise, this initiative aimed to strengthen Belize's capacity for evidence-based decision-making, ensuring more effective marine spatial planning, resource management, and long-term conservation of its coastal and marine environments.

Methods

This project used a multi-method approach to advance geospatial data curation and management in Belize. Key components included the development of geospatial guidelines, capacity building through a stakeholder workshop, data call campaign to collect valuable marine and coastal datasets, and assessment of spatial data sets from CZMAI and that received from the data call campaign. Rather than following a strictly iterative approach where each step occurred sequentially, these components informed and reinforced one another, with insights from one feeding into the next—all through continuous consultation and discussion with CZMAI (Figure 1).

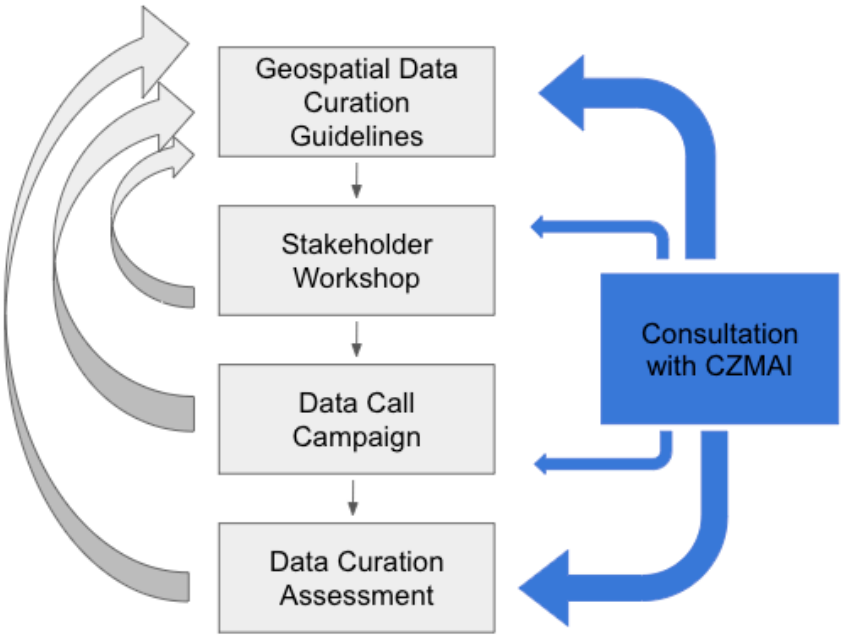


Figure 1. The multi-method approach to advancing geospatial data curation and management in Belize. The grey arrows on the left indicate inputs from each component, contributing to the refinement of the geospatial data curation guidelines. The blue arrows on the right indicate continuous consultation with CZMAI, ensuring that every component of the multi-method approach is informed by their insights and expertise.

Geospatial Data Curation Guidelines

The geospatial data curation guidelines were developed to establish best practices for curating and managing spatial datasets within CZMAI's Coastal and Marine Data Centre. These guidelines were informed by multiple sources, including MFE's extensive experience in data collection, curation, and analysis, internationally recognised data curation standards, and existing data management practices at CZMAI.

To ensure alignment with global best practices, the guidelines incorporate principles from the Committee on Data of the International Science Council (CODATA), the Open Geospatial Consortium (OGC), the Global Climate Observing System (GCOS), the International Organisation for Standardization (ISO 19115 for geospatial metadata), and the Consultative Group on International Agricultural Research (CGIAR). These frameworks help standardise data formats, improve metadata quality, and enhance data accessibility and interoperability.

Additionally, CZMAI provided a subset of the spatial data they manage, which was reviewed to assess the status of data formats, organisation, and storage practices. This assessment helped identify existing challenges and gaps, allowing the guidelines to be tailored to CZMAI's specific needs while ensuring compliance with international standards.

Stakeholder Workshop

In collaboration with CZMAI and the Ministry of Blue Economy and Marine Conservation (MBEMC), MFE conducted a one-day workshop in Belize at the Biltmore Best Western Plaza, Belize City on February 18th, 2025, to introduce the Geospatial Data Curation Guidelines. The workshop featured interactive activities and discussions, allowing participants to apply the guidelines in practice (Annex 1 – Stakeholder workshop schedule). Additionally, the workshop served as a data collection tool, gathering stakeholder input on existing challenges and additional considerations to refine the guidelines further.

Data Call Campaign

Following the workshop, once stakeholders had been introduced to the geospatial data curation guidelines at the workshop, a data call campaign was launched to collect valuable coastal and marine datasets (Annex 2 – Data call campaign form). Specifically, the campaign aimed to gather datasets relevant to the Integrated Coastal Zone Management Plan (ICZMP) and the Belize Sustainable Ocean Plan (BSOP) to enhance national efforts in sustainable coastal management. Stakeholders were invited to contribute datasets that would undergo review and evaluation against the newly developed geospatial data curation guidelines.

Assessment of spatial data against MFE's data curation guidelines

A subset of CZMAI datasets and data submitted by stakeholders through the data call campaign was assessed against the geospatial data curation guidelines. This evaluation aimed to identify gaps in metadata, data format and quality, and spatial integrity across key datasets. By assessing compliance with established curation standards, the findings provide actionable insights to enhance data accuracy, accessibility, and interoperability. The assessment of CZMAI datasets and data submitted by stakeholders through the data call campaign followed key steps of the detailed workflow for the data curation process of the geospatial data curation guidelines, ensuring a structured approach to identifying and addressing data inconsistencies.

