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

**Pacific Islands Fisheries Science Center**

Data Set (DS) | ID: 47784 | Published / External

Created: 2017-11-05 | Last Modified: 2025-04-30

**ID: 47784**  
**Data Set (DS)**

**\* Discovery**

**• First Pass**

**» Metadata Rubric**

**Parent:** Guam Long-term Coral Reef Monitoring Program

Project (PRJ) | ID: 26296

## Item Identification

<b>* » Title</b>	Guam Long-term Coral Reef Monitoring Program Benthic Cover Derived from Analysis of Benthic Images since 2010
<b>Short Name</b>	Guam LTMP Benthic Cover Derived Analysis of Benthic Images since 2010
<b>* Status</b>	In Work
<b>Creation Date</b>	
<b>Revision Date</b>	
<b>• Publication Date</b>	2020
<b>* » Abstract</b>	<p>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</p>

	<p>Marine Preserve, and the eastern side of the Cocos Barrier Reef (Cocos-East). Surveys were also carried at 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 HPRA since 2010, the Piti HPRA since 2012, and the Achang and Cocos-East HPRA began in 2014. Surveys for Fouha Bay HPRA began in 2015 with data collections also occurring in 2019 and 2021, but the site has not been re-visited due to shifting management priorities. Baseline data is available for the Western Shoals HPRA from 2011 but this site has not been re-visited.</p> <p>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.</p>
<b>* Purpose</b>	<p>The stated goals of the Guam Long-term Coral Reef Monitoring Program (GLTMP) are to determine the status and trends of selected coral reef ecosystem indicators to inform resource managers' decision-making process, provide managers with early notice of abnormal conditions, provide data to better understand the dynamic nature of the island's coastal ecosystems, allow resource agencies to meet certain legal and Congressional mandates, and measure progress towards performance goals. Benthic cover data collected by the GLTMP at several High Priority Reef Areas around Guam provide documentation of the structure and condition of the benthic communities at these sites; data from multiple visits can be used in time series analyses to determine trends in key ecosystem parameters.</p>
<b>Notes</b>	<p>Loaded by FGDC Metadata Uploader, batch 10200, 11-05-2017 15:30</p> <p>The following FGDC sections are not currently supported in InPort, but were preserved and will be included in the FGDC export:</p> <p>- Spatial Reference Information (FGDC:spref),</p>
<b>Other Citation Details</b>	
<b>• Supplemental Information</b>	<p>Benthic cover data have been generated from benthic photos captured since 2010 (with the noted exceptions below) in:</p> <p>Tumon Bay in 2010 (10 permanent and 10 non-permanent stations)*, 2012 (12 permanent and 9 non-permanent stations), 2014 (12 permanent and 4 non-permanent sta-</p>

	<p>tions), 2015 (12 permanent and 10 non-permanent stations), 2017 (12 permanent and 10 non-permanent stations), 2018 (12 permanent stations), 2019 (12 permanent and 10 non-permanent stations), 2020 (12 permanent and 10 non-permanent stations); 2021 (12 permanent and 10 non-permanent stations), 2022 (12 permanent and 10 non-permanent stations), 2023 (12 permanent and 10 non-permanent stations), and 2024 (12 permanent and 10 non-permanent stations)</p> <p>East Agana Bay in 2010 (10 permanent and 10 non-permanent stations), 2012 (10 permanent stations), 2014 (10 permanent stations), 2015 (10 permanent stations), 2017 (10 permanent and 11 non-permanent stations), 2018 (10 permanent stations), 2019 (9 permanent and 6 non-permanent stations), 2020 (10 permanent and 10 non-permanent stations), 2021 (10 permanent and 10 non-permanent stations), 2022 (10 permanent and 10 non-permanent stations), 2023 (10 permanent and 10 non-permanent stations) and 2024 (10 permanent and 10 non-permanent stations)</p> <p>Western Shoals in 2011 (11 permanent and 12 non-permanent stations)</p> <p>Piti in 2012 (10 permanent and 10 non-permanent stations), 2014 (10 permanent and 2 non-permanent stations), 2017/18 (8 permanent and 10 non-permanent stations), 2020 (10 permanent and 10 non-permanent stations), 2022 (10 permanent and 10 non-permanent stations), and 2024 (10 permanent and 7 non-permanent)</p> <p>Achang in 2014 (11 permanent and 3 non-permanent stations), 2018 (10 permanent and 10 non-permanent stations), 2021 (10 permanent and 10 non-permanent stations), and 2023 (10 permanent and 9 non-permanent stations)</p> <p>Cocos-East in 2014 (3 permanent and 2 non-permanent stations), 2018 (10 permanent stations), 2021 (10 permanent and 10 non-permanent stations), and 2023 (10 permanent and 7 non-permanent stations)</p> <p>Fouha Bay in 2015 (13 permanent stations), 2019 (13 permanent stations), and 2021 (13 permanent stations)</p> <p>*Boundaries for the Tumon Bay HPRA were shifted after the 2010 surveys. All sampling years from 2012 to present follow the new boundaries.</p>
<b>DOI (Digital Object Identifier)</b>	
<b>DOI Registration Authority</b>	
<b>DOI Issue Date</b>	

## Keywords

### Theme Keywords

Thesaurus	Keyword
ISO 19115 Topic Category	biota

CoRIS Discovery Thesaurus	Numeric Data Sets > Benthic
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Aquatic Habitat > Benthic Habitat
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Aquatic Habitat > Reef Habitat
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Microbiota > Blue-green Algae
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Microbiota > Cyanobacteria
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Vegetation > Algae > Algal Cover
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Vegetation > Algae > Crustose Coralline Algae
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Vegetation > Algae > Encrusting Macroalgae
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Vegetation > Algae > Turf Algae
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Coral Diseases > Bleaching
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Reef Monitoring and Assessment
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Reef Monitoring and Assessment > Benthos Analysis
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Reef Monitoring and Assessment > Benthos Analysis > Quadrat Monitoring > Photograph Analysis
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Reef Monitoring and Assessment > Photographic Analysis
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Corals > Reef Monitoring and Assessment > Rapid Assessment Studies
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Mollusks > Tridacna
CoRIS Theme Thesaurus	EARTH SCIENCE > Biosphere > Zoology > Sponges
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs > Coral Reef Ecology
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs > Coral Reef Ecology > Coral Cover
CoRIS Theme	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs > Coral Reef Ecology > Hard Coral

