

**Reef Resilience and Climate Change:
A Workshop for Coral Reef Managers**

Location

Date

(adapted from Guam 2009 workshop)

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Day 1

- 8:00-8:45 Introductions, Logistics, Agenda, and Overview of the Activities
- 8:45-9:45 Module 1: Climate Change Basics and Discussion
- 9:45-10:00 Coffee Break
- 10:00-11:00 Supplement: Climate Change in Micronesia
- 11:00-11:45 Module 1: Mass Coral Bleaching & Bleaching Physiology
- 11:45-12:00 Module 1: Ocean Acidification
- 12:00-1:00 Lunch
- 1:00-2:00 Module 1: Climate Change and Coral Disease
Supplemental Activity: Name that Disease!
- 2:00-3:00 Module 2: Bleaching Early Warning Systems
- 3:00-3:15 Coffee Break
- 3:15-4:00 Module 2: Bleaching Early Warning Systems (cont.)
Activity 1: You Make the Call
- 4:00-5:00 Participant Introductions
1 slide per participant or group if coming from the same agency and 2-3 minutes.

Day 2

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Day 3

8:00-8:15	Announcements, Discussions and Reactions
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9:00-9:45	Module 5: Monitoring for Resilience Factors
9:45-10:15	Coffee Break
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11:15-11:45	Socioeconomic Monitoring Case Studies
	Activity 3: Selecting Socioeconomic Indicators
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1:00-5:00	Field Trip Introduction
	Activity 4: Field Trip
	Field Trip Debriefing

Day 4

8:00-8:15	Announcements, Discussions and Reactions
8:15-8:45	Module 6: Socio-Ecological Resilience
8:45-10:00	Module 6: Incorporating Resilience into Management Discussion Gawel
10:00-10:30	Coffee Break
10:30-11:30	Module 7: Communications
11:30-12:00	Communications Examples and Discussion
12:00-1:00	Lunch
1:00-1:30	Module 8: Introduction to Bleaching Response Plans
1:30-2:45	Activity 5: Drafting your Bleaching Response Plan
2:45-3:00	Coffee Break
3:00-3:30	Activity 5: Drafting your Bleaching Response Plan (cont)
3:30-4:30	Group Presentations of Bleaching Response Plan Activity 5
4:30-5:00	Workshop Wrap Up Discussion: Challenges and Next Steps



Definitions

Acclimatization: Acclimatization refers to phenotypic changes by an organism to stresses in the natural environment that result in the readjustment of the organism's tolerance.

Accretion: Growth by external addition of new matter.

Adaptive Management: The process of changing a management strategy in response to measuring its success.

Agricultural Run-off: The drainage of water from agricultural land.

AVHRR: Advanced Very High Resolution Radiometer, a sensor that is used to measure sea surface temperature from satellites.

Bathymetry: Measurement of the depth of the sea floor below sea level.

Belt Transect: A unit of data collection using transect lines of a fixed width.

Biodiversity: The number of different species present in a given environment (species diversity). Or, the number of different ecosystems present in a given environment (ecological diversity).

Bioerosion: Erosion caused by living organisms.

Biogeographic: Refers to the distribution of biodiversity over space. A biogeographic region is a geographic area with similar dominant plants, organisms and prevailing climate conditions.

Biota: Living organisms.

BOFFF: The abbreviation for Big Old Fat Fertile Female. BOFFFs are more biologically valuable due to their age and reproductive abilities, and removing them from the system is more detrimental than removing younger, non-reproductive fish.

Bleaching: See Coral bleaching.

Bleaching threshold: The temperature above which corals experience thermal stress that can lead to bleaching; defined as 1°C above the maximum monthly mean.

Catchment: An area that catches water.

Calcium Carbonate: The mineral laid down by a coral to create the hard structure surrounding the organism.

Clades: A clade is a term used to distinguish a taxonomic group that consists of a common ancestor and all descendents (cladograms are graphical depictions of these relationships; see [Phylogenetic](#)).

Climate: Long-term characteristics of weather.

Climate Change: The long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate. It is also defined by the United Nations Convention on Climate Change as "change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Colony Integration: Influences the degree to which a whole colony responds to thermal stress. Characteristics of colony integration include polyp dimorphism, intra-tentacular budding and complex colony morphology. Species with high colony integration are predicted to

result in a greater whole-colony response to increased temperatures than species with low colony integration.