Deliverables

Geospatial Data Curation Guidelines

The geospatial data curation guidelines[1] provide a structured, step-by-step guide for curating and managing spatial data, ensuring that datasets are accurate, well-documented, and accessible for future use. It is primarily intended for data managers, GIS analysts, and

[1] MarFishEco Fisheries Consultants. (2025). *Geospatial Data Curation Guidelines*. Published on behalf of OCPP.

technical staff responsible for handling, processing, and maintaining marine and coastal spatial datasets. While the guidelines are not specifically designed for data collectors, it still serves as a valuable resource for understanding proper data recording practices and the key elements that make datasets useful and compliant with curation standards.

The document serves as both a practical guide for immediate data curation and a forward-looking resource to support the ongoing advancement of data management in Belize.

Key Features:

- **Detailed Workflow of the Data Curation Process:** A step-by-step workflow to guide users from data acquisition to storage, ensuring consistency and compliance with best practices.
- **Geospatial Data Curation Guidelines:** Each section of the workflow links to detailed guidelines on data formatting, quality assurance, metadata management, validation, and storage.
- **Practical Examples:** Includes practical examples throughout the guidelines to emphasise points are primarily based on ICZMP data, along with specific instructions using Arc/QGIS for error detection and correction.
- **Recommendations for Data Security, Sharing, and User Training:** Outlines key recommendations to enhance data management and sharing protocols, along with user support. While Belize may not yet have a centralised data repository or formalised training programmes, these recommendations establish a foundation for improving data security, streamlining data-sharing protocols, and offering practical use cases to help data users effectively access and apply available resources.

Stakeholder Workshop

The workshop was attended by 28 participants representing governmental agencies, NGOs, universities, and research institutions (Annex 3 – Workshop participants). Feedback indicated a strong positive impact, with 93% of participants reporting an improved understanding of geospatial data curation and 93% agreeing that the content was useful and directly applicable to their roles. For a comprehensive report on the monitoring, evaluation, and learning outcomes of the stakeholder workshop see Annex 4 - Monitoring, evaluation, and learning (MEL) short report.

Participants engaged in hands-on exercises focused on error detection, file structuring, and data-sharing protocols, reinforcing key concepts from the developed geospatial data curation guidelines through practical application. Most participants successfully identified data inconsistencies, applied best practices for file organisation, and actively contributed to discussions on improving data-sharing workflows. These interactive components enhanced participants' ability to implement standardised data curation practices within their respective organisations. A sample of the slides presented during the workshop are available in Annex 5 – Key slides presented in the stakeholder workshop

Data Call Campaign and Assessment of Submitted Spatial Data

A total of 26 stakeholders (Annex 6 – List of stakeholders targeted for the data call campaign) were invited to participate in the data call campaign, including government agencies, NGOs, academia, and industry partners. However, only one stakeholder participated in the campaign. The low participation may have stemmed from delayed communication and workshop scheduling. Although the data call was mentioned prior to the workshop, due to administrative delays with the MBEMC, the official announcement and details were not shared in advance as intended. As a result, the data call had to be discussed in depth during the workshop, limiting stakeholders' time to prepare and respond.

The single stakeholder to participation in the data call campaign was Sarteneja Alliance for Conservation and Development (SACD), an NGO committed to the conservation and sustainable use of marine resources, ensuring long-term benefits for both present and future generations. Based in Sarteneja, a traditional fishing village in the Corozal District of north-eastern Belize, SACD serves as the co-management partner for the Corozal Bay Wildlife Sanctuary (CBWS), working closely with the Forestry Department to protect and manage this critical ecosystem.

Since the data shared by SACD for the data call campaign is restricted, specific details cannot be provided regarding the results of the assessment. The data, which focused on coastal mapping of the Corozal Bay Wildlife Sanctuary, was evaluated against the developed geospatial data curation guidelines and similar patterns of inconsistencies were observed across multiple files.

The deliverables to SACD included:

- Review and error-checking of metadata from a select subset of data files, data format and quality, and topology and spatial integrity.
- Creation of an updated shapefile incorporating corrections identified during the review, with fully completed metadata.
- A map visualizing the updated data.
- Recommendations for improved project folder organisation to enhance data accessibility and management.

This targeted approach ensured that key data quality issues were addressed while also supporting sustainable data organisation practices for future use.

Assessment of CZMAI Spatial Data

While CZMAI shared numerous data files, the assessment of CZMAI's spatial data against the developed geospatial data curation guidelines specifically focused on a subset, namely the ICZM Plan Data 2020 (Table 1), as directed by CZMAI. MFE prioritised 10 key data files that pertain to marine habitat and human stressor spatial layers, located in the ICZM Plan Data 2020 folder rather than working through all files provided across all projects. This is because similar errors were observed across multiple files during the pre-screening audit, allowing the common issues to be addressed more efficiently and invest more time in building standardised guidelines to address commonalities across diverse datasets. While MFE provides potential corrections to these errors, they are intended as recommendations

rather than definitive fixes, as a full review by the CZMAI team is essential to ensure accuracy and alignment with their data expertise. Furthermore, these corrections represent just one possible solution, as alternative approaches may be equally valid in achieving the same outcome. By focusing on a subset of data files, this approach serves as a proof of concept, demonstrating a methodology that can be applied across all data files moving forward.

