

Syllabus

MSL F457: Field Techniques in Ocean Acidification Research

3 Credits

Class Schedule: TBD

MSL 211 & MSL 212 or instructor permission

Instructor: Dr. Amanda Kelley

Class location: Kasitsna Bay Laboratory

College of Fisheries and Ocean Sciences

Office: Irving II rm 234

Phone: (907) 474-2474

Email: alkelley@alaska.edu

Office hours: TBD

Catalog Description: An introduction to the design and fabrication of experimental ocean acidification systems and oceanographic pH sensors for the study ocean acidification. This course will require extra fees to cover laboratory activities, room and board. Students are responsible for travel to and from Kasitsna Bay Lab.

Course Goals: This course is designed to give students the tools, techniques and analytical skills necessary to conduct ocean acidification research. We will: 1) review the current state-of-knowledge regarding the techniques and systems used to conduct experiments that expose marine organisms to current and future $p\text{CO}_2$ (acidified) conditions projected by the Intergovernmental Panel on Climate Change; 2) build, from the ground up, a flow-through seawater aquarium system and learn how to adjust the carbonate chemistry conditions that reflect different target treatment exposures; 3) learn to measure the experimental seawater carbonate parameters following the “Guide to best practices for ocean acidification research and data reporting” (Riebesell et al. 2011); 4) learn how to use, calibrate, deploy, and conduct proper quality control and assurance protocols for oceanographic sensors used to measure pH *in situ*; 5) review relevant approaches for conducting time-series carbonate chemistry data analysis.

Specific Learning Objectives:

- (1) Recognize the role of anthropogenic carbon dioxide in the regulation of seawater carbonate chemistry and the process of ocean acidification.
- (2) Describe OA impacts to biological systems- why is studying ocean acidification important?
- (3) Distinguish the specific components used in the fabrication of the experimental ocean acidification system- i.e. mass flow control valves, CO_2 and H_2O scrubbers, header tanks, gas valves, etc. and recall their functional role.
- (4) Assemble, from the ground up, the flow-through seawater experimental ocean acidification system.
- (5) Practice sampling seawater from the experimental system and calculate the carbonate parameters using CO2calc, following the “Guide to best practices for ocean acidification research and data reporting” (Riebesell et al. 2011). This includes measuring seawater pH (spectrophotometric), total alkalinity (TA), salinity, and temperature and using these values to calculate $p\text{CO}_2$ and aragonite saturation state.
- (6) Identify the different types of oceanographic sensors used in ocean acidification monitoring.
- (7) Gain hands-on experience using the seaFET pH sensor, including sensor conditioning, deployment, calibration sample collection, and data quality control and assurance.
- (8) Review *basic* time-series analysis of ensuing sensor data.

Instructional method:

This class will use multiple modes of learning, including: lecture, lab hands-on activities, readings, field sampling and exams.

Course reading (required):

Text book: Ocean Acidification, edited Jean-Pierre Gattuso, Lina Hansson, published peer-review scientific literature and instrument manuals.

Class Evaluation:

Lecture quizzes (2).....	15 points
Laboratory quizzes (2).....	15 points
Lab note book.....	10 points
Exam 1: OA experimental system.....	30 points
Exam 2: Oceanographic pH/ pCO ₂ sensors.....	30 points
Total.....	100 points

Grading:

90-100%	A
80-89%	B
70-79%	C
60-69%	D
< 59%	F

Course Schedule: 2 weeks

Week 1:**Readings:**

- Text book: Ocean Acidification, edited by Jean-Pierre Gattuso, Lina Hansson
 - Chapter 1: Ocean acidification: background and history
 - Chapter 2: Past changes in carbonate chemistry
 - Chapter 3: Recent and future changes in carbonate chemistry
 - Chapter 5: Effects of ocean acidification on the diversity and activity of heterotrophic marine microorganisms
 - Chapter 6: Effects of ocean acidification on organisms and ecosystems
 - Chapter 10: Effects of ocean acidification on marine biodiversity and ecosystem function
 - Chapter 12: Biogeochemical consequences of ocean acidification and feedbacks to the earth system
- Riebesell, Ulf, et al. Guide to best practices for ocean acidification research and data reporting. Office for Official Publications of the European Communities, 2011.

Videos:

- Introduction to CO₂ Chemistry in Seawater Part 1: Presented by Dr. Andrew Dickson, Scripps Institution of Oceanography.
- Introduction to CO₂ Chemistry in Seawater Part 2: Presented by Dr. Andrew Dickson, Scripps Institution of Oceanography.

Lectures:

- History of seawater carbonate chemistry; understand the relationship between pH, pCO₂ and aragonite saturation state.
- Background of ocean acidification: climate change and anthropogenic atmospheric CO₂

- Using the Intergovernmental Panel on Climate Change report projections as a framework for determining “future-level” ocean acidification experimental conditions
- The OA system: a breakdown of all the system parts required for assembly of the experimental flow-through ocean acidification system
- Step-by-step review of the assembly of the experimental OA system
- How to measure the carbonate chemistry parameters of the experimental OA system using the “Guide to best practices for ocean acidification research and data reporting”

Exam 1: OA experimental system, end of week 1.

