

Please provide the following information, and submit to the NOAA DM Plan Repository.

Reference to Master DM Plan (if applicable)

As stated in Section IV, Requirement 1.3, DM Plans may be hierarchical. If this DM Plan inherits provisions from a higher-level DM Plan already submitted to the Repository, then this more-specific Plan only needs to provide information that differs from what was provided in the Master DM Plan.

URL of higher-level DM Plan (if any) as submitted to DM Plan Repository:

1. General Description of Data to be Managed

1.1. Name of the Data, data collection Project, or data-producing Program:

Guam Long-term Coral Reef Monitoring Program Benthic Cover Derived from Analysis of Benthic Images since 2010

1.2. Summary description of the data:

The Government of Guam's Comprehensive Long-term Monitoring at Permanent Sites in Guam project, also known as the Guam Long-term Coral Reef Monitoring Program (GLTMP), is a NOAA-funded project currently coordinated through the University of Guam Marine Laboratory. The program involves the regular, intensive collection of data for a suite of coral reef ecosystem health parameters at high priority reef areas (HPRAs) around Guam, as well as critical support for coral bleaching response and other activities carried out by the multi-partner Guam Coral Reef Response Team. The program currently utilizes a split-panel sampling approach, whereby a mix of permanent and non-permanent sampling stations (one sampling station = one transect) are visited within each HPRA. The HPRAs were selected by an advisory body comprised of reef managers, researchers, and technicians; these reef areas were not intended to be representative of Guam's reefs more broadly. The locations of the sampling stations within each HPRA are generated randomly using GIS software. Various coral reef surveys are carried out on an annual basis along the seaward slope between 7 and 15 m depth in the Tumon Bay Marine Preserve and in East Agana Bay, while surveys are carried out biennially within the Piti Bomb Holes Marine Preserve, the Achang Reef Flat Marine Preserve, the eastern side of the Cocos Barrier Reef (Cocos-East), and Fouha Bay. Surveys were also carried out along reef margin (1-2 m) and slope (2-15 m) of Western Shoals, in Apra Harbor, in 2011. The surveys, which are currently conducted by University of Guam Marine Laboratory biologists, and which were supported by NOAA PIRO through 2019, currently include benthic photo transects, stationary point count fish surveys, macroinvertebrate belt transects, and chain-length rugosity surveys. The GLTMP has conducted surveys at the Tumon and East Agana HPRAs since 2010 and the Piti HPRA since 2012. Data collection for the Achang and Cocos-East HPRAs began in 2014 and at the Fouha Bay HPRA in 2015. Baseline data is available for the Western Shoals HPRA from 2011 but this site has not been re-visited since its establishment due to shifting management priorities.

The data products described herein document the status and trends for benthic cover and composition at the monitoring sites mentioned above. Benthic cover and coral and algal generic diversity are currently assessed using digital photo transects. Benthic cover estimates were initially derived from photo transect images using Coral Point Count with Excel extensions (CPCe; Kohler and Gill 2006) point sampling software, but the web-based image analysis platform CoralNet (Beijborn et al. 2012, Beijborn 2015) was used beginning with the 2019 images. Benthic percent cover is calculated at the sampling station level (= one transect) for data derived from benthic images. Power analyses support the methodological approach, whereby statistically robust cover estimates at broad-level benthic categories can be successfully derived using the level of sampling effort employed by the program.

