SIO 134 / BIEB 134: Introduction to Biological Oceanography
WINTER 2020

Course Instructor

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Office Hours: Tuesdays 11am-12pm, Muir Hall 1104

Teaching Assistants

Vitul Agarwal	v3agarwa@ucsd.edu	Office Hours: Thursdays 11am-12pm
Antonia Bock	akbock@ucsd.edu	Office Hours: Thursdays 2-3pm
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TA office hours will be held in Galbraith 364.

Lectures: 0930 -10:50, Tuesdays and Thursdays, Ledden Auditorium

Lecture Notes: PDF files will be available on Canvas (https://canvas.ucsd.edu), generally on the day prior to lecture. Their purpose is to facilitate note taking and study, not to substitute for lecture attendance. Lectures will also be available as podcasts (https://podcast.ucsd.edu). For a variety of reasons, sometimes the podcasts are unavailable, so attendance is key.

Assigned readings: For each lecture, including guest lectures, there is an assigned journal article, review paper, or book section to read. The readings are available as PDF files on the course website. The purpose of the readings is twofold. First, the readings complement the lectures on ecological topics or issues of contemporary concern for marine ecosystems. In some cases, the readings go into greater technical or methodological detail than I will cover in the lectures. However, the general concepts discussed in the readings are "fair game" for exams. Secondly, in each discussion section starting in Week 2 (January 15), groups of students will prepare a presentation summarizing the main concepts in the readings. See "Discussion Sections" below for more details on the presentations in section.

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

Though both books are available online through the UCSD library at the links above, you will need to have a UCSD IP address to view the books. The books are not required reading.

Discussion Sections: TA-led discussion sections are designed to discuss content from the lectures and exams, and also to give students the opportunity to present a summary of the assigned readings. Discussion sections and associated grading will have two primary components: a) creation and discussion of exam-style questions and b) student presentations of the assigned reading.

For part a), each student should prepare no less than **6** 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. **The questions are due at the beginning of section in hard copy format (not electronic) – students that arrive without completing the written assignment are welcome to stay to learn, but will not get full credit for the study questions that week**. The questions are not graded for accuracy, so it is the students' responsibility to make sure they understand the answers by participating in section discussion. Students will then discuss the newly-crafted questions in small groups and together with the TA and entire section for select questions. A total of 10 points will be awarded for successful completion of these questions in each of 10 sections (see below for grading scheme). Some of

these questions from the discussion sections will be used for exam questions.

For part b), small groups of students (usually 2-3 per group) will work together to prepare summaries of the assigned readings for each week. The presentation should last 8 minutes, be prepared in PowerPoint or equivalent, and be emailed or transferred to the TA prior to the start of the Section. Each student will prepare 2 presentations during the course, worth 5 points each for a total of 10 points. The groups, paper topics, and dates will be assigned by the TA randomly and the schedule posted online.

The presentations should last no more than 8 minutes and include the following 5 components (1 point each for a total of 5 points):

1. Introduction, 1 slide. State the main objectives and questions from the reading. For full credit (1 point out of 5), clearly describe the main objectives and questions of the reading.

2. Background information, 1-2 slides. Describe any necessary background information to understand key aspects of the reading. These details can be technical or factual. For full credit (1 point out of 5), clearly explain any background information necessary to understand the reading.

3. Methods, 1 slide. Describe in brief fashion the method or methods used in the study. Focus on the methods that are most important for understanding the results. For full credit (1 point out of 5), clearly explain the methods used in the study. In the case of review papers, discuss the methods used in conducting the review and/or the methods in key literature cited.

4. Results, 2 slides. Describe the main results of the study and discuss in detail two figures from the reading. For full credit (1 point out of 5), clearly explain the study results and demonstrate understanding of what the study attempted to accomplish.

5. Conclusion and Discussion, 2 slides. In the first slide, clearly state the study conclusions. In the second slide, discuss any weaknesses of the study or how it might be improved. Also discuss the wider implications of the reading to oceanography, ecology, or global change biology. For full credit (1 point out of 5), clearly state the study conclusions, limitations, and possible implications.

