THE SCHOOL FOR FIELD STUDIES

Tropical Marine Ecosystems - Monitoring and Management

SFS 3530

Syllabus , Summer I

The School for Field Studies (SFS)

The Center for Marine Resource Studies

South Caicos, Turks and Caicos Islands

This syllabus may develop or change over time based on local conditions, learning opportunities, and faculty expertise. Course content may vary from semester to semester.

Course Overview

The Turks and Caicos Islands (TCI) advertises itself to tourists as "Beautiful by Nature." Indeed, the tourism that the country's economy is heavily dependent on is driven by its stunning marine environment, which is characterized by extensive coral reefs, seagrass meadows and mangrove forests. However, the health of these ecosystems, and therefore the "Beautiful by Nature" motto, is under threat. At the local level, unsustainable and damaging fishing practices, increased water-based recreational activities, and coastal development are potentially major sources of disturbance. Furthermore, the ocean impacts of global climate change will continue to negatively affect marine organisms and ecosystem processes, adding an additional layer of complexity to the problem.

Tropical Marine Ecosystems - Monitoring and Management is an interdisciplinary four-week summer course that highlights the ecological characteristics and current threats to coastal ecosystems, in addition to exploring existing and potential environmental management approaches that would encourage the sustainable development of small island nations such as the TCI. Course participants will gain knowledge of tropical marine ecosystem function and connectivity, and will be introduced to the most pressing threats at the intersection of marine conservation and economic development.

The course will take place on the island of South Caicos which is at a pivotal time in its development. Until recently, the island's economy centered around small-scale local fisheries, but tourism is now a growing industry and South Caicos is experiencing major changes to its social and structural fabric. As the economy and the population grow and diversify, so too do the demands on the marine environment, making this the perfect location to study a small, tropical island in transition.

The course has two main themes:

Marine Ecosystem Monitoring

Students will be introduced to the ecological characteristics of coral reefs, seagrass meadows and mangrove forests, including the biology of key organisms in each. The numerous ways in which these ecosystems are inter-connected and inter-dependent will also be discussed. This will be followed by an exploration of the multiple anthropogenic threats that the ecosystems face, including overfishing, coastal development and pollution, and climate change. Emphasis will be placed on indicators of stress that should be the focus of ecosystem health monitoring efforts.

Marine Ecosystem Management

After introducing students to the ecology and threats to the Turks and Caicos Islands marine ecosystems, a broader context of managing these ecosystems will be introduced. The class will examine management and advisory bodies of these ecosystems; how marine protected areas can be a tool for conservation and the impacts of these tools; engage stakeholders with design and implementation of management plans.

Both themes will be analyzed and discussed during lectures, discussions, workshops and exercises. Students will spend time snorkeling and/or diving (not mandatory to participate in the course) in mangrove, seagrass, and coral reef environments. Material taught in class and learned in the field will be assessed through a variety of assignments and a final exam. At the end of the course, students will actively integrate concepts and methodologies learned in class and field activities by designing a general

management plan for the Admiral Cockburn Land and Sea National Park (ACLSNP) and East Harbour Lobster and Conch Reserve (EHLCR) that considers ecological and human interests.

Learning Objectives

The learning objectives of this summer program are:

1) To gain a baseline understanding of coastal tropical marine ecosystems, their ecology, their connectivity, the ecosystem goods and services they provide, and the threats to their future good health.

2) To recognize and identify a broad range of organisms the characterize these ecosystems in the Tropical Northwestern Atlantic.

3) To develop skills, both in and out of water, to monitor the health and conservation status of tropical marine ecosystems.

4) To gain an understanding of international and local management approaches that affect the conservation status of tropical marine ecosystems.

5) To identify and engage stakeholders' views for the purpose of designing a general management plan.

