Tropical Ecology and Conservation (WFC 125)

Lecture Time: 12:10-1:30, Mon./Wed., **Location:** Teaching and Learning Complex 3214

Section A01 Time: 2:10-3:00, Thurs., **Location:** Wellman Hall 107

Section A02 Time: 3:10-4:00, Thurs., **Location:** Olson Hall 159

Section A03 Time: 3:10-4:00, Fri., **Location:** Olson Hall 244

Instructor: Daniel S. Karp
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TA: Katherine Lauck
Office: 1352 Academic Surge **Hours**: Fridays at 2-3pm (or by appointment)
Email: kslauck@ucdavis.edu **Include WFC 125 in subject line**

Reading Materials:

1. **Academic articles**, Available through the course website
2. **Optional text,** Tropical Ecology, John Kricher

Purpose:

WFC 125 is intended to (1) introduce students to the ecology and natural history of the tropics, including the similarities and differences with biomes in temperate latitudes; (2) explore the challenges and opportunities associated with pursuing tropical conservation; and (3) empower students to design, implement, and communicate their own research projects. In doing so, WFC 125 will help students understand and develop useful skills for the modern tropical conservation scientist. Specifically, students will learn basic science literacy (*e.g.,* by reading, discussing, and critiquing scientific articles), how to develop and answer novel scientific questions, how to collaborate in groups, and how to clearly communicate their findings.

Learning Objectives:

1. Be able to compare and contrast the ecology of tropical versus temperate regions.
2. Express the challenges and opportunities associated with tropical conservation.
3. Effectively critique cutting-edge studies in tropical ecology and conservation.
4. Apply the scientific method to answer an original question by developing and implementing a student-driven research project.
5. Work effectively in groups, leveraging your fellow students' skills and interests to produce novel scientific findings.
6. Demonstrate effective science communication via a conference-style poster presentation.

The Classroom Environment and Student Wellness:

Ecology and conservation biology suffer from long-standing cultural and gender biases that impede scientific progress, stagnate critical debates, and make for a less vibrant and inclusive workplace. Both for the people that lack opportunities to engage with ecology and conservation and for the sake of the disciplines, I am committed to finding ways to remove barriers and to make our communities more inclusive. Tropical ecology/conservation is particularly interwoven with issues surrounding colonialism, diversity, and justice. As such, we will return to these topics throughout the class. In this class, I have also tried to give more voice to those who have been

excluded from conservation in the past. ***This is a work in progress***, but hopefully will be apparent in the course readings, in the lectures, and in the broader content of the course. More broadly, I strongly believe that all classrooms must be inclusive and welcoming environments. Please do not hesitate to bring to my attention (or the TA's attention) any areas for improvement or any actions or statements that made you feel uncomfortable, unsafe, or excluded.

Relatedly, it is important to acknowledge the many physical and mental health issues that can impede student learning (*e.g.,* anxiety, alcohol/drug problems, depression, strained relationships, *etc.*). If you are suffering from any issues, or other stressful events, consider reaching out to the Counseling Center for support: https://shcs.ucdavis.edu/services/counseling-services or call 530-752-0871. An on-campus counselor or after-hours clinician is available 24/7. Finally, if you are a student who requires accommodations, please submit your SDC Letter of Accommodation to me as soon as possible, ideally within the first two weeks of this course. Anyone who is interested in learning more about the Student Disability Center (SDC) should contact them directly at sdc@ucdavis.edu or 530-752-3184.

COVID-19:

I am very excited to be back in the classroom; however, it is important to acknowledge the major anxieties that many of us feel with in-person activities during the pandemic. To make everyone feel safer, please consider the following:

1. I promise to work with you so that you can succeed in this class and still stay at home if you feel sick or have been exposed to COVID-19. **Your grade will not suffer** by making the responsible choice to stay at home. Lectures will be recorded and posted to the course website via lecture capture. Exam accommodations will be made. Just contact Dr. Karp or your TA ASAP to let us know your situation.
2. Current rules do not *require* that masks be worn in class; however, masks are **strongly recommended**. I second this recommendation, as wearing a mask is a proven way to reduce transmission, both safeguarding yourselves and vulnerable people in the classroom.
3. Monitor your daily potential exposure reports and assist in contact tracing if you are contacted (or if you acquire the disease).