*Table 1. Data files included in the ICZM Plan Data 2020, assessed against the geospatial data curation guidelines. Note: The file *s0_oil.shp could not be accessed in QGIS due to potential corruption and was therefore excluded from the assessment.*

Data File	Description (supporting ICZMP 2020)	Main Metadata		
		Missing	Needs Adjustments	Verified and Correct
corals.shp	Spatial extent of corals	31 (77.5%)	6 (15%)	3 (7.5%)
mangroves.shp	Spatial extent of mangroves	30 (75%)	6 (15%)	4 (10%)
seagrass.shp	Spatial extent of seagrass	31 (77.5%)	6 (15%)	3 (7.5%)
Agricultural_Runoff 2020.shp	Spatial extent of agricultural runoff	31 (77.5%)	6 (15%)	3 (7.5%)
aquaculture_2022. shp	Aquaculture farms	27 (67.5%)	4 (10%)	9 (22.5%)
Coastal Development 2020.shp	Spatial extent of coastal development	30 (75%)	7 (17.5%)	3 (7.5%)
s0_fishing.shp	Spatial extent of fishing zone	30 (75%)	7 (17.5%)	3 (7.5%)
s0_recreation.shp	Spatial extent of recreational use	29 (72.5%)	7 (17.5%)	4 (10%)
*s0_oil.shp	Spatial extent of oil exploration and development	NA	NA	NA
Marine Dredging 2020.shp	Areas of marine dredging	28 (70%)	8 (20%)	4 (10%)
Marine Transportation 2020.shp	Spatial extent of marine	30 (75%)	7 (17.5%)	3 (7.5%)

Main metadata

On average, 73–78% of metadata fields are missing across datasets (Table 1). 10–20% of fields require modifications, with some datasets having higher inconsistencies. Finally, only 7–22% of fields are fully compliant. Although all datasets included XML files, they were often inconsistent with the metadata stored within the shapefile and accessed through ArcGIS.

Attribute metadata

All datasets lacked critical attribute metadata, including attribute descriptions, units of measurement, value domains, data constraints, and handling of missing values (see geospatial data curation guidelines for more details). This limits the datasets' usability and interoperability, emphasizing the need for improved metadata documentation.

Data Format and Quality

For most datasets, an attribute table was not essential, as they primarily consist of a single feature representing the extent of a specific human activity. For datasets with informative attribute tables, several inconsistencies were identified when benchmarking the datasets against the standards laid out in the data curation guidelines. Most commonly, there were inconsistent case formatting of field names and the presence of blank cells.

Topology & Spatial Integrity Check

All datasets passed topology integrity checks, confirming that each feature contained valid spatial information. No issues such as self-overlapping, self-intersecting features, or other topological errors were identified, demonstrating strong spatial consistency.

Corrected Shapefiles and Maps

Following the assessment of CZMAI's geospatial data, MFE produced corrected shapefiles and corresponding maps. Corrected shapefiles integrate identified corrections and complete metadata (to the best extent possible using available supporting documents). Corresponding maps, based on the corrected shapefiles, incorporate essential cartographic elements such as titles, a north arrow, and a scale bar, ensuring clarity and ease of interpretation. MFE prioritised updating shapefiles and maps for coral (Annex 7 – Map of coral extent) and agricultural runoff (Annex 8 – Map of agriculture runoff extent) as representative examples of marine habitat and human stressors.

Recommendations for CZMAI

The assessment of CZMAI's geospatial data and the larger highlighted key observations and recommendations specific to CZMAI:

- **Ensure all Data aligns with the Geospatial Data Curation Guidelines:** CZMAI can strengthen its data management processes by systematically applying the geospatial data curation guidelines to all spatial datasets. This includes standardizing metadata, formatting, naming conventions, and file organization to ensure consistency, interoperability, and long-term usability.

- **Establish and Maintain Centralized Data Inventory System:** Once datasets are curated to meet the geospatial data curation guidelines, they should be logged in a centralized data inventory. This system would track key information such as metadata, version history, and access permissions, improving data transparency, accessibility, and long-term tracking. This system could also serve as an internal planning tool to prioritize updates and identify gaps across datasets.

- **Hold Contributors to Consistent Data Curation Standards upon Data Submission:** To maintain high data quality and consistency across projects and data sources, CZMAI should require all external contributors to adhere to the same data curation standards. This includes submitting complete metadata, properly formatted spatial files, and organizing content according to the agreed-upon file structure. Enforcing these shared expectations will enhance data integration and ensure all datasets are ready for analysis or public dissemination.

Potential work packages that CZMAI could seek help with to meet the above include:

1. Spatial Data Collection and Digitization Training

A targeted training series to improve the collection and digitization of spatial data using GPS tools and desktop platforms such as QGIS and ArcGIS. The sessions could cover best tools and practices in the field, workflows for converting raw field observations into structured spatial datasets, addressing common topology errors to ensure data complies with the newly proposed geospatial data curation guidelines.

2. R Training: Data Management, Basic Analysis, and Spatial Techniques

Training in R should address a wide range of technical skills, from basic data management and statistical analysis to advanced spatial workflows. Core modules would include data cleaning, visualization, and descriptive analysis using packages such as `tidyverse`, followed by spatial analysis using tools like `sf`, `terra`, and `ggplot2`. Participants would develop workflows for integrating, analyzing, and visualizing spatial and non-spatial datasets relevant to coastal and marine planning.

