University of California, Berkeley
Department of Environmental Science, Policy, and Management
Course Syllabus

Climate Change, Ecosystems, and Solutions

Course number	ESPM 176A
Term	Spring 2025
Mode of instruction	In-person
Units	2, letter grade or pass/fail
Lecture	2 hours per week, one class per week
Class day and time	[University will schedule]
Class location	[University will schedule]
Prerequisite	Skills to read, assess, and summarize scientific journal articles

Instructor
Patrick Gonzalez, Ph.D.
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Office Hours determined when university schedules the class time

Course Description (750 characters maximum)
Cars, power plants, deforestation, and other human sources pump greenhouse gases into the atmosphere, causing anthropogenic climate change, which has driven two animal species extinct and caused tree mortality, wildfire increases, sea level rise, ocean acidification, and other impacts. Scientific research shows that the world can cut carbon pollution to avoid the most severe risks. This course aims to teach (1) the science of anthropogenic climate change, (2) applications to biodiversity conservation in national parks and other protected areas, (3) carbon solutions. Students will produce a climate change assessment for a protected area of their choice. The course welcomes students interested in advancing meaningful action on climate change.

Learning Objectives
1. Students demonstrate mastery of the fundamental aspects of climate change science
2. Students develop excellence in applying climate change science to natural resource management, biodiversity conservation, and carbon solutions

Schedule (key scientific publications, assigned readings)

1. **Human-caused climate change, ecosystems, and carbon solutions** – Human cause of climate change, observed climate trends, detection and attribution of impacts, observed impacts on ecosystems and biodiversity, projected climate scenarios, future risks, national parks and protected areas, carbon solutions, science for policy in the Intergovernmental Panel on Climate Change (IPCC), communicating climate change (IPCC 2021, IPCC 2022a, IPCC 2022b, IPCC 2023, Gonzalez et al. 2018, Gonzalez 2020)

2. **Physical science** - Greenhouse effect, human cause of climate change, radiative forcing, paleoclimate; detection and attribution; observed changes in temperature, precipitation, drought, extreme events; observed glacial melt, snow pack loss, permafrost thaw, Antarctica, Greenland; natural inter-decadal cycles such as the El Niño-Southern

Oscillation; future emissions scenarios, general circulation models, climate projections (IPCC 2021, Friedlingstein et al. 2023, Gottlieb and Mankin 2024, Mahony et al. 2017, Marzeion et al. 2014, Rupp et al. 2013, Williams et al. 2020, 2022)

3. **Ecosystem carbon** – Carbon stocks, high aboveground carbon density forests, high soil carbon density ecosystems, quantifying carbon densities, changes, and uncertainties, reduced emissions from deforestation and degradation (REDD+), natural climate solutions (IPCC 2021, IPCC 2022a, Friedlingstein et al. 2023, Gonzalez et al. 2015, Melillo et al. 2016, Qin et al. 2021, Shah et al. 2021)

4. **Wildfire** – Detection and attribution, observed impacts, future risks, carbon, loss of Amazon rainforest, conversion of Arctic tundra, indigenous use of fire, adaptation of fire management (Abatzoglou and Williams 2016, Abatzoglou et al. 2021, Brando et al. 2020, Jolly et al. 2015, Marks-Block et al. 2019, Qin et al. 2021, Slingsby et al. 2017, Stephens et al. 2021, Turco et al. 2023, van Mantgem et al. 2016, Zaid and Dunn 2018)

5. **Vegetation** – Biome shifts, tree mortality, invasive species, range shifts, phenology changes, primary productivity changes, desertification, biodiversity conservation options (IPCC 2022a, Berner et al. 2017, Brando et al. 2020, Early et al. 2016, Eigenbrod et al. 2015, Gonzalez et al. 2010, Gonzalez et al. 2012, Goulden and Bales 2019, McDowell et al. 2016, Sweet et al. 2019, van Mantgem et al. 2009, Zemp et al. 2017)

6. **Animal life** –Extinctions, extirpations, genetic isolation, climate velocity, conservation of corridors, landscape-scale conservation, working landscapes, agroecology. (IPCC 2022a, Freeman et al. 2018, Iknayan and Beissinger 2018, Johnson et al. 2023, Kremen and Merenlender 2018, La Sorte and Thompson 2007, Moritz et al. 2008, Murali et al. 2023, Pounds et al. 2006, Urban 2015, Warren et al. 2018)

7. **Insect life** – Loss of insect species; changes in distribution; species of concern, including the monarch butterfly (*Danaus plexippus*); pests, including bark beetles; evolutionary adaptation (Lister and Garcia 2018, Patterson et al. 2020, Raffa et al. 2008, Sáenz-Romero et al. 2012, Soroye et al. 2020, Wagner et al. 2021)

8. **Marine and coastal ecosystems** – Sea level rise, ocean warming, ocean acidification, deoxygenation, marine heat waves, coral bleaching (Carter et al. 2017, Couce et al. 2023, Hughes et al. 2018, Kennedy et al. 2019, Marzeion and Levermann 2014, Slangen et al. 2016, von Kietzell et al. 2022)

9. **Freshwater ecosystems** - Increased water temperatures in lakes, rivers, and streams, changes in stream flow timing, fish mortality, provision of water to people, conservation of cold water refugia (Briggs et al. 2018, Cohen et al. 2016, Isaak et al. 2012, Mauger et al. 2017, O'Reilly et al. 2015, Tierney et al. 2010, Woolway et al. 2019)

10. **Climate change in national parks** – Hour 1: Agency approach, park-specific resource stewardship strategies, field actions; Hour 2: Guest Speaker, U.S. National Park Service (U.S. National Park System Advisory Board 2012)

11. **Policy** – Climate change policies, including U.N. Framework Convention on Climate Change, Paris Agreement, U.S. policies; Biodiversity policies, including U.N. Convention on

Biological Diversity, 30 x 30 Goal (UNFCCC 2015, USA 2021, UNCBD 2022)

12. **Carbon solutions and sustainability** – Recent progress on cutting greenhouse gas emissions, energy conservation, energy efficiency, renewable energy, life cycle analysis, social cost of carbon, halting deforestation, reduced emissions from deforestation and degradation (REDD+), effective individual actions that you can take to reduce climate change (IPCC 2022b, Eisen and Brown 2022, Groom et al. 2022, Knobloch et al. 2020, Lauvaux et al. 2022, Meinshausen et al. 2022, Wynes and Nicholas 2017)

13. **Student presentations, part 1 –** Each student concisely presents the results on climate change science and solutions in their national park or protected area and answer questions from other students (Assignment 3, described below)

14. **Student presentations, part 2 –** Each student concisely presents the results on climate change science and solutions in their national park or protected area and answer questions from other students (Assignment 3, described below)

Assignments

Readings
Each week, please read the publication underlined in the schedule above and be prepared to discuss it in class. We'll call on people using a random number generator. This work is aimed to help you read and concisely summarize scientific findings for your semester project.

