

Tutuila Reef Resilience Files – Metadata record

Resilience Factor	Metric	Files
Multiple	Multiple	1. samoa_all_zone_prop_area.csv 2. REA survey w_zone.csv
Pollution	Watershed health index	TUT_watersheds for archive.csv
Sedimentation	Rainfall vs. coastline	1. Precipitation.csv 2. Precipitation by coastline.csv
Herbivory	Biomass/m <sup>2</sup> of herbivorous fish	For Herbivorous fish calculation.csv
Macroalgae cover	Percent cover of macroalgae	Benthic Percent Cover observations.csv
Coral diversity	Taxonomic distinctness	Adult Coral Obs.csv
Coral recruitment	Recruits/m <sup>2</sup>	Juvenile Coral Obs.csv
Disease prevalence	Percent diseased corals	Adult Coral Obs.csv
Bleaching resistance	Percent susceptible corals*	Adult Coral Obs.csv
Physical impacts	Percent damaged corals	Adult Coral Obs.csv
Fishing pressure	Adjacent human population, Commercial fishing effort, Reef Area	1. Census 2010 Human population.csv 2. Human pop by reef area.csv 3. Fishing trips by reef area.csv
Sea surface temperature variability	Warmest month variability, Number of degree heating weeks ≥ 4	Sea surface temperature history.csv
*Coral susceptibility based on ESD RAMP data collected during the 2015 bleaching event.		

1. samoa\_all\_zone\_prop\_area.csv

- General: File with all the zones in the study, divided into each subzone (strata). The proportional area of each strata is provided. The area is used to calculate weighted averages of the resilience metrics
- Fields
  - A. ID – Unique numeric entry for each record
  - B. Zone\_Fine – Defines the eleven study zones used in the analysis
  - C. Zone\_Fine\_ReefZone\_Depth – The study zone, divided into strata. Depending on the zone, this may include just a depth category (Shallow, Mid, Deep, Bank), the reef zone (forereef/backreef or FR/BR, respectively), and/or a section of the bay (North/South or NO/SO, respectively).
  - D. Prop\_zone\_area – The proportional area of the zone in each strata. The sum of this column for each Zone\_Fine category is 1.0.

2. REA survey w\_zone.csv

- General: File with all Rapid Ecological Survey sites used in the study

- Fields
  - A. ID – Unique numeric entry for each record
  - B. SITE – Unique code for each site where a survey was conducted
  - C. LATITUDE – Latitude in decimal degrees, WGS 84 datum
  - D. LONGITUDE – Longitude in decimal degrees, WGS 84 datum
  - E. DATE\_ – Date of survey
  - F. OBS\_YEAR – Year of survey
  - G. Method – Survey method used (nSPC = fish, Coral Belt = coral survey)
  - H. REEF\_ZONE – Forereef or backreef
  - I. REEF\_ZONE\_Abr – Forereef (FR) or backreef (BR)
  - J. DEPTH\_BIN – Deep, Mid, Shallow or Bank
  - K. LBSP – Indicates whether site was surveyed as part of a study of Land-based sources of pollution (LBSP). 'Y' indicates that it was, 'N' that it was not and was surveyed as part of Pacific RAMP. Surveys for these projects were allocated differently, as reflected in
  - L. Zone\_Fine – Defines the eleven study zones used in the analysis
  - M. Zone\_Fine\_ReefZone\_Depth – The study zone, divided into strata. Depending on the zone, this may include just a depth category (Shallow, Mid, Deep, Bank), the reef zone (forereef/backreef or FR/BR, respectively), and/or a section of the bay (North/South or NO/SO, respectively).

### 3. Adult Coral Obs.csv

- General: File with observations of adults from coral belt surveys. Used for all metrics based on adult corals (e.g. bleaching, coral diversity, disease prevalence, physical damage)
- Fields
  - A. SITE – Unique code for each site where a survey was conducted
  - B. DIVER – Initials of diver making observations
  - C. TRANSECT – Transect at site
  - D. SEGMENT – Segment on transect
  - E. Seg\_WIDTH – Width of segment (meters)
  - F. Seg\_LENGTH – Length of segment (meters)
  - G. SPECIES – Four-letter code for coral colony at finest level of identification (maybe be species or genus)
  - H. COLONYLENGTH – Length of colony in centimeters (maximum dimension)
  - I. OLDDEAD – Percent of colony classified as old dead (overgrown with turf algae)
  - J. RECENTDEAD – Percent of colony classified as new dead (skeleton still white or only a very fine layer of biofilm or algae grown on the colony)
  - K. RECENT\_GENERAL\_CAUSE\_CODE – Cause of recent dead (e.g. Disease, predation). See list of codes and descriptions at the end of the document.
  - L. RECENT\_SPECIFIC\_CAUSE\_CODE – Specific cause of recent dead (e.g. black band disease, fish predation). See list of codes and descriptions at the end of the document.
  - M. RECENTDEAD\_2 – If recent dead is observed on a colony that can be attributed to more than one cause, the percent dead for that cause is entered here.
  - N. RECENT\_GENERAL\_CAUSE\_CODE\_2 – If recent dead is observed on a colony that can be attributed to more than one cause, the second general cause is entered here. See list of codes and descriptions at the end of the document.