1.3. Is this a one-time data collection, or an ongoing series of measurements?

One-time data collection

1.4. Actual or planned temporal coverage of the data:

2010-08-04 to 2010-09-02, 2012-09-05 to 2012-11-19, 2014-09-03 to 2014-09-09, 2015-06-23 to 2015-07-01, 2017-04-10 to 2017-08-10, 2018-10-23 to 2018-11-15, 2019-07-02 to 2019-10-25, 2020-07-23 to 2020-10-13, 2021-06-23 to 2021-08-18, 2022-08-05 to 2022-10-27, 2010-09-07 to 2010-11-26, 2012-11-16 to 2012-11-28, 2014-09-10 to 2014-09-16, 2016-02-16 to 2016-04-05, 2017-07-12 to 2017-12-27, 2018-11-15 to 2018-11-29, 2019-09-05 to 2019-12-19, 2020-10-13 to 2020-11-24, 2021-08-04 to 2021-09-03, 2022-09-29 to 2022-10-27, 2011-07-11 to 2011-08-19, 2012-07-23 to 2012-08-31, 2014-09-17 to 2014-11-13, 2017-11-15 to 2018-06-19, 2020-06-30 to 2020-07-16, 2022-05-22 to 2022-08-04, 2014-10-22 to 2014-10-27, 2018-07-26 to 2018-09-27, 2021-04-21 to 2021-05-14, 2014-10-27 to 2014-10-28, 2018-08-24 to 2018-09-27, 2021-04-30 to 2021-06-10, 2015-05-06 to 2015-10-27, 2019-05-09 to 2019-06-04, 2021-05-19 to 2021-06-11

1.5. Actual or planned geographic coverage of the data:

W: 144.789408, E: 144.798507, N: 13.517207, S: 13.510711

These bounding coordinates pertain to the Tumon Bay site boundaries modified after the 2010 survey effort and prior to the 2012 survey effort; these are the current boundaries for the Tumon Bay monitoring site.

W: 144.784502, E: 144.795528, N: 13.512988, S: 13.508506

These bounding coordinates pertain to the original Tumon Bay site surveyed in 2010. The site boundaries were modified prior to the 2012 surveys; the coordinates of the modified site boundaries are presented in a separate Geographic Area above.

W: 144.758065, E: 144.766983, N: 13.491396, S: 13.483792

These bounding coordinates pertain to the current boundaries for the East Agana Bay site, which has been monitored since 2010

W: 144.653292, E: 144.656443, N: 13.454042, S: 13.449599

These bounding coordinates pertain to the Western Shoals monitoring site in Apra Harbor. The Western Shoals site has not been re-surveyed since 2011 due to a shift in management priorities.

W: 144.683913, E: 144.697634, N: 13.47632, S: 13.468317

These bounding coordinates pertain to the Piti (Tepungan) Bay site, which has been surveyed since 2012.

W: 144.69765, E: 144.712233, N: 13.242611, S: 13.239282

These bounding coordinates pertain to the current Achang monitoring site boundaries, which were established in 2014.

W: 144.674888, E: 144.685944, N: 13.23992, S: 13.235939

These bounding coordinates pertain to the current Cocos-East site, which was established in 2014

W: 144.653677, E: 144.656082, N: 13.305903, S: 13.303514

These bounding coordinates pertain to the current Fouha Bay monitoring site, which was established in 2015

1.6. Type(s) of data:

(e.g., digital numeric data, imagery, photographs, video, audio, database, tabular data, etc.)
Table (digital)

1.7. Data collection method(s):

(e.g., satellite, airplane, unmanned aerial system, radar, weather station, moored buoy, research vessel, autonomous underwater vehicle, animal tagging, manual surveys, enforcement activities, numerical model, etc.)

1.8. If data are from a NOAA Observing System of Record, indicate name of system:

1.8.1. If data are from another observing system, please specify:

2. Point of Contact for this Data Management Plan (author or maintainer)

2.1. Name:

David R Burdick

2.2. Title:

Metadata Contact

2.3. Affiliation or facility:

2.4. E-mail address:

burdickd@triton.uog.edu

2.5. Phone number:

671-735-2175

3. Responsible Party for Data Management

Program Managers, or their designee, shall be responsible for assuring the proper management of the data produced by their Program. Please indicate the responsible party below.

3.1. Name:

David R Burdick

3.2. Title:

Data Steward

4. Resources

Programs must identify resources within their own budget for managing the data they produce.