Semester project – Climate change assessment for a park

Experiential learning
To help conserve biodiversity and protect human well-being under climate change, natural resource professionals require concise assessments that translate complex climate change science into easily readable information. This class offers students an opportunity to gain experience in producing such an assessment and communicating the findings.

Each of you will produce a climate change assessment for a specific national park or protected area that you choose from anywhere in the world. The assessment will consist of a written report, a 10-minute presentation, and a public communication. The report will be scientifically rigorous and easily understood by non-specialists. Ideally, the report and communication would be of high enough quality to share with the staff of the park for them to use. For students interested in a career working on climate change, a well-written, publicly available climate change report could be a solid qualification.

Two examples of a park-specific climate change assessment (longer than the class project):

Gonzalez, P. 2024. Climate Change and Forest Carbon in the Proposed Parcul Național Făgăraș, România. University of California, Berkeley, USA. https://ourenvironment.berkeley.edu/sites/ourenvironment.berkeley.edu/files/user/profile2/main/publications/Gonzalez_climate_change_Fagaras.pdf

Gonzalez, P. 2020. Anthropogenic Climate Change in Channel Islands National Park, California, USA. National Park Service, Berkeley, CA. https://irma.nps.gov/DataStore/DownloadFile/660859

Area selection

Select any conservation protected area in the world, including national parks, forests, refuges, state parks, and local parks. Criteria to consider:

1. Personal connection, experience, or previous visit, or a wish to learn about a new place

2. Existence of published scientific information for the protected area, its geographic region, and its species, ecosystems, and natural resources

3. A job, project, thesis, or dissertation on which you are already working or that you are planning that this project could help advance (but not work that you already completed)

The following areas already have climate change assessments, so do not select these:

Cabrillo National Monument
Channel Islands National Park
Delaware Water Gap National Recreation Area
Farallon Islands National Wildlife Refuge
Golden Gate National Recreation Area
Joshua Tree National Park
Kings Canyon National Park
Lassen Volcanic National Park
Mount Diablo State Park
Muir Woods National Monument
Parcul Național Făgăraș, România
Point Reyes National Seashore
Rock Creek Park
Sagamore Hill National Historic Site
Sequoia National Park
Yosemite National Park

The United Nations World Conservation Monitoring Center has compiled the authoritative database of protected areas of the world: https://www.protectedplanet.net. In addition, consult the official government web site of the agency that manages the area to confirm the name, location, and distinctive features.

Assignment 1: Verbal description

Each person will identify the area they have selected and give the group a brief description. Add any information preliminarily on climate change in the area. It will be informal, standing in front of class and speaking. In addition, select a second backup area in case your first choice is chosen or might not work well.

Assignment 2: Annotated Outline

Outline of the report

1. Cover page (Full information, no abbreviations, a photo would be excellent, credit the photographer)
2. Summary (Approximately 300 words)
3. Table of Contents
4. Introduction
5. Location description

6. Observed climate trends, change over time (temperature, precipitation, snowfall, drought, fog, wind; for marine ecosystems – sea surface temperature, marine heat waves, ocean acidification, ocean deoxygenation; other atmospheric and physical climate variables); separate changes that are consistent, but not attributed to anthropogenic climate change from changes that have been detected and attributed to anthropogenic climate change)
7. Observed ecological changes and impacts (plant and animal species extinctions, range shifts, biome shifts, flooding, wildfire, tree mortality; for marine ecosystems – sea level rise; other species- or ecosystem-level effects); separate changes that are consistent, but not attributed to anthropogenic climate change from changes that have been detected and attributed to anthropogenic climate change)
8. Projected climate trends, change over time (temperature, precipitation, snowfall, drought, fog, wind; for marine ecosystems – sea surface temperature, marine heat waves, ocean acidification, ocean deoxygenation; other atmospheric and physical climate variables)
9. Projected risks to ecosystems
10. Carbon solutions – ecosystems and fossil fuels
11. Tables, Figures, Legends (Throughout the report or gathered in one section)
12. References

The objective of this assignment is to organize, research, and summarize authoritative scientific information on each topic so that you are set up to fill in each section for the final version.

Annotated outline – produce a single file with the following content by section

1. Draft cover page
2. Not needed for this assignment
3. Draft table of contents
4. Not needed for this assignment

5-10. List of topics within each section and a concise summary of each topic, consisting of a sentence or complete descriptive phrase and at least one scientific reference - the most authoritative reference. Complete text will only be needed for the final version. (More information below on information sources).

11. List of tables and figures that you plan to include. You could decide to change this for the final version.
12. Full list of references cited (more information below)

Examples for Sections 5-10, extracted from a report for Joshua Tree National Park

Observed temperature - Statistically significant increase 1.5ºC ± 0.1ºC per century, 1895 to 2016 (Gonzalez et al. 2018).

Observed precipitation - Statistically significant decrease -39 ± 15% per century, 1895 to 2016 (Gonzalez et al. 2018).

Bird species decline – Anthropogenic climate change caused 43% loss of bird species in Mojave Desert sites, 1908-2016 (Iknayan and Beissinger 2018).

Desert tortoise mortality – From 1993 to 2012, 90% population decline but not formally attributed to climate change (Lovich et al. 2014).

Projected Joshua Tree loss – Under highest emissions, suitable habitat nearly eliminated from the park by 2099 (Sweet et al. 2019).

Ecosystem carbon – Aboveground live vegetation 140 000 ± 200 000 tons carbon, equivalent to one year of emissions from approximately 24 000 people in the U.S. (Gonzalez et al. 2015).

You can, if you have the initiative, produce a full draft. That is extra and not required.

