



## Directed Oceanographic Research

XAS NS 325 (4 credits)

### Course Catalog Description:

Design and conduct original marine ecological research on coastal ecosystems in the Eastern Caribbean. Collect and analyze observational data using various statistical approaches. Compile results in peer-reviewed manuscript format and share during a poster presentation session. Emphasis on development of research skills and written/oral communication abilities.

**Instructor:** Sea Education Association Oceanography Faculty

**Location:** SEA campus in Woods Hole, MA, at field station in U.S. Virgin Islands, at sea on SEA's sailing school vessel *Corwith Cramer*, and on reefs during several island port stops.

**Prerequisites:** Admission to SEA Semester. Three lab science courses (one at the 300-level or higher) or consent of instructor.

### Course Philosophy and Approach:

Field research is central to the study of the marine environment. Throughout the shore component we will explore the scientific process as students develop research inquiries, plan experiments, and craft a thorough yet concise project proposal. This student-generated suite of research objectives will define much of the subsequent scientific mission and sampling plan while we study reefs at a field station in the U.S. Virgin Islands, during island port stops and at sea.

Additionally, a critical educational goal of the Directed Oceanographic Research course is the transfer of “what sounded good onshore” to “what really works as sea,” and the evolution of each scientific project to the real world will occupy much of our time while collecting and analyzing data.

Students will complete independent research projects in oceanography and marine ecology under the guidance of the Chief Scientist on Caribbean island reefs and aboard the vessel. In conducting their projects, students will learn and perform standard visual survey field techniques using snorkel and small boat operations. Essential project components include the collection, analysis and presentation of data; a formal scientific manuscript will be written per the guidelines of a selected high impact scientific journal. Each submission will also be subject to peer-review by faculty and fellow students.

This course consists of 36 hours of lecture/lab/discussion sessions on shore in Woods Hole; 35 hours of reef work (data collection and mentored analysis) in the U.S. Virgin Islands and during port stops; 4 scheduled discussion/mentoring sessions (1.5 hours each), countless informal conversations, and 1 research poster session (3 hours) at sea; as well as 36 hours of laboratory watch participation (active learning/laboratory) during 18 days underway at sea.

### Learning Outcomes:

1. Read, analyze and evaluate scientific literature and data sources in relevant disciplines.
2. Develop, implement, and complete an oceanographic/marine ecology research project.
3. Critically analyze and interpret authentic oceanographic data.
4. Generate clear visual representations of oceanographic data.
5. Compose a professional-quality manuscript and deliver a professional presentation.

### Evaluation/Assignments:

#### On Shore:

Taxonomic ID Quizzes	10%
Research Project Technique Assignments	10%
Research Project Proposal	10%

#### At Sea:

Coral Reef Report Cards	20%
Data Discussions	5%
Peer-Review Critiques	5%
Research Poster Presentation	15%
Research Project Paper	25%

### Assignments Onshore:

Taxonomic ID Quizzes: Students will take four taxonomic identification quizzes during the shore component. A quiz re-take will be offered during Week 5.

Research Project Techniques Assignments: Students will learn a variety of data collection and analysis techniques during the shore component that are crucial for subsequently completing their research projects at sea – substrate analysis, diversity indices and mapping techniques, as well as in-pool snorkeling training. Students will complete a series of assignments to practice and demonstrate mastery of these techniques, prior to heading to the Caribbean.

Research Project Proposal: A series of research-focused seminars on shore will guide students through the rigors of the scientific process including the reading of scientific journal articles, gathering essential background information, crafting hypotheses to be investigated, describing field methods and data analysis plans, etc. Thoughtful, well-prepared participation during research seminars is expected of each student and essential to successful project development. Each student research team will complete a thoroughly researched and carefully written explanation of proposed scientific work at sea and/or on the seven reef sites we will study, including an introductory literature review, intended methods and sampling locations, data analysis plan, and references.

## Assignments at Sea:

Coral Reef Report Cards: Students will compile and complete Coral Reef Report Cards for each of the seven sites we study. Modeled after the Healthy Reef Initiative's report cards from the Central America region and The Nature Conservancy's report cards from the Caribbean, these will be concise, visual, easy-to-understand tools designed to be accessible for a diverse range of audiences. They will be collaborative efforts, with teams of students contributing sections to each report.