Field Exercises, Workshops, and Data Analysis

Students will participate in several field exercises to view and identify the organisms that characterize coral reef, seagrass and mangrove ecosystems. Students will also take part in field exercises and workshops that allow them to live the stakeholder experience, cast as the TCI Marine Police in a mock enforcement exercise, and develop a general management plan for two key Marine Protected Areas (MPAs), and as fishers, developers, or politicians in a final presentation. In addition, students will be responsible for reports and data management.

Assessment

Course Component	**Value (%)**
Mangrove and Seagrass Communities	10
Coral Reef Invertebrates	10
Coral Reef Fishes	10
Marine Resource Management Exercise	20
Coral Watch Report	5
General Management Plan (Presentation)	20
Written Examination	25
Total	**100**

Mangrove and Seagrass Communities: In class, students will be introduced to the taxonomic classification and trophic characteristics of local mangrove and seagrass species, as well as their associated macroalgae, invertebrates, and fishes. This briefing will be followed by an in-water observation session, a desk-based taxonomic review session, and an identification test.

Coral Reef Invertebrates: In class, students will be introduced to the taxonomic classification and trophic characteristics of local corals and other invertebrates that are common on local coral reefs. This briefing will be followed by an in-water observation session, a desk-based taxonomic review session, and an identification test.

Coral Reef Fishes: In class, students will be introduced to the taxonomic classification and trophic characteristics of fish species that are commonly encountered on local coral reefs. This briefing will be followed by an in-water observation session, a desk-based taxonomic review session, and an identification test.

Marine Resource Management Exercise (Conch Assessment Exercise): During this field exercise, the students will work in groups to employ visual survey methods outlined during the lectures to collect data on the size & age structure of the queen conch (*Lobatus gigas*) population according to habitat type both inside and outside a Marine Protected Area (MPA).

The second objective of the field exercise is to enhance student ability to analyze data and produce an accurate and coherent scientific paper. Each group will produce a written report, and each member of the group will be required to participated in the data collection, analysis and writing of the report. You will receive a group grade on the paper and an individual grade for performance and participation as a portion of the final grade for the exercise. Students will be assessed based on their ability to write a scientific report in a coherent and logical way, as well as data entry and management.

Coral Bleaching Assessment Exercise: Students will work in buddy-pairs to assess the extent of bleaching on local coral reefs, using the CoralWatch Coral Health Chart. The data collected will then be analyzed and used as the basis for a short, written report.

General Management Plan: During this project student groups will examine two MPAs around South Caicos. The group will design a general management plan from one of three scenarios. The objective of this exercise is to apply your knowledge of the marine ecosystems, threats to those systems and the local situation. You will work in groups to design your general management plan and present the plan in class via power point. You will receive a group grade as well as an individual grade for peer reviewed performance and participation.

Grading Scheme

A	95.00 – 100.00%	B+	86.00 – 89.99%	C+	76.00 – 79.99%	D	60.00 – 69.99%
A-	90.00 – 94.99%	B	83.00 – 85.99%	C	73.00 – 75.99%	F	0.00 – 59.99%
		B-	80.00 – 82.99%	C-	70.00 - 72.99%		

General Reminders

Readings: Assigned readings will be available on the student server. It is important that you read all materials before class since the volume of the material in the class requires a brisk pace. You are expected to have read all the assigned articles and demonstrate that by answering quiz questions based on them. Anything contained in the readings is fair game for the exams.

Plagiarism and Cheating: Using ideas and materials of others without giving due credit is cheating and will not be tolerated. A grade of zero will be assigned to anyone caught cheating or aiding another person to cheat, either actively or passively (e.g., allowing someone to look at your exam). Unless specifically stated otherwise, all assignments should be individual pieces of work.

Appropriate use of technology: SFS has worked hard to provide internet access to all its staff and students but is limited in capacity, so there can be no inappropriate uses (gaming or video/music downloading). Screens (laptops and tablets) are permitted during lessons for taking notes, however inappropriate use will result in the loss of this privilege. Phones are not permitted in class.