Save as a PDF file, with a name in this format: <Smith climate change Yellowstone 2023-03-06.pdf>

Information sources
Use and cite refereed peer-reviewed scientific journal articles, IPCC reports, government technical reports, technically sound non-governmental organization reports.

Your first information source is the material presented in each class. Go through the pdf files of the presentations, posted on bCourses, for results applicable to your area.

After that, a primary source will be publications listed in the authoritative database of scientific literature, the Web of Science https://webofknowledge.com (available to students while on the network on campus or on the virtual private network off campus). Research your particular protected area, the general region, and specific species and ecosystems in your protected area. Examine maps carefully to locate your protected area and report results as specific to your local area as possible.

Additional sources of regional information include regional chapters in the Intergovernmental Panel on Climate Change assessment https://www.ipcc.ch/assessment-report/ar6, the U.S. National Climate Assessment https://nca2018.globalchange.gov, the California Climate Change Assessment https://climateassessment.ca.gov, and assessments for other countries, states, and areas. Read text and examine maps carefully to report results as specific to your local area as possible.

Climate trends data
For observed and projected trends in U.S. national parks, use Table S5 and spatial data from Gonzalez et al. (2018):
https://doi.org/10.1088/1748-9326/aade09
http://gif.berkeley.edu/resources/anthropogenic_climate_change.html

For observed temperature trends around the world by 5 x 5 geographic degree pixels, you can use National Oceanic and Atmospheric Administration global time series
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series

For observed temperature trends by U.S. county, you can use National Oceanic and Atmospheric Administration county time series
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/county/time-series

For projections in California, you can use UC Berkeley Cal-Adapt:
https://cal-adapt.org

For projections around the world, you can use the Intergovernmental Panel on Climate Change Atlas, using model projections dataset CMIP6, baseline 1850-1900, change over time:
https://interactive-atlas.ipcc.ch

References
Again, use and cite refereed peer-reviewed scientific journal articles, IPCC reports, government technical reports, technically sound non-governmental organization reports. The objective of a citation is to cite the authoritative, original source of a piece of information. Use the format of the reference list below at the end of this syllabus.

In some cases, such as a species list, you will only find the information in an online database.

For example, Audubon Christmas Bird Count data have been examined and used in numerous scientific publications <https://www.audubon.org/conservation/science/christmas-bird-count/christmas-bird-count-bibliography>. If you use such data, cite in this way:

National Audubon Society. 2021. Christmas Bird Count. Diablo count circle, CA26. https://netapp.audubon.org/CBCObservation/Historical/ResultsByCount.aspx#.

English Grammar and Usage
A recognized standard of English grammar and usage for professional publishing and the standard for this report is the Chicago Manual of Style https://www.chicagomanualofstyle.org (available to students while on the network on campus or on the virtual private network off campus). Following Chicago Manual Section 5.250 (Good usage versus common usage), use "impact" only as a noun.

Assignment 3; Class presentation
Communication forms a key part of science. Each student will present a brief overview of their results, standing in front of class. Due to the semester schedule and the number of students, each presentation will be just 10 minutes. The group will ask questions as part of that time.

Because the presentation is brief, dedicate your time to the most important points unique to your protected area rather than trying to discuss everything. Conveying information visually is often more effective than blocks of text.

So that we can be efficient, please upload your presentation by 3 PM to the folder <presentations> in <files> in our bCourses site and we will avoid losing time switching computers by using one computer. You can conserve the format of your presentation by saving as a PDF file. Practice beforehand so that you can present smoothly the day of your presentation.

Assignment 4: Final report
Approximately 2500 words text (Sections 1-10). This is just a guideline so that it is long enough to be substantive but not too long to keep the information concise for the user and manageable for your work load.
Figures, tables, legends, references not included in word count (Sections 11-12)
PDF file, use this format for the file name <Smith climate change Yellowstone 2023-05-10.pdf>

See the sections above on the outline, information sources, climate trends data, references, and English grammar and usage. Write complete text for each topic, building on your annotated outline and addressing the review comments.

Assignment 5: Public communication
Each student will publicly post a science-based communication about the park results on the digital platform of the student's choice. The communication must be publicly available – no account or login needed for a person to view it.

The communication could be a brief social media post (for example https://twitter.com/pgonzaleztweet/status/1498305953430523905), a journalistic story on your own personal web site or a public site, or another public digital form. The communication must be scientifically accurate, professional, use appropriate language and images, and publicly available.

Your communication could be artistic. It should be engaging. It will include a URL pointing to more detailed information – your final report or an important scientific publication relevant to your protected area. This communication will inform and engage people in appreciating your park and its challenges under human-caused climate change. I encourage you to be creative.

Communicating with park staff

Ideally, the report will be of such a high quality that, students could deliver the results to park staff and it could be posted publicly on the web site of the University of California, Berkeley, Institute for Parks, People, and Biodiversity. The report could provide a park with information helpful to conservation under climate change. This experience follows the actual work of scientists assisting natural resource managers.

Deadlines – [Exact dates determined when University schedules class]

I encourage you to work on the assessment a little each week so that you can be relaxed at the end of the semester.

January	Assignment 1: Verbal description of area (informal, in class)
March	Assignment 2: Annotated outline (e-mail pdf file to me)
April	Assignment 3: Presentation, students in alphabetical order (presentation in front of class, upload file to bCourses)
May	Final exam date and time set by the university Assignment 4: Final report (e-mail pdf file to me) Assignment 5: Public communication (e-mail the URL to all)

Grades [details for each category starting on next page]

30%	Class participation (attendance, class discussions)
20%	Communications (presentation, public communication)
15%	Annotated outline of report
35%	Final report

Grades are by absolute score, using the 10-point scale of the College Board:

98-100%	A+		
93-97	A		
90-92	A-		
88-89	B+	70-72	C-
83-87	B	68-69	D+
80-82	B-	63-67	D
78-79	C+	60-62	D-
73-77	C	<60	F

Total Course Grade	item grade	weight	total
Class Participation			
Attendance: present z, late y, absent x grade = 100*(z + 0.5*y)/(z+y+x)	%	15%	%
Interactive discussions during class (see below)	%	15%	%
Communications			
Initial park description	%	5%	%
Presentation	%	10%	%
Public communication	%	5%	%
Annotated Outline	%	15%	%
Final Report	%	35%	%
Total		100%	%

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Semester project grade		
Scientific accuracy	nn/40	
Completeness	nn/20	
Clarity of writing	nn/30	
Format	nn/10	
Report Total	nn/100	**nn%**

