**BIOL 4720 –** Marine Ecology

**Instructor**: Dr. Patrick Krug

Lab: Tues 1:50 - 4:20 PM, ASC-L 344 (LaKretz Hall)

Lecture: Tues-Thurs 5:00 - 5:50 PM, ASC-L 344 (LaKretz Hall)

**Office hours**:

Krug: Thursday 4:00 - 5:00 PM Office: LaKretz Hall (ASC-L) 314

**Contact information**

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**Course description**

Marine ecology is the study of the natural processes that structure ocean and coastal communities, and how those communities are rapidly changing in response to anthropogenic stresses. Compared to when I was in grad school, marine ecological studies are now highly interdisciplinary and routinely encompass diverse tools such as satellite imaging, statistical modeling, genomics and eDNA profiling, and/or socio-economic and policy considerations to increase our understanding and improve our stewardship of the oceans. It can take a while to get used to the very different scale between marine ecological studies, whether thinking about size, distance, or time. Studies range from monitoring the tiniest viruses to the blue whale, the largest-ever living animal. Other papers track seabirds flying hundreds of meters in the sky over thousands of km, or nutrient flux from the surface to the bottom of the deepest oceanic trench. Consider the very different challenges and scales involved in trying to measure the response of a snail that moves only a few cm in a day, to a panicked white shark that dives a thousand meters and swims from California to Hawai’i.

This course will review key concepts in marine ecological theory and practice. It will also develop skills used in marine ecology by having students participate in field and laboratory work, developing and testing an original hypothesis based on the instructor’s ongoing research. There are two weekly lectures (1 hour) and one laboratory (3 hours) session. The class will develop your communication skills by having group presentations on background topics for papers we will read, as well as on your research findings. Our readings for the course will be primary literature articles. Lectures will be put online ahead of time, so that class time can be used for discussion and review of the subject matter. Exams will be take-home written tests that emphasize data interpretation and experimental design rather than memorization, although understanding lecture and lab content will be essential to perform will.

**Governing policies**

***Attendance***: Attendance and participation in lecture and lab are important parts of the course. Especially given the continuing pandemic, please be aware that all medically excused absences (such as quarantining or illness) and other excused absences are managed per our campus missed-class policy: www.calstatela.edu/academicsenate/handbook/ch5. Students have the right to make up missed work for an excused absence but are responsible for notifying faculty and working together with faculty to devise appropriate make-up work. Whenever possible, please provide advance notice if you will be missing lecture or lab (for instance, if you know you may be attending a conference during a certain week, tell me at the start of the term), or notify me as soon as possible following an unplanned absence due to illness or emergency.

***Academic honesty***: This class is structured to encourage group work and collaboration, but students are expected to turn in their own work in accordance with the University’s Academic Honesty Policy, especially with regard to plagiarism (http://www.calstatela.edu/academicsenate/handbook/ch5a). Students who violate this policy will be reported to the University and may receive a failing grade in the course for violating the policy. I want to support you and ensure you are successful in the course, so please let me know if you need any additional time or resources rather than resorting to academic dishonesty; give me the opportunity to assist or accommodate your situation. If you are unsure what constitutes an acceptable degree of paraphrasing, ask me; when in doubt, cite your sources *excessively* rather than failing to cite appropriately, and use your own words.

***Accommodations***: Reasonable accommodation will be provided to any student who is registered with the Office of Students with Disabilities (OSD) and requests needed accommodation. Contact OSD (<http://web.calstatela.edu/univ/osd/>; Administration Building, Room 127; x3140) to initiate requests for academic accommodations.

***Drop policy*:** The no-record drop deadline is **Feb 7;** no exceptions can be made to University policy. Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. Students should be aware of the current deadlines and penalties for adding and dropping classes by visiting the GET home page.

***Student Conduct:*** Information on student rights and responsibilities, standards of conduct, etc., can be found by visiting the Cal State LA University Catalog Appendices.

**Resources**

1) **Canvas** course website

Please visit the course e-learning site for all electronic materials, including powerpoint slides and lecture recordings; resources and general references; PDF copies of papers; upload links for assignments; and discussion boards. All course materials will be distributed regularly through Canvas. Some of the materials in this course may be copyrighted, and are intended for use only by registered and enrolled students, and only for instructional activities associated with and for the duration of this course. They may not be retained in another medium or disseminated further, and are provided in compliance with the provisions of the Teach Act.

2) **Recommended textbook**: ***Marine Biology: Function, Biodiversity, Ecology*** by Jeffrey S. Levinton, 2017, Oxford University Press (publisher). 5th edition.

A copy of this book will be on reserve in the University Library as background reading. You can also purchase older editions online for background reading to assist you in the course.