Deadlines: Deadlines for written and oral assignments are instated for several reasons:

1. Deadlines are a part of working and academic life to which students need to become accustomed.
2. Deadlines promote equity among students.
3. Deadlines allow faculty ample time to review and return assignments before others are due.

As such, deadlines are *firm* and extensions will only be considered under the most extreme circumstances. Late assignments will incur a 10% penalty for every day that they are late. This means an assignment that is five minutes late will have 10% removed, an assignment that is one day and five minutes late will have 20% removed, and so on. Assignments will be handed back to students after a one-week grading period.

Naming assignments:

1. Word documents, Excel documents, and PDFs for all individual assignments, exams, reports should be saved as…

   FirstName_LastName_Assignment

   Example… John_Smith_Literature Review

3. Group assignments should be named…

   Group#_Assignment

   Example… Group1_DataAnalysis

Participation in all components of the program is mandatory, as there will be no spare time to catch up on any missed classes. Missing even one lecture or discussion can significantly affect the experience you and your classmates have while at CMRS. Within our teaching environment, there is no reason to miss classes. You will get as much out of this course as you put into it, so please dive in. In all circumstances, we expect you to respect yourself and your fellow students. Dissent and discord are expected, but disrespect will not be tolerated.

Course Content

Key : L (Lecture), **FEX** (Field Exercise), **EX** (Desk Exercise), **P** (Presentation), **T** (Test)

No.	*Lecture Title and Description*	*Readings*
SME01 (**L**, 1.0 hrs.)	**Course Introduction – SFS teaching and research** Outline of the summer program at CMRS including an introduction to course structure and expectations	
SME02 (**L**, 1.0 hrs.)	**History of the Turks and Caicos Islands** Students will be exposed to the Turks and Caicos Islands history, including the past industries that have fallen, the current status of the economy and the evolution of TCI government. We will begin with time prior to Columbus "landfall", eras of slavery and finish with the current situation in South Caicos.	Mills, C. (Ed.) 2008
SME03 (**L**, 1.0 hrs.) AH	**Mangrove Biology** An introduction to the biology of mangrove trees and their adaptations for life in the marine environment.	
SME04 (**L**, 1.0 hrs.)	**Mangrove Forest Ecology** The ecological characteristics of mangrove forests, including physiographic classification, forest zonation, and trophodynamics.	Alongi, D. M. 2002
SME05 (**L**, 1.0 hrs.)	**Tropical Marine Ecosystems a Global Perspective** The world has a variety of different marine ecosystems. However, the tropical marine ecosystems are limited in range based on environmental factors. Students will be introduced to the availability and conservation interest of these ecosystems.	Polidoro, B. et al. 2010 Spalding, M., Taylor, M., & Ravilious, C. 2003. Costanza, R., et al. 2014
SME06 (**L**, 1.0 hrs.)	**Seagrass Biology** An introduction to the biology of seagrasses and their adaptations for life in the marine environment.	
SME07 (**L**, 1.0 hrs.)	**Seagrass Meadow Ecology** The ecological characteristics of seagrass meadows, including the importance of epibionts, and trophodynamics.	Short, F. *et al*. 2007