Week 2:

Readings:

- Hofmann, Gretchen E., et al. "High-frequency dynamics of ocean pH: a multi-ecosystem comparison." PloS one 6.12 (2011): e28983.
- Martz, Todd et al. Testing the Honeywell Durafet® for seawater pH applications. Limnology and Oceanography: Methods 8.5 (2010): 172-184.
- Gray, Sarah E. Cullison, et al. "Applications of in situ pH measurements for inorganic carbon calculations." Marine Chemistry 125.1 (2011): 82-90.
- SeaFET 2.0 Manual
- Satlantic SeaFET Ocean pH Sensor Verification Report, Project # 3021
- An evaluation of the performance of Sea-Bird Scientific's SeaFET™ autonomous pH sensor: considerations for the broader oceanographic community, Miller & Kelley, 2018.
- Seidel, Matthew, et al. A sensor for in situ indicator-based measurements of seawater pH. Marine chemistry 109.1 (2008): 18-28.
- Dickson, Andrew, et al. "Guide to best practices for ocean CO₂ measurements." (2007): OceanBestPractices

Lectures:

- Overview: SeaFET Ocean pH sensor pt. 1
- Overview: SeaFET Ocean pH sensor pt. 2
- Oceanographic pH sensor considerations: deployment, sampling regime, data quality control and assurance, and calibration sample collection
- Determination of seawater carbonate chemistry
- Overview: pH/pCO₂ time-series data analysis

Exam 2: Oceanographic pH/ pCO₂ sensors, end of week 2.

Lab and Recitation: Lab and recitation will occur daily every afternoon after lecture. There we will review and put to use the objectives and techniques discussed in lecture. Students will keep lab notebooks that include sketches of the functional components of the OA system and how they relate to each other and measurement/analysis data. We will add to the lab notebook everyday as the course moves through the various lab and recitation activities. This course is designed to give students the tools, techniques and analytical skills necessary to conduct ocean acidification research. We will: 1) review the current state-of-knowledge regarding the techniques and systems used to conduct experiments that expose marine organisms to current and future pCO₂ (acidified) conditions projected by the Intergovernmental Panel on Climate Change; 2) build, from the ground up, a flow-through seawater aquarium system and learn how to adjust the carbonate chemistry conditions that reflect different target treatment exposures; 3) learn to measure the experimental seawater carbonate parameters following the “Guide to best practices for ocean acidification research and data reporting” (Riebesell et al. 2011); 4) learn how to use, calibrate, deploy, and conduct proper quality control and assurance protocols

for oceanographic sensors used to measure pH *in situ*; 5) review relevant approaches for conducting time-series carbonate chemistry data analysis.

Course Location: Kasitsna Bay Laboratory

The main requirement for this course is access to seawater! Because of the need for this crucial element, this course will take place at the Kasitsna Bay Laboratory, located in beautiful Kachemak Bay. Much of the hands-on work will take place in the seawater workroom at the lab. The sensor work and seawater chemistry analysis will occur in an adjacent dry lab. Our field work will consist of sensor deployment and field sampling of seawater.

You can reach Kasitsna Bay Lab by driving or flying to Homer, and then taking a water taxi across Kachemak Bay to the lab. Please contact the instructor at alkelley@alaska.edu to coordinate travel with other students taking the course.

Course Policies:

(1) Attendance: *Students are expected to attend all scheduled lectures and labs, and are responsible for all material presented in lecture and in the assigned readings.* Students who miss either lecture or lab are welcome to ask to borrow the notes of their classmates; the instructor will not be responsible for providing notes. Please note that no in-class activities can be made up, regardless of the reason for missing class. Lectures will be presented using PowerPoint. It is important to realize that these PowerPoint slides represent only an outline of the material covered. Important details that will be covered in exams will be added by the instructor verbally in each lecture and slides not posted on Blackboard may be described in lecture. Thus attending class and taking detailed notes is the key to success in this course.

(2) Exams and Quizzes: Exams/quizzes will be based on any material covered during lecture, lab and or from the assigned reading. This can include illustrations, films, Powerpoint slides, and actual lectures. Take notes! Make-up exams will only be available in cases of medical and/or family emergencies, or for official academic activities (in which case the instructor should be contacted a minimum of two weeks in advance). The student is responsible for scheduling timely make-up exams with the instructor.

(3) Support and Disability Services: The Office of Disability Services can be reached by phone- (907) 474-5655, or email- fydso@uaf.edu, and can be located in WHIT 203 on the UAF campus. The Office of Disability Services is available for students with physical or learning disabilities. If you feel that you are differently abled and need these services, please contact the office or ask the instructor to make arrangements.

(4) Courtesy: Please turn off all audible sounds to any electronic devices (phones, laptops, tablets etc.) while in lecture. Refrain from using your laptops for activities not related to lecture during class time, e.g. emailing or browsing the web. Use of these items is strictly prohibited during exams. Students are free to record lectures. You may bring food or drink in the classroom unless otherwise instructed, for example when shared computers are in use.

(5) Plagiarism and academic integrity: Plagiarism will not be tolerated in any way during this course. All assignments are expected to consist of students' original ideas and/or information from properly cited published sources. Students may seek assistance with proper referencing of scientific literature from the instructor as needed. Students are expected to conduct themselves according to the UAF Student Code of Conduct, which can be found in the course catalog. Failure to comply with these guidelines will result in a failing grade, and the student may face consequences at the university level, depending on the severity of the offense. I also use a

program that can identify plagiarism from any internet source. So please consider this when contemplating using cut and paste for your assignments and research project.

Student protections and services statement: Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. As required, if I notice or am informed of certain types of misconduct, then I am required to report it to the appropriate authorities. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook/ OR GRADUATE STUDENT VERSION: Student protections and services statement: Every qualified student is welcome in my classroom. As needed, I am happy to work with you, disability services, veterans' services, rural student services, etc to find reasonable accommodations. Students at this university are protected against sexual harassment and discrimination (Title IX), and minors have additional protections. For more information on your rights as a student and the resources available to you to resolve problems, please go the following site: www.uaf.edu/handbook/