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Presentation grade		
Scientific accuracy	nn/40	
Clarity of speaking	nn/30	
Clarity of visuals	nn/30	
Presentation Total	nn/100	**nn%**

Public communication grade

Scientific accuracy	nn/50	
Clarity	nn/50	
Communication Total	nn/100	**nn%**

Class Participation Criteria

High (90-100%)
Demonstrates mastery of ideas presented in assigned reading
Actively contributes to discussions in class
Often raises new and relevant issues or questions

Medium (70-90%)
Shows awareness of ideas in assigned reading
When prompted, contributes to discussions in class
Sometimes raises new and relevant issues or questions

Low (<70%)
Unawareness of reading material
Rarely contributes to discussions in class
Does not raise new or relevant issues or questions

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Policies

1. **Attendance** – Students are expected to attend every class.
2. **bCourses** – I will post course files on bCourses. Students can submit their written assignments by e-mail or on bCourses.
3. **E-mail** – Outside of class, communicate with me by e-mail since this will reach me more quickly than bCourses.
4. **Zoom** – While the default mode for this class is instruction in person, in certain cases, Zoom may be the only option for a specific class. Of course, in that case, students can log in from their location of choice. To maximize interactive lectures and discussions, we will turn on our video cameras. Classes will not be recorded. I will send an e-mail calendar invitation with the meeting information. The UC Berkeley Zoom system requires all attendees to be logged into a Zoom account, either a UC Berkeley or individual account, and attendees will enter through a waiting room.
5. **Presentation files** – The pdf files of presentations will be posted on bCourses. Each presenter will hold the copyright to their presentations. Students agree to not publicly post or share the files but can request permission from individual presenters.
6. **Late Penalties** – For assignment 2 (outline), students can request a one-week extension, with a grade reduction of 10%. For assignment 4 (final report), students can request a two-day extension, with a grade reduction of 5%. Those will be the final deadlines. No later submissions will be accepted.

7. **Office hours** – I'll be pleased to speak with you individually. Send an e-mail to schedule.
8. **Changes** – I may need to update the syllabus and schedule and will let you know.

University of California Policies

Academic Integrity

You are a member of an academic community at one of the world's leading research universities. Universities like Berkeley create knowledge that has a lasting impact in the world of ideas and on the lives of others; such knowledge can come from an undergraduate paper as well as the lab of an internationally known professor. One of the most important values of an academic community is the balance between the free flow of ideas and the respect for the intellectual property of others. Researchers don't use one another's research without permission; scholars and students always use proper citations in papers; professors may not circulate or publish student papers without the writer's permission; and students may not circulate or post materials (handouts, exams, syllabi--any class materials) from their classes without the written permission of the instructor.

Any test, paper or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor. In all of your assignments, including your homework or drafts of papers, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. If you are not clear about the expectations for completing an assignment or taking a test or examination, be sure to seek clarification from your instructor or GSI beforehand. Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. The consequences of cheating and academic dishonesty—including a formal discipline file, possible loss of future internship, scholarship, or employment opportunities, and denial of admission to graduate school—are simply not worth it.

Collaboration and Independence

Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do together with one's fellow students. We recommend this. However, homework assignments should be completed independently and materials turned in as homework should be the result of one's own independent work.

Plagiarism/Self-plagiarism

You must be original in composing the writing assignments in this class. To copy text or ideas from another source (including your own previously, or concurrently, submitted course work) without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism, self-plagiarism, and how to avoid it, see, for example:
http://www.lib.berkeley.edu/instruct/guides/citations.html#Plagiarism
http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.html

Academic Integrity and Ethics
Cheating on exams and plagiarism are examples of violations in the realm of ethics and integrity. Honesty, integrity, and ethical behavior are of great importance in all facets of life. They are so important that it is generally assumed that one has learned and internalized these qualities at an early age. As a result, these issues rarely get explicitly addressed by the time one gets to be a university student. However, it cannot be overstated just how important honesty is to the academic enterprise.

Turnitin
UC Berkeley's honor code states “As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others.” As a tool to promote academic integrity in this course, written work submitted via bCourses may be checked for originality using Turnitin. Turnitin compares student work to a database of books, journal articles, websites, and other student papers. This creates an opportunity for students to improve their academic writing skills, by ensuring that other sources have been properly cited and attributed.
Academic Integrity http://ets.berkeley.edu/academic-integrity
Code of Conduct http://sa.berkeley.edu/code-of-conduct
Resources https://teaching.berkeley.edu/resources/design/academic-integrity

Academic Accommodations
The purpose of academic accommodations is to ensure that all students have a fair chance at academic success. If you have Letters of Accommodations from the Disabled Students' Program or another authorized office, please share them with me as soon as possible, and we will work out the necessary arrangements. While individual circumstances can vary, requests for accommodations often fall into the categories listed on the Academic Calendar and Accommodations website. The campus has well-developed processes in place for students to request accommodations, and you are encouraged to contact the relevant campus offices listed on the Academic Accommodations Hub. These offices, some of which are confidential, can offer support, answer questions about your eligibility and rights, and request accommodations on your behalf, while maintaining your privacy.
Web site https://evcp.berkeley.edu/programs-resources/academic-accommodations-hub

Student Advocate's Office - Confidential Assistance
Provides free, confidential, student-to-student assistance for undergraduate and graduate students navigating issues with academics, financial aid, accusations of misconduct, instances of harassment and discrimination, and other grievances within the scope of the university.
Telephone (510) 642-6912
Web site https://advocate.berkeley.edu/
e-mail help@berkeleysao.org

Ombuds Office for Students and Postdoctoral Appointees - Confidential Assistance
Confidential conflict resolution services, coaching, referrals, clarifying policies and procedures. Empowering students to make informed decisions with the goal of resolutions that meet their needs.
Telephone (510) 642-5754
Web site https://sa.berkeley.edu/ombuds

Basic Needs Center
The Basic Needs Center is a virtual & physical hub located in the lower level of the MLK Student Union that supports students' holistic wellbeing through a set of essential programs and services. Our programs include education, prevention & emergency relief for the following areas: food, housing, finances, health, and wellness. All students including undergraduate, graduate, international and undocumented students are eligible for Basic Needs Center resources and services.
Web site https://basicneeds.berkeley.edu

The Syllabus is a Contract and Subject to Change
This syllabus is a contract that you, as an enrolled student in this course, agree to abide by throughout the semester. You agree to complete the assignments in a timely manner in accordance with the schedule printed in the syllabus and to participate in the class using proper student conduct and netiquette. As part of this agreement, your responsibilities are printed clearly within this syllabus with deadlines so that you will know well in advance when readings and assignments are due. The syllabus is also subject to change if deemed necessary by the instructor. You will be afforded ample warning before any new responsibility or assignment is due. Most often, a change to the syllabus will constitute a minor change in reading materials or the cancellation of a day of class. If such a change occurs, a revised syllabus will be made available to students and replace any old copies of the syllabus.

