

SIO 134: Introduction to Biological Oceanography

WINTER 2019

Course Instructors:

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Teaching Assistants:

Sarah Schwenck sschwenc@ucsd.edu

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Office: Tuesday 5-6pm, York 3030

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Office: Wednesday 4-5pm, Galbraith 364

Lectures: 0930 -10:50, Tuesday and Thursday, **Center Hall 115**

Lecture Notes: PDF files will be available on **TritonEd** (<https://tritoned.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>).

Assigned readings: These short journal articles, available as PDF files on the course website, are meant to complement the lectures on important ecological topics or issues of contemporary concern for marine ecosystems. Details in these readings may go beyond what is necessary to understand for the course, so they need not be studied in detail. **However, the general concepts are “fair game” for exams.** *Readings are assigned by lecture week and are best completed before the relevant lecture or weekly Discussion Section.*

Additional background reading: While not necessary to do well in the course, interested students can find additional information on concepts in the following 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.

Discussion Sections (not mandatory): TA-led sections are primarily for the clarification of lecture material and readings and preparation for exams. The TA will lead discussions of assigned readings for the week. Reviews for Mid-term Exams will also be done in sections.

Section times and locations:

Monday, 5:00-5:50 am, HSS 1305, Sarah Schwenck

Monday, 6:00-6:50 am, HSS 1305, Sarah Schwenck

Tuesday, 6:00-6:50 pm, Center 207, Alaina Smith

Tuesday, 7:00-7:50 pm, Center 207, Alaina Smith

Wednesday, 5:00-5:50 pm, HSS 1305, Jennifer Le

Wednesday, 6:00-6:50pm, HSS 1305, Jennifer Le

Clickers: Clickers will be used in lecture to assess participation (see below). If you do not already have a Clicker, you will need to purchase (or borrow) one. To register your Clicker, log into TritonEd. On your homepage you will see a window titled “iClicker Remote ID Registration.” We will start using Clickers on January 10.

Grading: Evaluation is by letter grade based on three exams, plus lecture participation points. The final exam will be comprehensive, but emphasize material since the second midterm.

Lecture Participation	10 points
Midterm Exam I (Tuesday, January 29)	50 points
Midterm Exam II (Tuesday, February 19)	50 points
Final Exam (Tuesday, 19 March)	90 points
TOTAL	200 points

Lecture participation points (10 out of 200 total for the class) are assessed using i-Clicker questions in lecture. To gain full credit, answer 75% of questions in 75% of lectures (starting January 10). **No partial credit will be given** for attendance and participation below this threshold, but the 75% criteria allows for excused absences, sickness, etc. Clicker answers do not need to be correct to get credit. Exam questions are modeled on in-class Clicker questions, however.

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.

Course Content: SIO 134 provides the basics for understanding the ecology of marine communities in a dynamic and changing ocean environment. In the first part, we take a process approach, focusing on major functional groups of marine organisms, how they interact in ocean food webs, and how the resulting communities respond to their environment. In the second half, we use this foundation as a basis for considering contemporary issues in ocean ecology, including human and climate influences.

Lecture Schedule

Date	Topic
Week 1	Readings: <i>Anderson & Rice (2006); Miller (2004)</i>
Jan 8	Lecture 1: Overview - habitats, major themes and issues, historical perspective (Barton)
Jan 10	Lecture 2: Why plankton “bloom” – the dynamics of ocean biology (Barton)
Week 2	Readings: <i>Capone et al. (1997); Hansen & Calado (1999); De Vargas et al. (2015)</i>
Jan 15	Lecture 3: Phytoplankton - diversity and environmental relationships (Barton)
Jan 17	Lecture 4: Zooplankton - diversity and adaptations of planktonic consumers (Barton)
Week 3	Readings: <i>Barton et al. (2013); Koehl & Strickler (1981); Alldredge & Madin (1982)</i>
Jan 22	Lecture 5: Upper ocean circulation, biogeography, biomes (Barton)
Jan 24	Lecture 6: Secondary production processes and relationships (Landry)
Week 4	Readings: <i>Pomeroy et al. (2007); Frank et al. (2005); Condon et al. (2011)</i>
Jan 29	MIDTERM 1, covering Lectures 1-5
Jan 31	Lecture 7: Organization of pelagic food webs (Landry)
Week 5	Readings: <i>Benoit-Bird (2004); Smith et al. (1989); Danovaro et al. (2014)</i>
Feb 5	Lecture 8: Vertical migrations and life in the twilight zone (Landry)
Feb 7	Lecture 9: Ecology of deep-sea organisms and habitats (Landry)
Week 6	Readings: <i>Williams & Follows, Chapters 2 and 6 (2011); Knowlton (2001); Sandin et al. (2010)</i>
Feb 12	Lecture 10: Ocean biogeochemical cycles I: carbon cycle (Barton)
Feb 14	Lecture 11: Coral reef ecology (Dr. Jennifer Smith)