**Group presentations**

During the semester, we will read and discuss **three major topics** in marine ecology that have significantly impacted California’s marine ecosystems:

#1: Sea star wasting disease

#2: Loss of bull kelp amid recent marine heat waves

#3: Invasive species: attempted eradication of European green crab

For each topic, we will read and discuss 2-3 papers that present data and analyze present-day challenges facing California’s marine communities, due to a combination of natural and anthropogenic stressors. To make sure you have the necessary background information to fully digest these papers, the class will be divided into small groups. Each group will get a subtopic related to the main topic; we will figure out those assignments at the start of the class, so you will have the whole semester to research and put together your short presentations as a group. Each presentation should take about 8 minutes with 2 minutes for questions. *Expect to* *work with me* *in advance* of your presentation to review the materials you have drawn from, and the content you intend to cover. For full credit, you will need to submit a list of references (including websites, textbooks, and research articles) from which you have drawn information a week in advance, so I can make sure you are finding all the content you need and have enough to present to the class.

The goal is that after the group presentations, you will be familiar with all the background material necessary to thoroughly absorb the papers we will discuss the following week. However, I strongly encourage you to get a jump on reading these papers early; it may take several readings to grasp fully the material, including the methods used for data collection and analysis, and the basis for the conclusions.

**Field trips and research** **project**

A major activity of this class is an original research project that you will perform individually or in small groups, based on your interests and ideas. My laboratory is investigating the community ecology of mudflats in Californian estuaries. Research projects will ideally expand from this core set of planned experiments and field monitoring, to understand how the chemical defenses of a common sea slug affect energy flow and alter the microbiome and animal community. Part of this work will involve sampling local mudflats using techniques in marine ecology to compare community composition between estuaries or experimental treatments. The work will also involve laboratory sorting and identification of organisms from field-collected samples, and experiments using live organisms to test hypotheses you will develop based on our discussions and readings.

The main field sites we will visit are: (1) Salinas de San Pedro salt marsh, maintained by the Cabrillo Marine Aquarium in San Pedro, near the L.A. Harbor; and (2) Golden Shores marine reserve, at the mouth of the Los Angeles River in Long Beach. Both sites are mitigation or man-made wetlands, intended to compensate for the natural wetlands destroyed to make the harbor. We may also census other sites or examine samples from Long Beach and Venice, or Northern California, for comparison (depending on the nature of your project).

Days when fieldwork may be completed during class (between 1:50 and 5:50 PM on Tuesday) are indicated on the Course Schedule page with low tides in ***blue font***. On these days, you can plan to leave campus at 1:50 PM and meet at the field site by roughly 2:45 PM. This will allow 2-3 hours of fieldwork depending on your needs to return to campus (depart field site by 5 PM) or return directly home afterwards. There are a number of days marked when fieldwork is possible, given the timing of low tides and class; not everyone is required to perform fieldwork every time. You may have lab experiments or data analyses to perform on some days; we will work out individual schedules, and discuss transportation to field sites as needed to ensure everyone can be successful. There are also long-term data available for the mudflat and eelgrass communities at San Pedro that we will be able to analyze and compare with the original data we collect as a class.

The culminating products for your chosen project includes a **research paper** that will follow the format of a scientific journal article, which we will go over in class. This should be accompanied by an archived digital upload of your raw and processed data, as most journals now require as a condition of publication. Although you may work in a group, every student will do their own write-up. The second product is a **final research presentation**, which will be given during the scheduled final exam time period. Each group or individual will give a short presentation on their findings at the end of the semester, either as a talk or as a poster (up to the group or student). Our final exam time will thus function as a mini-conference to present and share your findings with each other.

**Learning objectives**

This course will develop the skills and content knowledge needed to work as a marine ecologist. You will demonstrate your skills through take-home exams, presentations and class discussions, and in the design, execution, and final write-up of your original research project.

**Content knowledge** – You will develop foundational knowledge of major concepts, terminology, and theory in marine ecology. Drawing on this knowledge, you will make interdisciplinary connections; synthesize ideas from this course and other courses you have taken; and propose and evaluate hypotheses.

* Explain major physical oceanographic processes that affect coastal organisms and ecosystems
* Differentiate top-down versus bottom-up processes structuring communities
* Explain the role of larval dispersal and recruitment in supply-side ecology
* Describe synergistic effects of anthropogenic stressors (including warming, OA, overfishing and invasive species) and natural stressors, like El Nino cycles or disease outbreaks
* Provide examples of chemically mediated interactions in marine ecology
* Evaluate experimental methods and study design, including statistical analyses

**Scientific skills** – Develop skills needed to perform marine ecological research on an original question, collecting and analyzing data through field and laboratory investigations.