References

Original pdf files from the publisher are on bCourses

Abatzoglou, J.T. and A.P. Williams. 2016. Impact of anthropogenic climate change on wildfire across western US forests. Proceedings of the National Academy of Sciences of the USA 113: 11 770-11 775.

Abatzoglou, J.T., D.S. Battisti, A.P. Williams, W.D. Hansen, B.J. Harvey, and C.A. Kolden. 2021. Projected increases in western US forest fire despite growing fuel constraints. Communications Earth and Environment 2: 227. doi:10.1038/s43247-021-00299-0.

Barrows, C.W., A.R. Ramirez, L.C. Sweet, T.L. Morelli, C.I. Millar, N. Frakes, J. Rodgers, and M.F. Mahalovich. 2020. Validating climate change refugia: Empirical bottom-up approaches to support management actions. Frontiers in Ecology and the Environment 18: 298-306.

Berner, L.T., B.E Law, A.J.H. Meddens, and J.A. Hicke. 2017. Tree mortality from fires, bark beetles, and timber harvest during a hot and dry decade in the western United States (2003–2012). Environmental Research Letters 12: 065005. doi:10.1088/1748-9326/aa6f94.

Biber, E. and E.L. Esposito. 2016. The National Park Service Organic Act and climate change. Natural Resources Journal 56: 193-245.

Bonilla-Alicea, R.J., B.C. Watson, Z. Shen, L. Tamayo, and C. Telenko. 2020. Life cycle assessment to quantify the impact of technology improvements in bike-sharing systems. Journal of Industrial Ecology 24: 138-148.

Brando, P.M, B. Soares-Filho, L. Rodrigues, A. Assunção, D. Morton, D. Tuchschneider, E.C. M. Fernandes, M.N. Macedo, U. Oliveira, and M.T. Coe. 2020. The gathering firestorm in southern Amazonia. Science Advances 6: eaay1632. doi:10.1126/sciadv.aay1632.

Briggs, M.A., J.W. Lane, C.D. Snyder, E.A. White, Z.C. Johnson, D.L. Nelms, and N.P. Hitt. 2018. Shallow bedrock limits groundwater seepage-based headwater climate refugia. Limnologica 68: 142-156.

Carter, B.R., R.A. Feely, S. Mecking, J.N. Cross, A.M. Macdonald, S.A. Siedlecki, L.D. Talley, C.L. Sabine, F.J. Millero, J.H. Swift, A.G. Dickson, and K.B. Rodgers. 2017. Two decades of Pacific anthropogenic carbon storage and ocean acidification along Global Ocean Ship-based Hydrographic Investigations Program sections P16 and P02. Global Biogeochemical Cycles 31: 306-327.

Cohen, A.S., E.L. Gergurich, B.M. Kraemer, M.M. McGlue, P.B. McIntyre, J.M. Russell, J.D. Simmons, and P.W. Swarzenski. 2016. Climate and fishery declines in Lake Tanganyika. Proceedings of the National Academy of Sciences of the USA 113: 9563-9568.

Couce, E., B. Cowburn, D. Clare, and J.K. Bluemel. 2023. Paris Agreement could prevent regional mass extinctions of coral species. Global Change Biology 29: 3794–3805.

Early, R., B.A. Bradley, J.S. Dukes, J.J. Lawler, J.D. Olden, D.M. Blumenthal, P. Gonzalez, E.D. Grosholz, I. Ibañez, L.P. Miller, C.J.B. Sorte, and A.J. Tatem. 2016. Global threats from invasive alien species in the twenty-first century and national response capacities. Nature Communications 7: 12485. doi:10.1038/ncomms12485.

Eigenbrod, F., P. Gonzalez, J. Dash, and I. Steyl. 2015. Vulnerability of ecosystems to climate change moderated by habitat intactness. Global Change Biology 21: 275-286.

Eisen, M.B., and P.O. Brown. 2022. Rapid global phaseout of animal agriculture has the potential to stabilize greenhouse gas levels for 30 years and offset 68 percent of CO2 emissions this century. PLoS Climate 1: e0000010. doi:10.1371/journal.pclm.0000010.

Freeman, B.G., M.N. Scholer, V. Ruiz-Gutierrez, and J.W. Fitzpatrick. 2018. Climate change causes upslope shifts and mountaintop extirpations in a tropical bird community.

