

**SIO 134 / BIEB 134: Introduction to Biological Oceanography
WINTER 2024**

Lectures: Tuesday/Thursday 9:30-10:50am, Mosaic 114
Final exam Tuesday March 19 8-9:20am, location TBD

Course Instructor

Andrew Barton, Associate Professor

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Office Hours: in person unless otherwise noted, 11am-12pm Tuesdays, Muir 1102

Teaching Assistants

Zachary Daniel	zdaniel@ucsd.edu
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Section times (all on Wednesdays), locations, and responsible TA are listed below:

9-9:50am	HSS 2150	Zachary Daniel
10-10:50am	HSS 2150	Alexia Fabiani
11-11:50am	HSS 2150	Alexia Fabiani
12-12:50	DIB 122	Qianqian Tao
1-1:50pm	DIB 122	Qianqian Tao
2-2:50pm	PCYNH 240	Julia Hagedorn
3-3:50pm	CENTR217B	Julia Hagedorn

All sections will be held in person and attendance is required. TA office hours will be held on Zoom. Check Canvas for available times and Zoom links. You can attend office hours held by any TA.

Course Description: This course presents the basics for understanding the ecology of marine communities in the context of a dynamic and changing environment. In the first part of the course, we will take a process-oriented approach, focusing on major functional groups of marine organisms, how they interact in ocean food webs, and how communities respond to, reflect, and potentially modulate environmental forcing. We will use this foundation as a basis for considering contemporary issues in ocean ecology, including human and climate influences.

Lectures: Lectures will be held in Mosaic 114 on Tuesdays and Thursdays from 9:30-10:50am, and will also be available as podcasts for review and study (<https://podcast.ucsd.edu>). Note that attendance is required in lectures; see below for details.

Assigned Readings: For each lecture, including guest lectures, there is an assigned journal article, review paper, or book section to read (available as pdf files on Canvas). The readings reinforce and complement the material covered in lectures. The reading may explain material in a way that you understand better than the lectures. In some cases, the readings go into

greater technical or methodological detail than I will cover in the lectures. While I will not create test questions on small details from a paper, the general concepts discussed in the readings may be covered in exams. In each discussion section starting in Week 1, you will prepare a written summary of the paper to be submitted for credit. See “Discussion Sections” below for more details on how to write a paper summary.

Additional Background Reading: Additional information on concepts covered by the course can be found in the following online books:

Biological Oceanography, C.B. Miller & P.A. Wheeler, Wiley Blackwell Publ., 2nd ed., 2013.

Available online: <https://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=892193>

Biological Oceanography: An Introduction, C.M. Lalli & T.R. Parsons, 2nd ed., 1997.

Available online:

<https://ebookcentral.proquest.com/lib/ucsd/detail.action?docID=403917>

Both books are available online through the UCSD library at the links above, but you will need to have a UCSD IP address to view the books. When off campus, you’ll need to use a VPN. **The books are not required reading**, but many students find these books useful.

Discussion Sections: TA-led discussion sections will be held in-person. Sections are designed to discuss content from the lectures and exams, and also to give students the opportunity to read and digest the assigned readings. Discussion sections will have three primary components: a) creation and discussion of exam-style questions, b) preparation of summaries of the assigned reading, and c) participation. Grading for sections will be based equally upon a, b, and c. **Late assignments will not receive credit.**

For part a), each student should prepare no less than **5** original, written exam-style or review questions focusing on the lecture or lectures covered for each section. The student should write both the question and the answer, and submit the questions via Canvas by 9am on the day of section. 9am is the time the first section starts on Wednesday, so in fairness to all students this will be the time the assignments are due. During section, students may break up into small groups to discuss their questions, and may present back to the full group when the small groups are dissolved. The submitted questions will not be graded for accuracy, so it is the responsibility of the student to make sure they understand the answers by participating in section discussion. 10 points for each section will be awarded for completion of at least 5 questions and answers, submitted prior to the deadline. **You may discuss the questions with other students but must complete the submitted questions by yourself.** Submitted work will be checked with Turnitin. The 5 questions need not cover both lectures covered in section, but ideally should.

For part b), each student must write a short summary of one assigned reading for each section. If there is more than one assigned reading for a given week, select only one paper to summarize. The paper summary must be submitted to Canvas by 9am on the day of section. The summary must include the following, **but not more**, components (a template will be provided in the assignment on Canvas):

Main theme: State the main objectives and questions from the reading in 2-3 sentences.