Connectivity: Natural linkages among reefs including ocean currents, larval dispersal, spawning patterns, and movements of adult fishes. Connectivity is an important part of dispersal and the replenishment of biodiversity on reefs damaged by natural or human related agents.

Contiguous: Touching area.

Contiguous Habitats: Habitats that share a boundary.

Cooling: Local oceanographic conditions such as vertical mixing of heated surface waters with cooler deeper water that can reduce temperature stress.

Coral bleaching: The paling of corals resulting from a loss of symbiotic algae. Bleaching occurs in response to physiological shock in response to abrupt changes in temperatures, salinity and turbidity. (see also Mass coral bleaching).

Coral Recruit: Settlement of a coral larvae to a permanent location.

Corallivorous: Organisms that consume coral.

Cryptic: Hidden or difficult to see.

CPUE: Catch Per Unit Effort, the number of fish caught per unit time/effort.

Deforestation: The act of cutting down trees within a given forested habitat.

Desiccation: To dry out.

Destructive Fishing: Using cyanide, dynamite, or other methods that cause coral breakage to kill all reef life (including corals, other invertebrates, as well as unmarketable species).

DHW (Degree Heating Weeks): A measurement that combines the intensity and duration of thermal stress in order to predict coral bleaching.

Distant Linked Habitats: Non contiguous habitats linked by connectivity.

Ecoregion: An area that contains a distinct assemblage of communities and species.

Ecosystem Resilience: The ability of an ecosystem to maintain key functions and processes in the face of stresses or pressures by either resisting or adapting to change.

Ecotourism: Responsible travel to natural areas that conserves the environment and sustains the well-being of local people. (The International Ecotourism Society)

Eddy: A current, as of water or air, moving contrary to the direction of the main current, especially in a circular motion.

Electromagnetic Spectrum: Energy that travels through space in the form of waves. The highest frequencies in the spectrum of electromagnetic radiation are gamma-rays; the lowest frequencies are radio waves. All electromagnetic radiation travels at the speed of light. Shorter wavelength radiation (e.g., ultraviolet) carries more energy and is likely to be more harmful to living tissue.

El Niño: An irregular variation of ocean current that from January to March flows off the west coast of South America, carrying warm, low-salinity, nutrient-poor water to the south. It is associated with the Southern Oscillation. These two effects are known as the El Niño Southern Oscillation (ENSO).

Eddy: A current, as of water or air, moving contrary to the direction of the main current, especially in a circular motion.

Energy Regime: Refers to the level of energy that characterizes a location. For example, a site on the leeward side of an island would have a lower energy regime because the influence of the wind on a daily basis is minimal.

Exposure: Describes the level of being exposed to physical forces such as high wave energy, wind, and strong currents. If an area is surrounded by islands with limited influence from waves, wind, and currents, its level of exposure is minimal.

Extractive (Non-Extractive): Taking something out of an environment versus leaving it in place. For example, food fishing is extractive, but catch and release fishing, snorkeling and diving, which leave the fishes in the environment, are non-extractive.

Fecundity: Refers to the potential reproductive capacity of an organism.

Functionally linked habitats Connected environments that are intended to conserve "all" biodiversity in an area- typically large and usually include both aquatic and terrestrial targets.

GBRMPA: Great Barrier Reef Marine Park Authority

Genetic Diversity: Genetic variation within a species.

GOES (Geostationary Operational Environmental Satellite): Geostationary satellites operated by NOAA. Hover at an altitude of about 36,000 km to give continuous data for one fixed area of the Earth's surface and lower parts of a given surface.

GPS: Global Positioning System; An electronic unit that receives satellite signals that tell your specific position in latitude and longitude.

HotSpot: A satellite product that highlights areas where the current sea surface temperature is above the mean temperature for the warmest month. May indicate a risk for coral bleaching.

Infrared Radiation: The part of the electromagnetic spectrum that has energy levels just below visible light. This is felt as radiant heat, and is sensed by the AVHRR sensor on NOAA's satellites.

Integrated Coastal Management: A continuous and dynamic process by which decisions are taken for the sustainable use, development, and protection of coastal and marine areas and resources.

La Niña: A phenomenon characterized by unusually cold ocean temperatures in the eastern Equatorial Pacific, compared to El Niño, which is characterized by unusually warm ocean temperatures in the eastern Equatorial Pacific.