3. Curation of Existing Datasets

Review and standardization of existing Belizean spatial datasets relevant to CZMAI and partners are needed to align with the newly proposed geospatial data curation guidelines. This work includes assessing and correcting metadata, attribute tables, data formatting, and spatial properties. Curated outputs will be documented and will allow for integration into CZMAI's central data catalogue, enabling more consistent use across institutions and projects.

4. Web-Based Data Request Portal

Development of a web-based data request portal would support streamlined access to CZMAI's curated datasets. The portal should include a structured request form and allow administrators to manage submissions, track access, and provide links to relevant metadata or downloadable data where applicable. This system would enhance transparency, improve efficiency, and reduce the administrative burden associated with ad hoc data sharing.

Project Synthesis

This project has taken important steps toward strengthening marine and coastal spatial data curation and management in Belize. The development of the geospatial data curation guidelines provided a structured and standardised framework for curating and managing spatial datasets. Through the stakeholder workshop, Belizean stakeholders were introduced to these guidelines, reinforcing the value of standardised data practices. The data assessments of CZMAI's datasets and submissions from the data call campaign initiated the process of adopting the guidelines, identifying key areas for improvement in metadata quality, spatial format and quality, and data organisation.

Limitations[2]

Despite progress achieved through this project, several key barriers hinder widespread implementation of improved spatial data management practices across Belize. Discussions on data sharing during the workshop underscored persistent challenges in cross-agency collaboration and stakeholder engagement. Systemic barriers, including infrastructure constraints and technical capacity continue to hinder efficient data management across Belize. Many stakeholders pointed to difficulties in handling large volumes of data due to insufficient storage and infrastructure (e.g., lack of high-performance servers or centralised data repositories). Additionally, data management is rarely a dedicated role, and individuals often juggle multiple responsibilities, leaving little time or support for appropriate data curation. The lack of consistent training and frequent staff turnover further hinder the development of long-term technical capacity, making it challenging to establish and maintain effective data management practices. These challenges were further reflected in low participation in the data call campaign, highlighting ongoing obstacles to stakeholder engagement and data-sharing initiatives despite the established value and need for data curation.

Next steps

To build on the progress made thus far and address the limitations identified in this project, targeted efforts are needed to broaden the adoption of the developed geospatial data curation guidelines and strengthen Belize's spatial data management capacity. Addressing infrastructure constraints, limited technical capacity, and stakeholder engagement challenges will be essential for ensuring long-term success.

- **Expanding Technical Training and Support:** Continued capacity-building initiatives should focus on enhancing technical expertise in data curation and management. This includes providing regular, structured training on metadata documentation, spatial data formatting, and quality control procedures to help stakeholders integrate best practices into their workflows, even with limited dedicated resources for data

[2] MFE aimed to tailor the workshop to align with participants' experience and expertise in spatial data work. To support this, a survey was designed in advance to gauge interest and assess knowledge levels of participants. However, due to timing constraints, the survey was distributed just one day before the workshop, limiting the ability to fully customize the content in advance. As a result, the workshops were presented in a more generalized format, with a focus on foundational concepts to ensure accessibility for participants with varying levels of prior knowledge.

management. Additionally, capacity building initiatives should focus on advanced training in GIS and spatial analysis to empower stakeholders to derive deeper insights from spatial data, supporting more informed decision-making and strategic resource management. Finally establishing dedicated full-time data management roles can improve accountability and consistency. Consistent training programmes and dedicated full-time data management roles can help mitigate the impact of staff turnover and ensure long-term institutional knowledge and technical capacity.

- **Strengthening Institutional Support and Infrastructure:** Given the challenges associated with data storage limitations and lack of centralised repositories, investing in high-performance servers, cloud storage solutions, and centralised data repositories will improve data accessibility and security.

- **Enhancing Data-Sharing Mechanisms:** The discussion around the limited stakeholder collaboration and low participation in the data call campaign highlights the need for stronger data-sharing frameworks and collaboration agreements between agencies and organisations. Establishing clear data-sharing policies, promoting transparency in data access, and encouraging cross-agency partnerships can facilitate a more integrated and cooperative approach to spatial data management and planning.

- **Establishing a National Data Repository:** A centralised national data repository would provide a structured, secure, and accessible platform for storing and managing spatial data across agencies and organisations. A national repository could streamline data sharing, reduce duplication of efforts, and ensure long-term preservation of critical datasets. Additionally, by improving data accessibility and integration, it could support marine spatial planning and enhance resource management efforts, enabling more informed decision-making for sustainable coastal and marine conservation, fisheries management, and development initiatives.

By addressing these key areas, Belize can overcome current barriers and build a more resilient, standardised, and collaborative spatial data infrastructure that effectively supports marine resource management, conservation planning, and long-term sustainability efforts.

Conclusion

Comprehensive, standardised marine and coastal data are essential for enhancing environmental stewardship, informing conservation strategies, and supporting sustainable development in Belize. This project has taken foundational steps toward improving spatial data curation by establishing geospatial data curation guidelines, strengthening stakeholder capacity, and evaluating a subset of Belize's data against the developed guidelines. By establishing geospatial standards for data curation and management practices, this initiative has improved data integrity, accessibility, and usability, laying the groundwork for more effective decision-making in marine resource management. Continued investment in training, institutional support, and cross-agency collaboration will be key to ensuring long-term adoption of standardised data curation practices, ultimately strengthening Belize's marine spatial planning and conservation efforts.