Background information: Describe in 2-3 sentences any necessary background information to understand key aspects of the reading. These details can be technical or factual.

Methods: Describe in 1-2 sentences the method or methods used in the study. If the paper is a review paper, you may skip this part.

Results: Describe the main results of the study in 2-3 sentences.

Conclusions and Implications: Describe the conclusions and implications of the results in 2-3 sentences.

The purpose of this weekly summary assignment is to gain practice reading and synthesizing scientific papers. Please do not write a lengthy summary; instead, provide crisp text filling only the categories outlined above. Up to 10 points for each section will be awarded for completion of your paper summary, submitted prior to the deadline. Your TA will grade only for completeness; partial credit may be awarded for poor effort. You may discuss the papers with other students but must complete the summary by yourself. **Do not simply quote the paper or other sources; instead, you should prepare a written synthesis in your own words.** Submitted work will be checked with Turnitin. During section, you will discuss the paper or papers after going over your study questions.

For part c), you will receive a grade for participation in the entire section. 10 points will be awarded for each section for participation. If you are sick, please do not attend section. Instead, you should submit as normal your paper summary and study questions to Canvas on time for full credit. You can receive credit for participation by completing a short, written assignment. To receive participation credit while sick, you must: 1) email your TA before section, or as soon as possible in case of an emergency, 2) submit documentation of the issue (screenshot of your daily symptom checker is sufficient in the case of illness or symptoms), and 3) write a 1-page essay on one of the main topics from lectures in the previous week (email the essay to your IA within five days of the missed section for full credit). Your TA must approve the topic, and can suggest topics as well. As with all other written assignments, the writing must be in your own words and not copied from published sources or other students. Note that you cannot regularly submit written assignments in place of attending sections; this process is designed to accommodate students experiencing illness or unavoidable absences. You may submit a maximum of two written assignments in lieu of participating in section. The TA's keep track of all discussion sections points.

In addition, prior to and after exams, students can ask questions related to the exams. For a detailed week-by-week schedule of sections, see the schedule below.

You may attend a section run by the same TA occurring at a different time, but you cannot attend a section run by a different TA.

Academic Integrity: You may discuss discussion section study questions with other students, but you must write the questions and answers in your own words (your responses will be monitored by Turnitin plagiarism software). Similarly, you may discuss the assigned readings with other students, but the summary must be completed in your own words (and will be assessed by Turnitin). You may not copy text wholly or in part from published sources or other

students. If Turnitin indicates that your work is plagiarized, **you will receive no credit for the assignment.** Plagiarism is a serious violation of UCSD's code of academic integrity.

You may not use any resources (books, notes, phone, etc.) during your exams.

For information on academic integrity at UCSD: <http://senate.ucsd.edu/Operating-Procedures/Senate-Manual/Appendices/2>

Clickers: Clickers will be used in lecture to assess participation and attendance (see below). For this class, you can use your Clicker handset or the mobile app. You will need to register your Clicker prior to when we will start using Clickers on January 11. It is your responsibility to have your Clicker with you at lectures and to make sure it is working properly. There will be no make-up opportunities for Clicker questions, for any reason, nor can you gain clicker credit for submitting questions on paper or other means. Guest lecturers will not use Clickers, and for the few occasions when Professor Barton pre-records a lecture, a Canvas quiz will take the place of Clicker points.

Grading: Grading will be based upon the following assessments:

70% Exams

There will be three exams during the quarter, plus a final exam. The exams will consist of multiple choice, graphing, conceptual calculation, and/or short-answer questions. The exams during the quarter will occur in regular class time, and the final exam will occur during the final exam period, but will be the same length as the other exams (80 minutes). The lowest exam score will be dropped, such that your best three scores account for 70% of your grade. This policy allows for events that could cause you to miss an exam, or impact your performance, such as illness. The final exam will be comprehensive but focus on the big ideas covered repeatedly during the quarter. Missed exams earn a score of 0.

21% Discussion Sections

As described above, for each section you will earn up to 10 points each for completing at least 5 study questions, completing a paper summary, and participating in section. Assignments turned in after the due date and time will not receive credit. Your lowest study question, paper summary, and participation score will be dropped (one each).

9% Lecture Attendance (Clickers)

To gain full credit, answer 75% of questions in 75% of available lectures, starting January 11. The 75% threshold allows for sickness and excused absences. Partial credit will be given for attendance and participation below this threshold. Clicker answers do not need to be correct to get credit.