Thesaurus	Cover
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs > Coral Reef Ecology > Hard Coral Cover Live percentage
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Coastal Processes > Coral Reefs > Coral Reef Ecology > Octocoral Cover
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Marine Biology > Marine Invertebrates
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Marine Biology > Marine Invertebrates > Macroinvertebrates
CoRIS Theme Thesaurus	EARTH SCIENCE > Oceans > Marine Biology > Marine Plants > Seagrass
CRCP Project	488
CRCP Project	Guam Coral Reef Monitoring Data Management Initiative
PARR Exclusion	Obsolete
None	Benthic Cover
None	Coral Reef Ecosystem
None	Guam Long-term Coral Reef Monitoring Program
None	Long-term Monitoring Program
None	Marine Ecosystem
None	Rapid Ecological Assessments
None	REA

## Temporal Keywords

Thesaurus	Keyword

## \* Spatial Keywords

Thesaurus	Keyword
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Achang (13N144E0064)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Cocos Barrier Reefs (13N144E0001)

CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > East Agana Bay (13N144E0063)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Fouha Bay (13N144E0024)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Guam (13N144E0000)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Piti Bay (13N144E0061)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Tumon Bay (13N144E0004)
CoRIS Place Thesaurus	COUNTRY/TERRITORY > United States of America > Guam > Western Shoal (13N144E0062)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Achang (13N144E0064)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > East Agana Bay (13N144E0063)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Fouha Bay (13N144E0024)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Guam (13N144E0000)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Piti Bay (13N144E0061)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Tumon Bay (13N144E0004)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam > Western Shoal (13N144E0062)
CoRIS Place Thesaurus	OCEAN BASIN > Pacific Ocean > Western Pacific Ocean > Guam Reefs > Cocos Barrier Reefs (13N144E0001)
None	Mariana Archipelago
None	Mariana Islands
None	Marianas

## Stratum Keywords

Thesaurus	Keyword

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## Instrument Keywords

Thesaurus	Keyword

## Platform Keywords

Thesaurus	Keyword

## Physical Location

• » Organization	University of Guam Marine Laboratory
• » City	Mangilao
• » State/Province	GU
• Country	USA
• » Location Description	

## Data Set Information

* Data Set Scope Code	Data Set
• Data Set Type	Database
• Maintenance Frequency	As Needed
Maintenance Note	
» Data Presentation Form	Table (digital)

<b>• Entity Attribute Overview</b>	
<b>Entity Attribute Detail Citation</b>	
<b>Entity Attribute Detail URL</b>	<a href="https://www.fisheries.noaa.gov/inport/item/47787">https://www.fisheries.noaa.gov/inport/item/47787</a>
<b>Distribution Liability</b>	While every effort has been made to ensure that these data are accurate and reliable within the limits of the current state of the art, the University of Guam Marine Laboratory and the Guam Coastal Management Program cannot assume liability for any damages caused by errors or omissions in the data, nor as a result of the failure of the data to function on a particular system. The University of Guam Marine Laboratory and the Guam Coastal Management Program make no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.
<b>Data Set Credit</b>	University of Guam Marine Laboratory, NOAA Pacific Islands Regional Office, and Guam Coastal Management Program.

## Support Roles

» At least one Distributor Org, one Metadata Contact, one Point of Contact, and one Data Steward should be listed.

<b>* » Support Role</b>	Data Steward
<b>* » Date Effective From</b>	2010
<b>Date Effective To</b>	
<b>Person</b>	Burdick, David R
<b>Address</b>	303 University Dr. Mangilao, GU 96913 USA
<b>Email Address</b>	burdickd@triton.uog.edu
<b>Phone</b>	671-735-2175
<b>Fax</b>	
<b>Mobile</b>	
<b>URL</b>	
<b>Business Hours</b>	0800-1700 Chamorro Standard Time (GMT+10)
<b>Contact Instructions</b>	



<b>* » Support Role</b>	Distributor
<b>* » Date Effective From</b>	2010
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<b>Contact Instructions</b>	

<b>* » Support Role</b>	Metadata Contact
<b>* » Date Effective From</b>	2010
<b>Date Effective To</b>	
<b>Person</b>	Burdick, David R
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<b>Contact Instructions</b>	

<b>* » Support Role</b>	Originator
<b>* » Date Effective From</b>	2010
<b>Date Effective To</b>	
<b>Organization</b>	NOAA Coral Reef Conservation Program (CRCP)
<b>Address</b>	1305 East West Highway 10th Floor Silver Spring, MD 20910-3281
<b>Email Address</b>	
<b>Phone</b>	(301) 713-3155
<b>Fax</b>	
<b>Mobile</b>	
<b>URL</b>	<a href="https://coralreef.noaa.gov">https://coralreef.noaa.gov</a>
<b>Business Hours</b>	
<b>Contact Instructions</b>	

<b>* » Support Role</b>	Point of Contact
<b>* » Date Effective From</b>	2010
<b>Date Effective To</b>	
<b>Person</b>	Burdick, David R
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<b>* » Support Role</b>	Principal Investigator
-------------------------	------------------------

<b>* » Date Effective From</b>	2017
<b>Date Effective To</b>	
<b>Person</b>	Burdick, David R
<b>Address</b>	303 University Dr. Mangilao, GU 96913 USA
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<b>Business Hours</b>	0800-1700 Chamorro Standard Time (GMT+10)
<b>Contact Instructions</b>	

<b>* » Support Role</b>	
<b>* » Date Effective From</b>	
<b>Date Effective To</b>	
<b>* » Contact</b>	
<b>* Contact Instructions</b>	

<b>* » Support Role</b>	
<b>* » Date Effective From</b>	
<b>Date Effective To</b>	
<b>* » Contact</b>	
<b>* Contact Instructions</b>	

<b>* » Support Role</b>	
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<b>* » Date Effective From</b>	
<b>Date Effective To</b>	
<b>* » Contact</b>	
<b>* Contact Instructions</b>	

## Extents

<b>Currentness Reference</b>	Ground Condition
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### Extent Group 1

<b>Extent Description</b>	Tumon Bay
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### Extent Group 1 / Geographic Area 1

<b>* » W° Bound</b>	144.789408
<b>* » E° Bound</b>	144.798507
<b>* » N° Bound</b>	13.517207
<b>* » S° Bound</b>	13.510711
<b>* » Description</b>	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.