Annex 1 – Stakeholder workshop schedule

Annex 1. Stakeholder workshop schedule held on February 18th, 2025, in Belize City. This workshop was designed to advance geospatial data curation and management practices. The agenda featured a combination of lectures and interactive activities designed to reinforce key concepts and encourage hands-on learning.

Time	Focus/Topic
9:00-9:30	Registration and Refreshments
9:30-9:45	Welcome, Introductions, & Run of Show
9:45-10:00	Project Background, Objectives, and Impact
10:00-10:45	Data Format, Quality, and Metadata
10:45-12:00	**Activity:** Hunting For Errors
12:00-1:00	Lunch
1:00-1:15	Shapefile/QGIS Demonstration
1:15-1:45	Data Storage & Organisation
1:45-2:15	**Activity:** Taming the File Frenzy
2:15-2:30	Coffee Break & Feedback
2:30-2:45	Data Requests and Sharing
2:45-3:30	**Activities:** Data Requests Dilemmas & Streamlining Data Sharing
3:30-4:00	Concluding Remarks

Annex 2 – Data call campaign form

Annex 2. Table of the data call campaign form for participants to submit along with their data. To streamline the process these questions were presented in a google form for easier data submission and management.

Thank you for participating in the data call campaign. Please provide your responses in the "Response" column corresponding to each listed item to the best of your ability. If you are uncertain about a specific item, please indicate "unsure." For fields that do not apply to your data file, please mark them as "NA."	
Core Information	**Response**
Filename:	
File type (e.g., Shapefile, GEOJSON, KML/KMZ, GeoTIFF, NetCDF, ASCII Grid, Other):	
Short description of data (how it was collected, manipulated, analysed, etc.):	
Technical Details	
Software used to develop data file (e.g., ArcGIS, QGIS, R, etc.):	
Spatial extent (e.g., bounding coordinates in decimal degrees, region name, or specific extent):	
Temporal extent:	
Format (point, line, polygon, grid, etc.):	
Coordinate reference system (e.g., WGS84):	
Resolution (if applicable, e.g., 10 m):	
Known issues or limitations with the data:	
Data Source and Processing	
Associated metadata (please send to CZMAI as an attachment):	
Original source of the data (e.g. field survey, publicly available satellite imagery, modelled data, etc.):	
Data Collector:	
Data Manager:	
Links to any detailed methods used:	
Use and Access	
Importance or relevance of the data:	
Who typically has access to the data (e.g., specific individuals of your organisation, partner organisations upon data sharing agreement, publicly available on website, etc.):	

Annex 3 – Workshop participants

Annex 3. List of participants who attended the stakeholder workshop held on February 18th, 2025, in Belize City. This workshop was designed to advance geospatial data curation and management practices. Participants included data managers and collectors from various stakeholder groups, including government agencies, NGOs, academia, and research institutions, fostering cross-sector collaboration and knowledge exchange.

Name	Organisation
Ali Cansino	Fragments of Hope
Alicia Nunez	Belize Fisheries Department
Andria Grinage	Ministry of Blue Economy and Marine Conservation
Antonio Cano	University of Belize
Arlene Young	Coastal Zone Management Authority and Institute
Carlie Gillett	Ministry of Blue Economy and Marine Conservation
Celi Cho	Department of the Environment
Darling Ortega	Sarteneja Alliance for Conservation and Development
Delwin Guevara*	Coastal Zone Management Authority and Institute
Dwayne Pech	Belize Audubon Society
Edgar Ek	Department of the Environment
Felicia Cruz	Ministry of Blue Economy and Marine Conservation
Indera Montero	Department of the Environment
Israel Correa*	Coastal Zone Management Authority and Institute
Jafet Pat	National Biodiversity Office
Kenneth Esquivel	Belize Fisheries Department
Kevin Novelo	Turneffe Atoll Sustainability Association
Kevin Tao	Belize Audubon Society
Kiran Forman	MAR Alliance
Leomir Santoya	Sarteneja Alliance for Conservation and Development
Lindolfo Chicas	Belize Fisheries Department
Maritza Cano	Statistical Institute of Belize
Monica Coe	National Emergency Management Organisation
Rubiceli Perrea	Ministry of Economic Development
Saul Cruz/Nigel Gomez	National Biodiversity Office
Shakera R. Arnold	Belize Fisheries Department
Yamira Novelo	Wildlife Conservation Society
Mercedes Rayguna	Hol Chan Marine Reserve
Jared Cain	Ministry of Natural Resources and Environment
Nigel Gomez	National Biodiversity Office
Brittany Cornett	Hol Chan Marine Reserve

* Delwin Guevara and Israel Correa played a pivotal role in supporting the development of workshop content and coordinating its execution.

Annex 4 - Monitoring, evaluation, and learning (MEL) short report

Annex 4. Monitoring, Evaluation, and Learning (MEL) short report of the stakeholder workshop held on February 18th, 2025, in Belize City. This workshop was designed to advance geospatial data curation and management practices. Following the workshop, participants completed a feedback questionnaire, the insights from which informed this report.