- O. RECENT\_SPECIFIC\_CAUSE\_CODE\_2 – If recent dead is observed on a colony that can be attributed to more than one cause, the second specific cause is entered here. See list of codes and descriptions at the end of the document.
- P. DZCODE – Shorthand code for a disease or condition. These are conditions that may affect the health of the colony, but have not caused tissue death (e.g. bleaching, skeletal growth anomalies.)
- Q. DZCLASS – Name of disease or condition
- R. EXTENT – Percent of colony affected by disease or condition
- S. SEVERITY – Severity of disease or condition, if applicable
- T. TAXONNAME – Name of identified taxa. May be at genus or species level.
- U. PHYLUM – Phylum of coral
- V. CLASS – Class of coral
- W. S\_ORDER – Suborder of coral
- X. FAMILY – Family of coral
- Y. GENUS\_CODE – Four-letter code of genus of coral.
- Z. GENUS – Full name of genus of coral
- AA. RANK – Indicates whether identification is to genus or species level.

4. Juvenile Coral Obs.csv

- General: File with observations of juveniles from coral belt surveys. Used for juvenile density (recruitment) metric
- Fields
  - A. SITE – Unique code for each site where a survey was conducted
  - B. DIVER – Initials of diver making observations
  - C. TRANSECT – Transect at site. Transect 3 corresponds to adult transect 1, and transect 4 corresponds to adult transect 2
  - D. SEGMENT – Segment on transect
  - E. Seg\_WIDTH – Width of segment (meters)
  - F. Seg\_LENGTH – Length of segment (meters)
  - G. SPECIES – Four-letter code for coral colony at finest level of identification (maybe be species or genus)
  - H. COLONYLENGTH – Length of colony in centimeters (maximum dimension)
  - I. COLONYWIDTH – Width of colony in centimeters (maximum dimension)
  - J. TAXONNAME – Name of identified taxa. May be at genus or species level.
  - K. PHYLUM – Phylum of coral
  - L. CLASS – Class of coral
  - M. S\_ORDER – Suborder of coral
  - N. FAMILY – Family of coral
  - O. GENUS\_CODE – Four-letter code of genus of coral.
  - P. GENUS – Full name of genus of coral
  - Q. RANK – Indicates whether identification is to genus or species level.

5. Census 2010 Human population.csv

- General: File with human population. Census blocks adjacent to reef used as an input for proxy for fishing pressure.
- Fields
  - A. NAME10 – Name used by US census for block
  - B. POP – Number of people living in block
  - C. Zone\_Fine – Defines the eleven study zones used in the analysis

6. Human pop by reef area.csv

- General: File with human population by zone, normalized by reef area, calculated using ArcGIS. Used as an input for proxy for fishing pressure
  - Fields
    - A. Zone\_Fine – Defines the eleven study zones used in the analysis
    - B. Area\_m2 – Reef area of each zone in square meters
    - C. Area\_km2 – Reef area of each zone in square kilometers
    - D. POP – Number of people living in blocks adjacent to reef in each zone
    - E. Pop/km2 – Number of people per square kilometer of reef in each zone
7. Fishing trips by reef area.csv
- General: File with number of commercial fishing trips by zone, normalized for reef area. Data from the American Samoa Bio-sampling project provided by AS Coral Reef Advisory Group. Used as an input for proxy for fishing pressure
  - Fields
    - A. Zone\_Fine – Defines the eleven study zones used in the analysis. Zones were used that most closely approximated those in the data source.
    - B. Area\_km2 – Reef area of each zone in square kilometers
    - C. Fishing trips – Number of commercial fishing trips in each zone. Zones that are designated as no-take marine protected areas were assumed to not have any fishing trips
    - D. Fishing trips per km2 – Number of fishing trips per square kilometer of reef in each zone
8. Benthic Percent Cover observations.csv
- General: File with observations from analysis of photoquadrats using the web-based platform CoralNet. Thirty quadrats were taken at each site, and 10 points are projected for analysis on each image. Each line is a record for each individual point. Points are averaged at the site level, not image or transect level.
  - Fields
    - A. SITE – Unique code for each site where a survey was conducted
    - B. DATE – Date of field survey
    - C. OBS\_YEAR – Year of field survey
    - D. ANALYST – Initials of individual who analyzed the image
    - E. ORIGINAL\_FILE\_NAME – File name of the image
    - F. ROW\_ – Pixel row that defines the location of the analysis point on the image
    - G. COL – Pixel column that defines the location of the analysis point on the image
    - H. SHORT\_CODE – Code used to identify the substrate type under the point
    - I. SUBCATEGORY\_NAME – Long name of the SHORT\_CODE
    - J. CATEGORY\_CODE – General category of the substrate type under the point
    - K. CATEGORY\_NAME – Long name of the CATEGORY CODE
9. For Herbivorous fish calculation.csv
- General: File with observations of herbivorous fish recoded on each survey. Original data with all fish observations was filtered to include only herbivorous fish.
  - Fields
    - A. ID – Unique numeric entry for each record
    - B. SITE – Unique code for each site where a survey was conducted
    - C. DIVER – Initials of diver making observation. Two divers conduct adjacent surveys at each site.