### Extent Group 1 / Geographic Area 2

<b>* » W° Bound</b>	144.784502
<b>* » E° Bound</b>	144.795528
<b>* » N° Bound</b>	13.512988
<b>* » S° Bound</b>	13.508506
<b>* » Description</b>	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.

### Extent Group 1 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

### Extent Group 1 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2018-10-23
<b>End</b>	2018-11-15
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2018 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2019-07-02
<b>End</b>	2019-10-25
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2019 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2020-07-23
<b>End</b>	2020-10-13

<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2020 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 4

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2010-08-04
<b>End</b>	2010-09-02
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame of benthic photo transect surveys carried out within the original Tumon Bay site as established in 2010. The boundaries of the Tumon Bay site changed after the 2010 surveys were carried out and prior to the 2012 surveys.

### Extent Group 1 / Time Frame 5

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2012-09-05
<b>End</b>	2012-11-19
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2012 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 6

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2014-09-03

<b>End</b>	2014-09-09
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2014 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 7

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2015-06-23
<b>End</b>	2015-07-01
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2015 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 8

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2017-04-10
<b>End</b>	2017-08-10
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2017 at the current Tumon Bay site, the boundaries of which were modified after the 2010 survey effort but before the 2012 survey effort.

### Extent Group 1 / Time Frame 9

<b>* » Time Frame Type</b>	Range
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<b>* » Start</b>	2021-06-23
<b>End</b>	2021-08-18
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 1 / Time Frame 10

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2022-08-05
<b>End</b>	2022-10-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 1 / Time Frame 11

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2023-05-11
<b>End</b>	2023-06-29
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 1 / Time Frame 12



<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2024-07-10
<b>End</b>	2024-08-16
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 2

<b>Extent Description</b>	East Agana Bay
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## Extent Group 2 / Geographic Area 1

<b>* » W° Bound</b>	144.758065
<b>* » E° Bound</b>	144.766983
<b>* » N° Bound</b>	13.491396
<b>* » S° Bound</b>	13.483792
<b>* » Description</b>	These bounding coordinates pertain to the current boundaries for the East Agana Bay site, which has been monitored since 2010

## Extent Group 2 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

## Extent Group 2 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2010-09-07

<b>End</b>	2010-11-26
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2010 at the current East Agana Bay site, the boundaries of which have been consistent since the site's establishment in 2010

## Extent Group 2 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2012-11-16
<b>End</b>	2012-11-28
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2012 at the current East Agana Bay site, the boundaries of which have been consistent since the site's establishment in 2010

## Extent Group 2 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2014-09-10
<b>End</b>	2014-09-16
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2014 at the current East Agana Bay site, the boundaries of which have been consistent since the site's establishment in 2010

## Extent Group 2 / Time Frame 4

<b>* » Time Frame Type</b>	Range
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<b>* » Start</b>	2016-02-16
<b>End</b>	2016-04-05
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2016 at the current East Agana Bay site, the boundaries of which have been consistent since the site's establishment in 2010

## Extent Group 2 / Time Frame 5

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2017-07-12
<b>End</b>	2017-12-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2017 at the East Agana site

## Extent Group 2 / Time Frame 6

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2018-11-15
<b>End</b>	2018-11-29
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2018 at the East Agana site

## Extent Group 2 / Time Frame 7

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2019-09-05
<b>End</b>	2019-12-19
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2019 at the East Agana site

## Extent Group 2 / Time Frame 8

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2020-10-13
<b>End</b>	2020-11-24
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2020 at the East Agana site

## Extent Group 2 / Time Frame 9

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2021-08-04
<b>End</b>	2021-09-03
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 2 / Time Frame 10

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2022-09-29
<b>End</b>	2022-10-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 2 / Time Frame 11

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2023-08-16
<b>End</b>	2023-09-13
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 2 / Time Frame 12

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2024-08-16
<b>End</b>	2024-11-19
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 3

<b>Extent Description</b>	Western Shoals
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## Extent Group 3 / Geographic Area 1

<b>* » W° Bound</b>	144.653292
<b>* » E° Bound</b>	144.656443
<b>* » N° Bound</b>	13.454042
<b>* » S° Bound</b>	13.449599
<b>* » Description</b>	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.

## Extent Group 3 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

## Extent Group 3 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2011-07-11
<b>End</b>	2011-08-19
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out at the Western Shoals site in 2011. Subsequent surveys have not been carried out at this site due to a shift in management priorities.

## Extent Group 4

<b>Extent Description</b>	Piti (Tepungan) Bay
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## Extent Group 4 / Geographic Area 1

<b>* » W° Bound</b>	144.683913
<b>* » E° Bound</b>	144.697634
<b>* » N° Bound</b>	13.47632
<b>* » S° Bound</b>	13.468317
<b>* » Description</b>	These bounding coordinates pertain to the Piti (Tepungan) Bay site, which has been surveyed since 2012.

## Extent Group 4 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

## Extent Group 4 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2014-09-17
<b>End</b>	2014-11-13
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out within the Piti (Tepungan) Bay site in 2014

## Extent Group 4 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2020-06-30
<b>End</b>	2020-07-16
<b>Alternate Start As Of Info</b>	

<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2020 at the Piti (Tepungan) Bay site

### Extent Group 4 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2012-07-23
<b>End</b>	2012-08-31
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out within the Piti (Tepungan) Bay site in 2012

### Extent Group 4 / Time Frame 4

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2017-11-15
<b>End</b>	2018-06-19
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out within the Piti (Tepungan) Bay site between the end of 2017 and mid-2018

### Extent Group 4 / Time Frame 5

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2022-05-22
<b>End</b>	2022-08-04



<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 4 / Time Frame 6

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2024-09-26
<b>End</b>	2024-11-08
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Extent Group 5

<b>Extent Description</b>	Achang
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## Extent Group 5 / Geographic Area 1

<b>* » W° Bound</b>	144.69765
<b>* » E° Bound</b>	144.712233
<b>* » N° Bound</b>	13.242611
<b>* » S° Bound</b>	13.239282
<b>* » Description</b>	These bounding coordinates pertain to the current Achang monitoring site boundaries, which were established in 2014.