Each student in the group should participate in presenting the summary, but grades out of 5 points will be assessed for the group collectively. Students are free to self-organize how to break up the presentation requirements (i.e., one student presents one part and the others two parts each)

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

For reference, the section times and location are as follows:

Wednesday, 8:00-8:50 am, SEQUO 148
Wednesday, 9:00-9:50 am, SEQUO 148
Wednesday, 10:00-10:50 am, SEQUO 148
Wednesday, 1:00-1:50 pm, SEQUO 148
Wednesday, 2:00-2:50 pm, SEQUO 148
Wednesday, 7:00-7:50pm, SEQUO 148

Attendance in section is necessary to do well in the course. You must attend your assigned section.

Clickers: Clickers will be used in lecture to assess participation (see Grading below). If you do not already have a Clicker, you will need to acquire one. We will start using Clickers on January 9. Visiting lecturers will not use Clickers.

Grading: Evaluation is by letter grade based on three midterm exams, a final exam, lecture participation (Clickers), and section participation points. The final exam will be comprehensive, but emphasize material since the third midterm.

Lecture Participation	**10 points**
Section Participation	**20 points**
Midterm Exam 1 (Thursday, January 23)	**40 points**
Midterm Exam 2 (Thursday, February 13)	**40 points**
Midterm Exam 3 (Thursday, February 27)	**40 points**
Final Exam (Tuesday, 17 March)	**70 points**
TOTAL	**220 points**

Lecture participation points (10 total) are assessed using i-Clicker questions in lecture. To gain full credit for each day, answer 75% of questions on that day. To gain full credit for Clicker points (10 points), attend and answer 75% of questions in at least 10 lectures. Partial credit (i.e., less than the total 10 points) will be awarded for less than full attendance. Clicker answers do not need to be correct to get credit. Exam questions are modeled on in-class Clicker questions, however.

Section participation points (20 total) are assessed based upon in-section paper presentations (10 points; 5 points for each of 2 presentations prepared by each student) and written study questions (10 points).

Make-up Policy: If you miss a midterm or final exam, you will be required to submit documentation of illness, emergency or other unavoidable absence. Without such documentation, you will receive zero points for that assessment. For missed midterms, and with documentation, the proportion of your grade that is based on your final exam will be increased to cover the assessment that was missed. For a missed final exam and with valid documentation, you will be expected to take the final orally or you will receive an incomplete for the course.

Lecture and Section Schedule

Date	Topic
Week 1	
Jan 7	**Lecture 1**: Overview - habitats, major themes and issues, historical perspective
Jan 8	**Section 1:** Covering Lecture 1
	Readings: Lecture 1 → Anderson & Rice (2006)
Jan 9	**Lecture 2**: Why plankton "bloom" – the dynamics of ocean biology
Week 2	
Jan 14	**Lecture 3**: Phytoplankton - diversity and environmental relationships
Jan 15	**Section 2:** Covering Lectures 2 & 3
	Readings: Lecture 2 → Behrenfeld & Boss (2014), pages 167-176
	Lecture 3 → de Vargas et al. (2015)
Jan 16	**Lecture 4**: Zooplankton - diversity and adaptations of planktonic consumers
Week 3	
Jan 21	**Lecture 5**: Upper ocean circulation, biogeography, biomes
Jan 22	**Section 3:** Covering Lectures 4 & 5, and Midterm 1 review
	Readings: Lecture 4 → Hansen & Calado (1999)
	Lecture 5 → Follows et al. (2007)
Jan 23	**MIDTERM 1, covering Lectures 1-4**
Week 4	
Jan 28	**Lecture 6**: Secondary production processes and relationships
Jan 29	**Section 4:** Covering Lecture 6, and Midterm 1
	Readings: Lecture 6 → Hansen et al. (1994)
Jan 30	**Lecture 7**: Organization of pelagic food webs

Week 5

Feb 4 **Lecture 8**: Ocean biogeochemical cycles I: carbon cycle

Feb 5 **Section 5:** Covering Lectures 7 & 8
Readings: Lecture 7 → Steinberg & Landry (2017), pages 413-426
Lecture 8 → Henson et al. (2012)