Larval Duration: Pelagic larval duration refers to the amount of time the larvae spend in the open ocean before settlement on the reef.

Local Extinction: The complete loss of an organism in a specific part of its range.

Marine Protected Area(MPA): Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (IUCN definition).

Marine Protected Area Network: An MPA network can include zones that are designed for different levels of use and extraction. For example, within the MPA network, no-take zones can be strategically placed to prohibit harvest. Multiple-use MPA zoning, including no-take areas, provides a way to accommodate multiple uses (e.g., recreational fishing, commercial fishing, tourism, etc.) and balances the trade-offs between sustainable use and conservation.

Marine Tenure: Locally specified entitlements to marine territories and resources claimed and exercised by the 'guardians' of those territories and resources.

MARXAN: Computer software available at no charge that provides decision support for those designing marine reserves or networks of reserves. It has become the most utilized conservation planning tool in the world.

Mass coral bleaching: (See also coral bleaching) Coral bleaching extending over large distances (often affecting reef systems spanning tens to hundreds of kilometres) as a result of anomalously high water temperatures.

Migration Corridors: Many large marine animals (i.e., whales, predatory fish, turtles, etc.) follow set routes when they migrate (for feeding, nesting, birthing, or breeding purposes) from one area to another. These routes are referred to as migration corridors.

MMM (Maximum Monthly Mean) Temperature: in other words, the average temperature for the warmest month of the year.

Mortality: The rate at which a particular species or population dies.

Mutualistic Relationships: Biological interaction between two species where each derives a benefit from the other.

NGO: Non-Governmental Organization.

NOAA: The U.S. National Oceanic and Atmospheric Administration.

Ocean Acidification: The declining pH (increased acidification) of the oceans due to increased CO₂ emissions globally.

Ocean Neighborhood: The area centered on a set of parents that is large enough to retain most of the offspring of those parents.

Pathogen: An organism which causes disease within another organism.

Pelagic Planktonic Larvae: Larvae of planktonic organisms that are located in the open ocean.

Phenotypic Plasticity: Refers to non-genetic variation in organisms in response to environmental factors.

Photosynthetically Active Radiation: Electromagnetic radiation in the wavelengths $\lambda = 400-700$ nm (the visible wavelengths and the spectrum used by plants for photosynthesis) that is absorbed by the chlorophyll molecule.

Phylogenetic: Pertains to the evolutionary development of an organism.

Pigment: A compound that gives color to tissue.

Planktivorous: Organisms that consume plankton.

POES (Polar Operational Environmental Satellite): Polar-orbiting satellites operated by NOAA. Orbit the earth at an altitude of about 850km to give global coverage every day and lower parts of a given surface.

Pond-Effect: Wide temperature fluctuations in back-reef lagoons, especially shallow lagoons behind fringing reefs.

Promontory: A high ridge of land or rock jutting out into a body of water.

Refugia: 1. An area that has escaped ecological changes occurring elsewhere and so provides a suitable habitat for relict species. 2. An area of relatively unaltered climate that is inhabited by plants and animals during a period of continental climatic change (e.g., glaciation) and remains as a center of relict forms from which a new dispersion and speciation may take place after climatic readjustment. 3. Secure areas that are protected by natural factors and human intervention from a variety of stresses. They function as reliable sources of seed.

Relief (High or Low, Mapped): The differences between elevation and slope of higher and lower parts of a given surface.

Remote Sensing: Measuring some property of an object from a distance, without touching the object itself.

Replication: The process by which multiple samples of any habitat types are secured in a network of protected areas. Replication helps to spread the risk of any large-scale event destroying all protected examples of any habitat type.

Representation: The inclusion of a full range of habitat types into a protected area system. Representation of all habitat types helps to ensure that the full complement of species for that habitat type is protected.

Resilience to bleaching: Coral colonies bleach and partially or entirely die, but the coral community recovers rapidly to its former state. Resilient reefs should be managed to maintain conditions that facilitate successful coral recruitment and recovery.

Resistance: The capacity of an organism or a tissue to withstand the effects of a harmful environmental agent. Resistance to bleaching is exhibited when coral colonies do not bleach, or bleach but don't die. This may vary among different parts of a reef and between different reef communities.

Resistance to bleaching: Coral colonies don't bleach or bleach but don't die. Resistant reefs play a critical role in reef survival by providing a reliable source of larvae which can recruit to and enable recovery of affected areas.