- Week 7** Readings: *Boyd et al. (2007); Zehr (2011)*
 Feb 19 **MIDTERM 2, covering lectures 6-10**
 Feb 21 **Lecture 12:** Ocean biogeochemical cycles II: nitrogen, phosphorus and iron (**Barton**)
- Week 8** Readings: *Ballance et al. (2001); Ducklow et al. (2013)*
 Feb 26 **Lecture 13:** Seabird ecology of the oceanic tropical Pacific (**Dr. Lisa Ballance**)
 Feb 28 **Lecture 14:** Sea ice, global warming and the ecology of polar regions (**Landry**)
- Week 9** Readings: *Gargett (1997); Chavez et al. (2003)*
 Mar 5 **Lecture 15:** Larval ecology and recruitment of ocean fishes (**Landry**)
 Mar 7 **Lecture 16:** Natural climate cycles and the ups and downs of ocean fisheries (**Landry**)
- Week 10** Readings: *Estes et al (2016); IPCC Summary for Policy Makers (2013)*
 Mar 12 **Lecture 17:** Ecology of marine mammals (**Dr. Simone Baumann-Pickering**)
 Mar 14 **Lecture 18:** Impacts of anthropogenic climate change on marine ecosystems (**Barton**)
- Mar 19 FINAL EXAM (Tuesday, 0800 – 1100)**

Weekly Reading Assignments

Week 1

- Anderson, T.R. & T. Rice. 2006. Deserts on the sea floor: Edward Forbes and his azoic hypothesis for a lifeless deep ocean. *Endeavour*, 30: 131-136.
- Miller, C.B. 2004. The spring phytoplankton bloom. Chapter 1 (pp 1-19) in Miller, C.B. *Biological Oceanography*, Blackwell Science Ltd., Oxford.

Week 2

- Capone, D.G., et al. 1997. *Trichodesmium*, a globally significant marine cyanobacterium. *Science*, 276: 1221-1229.
- Hansen, P.J. & A.J. Calado. 1999. Phagotrophic mechanisms and prey selection in free-living dinoflagellates. *J. Eukary. Microbiol.*, 46: 382-389.
- De Vargas, C., et al. 2015. Eukaryotic plankton diversity in the sunlit ocean. *Science*, 348, DOI: 10.1126/science.1261605

Week 3

- Koehl, M.A.R. & J.R. Strickler. 1981. Copepod feeding currents: Food capture at low Reynolds Number. *Limnol. Oceanogr.*, 26: 1062-1073.
- Allredge, A.L. & L.P. Madin. 1982. Pelagic tunicates: unique herbivores in the marine plankton. *BioScience*, 32: 655-663.
- Barton A.D., et al. 2013. The biogeography of marine plankton traits. *Ecol. Lett.*, 16:522-534.

Week 4

- Pomeroy, L.R., et al. 2007. The microbial loop. *Oceanography*, 20: 28-33.
- Frank, K.T., et al. 2005. Trophic cascades in a formerly cod-dominated ecosystem. *Science*, 308: 1621-1623.
- Condon, R.H., et al. 2011. Jellyfish blooms result in major microbial respiratory sink of carbon in marine systems. *Proc. Nat. Acad. Sci.*, 108: 10225-10230.

Week 5

- Benoit-Bird, K.J. 2004. Prey caloric value and predator energy needs: Foraging predictions for wild spinner dolphins. *Mar. Biol.*, 145: 435-444.
- Smith C.R. et al. 1989. Vent fauna on whale remains. *Nature*, 341: 27-28.
- Danovaro R. et al. 2014. Challenging the paradigms of deep-sea ecology. *TREE*, 29: 465-475.

Week 6

- Williams, R. & M.J. Follows. 2011. An introductory view of the ocean. Chapter 2 (pp 34-38) in Williams, R. & M.J. Follows, *Ocean Dynamics and the Carbon Cycle*, Cambridge University Press.
- Williams, R. & M.J. Follows. 2011. Carbonate chemistry fundamentals. Chapter 6 (pp 125-133) in Williams, R. & M.J. Follows, *Ocean Dynamics and the Carbon Cycle*, Cambridge University Press.
- Knowlton, N. 2001. The future of coral reefs. *Proc. Nat. Acad. Sci.*, 98: 5419-5425.
- Sandin, S.A., S.M. Walsh & J.B.C. Jackson. 2010. Prey release, trophic cascades, and phase shifts in tropical nearshore marine ecosystems, Pp. 71-90 in J. Terborgh & J.A. Estes, eds. *Trophic cascades: predators, prey, and the changing dynamics of nature*. Island Press.

Week 7

- Boyd, P.W. et al. 2007. Mesoscale iron enrichment experiments 1993-2005: Synthesis and future directions. *Science*, 315: 612-617.
- Zehr, J.P. (2011). Nitrogen fixation by marine cyanobacteria. *Trends Microbiol.*, 19: 162–173.

Week 8

- Ballance L.T., et al. 2001. Seabird foraging ecology. Pages 2636-2644 In: Steele, J.H., S.K. Thorpe and K.K. Turekian (eds.), *Encyclopedia of Ocean Science*, Academic Press.
- Ducklow, H.W., et al. 2013. West Antarctic Peninsula: An ice-dependent coastal marine ecosystem in transition. *Oceanography*, 26: 190-203.

Week 9

- Chavez, F.P., et al. 2003. From anchovies to sardines and back: Multidecadal change in the Pacific Ocean. *Science*, 299: 217-221.
- Gargett, A.E. 1997. Physics to fish: Interactions between physics and biology on a variety of scales. *Oceanography*, 10: 128-131.

Week 10

- Estes, J. A., M. Heithaus, D. J. McCauley, D. B. Rasher and B. Worm. 2016. Megafaunal Impacts on structure and function of ocean ecosystems. *Annu. Rev. Environ. Res.* 41: 83-116.
- IPCC, 2013: Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.