

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:

Benthic cover derived from structure from motion images collected during marine debris surveys at coral reef sites entangled with derelict fishing nets at Pearl and Hermes Atoll in the Northwestern Hawaiian Islands from missions in 2018 and 2021

1.2. Summary description of the data:

The benthic cover and fishing-net related data described in this dataset are derived from the GIS analysis of benthic orthophotos. The source imagery was collected by snorkelers using a Structure from Motion (SfM) approach during swim surveys in search of derelict fishing nets. Surveys were conducted by the NOAA Fisheries, Ecosystem Sciences Division (ESD) at Pearl and Hermes Atoll in the Northwestern Hawaiian Islands (NWHI). Initial surveys occurred from September 24 - October 3, 2018 during an ESD-led marine debris removal mission aboard the NOAA Ship Oscar Elton Sette, and follow-up surveys occurred from September 13-14, 2021 on a joint mission with non-profit organization Papahānaumokuākea Marine Debris Project aboard the M/V IMUA.

During the 2018 mission, fishing nets were located during swim surveys and selected for SfM if the net was interacting with coral or hard substrate, the depth of the net was within ~1 - 4 m of the surface, and the area of the net fit within the 9 sq. meter SfM survey plot. During the SfM survey, a permanent 3 x 3 m plot was established around the center of the fishing net, and the net was photographed using a back and forth swim pattern ("before" photos) for later processing using a SfM approach. The net was then removed, the volume of net removed was estimated and recorded, and the same area was photographed again in the same way ("after" photos). A nearby (>50 m distant) paired control site was also photographed using the same method ("control" photos).

During the 2021 mission, we attempted to relocate all paired sites where "after" and "control" photos were taken in 2018 and if found, we reimaged the permanent 3 x 3m plot using the same SfM approach. Only a subset of 2018 sites were successfully relocated in 2021 (12 "after" sites, 8 "control" sites), and five new nearby "control" sites had to be established to fulfill our paired study design.

The photographs from each site were processed using Agisoft Metashape software to

generate orthomosaic images that were analyzed in ArcGIS for benthic cover using a random point approach. In 2018, the number of points at net-impacted sites were constrained to the net coverage area and were scaled to the net area to ensure an equal point density among replicate net-impact sites. The same number of points were randomly assigned to the 3 by 3 m paired control site. In 2021, twenty random points were assigned to each orthophoto within the 2018 net polygon. Each point was classified into one of seven benthic categories: turf algae, macroalgae, sand, bare substrate, *Porites compressa*, sponge, or crustose coralline algae (CCA). In 2021, turf and macroalgae categories were merged into a single algae category and all coral species were assigned the coral category. The annotated points for each site were converted to percent cover for each benthic category. Fishing net size (sq. m) and degree of fouling were also calculated from the initial "before" orthophotos. Analyses were conducted to compare the benthic composition of net sites to control sites and to determine if fouling or net size contributed to these differences.

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:

2018-09-24 to 2018-10-03, 2021-09-13 to 2021-09-14

1.5. Actual or planned geographic coverage of the data:

W: -175.8211335, E: -175.7880926, N: 27.89404863, S: 27.82745706

Geographic extent of marine debris structure from motion surveys conducted at Pearl and Hermes Atoll.

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:

Lori H Luers

2.2. Title:

Metadata Contact

2.3. Affiliation or facility:

2.4. E-mail address:

lori.luers@noaa.gov

2.5. Phone number:

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:

Ariel Halperin

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:

Marine debris removal has been conducted by the Pacific Islands Fisheries Science Center's Ecosystem Sciences Division at the atolls, reefs and islands of Northwestern Hawaiian Islands since 1996. Standardized data collection has been implemented since 1999. Swim surveys are typically used in the comparatively high-relief and patchy lagoonal reef habitats. Survey areas are chosen based on regional reef morphology and past accumulation records. At each Structure from Motion (SfM) data collection site, a permanent 3 x 3 m plot was established around the center of the entangled fishing net in 2018. SfM images were taken underwater before and after net removal. The same method was also used at the paired control sites. Sites were relocated and reimaged in

2021. We used Agisoft Metashape software to generate orthomosaic images of each site from the photographs captured. Using 2018 orthomosaics, the planar net area (square meters) was calculated by delineating the net boundary in ArcGIS. In addition, the degree of fouling was estimated for each net based on the percent of the net surface area that was covered by fouling organisms. Using the orthomosaics from the "after" (impact) and "control" sites, benthic cover was assessed using a random point approach within the boundary of the net and at the paired control site. Each point was classified into an appropriate benthic category. The annotated points for each site were converted to percent cover. For both years, analyses were conducted to compare the benthic composition of net sites to control sites. In 2018, analyses were carried out to determine if fouling or net size contributed to these differences, and in 2021, analyses were conducted to track changes in benthic composition at net impacted sites three years after removal.