## Extent Group 5 / Vertical Extent

<b>EPSG Code</b>	
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<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

### Extent Group 5 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2014-10-22
<b>End</b>	2014-10-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2014 at the Achang site

### Extent Group 5 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2018-07-26
<b>End</b>	2018-09-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2018 at the Achang site

### Extent Group 5 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2021-04-21
<b>End</b>	2021-05-14
<b>Alternate Start As Of Info</b>	

<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 5 / Time Frame 4

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2023-06-30
<b>End</b>	2023-08-25
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 6

<b>Extent Description</b>	Cocos-East
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### Extent Group 6 / Geographic Area 1

<b>* » W° Bound</b>	144.674888
<b>* » E° Bound</b>	144.685944
<b>* » N° Bound</b>	13.23992
<b>* » S° Bound</b>	13.235939
<b>* » Description</b>	These bounding coordinates pertain to the current Cocos-East site, which was established in 2014

### Extent Group 6 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	

<b>Vertical Maximum</b>	
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## Extent Group 6 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2014-10-27
<b>End</b>	2014-10-28
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2014 at the Cocos-East site

## Extent Group 6 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2018-08-24
<b>End</b>	2018-09-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2018 at the Cocos-East site

## Extent Group 6 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2021-04-30
<b>End</b>	2021-06-10
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	

<b>Description</b>	
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### Extent Group 6 / Time Frame 4

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2023-10-19
<b>End</b>	2023-11-08
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

### Extent Group 7

<b>Extent Description</b>	Fouha Bay
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### Extent Group 7 / Geographic Area 1

<b>* » W° Bound</b>	144.653677
<b>* » E° Bound</b>	144.656082
<b>* » N° Bound</b>	13.305903
<b>* » S° Bound</b>	13.303514
<b>* » Description</b>	These bounding coordinates pertain to the current Fouha Bay monitoring site, which was established in 2015

### Extent Group 7 / Vertical Extent

<b>EPSG Code</b>	
<b>Vertical Minimum</b>	
<b>Vertical Maximum</b>	

## Extent Group 7 / Time Frame 1

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2015-05-06
<b>End</b>	2015-10-27
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2015 at the Fouha Bay site

## Extent Group 7 / Time Frame 2

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2019-05-09
<b>End</b>	2019-06-04
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	Time frame for benthic photo transect surveys carried out in 2019 at the Fouha Bay site

## Extent Group 7 / Time Frame 3

<b>* » Time Frame Type</b>	Range
<b>* » Start</b>	2021-05-19
<b>End</b>	2021-06-11
<b>Alternate Start As Of Info</b>	
<b>Alternate End As Of Info</b>	
<b>Description</b>	

## Spatial Information

### Spatial Resolution

<b>Angular Distance</b>	
<b>Angular Distance Units</b>	
<b>Horizontal Distance</b>	
<b>Horizontal Distance Units</b>	
<b>Vertical Distance</b>	
<b>Vertical Distance Units</b>	
<b>Equivalent Scale Denominator</b>	
<b>Level of Detail Description</b>	

### Spatial Representation

<b>Grid Representation Used?</b>	
<b>Vector Representation Used?</b>	
<b>Text / Table Representation Used?</b>	
<b>TIN Representation Used?</b>	
<b>Stereo Model Representation Used?</b>	
<b>Video Representation Used?</b>	

### Grid Representation

<b>Dimension Count</b>	
------------------------	--

<b>Cell Geometry</b>	
<b>Transformation Parameter Available?</b>	

## Axis Dimension

Dimension Type	
Size	
Resolution	
Resolution Units	
Resolution Type	
Description	

## Axis Dimension

Dimension Type	
Size	
Resolution	
Resolution Units	
Resolution Type	
Description	

## Vector Representation

Topology Level	
Complex Object Present?	
Complex Object Count	
Composite Object Present?	
Composite Object Count	
Curve Object Present?	



<b>Curve Object Count</b>	
<b>Point Object Present?</b>	
<b>Point Object Count</b>	
<b>Solid Object Present?</b>	
<b>Solid Object Count</b>	
<b>Surface Object Present?</b>	
<b>Surface Object Count</b>	

## Reference Systems

### Reference System

<b>EPSG Code</b>	
<b>Horizontal Resolution</b>	
<b>Horizontal Encoding Method</b>	
<b>Latitude Resolution</b>	
<b>Longitude Resolution</b>	
<b>Coordinate X Resolution</b>	
<b>Coordinate Y Resolution</b>	
<b>Row Resolution</b>	
<b>Column Resolution</b>	
<b>Horizontal Units</b>	
<b>Distance Resolution</b>	
<b>Distance Units</b>	
<b>Bearing Resolution</b>	

<b>Bearing Units</b>	
<b>Reference Direction</b>	
<b>Reference Meridian</b>	

## Vertical Resolution

<b>Vertical Encoding Method</b>	
<b>Vertical Resolution</b>	
<b>Vertical Units</b>	

## Access Information

<b>Data License</b>	
<b>Data License URL</b>	
<b>Data License Statement</b>	
<b>* » Security Class</b>	Unclassified
<b>* Security Classification System</b>	Not applicable
<b>Security Handling Description</b>	Not applicable
<b>• Data Access Policy</b>	
<b>» Data Access Procedure</b>	Data can be accessed online via the NOAA National Centers for Environmental Information (NCEI) Ocean Archive.
<b>• » Data Access Constraints</b>	None

<b>• Data Use Constraints</b>	<p>Please cite the Guam Coastal Management Program when using data collected prior to October 2013. Guam Coastal Management Program, Guam Bureau of Statistics and Plans, Government of Guam. Please cite the University of Guam Marine Laboratory when using data collected after (and including) October 2013.</p> <p>Example citation:</p> <p>For data collected from 2010 to 2012:</p> <p>Guam Coastal Management Program (2019). Guam Long-term Coral Reef Monitoring Program Benthic Percent Cover Derived from Image Analysis since 2010. NOAA's National Center for Environmental Information, <a href="https://www.fisheries.noaa.gov/inport/item/47784">https://www.fisheries.noaa.gov/inport/item/47784</a>.</p> <p>For data collected after 2012:</p> <p>University of Guam Marine Laboratory (2019). Guam Long-term Coral Reef Monitoring Program Benthic Percent Cover Derived from Image Analysis since 2010. NOAA's National Center for Environmental Information, <a href="https://www.fisheries.noaa.gov/inport/item/47784">https://www.fisheries.noaa.gov/inport/item/47784</a>.</p>
<b>Metadata Access Constraints</b>	None
<b>Metadata Use Constraints</b>	None