- D. OBS\_TYPE – I = Instantaneous, N = Non-instantaneous. Both observation types are included in the calculation
- E. TROPHIC – Trophic level. H = Herbivore for all taxa included
- F. SPECIES\_Code – Four-letter code used to identify the taxa of the fish in the record.
- G. TAXONNAME – Scientific name of the fish.
- H. SIZE\_ – Total length in centimeters
- I. COUNT – Number of fish recorded at that size.
- J. BIOMASS\_G\_M2 – Biomass (grams) of the fish of that size, averaged across the total area surveyed at the site (square meters). Biomass estimated from Length-weight relationships

#### 10. TUT\_watersheds for archive.csv

- General: File with watershed classifications from 2016 report from the American Samoa EPA. Used to calculate pollution metric.
- Fields
  - A. SHED\_NAME – Name of the watershed as listed in the AS EPA report
  - B. Zone – Study zone for the reef resilience project
  - C. Shed\_Cond – Condition as defined in the AS EPA report
  - D. Shed\_Area\_Calc – Area of the watershed in square meters, calculated using ArcGIS
  - E. Zone area – Sum of the areas of the watersheds within a study zone
  - F. Perc\_Area – Percent area of a watershed relative to the zone area. Used to calculate a weighted average of the watershed health index.
  - G. Cond\_Scale – A numerical scale based on the Shed\_Cond. Extensive = 1, Intermediate = 2, Minimal = 3, Pristine = 4
  - H. Perc\_Area\*Cond\_Scale = Percent area of a zone multiplied by the condition scale. Can be summed for zones to determine the weighted average for the watershed health index

#### 11. Precipitation.csv

- General – Average daily precipitation from NOAA National Weather Service over a 100 year interval. Data was downloaded as a raster, converted to a polygon shapefile grid and intersected with the watersheds of Tutuila and Aunu'u to estimate the rainfall in the land above each survey zone.
- Fields
  - A. ID – Unique identifier for each record
  - B. Rainfall\_in – Mean rainfall in inches
  - C. SHED\_NAME – Name of watershed
  - D. Zone\_Fine – Defines the eleven study zones used in the analysis
  - E. Area\_m2 – Area of the part of the precipitation grid on land and within the watershed. Calculated using ArcGIS
  - F. Grid\_size – Size of the original grid in meters squared
  - G. Prop of grid – Proportion of the grid that is on land and within the watershed. Equal to Area/m2 divided by Grid size.
  - H. Adj\_rain – Amount of rain that fell on land and within the watershed. Equal to Rainfall\_in multiplied by Prop of grid.

#### 12. Precipitation by coastline.csv

- General – Combination of rainfall for each zone and the shoreline, used as a proxy for the amount of sediment that could impact the adjacent reef

- Fields
  - A. Zone\_Fine – Defines the eleven study zones used in the analysis
  - B. Sum of Adj\_rain - Sum of Adj\_rain from Precipitation.csv
  - C. Shoreline\_m – Length of shoreline of each Zone\_Fine, calculated in ArcGIS
  - D. Adj\_rain/shoreline – Amount of rain per unit of shoreline, calculated by dividing Adj\_rain by Shoreline\_m