Proceedings of the National Academy of Sciences of the USA 115: 11 982-11 987.
Friedlingstein, P. et al. 2023. Global carbon budget 2023. Earth System Science Data 15: 5301–5369.
Gonzalez, P. 2020. Human-caused climate change in United States national parks and solutions for the future. Parks Stewardship Forum 36: 188-210.
Gonzalez, P., J.J. Battles, B.M. Collins, T. Robards, and D.S. Saah. 2015. Aboveground live carbon stock changes of California wildland ecosystems, 2001-2010. Forest Ecology and Management 348: 68-77.
Gonzalez, P., R.P. Neilson, J.M. Lenihan, and R.J. Drapek. 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. Global Ecology and Biogeography 19: 755-768.
Gonzalez, P., F. Wang, M. Notaro, D.J. Vimont, and J.W. Williams. 2018. Disproportionate magnitude of climate change in United States national parks. Environmental Research Letters 13: 104001. doi:10.1088/1748-9326/aade09.
Gottlieb, A.R. and J.S. Mankin. 2024. Evidence of human influence on Northern Hemisphere snow loss. Nature 625: 293–300.
Goulden, M.L. and R.C. Bales. 2019. California forest die-off linked to multi-year deep soil drying in 2012–2015 drought. Nature Geoscience 12: 632-637.
Groom, B., C. Palmer, and L. Sileci. 2022. Carbon emissions reductions from Indonesia's moratorium on forest concessions are cost-effective yet contribute little to Paris pledges. Proceedings of the National Academy of Sciences of the USA 119: e2102613119. doi:10.1073/pnas.2102613119.
Holden, Z.A., A. Swanson, C.H. Luce, W.M. Jolly, M. Maneta, J.W. Oyler, D.A. Warren, R. Parsons, and D. Affleck. 2018. Decreasing fire season precipitation increased recent western US forest wildfire activity. Proceedings of the National Academy of Sciences of the USA 115: E8349-E8357.
Hoover, D.J., K.O. Odigie, P.W. Swarzenski, and P. Barnard. 2017. Sea-level rise and coastal groundwater inundation and shoaling at select sites in California, USA. Journal of Hydrology: Regional Studies 11: 234-249.
Hughes, T.P., K.D. Anderson, S.R. Connolly, S.F. Heron, J.T. Kerry, J.M. Lough, A.H. Baird, J.K. Baum, M.L. Berumen, T.C. Bridge, D.C. Claar, C.M. Eakin, J.P. Gilmour, N.A.J. Graham, H. Harrison, J.P.A. Hobbs, A.S. Hoey, M. Hoogenboom, R.J. Lowe, M.T. Mcculloch, J.M. Pandolfi, M. Pratchett, V. Schoepf, G. Torda, and S.K. Wilson. 2018. Spatial and temporal patterns of mass bleaching of corals in the Anthropocene. Science 359: 80-83.
Iknayan, K.J., and S.R. Beissinger. 2018. Collapse of a desert bird community over the past century driven by climate change. Proceedings of the National Academy of Sciences of the USA 115: 8597-8602.
Intergovernmental Panel on Climate Change (IPCC). 2021. Climate Change 2021: The Physical Science Basis. [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)] Cambridge University Press, Cambridge, UK.
Intergovernmental Panel on Climate Change (IPCC). 2022a. Climate Change 2022: Impacts, Adaptation, and Vulnerability. [Pörtner, H.-O., D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama (eds.)] Cambridge University Press, Cambridge, UK.
Intergovernmental Panel on Climate Change (IPCC). 2022b. Climate Change 2022: Mitigation of Climate Change. [Shukla, P.R., J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D.

McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley (eds.)]. Cambridge University Press, Cambridge, UK.
Intergovernmental Panel on Climate Change (IPCC). 2023. Climate Change 2023: Synthesis Report. [IPCC Core Writing Team, H. Lee, and J. Romero (eds.)] IPCC, Geneva, Switzerland.
Isaak, D.J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest U.S. from 1980-2009 and implications for salmonid fishes. Climatic Change 113: 499-524.
Jolly, W.M., M.A. Cochrane, P.H. Freeborn, Z.A. Holden, T.J. Brown, G.J. Williamson, and D.M.J.S. Bowman. 2015. Climate-induced variations in global wildfire danger from 1979 to 2013. Nature Communications 6: 7537. doi:10.1038/ncomms8537.
Johnson, T.F., N.J.B. Isaac, A. Paviolo, and M. González-Suárez. 2023. Socioeconomic factors predict population changes of large carnivores better than climate change or habitat loss. Nature Communications. doi:10.1038/s41467-022-35665-9.
Kapsenberg, L. and G.E. Hofmann. 2016. Ocean pH time-series and drivers of variability along the northern Channel Islands, California, USA. Limnology and Oceanography 61: 953-968.
Kennedy, J.J., N.A. Rayner, C.P. Atkinson, and R.E. Killick. 2019. An ensemble data set of sea surface temperature change from 1850: The Met Office Hadley Centre HadSST.4.0.0.0 data set. Journal of Geophysical Research: Atmospheres 124: 7719-7763.
Knobloch, F., S.V. Hanssen, A. Lam, H. Pollitt, P. Salas, U. Chewpreecha, M.A.J. Huijbregts, and J.F. Mercure. 2020. Net emission reductions from electric cars and heat pumps in 59 world regions over time. Nature Sustainability 3: 437-447.
Kremen, C. and A.M. Merenlender. 2018. Landscapes that work for biodiversity and people. Science 362: eaau6020. doi:10.1126/science.aau6020.
La Sorte, F.A. and F.R. Thompson. 2007. Poleward shifts in winter ranges of North American birds. Ecology 88: 1803-1812.
Lauvaux, T., C. Giron, M. Mazzolini, A. d'Aspremont, R. Duren, D. Cusworth, D. Shindell, and P. Ciais. 2022. Global assessment of oil and gas methane ultra-emitters. Science 375: 557-561.
Lister, B.C. and A. Garcia. 2018. Climate-driven declines in arthropod abundance restructure a rainforest food web. Proceedings of the National Academy of Sciences of the USA 115: E10397-E10406.
Loarie, S.R., P.B. Duffy, H. Hamilton, G.P. Asner, C.B. Field, and D.D. Ackerly. 2009. The velocity of climate change. Nature 462: 1052-1055.
Lovich, J.E., C.B. Yackulic, J. Freilich, M. Agha, M. Austin, K.P. Meyer, T.R. Arundel, J. Hansen, M.S. Vamstad, and S.A. Root. 2014. Climatic variation and tortoise survival: Has a desert species met its match? Biological Conservation 169: 214-224.
Mahony, C.R., A.J. Cannon, T. Wang, and S.N. Aitken. 2017. A closer look at novel climates: New methods and insights at continental to landscape scales. Global Change Biology 23: 3934-3955.
Mansuy, N., C. Miller, M.A. Parisien, S.A. Parks, E. Batllori, and M.A. Moritz. 2019. Contrasting human influences and macro-environmental factors on fire activity inside and outside protected areas of North America. Environmental Research Letters 14: 064007. doi:10.1088/1748-9326/ab1bc5.
Marks-Block, T., F.K. Lake, and L.M. Curran. 2019. Effects of understory fire management treatments on California Hazelnut, an ecocultural resource of the Karuk and Yurok Indians in the Pacific Northwest. Forest Ecology and Management 450: 117517. doi:10.1016/j.foreco.2019.117517.

