Climate Change Ecology (in English)

Lecturer: Prof. Marcelo Sternberg
Semester: 2nd
Day: Wednesday – 16:00-18:00 hs
Time: Weekly lectures of 2 hr each + two Friday field trip.
Credits: 3 points
Target students: 2nd - 3rd year undergraduate Biology/Environmental Science students, open to graduate students.
Course Prerequisites: Ecology (0455.1809.01 – Life Sciences faculty) or Introduction to Ecology (0910.1500.01 – Porter School). **Students that have not taken these courses or equivalent will not be accepted.**
Course Language: English
Course Name in Hebrew: אקולוגיה של שינוי אקלים
Students #: The course will be limited to 48 students (maximum bus capacity in field trips).

Background:
While global climate change is of increasing concerns worldwide, the rapidly-emerging field of Climate Change Ecology is just beginning to address how organisms and ecosystems will respond. This course will focus on the physical science perspectives on global environmental change by discussing the causes, mechanisms, and impacts of major types of global changes (climate and land-use/sea-use changes) on ecosystem structure and functions. The course will emphasize how integrating ecology, physiology, behavior, and evolution is enabling understanding past responses and predicting future responses at various scales. **The course will emphasize on the biological aspects of global climate change.** The course will consist of lectures, student presentations and discussion of readings, and two field trips to visit climate change research stations and laboratories in Israel. Emphasis will be placed on the recent literature, but will also include readings from various sources and lecturers of guest leading climate change researchers.
No similar course is being given at any university in Israel.

This course will rely on both lectures, reading of primary scientific literature, student presentation and discussion. Efforts will be made to provide students with some important "fundamentals" and generally deepen our understanding on climate change ecology.

Course Learning Goals:
The goal of the course is to critically evaluate information about the causes and biological consequences of the major types of global change as a result of human activities.

1. To gain a broad understanding of the mechanisms by which microorganisms, plants, animals, communities, and ecosystems are responding to climate and land-use/sea-use change
2. To directly engage with the primary literature and identify topics at the frontier of global change research

3. To enhance skills in communicating science and to become acquainted with methods and tools for predicting future responses to global climate change.
4. To gain knowledge on what changes would be needed to stabilize or reverse current trends and how science is (or is not) translated into policy.

Activities

Course meetings will consist of lectures and discussing the motivations, methods, results, of recent papers. Debates of hot topics of current interest in global change ecology will be discussed in class. Guest lecturers will be invited to present their research in climate change ecology related topics. **Attendance at the course is compulsory with minimal of 80% of classes presence**.

Background reading will be assigned in some occasions before the class. Students will sign up on the course moodle website. Text and reading materials will include: articles, chapters and online reading materials that will be assigned and distributed on the course moodle site. The course textbook is "Climate Change Biology" by Lee Hannah (2nd edition, 2015), although recent review papers will also serve as a basic course source of knowledge. The readings from manuscripts are meant to supplement the lectures and cover topics that we may not have time to discuss in class. Additional peer-reviewed papers will be given for reading and class discussion.

Research Presentations on Primary Literature (student talks)

Each student will select one research paper about climate change ecology from a list of manuscripts offered by the lecturer. This article will be summarized by the student into a one-page English report following clear instructions given by the course lecturer. Additionally, each student will orally present the summarized paper. Presentations will be modeled on the format of a scientific conference (13' presentation – 2' questions). More details will be given in class on how to prepare the presentation and how it will be graded. Number of papers presented at each lecture/week will be a function of numbers of students enrolled. It is expected that each student will present a different peer-reviewed paper.

Invited lecturers

Leading scientists on climate change ecology will be invited to introduce their research to the students. Emphasis will be made on methodological and experimental design challenges when planning a climate change experiment or challenges related to their research area.

Field trips:

Two field trip are planned: **Friday, March 22nd , 2024**. It will focus on experimental climate change research on terrestrial ecosystems. The first field trip will include a visit to study sites in the Judean Hills. **Friday, April 12th, 2023**; the second field trip will include a visit study sites in desert ecosystems in the northern Negev. Students will be exposed to real climate change experiments in terrestrial ecosystems. Issues about climate change along environmental gradients will be discussed while travelling in the bus. Introduction to main vegetation and soil types will be discussed at each field trip stop while considering climatic gradients. A field report

with a task will be requested. Students can do the report in couples and will be based on elements discussed during the field trip. Full instructions will be given towards the field trip. **The field trips are planned for Fridays, and will last around six or seven hours** (departure from the university at 8:00 hs and return around 14:30 hs). **Attendance to the field trips is compulsory**. Students not attending the field trip by a non-justified reason will regrettably left out of the course.

Late-term exam:

There will be one late-term exam that will cover the material from the manuscripts presented by students in their summary report and classes presentations. The late-term exam will be composed of mostly by short-answer essay questions, but may also include some true/false, matching or multiple-choice questions. Questions based on keynote speakers' presentations and paper readings during the class will be included in the exam.