Data Discussions: Two mentor meetings will guide the progress of data analysis. For the first session, research teams will be required to retrieve relevant data from current cruise archives and plot station locations. For the second session, research teams will generate two figures that begin to address the hypothesis being tested.

Peer-Review Critiques: Scientific research is subject to peer-review prior to publication. Students will practice these skills by critiquing the Introduction and Methods sections for another student's project. Also, each manuscript submission will be reviewed by three anonymous student reviewers who will make suggestions and recommendations for publication.

Poster Presentation: Research teams will present their research in a poster session. Emphasis will be placed on clear visual representation of the research question, methods, data analysis and interpretation, as well as oral explanation of the work and response to questions. There is an expectation of mastery of supporting literature to contextualize current research results.

Final Written Manuscript: Research teams will produce a written manuscript following guidelines for a selected high impact journal. There is an expectation of senior thesis/professional quality work. The final manuscript will be archived at SEA.

## Readings:

To begin the scientific process regionally relevant journal articles will be provided to the students on the course website. Additional supporting references and scientific literature are project dependent and will be obtained by each research team.

## Expectations and Requirements:

- Punctual attendance is required at every class meeting.
- Active participation in class discussion is expected.
- Late assignment submissions are not accepted.
- The policy on academic accuracy, quoted below, will be strictly followed in this class.

The papers that you submit in this course are expected to be **your original work**. You must take care to distinguish your own ideas and knowledge from wording or substantive information that you derive from one of your sources. The term "sources" includes not only published

primary and secondary material, but also information and opinions gained directly from other people and text that you cut and paste from any site on the Internet.

**The responsibility for learning the proper forms of citation lies with you.** Quotations must be placed properly within quotation marks and must be cited fully. In addition, all paraphrased material must be acknowledged completely. Whenever ideas or facts are derived from your reading and research, the sources must be indicated. (Harvard *Handbook for Students*, 305)

- Considerations for use of internet sources:

As you browse websites, assess their usefulness very critically. Who posted the information and why? Can you trust them to be correct? Authoritative? Unbiased? (It's okay to use a biased source as long as you incorporate it knowingly and transparently into your own work.) Keep track of good sources that might be useful for subsequent assignments, and annotate in your bibliography any sites you cite. Your annotation should include the name of the author or organization originating any material that you reference. If you can't identify the source, don't use it!

### Course Calendar:

Topic	Readings/Assignments Due
<b>Week 1 (6 hours) – on shore at SEA campus in Woods Hole</b>	
<p>Introduction to <i>Caribbean Reef Expedition</i> program and <i>Directed Oceanographic Research (DOR)</i>; Overview of course goals &amp; assignments.</p> <p>Lecture/Discussion Topics:</p> <ul style="list-style-type: none"> <li>• Introduce SEA's Research Capabilities and Research Program</li> <li>• Ridge Top to Reef: An Introduction to Caribbean Coastal Ecosystems</li> </ul> <p>Drawing Exercise</p> <p>MBL/WHOI Library Resources and Woods Hole tour</p>	<p><b>Readings:</b></p> <p>Cruise Research Prospectus Designated project readings TBD</p> <p><b>Identification of preliminary reef survey research interests</b></p>
<b>Week 2 (6 hours) – on shore at SEA campus in Woods Hole</b>	
<p>Lecture/Lab/Discussion Topics:</p> <ul style="list-style-type: none"> <li>• Coral Reef Ecology, part I and Taxonomic IDs (Coral, Sponge, Inverts)</li> <li>• Techniques and Data Analysis: Quadrat, Camera and Coral Point Count substrate analysis</li> <li>• Research Topic Refinement</li> </ul>	<p><b>Start Literature Review Research</b></p> <p><b>Techniques and Analysis Exercise due</b></p> <p><b>Taxonomic ID Quiz</b></p>