Land Acknowledgement:

We should take a moment to acknowledge the land on which we are gathered. For thousands of years, this land has been the home of Patwin people. Today, there are three federally recognized Patwin tribes: Cachil DeHe Band of Wintun Indians of the Colusa Indian Community, Kletsel Dehe Wintun Nation, and Yocha Dehe Wintun Nation. The Patwin people have remained committed to the stewardship of this land over many centuries. It has been cherished and protected, as elders have instructed the young through generations. We are honored and grateful to be here today on their traditional lands.

Assessment (Overview):

WFC 125 is organized into a twice weekly lecture and a once-a-week section. Lectures will focus on the theoretical basis of tropical ecology and conservation; sections will concentrate on activities and the student-led research project. Before each lecture, Prof. Karp will assign 1-2 mandatory scientific articles. In-class activities will center on these articles, so be sure to do the reading **before class.** Lectures will roughly follow Tropical Ecology by John Kricher. Reading this textbook is **optional**— students will only be required to learn material covered in lectures, sections, or assigned scientific articles. Grades will be assigned as follows:

Assessment	Value	Due date
Weekly quizzes (Individual)	5%	Thursdays at 5pm
Section participation (Individual)	5%	Ongoing
Questions and hypotheses (Group)	5%	10/7 at 5pm
Database creation (Individual)	5%	10/14 at 5pm
Midterm exam (Individual)	20%	10/19 in class
Database quality control (Individual)	5%	10/21 at 5pm
Annotated bibliography (Individual)	5%	11/9 at 5pm
Graphs and captions (Group)	5%	11/18 at 5pm
Project reflection 1 (Individual)	2.5%	11/18 at 5pm
Poster presentation (Group)	15%	11/30 in class
Project reflection 2 (Individual)	2.5%	12/2 at 5pm
Final exam (Individual)	25%	12/9 at 3:30-5:30pm

Late Policy: Students will lose 10% each day that an assignment is late. If an assignment is late, email it as soon as it is finished to both Prof. Karp and TA Lauck. Any assignment that is not submitted ***by 5:00 pm*** the day an assignment is due will be considered late. If canvas malfunctions, assignments can be emailed to Prof. Karp and TA Lauck and still receive full credit (provided that the email is time stamped before the due date).

Schedule (Readings, topics, and timings subject to change)

WEEK 1

Lecture 1 (9/21/2022): Introduction to the tropics

- Readings: Barlow *et al.* (2018) *Nature*.
- In class activities: None- introductory class and lecture.
- Learning Objectives: (I) Understand the course structure and assignments; (II) articulate how climate structures tropical biomes

Section 1: Reading and critiquing scientific literature

- Learning Objectives: (I) Articulate how academic articles are structured; (II) Be able to search for pertinent articles; (III) Demonstrate ability to critique published literature

WEEK 2

Lecture 2 (9/26/2022): Biogeography and evolution of the tropics

- Readings*:* (I) Haffer (1969) *Science.* (II) Knapp and Mallet (2003) *Science*.
- In class activities: Discussion and debate of the "refugium hypothesis"
- Learning Objectives: (I) Articulate different modes of dispersal for explaining tropical species distributions and how plate tectonics fits in; (II) Explain how to tell when traits are or were adaptive; (III) Spell out the different modes of tropical speciation

Lecture 3 (9/28/2022): Tropical biodiversity 1: the latitudinal diversity gradient

- Readings: (I) Cadena et al (2012) *Proceedings of the Royal Society B*.
- In class activities: (I) Calculating diversity at multiple scales, (II) Differentiating between alternative drivers of tropical biodiversity on mountains
- Learning Objectives: (I) Calculate alpha, beta, and phylogenetic diversity, (II) Compare and contrast different explanations for latitudinal diversity gradients, arguing for their merits based on the underlying evidence