Process Steps:

- This step describes the initial site survey in 2018. The swim survey method was developed for surveys in lagoonal, reticulated reef areas. During swim surveys, two or more divers swim across reefs to search for debris while being directed by personnel in small boats to follow pre-planned routes and are coordinated for maximum visual area covered. Survey areas and routes are chosen based on regional reef morphology and past accumulation records. Based on this net prevalence information, five spatial zones were defined. A minimum of three nets in each of the five zones were surveyed using a Structure from Motion (SfM) approach if the net also fit within the additional selection criteria (< 75% hard substrate and within ~1-4 m depths). (Citation: Dameron, O. J., Parke, M., Albins, M. A., & Brainard, R. (2007). Marine debris accumulation in the Northwestern Hawaiian Islands: an examination of rates and processes. *Marine Pollution Bulletin*, 54(4), 423-433.)
- At each impact site established in 2018, a permanent 3 x 3 m plot was established around the center of the net by securing zip ties to the reef at each corner of the plot and taking a GPS location at the center. Depth measurements were recorded at each corner of the plot. Only nets that fit within the plot were selected for this study to allow rapid data collection of the Structure from Motion (SfM) imagery. In 2018, SfM images were taken underwater before net removal to record the extent of the reef covered by net. In both years, images were collected by snorkeling in a cross-hatch pattern over the plot at 1 m above the substrate to achieve image overlap of at least 60% (~580 images per site). JPEG images were collected using a Nikon SL2 digital camera in an underwater housing. (Citation: Suka R, Asbury M, Couch C, Gray A, Winston M, Oliver T. 2019. Processing Photomosaic Imagery of Coral Reefs Using Structure-from-Motion Standard Operating Procedures. U.S. Dept. of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-PIFSC-93, 54 p. doi:10.25923/h2q8-jv47)
- The Structure from Motion (SfM) approach produces an accurately scaled, two-dimensional (2D) orthomosaic model created from the overlapping imagery. We used Agisoft Metashape software (version 1.2.5 build 2735) to generate the

orthomosaic following parameters published by Burns et al., 2015. (Citation: Burns J, Delparte D, Gates R, Takabayashi M. 2015. Integrating structure-from-motion photogrammetry with geospatial software as a novel technique for quantifying 3D ecological characteristics of coral reefs. *PeerJ* 3:e1077)

- This step was only completed at net impacted sites surveyed in 2018. From the pre-net removal ("before") orthomosaics, the planar net area (square meters) was calculated by delineating the net boundary with a polygon shapefile and using the Calculate Geometry tool in ArcMap v10.6.1. In addition, the degree of fouling was estimated for each net based on the percent of the net surface area that was covered by fouling organisms. Fouling scores ranged from 1 to 3, where 1 = Light: 1-40% of net surface area covered, 2 = Moderate: 41-75% of net surface area covered, and 3 = Heavy: >75% of net surface area covered (adapted from Donohue et al., 2001). Four nets were classified as fouling level 1, eight nets as fouling level 2, and eight nets as fouling level 3. (Citation: Donohue, M. J., Boland, R. C., Sramek, C. M., & Antonelis, G. A. (2001). Derelict fishing gear in the Northwestern Hawaiian Islands: diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. *Marine pollution bulletin*, 42(12), 1301-1312.)