<b>Week 3 (6 hours) – on shore at SEA campus in Woods Hole</b>	
Lecture/Lab/Discussion Topics: <ul style="list-style-type: none"> <li>• Coral Reef Ecology, part II and Taxonomic IDs (Fish)</li> <li>• Techniques and Data Analysis: Belt Transect, Roving, and Stationary Point Count for diversity indices</li> <li>• Hypothesis Development</li> </ul>	<b>Literature Review Research (ongoing)</b> <b>Taxonomic ID Quiz</b>
<b>Week 4 (6 hours) – on shore at SEA campus in Woods Hole</b>	
Lecture/Lab/Discussion Topics: <ul style="list-style-type: none"> <li>• Seagrass Ecology and Taxonomic IDs</li> <li>• Techniques and Data Analysis: Compass and Contour Mapping</li> <li>• Research Methods Development</li> </ul>	<b>Literature Review Research (ongoing)</b> <b>Draft Introduction &amp; Methods sections due</b> <b>Techniques and Analysis Exercise due</b> <b>Taxonomic ID Quiz</b>
<b>Week 5 (6 hours) – on shore at SEA campus in Woods Hole</b>	
Lecture/Lab/Discussion Topics: <ul style="list-style-type: none"> <li>• Mangrove Ecology and Taxonomic IDs</li> <li>• Techniques and Data Analysis: In Pool Training</li> </ul>	<b>Techniques and Analysis Exercise due</b> <b>Taxonomic ID Quiz</b>
<b>Week 6 (6 hours) – on shore at SEA campus in Woods Hole</b>	
Lecture/Lab/Discussion Topics: <ul style="list-style-type: none"> <li>• Ecosystem Connections: Nutrients, Energy, and Life Cycles</li> <li>• Techniques and Data Analysis: In Pool Training</li> </ul>	<b>Taxonomic ID Quiz retakes</b> <b>Research Project Proposal due</b>
<b>Week 7 (10 hours) – at field station in U.S. Virgin Islands</b>	
Site 1: Orientation, Mapping, Water Sampling; Invert/Fish Survey  Site 2: Orientation, Mapping, Water Sampling; Invert/Fish Survey	<b>Data fidelity and analysis</b> <b>Reef Report Cards due (x2)</b>
<b>Week 8 (10 hours) – at field station in U.S. Virgin Islands</b>	
Site 3: Orientation, Mapping, Water Sampling; Invert/Fish Survey  Site 4: Orientation, Mapping, Water Sampling; Invert/Fish Survey	<b>Data fidelity and analysis</b> <b>Reef Report Cards due (x2)</b>

<b>Week 9 (15 hours) – at sea + reef survey work during port stop</b>	
Port Stop Visit #1 Site 5: Orientation, Mapping, Water Sampling; Invert/Fish Survey  Methods Refinement  Methods Sessions  Meeting Topic: <ul style="list-style-type: none"> <li>• Making the Most of the Peer Critique Process</li> </ul>	<b><i>Data fidelity and analysis</i></b> <b><i>Reef Report Card due (x1)</i></b>  <b><i>Revised Intro/Methods due</i></b> <b><i>Intro/Methods Critiques due</i></b>
<b>Week 10 (15 hours) – at sea + reef survey work during port stop</b>	
Port Stop Visit #2 Site 6: Orientation, Mapping, Water Sampling; Invert/Fish Survey  Data Analysis  Mentoring Sessions  Meeting Topics: <ul style="list-style-type: none"> <li>• Data Discussion I</li> </ul>	<b><i>Data fidelity and analysis</i></b> <b><i>Reef Report Card due (x1)</i></b> <b><i>Data Discussion Assignment due</i></b>
<b>Week 11 (15 hours) – at sea + reef survey work during port stop</b>	
Port Stop Visit #3 Site 7: Orientation, Mapping, Water Sampling; Invert/Fish Survey  Data Analysis  Mentoring Sessions  Meeting Topic: <ul style="list-style-type: none"> <li>• Data Discussion II</li> </ul>	<b><i>Data fidelity and analysis</i></b> <b><i>Reef Report Card due (x1)</i></b> <b><i>Draft Results due</i></b>
<b>Week 12 (18 hours) – at sea</b>	
Data Analysis  Mentoring Sessions  Meeting Topic: <ul style="list-style-type: none"> <li>• Poster Presentation tips</li> </ul>	<b><i>Final Manuscript Peer-Review</i></b> <b><i>Poster Presentation</i></b> <b><i>Final Manuscript due</i></b>