SME08 (**L**, 1.0 hrs.)	**Mangrove and Seagrass Communities – ID slide Show** Taxonomic and trophic characteristics of the plants, macroalgae and invertebrates that characterize mangrove and seagrass ecosystems.	Littler et al. 1999 Kaplan. 1988
SME09 (**FEX**, 2.0 hrs.)	**Mangrove and Seagrass Communities – Field ID** In-water identification of organisms covered during SME08. Snorkeling required.	
SME10 (**EX**, 2.0 hrs.)	**Mangrove and Seagrass Communities – ID Review Session** Desk-based review of the organisms from SME08/09.	
SME11 (**T**, 0.0 hrs.)	**Mangrove and Seagrass Communities – ID Test** A test that will require students to scientifically identify a collection of organisms from mangrove and seagrass communities.	
SME12 (**L**, 1.0 hrs.)	**Management and Advisory Bodies** Ecosystem management often falls on the shoulders of the Country of domain. However, there are international bodies that are highly influential in the delegation and creation of management strategies. Students will be introduced to the advisory and management bodies that drive research and conservation of the tropical marine ecosystems.	Bustamante, G., et al. 2014
SME13 (**L**, 1.0 hrs.)	**Coral Biology** An introduction to the biology of the Phylum Cnidaria, with particular attention paid to reef-forming anthozoans.	
SME14 (**L**, 1.0 hrs.)	**Coral Reef Ecology** The ecological characteristics of coral reefs, including reef formation, reef structure, and trophodynamics.	Hughes, T. P. et al. 2010.
SME15 (**L**, 1.0 hrs.)	**Coral Reef Invertebrates - ID slideshow** Taxonomic and trophic characteristics of reef-forming corals and other associated invertebrates.	Reference books: Humann and DeLoach (2013). Reef coral identification. Humann et al. (2013). Reef creature

		identification.
SME16 (**FEX**, 2.0 hrs.)	**Coral Reef Invertebrates - Field ID** In-water identification of organisms covered during SME13. Snorkeling required.	
SME17 (**EX**, 2.0 hrs.)	**Coral Reef Invertebrates – ID Review Session** Desk-based review of the organisms from SME15/16.	
SME18 (**T**, 0.0 hrs.)	**Coral Reef Invertebrates – ID Test** A test that will require students to scientifically identify a collection of corals and other reef associated invertebrates.	
SME19 (**L**, 1.0 hrs.)	**Reef Fishes - ID slideshow** Taxonomic and trophic characteristics of reef-associated fishes (Class Chondrichthyes and Class Osteichthyes)	Reference book: Humann and DeLoach (2013). Reef fish identification.
SME20 (**FEX**, 2.0 hrs.)	**Reef Fishes - Field ID** In-water identification of fishes covered during SME15. Snorkeling required.	
SME21 (**EX**, 2.0 hrs.)	**Reef Fishes – ID Review Session** Desk-based review of the organisms from SME19/20.	
SME22 (**T**, 0.0 hrs.)	**Reef Fishes – ID Test** A test that will require students to scientifically identify a collection of reef fishes.	
SME23 (**L**, 1.0 hrs.)	**Ecosystem Connectivity** The biogeochemical and ecological linkages between coral reefs, seagrass meadows and mangrove forests.	McCauley, D. J. *et al*. 2012.
SME24 (**L**, 1.0 hrs.)	**Fisheries Impacts** Marine ecosystems are directly affected by impacts caused by fishery activities. An introduction to the impacts caused by fishing practices and high exploitation will demonstrate the need for research and	Coll, M., et al., 2016.

	management of these systems.	
SME25 (**L**, 1.0 hrs.)	**The Ocean Impacts of Climate Change** The causes of climate change; impacts of temperature change; the process and effects of ocean acidification.	
SME26 (**L**, 1.0 hrs.)	**Coastal Development Impacts (Recreation and Pollution)** Small developing island nations have found it difficult to protect marine ecosystems, while finding economic security in coastal development. Developments on the coast line can both directly and indirectly affect the marine waters through pollution, erosion, siltation and even recreational activities.	Polidoro, B. et al. 2010. Upadhyay, V., Ranjan, R., Singh, J., 2002. Jackson, J. B. C., et al. 2014.
SME27 (**FEX**, 2.0 hrs.)	**Enforcement at Sea** In this mock sea-based exercise you will be cast as a conservation officer of the Department of Environment and Coastal Resources (DECR), charged with enforcing local marine legislation.	
SME28 (**L**, 1.0 hrs.)	**Enforcement Lecture (Guest)** A DECR conservation officer will provide a detailed array of his daily, week and monthly activities as a DECR officer. He will speak of the difficulty in the job both socially and economically.	Quinton Phillips
SME29 (**L**, 1.0 hrs.)	**Restoration and Rehabilitation** The degradation of coastal and marine habitat due to human activity and, to a lesser extent, natural events is pervasive and has direct and measurable effects on marine ecosystem communities and processes. Restoration ecology seeks to mitigate anthropogenic biological and physical degradation by restoring impacted habitats. We review restoration and rehabilitation practices.	Thayer, G. 1992 Seaman, W. 2000 Cruz et al. 2015
SME30 (**L/FEX**, 2.0 hrs.)	**Coral Bleaching Briefing and FEX** Introduction to the CoralWatch Coral Health Chart; field collection of coral health data. Diving or snorkeling required.	