Marzeion, B., J.G. Cogley, K. Richter, and D. Parkes. 2014. Attribution of global glacier mass loss to anthropogenic and natural causes. Science 345: 919-921.
Marzeion, B. and A. Levermann. 2014. Loss of cultural world heritage and currently inhabited places to sea-level rise. Environmental Research Letters 9: 034001. doi:10.1088/1748-9326/9/3/034001.
Mauger, S., R. Shaftel, J.C. Leppi, and D.J. Rinella. 2017. Summer temperature regimes in southcentral Alaska streams: watershed drivers of variation and potential implications for Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences 74: 702-715.
McDowell, N.G., A.P. Williams, C. Xu, W.T. Pockman, L.T. Dickman, S. Sevanto, R. Pangle, J. Limousin, J. Plaut, D.S. Mackay, J. Ogee, J.C. Domec, C.D. Allen, R.A. Fisher, X. Jiang, J.D. Muss, D.D. Breshears, S.A. Rauscher, and C. Koven. 2016. Multi-scale predictions of massive conifer mortality due to chronic temperature rise. Nature Climate Change 6: 295-300.
Meinshausen, M., J. Lewis, C. McGlade, J. Gütschow, Z. Nicholls, R. Burdon, L. Cozzi, and B. Hackmann. 2022. Realization of Paris Agreement pledges may limit warming just below 2 °C. Nature 604: 304-309.
Melillo, J.M., X. Lu, D.W. Kicklighter, J.M. Reilly, Y. Cai, and A.P. Sokolov. 2016. Protected areas' role in climate-change mitigation. Ambio 45: 133-145.
Moritz, C., J.L. Patton, C.J. Conroy, J.L. Parra, G.C. White, and S.R. Beissinger. 2008. Impact of a century of climate change on small-mammal communities in Yosemite National Park, USA. Science 322: 261-264.
Murali, G., T. Iwamura, S. Meiri, and U. Roll. 2023. Future temperature extremes threaten land vertebrates. Nature. doi:10.1038/s41586-022-05606-z.
O'Reilly, C.M., S. Sharma, D.K. Gray, S.E. Hampton, J.S. Read, R.J. Rowley, P. Schneider, J.D. Lenters, P.B. McIntyre, B. M. Kraemer, G.A. Weyhenmeyer, D. Straile, B. Dong, R. Adrian, M.G. Allan, O. Anneville, L. Arvola, J. Austin, J.L. Bailey, J.S. Baron, J.D. Brookes, E. de Eyto, M.T. Dokulil, D.P. Hamilton, K. Havens, A.L. Hetherington, S.N. Higgins, S. Hook, L.R. Izmest'eva, K.D. Joehnk, K. Kangur, P. Kasprzak, M. Kumagai, E. Kuusisto, G. Leshkevich, D.M. Livingstone, S. MacIntyre, L. May, J.M. Melack, D.C. Mueller-Navarra, M. Naumenko, P. Noges, T. Noges, R.P. North, P.D. Plisnier, A. Rigosi, A. Rimmer, M. Rogora, L.G. Rudstam, J.A. Rusak, N. Salmaso, N.R. Samal, D.E. Schindler, S.G. Schladow, M. Schmid, S.R. Schmidt, E. Silow, M.E. Soylu, K. Teubner, P. Verburg, A. Voutilainen, A. Watkinson, C.E. Williamson, and G. Zhang. 2015. Rapid and highly variable warming of lake surface waters around the globe. Geophysical Research Letters 42: 10 773-10 781.
Parmesan, C., M. Morecroft, Y. Trisurat, R. Adrian, G.Z. Anshari, A. Arneth, Q. Gao, P. Gonzalez, R. Harris, J. Price, N. Stevens, and G.H. Talukdar. 2022. Terrestrial and freshwater ecosystems and their services. In Intergovernmental Panel on Climate Change. Climate Change 2022: Impacts, Adaptation, and Vulnerability. [Pörtner, H.-O., D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama (eds.)] Cambridge University Press, Cambridge, UK.
Patterson, T.A., R. Grundel, J.D.K. Dzurisin, R.L. Knutson, and J.J. Hellmann. 2020. Evidence of an extreme weather-induced phenological mismatch and a local extirpation of the endangered Karner blue butterfly. Conservation Science and Practice 2: e147. doi:10.1111/csp2.147.
Pederson, G.T., S.T. Gray, C.A. Woodhouse, J.L. Betancourt, D.B. Fagre, J.S. Littell, E. Watson, B.H. Luckman, and L.J. Graumlich. 2011. The unusual nature of recent snowpack declines in the North American Cordillera. Science 333: 332-335.

Pounds, J.A., M.R. Bustamante, L.A. Coloma, J.A. Consuegra, M.P.L. Fogden, P.N. Foster, E. La Marca, K.L. Masters, A. Merino-Viteri, R. Puschendorf, S.R. Ron, G.A. Sanchez-Azofeifa, C.J. Still, and B.E. Young. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439: 161-167.

Qin, Y., X. Xiao, J.P. Wigneron, P. Ciais, M. Brandt, L. Fan, X. Li, S. Crowell, X. Wu, R. Doughty, Y. Zhang, F. Liu, S. Sitch, and B. Moore. 2021. Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon. Nature Climate Change 11: 442-448.

Raffa, K.F., B.H. Aukema, B.J. Bentz, A.L. Carroll, J.A. Hicke, M.G. Turner, and W.H. Romme. 2008. Cross-scale drivers of natural disturbances prone to anthropogenic amplification: The dynamics of bark beetle eruptions. BioScience 58: 501-517.

Rupp, D.E., P.W. Mote, N.L. Bindoff, P.A. Stott, and D.A. Robinson. 2013. Detection and attribution of observed changes in Northern Hemisphere spring snow cover. Journal of Climate 26: 6904-6914.

Sáenz-Romero, C., G.E. Rehfeldt, P. Duval, and R.A. Lindig-Cisneros. 2012. *Abies religiosa* habitat prediction in climatic change scenarios and implications for monarch butterfly conservation in Mexico. Forest Ecology and Management 275: 98-106.

Shah. P., K. Baylis, J.Busch, and J. Engelmann. 2021. What determines the effectiveness of national protected area networks? Environmental Research Letters 16: 074017. doi:10.1088/1748-9326/ac05ed.

Slangen, A.B.A, J.A. Church, C. Agosta, X. Fettweis, B. Marzeion, and K. Richter. 2016. Anthropogenic forcing dominates global mean sea-level rise since 1970. Nature Climate Change 6: 701-705.