Feb 6 **Lecture 9**: Vertical migrations and life in the twilight zone (Professor Anela Choy)

Week 6

Feb 11 **Lecture 10**: Ocean biogeochemical cycles II: nitrogen, phosphorus

Feb 12 **Section 6:** Covering Lectures 9 & 10, Midterm 2 review
Readings: Lecture 9 → Choy et al. (2017)
Lecture 10 → Zehr (2011)

Feb 13 **MIDTERM 2, covering Lectures 5-8**

Week 7

Feb 18 **Lecture 11**: Trait based ecology of marine microbes

Feb 19 **Section 7:** Covering Lecture 11, and Midterm 2
Readings: Lecture 11 → Barton et al. (2013)

Feb 20 **Lecture 12**: Larval ecology and recruitment of ocean fishes **&** Natural climate cycles and the ups and downs of ocean fisheries

Week 8

Feb 25 **Lecture 13**: Ecology of marine mammals (Dr. Simone Baumann-Pickering)

Feb 26 **Section 8:** Covering Lectures 12 & 13, and Midterm 3 review
Readings: Lecture 12 → Chavez et al. (2003)
Lecture 13 → Ballance (2006)

Feb 27 **MIDTERM 3, covering Lectures 9-12**

Week 9

Mar 3 **Lecture 14**: Impacts of anthropogenic climate change on marine ecosystems

Mar 4 **Section 9:** Covering Lecture 14, and Midterm 3
Readings: Lecture 14 → Edwards & Richardson (2004)

Mar 5 **Lecture 15**: Coral reef ecology (Professor Jennifer Smith)

Week 10

Mar 10 **Lecture 16**: Sea ice, climate change, and the ecology of polar regions

Mar 11 **Section 10:** Covering Lectures 15 & 16
Readings: Lecture 15 → Hoegh-Guldberg (1999)
Lecture 16 → Ducklow et al. (2013)

Mar 12 **Lecture 17**: In class review and synthesis

Mar 17 FINAL EXAM (0800 – 1100)

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. Endeavour 30:131-137.

Ballance, L. T., R. L. Pitman, R. P. Hewitt, D. B. Siniff, W. Z. Trivelpiece, P. J. Clapham, and R. L. Brownell. 2006. The Removal of Large Whales from the Southern Ocean Evidence for Long-Term Ecosystem Effects?, Pages 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., A. J. Pershing, E. Litchman, N. R. Record, K. F. Edwards, Z. V. Finkel, T. Kiorboe et al. 2013. The biogeography of marine plankton traits. Ecology Letters 16:522-534.

Behrenfeld, M. J., and E. S. Boss. 2014. Resurrecting the ecological underpinnings of ocean plankton blooms. Annual Review of Marine Science 6:167-194.

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 of the Royal Society B 284.

de Vargas, C., S. Audic, N. Henry, J. Decelle, F. Mahé, R. Logares, E. Lara et al. 2015. Eukaryotic plankton diversity in the sunlit ocean. Science 348:1261605.

Ducklow, H., W. Fraser, M. Meredith, S. Stammerjohn, S. Doney, D. Martinson, S. Sailley et al. 2013. West Antarctic Peninsula: An Ice-Dependent Coastal Marine Ecosystem in Transition. Oceanography 26:190-203.

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.

Hansen, B., P. K. Bjørnsen, and P. J. Hansen. 1994. The size ration between planktonic predators and their prey. Limnology and Oceanography 39:395-403.

Hansen, P. J., and A. J. Calado. 1999. Phagotrophic mechanisms and prey selection in free-living dinoflagellates. Journal of Eukaryotic Microbiology 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 Biogeochemical Cycles 26.

Hoegh-Guldberg, O. 1999. Climate change, coral bleaching and the future of the world's coral reefs. Marine and Freshwater Research 50:839-866.

Steinberg, D. K., and M. R. Landry. 2017. Zooplankton and the Ocean Carbon Cycle. Annual Reviews of Marine Science 9:413-444.

Zehr, J. P. 2011. Nitrogen fixation by marine cyanobacteria. Trends in Microbiology 19:162-173.