4.1. Have resources for management of these data been identified?

Yes

4.2. Approximate percentage of the budget for these data devoted to data management (specify percentage or "unknown"):

Unknown

5. Data Lineage and Quality

NOAA has issued Information Quality Guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information which it disseminates.

5.1. Processing workflow of the data from collection or acquisition to making it publicly accessible

(describe or provide URL of description):

Lineage Statement:

The Benthic Photo Transect Survey methodology, employed by the Guam Long-term Coral Reef Monitoring Program since 2010

Process Steps:

- Benthic photo transect surveys are carried out at all sampling stations. All sampling stations have been selected in hard-bottom habitats using a stratified random sampling design, and the stations have been designed using the split-panel approach (combination of fixed and non-fixed transects).
- Each sampling station is located using a GPS receiver. Upon reaching a given station, a small weight and line tied to a buoy is carefully lowered to the ocean floor. In optimal situations where four divers are available, two divers enter the water first to carry out the fish surveys. Starting at the weight tied to the buoy, a 30 m transect is laid out [25 m-long transects were used prior to 2017]. The transect is laid out in a clockwise direction relative to the island, following the depth contour if it is readily determined; if the area is relatively flat and a depth contour is not readily discernible the transect is laid at an angle parallel to the reef margin (which is determined prior to entering the water). Compact digital point and shoot cameras and housings are used by individual observers to document unknown organisms, incidences of coral disease, and species/behaviors of special interest. For

the initial establishment of fixed sampling stations, 24 inch rebar is installed at the beginning of the transect and 12 inch rebar is installed at the center and end of the transect; four-inch concrete nails are installed in at least two of the corners of each quadrat used for coral size and condition surveys. For the Western Shoals site, rebar and concrete nails were not used and instead a small PVC float was tied to dead coral with a line at the beginning of the transect and large zip ties were placed at the beginning, middle, and end of the transect. Two small zip ties were used to mark two corners of each permanent quadrat location. [Note that due to capacity limitations coral quadrat surveys were eliminated beginning in 2020; the nails for quadrats at some sampling stations have been maintained opportunistically] To minimize diver disruptions, the two divers conducting the benthic surveys enter the water after the fish team has finished enumerating fish. In situations where only three divers are available, all three divers enter the water at the same time and remain as a three-person buddy team to ensure diver safety throughout the survey. A fish diver partners with a benthic diver when two fish divers are not available. In this situation, the fish diver lays the transect and conducts the first SPC at 22.5 m while the benthic diver works from 0-15 m; they then switch positions along the transect so that the fish diver can carry out the second SPC. Beginning in 2020, most surveys have been conducted by a single pair of divers. After deploying the transect tape the two divers would simultaneously carry out a reef fish SPC survey replicate (if both observers were trained and calibrated) or if only one of the divers was trained and calibrated this individual would carry out both replicates, one after the other. Following the completion of the reef fish survey replicates, one diver would carry out the benthic photo transect survey while the other carried out the macroinvertebrate belt transect survey and the rugosity survey.

- At the start of a benthic survey, one of the divers begins the photo transect and captures non-overlapping digital photos every 0.5 meters along the left side of a 30-meter transect, for a total of 30 images; prior to 2017 the diver would return along the right side of a 25 m transect (for a total of 50 images). Beginning in 2017, images are obtained using a 20 megapixel Sony Cybershot RX-100 digital point and shoot camera (in a Nauticam NA-RX100 housing with a red filter) mounted on a PVC monopod. Prior to 2017, several different cameras in underwater housings were mounted to PVC frame such that a 0.5 m x 0.5 m quadrat at the base of the frame is visible within each image. Please refer to the Data Quality/Comparability section in this record for detailed information about the PVC monopod and frame as well as the camera models used for the benthic photo transect surveys.