Reach & Participation

- **Total Trained:** *28 participants* from various government agencies and NGOs.
- **Engagement Activities:**
    - *Inception meeting with CZMAI (Feb 17)*: Reviewed guidelines and training materials and refined workshop materials and structure.
    - *Workshop (Feb 18)*: Focused on geospatial data curation and management within interactive activities.
    - *Follow-up meetings (Feb 20-21)* with the Fisheries Department and Fragments of Hope for further discussion and tailored support.

Learning Outcomes & Knowledge Retention

- **Knowledge Enhancement:**
    - *93%* of participants reported the workshop improved their understanding of geospatial data curation.
    - *93%* agreed the content was useful and applicable to their roles.
    - The 7% of participants who reported the workshop improved their understanding of geospatial data curation felt as though the workshop was basic and had expected more in-depth coverage of advanced topics.
- **Skills Development:**
    - Participants engaged in hands-on exercises on error detection, file structuring, and data-sharing protocols to reinforce learning.
    - The majority successfully identified data inconsistencies, applied structuring techniques, and discussed data sharing practices.

Engagement & Interaction

- **Interactive Sessions Included:**
    - *Hunting for Errors*: Practical correction of data inconsistencies.
    - *Taming the File Frenzy*: Group exercise on organizing unstructured datasets.
    - *Data Sharing Discussion*: Addressing institutional data-sharing challenges and solutions.
- **Follow-Up Support:**
    - One-on-one consultation offered post-workshop.
    - *Data Call Campaign (Feb 19)* launched to improve Belize's coastal/marine data submission and curation.

Challenges

- **Delayed Communication and Poor Coordination by MBEMC:** The MBEMC delayed the official workshop announcement until less than a week before the event and did not distribute the participant survey, which was intended to assess participants' experience and skill levels, until the day before the workshop. This survey was crucial for tailoring the content to participants' needs, ensuring the workshop was as effective and valuable as possible. However, with the final participant list provided only a day before the workshop, there was no opportunity to adjust the content based on attendees' expertise levels, ultimately limiting the workshop's ability to fully meet participant expectations.
- **Mismatched Participant Expectations:** Due to the lack of early coordination, participants had varying levels of expertise. While most found the foundational focus on data curation valuable and necessary, some attendees expected advanced GIS training, leading to misaligned expectations about the workshop's scope.

These challenges directly impacted the ability to optimise the workshop's effectiveness, reinforcing the need for better planning, earlier communication, and clearer coordination from key government agencies in future capacity-building efforts.

Conclusion

The workshop successfully strengthened geospatial data curation capacity in Belize, despite logistical challenges. The high engagement levels, strong post-workshop feedback, and demand for advanced GIS training highlight a clear need for ongoing support in this area.

Annex 5 – Key slides presented in the stakeholder workshop

Annex 5. Example of key slides presented during the stakeholder workshop held on February 18th, 2025, in Belize City. This workshop was designed to advance geospatial data curation and management practices. The presentation slides are available from MFE (projects@marfisheco.com) upon request.

Project Objectives

1. The development of a **Geospatial Data Curation Guideline** for CZMAI's Coastal and Marine Data Centre.
2. Spatial data **curation of historic, and recent spatial datasets** hosted at CZMAI's Coastal and Marine Data Centre.
3. **Data Call Campaign** for coastal and marine datasets to be used to support spatial planning.
4. **Capacity development** for CZMAI's technical staff and key partners on data management including spatial and non-spatial data curation.

Geospatial Data Curation Guidelines

Developed using:

- Extensive firsthand experience working with diverse data types across international organizations and disciplines.
- Aligned with international standards
  - International Organization for Standardization (ISO)
  - Consultative Group on International Agricultural Research (CGIAR)
  - Data Documentation Initiative (DDI)
  - Open Data Standards (OGC)
- Collaboration with CZMAI
- You all

Best Practices

Appropriate and Consistent Column Headers

- Use clear, concise, and descriptive column headings that accurately represent the data
- Replace spaces in column headings with underscores (_) or periods (.)
- Use consistent case format across headers

Data Column Consistency

- Ensures that all values within a given column follow the same structure, format, and conventions

Complete Data Rows

- Ensure all rows in the attribute table are complete, with no blank cells unless explicitly justified and documented.
- Use consistent symbols or values (e.g., "NA", "ND","Unknown") to represent missing data

Correspondence with Metadata

- Use consistent column headers in the attribute table as in in the metadata
- Ensure ranges of data columns in the attribute table are consistent with ranges defined in the metadata

BAD PRACTICE

species	date_recorded	temperature
Unknown	2023-01-22	25
Queen Triggerfish	1975-09-15	7

Temporal Range: 1975 - 2020
Temperature Range: 20-35 degrees C

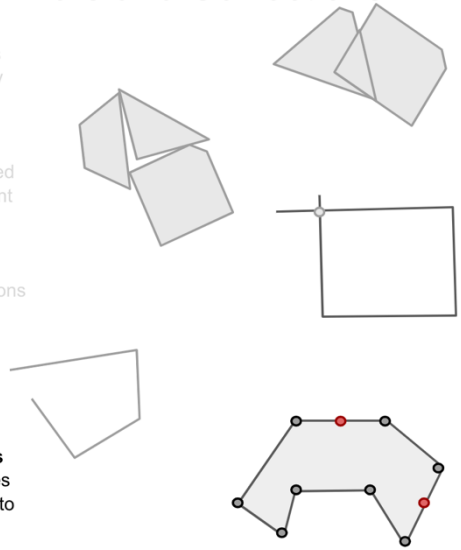
GOOD PRACTICE

species	date_recorded	temperature
Unknown	2023-01-22	25
Queen Triggerfish	1975-09-15	27