- For each SfM site surveyed, benthic cover was assessed using a random point approach and the stitched together orthomosaic in ArcMap 10.6.1. In 2018, using the post-net removal ("after") orthomosaics, benthic cover was assessed within the boundary of the net (based on the net boundary shapefile). The number of points at net-impacted sites was scaled to the net size to ensure an equal point density (mean point density = 10.9 points/m² ± 0.40 SE) among replicate net-impact sites. Using the paired "control" orthomosaic, the same number of points were randomly assigned to the 3 x 3 m paired control site. Each point was classified into one of seven benthic categories: turf algae, macroalgae, sand, bare substrate, *Porites compressa*, sponge, and crustose coralline algae (CCA). The annotated points for each site were converted to percent cover (number of points for a given category/total number of points x 100) for each benthic category. In 2021, orthomosaics from net-impacted sites and paired controls were assessed for benthic cover using much of the same methodology. For each impact site, a shapefile of the net boundary delineated by Suka et al. in 2020 was overlaid and repositioned on the recent orthophotos to align with the original location of the derelict net. For control sites, the same boundary shapefile was overlaid in the center of the orthophoto. The benthic cover at each control and impact site was assessed from 20 random points placed within the net boundary shapefile of each orthophoto. The benthic feature under each point was then classified into one of six benthic categories: algae (grouping turf and macroalgae), sand, bare, coral, sponge, and crustose coralline algae (CCA) and then converted to percent cover for the site.

- This process step occurred only with the 2018 data. To test whether derelict fishing nets impact benthic assemblages regardless of net size or level of fouling, all net-impact and control sites were compared using both multivariate and univariate techniques. Differences in the benthic assemblage between control and net-impact sites were visualized using an ordination plot generated from non-metric multi-

dimensional scaling (nMDS) performed on Bray-Curtis distances using untransformed cover data. Assemblage differences indicated by the nMDS were tested for significance using a permutational analysis of variance (PERMANOVA) with treatment (net-impacts or control) as a fixed factor. PERMANOVA models used 999 permutations and the assumption of equal dispersion among the treatment groups was confirmed. To determine which specific categories drove the difference in the benthic assemblage between net-impact and control sites, we ran paired t-tests (or the non-parametric equivalent based on Shapiro-Wilk tests of normality) on the paired difference for each of the seven benthic cover categories.

- This processing step was only conducted with the 2018 data. To test whether the impact of derelict nets on the benthos differed depending on the net size or level of fouling, a distance-based redundancy analysis (db-RDA) was performed. However, in this analysis control sites were excluded (as control sites have no associated derelict net) and only the net-impacted sites were analyzed (n=20). As with PERMANOVA, db-RDA is a method for carrying out constrained ordinations on data using non-Euclidean distance measures, such as Bray Curtis distance. The results of db-RDA can reveal whether a matrix of explanatory variables has some significant impact on the dissimilarities derived from the community composition data as a whole. The db-RDA model considered fouling level (ordinal) and net size (continuous) as explanatory variables. Although db-RDA does not make explicit assumptions about the distribution of the explanatory variables, net size and fouling level were evaluated for skew and co-linearity prior to executing the analysis. All data analyses were conducted in R Version 3.6.1. PERMANOVA and dbRDA analyses were conducted using the vegan package. Non-parametric paired t-test were carried out using the coin package.

- This processing step was only done with the 2021 data. Paired t-tests were used to compare the 2021 impact relative to unimpacted control sites, as well as how benthic cover changed over time at the impact sites from 2018 to 2021. Lastly, we assess if control sites remained stable over time using an unpaired t-test (as control sites in 2018 were not identical to those used in 2021). For each comparison, benthic cover values were extremely left skewed and thus arcsin square root transformed.

Percent cover data was generated using ArcMap v10.6.1. All data analyses were conducted in R Version 3.6.1. (R Core Team, 2019). Paired t-test analyses were conducted using the rstatix package version 0.7.0.

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):

Size estimates of debris in water were verified against the more accurate volume estimates of the nets once removed from the shallow coral reef environments and hauled onto the small boats.

Each image set was evaluated for image quality. Images deemed unsatisfactory were removed from the image set.

The benthic category assigned to each random point across each mosaic were verified by an expert. Any points that fell onto an unidentifiable area (i.e., shadow) were discarded and re-generated (for the 2018 data).

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/59172>

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:

<https://accession.nodc.noaa.gov/0253462>

<https://accession.nodc.noaa.gov/0209247>

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):

Pacific Islands Fisheries Science Center - Honolulu, HI

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

NOAA IRC and NOAA Fisheries ITS 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.