Review paper assignment:

The aim of the final course assignment is to write a review paper around a topic that was discussed along the course. Students are expected to strength their knowledge in the selected topic and gain critical understanding of scientific research in climate change ecology. **The assignment will provide 50% of the final grade.**

The final course review paper assignment consists in the analysis and critical reading of seven (7) topical peer-review papers in climate change ecology. Students are encouraged to write a review manuscript where the discussed topic is covered by the findings of the papers reviewed, while highlighting the new knowledge provide for the respective paper in the revised topic. Additionally, the review should also include the critical reading by adding the pros and cons of the study and highlighting the missing knowledge gaps in the topic considered in the papers. Full instructions will be given during the course.

Student performance in the course will be evaluated as follows:

Field trip report	10%
Research paper summary and presentation	10%
Late-term exam	30%
Review paper assignment	50%

Syllabus
(slight changes may occur on certain classes topics)

Week/ Lecture N#	Topics and tasks
1	**Introduction to Global Change Ecology** – The Climate System; Evolution of the Earth's Climate; Natural Drivers of Change; Natural Drivers of Change; Major Features of Present Climate; Stable States of the climate system; Human-Driven Change: Effects of rising CO2 on ecosystems
2	**Species Range Shifts Under Climate Change** - First Sign of Change: Coral Bleaching; Ocean Acidification; First Changes on Land; Mounting Evidence of Range Shifts; Patterns of range shifts and extinctions; Freshwater Changes; Pests and Pathogens range change.
3	**Ecosystem Changes under Global Change -** Biological invasions and global climate change; Changes in different biomes under climate change; Food web changes in terrestrial, marine and freshwater ecosystems, Ecosystem Feedbacks to Climate System **Phenology: Changes in Timing of Biological Events Due to Climate Change** Phenology in Freshwater Systems; Tropical Forest Phenology; Marine Ecosystems; Mechanisms : Temperature and Photoperiod; Life Cycles of Insect Herbivores; Timing Mismatches Between Species ***Field trip N#1 (Friday,)*** *Visit to Matta LTER climate change research stations and Hakdoshim LTER forest. Introduction to climate change field experiments – possible visit to burnt forest area in the Judean Hills*
4	**Continuation of Climate Change and Phenology** **Effects of land-use and sea-use change on ecosystem functioning under climate chage**
5	**Past Terrestrial and Marine Response to Climate Change -**

	The Record of the Ice Ages; Ice Racing in North America and Europe; Out of Land: The Southern Temperate Response; North Meets South; Rapid Change: The Younger Dryas; Milankovitch Forcing in the Biological Record; Ocean Chemical Changes, Effects of Ocean Circulation; Lessons of Past Change *Students paper presentation** ***Field trip N#2 (Friday,)*** *Visit to Yatir LTER forest and climate change monitoring station.* *Visit Park Sayeret Shaked – shrub and snail mortality*
6	**Extinctions and Climate Change** The Five Major Mass Extinctions; Causes of Extinction Events; Climate as the Common Factor in Major Extinctions; Does Climate Change Always Cause Extinction? The Past 100 Million Years; The Past 2 Million Years: Extinction at the Dawn of the Ice Ages and the Pleistocene; The Missing Ice Age Extinctions. *Students paper presentation**
7	**Experimentation and Modeling Species and Ecosystem Response** Field Experiments; Whole-Vegetation Experiments; Results of Field CO_2 Experiments; Arctic Experiments; Modeling Species and Ecosystem Response; Dynamic Global Vegetation Models; Modeling Aquatic Systems *Student paper presentation**
8	**Adaptation of Conservation Strategies under Climate Change -** Early Concepts of Protected Areas and Climate Change; Protected Area Planning; Planning for Persistence; Resistance and Resilience; Protected Area Management; Marine Protected Areas
9	**Connectivity and Landscape Management under Climate Change** Area -Demanding Species; Migratory Species under Global Change; Species Range Shifts; Managing Connectivity in Human-Dominated Landscapes; Regional Coordination Monitoring *Student paper presentation**

10	**Mitigation: Reducing Greenhouse Gas Emissions** Sinks, and Solutions; Climate Policy; Stabilizing Atmospheric Greenhouse Gas Concentrations; Practical Steps for the Next 50 Years; Energy Efficiency; Renewable Energy Sources
11	**Keynote speaker: *to be confirmed*** **Extinction Risk from Climate Change Solutions** Wedges Beyond 50 Years; Land use Requirements of Alternate Energy; Carbon Sequestration; Geoengineering *Student paper presentation*
12	**Israel and Global Climate Change** Desert and Mediterranean ecosystems under climate change. The eastern Mediterranean and Red Sea under climate change. *Student paper presentation*
13	**Food Security and Global Changes** Food production under climate change; Agriculture and Land-use management under climate change. Soil health under climate change