Temporal Range: 1975 - 2023
Temperature Range: 20-35 degrees C

Common Topology Errors and Corrections

- **Overlapping Polygons**
  - Ensure that adjacent polygons do not overlap unless explicitly required (e.g., marine jurisdictional boundaries)
- **Gaps Between Polygons**
  - Check for and correct unwanted gaps (slivers) between adjacent polygons
- **Self-Intersecting Features**
  - Identify and resolve self-intersecting lines or polygons that cause spatial inconsistencies
- **Unclosed Polygons**
  - Ensure that polygons are fully closed and valid, preventing errors in area calculations
- **Duplicate Vertices and Overshoots**
  - Clean up unnecessary vertices and snap misaligned features to correct positions



What is a metadata?

- A set of data that describes and gives information about other data
  - Provides essential information to help users understand, organize, and utilize the data effectively
- Metadata serves various purposes:
  - **Administrative** (ownership, credit, access and rights)
  - **Descriptive** (general description of datasets)
  - **Structural** (file dependencies, hierarchical folder structure)
  - **Technical** (data collection methods, data processing, file formats, description of data columns and unit)
  - **Preservation** (version information, retention policies)

Well-documented metadata enhances transparency, interpretability, and reusability, ensuring spatial datasets remain valuable over time

Data Storage

- **Standardized data formats**
  - non-proprietary, widely accepted formats
- **Define data storage system**
  - Public Data
  - Restricted/Confidential Data
- **Define data retention policies**
  - How long should data be kept?
  - Which/when data can be archived?
  - Which/when data can be deleted?
- **Regular backups and Redundancy**
  - Use multiple storage locations to prevent loss.
  - Automate backups on a regular (weekly? monthly?) basis.

Systematic Data Organization

- **File Labeling and Naming Conventions**
  - Use consistent, structured naming conventions to enhance searchability and avoid confusion.
  - Avoid spaces in file and folder names; use underscores (_) or hyphens (-) instead.
  - Ensure file names are descriptive but not excessively long.
  - Include key information in filenames:
    - **Project Name or Acronym**
    - **Date in YYYY-MM-DD format for sorting** (e.g., 2024_02_10)
    - **Data type** (e.g., _metadata, _survey)
- **Version Control**
  - Implement a clear version control strategy to track changes and avoid duplication.
  - Use numerical or descriptive versioning and Store older versions in an Archive folder to prevent clutter.
    - Numerical Versioning: v1, v2, v3 (increment as changes are made)
    - Descriptive Versioning: draft, final, final_v2
  - Avoid ambiguous terms like "new" or "latest."

Water Quality Assessment
- survey 03/20/2003
- Lab Experiment
- metadata

water_quality_assessment
- wqa_survey_2003_03_20
- wqa_lab_experiment
- wqa_metadata

water_quality_assessment
- **wqa_survey_2003_03_20**
- **wqa_survey_2003_03_20 FINAL**
- **wqa_survey_2003_03_20 FINAL FINAL**
- **wqa_lab_experiment**
- **wqa_metadata**

water_quality_assessment
- **wqa_survey_2003_03_20_v1**
- **wqa_survey_2003_03_20_v2**
- **wqa_survey2003_03_20_v3**
- **wqa_lab_experiment**
- **wqa_metadata**

Streamlining Data Requests

Point of Contact

- Designated email contact
  - generic/info email for continuity
- Clear instructions on how requesters should reach out.

Data Request Portal

- Web-based portal for submitting structured requests

Information Required from Requester
- Name and Affiliation
- Dataset of Interest
- Spatial and Temporal Extent
- Scale and Resolution
- Intended Use of data

Key Takeaways

1. **Data Format and Quality**
   - **Ensure data consistency by adhering to standardized formats and conducting regular quality checks to maintain accuracy and reliability.**
2. **Metadata (need i say more!)**
   - **Implement comprehensive metadata to make your data discoverable, understandable, and reusable, enhancing its long-term value.**
3. **Data Storage**
   - **Choose secure and scalable storage solutions that facilitate easy access and protect data integrity over time.**
4. **Data Sharing**
   - **Utilize appropriate platforms (aka data repositories) and establish clear protocols to promote efficient and secure data sharing among stakeholders and clients.**