Salinity: Measure of salt per unit of water usually measured in parts per thousand (seawater is generally around 35 parts per thousand).

Satellite: An object that goes around (orbits) a larger object, such as a planet.

SBA (Satellite Bleaching Alert): These free automatic e-mails are sent by NOAA to warn of elevated temperatures that may lead to coral bleaching.

Screening: Screening by suspended or dissolved matter reduces sunlight penetration and may reduce bleaching.

Sediment: Soil or particulate organic and inorganic matter carried in the water.

Sedimentation: The settling of particulate matter.

Shading: Reduced exposure to the harmful effects of sunlight. Examples include high island shadow or overhanging vegetation.

Sink Area: The area to which eggs and larvae disperse and settle.

Site Conservation Planning: Planning methodology which places sites in their larger ecological context; setting conservation priorities and strategies to conserve both single and multiple conservation areas, taking direct conservation action; and measuring conservation success.

SocMon Guidelines: A set of guidelines for establishing a socioeconomic monitoring program at a coastal management site. The guidelines provide a prioritized list of socioeconomic variables useful to managers, questions for data collection, and tables for data analysis.

Social Resilience: The resilience of communities to adapt to and withstand institutional, environmental and economic changes in their particular geography. Often these changes take the form of policies or regulations, with more resilient communities more likely to comply and sustain change.

Source Area: The area from which eggs and larvae originate to supplement populations down current.

Species Diversity: The number of different species present in a given environment.

Spillover: Spillover from an MPA accounts for two types of movements outside the MPA: (1) adults and juvenile animals swim into adjacent areas, and (2) young animals and eggs can drift out from the MPA into the surrounding waters.

Spur and Groove: The series of gullies divided by higher spurs that cross reefs at right angles below the reef crest.

SST: Sea surface temperature.

SST Anomaly: The difference between the current sea surface temperature and a long-term average.

Stakeholder: Any person with a vested interest in the natural resources of concern (e.g., coral reefs).

Stress Tolerance: The response of organisms to stressful conditions that have been repeatedly exposed to a stress, such as an exposed reef flat exposed to warm waters, that may result in a natural tolerance against bleaching.

Stressor: A physical, chemical or biological factor that adversely affects organisms; an agent, condition or similar stimulus that causes stress to an organism.

Stress Tolerance: The response of organisms to stressful conditions that have been repeatedly exposed to a stress, such as an exposed reef flat exposed to warm waters that may result in a natural tolerance against bleaching.

Susceptibility to bleaching: How easily corals are influenced or affected by bleaching.

Symbiotic Algae: Zooxanthellae are tiny symbiotic algae that provide food and oxygen to the coral, allowing their host to direct more energy toward constructing its calcium carbonate skeleton. Bleached corals lose their zooxanthellae and turn white (see also Zooxanthellae).

Synergistic: Producing a combined effect greater than the same agents used separately.

Thermal Stress: Adverse stress caused to an organism by elevated temperature.

Thermohaline Circulation (THC): Large-scale ocean circulation patterns that are driven by global density gradients that result from both temperature (thermo) and freshwater inputs that alters the salinity of the water (haline).

Tolerance (Thermal, Stress): The ability to survive and grow in the presence of normally toxic conditions (i.e. Heat)

Topographical: The characteristics describing the physical features of the environment.

Transect: Typically a straight line across an area along which ecological measurements are taken.

Trophic Structure: The relationship of an organism to other organisms in the context of a food web (trophic refers to an organisms assignment to different trophic levels, i.e., consumers, producers, decomposers, etc.).

Turbid (or turbidity): Limited visibility due to particulate matter suspended in the water; murky.

Turbulence: Small-scale non-directional water movements.

Upwelling: Movement toward the surface of deeper waters, bringing cooler waters with nutrients to the surface.

UTM (Coordinates): Universal Transverse Mercator (UTM) Coordinates measure in meters east and north from two perpendicular reference baselines.

Waypoint: A point of latitude and longitude given when using a GPS unit to map an area.

Zooxanthellae: Symbiotic algae (in the dinoflagellate genus *Symbiodinium*) that lives in the tissues of coral polyps and other host animals. The tiny photosynthetic organisms provide both nutrients and oxygen to the corals and other host animals in which they live (see also symbiotic algae).

****Also See NOAA's CoRIS coral reef glossary for more definitions:***

<http://coris.noaa.gov/glossary/>