SME31 (**EX**, 2.0 hrs.)	**Coral Bleaching Analysis and Write-Up** Analysis of data collected during SME30, and preparation of a short, written report.	
SME32 (**L**, 1.0 hrs.)	**Introduction to MPAs** Management of entire ecosystems is difficult with a variety of needs and uses by multi-users. Often Marine Protected Areas are tools that can assist with the management of differing ecosystems. This lecture will introduce what MPAs are and how they can be designed and used as a management tool.	Salm, R and Clark, J. 2000 Edgar, G. et al. 2014 Roberts C. et al. 2003
SME33 (**L**, 1.0 hrs.)	**Ecological and Fisheries Impacts of MPAs** What ecological changes take place within a Marine Protected Area, and can these changes lead to benefits for fishers beyond the boundaries of the MPA?	Lester, S. E. *et al*. 2009
SME34 (**L**, 1.0 hrs.)	**Introduction to Conch Assessment** This briefing will introduce the students to the underwater survey method often used for assessment of different species, habitat and substrate. This particular exercise will introduce students to data collection to assess abundance, size-class, habitat use, and overall habitat availability for the Queen conch (*Lobatus gigas*).	
SME35 (**FEX**, 2.0 hrs.)	**Dry Run – Conch Assessment** This is a run of survey skills necessary to collect and record accurate data during the conch field exercise. This exercise will be done on land and in shallow water near the center, so as to have students physically deploy and use research equipment effectively in the marine waters.	
SME36 (**FEX**, 8.0 hrs.)	**Conch Assessment** A field activity involving the underwater visual assessment of the Queen conch both inside and outside a MPA. Included will be specific measurement of size and age structure, habitat coverage and overall abundance.	

SME37 (**EX**, 2.0 hrs.)	**Conch Data Analysis and Write Up** Data collected during the Conch Assessment will be analyzed and a scientific paper prepared. During this time students will be advised on what types of statistics and analysis can be conducted on the data with the JMP Pro 10 program and how to write a scientific paper cohesively.	
SME38 (**L**, 1.0 hrs.)	**Environmental Impact Assessments** In this lecture, we will learn about Environmental Impact Assessments (EIAs), how they are constructed, and why they inform policy decisions, in the US and TCI.	Smith, L. G. 2014
SME39 (**L**, 1.0 hrs.)	**General Management Plans** We will examine why GMPs are necessary in the modern day, who is the target audience, what is included, how are issues managed, the operational framework, the zoning scheme, regulated or prohibited activities, management structure and monitoring effectiveness.	Kelleher, G. and Kenchington, R. 1991.
SME40 (**L**, 1.0 hrs.)	**General Management Plan Briefing** In this class you will be briefed on your final FEX assignment, designing a general management plan for two MPAs based on one of three scenarios.	
SME41 (**EX**, 3.0 hrs.)	**General Management Plan Presentation Prep** Time allotted for designing your management plan and preparing your group's presentation.	
SME42 (**P**, 0 hrs.)	**General Management Plan Presentations** With your groups, you will present the management plan for the two MPAs which you have designed for your scenario.	
SME43 (**L**, 1.0 hrs.)	**Course Review** A recap of topics covered during the course, and an explanation of exam structure and expectations.	
SME44 (**T**, 1.0 hrs.)	**Exam** A two-hour written exam that will assess students' understanding of the course material.	
Total 60 hrs.		