- Beginning in 2016 images are retrieved from the camera's memory card using Adobe Lightroom and are attributed with keywords according to date, site, station, and transect. The white balance of a single representative image for a given transect is adjusted and the settings synced with the rest of the images from that transect. The images are then exported as high quality jpegs to the appropriate folder within a well-defined hierarchical directory structure. The original, unedited RAW files retrieved by Lightroom from the memory card are stored in a separate folder and are organized only by date. Prior to 2016, images were copied from the

camera's memory card and placed directly within the hierarchical directory structure. A batch color correction action was applied to all images within a given folder (= one transect), with the resulting edited image saved to a sub-folder separate from the location of the original unedited images. A free application called File Renamer (<http://www.webxpace.com>) was then used to rename all of the color-corrected image files within a given folder (= one transect) using a batch renaming action. Images are named using the following template: SIT-ST_YEARMMDD_T_S.jpg, where SIT = three letter side code, ST = sampling station number, YEARMDD = date, T = transect number, and S = transect side (e.g., TUM-36_20170924_1_L). Beginning in 2016, the re-named images were added to Lightroom to reflect the new location of the edited jpeg files. The original and color-corrected/renamed images obtained prior to 2016 were added to Lightroom in 2016.

All images are automatically backed up to cloud storage on a regular basis.

- Percent cover was estimated from quantitative analysis of the 2010-2018 benthic still images using Coral Point Count with Excel extensions (CPCe; Kohler and Gill, 2006), a software application developed by Nova Southeastern University's National Coral Reef Institute. Images were opened within the CPCe program and the area for image analysis is set for those images obtained using the PVC quadrat; the image area did not need to be defined for those images obtained using the monopod (beginning in 2017). Initially, each frame was analyzed using 25 random points stratified with a 5 x 5 grid. After conducting a series of tests using various combinations of images and points in an effort to maximize accuracy while minimizing effort, it was determined that 16 random points stratified using a 4 x 4 grid would provide the desired accuracy and efficiency. The use of 16 points per frame began with the 2014 images. Beginning with the 2019 images, the web-based image analysis platform CoralNet was utilized in place of CPCe. Currently, 16 points are analyzed per frame, but this number will likely increase (in order to better detect less common benthic classes) once the CoralNet robot is relied upon to alleviate a majority of the annotations. The 2019-2022 images were analyzed entirely by a human observer, but beginning with the 2023 images the confidence threshold will be lowered and the robot annotations considered confirmed will not be examined. The benthic feature falling directly underneath each point is identified to the lowest taxonomic level possible. For those images analyzed using CPCe a "note" was added to points that fall on recently dead, diseased, or bleached corals; the notes indicated the likely cause of the mortality or the name of the disease. However, a note was only provided if the point fell directly on an area of recently dead tissue or an area of disease activity of pale/bleached tissue. The ability to separately record colony condition is not currently available in CoralNet. If a point falls precisely on the border between two benthic categories (e.g., coral-algae), the benthic category occupying the greatest area within the symbol (circle wrapping the cross-hairs) is classified. Additionally, if the two benthic categories occupy equal space within the symbol, the benthos falling on the top left quadrant within the point symbol is classified. The category Shadow is used when the point falls on an area that is dark and the nature of the benthos cannot be assessed due to

diminished light. The categories Tape and Frame are used when the point falls on a transect line/tape measure or photo quadrat frame. Percent cover is calculated at the sampling station level.

5.1.1. If data at different stages of the workflow, or products derived from these data, are subject to a separate data management plan, provide reference to other plan:

5.2. Quality control procedures employed (describe or provide URL of description):

Quality control for images obtained between 2010 and 2018 was carried out by the Monitoring Program Coordinator or the full-time technical support staff. The quality control process involved reviewing CPCe output files for all images for at least 25% of the total number of sampling stations for each monitoring site. If a significant number of misidentifications were encountered the original photo analyst was asked to undergo additional training and then re-analyze the images; alternatively, the coordinator or technical support staff would re-analyze all the images for the image sets in question. CPCe output files generated through an analysis of images carried out by the coordinator did not undergo a quality control check. After receiving extensive training, a single full-time technician analyzed images (using the CoralNet platform) for images obtained between 2019 and 2022. The technician regularly consulted with the coordinator throughout the analysis of these images in order to maintain a high degree of accuracy and the standardized implementation of the benthic classification system.

