

Marine Ecology and Blue Carbon Conservation in the Pacific and Caribbean

ENVI 3000 (3 Credits / 45 hours)

SIT Study Abroad Program:
Panama: Marine Ecology and Blue Carbon Conservation
in the Pacific and Caribbean

PLEASE NOTE: This syllabus is representative of a typical term. Because courses develop and change over time to take advantage of unique learning opportunities, actual course content varies from semester to semester.

Course Description

Coastal and marine ecosystems represent some of the most threatened ecosystems in the world. They play a particularly vital role in carbon sequestration. While most carbon conservation efforts have been geared toward terrestrial systems, scientists are increasingly focused on coastal ecosystems due to their superior capacity as carbon sinks for climate change mitigation. Blue carbon ecosystems not only provide key carbon reserves but also shelter coastal populations from floods, house fisheries, and protect coastal waters from pollutants.

Coastal ecosystem health links directly with marine ecosystem diversity. Interdependent and intrinsically linked, coastal ecosystems provide the nesting grounds for an unquantified array of marine organisms and are a cornerstone for marine ecosystem health and biodiversity. In this course, students divide their time between the Pacific and the Caribbean exploring marine biodiversity and blue carbon in Panama's mangroves, coral reefs, and sea grass beds.

Learning Outcomes

Upon completion of this course, students will be able to:

- Discuss the importance and ecology of blue carbon and marine ecosystems with specific reference to the tropics.
- Describe the relationships among a range of marine organisms both with each other and in the context of climate change.
- Effectively apply methodologies for assessing and measuring blue carbon stocks and tropical marine biodiversity.

Prerequisites

Previous college-level coursework and/or other preparation in environmental studies, ecology, biology, or related fields, as assessed by SIT. This is a science course which is entirely hands-on. Students will spend most of the time in the water and must be able to swim well.

Language of Instruction

This course is taught in English.

Schedule

Introduction to Blue Carbon

Professor: Dr. Aly Dagang

Location: Porvenir Island, Guna Yala Comarca, Caribbean

Blue carbon topics include:

- Introduction to coastal ecosystems
- Introduction to blue carbon

Blue carbon readings:

- Beaumont et al. 2014 The value of carbon sequestration and storage in coastal habitats. *Estuarine, Coastal, and Shelf Science*, 137, 32-40.
- Grace et al. 2014 Perturbations in the carbon budget of the tropics. *Global Change Biology*, 20(10), 3238-3255.

Further readings:

- Alongi, DM 2014 Carbon cycling and storage in mangrove forests. *Annual review of marine science*, 6, 195-219.
- Alongi DM 2012 Carbon sequestration in mangrove forests. *Carbon management*, 3(3), 313-322.
- Lee et al. 2014 Ecological role and services of tropical mangrove ecosystems: a reassessment. *Global Ecology and Biogeography*, 23(7), 726-743.
- Pendleton et al. 2012 Estimating global “blue carbon” emissions from conversion and degradation of vegetated coastal ecosystems. *PloS one*, 7(9), e43542.

Module I - Caribbean Coral Reefs and Reef Organisms, Guna Yala Comarca, Caribbean

Guna Yala is the first indigenous reserve in Latin America to have been granted autonomous rights, and is fully governed under autonomous indigenous stewardship. It boasts one of the best preserved coral reef systems in the Caribbean.

Professor: Dr. Juan Maté

Location: Porvenir Island, Guna Yala Comarca

Module I topics include:

- Coral reef systems of the Caribbean
- Corals, coral biology and reproduction, marine organism diversity
- Climate change and impacts on coral reefs and coral reef health
- Field methods to measure marine organism diversity, identify coral species, and measure reef health

Module I readings to be assigned for analysis:

- Anton, A., Cure, K., Layman, C. A., Puntilla, R., Simpson, M. S., & Bruno, J. F. (2016). Prey naiveté to invasive lionfish *Pterois volitans* on Caribbean coral reefs. *Marine Ecology Progress Series*, 544, 257-269.
- Castillo, A., & Lessios, H. A. (2001). Lobster fishery by the Kuna indians in the San Blas region of Panama (Kuna Yala). *Crustaceana*, 74(5), 459-475.
- Clifton et al. 1997 A field guide to the reefs of Caribbean Panama with an emphasis on Western San Blas. *Proc. 8th Int. Coral Reef Sym* 1:167-184.
- S Andrefouet and H Guzman 2005 Coral reef distribution, status, and geomorphology-biodiversity relationship in Kuna Yala (San Blas) archipelago, Caribbean Panama. *Coral Reefs* 24:31-42.
- Guzmán, H. M., Guevara, C., & Castillo, A. (2003). Natural disturbances and mining of Panamanian coral reefs by indigenous people. *Conservation Biology*, 17(5), 1396-1401.
- Lessios, H. A. (2016). The great *Diadema antillarum* die-off: 30 years later. *Annual review of marine science*, 8, 267-283.
- Lessios, H. A. (2005). *Diadema antillarum* populations in Panama twenty years following mass mortality. *Coral Reefs*, 24(1), 125-127.
- Wilson, D. T. (2001). Patterns of replenishment of coral-reef fishes in the nearshore waters of the San Blas Archipelago, Caribbean Panama. *Marine Biology*, 139(4), 735-753.
- Wulff, J. L. (2006). Ecological interactions of marine sponges. *Canadian Journal of Zoology*, 84(2), 146-166.