* Summarize, synthesize and critique the primary scientific literature
* Propose and design a research study to test an original hypothesis
* Demonstrate proper field sampling techniques and laboratory equipment use
* Collect, organize and analyze data in a repeatable and understandable manner
* Perform statistical analyses appropriate to the question and dataset
* Present and explain data effectively in oral and written communication, and in graphical and tabular formats suitable for publication
* Develop information literacy skills needed to compile information and references needed for your group presentations and research project

**Lifelong work skills** – Develop skills that will transfer to any career or work setting, including the ability to collaborate and work effectively as part of a team; project and time management; troubleshooting and problem solving; good communication; and conflict resolution. These will serve you well in any field, but are notably important in marine ecology given its interdisciplinary and international nature, the role of fieldwork under challenging conditions, etc.

* Promote an inclusive, respectful, safe and positive work and study environment for everyone; listen as much as you talk, and make sure everyone gets to make their best contribution
* Work effectively in a team setting to develop a research plan that can be carried out with appropriate design and replication
* Set and adhere to timelines, meet your obligations and live up to expectations
* Work to get the most out of each group member: maximize the yield from each person’s skills, and help each other by leveraging your strengths
* Power through setbacks (inevitable in ecological research) – we learn when things don’t work, too!

**Grading**

10% 30 points online/in-class activities & exercises (participation, engagement)

20% 60 points 3 group presentations (10 minutes each)

30% 90 points take-home exams: data interpretation and experimental design

40% 120 points original research project (laboratory or field-based): paper and presentation

100% 300 points total

Credit for online and in-class activities will be awarded through Canvas based on completing the assigned activity, to recognize participation and engagement in class. Detailed rubrics for presentations and final project papers will be handed out and reviewed in class.

Take-home exams will emphasize data interpretation and experimental design rather than memorizing concepts. These exams will require you to be engaged and following the lecture and lab content to demonstrate an understanding of the key concepts in marine ecological theory and practice. You will have 2 weeks from the time an exam opens on Canvas to complete and upload your answers. You may discuss your approach with others but every student must write original answers reflecting their independent thought.

Grades in this course will be assigned as follows:

A: 92% - 100% C: 72% - 74%

A-: 88% - 91% C-: 68% - 71%

B+: 85% - 87% D+: 65% - 67%

B: 82% - 84% D: 62% - 64%

B-: 78% - 81% F: <61%

C+: 75% - 77%

**Course Schedule**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Week** | **Date** | **lab activities T 1:50-4:20 PM** | **lecture topic T/Th 5:00-5:50 PM** | **Assignment due** | **Reading due** |
| 1 | Jan 24 | 1. Course overview  2. Intro to research projects  3. Group presentation topics | How the ocean works I: currents, Coriolis, upwelling | 1a. complete course pre-  quizzes on Canvas | 1. syllabus |
|  | Jan 26 |  | How the ocean works II: tides, waves, stratification, El Niño | 1b. complete entry on course  Discussion board |  |
| 2 | Jan 31 | *low tide: -0.2, 1:10 PM (sunset: 5:20)*  4. Field orientation, initial sampling @  Cabrillo wetland | Bottom-up processes I: Primary production; nutrient limitation; upwelling |  | 2. NSF proposal on  keystone molecules:  *Alderia* chemical ecology |
|  | Feb 2 |  | Bottom-up processes II: Phytoplankton; macroalgae; sea grasses |  |  |
| 3 | Feb 7 | *low tide: -0.4, 4:30 PM (sunset: 5:30)*  5. Lab activity: process field samples  6. Initial experiments | Top-down processes I: Herbivory | 2. preliminary references for  group presentation #1 | 3. top-down vs. bottom-  up review articles |
|  | Feb 9 |  | Top-down processes II: Predation; food webs | 3. Upload topic and tentative  question/approach for  research project |  |
| 4 | Feb 14 | *low tide: 0.3, 11:20 AM*  7. Lab activity: live animal work  8. Process field samples | Supply-side processes I: Spawning; larval biology |  | 4. supply-side ecology  review articles |
|  | Feb 16 |  | Supply-side processes II: Dispersal; modeling | 4. self-quiz 1 (online); 5 pt |  |
| 5 | Feb 21 | *low tide: -1.1, 4:15 PM (sunset: 5:45)*  9. **Group presentations part 1**: sea  star wasting disease papers  10. Lab activity: process field samples | Supply-side processes III: Larval settlement | 🡪 **Group presentations** |  |
|  | Feb 23 |  | **Discussion**: Sea star wasting disease papers | 5. Discussion questions pt 1  (5 pt) | **5. Sea star wasting disease papers**: (A) Menge et al. 2016; (B) Miner et al. 2017;  (C) Moritsch 2021 |
| 6 | Feb 28 | *low tide: 0.2, 12:00 PM*  11. Lab activity: data analyses | Supply-side processes IV:  Recruitment dynamics | 6. Outline for planned  research project, including  timeline and references |  |
|  | Mar 2 |  | Marine chemical ecology I: Defenses, Harmful Algal Blooms (HABs) | 7. self-quiz 2 (online); 5 pt | 6. chemical ecology  review articles |
| 7 | Mar 7 | *low tide: -0.3, 3:20 PM (sunset: 6:00)*  12. Field work: manipulative  experiments, or re-sample sites | Marine chemical ecology II: Chemical signaling in predation, settlement, and mating |  |  |
|  | Mar 9 |  | Community composition I: Foundation species; keystone species | 8. preliminary references for  group presentation #2 | 7. keystone vs foundation  species review |