Reading List

(In the order the appear in the above table)

Mills, C. (Ed.) (2008) A history of the Turks and Caicos Islands. *Macmillan: Oxford*, 222-232, 247-248.

Alongi, D. M. (2002). Present state and future of the world's mangrove forests. *Environmental Conservation* 29: 331 – 349.

Polidoro, B. et al. (2010) The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern. *PLoS ONE* 5(4).

Spalding, M., Taylor, M., & Ravilious, C. (2003) Global Overview–The Distribution and Status of Seagrass In: *Green EP, Short FT, Spalding MD (eds) The World Atlas of Seagrasses: present status and future conservation*

Costanza, R., et al. (2014).Changes in the global value of ecosystem services. *Global Environmental Change* 26: 152-158.

Short, F. *et al*. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology* 350: 3 – 20.

Littler et al. (1999). *Marine plants of the Caribbean.*

Kaplan (1988). A field guide to south eastern and Caribbean seashores.

Bustamante, G., et al. (2014). Marine protected areas management in the Caribbean and Mediterranean seas: making them more than paper parks. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(S2), 153-165.

Hughes, T. P. *et al*. (2010). Rising to the challenge of sustaining reef resilience. *Trends in Ecology and Evolution* 25: 633 – 642.

Humann and DeLoach (2013). Reef coral identification.

Humann et al. (2013). Reef creature identification.

Humann and DeLoach (2013). Reef fish identification.

McCauley, D. J. *et al*. (2012). Assessing the effects of large mobile predators on ecosystem connectivity. *Ecological Applications* 22: 1711 – 1717.

Coll, M., et al. (2016). Ecological indicators to capture the effects of fishing on biodiversity and conservation status of marine ecosystems. *Ecological Indicators*, *60*, 947-962.

Polidoro, B. et al. (2010). The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern. *PLoS ONE* 5(4),

Upadhyay, V., Ranjan, R., Singh, J., (2002). Human-mangrove conflicts: The way out. *Curr Sci India* 83, 1328-1336.

Jackson, J. B. C., et al. (2014). Status and trends of Caribbean coral reefs. *Global Coral Reef Monitoring Network, IUCN,* Gland, Switzerland.

Thayer, G. (1992). Restoring the Nation's Marine Environment. Maryland Sea Grant College. *UM-SF-TS-92-06.* Chapter 3. Pg.80-104.

Seaman, W. (2000). Artificial Reef Evaluation: with application to Natural Marine Habitats. *CRC Marine Science Series*. (Chapter 1). Page 1-20.

Cruz et al. (2015). Assessing an abridged nursery phase for slow growing corals used in coral restoration. *Ecological Engineering* 84:408-415.

Salm, R and Clark, J. (2000). Marine and Coastal Protected Areas. International Union for Conservation of Nature and Natural Resources (IUCN). (Chap 1) 13-34. (Chap 4) 81-93

Edgar, G. et al. (2014). Global conservation outcomes depend on marine protected areas with five key features. *Nature*. 506: 216-220.

Roberts C. et al. (2003). Applications of Ecological Criteria in Selecting Marine Reserves and Developing Reserve Networks. *Ecological Application* 13(1): 215-228.

Lester, S. E. *et al*. (2009). Biological effects within no-take marine reserves: a global synthesis. *Marine Ecology Progress Series* 384: 33 – 46.

Smith, L. G. (2014). Impact assessment and sustainable resource management. Routledge.

Kelleher, G. and Kenchington, R. (1991). Guidelines for Establishing Marine Protected Areas. *IUCN*, Gland.