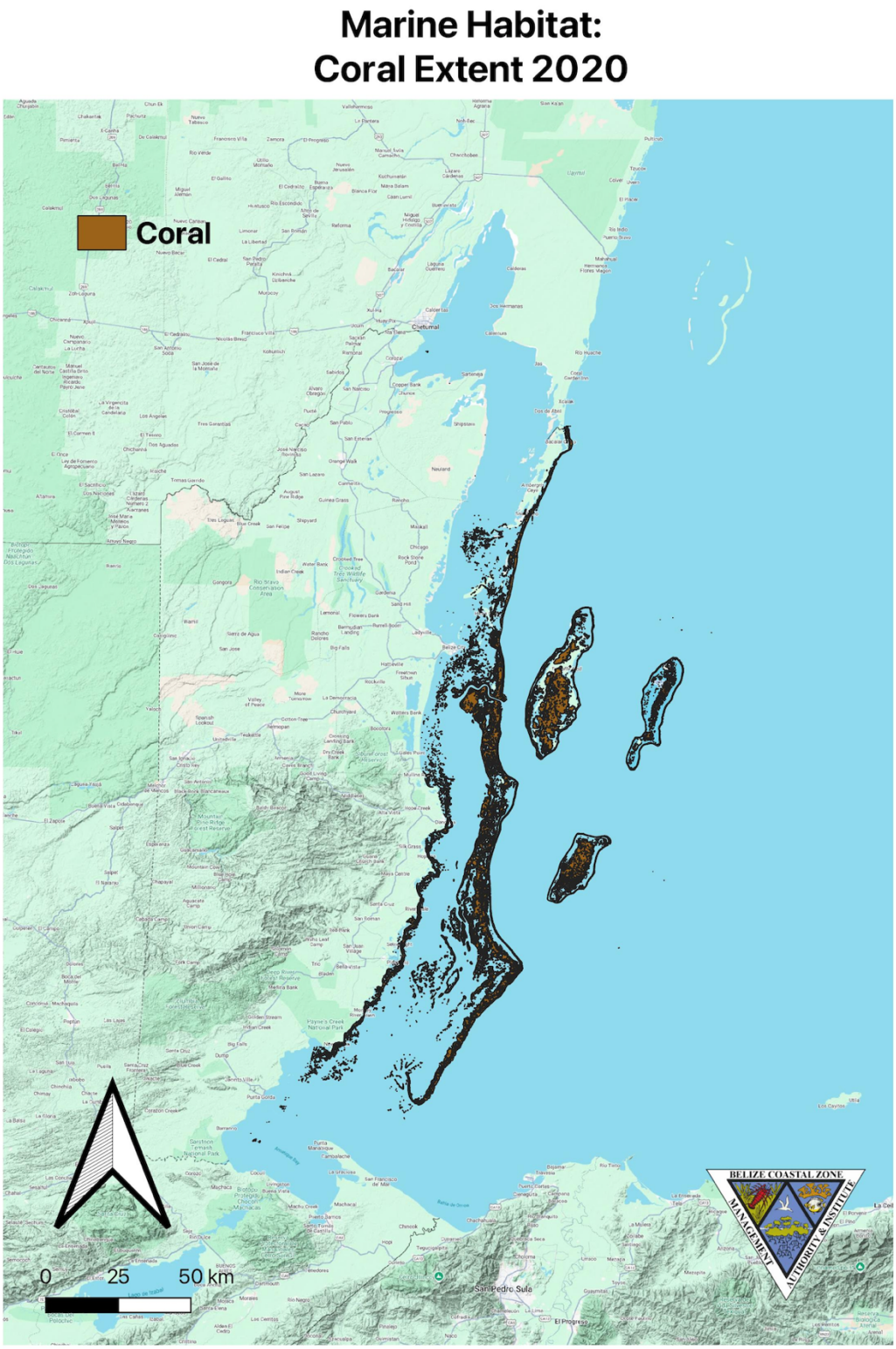
Annex 6 – List of stakeholders targeted for the data call campaign

Annex 6. List of stakeholders targeted for the data call campaign. This list was developed by CZMAI based on data needs.

Name	Organisation
Kevin Tsao	Belize Audubon Society
Marty Alvarez	Belize Audubon Society
Kaylon Young	Belize Port Authority
Michael Jenkins	Belize Port Authority
Abil Castaneda	Belize Tourism Board
Stacey Alpuche	BWS
Jamal Galvez	Clearwater Marine Aquarium
Anthony Mai	Department of the Environment
Abigail Quiroz	Fisheries Department
Adriel Castaneda	Fisheries Department
Edgar Correa	Forest Department
Koren Sanchez	Forester
Ali Cansino	Fragments of Hope
Errol Sebastian	Geologist
Rafael Martinez	Healthy Reefs Initiative
Emily Gomez	Hol Chan Marine Reserve
Tennielle Williams	Hydrology Unit
Elam Torres	Land Information Center
Stacey Cayetano	Land Information Center
Kirah Forman-Castillo	MarAlliance
Joel Verde	Sarteneja Alliance for Conservation and Development
Leomir Santoya	Sarteneja Alliance for Conservation and Development
Elizabeth Muschamp	Southern Environmental Association
Maritza Canto	Statistical Institute of Belize
Kamil Salazar	The National Climate Change Office
Caroline Oliver	Toledo Institute for Development and Environment
Andres Aldana	Turneffe Atoll Sustainable Association
Valdemar Andrade	Turneffe Atoll Sustainable Association
Dr. Apolonio Aguilar	University of Belize
Jake Snaddon	University of Belize Environmental Research Institute
Juilo Mazz	Wildlife Conservation Society
Zoe Walker	Wildtracks
Andria Rosado-Grinage	Ministry of Blue Economy and Marine Conservation
LT Otto Garcia	Belize Coast Guard

Annex 7 – Map of coral extent

Annex 7. Map of coral extent with inclusion of appropriate title, north star, legend, and scale bar.



Annex 8 – Map of agriculture runoff extent

Annex 8. Map of extent of agriculture runoff with inclusion appropriate title, north star, and scale bar.