Note that 30% of the total grade comes from attending and participating in section and lecture, and that it will be difficult to earn a high grade in the course without earning most of these points.

I will use the following grading scale this quarter:

A+	100% to 98%
A	<98% to 90%
A-	<90% to 88%
B+	<88% to 85%
B	<85% to 80%
B-	<80% to 78%
C+	<78% to 76%
C	<76% to 70%
C-	<70% to 65%
D	<65% to 60%
F	<60%

Make-up Policy: There will be no make-up exams. If you miss an exam or the final exam, you will be assigned zero points for that assessment. Remember, you can drop the lowest exam grade. If you miss a test due to a serious illness, emergency, or unavoidable absence, please provide documentation to me within 5 days of the exam. I can then advise you on how best to stay current with the material, and ensure you're on track to do well with your remaining exams and assignments. In the unusual event that you miss more than two exams due to these kinds of serious, unavoidable, and documented issues, your grade will be calculated on the basis of the remaining assessments.

Lecture and Section Schedule

Week 1

- Jan 9 **Lecture 1:** Course overview - habitats, major themes, historical perspective
Jan 10 **Section 1:** Covering Lecture 1
 Reading: Lecture 1 → Anderson and Rice (2006)
Jan 11 **Lecture 2:** Why plankton “bloom” – the dynamics of ocean biology (First day using Clickers in class)

Week 2

- Jan 16 **Lecture 3:** Phytoplankton - diversity and environmental relationships
Jan 17 **Section 2:** Covering Lectures 2 and 3
 Readings: Lecture 2 → Behrenfeld and Boss (2014), pages 167-176
 Lecture 3 → de Vargas et al. (2015)
Jan 18 **Lecture 4:** Zooplankton - diversity and adaptations of planktonic consumers

Week 3

- Jan 23 **Lecture 5:** Upper ocean circulation, biogeography, biomes
Jan 24 **Section 3:** Covering Lectures 4 and 5
Readings: Lecture 4 → Hansen and Calado (1999)
Lecture 5 → Follows et al. (2007)
Jan 25 **Exam 1: Covering Lectures 1-5**

Week 4

- Jan 30 **Lecture 6:** Ecology of marine mammals (Professor Simone Baumann-Pickering)
Jan 31 **Section 4:** Covering Lecture 6
Reading: Lecture 6 → Ballance (2006)
Feb 1 **Lecture 7:** Vertical migrations and life in the twilight zone (Professor Anela Choy)
This lecture will be pre-recorded and posted on Canvas.

Week 5

- Feb 6 **Lecture 8:** Secondary production processes and relationships
Feb 7 **Section 5:** Covering Lectures 7 and 8
Readings: Lecture 7 → Choy et al. (2017)
Lecture 8 → Shurin et al. (2006)
Feb 8 **Lecture 9:** Organization of pelagic food webs
This lecture will be pre-recorded and posted on Canvas. A Canvas quiz will take the place of in-class Clicker questions.

Week 6

- Feb 13 **Lecture 10:** Trait-based ecology of marine microbes
Feb 14 **Section 6:** Covering Lectures 9 and 10
Readings: Lecture 9 → Steinberg & Landry (2017), pages 413-426
Lecture 10 → Barton et al. (2013)
Feb 15 **Exam 2: Covering Lectures 6-10**

Week 7

- Feb 20 **Lecture 11:** Ocean biogeochemical cycles I: carbon cycle.
This lecture will be pre-recorded and posted on Canvas. A Canvas quiz will take the place of in-class Clicker questions.
Feb 21 **Section 7:** Covering Lecture 11
Reading: Lecture 11 → Henson et al. (2012)
Feb 22 **Lecture 12:** Ocean biogeochemical cycles II: nitrogen, phosphorus, iron
This lecture will be pre-recorded and posted on Canvas. A Canvas quiz will take the place of in-class Clicker questions.

