

SIO 134: Introduction to Biological Oceanography

WINTER 2018

Course Instructors:

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Office Hours: Tuesdays 11:00-12:00, Muir Hall 2165

Teaching Assistants:

Abigail Cannon	alcannon@ucsd.edu	Office: Wed, 1:00-1:50 pm, Location TBD
Angus Thies	athies@ucsd.edu	Office: Wed, 4:00-4:50 pm, Location TBD
Ben Whitmore	bmwhitmo@ucsd.edu	Office: Wed, 10:00-10:50 am, Location TBD

Lectures: 0930 -10:50, Tuesday and Thursday, **Center Hall 119**

Lecture Notes: PDF files will be available on **TritonEd**, <https://tritoned.ucsd.edu>, generally on the afternoon 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>). Access is by your UCSD Academic Computing **username** and **password**.

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 on library reserve:

Biological Oceanography, C.B. Miller & P.A. Wheeler, Wiley Blackwell Publ., 2nd ed., 2013.
Biological Oceanography: An Introduction, C.M. Lalli & T.R. Parsons, 2nd ed., 1997.

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:

Wednesday, 9:00-9:50 am, HSS 1315, TA Ben Whitmore
Wednesday, 10:00-10:50 am, HSS 1315, TA Ben Whitmore
Wednesday, 2:00-2:50 pm, Center 217B, TA Abby Cannon
Wednesday, 3:00-3:50 pm, Center 217B, TA Abby Cannon
Wednesday, 5:00-5:50 pm, HSS 1315, TA Angus Thies

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

Midterm Exam I (Tuesday, 30 January)	50 points
Midterm Exam II (Tuesday, 20 February)	50 points
Final Exam (Tuesday, 20 March)	100 points
TOTAL	200 points

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 9	Lecture 1: Overview - habitats, major themes and issues, historical perspective (Landry)
Jan 11	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 16	Lecture 3: Phytoplankton - diversity and environmental relationships (Barton)
Jan 18	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 23	Lecture 5: Upper ocean circulation, biogeography, biomes (Barton)
Jan 25	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 30	MIDTERM 1, covering Lectures 1-5
Feb 1	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 6	Lecture 8: Vertical migrations and life in the twilight zone (Landry)
Feb 8	Lecture 9: Ecology of deep-sea organisms and habitats (Landry)
Week 6 Readings: <i>Ballance et al. (2001); Knowlton (2001); Sandin et al. (2010)</i>	
Feb 13	Lecture 10: Seabird ecology of the oceanic tropical Pacific (Dr. Lisa Ballance)
Feb 15	Lecture 11: Coral reef ecology (Dr. Jennifer Smith)
Week 7 Readings: <i>Doney et al. (2009); Williams and Follows, Chapters 2 and 6 (2011)</i>	
Feb 20	MIDTERM 2, covering lectures 6-10
Feb 22	Lecture 12: Ocean biogeochemical cycles I: carbon cycle (Barton)
Week 8 Readings: <i>Boyd et al. (2007); Zehr (2011); Ducklow et al. (2013)</i>	
Feb 27	Lecture 13: Ocean biogeochemical cycles II: nitrogen, phosphorus and iron (Barton)
Mar 1	Lecture 14: Sea ice, global warming and the ecology of polar regions (Dr. Jeff Bowman)
Week 9 Readings: <i>Estes et al (2016); Jackson et al. (2001)</i>	
Mar 6	Lecture 15: Ecology of marine mammals (Dr. Simone Baumann-Pickering)
Mar 8	Lecture 16: Larval ecology and recruitment of ocean fishes (Landry)
Week 10 Readings: <i>Gargett (1997); Chavez et al. (2003); IPCC Summary for Policy Makers (2013)</i>	
Mar 13	Lecture 17: Natural climate cycles and the ups and downs of ocean fisheries (Landry)
Mar 15	Lecture 18: Impacts of anthropogenic climate change on marine ecosystems (Barton)
Mar 20	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

- 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.
- 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

- Doney, S.C., et al. 2009. Ocean acidification: the other CO₂ problem. *Annu. Rev. Mar. Sci.*, 1: 169-192.
- 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.

Week 8

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.

Ducklow, H.W., et al. 2013. West Antarctic Peninsula: An ice-dependent coastal marine ecosystem in transition. *Oceanography*, 26: 190-203.

Week 9

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.

Jackson, J.B.C. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science*, 293: 629-638.

Week 10

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.

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.