**Course Schedule, continued**

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| **Week** | **Date** | **lab activities T 1:50-4:20 PM** | **lecture topic T/Th 5:00-5:50 PM** | **Assignment due** | **Reading due** |
| 8 | Mar 14 | 13. Lab activity: live animal expts, or  process field samples | Community composition II: Ecosystem engineers |  |  |
|  | Mar 16 |  | Community composition III: Competition, intermediate disturbance |  |  |
| 9 | Mar 21 | 14. **Group presentations part 2**: Bull  kelp papers  15. Lab activity: process field samples,  or continue experiments | Community composition IV: Biodiversity and ecosystem function |  |  |
|  | Mar 23 |  | Range limits | 🡪 Take-home midterm open |  |
| 10 | Mar 28 | Spring Break | Spring Break |  |  |
| 11 | Apr 4 | *low tide: +0.1, 3:15 PM (sunset: 7:15)*  16. Field work: manipulative  experiments, or re-sample sites  17. Lab activity: preliminary data  analyses; process field samples | Coastal CA I: Rocky intertidal |  |  |
|  | Apr 6 |  | Discussion: Bull kelp papers | 9. Discussion questions pt 2  (5 pt)  10. Take-home midterm due | **8. Bull kelp papers**:  (A) McPherson et al. 2021; (B) Rogers-Bennett & Catton 2021 |
| 12 | Apr 11 | *low tide: 0.0, 8:30 AM*  18. Lab activity: preliminary data analyses; process field samples | Coastal CA II: Estuaries |  | 9. MPA review |
|  | Apr 13 |  | Marine conservation I: Fisheries & overfishing | 11. Draft project update:  preliminary data, analyses |  |
| 13 | Apr 18 | *low tide: -0.1, 3:00 PM (sunset: 7:25)*  19. Field work: manipulative  experiments, or re-sample 2nd site | Marine conservation II: MPAs |  | 10. climate change article |
|  | Apr 20 |  | Marine conservation III: Warming and acidification | 12. preliminary references  for group presentation #2 |  |
| 14 | Apr 25 | *low tide: 0.3, 8:30 AM*  20. Field work: manipulative experiments, or re-sample 3rd site  21. Lab activity: final experiments | Marine conservation IV: Microplastics; pollution |  | 11. invasive species review |
|  | Apr 27 |  | Marine conservation V: Invasive species | 13. self-quiz 3 (online); 5 pt |  |

**Course Schedule, continued**

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| --- | --- | --- | --- | --- | --- |
| **Week** | **Date** | **lab activities T 1:50-4:20 PM** | **lecture topic T/Th 5:00-5:50 PM** | **Assignment due** | **Reading due** |
| 15 | May 2 | 22. **Group presentations part 3**:  invasive species papers  23. Lab activity: final experiments or  data analyses | Marine urban ecology |  |  |
|  | May 4 |  | **Discussion**: Invasive species papers | 14. Discussion questions pt 3  (5 pt)  🡪 Take-home final open | **12.invasive species papers**: (A) Grozholz et al. 2021;  (B) Desharnais et al. 2001 |
| 16 | May 9 | 24. Final research presentations  35. finalize data analyses | Restoration ecology | 15. Final project report draft |  |
|  | May 11 |  | Summary & synthesis | 16. Final project report |  |

**Final exam**: official time/date TBD; tentatively, **Thursday May 19, 5-7 PM** in ASC-B 344.

**Final presentations** on your research projects will be given in lieu of an in-person final examination. Your take-home final is due by the start time of the final exam, uploaded to Canvas.

Note: low tides in **blue** happen during lab + lecture time; low tides in **red** happen outside of class time, but are when I could obtain samples or census sites outside of class depending on project needs.