## Distribution Information

<b>Start Date</b>	2010-08-04
<b>End Date</b>	2016-04-05
<b>» Download URL</b>	<a href="http://accession.nodc.noaa.gov/accession#">http://accession.nodc.noaa.gov/accession#</a>
<b>Distributor</b>	
<b>File Name</b>	GLTMP_cover_2010-2016.csv
<b>Description</b>	Benthic cover data from the Tumon Bay, East Agana Bay, Piti (Tepungan) Bay, Achang, Cocos-East, Fouha Bay, and Western Shoals sites between 2010 and 2016
<b>File Date/Time</b>	
<b>File Type (Deprecated)</b>	csv (comma-separated values)
<b>Distribution Format</b>	CSV - Comma Separated Values (Text)

<b>File Size</b>	
<b>Application Version</b>	
<b>Compression</b>	
<b>Review Status</b>	

<b>Start Date</b>	
<b>End Date</b>	
<b>» Download URL</b>	
<b>Distributor</b>	
<b>File Name</b>	
<b>Description</b>	
<b>File Date/Time</b>	
<b>File Type</b>	
<b>FGDC Content Type</b>	
<b>File Size</b>	
<b>Application Version</b>	
<b>Compression</b>	
<b>Review Status</b>	

<b>Start Date</b>	
<b>End Date</b>	
<b>» Download URL</b>	
<b>Distributor</b>	
<b>File Name</b>	
<b>Description</b>	
<b>File Date/Time</b>	
<b>File Type</b>	
<b>FGDC Content Type</b>	

<b>File Size</b>	
<b>Application Version</b>	
<b>Compression</b>	
<b>Review Status</b>	

<b>Start Date</b>	
<b>End Date</b>	
<b>» Download URL</b>	
<b>Distributor</b>	
<b>File Name</b>	
<b>Description</b>	
<b>File Date/Time</b>	
<b>File Type</b>	
<b>FGDC Content Type</b>	
<b>File Size</b>	
<b>Application Version</b>	
<b>Compression</b>	
<b>Review Status</b>	

## Archive Information

<b>Location</b>	
<b>File Identifier</b>	
<b>File Name</b>	
<b>URL</b>	
<b>Description</b>	
<b>DOI</b>	
<b>Archive Date</b>	
<b>Archive Update</b>	

<b>Frequency</b>	
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<b>Location</b>	
<b>File Identifier</b>	
<b>File Name</b>	
<b>URL</b>	
<b>Description</b>	
<b>DOI</b>	
<b>Archive Date</b>	
<b>Archive Update Frequency</b>	

<b>Location</b>	
<b>File Identifier</b>	
<b>File Name</b>	
<b>URL</b>	
<b>Description</b>	
<b>DOI</b>	
<b>Archive Date</b>	
<b>Archive Update Frequency</b>	

## URLs

<b>URL</b>	<a href="https://guamcoralreefmonitoring.files.wordpress.com/2020/02/guam_ltmp_spring2019_report_final-2.pdf">https://guamcoralreefmonitoring.files.wordpress.com/2020/02/guam_ltmp_spring2019_report_final-2.pdf</a>
<b>Name</b>	A report of the Comprehensive Long-term Coral Reef Monitoring at Permanent Sites on Guam Project: Including the results of an analysis of data collected at high priority reef areas between 2010 and 2018
<b>URL Type</b>	Online Resource
<b>File Resource Format</b>	PDF

<b>Description</b>	End-of-grant report that includes detailed information about the monitoring program's background and survey methodology, as well as the results of an analysis of baseline data collected at the Fouha Bay, Achang, Tepungan (Piti) Bay and the modified Tumon Bay site, and an analysis of time series data collected at the Tumon Bay, East Agana Bay, and Tepungan (Piti) Bay sites.
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<b>URL</b>	<a href="https://guamcoralreefmonitoring.wordpress.com/">https://guamcoralreefmonitoring.wordpress.com/</a>
<b>Name</b>	
<b>URL Type</b>	Online Resource
<b>File Resource Format</b>	
<b>Description</b>	Guam Long-term Coral Reef Monitoring Program website

<b>URL</b>	<a href="http://cnso.nova.edu/cpce/index.html">http://cnso.nova.edu/cpce/index.html</a>
<b>Name</b>	
<b>URL Type</b>	Online Resource
<b>File Resource Format</b>	
<b>Description</b>	CPCe website

<b>URL</b>	<a href="https://www.uog.edu/_resources/files/ml/technical_reports/UOGML_TechRep170_GLTMP_2023.pdf">https://www.uog.edu/_resources/files/ml/technical_reports/UOGML_TechRep170_GLTMP_2023.pdf</a>
<b>Name</b>	A decade of change on Guam's coral reefs: A report of Guam Long-term Coral Reef Monitoring Program activities between 2010 and 2021
<b>URL Type</b>	Online Resource
<b>File Resource Format</b>	PDF
<b>Description</b>	End-of-grant report that includes detailed information about the monitoring program's background and survey methodology, as well as the results of analyses of data collected at several High Priority Reef Areas (HPRAs) between 2010 and 2021, at island-wide bleaching response and recovery sites between 2013 and 2021, at Reef Flat Monitoring Program sites between 2009 and 2022, and at staghorn coral communities between 2015 and 2021.

<b>URL</b>	
<b>Name</b>	

<b>URL Type</b>	
<b>File Resource Format</b>	
<b>Description</b>	

<b>URL</b>	
<b>Name</b>	
<b>URL Type</b>	
<b>File Resource Format</b>	
<b>Description</b>	

<b>URL</b>	
<b>Name</b>	
<b>URL Type</b>	
<b>File Resource Format</b>	
<b>Description</b>	

## Activity Log

<b>Activity Time</b>	
<b>Activity Type</b>	
<b>Responsible Party</b>	
<b>Description</b>	

<b>Activity Time</b>	
<b>Activity Type</b>	



<b>Responsible Party</b>	
<b>Description</b>	

<b>Activity Time</b>	
<b>Activity Type</b>	
<b>Responsible Party</b>	
<b>Description</b>	

## Issues

<b>Issue Date</b>	
<b>Author</b>	
<b>Issue</b>	

<b>Issue Date</b>	
<b>Author</b>	
<b>Issue</b>	

<b>Issue Date</b>	
<b>Author</b>	
<b>Issue</b>	

## Technical Environment

<b>Description</b>	Benthic images are organized and edited on the desktop workstation of the Monitoring Program Coordinator, with backup copies of each image and associated
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data files stored on an external hard drive and with the GSuite cloud storage service. Between 2010 and 2018 images were analyzed using CPCe installations on the workstation or laptop computer of individual monitoring team members. CPCe output files generated by other team members were obtained by the coordinator and modified to conform to the directory structure of the coordinator's computer. Spreadsheets containing raw CPCe data from across multiple sites and years were generated by compiling .cpc files using CPCe and assembling the raw data within a single master spreadsheet. In 2021, benthic images obtained at the HPRAS beginning in 2019 were uploaded to CoralNet, a web-based image analysis platform. The CoralNet robot was initially trained using images and CPCe data from 2015-2018. Approximately 5% to 20% of annotations (depending on the site) suggested by the CoralNet robot for the 2019-present images exceeded the 80% confidence threshold set for the source, but a human observer still verified each annotation manually.