6. Data Documentation

The EDMC Data Documentation Procedural Directive requires that NOAA data be well documented, specifies the use of ISO 19115 and related standards for documentation of new data, and provides links to resources and tools for metadata creation and validation.

6.1. Does metadata comply with EDMC Data Documentation directive?

No

6.1.1. If metadata are non-existent or non-compliant, please explain:

Missing/invalid information:

- 1.7. Data collection method(s)
- 7.2. Name of organization of facility providing data access
- 7.2.1. If data hosting service is needed, please indicate

6.2. Name of organization or facility providing metadata hosting:

NMFS Office of Science and Technology

6.2.1. If service is needed for metadata hosting, please indicate:

6.3. URL of metadata folder or data catalog, if known:

<https://www.fisheries.noaa.gov/inport/item/47784>

6.4. Process for producing and maintaining metadata

(describe or provide URL of description):

Metadata produced and maintained in accordance with the NOAA Data Documentation Procedural Directive: https://nosc.noaa.gov/EDMC/DAARWG/docs/EDMC_PD-Data_Documentation_v1.pdf

7. Data Access

NAO 212-15 states that access to environmental data may only be restricted when distribution is explicitly limited by law, regulation, policy (such as those applicable to personally identifiable information or protected critical infrastructure information or proprietary trade information) or by security requirements. The EDMC Data Access Procedural Directive contains specific guidance, recommends the use of open-standard, interoperable, non-proprietary web services, provides information about resources and tools to enable data access, and includes a Waiver to be submitted to justify any approach other than full, unrestricted public access.

7.1. Do these data comply with the Data Access directive?

Yes

7.1.1. If the data are not to be made available to the public at all, or with limitations, has a Waiver (Appendix A of Data Access directive) been filed?

7.1.2. If there are limitations to public data access, describe how data are protected from unauthorized access or disclosure:

7.2. Name of organization of facility providing data access:

7.2.1. If data hosting service is needed, please indicate:

7.2.2. URL of data access service, if known:

<http://accession.nodc.noaa.gov/accession#>

7.3. Data access methods or services offered:

Data can be accessed online via the NOAA National Centers for Environmental Information (NCEI) Ocean Archive.

7.4. Approximate delay between data collection and dissemination:

Unknown

7.4.1. If delay is longer than latency of automated processing, indicate under what authority data access is delayed:

8. Data Preservation and Protection

The NOAA Procedure for Scientific Records Appraisal and Archive Approval describes how to

identify, appraise and decide what scientific records are to be preserved in a NOAA archive.

8.1. Actual or planned long-term data archive location:

(Specify NCEI-MD, NCEI-CO, NCEI-NC, NCEI-MS, World Data Center (WDC) facility, Other, To Be Determined, Unable to Archive, or No Archiving Intended)

NCEI_MD

8.1.1. If World Data Center or Other, specify:

8.1.2. If To Be Determined, Unable to Archive or No Archiving Intended, explain:

8.2. Data storage facility prior to being sent to an archive facility (if any):

University of Guam Marine Laboratory - Mangilao, GU

8.3. Approximate delay between data collection and submission to an archive facility:

Unknown

8.4. How will the data be protected from accidental or malicious modification or deletion prior to receipt by the archive?

Discuss data back-up, disaster recovery/contingency planning, and off-site data storage relevant to the data collection

University of Guam Marine Lab resources and assets

9. Additional Line Office or Staff Office Questions

Line and Staff Offices may extend this template by inserting additional questions in this section.