School for International Training | 1 Kipling Road, PO Box 676 | Brattleboro, VT 05302-0676 USA
Tel 888 272-7881 | Fax 802 258-3296 | studyabroad.sit.edu

Marine Ecology and Blue Carbon Conservation in the Pacific and Caribbean

ENVI-3000 (3 credits)

Panama: Marine Ecology and Blue Carbon Conservation in the Pacific and Caribbean

This syllabus is representative of a typical semester. 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 the 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.

Instructional Methods
SIT's teaching and learning philosophy is grounded in the experiential learning theory developed by Kolb (1984; 2015) and informed by various scholars, such as Dewey, Piaget, Lewin, among others. Experiential learning theory recognizes that learning is an active process that is not confined to the formal curriculum; "knowledge is created through the transformation of experience" (Kolb, 2015, p. 49). Learning involves both content and process. Learning is holistic and happens through various life experiences upon which students draw to generate new ways of knowing and being. Learning involves a community and is a lifelong endeavor. Learning is transformational. The suggested four step-cycle of a *concrete experience*, *reflective observation*, *abstract conceptualization*, and *active experimentation* embedded in the experiential learning model is not linear and might not always happen in that specific order, as any learning is highly context dependent. These stages of taking part in a shared experience; reflecting on that experience by describing and interpreting it; challenging their own assumptions and beliefs to generate new knowledge; and ultimately applying new knowledge, awareness, skills, and attitudes in a variety of situations and contexts are important for students to engage in to become empowered lifelong learners.

Required Texts
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.

Assignments and Evaluation

<u>Assessment</u>

Coral reefs module	30%

Seagrasses and mangroves module	30%
Ichthyology module	30%
Participation	10%

Attendance and Participation

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.

Late Assignments

SIT Study Abroad programs integrate traditional classroom lectures and discussion with field-based experiences, site visits and debriefs. The curriculum is designed to build on itself and progress to the culmination (projects, ISP, case studies, internship, etc.). It is critical that students complete assignments in a timely manner to continue to benefit from the sequences in assignments, reflections and experiences throughout the program.
Example: Students may request a justified extension for one paper/assignment during the semester. Requests must be made in writing and at least 12 hours before the posted due date and time. If reason for request is accepted, an extension of up to one week may be granted at that time. Any further requests for extensions will not be granted. Students who fail to submit the assignment within the extension period will receive an 'F' for the assignment.

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

Program Expectations

- 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.

SIT Policies and Resources

Please refer to the SIT Study Abroad Handbook and the Policies section of the SIT website for all academic and student affairs policies. Students are accountable for complying with all published policies. Of particular relevance to this course are the policies regarding: academic integrity, Family Educational Rights and Privacy Act (FERPA), research and ethics in field study and internships, late assignments, academic status, academic appeals, diversity and disability, sexual harassment and misconduct, and the student code of conduct.

Please refer to the SIT Study Abroad Handbook and SIT website for information on important resources and services provided through our central administration in Vermont, such as Library resources and research support, Accessibility Services, Counseling Services, Title IX information, and Equity, Diversity, and Inclusion resources.

Course Schedule

**Please be aware that topics and excursions may vary to take advantage of any emerging events, to accommodate changes in our lecturers' availability, and to respect any changes that would affect student safety. Students will be notified if this occurs*

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.

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., Puntila, 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. Field work 20%

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

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., Murdiyarso, 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 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. Field work 20%