Module I evaluation

- a. Presentations 30%
- b. Quiz 50%
- c. Active class and field participation 20%

Module II - Mangroves and Seagrass Beds, Bocas del Toro, Caribbean

Professor: Prof. Gabriel Jacome

Location: Boca del Drago, Bocas Island, Bocas del Toro

Module II topics include:

- Seagrass beds: seagrass biology and productivity, biodiversity in seagrass beds, distribution and adaptation, role of seagrass beds in coastal and other ecosystem protection. Fishery and megafauna support.
- Blue carbon stocks in seagrass beds. Threats to seagrass systems. Field methods for seagrass research.

- Mangrove biology, succession, mangroves as nursery habitat, mangrove organisms, mangrove reproduction
- Field methods to measure seagrass productivity, seagrass carbon content, mangrove organism diversity, mangrove carbon

Module II readings:

- Lopez Calderon et al. 2013 Decadal increase in seagrass biomass and temperature at the CARICOMP site in Bocas del Toro, Panama. *International Journal of Tropical Biology* 61(4): 1815-1826.
- Donato, D. C., Kauffman, J. B., Murdiyarto, D., Kurnianto, S., Stidham, M., & Kanninen, M. (2011). Mangroves among the most carbon-rich forests in the tropics. *Nature geoscience*, 4(5), 293-297.
- Cheng A 2016 Benthic algae and diatom communities in seagrass meadows under three different human impact regimes in Bocas del Toro, Panamá. SIT Digital Collection.

Further reading:

- van Tussoenbroek et al. 2014 Caribbean-wide long-term study of seagrass beds reveals local variations, shifts in community structure and occasional collapse. *PLoS ONE* 9(3): e90600.
- Orth RH et al. 2006 A global crisis for seagrass ecosystems. *BioScience* 56(12): 987-996.

Module II evaluation

- a. Oral presentations and analysis 30%
- b. Quiz 50%
- c. Field work and participation 20%

Module III - Pacific Ocean Ichthyology, Coiba Island, Pacific

The Pacific coast of Panama experiences exceptional diversity due to dramatically fluctuating rainfall and climatic variations related to the Humboldt Current and the northern trade winds. The majority of Panama's 169,700 hectares of mangroves are located on the Pacific coast and have been well-preserved, although they come under increasing pressure from development and climate change. Coral reefs have suffered in particular from effects of El Niño and have begun to show reduced growth and calcification. Students will explore mangroves and coral reefs on Coiba Island, a UNESCO protected heritage site. Coiba is also part of the Eastern Tropical Pacific Seascape (ETPS). It is the largest island in Mesoamerica and considered widely to be one of the top 10 diving sites in the world.

Module III topics include:

- Introduction to fish biology, reproduction, anatomy
- Fish diversity of the Eastern Pacific

- Field methods to measure fish diversity, fish abundance in the field, fish species identification

Module III readings:

- Benfield, S., Baxter, L., Guzman, H. M., & Mair, J. M. (2008). A comparison of coral reef and coral community fish assemblages in Pacific Panama and environmental factors governing their structure. *Journal of the Marine Biological Association of the UK*, 88(07), 1331-1341.
- Dominici-Arosemena, A., & Wolff, M. (2006). Reef fish community structure in the Tropical Eastern Pacific (Panamá): living on a relatively stable rocky reef environment. *Helgoland Marine Research*, 60(4), 287.
- Thacker, C. (2017). Patterns of divergence in fish species separated by the Isthmus of Panama. *BMC Evolutionary Biology*, 17(111), 1-14.

Module III evaluation

- a. Lab report and field observations 50%
- b. Quiz 30%
- c. Contribution to fieldwork 10%
- d. Participation 10%

Course Evaluation and Grading Criteria

Assessment:

Coral reefs module	30%
Seagrasses and mangroves module	30%
Ichthyology module	30%
*Participation	10%

*Participation is crucial to student success in this course and will be gauged based on student contribution to discussions, involvement during excursions, respect for the host culture, punctuality, cooperation, and flexibility. Attendance at all program activities is mandatory.

Grading Scale

94-100%	A
90-93%	A-
87-89%	B+
84-86%	B
80-83%	B-
77-79%	C+
74-76%	C
70-73%	C-
67-69%	D+
64-66%	D
below 64	F

Expectations and Policies

- Show up prepared. Be on time, have your readings completed and points in mind for discussion or clarification. Complying with these elements raises the level of discussion and the quality of the activity for everyone.
- Put safety first, your own and others. Being in the water is fun but demands responsibility. Please follow the rules.
- Comply with academic integrity policies.
- Respect differences of opinion (classmates', lecturers, local constituents engaged with on the visits). Conservation policies can provoke passionate responses. You are not expected to agree with everything you hear, but you are expected to listen across difference and consider other perspectives with respect.

Please refer to the SIT Study Abroad Student Handbook for policies on academic integrity, ethics, warning and probation, diversity and disability, sexual harassment and the academic appeals process.

Disability Services: Students with disabilities are encouraged to contact Disability Services at disabilityservices@sit.edu for information and support in facilitating an accessible educational experience. Additional information regarding SIT Disability Services, including a link to the online request form, can be found on the Disability Services website at <http://studyabroad.sit.edu/disabilityservices>.