## Data Quality

<b>Representativeness</b>	
<b>Accuracy</b>	Data sets derived from image analysis are highly reliable within the stipulated taxonomic context. Image analysts undergo a training period during which they analyze images from numerous sampling stations in the presence of the monitoring program coordinator. The total number of images analyzed during the training period varies according to the prior experience level of the trainee. The results of the CPCe image analyses (2010-2018) and the initial fully-manual CoralNet-based analyses (2019-present) underwent extensive quality control procedures carried out by the benthic community specialist (currently the program coordinator). However, it should be understood that some benthic features, such as turf algae, crustose coralline algae, small coral colonies and other diminutive living or non-living features may be difficult to discern from each other in the benthic photo transect images. It should also be noted that the higher image resolution achieved by the more recently-used cameras allows for greater taxonomic resolution during image analysis, and likely allows for greater accuracy in the identification of benthic features, particularly for features, such as turf algae, crustose coralline algae, and small corals, that can be difficult to discern at lower image resolutions. Beginning with images obtained in 2023 the accuracy of the outputs of image analysis, which will involve a combination of human observer and CoralNet robot-alleviated annotations, will be evaluated using tools available on the CoralNet site (e.g., confusion matrix and confidence threshold sweep graph).
<b>Analytical Accuracy</b>	
<b>Horizontal Positional Accuracy</b>	

<b>Vertical Positional Accuracy</b>	
<b>Quantitation Limits</b>	
<b>Bias</b>	Effort is made to avoid inter-observer bias through consistent training of image analysis technicians by the Program Coordinator and by reference to an established protocol document. The use of the CoralNet platform for the semi-automated analysis of images obtained beginning in 2023 will further minimize inter-observer bias, but will introduce new biases.
<b>Comparability</b>	<p>Comparisons of data across HPRAs or across years must take into account differences in environmental and biological aspects of each site. Comparisons for a give HPRA across time should consider any changes to the site boundaries over time and the mix of paired and unpaired sampling stations. Please refer to the Extents section of this metadata record to see how the Tumon site boundaries shifted after 2010.</p> <p>Comparisons for a given site across time could potentially be affected by changes in the benthic photo transect survey and image analysis methodologies. Changes are:</p> <p>Transect length: Benthic photo transect length for all sampling stations except the Western Shoals HPRA was 25 meters between 2010 and 2016 and, with the exception of the Fouha Bay HPRA, was extended to 30 m beginning in 2017.</p> <p>Image spacing: Between 2010 and 2012 benthic photos were captured every 0.5 meters along both sides of the transect tape. Photos were taken every 1 meter beginning in 2014 in order to avoid overlapping images, and beginning in 2017 images were only taken along the left side of the transect.</p> <p>Image analysis: Prior to 2014 a total of 25 points (random stratified using a 5 x 5 grid) were used to analyze each image in CPCe. For photos analyzed since (and including) 2014, a total of 16 points (random stratified using a 4 x 4 grid) are used.</p> <p>Image quality: Image quality has improved over time with the availability of digital cameras capable of capturing higher resolution images and with more advanced functionality. A Canon PowerShot A720 IS digital camera (8 Megapixel sensor; 3264x2448 pixel image resolution) was used between 2010 and 2011, a Nikon Coolpix 36300 (16 Megapixel sensor; 4608x3456 pixel image resolution) was used for most sampling stations in 2012; and a Canon PowerShot ELPH 300 HS (12 Megapixel sensor; 4000x3000 pixel image resolution) was used for a limited number of sampling stations in 2012. The lower resolution PowerShot A720 was again used in 2014, and a Sony Cybershot RX-100 (20 Megapixel sensor; 5472x3648 pixel image resolution) was used from 2015-2023. Since 2024 a Canon EOS M6 Mark II (32.5 Megapixel sensor; 6960 x 4640 pixel image resolution) has been used. The higher image resolution achieved by the more recent cameras allows for greater taxonomic resolution during image analysis, and likely allows for greater accuracy in the identification of benthic features.</p>

	<p>Camera frame/monopod: Initially, the camera/housing was mounted to a PVC frame/quadrat structure that allowed the consistent positioning of the camera directly above a 0.5 x 0.5 m quadrat. A 1.15 m-tall PVC monopod was used beginning in 2017. In order to minimize the presence of the monopod within the image frame the camera is mounted on a piece of PVC that extends 0.28 m horizontally at the top of the monopod. The field of view captured using the Sony RX100/monopod combination is approximately 50% larger than that obtained using the frame/quadrat.</p> <p>Modification of benthic classification system: An effort was made to standardize benthic classes used in the analysis of all images to the extent possible, but care must still be taken in time series analyses of classes that had been split into two or more classes, or for which the definition had been modified at some point during the study period. Examples include the redefinition of TURF to refer to just micro-turf, the redefinition of TURS to refer to conspicuous turfing algae, the creation of the class CCRA to refer mainly to the Peyssonneliales and related encrusting coralline algae, the redefinition of FMAD to include only encrusting fleshy macroalgae. It is highly recommended that any users of these data reach out to the program coordinator if changes in the definition of these and some other classes may impact an analysis of these benthic cover data.</p>
<b>Completeness Measure</b>	
<b>Precision</b>	
<b>Analytical Precision</b>	
<b>Field Precision</b>	
<b>Sensitivity</b>	
<b>Detection Limit</b>	
<b>Completeness Report</b>	<p>Only hard-bottom habitats are surveyed. Surveys are conducted annually to biennially for the Tumon and East Agana sites, but are conducted on a less frequent basis at other sites. In addition, while all permanent sampling stations are generally surveyed each sampling period, surveys are not always conducted at the full set of non-</p>

permanent stations for each site during each sampling period. Below is a summary of the number of permanent and non-permanent sampling stations surveyed each year for each site:

Tumon Bay: 2010 (10 perm, 10 non-perm); 2012 (12 perm, 9 non-perm); 2014 (12 perm, 4 non-perm); 2015 (12 perm, 10 non-perm); 2017 (12 perm, 10 non-perm); 2018 (12 perm, 0 non-perm); 2019 (12 perm, 10 non-perm); 2020 (12 perm, 10 non-perm); 2021 (12 perm, 10 non-perm); 2022 (12 perm, 10 non-perm); 2023 (12 perm, 10 non-perm); 2024 (12 perm, 10 non-perm)

East Agana Bay: 2010 (10 perm, 10 non-perm); 2012 (10 perm, 0 non-perm); 2014 (10 perm, 0 non-perm); 2015 (10 perm, 0 non-perm); 2017 (10 perm, 11 non-perm); 2018 (10 perm, 0 non-perm); 2019 (9 perm, 6 non-perm); 2020 (10 perm, 10 non-perm); 2021 (10 perm, 10 non-perm); 2022 (10 perm, 10 non-perm); 2023 (10 perm, 10 non-perm); 2024 (10 perm, 10 non-perm)

Western Shoals: 2011 (11 perm, 12 non-perm)

Piti Bay: 2012 (10 perm, 10 non-perm); 2014 (10 perm, 2 non-perm); 2017-2018 (8 perm, 6 non-perm); 2020 (10 perm, 10 non-perm); 2022 (10 perm, 10 non-perm); 2024 (10 perm, 7 non-perm)

Achang: 2014 (11 perm, 3 non-perm); 2018 (9 perm, 6 non-perm); 2021 (10 perm, 10 non-perm); 2023 (10 perm, 9 non-perm)

Cocos-East: 2014 (3 perm, 4 non-perm); 2018 (10 perm); 2021 (10 perm, 10 non-perm); 2023 (10 perm, 7 non-perm)

Fouha Bay: 2015 (13 perm); 2019 (13 perm); 2021 (13 perm)

The analysis of images collected through 2022 is complete and the results have all undergone quality control. As of the publication of this metadata record images the analysis of images obtained in 2023 have not yet been completed.

### Conceptual Consistency

Baseline benthic cover data derived from photo transects were explored in multivariate space using the statistical software package PRIMER and the PERMANOVA add-on. The exploration of the benthic cover data in multivariate space allowed for the visualization of the spatial structure of the data and the examination of the possible influence of environmental factors on this spatial structure. This preliminary data exploration also assisted in determining if the benthic community remained relatively homogeneous across the monitoring sites or strata as original delineated, and whether or not the site boundaries should be adjusted, subdivided into two or more strata, or if certain sampling stations should be abandoned. Univariate power analyses using the R software program were carried out separately on total coral cover for sampling stations from different strata or other sampling station groupings. Multivariate power analyses were carried out in order to examine the ability of the sampling regime to adequately capture the overall character of the benthic communities. The results of these analyses were presented in previous reports.

Due to time constraints, for most sampling stations only images collected along the left side of the transect were analyzed and underwent quality control. However, images collected along the right side of the transect may be analyzed at a later date to

	<p>determine if the additional data points affect statistical power for target parameters. Beginning in 2017, images were only obtained along the left side of the transect.</p> <p>The data set derived from the image analysis is only as good as the images themselves; poor images with low contrast, inappropriate white balance, or out of focus are discarded. Therefore, percent cover estimates for some sites may derive from differing number of points between sites. Although the analysis process is statistically robust to allow for differing n (points) between sites the users should be aware of this limitation.</p> <p>These data do not contain zero counts for benthic classes not observed at a given sampling station, but zero counts should be accounted for when calculating mean values for parameters across sampling stations (e.g., by using the <code>expand_grid</code> function in R).</p> <p>Note that while the SURVEY_YEAR value is generally consistent with the SURVEY_DATE, the SURVEY_YEAR value for several sampling stations in the Piti HPRA is not consistent with the SURVEY_DATE. These stations were surveyed in November and December of 2017, but surveys at the remainder of the sampling stations were completed between March and August of 2018. The SURVEY_YEAR was changed to 2018 for the stations surveyed in late 2017 in order to allow these stations to be considered together in a time series analysis.</p>
<b>» Quality Control Procedures Employed</b>	<p>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 2024. 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.</p>

## Data Management

<b>» Have Resources for Management of these Data Been Identified?</b>	Yes
<b>» Approximate Percentage of Budget for these Data Devoted to Data Management</b>	Unknown

<b>» Do these Data Comply with the Data Access Directive?</b>	Yes
<b>» Is Access to the Data Limited Based on an Approved Waiver?</b>	No
<b>» If Distributor (Data Hosting Service) is Needed, Please Indicate</b>	
<b>» Approximate Delay Between Data Collection and Dissemination</b>	Unknown
<b>» If Delay is Longer than Latency of Automated Processing, Indicate Under What Authority Data Access is Delayed</b>	
<b>» Actual or Planned Long-Term Data Archive Location</b>	NCEI-MD
<b>» Approximate Delay Between Data Collection and Archiving</b>	Unknown
<b>» How Will the Data Be Protected from Accidental or Malicious Modification or Deletion Prior to Receipt by the Archive?</b>	University of Guam Marine Lab resources and assets

## Lineage

<b>» Lineage Statement</b>	The Benthic Photo Transect Survey methodology, employed by the Guam Long-term Coral Reef Monitoring Program since 2010
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## Sources

<b>Citation Title</b>	
<b>Contact Role Type</b>	
<b>Contact Type</b>	
<b>Contact Name</b>	
<b>Publish Date</b>	
<b>Extent Type</b>	
<b>Extent Start Date/Time</b>	
<b>Extent End Date/Time</b>	
<b>Citation URL</b>	
<b>Citation URL Name</b>	
<b>Citation URL Description</b>	
<b>Scale Denominator</b>	

<b>Citation Title</b>	
<b>Contact Role Type</b>	
<b>Contact Type</b>	
<b>Contact Name</b>	
<b>Publish Date</b>	
<b>Extent Type</b>	
<b>Extent Start Date/Time</b>	
<b>Extent End Date/Time</b>	
<b>Citation URL</b>	
<b>Citation URL Name</b>	