Week 8

- Feb 27 **Lecture 13:** Larval ecology and recruitment of ocean fishes & natural climate cycles
Feb 28 **Section 8:** Covering Lectures 12 and 13
Readings: Lecture 12 → Zehr (2011)
Lecture 13 → Chavez et al. (2003)
Feb 29 **Lecture 14:** Coral reef ecology (Professor Jennifer Smith)

Week 9

- Mar 5 **Lecture 15:** Impacts of anthropogenic climate change on marine ecosystems
Mar 6 **Section 9:** Covering Lectures 14 and 15
Readings: Lecture 14 → Hoegh-Guldberg (1999)
Lecture 15 → Edwards & Richardson (2004)
Mar 7 **Exam 3: Covering Lectures 11-15**

Week 10

- Mar 12 **Lecture 16:** Sea ice, climate change, and the ecology of polar regions
Mar 13 **Section 10:** Covering Lecture 16
Reading: → Ducklow et al. (2013)
Mar 14 **In-class review session** (no Clicker points)

Final Exam

- Mar 19 Final exam (8am-9:20am), location TBD

Reading Assignments

- Anderson, T. R., and T. Rice. 2006. Deserts on the sea floor: Edward Forbes and his azoic hypothesis for a lifeless deep ocean. **30**: 131-137. 10.1016/j.endeavour.2006.10.003
- Ballance, L. T. and others 2006. The Removal of Large Whales from the Southern Ocean Evidence for Long-Term Ecosystem Effects?, p. 215-230. *In* R. L. Brownell, J. A. Estes, D. P. Demaster, D. F. Doak and T. M. Williams [eds.], Whales, Whaling, and Ocean Ecosystems. University of California Press.
- Barton, A. D. and others 2013. The biogeography of marine plankton traits. *Ecol. Lett.* **16**: 522-534. 10.1111/ele.12063
- Behrenfeld, M. J., and E. S. Boss. 2014. Resurrecting the ecological underpinnings of ocean plankton blooms. *Ann. Rev. Mar. Sci.* **6**: 167-194. 10.1146/annurev-marine-052913-021325
- Chavez, F. P., J. Ryan, S. E. Lluch-Cota, and M. C. Niquen. 2003. From anchovies to sardines and back: multidecadal change in the Pacific Ocean. *Science* **299**: 217-221.
- Choy, C. A., S. H. D. Haddock, and B. H. Robison. 2017. Deep pelagic food web structure as revealed by in situ feeding observations. *Proceedings. Biological sciences / The Royal Society* **284**. 10.1098/rspb.2017.2116
- De Vargas, C. and others 2015. Eukaryotic plankton diversity in the sunlit ocean. *Science* **348**: 1261605. 10.1126/science.1261605
- Ducklow, H. and others 2013. West Antarctic Peninsula: An Ice-Dependent Coastal Marine Ecosystem in Transition. *Oceanogr.* **26**: 190-203. 10.5670/oceanog.2013.62

- Edwards, M., and A. J. Richardson. 2004. Impact of climate change on marine pelagic phenology and trophic mismatch. *Nature* **430**: 881-884.
- Follows, M. J., S. Dutkiewicz, S. Grant, and S. W. Chisholm. 2007. Emergent biogeography of microbial communities in a model ocean. *Science* **315**: 1843-1846.
10.1126/science.1138544
- Hansen, B., P. K. Bjørnsen, and P. J. Hansen. 1994. The size ration between planktonic predators and their prey. *Limnol. Oceanogr.* **39**: 395-403.
- Hansen, P. J., and A. J. Calado. 1999. Phagotrophic mechanisms and prey selection in free-living dinoflagellates. *J. Eukaryot. Microbiol.* **46**: 382-389.
- Henson, S. A., R. Sanders, and E. Madsen. 2012. Global patterns in efficiency of particulate organic carbon export and transfer to the deep ocean. *Global Biogeochem Cyc* **26**.
10.1029/2011gb004099
- Hoegh-Guldberg, O. 1999. Climate change, coral bleaching and the future of the world's coral reefs. *Mar. Freshwater. Res.* **50**: 839-866.
- Shurin, J. B., D. S. Gruner, and H. Hillebrand. 2006. All wet or dried up? Real differences between aquatic and terrestrial food webs. *Proceedings of The Royal Society Biological Sciences* **273**: 1-9. 10.1098/rspb.2005.3377
- Steinberg, D. K., and M. R. Landry. 2017. Zooplankton and the Ocean Carbon Cycle. *Ann Rev Mar Sci* **9**: 413-444. 10.1146/annurev-marine-010814-015924
- Zehr, J. P. 2011. Nitrogen fixation by marine cyanobacteria. *Trends Microbiol.* **19**: 162-173.
10.1016/j.tim.2010.12.004