



Study Center in Bonaire, Caribbean Netherlands

Course name:	Coral Reef Ecology
Course number:	ECOL 3001 BONA
Programs offering course:	Tropical Marine Ecology and Conservation
Language of instruction:	English
Semester Credits:	4
Contact Hours:	60
Term:	Fall and Spring Semester

Course Description

Coral Reef Ecology introduces students to basic ecological and biological principles such as competition, diversity, symbiosis, disturbance, adaptation, reproduction, and recruitment as well as basic biology and identification of the major taxa living in coral reef ecosystems. This course also examines the importance of seagrass and mangrove ecosystems and gives an introduction to oceanography and planktonic communities. Scuba and snorkeling excursions to the coral reef and laboratory sessions supplement the lectures and give students practical experience.

Learning Objectives

Upon completion of the course the students will:

- be able to identify and describe how common coral reef fauna and flora are ecologically interconnected
- be able to relate how fundamental ecological concepts in coral reef ecosystems shape biodiversity and the distribution of life on reefs
- gain experience gathering and analyzing ecological data on fish behavior, biodiversity, and disease
- understand the biology, life history, and identification of representative marine species
- gain comprehensive view of the development of coral reefs over ecological time
- learn to read and critique the scientific literature
- be able to discuss the strengths and weaknesses of scientific studies

Course Prerequisites

Two semesters of college-level biology courses required; 1 upper-level ecology/zoology/botany or equivalent required: Open water scuba certification or referral, AAUS dive medical exam, and DAN diving insurance

Methods of Instruction

Lectures, readings, home assignments, article discussions, laboratory and/or field reports, and external/invited lecturers are fundamental components of the course. It heavily relies on practical excursions (e.g. diving, snorkeling, kayaking) to underline the theoretical principles learned in class.

Students are expected to attend and fully participate in all lectures, laboratories, and excursions and complete all reading and research assignments prior to class meetings. All assigned readings are available as PDF files on the FTP site and most of the readings are in the library at CIEE Bonaire.

Assessment and Final Grade

1. Attendance:	2%
2. Participation:	2.5%
3. Field and Laboratory reports:	12%
4. Article Discussions:	7.5%
5. Quizzes:	6%
6. Did You Know assignment:	7%
7. Marine Mammals presentation:	7%
8. Exam 1:	25%
9. Exam 2:	25%

Course Requirements

Field and Laboratory Reports

They are all due at 9am one week after the activity or at any point prior to that time (unless stated otherwise) and are to be completed individually. The length of assignments varies from one page to five pages of text or a single excel spreadsheet. Given the variation among the assignments, each one is evaluated differently, but all evaluated based on quality, clarity, and logic. Assignments that are turned in late will be penalized with a 10% reduction per day, i.e. an assignment turned in one day late will be graded out of 90%. Specific guidelines for each report will be provided in class.

Article Discussions

Some lectures have an assigned scientific article for group discussion. Everyone must read the article and one (randomly picked) student will summarize it and lead the discussion. Every student must e- mail the instructor in advance four questions intended to be used during the discussion. Questions should be thoughtful and broad enough to stimulate scientific discussion. Grading will be based on the quality of the questions (i.e. Relevance to the subject, thoughtfulness, and ability to stimulate

External Lecture Series

Many of the lectures in our public lecture series are mandatory and students should take notes. There will be questions on the exams covering broad ecological/biological findings from these researchers. The class will also attend a lecture at Sea Turtle Conservation Bonaire (STCB) during the semester.

Attendance and Participation

It is mandatory for students to attend lectures and activities. Additionally, students must arrive on time and participate in class discussions, activities, etc. Much of the material covered in lectures or activities cannot be found in the readings. Students that fail to attend lectures or activities, arrive late, or do not participate will be penalized at the discretion of the instructor based on the frequency of these infractions. In-class assignments, quizzes, and exams can only be made up with a valid and documented excuse, ex. doctor's note.

Students are expected to adhere to CIEE Research Station Bonaire's Academic Honesty Policy. Students found violating the conditions of academic honesty are subject to receiving an "F" for the course. The violation will also be reported to the Director of CIEE Research Station Bonaire and may be documented on the student's permanent record at their home institution.

Weekly Schedule

Due to the nature of this course, the schedule may be subjected to changes. For an updated schedule, check Google Calendar, which is posted on the website, www.cieebonaire.org.