Stephens, S.L., B.M. Collins, E. Biber, and P.Z. Fulé. 2016. U.S. federal fire and forest policy: emphasizing resilience in dry forests. Ecosphere 7: e01584. doi:10.1002/ecs2.1584.

Stephens, S.L, S. Thompson, G. Boisramé, B.M. Collins, L.C.Ponisio, E. Rakhmatulina, Z.L. Steel, J.T. Stevens, J.W. van Wagtendonk, and K. Wilkin. 2021. Fire, water, and biodiversity in the Sierra Nevada: A possible triple win. Environmental Research Communications 3: 081004. doi:10.1088/2515-7620/ac17e2.

Slingsby, J.A., C. Merow, M. Aiello-Lammens, N. Allsopp, S. Hall, H.K. Mollmann, R. Turner, A.M. Wilson, and J.A. Silander. 2017. Intensifying postfire weather and biological invasion drive species loss in a Mediterranean-type biodiversity hotspot. Proceedings of the National Academy of Sciences of the USA 114: 4697-4702.

Sweet, L.C., T. Green, J.G.C. Heintz, N. Frakes, N. Graver, J.S. Rangitsch, J.E. Rodgers, S. Heacox, and C.W. Barrows. 2019. Congruence between future distribution models and empirical data for an iconic species at Joshua Tree National Park. Ecosphere 10: e02763. doi:10.1002/ecs2.2763.

Tierney, J.E., M.T. Mayes, N. Meyer, C. Johnson, P.W. Swarzenski, A.S. Cohen, and J.M. Russell. 2010. Late-Twentieth-Century warming in Lake Tanganyika unprecedented since AD 500. Nature Geoscience 3: 422-425.

Turco, M., J.T. Abatzoglou, S. Herrera, Y. Zhuang, S. Jerez, D.D. Lucas, A. AghaKouchak, and I. Cvijanovic. 2023. Anthropogenic climate change impacts exacerbate summer forest fires in California. Proceedings of the National Academy of Sciences of the USA 120: e2213815120. https://doi.org/10.1073/pnas.2213815120

United Nations Framework Convention on Climate Change (UNFCCC). 2015. Paris Agreement. Document FCCC/CP/2015/10/Add1, Decision 1/CP21. UNFCCC, Bonn, Germany.

United Nations Convention on Biological Diversity (UNCBD). 2022. Kunming-Montreal Global Biodiversity Framework. Document CBD/COP/DEC/15/4, Decision 15/4. UNCBD, Montreal, Canada.

United States of America (USA). 2021. Tackling the Climate Crisis at Home and Abroad. Executive Order 14008, January 27, 2021, White House, Washington, DC.
U.S. National Park System Advisory Board. 2012. Revisiting Leopold: Resource Stewardship in the National Parks. U.S. National Park System Advisory Board, Washington, DC.Urban,
Urban, M.C. 2015. Accelerating extinction risk from climate change. Science 348: 571-573.
van Asch, M., L. Salis, L.J.M. Holleman, B. van Lith, and M.E. Visser. 2013. Evolutionary response of the egg hatching date of a herbivorous insect under climate change. Nature Climate Change 3: 244-248.
van Mantgem, P.J., A.C. Caprio, N.L. Stephenson, and A.J. Das. 2016. Does prescribed fire promote resistance to drought in low elevation forests of the Sierra Nevada, California, USA? Fire Ecology 12: 13-25.
van Mantgem, P.J., N.L. Stephenson, J.C. Byrne, L.D. Daniels, J.F. Franklin, P.Z. Fule, M.E. Harmon, A.J. Larson, J.M. Smith, A.H. Taylor, and T.T. Veblen. 2009. Widespread increase of tree mortality rates in the western United States. Science 323: 521-524.
Van Pelt, R., S.C. Sillett, W.A. Kruse, J.A. Freund, and R.D. Kramer. 2016. Emergent crowns and light-use complementarity lead to global maximum biomass and leaf area in Sequoia sempervirens forests. Forest Ecology and Management 375: 279-308.
von Kietzell, A., A. Schurer, and G.C Hegerl. 2022. Marine heatwaves in global sea surface temperature records 1850. Environmental Research Letters 17: 084027. doi:10.1088/1748-9326/ac81db.
Wagner, D.L., E.M. Grames, M.L. Forister, and D. Stopak. 2021. Insect decline in the Anthropocene: Death by a thousand cuts. Proceedings of the National Academy of Sciences of the USA 118: e2023989118. doi:10.1073/pnas.2023989118.
Warren, R., J. Price, E. Graham, N. Forstenhaeusler, and J. VanDerWal. 2018. The projected effect on insects, vertebrates, and plants of limiting global warming to 1.5°C rather than 2°C. Science 360: 791-795.
Williams, A.P., E.R. Cook, J.E. Smerdon, B.I. Cook, J.T. Abatzoglou, K. Bolles, S.H. Baek, A.M. Badger, and B. Livneh. 2020. Large contribution from anthropogenic warming to an emerging North American megadrought. Science 368: 314-318.
Williams, A.P., B.I. Cook, and J.E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. Nature Climate Change 12: 232–234.
Woolway, R.I., G.A. Weyhenmeyer, M. Schmid, M.T. Dokulil, E. de Eyto, S.C. Maberly, L. May, and C.J. Merchant. 2019. Substantial increase in minimum lake surface temperatures under climate change. Climatic Change 155: 81–94.
Woolway, R.I., B.M. Kraemer, J.D. Lenters, C.J. Merchant, C.M. O'Reilly, and S. Sharma. 2020. Global lake responses to climate change. Nature Reviews Earth and Environment 1: 388–403.
Wynes, S. and K.A. Nicholas. 2017. The climate mitigation gap: Education and government recommendations miss the most effective individual actions. Environmental Research Letters 12: 074024. doi.org/10.1088/1748-9326/aa7541.
Zald, H.S.J. and C.J. Dunn. 2018. Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications 28: 1068-1080.
Zemp, D.C., C.F. Schleussner, H.M.J. Barbosa, M. Hirota, V. Montade, G. Sampaio, A. Staal, L. Wang-Erlandsson, and A. Rammig. 2017. Self-amplified Amazon forest loss due to vegetation-atmosphere feedbacks. Nature Communications 8: 14681. doi:10.1038/ncomms14681.