

**SIO 134 / BIEB 134: Introduction to Biological Oceanography
WINTER 2022**

Lectures: Tuesday/Thursday 9:30-10:50am, CTL 0125
Final exam Tuesday March 15 8-11am, CTL 0125

The course will be taught remotely from January 3-17, 2022. During this time, lectures will be pre-recorded and posted on Canvas, and sections will be held via Zoom. Participation in Zoom sections is required. After January 17, lectures and sections will be held in person, and attendance is required. For details, read below.

If you are sick, please do not attend lectures or sections. See details below for how to keep up with the class in the event of illness.

Course Instructor

Andrew Barton, Assistant Professor

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Office Hours: Tuesdays 11:15am-12pm, Muir 1104. During remote instruction periods, office hours will be held via Zoom. See Canvas for schedule and links.

Teaching Assistants

Chase James ccjames@ucsd.edu

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Alaina Smith ans132@ucsd.edu

Heidi Tate htate@ucsd.edu

Section times, locations, and responsible TA are listed below:

| | | |
|------------|----------|---------------------|
| 8-8:50am | HSS 2150 | Alaina Smith |
| 10-10:50am | WLH 2114 | Alaina Smith |
| 10-10:50am | HSS 2150 | Christy Puzzanghera |
| 2-2:50pm | HSS 2154 | Christy Puzzanghera |
| 5-5:50pm | WLH 2112 | Chase James |
| 7-7:50pm | HSS 2154 | Heidi Tate |
| 8-8:50pm | HSS 2154 | Heidi Tate |

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: Following UCSD guidance, the course will be taught remotely from January 3-17, and

then held in-person after that. While remote, lectures will be pre-recorded and posted on Canvas's Media Gallery (<https://canvas.ucsd.edu>). When UCSD indicates that we are again allowed to do so, lectures will be held in-person at the regularly scheduled time and place. pdf files of the lectures will be available on Canvas prior to lecture. The in-person lectures will also be available as podcasts (<https://podcast.ucsd.edu>). In my experience, sometimes the podcasts are unavailable, so it is essential to attend the in-person lectures.

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 would not add test questions on minutiae from a paper, the general concepts discussed in the readings are "fair game" for 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. One way to do this is: 1) Go to vpn.ucsd.edu in a browser, 2) Enter your login credentials, 3) Paste the links above into the open field. The books are not required reading, but many students find these books useful.

Discussion Sections: As with the lectures, TA-led discussion sections will be conducted remotely initially (until January 17) but revert to in-person format when we are allowed to do so. The remote sections will be held on Zoom, and the in-person sections will be held at the regularly-scheduled time and place. 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 8am on the day of section. 8am 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 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 8am 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 1-2 sentences.

Background information: Describe in 1-2 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 1-2 sentences.

Conclusions and Implications: Describe the conclusions and implications of the results in 1-2 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. You may discuss the papers with other students but must complete the summary by yourself. **Do not simply quote the paper; 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. **Please do not attend section in person if you are sick.** If you are sick, 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. 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>

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.

30% 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.

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 4 **Lecture 1:** Course overview - habitats, major themes, historical perspective
Jan 5 **Section 1:** Covering Lecture 1
 Reading: Lecture 1 → Anderson and Rice (2006)
Jan 6 **Lecture 2:** Why plankton “bloom” – the dynamics of ocean biology

Week 2

- Jan 11 **Lecture 3:** Phytoplankton - diversity and environmental relationships
Jan 12 **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 13 **Lecture 4:** Zooplankton - diversity and adaptations of planktonic consumers

Week 3

- Jan 18 **Lecture 5:** Upper ocean circulation, biogeography, biomes
Jan 19 **Section 3:** Covering Lectures 4 and 5
 Readings: Lecture 4 → Hansen and Calado (1999)
 Lecture 5 → Follows et al. (2007)
Jan 20 **Exam 1: Covering Lectures 1-5**

Week 4

- Jan 25 **Lecture 6:** Vertical migrations and life in the twilight zone (Professor Anela Choy)
Jan 26 **Section 4:** Covering Lecture 6
Reading: Lecture 6 → Choy et al. (2017)
Jan 27 **Lecture 7:** Ecology of marine mammals (Dr. Simone Baumann-Pickering)

Week 5

- Feb 1 **Lecture 8:** Secondary production processes and relationships
Feb 2 **Section 5:** Covering Lectures 7 and 8
Readings: Lecture 7 → Ballance (2006)
Lecture 8 → Shurin et al. (2006)
Feb 3 **Lecture 9:** Organization of pelagic food webs

Week 6

- Feb 8 **Lecture 10:** Trait-based ecology of marine microbes
Feb 9 **Section 6:** Covering Lectures 9 and 10
Readings: Lecture 9 → Steinberg & Landry (2017), pages 413-426
Lecture 10 → Barton et al. (2013)
Feb 10 **Exam 2: Covering Lectures 6-10**

Week 7

- Feb 15 **Lecture 11:** Ocean biogeochemical cycles I: carbon cycle
Feb 16 **Section 7:** Covering Lecture 11
Reading: Lecture 11 → Henson et al. (2012)
Feb 17 **Lecture 12:** Ocean biogeochemical cycles II: nitrogen, phosphorus

Week 8

- Feb 22 **Lecture 13:** Larval ecology and recruitment of ocean fishes & natural climate cycles and the ups and downs of ocean fisheries
Feb 23 **Section 8:** Covering Lectures 12 and 13
Readings: Lecture 12 → Zehr (2011)
Lecture 13 → Chavez et al. (2003)
Feb 24 **Lecture 14:** Coral reef ecology (Professor Jennifer Smith)

Week 9

- Mar 1 **Lecture 15:** Impacts of anthropogenic climate change on marine ecosystems
Mar 2 **Section 9:** Covering Lectures 14 and 15
Readings: Lecture 14 → Hoegh-Guldberg (1999)
Lecture 15 → Edwards & Richardson (2004)
Mar 3 **Exam 3: Covering Lectures 11-15**

Week 10

- Mar 8 **Lecture 16:** Sea ice, climate change, and the ecology of polar regions
Mar 9 **Section 10:** Covering Lecture 16
Reading: → Ducklow et al. (2013)
Mar 10 **In-class review session**

Final Exam

Mar 15 Final exam (8-11am)

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