- Week 1 Orientation Week
Lectures: Introduction to class, Reef Development, Introduction to Oceanography
Mandatory Readings: Nybakken and Bertness 2004 (Chap. 1)
- Week 2 No Class
- Week 3 Lectures: Coral Reef Phyla, Invertebrate Taxonomy and ID, Invertebrate Ecology Activities: Reef Phyla and Invertebrate ID Dive (**Report due on Week 4**), Invertebrates' structures laboratory (**Report due on Week 4**).
Mandatory Readings: Dubinsky and Stambler 2011. (Chap. 18), Humann and DeLoach 2010 (Read sections un upper divisions)
- Week 4 Lectures: Zooxanthellae and Bleaching, Sea Turtle Conservation Bonaire's (STCB) talk.
Activities: Article Discussion on zooxanthellae and bleaching (send questions to instructor)
Due Date: Reports for Reef Phyla and Invertebrate ID Dive and Invertebrates' structures laboratory
Mandatory Readings: Dubinsky and Stambler 2011. (Chap. 7), Tolleter et al. 2013 (Article for discussion)
Optional Readings: Baker 2001
- Week 5 Lectures: Coral Biology, Coral Reproduction, Symbiosis, Competition
Readings: Birkeland 1997, Sheppard et al. 2009 (Chap. 4), Dubinsky and Stambler 2011 (Chap. 20)
Optional Readings: Nybakken and Bertness 2004 (Chap. 9, pp. 407-453), Sheppard et al. 2009 (Chap. 1 & 2), Dubinsky and Stambler 2011 (Chap. 6 and 20)
- Week 6 Lectures: Fish Behavior
Activities: Symbiosis & Competition Dive (**Due on Week 7**), Fish Behavior snorkel, Fish Behavior data laboratory, Article Discussion on Fish Behavior (send questions to instructor) Due date: Did You Know assignment
Mandatory Readings: DeLoach 1999 (pp. 8-31, 44-85), Reinthal and Lewis 1986 (Article for discussion)
- Week 7 Lectures: Fish Biology and Ecology Activities: Exam 1
Due date: Report on Symbiosis & Competition Dive and data laboratory
Optional Readings: Sheppard et al. 2009 (Chap. 6), Dubinsky and Stambler (Chap. 19)

Week 8

Lectures: Mangroves Biology and Ecology, Seagrass Ecology, Bioluminescence, Fluorescence, Plankton and Larval Ecology

Activities: Article discussion: Mangroves, Seagrass and Coral Reef Connectivity (send questions to instructor), Ostracods and Bioluminescence night dive, Fluorescence night dive, Plankton ID laboratory (**Report due on Week 9**)

Mandatory Readings: Mumby et al. 2004 (Article for discussion), Nybakken and Bertness 2004 (Chap. 9 pp. 453-474), Morin 1986, Piniak 2005, <http://www.nightsea.com/articles/underwater-fluorescence-faq/>, Nybakken and Bertness 2004 (Chap. 2 pp.42-75)

Optional Readings: Haddock et al. 2009

Week 9

Lectures: Invasive Species, Marine Rhythms and Chronobiology

Activities: Mangrove kayaking and Seagrass snorkeling field trip, Invasive Species dive Due date: Report on Plankton ID laboratory

Mandatory Readings: Debrot et al. 2011, Tessmar-Raible et al. 2011

Week 10

Lectures: Ecological Responses to Climate Change

Activities: Article Discussion on Climate Change (send questions to instructor) Mandatory Readings: Hughes et al. 2007 (Article for discussion)

Optional Readings: Sunday et al. 2014 (Highly recommended), Buddemeier et al. (2004), IUCN 2009 (pp. 9-26).

Week 11

Lectures: No lectures

Activities: Marine Mammals presentations Optional Readings: Debrot et al. 2011

Week 12

Lectures: Apex Predators, Intertidal Ecology

Activities: Article Discussion on Apex Predators (send questions to instructor), Intertidal Ecology fieldtrip

Mandatory Readings: Stevenson (Article for discussion)

Week 13

Lectures: No lectures

Activities: Exam 2, Staghorn Reef snorkel

Readings

Baker, Andrew. *Ecosystems: Reef coral bleach to survive change*. Nature, 2001. Print

Birkeland, Charles. *Life and Death of Coral Reefs: Chapter 8: Reproduction and Recruitment*. Springer, 1997. Print.

Buddemeier, Robert. Kleypas, Joan. Aronson, Richard. *Coral reefs & global climate change*. Pew Center on Global Climate Change, 2004. Print.

Debrot, Adolphe, van Buurt, Gerard, Vermeij, Mark. *Preliminary pverview of exotic and invasive marine species in the Dutch Caribbean*. IMARES, 2011. Print.

Debrot, Adolphe. Witte, Richard. Scheidat, Meike. *The marine mammals of the Dutch Caribbean: a comparison between EEZ sectors, contrasts the concerns*. IMARES, 2011. Online.

DeLoach, Ned. *Reef Fish Behavior: Florida, Caribbean, Bahamas (pp 8-31 & 44-85)*. New World Publications, 1999. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 4: Coral Reef Fishes: Opportunities, Challenges and Concerns*. Springer, 2011. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 6: Sexual Reproduction of Scleractinian Corals*. Springer, 2011. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 7: Zooxanthellae: The Yellow Symbionts Inside Animals*. Springer, 2011. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 18: Invertebrates and Their Roles in Coral Reefs Ecosystems*. Springer, 2011. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 19: Coral Reef Fishes: Opportunities, Challenges and Concerns*. Springer, 2011. Print.