### 13. Sea surface temperature history.csv

- General – Sea surface temperature metrics derived for grids around Tutuila and Aunu'u. Weekly composite SST data from Pathfinder version 5.2. 4km-weekly composites were gapfilled using temporal and spatial techniques. Data was converted to a polygon shapefile grid in ArcGIS and pixels associated with study zones. Because of the relatively large size of pixels relative to some of the smaller study zones, some pixels were associated with more than one zone. Values of pixels were averaged to determine a composite value for degree heating weeks and the standard deviation of the warmest month. These two values were then averaged to form a composite resilience score for each study zone.
- Fields
  - A. Line – Unique identifier for each record
  - B. DWH\_ge4 – Number of times where there was a Degree Heating Week greater or equal to 4
  - C. Warm\_SD – Standard deviation in temperature (degree C) of the warmest climatological month
  - D. Northeast – 0 indicates this pixel was not associated with this zone, 1 indicates it was
  - E. Aunuu\_E – 1 pixel associated with this zone, 0 = pixel was not
  - F. Aunuu\_W – 1 pixel associated with this zone, 0 = pixel was not
  - G. Southeast – 1 pixel associated with this zone, 0 = pixel was not
  - H. Faga\_alu – 1 pixel associated with this zone, 0 = pixel was not
  - I. Taema – 1 pixel associated with this zone, 0 = pixel was not
  - J. Fagatele – 1 pixel associated with this zone, 0 = pixel was not
  - K. Northwest – 1 pixel associated with this zone, 0 = pixel was not
  - L. Southwest – 1 pixel associated with this zone, 0 = pixel was not
  - M. Fagamalo – 1 pixel associated with this zone, 0 = pixel was not
  - N. Vatia – 1 pixel associated with this zone, 0 = pixel was not

### 14. Composite 11 Resilience Scores

- General – File provide scores for individual resilience metrics for the primary analysis with all 11 metrics. Raw scores from each of the individual metrics were scaled from 0.0 to 1.0, where 1 represents the healthiest condition in the study. Although it is not a metric used to analyze resilience, percent coral cover is provided as it is frequently used to evaluate reef status and prioritize management.
- Fields
  - A. Rank – Rank of the zones, based on Comp 11
  - B. Comp 11 – Composite 11 resilience score. The mean of fields C – M
  - C. Ble – Bleaching resistance
  - D. DZ – Disease prevalence
  - E. Div – Coral diversity
  - F. FP – Fishing pressure
  - G. Herb – Herbivory

- H. Rec – Coral recruitment
- I. MA – Macroalgae cover
- J. Dam – Physical Damage
- K. Poll – Pollution
- L. Sed – Sedimentation
- M. SST Var – Sea surface temperature variability.
- N. % Coral – Percent coral cover

15. Composite 8 Resilience scores

- General – File provide scores for the secondary analysis with the eight metrics available for Taama Bank. Raw scores from each of the individual metrics were scaled from 0.0 to 1.0, where 1 represents the healthiest condition in the study. Although it is not a metric used to analyze resilience, percent coral cover is provided as it is frequently used to evaluate reef status and prioritize management.
- Fields
  - A. Rank – Rank of the zones, based on Comp 11
  - B. Comp 8 – Composite 8 resilience score. The mean of fields C – J
  - C. Ble – Bleaching resistance
  - D. DZ – Disease prevalence
  - E. Div – Coral diversity
  - F. Herb – Herbivory
  - G. Rec – Coral recruitment
  - H. MA – Macroalgae cover
  - I. Dam – Physical Damage
  - J. SST Var – Sea surface temperature variability.
  - K. % Coral – Percent coral cover

**RECENT\_GENERAL\_CAUSE– List of codes and descriptions**

GENERAL CAUSE CODE	GENERAL CAUSE CODE DESCRIPTION
DAMA	Physical Damage - Abrasion
DAMB	Physical Damage - Broken
DAMT	Physical Damage - Toppled
DZGN	Disease - General
OTHR	Other
OVRG	Overgrowth
PRED	Predation
SEDI	Sediment
UNKN	Unknown

**RECENT\_SPECIFIC\_CAUSE – List of codes and descriptions**

SPECIFIC CAUSE CODE	SPECIFIC CAUSE CODE DESCRIPTION
ALGA	Algae Overgrowth
BFI	Banded Fungal Infection
CORA	Stony coral - Scleractinia and Milleporina
COTS	Crown of Thorns Predation
CRCA	Crustose Coralline Algae Overgrowth
CYA	Cyanophyte infection
DZGN	Disease - general
ENCA	Encrusting Algae Overgrowth
FISH	Fish Predation
GAST	Gastropod Predation
MACA	Macroalgae Overgrowth
OCTO	Octocoral Overgrowth
OTH	Other
OTHR	Other
OVRG	Overgrowth - general
PRED	Predation - General
SEDI	Sediment Necrosis
SPON	Sponge Overgrowth
TLS	Sub-acute tissue loss
TRFA	Turf Algae Overgrowth
TUNI	Tunicate Overgrowth
UNKN	Unknown
WSY	Acute tissue loss - White syndrome
ZOAN	Zoanthid Overgrowth