<b>Citation URL Description</b>	
<b>Scale Denominator</b>	

<b>Citation Title</b>	
<b>Contact Role Type</b>	
<b>Contact Type</b>	
<b>Contact Name</b>	
<b>Publish Date</b>	
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<b>Extent End Date/Time</b>	
<b>Citation URL</b>	
<b>Citation URL Name</b>	
<b>Citation URL Description</b>	
<b>Scale Denominator</b>	

## Process Steps

<b>Process Step Number</b>	1
<b>» Description</b>	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).
<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David R
<b>Phone (Voice)</b>	671-735-2175
<b>Email Address</b>	burdickd@triton.uog.edu
<b>Source</b>	

<b>Process Step Number</b>	2
<b>» Description</b>	<p>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).</p> <p>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]</p> <p>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.</p>
<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David R
<b>Phone (Voice)</b>	671-735-2175
<b>Email Address</b>	burdickd@triton.uog.edu

<b>Source</b>	
<b>Process Step Number</b>	3
<b>» Description</b>	At the start of a benthic survey, one of the divers begins the photo transect and captures non-overlapping digital photos every 1 meter 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 2024, images are obtained using a Canon EOS M6 Mark II (32.5 Megapixel sensor; 6960 x 4640 pixel image resolution) mounted on a PVC monopod. Prior to 2024, several different cameras in underwater housings were mounted the monopod and to a 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.
<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David R
<b>Phone (Voice)</b>	671-735-2175
<b>Email Address</b>	burdickd@triton.uog.edu
<b>Source</b>	

<b>Process Step Number</b>	4
<b>» Description</b>	<p>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.</p> <p>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.</p> <p>A free application called File Renamer (<a href="http://www.webxpace.com">http://www.webxpace.com</a>) 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_YEARMMDT_S.jpg, where SIT = three letter site code, ST = sampling station number, YEARMMDT = 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</p>

	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.
<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David R
<b>Phone (Voice)</b>	671-735-2175
<b>Email Address</b>	burdickd@triton.uog.edu
<b>Source</b>	

<b>Process Step Number</b>	5
<b>» Description</b>	<p>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-present images were analyzed entirely by a human observer, with the aid of the CoralNet robot.</p> <p>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.</p>

<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David R
<b>Phone (Voice)</b>	671-735-2175
<b>Email Address</b>	burdickd@triton.uog.edu
<b>Source</b>	

<b>Process Step Number</b>	6
<b>» Description</b>	Newly generated annotations are acquired from CoralNet and integrated into a master benthic cover data set using a custom R script.
<b>Process Date/Time</b>	
<b>Process Contact</b>	Burdick, David
<b>Phone (Voice)</b>	
<b>Email Address</b>	David.Burdick@unh.edu
<b>Source</b>	

<b>Process Step Number</b>	
<b>» Description</b>	
<b>Process Date/Time</b>	
<b>Process Contact</b>	
<b>Phone (Voice)</b>	
<b>Email Address</b>	
<b>Source</b>	

<b>Process Step Number</b>	
<b>» Description</b>	

<b>Process Date/Time</b>	
<b>Process Contact</b>	
<b>Phone (Voice)</b>	
<b>Email Address</b>	
<b>Source</b>	

<b>Process Step Number</b>	
<b>» Description</b>	
<b>Process Date/Time</b>	
<b>Process Contact</b>	
<b>Phone (Voice)</b>	
<b>Email Address</b>	
<b>Source</b>	

## Acquisition Information

### Instruments

<b>Instrument Unavailable Reason</b>	
<b>Identifier</b>	
<b>Docucomp UUID</b>	
<b>Instrument / Gear</b>	
<b>Instrument Type</b>	
<b>Description</b>	

<b>Identifier</b>	
<b>Docucomp UUID</b>	
<b>Instrument /</b>	

<b>Gear</b>	
<b>Instrument Type</b>	
<b>Description</b>	

<b>Identifier</b>	
<b>Docucomp UUID</b>	
<b>Instrument / Gear</b>	
<b>Instrument Type</b>	
<b>Description</b>	

## Platforms

<b>Platform Unavailable Reason</b>	
<b>Identifier</b>	
<b>Docucomp UUID</b>	
<b>Description</b>	

## Mounted Instruments

<b>Identifier</b>	
<b>Identifier</b>	
<b>Identifier</b>	

<b>Identifier</b>	
<b>Docucomp UUID</b>	
<b>Description</b>	

## Mounted Instruments

Identifier	
Identifier	
Identifier	

Identifier	
Docucomp UUID	
Description	

## Mounted Instruments


Identifier	
Identifier	
Identifier	

## FAQs

Date	
Author	
Question	
Answer	

## Child Items





Rubric scores updated every 15m

Score	Type	Title
	 Entity (ENT)	<a href="#">Guam Long-term Monitoring Program: Benthic Cover at HPRAs</a>



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## Related Items

Item Type	Relationship Type	Title
 Data Set (DS)	Cross Reference	<a href="#">Guam Long-term Coral Reef Monitoring Program Benthic Images since 2010</a>
 Data Set (DS)	Cross Reference	<a href="#">Guam Long-term Coral Reef Monitoring Program Coral Colony Size and Condition Surveys since 2010</a>
 Data Set (DS)	Cross Reference	<a href="#">Guam Long-term Coral Reef Monitoring Program Macroinvertebrate Belt Transects since 2010</a>
 Data Set (DS)	Cross Reference	<a href="#">Guam Long-term Coral Reef Monitoring Program Reef Fish Surveys since 2010</a>

## Catalog Details

<b>Catalog Item ID</b>	47784
<b>Metadata Record Created By</b>	Troy T Kanemura
<b>Metadata Record Created</b>	2017-11-05 15:30+0000
<b>Metadata Record Last Modified By</b>	David R Burdick
<b>» Metadata Record Last Modified</b>	2025-04-30 00:15+0000
<b>Metadata Record Published</b>	2023-10-03
<b>Owner Org</b>	PIFSC
<b>Metadata Publication Status</b>	Published Externally
<b>Do Not Publish?</b>	N
<b>Metadata Workflow State</b>	Published / External
<b>Metadata Last Review Date</b>	2023-10-03

<b>Metadata Review Frequency</b>	1 Year
<b>Metadata Next Review Date</b>	2024-10-03
<b>Tags</b>	