Dubinsky, Zvy. Stambler, Noga. *Coral Reefs: An Ecosystem in Transition: Chapter 20: Competition Among sessile Organisms on Coral*. Springer, 2011. Print.

Haddock, Steven, Moline, Mark, Case, James. *Bioluminescence in the Sea*. Annual Review of Marine Science, 2009. Online.

Hughes, Terence. Rodriguez, Maria. Bellwood, David. Ceccarelli, Daniela. Hoegh-Guldberg, Ove. McCook, Laurence. Moltschaniwskyj, Natalie. Pratchett, Morgan. Steneck, Robert. Willis, Bette. *Phase Shifts, Herbivory, and the Resilience of Coral Reefs to Climate Change*. Elsevier Ltd. , 2007. Online.

Humann, Paul. DeLoach, Ned. *Reef Creature Identification Tropical Pacific*. New World Publications, 2010. Print.

IUCN. *Coral Reef Resilience Assessment of Bonaire national Marine Park, Netherlands Antilles*. 2009. Print.

- Morin, James. *Fireflies of the Sea: Luminescent signaling in marine ostracide crustaceans*. The Florida Entomologist, 1986. Print.
- Mumby, Peter. Edwards, Alasdair. Arias-Gonzalez, Ernesto. Lindeman, Kenyon. Blackwell, Paul. Gall, Angela. Gorczynska, Malgosia. Harborne, Alistair. Pescod, Claire. Renken, Henk. Wabnitz, Colette.
- Llewellyn, Ghislane. *Mangroves enhance the biomass of coral reef fish communities in the Caribbean*. Nature, 2004. Online.
- Nybakken, James. Mark, Bertness. *Marine biology: an Ecological Approach: Chapter 1: Introduction to the Marine Environment*. Benjamin Cummings, 2004. Print.
- Nybakken, James. Mark, Bertness. *Marine biology: an Ecological Approach: Chapter 2: Plankton and plankton communities*. Benjamin Cummings, 2004. Print.
- Nybakken, James. Mark, Bertness. *Marine biology: an Ecological Approach: Chapter 9: Tropical Communities*. Benjamin Cummings, 2004. Print.
- Piniak, Gregory. Fogarty, Nicole. Addison, Christine. Kenworthy, Judson. *Fluorescence census techniques for coral recruits*. Coral Reefs. 2005. Printed.
- Reinthal, Peter, Lewis, Sara. *Social behaviour, foraging efficiency and habitat utilization in a group of tropical herbivorous fish (pp 1687-1693)*. Elsevier Ltd. 1986. Online.
- Sheppard, Charles, Davy, Simon, Pilling, Graham. *The Biology of Coral Reefs (Biology of Habitats): Chapter 1: Coral Reefs – Biodiverse and Productive Tropical Ecosystems*. Oxford University Press, 2009. Print
- Sheppard, Charles, Davy, Simon, Pilling, Graham. *The Biology of Coral Reefs (Biology of Habitats): Chapter 2: The Main Reef Builders and Space Occupiers*. Oxford University Press, 2009. Print.
- Sheppard, Charles, Davy, Simon, Pilling, Graham. *The Biology of Coral Reefs (Biology of Habitats): Chapter 4: Symbiotic Interactions*. Oxford University Press, 2009. Print.
- Sheppard, Charles, Davy, Simon, Pilling, Graham. *The Biology of Coral Reefs (Biology of Habitats): Chapter 6: Reef Fishes: Diversity, Feeding, and Food Chains*. Oxford University Press, 2009. Print.
- Stevenson, Charlotte. Katz, Laure. Micheli, Fiorenza. Heiman, Kimberly. Perle, Chris. Weng, Kevin. Dunbar, Robert. Witting, Jan. *High apex predator biomass on remote Pacific islands*. Coral Reefs, 2007. Printed.
- Sunday, Jennifer. Calosi, Piero. Dupont, Sam. Munday, Philip. Stillman, Jonathon. Reusch, Thorsten. *Evolution in an acidifying ocean*. Trends in Ecology and Evolution. 2014. Printed.
- Tessmar-Raible, Kristin, Raible, Florian, Arboleda, Enrique. *Another place, another timer: Marine species and the rhythms of life*. BioEssays, 2011. Online.
- Tolleter, Dimitri. Seneca, Francois. DeNofrio, Jan. Krediet, Cory. Palumbi, Stephen. Pringle, John. Grossman, Arthur. *Coral bleaching independent of photosynthetic activity*. Current Biology. 2013. Print.



ENGAGE. EXPERIENCE. EMBRACE. EDUCATE.

Young, Craig. *A brief history and some fundamentals*. Elsevier Ltd., 2006. Print.