Section 2: Formulating questions and hypotheses

- Learning Objectives: (I) learn to pose a testable hypothesis and compare against null expectations; (II) collaboratively develop novel questions for group-based research topics

WEEK 3

Lecture 4 (10/3/2022): Guest Lecture: Alejandra Echeverri

- Readings*:* (I) Echeverri *et al*. (2019) *People and Nature.*
- In class activity: Following the guest lecture and discussion, students will assemble into their research groups and be given dedicated time to make progress on their research projects. Dr. Karp and TA Lauck will spend time with each group to help refine hypotheses and discuss ideas for data analysis.
- Learning Objectives: (I) Differentiate between cultural services; (II) Articulate strategies for measuring cultural services in Neotropical birds; (III) Make concrete hypotheses about how avian traits should relate to bird-mediated cultural services; (IV) As a research group, come up with a rough plan for future data collection and analysis

Lecture 5 (10/5/2022): Tropical biodiversity 2: maintaining biodiversity

- Readings*:* (I) Fragoso 1997 *Journal of Applied Ecology*.
- In class activity: (I) Unpacking Fragoso 1997 and how it relates to diversity maintenance
- Learning Objectives: (I) Compare and contrast the different hypotheses for how such high tropical diversity can be maintained, (II) Weigh the evidence for and against Neutral Theory, (III) Apply Island Biogeography to tropical systems

Section 3: Finding and collecting data

- Learning Objectives: (I) learn to collect data from trip itineraries; (II) understand quality control and how to collaboratively build a large database; (III) learn how to document metadata

WEEK 4

Lecture 6 (10/10/2022): Tropical rainforests

- Readings: (I) Meli *et al*. 2017 *PLOS One.* (II) Watch Planet Earth II- Rainforests episode ($2 on Amazon Video).
- In class activity: (I) Strategizing forest restoration in the context of tropical forest succession; (II) Discussion about Planet Earth II video.
- Learning Objectives: (I) Describe the characteristics of tropical rainforest flora, (II) Compare and contrast alternative approaches to restoration, using succession theory

Lecture 7 (10/12/2022): Tropical dry forests and savannahs

- Readings*:* (I) Banda *et al.* (2016) *Science*, (II) Kartinzel *et al*. (2015) *PNAS*, (III) Watch this video: https://www.youtube.com/watch?time_continue=476&v=8eH6X2rAQEs
- In class activity: (I) Niche partitioning and species coexistence on the African savanna, (II) Dry forest endemism discussion
- Learning Objectives: (I) Explain what regulates the existence of savannas vs. dry forests, (II) Learn to collect data that explains how African herbivores are able to coexist

Section 4: Midterm review session

- Learning Objectives: (I) solidify understanding of tropical ecology; (II) compare the ecology of different tropical biomes; (III) explain the evolution and maintenance of tropical diversity

WEEK 5

Lecture 8 (10/17/2022): From rivers to reefs

- Readings: (I) Costello *et al.* (2013) *Conservation Letters*; (II) Mumby *et al.* (2004) *Nature*
- In class activities: (I) Dissecting Mumby *et al.* (2004) and proposing follow-up experiments
- Learning Objectives: (I) Articulate the key drivers of and threats to diversity in tropical aquatic systems; (II) List out the unique adaptions that fish, mangroves, and corals exhibit to

thrive in aquatic environments

MIDTERM 1 (10/19/2022)

Section 5: Forest conservation in the Congo— role play activity

- Learning Objectives: (I) gain awareness of cultural and personal motivations; (II) engage in thoughtful debate; (III) appreciate the complexities of navigating conservation decisions

WEEK 6

Lecture 9 (10/24/2022): Soils and nutrient cycling

- Readings*:* (I) Cleveland *et al.* (2011) *Ecology Letters*; (II) Turner *et al.* (2018) *Nature*
- In class activity: Comparing approaches for studying Phosphorous limitation in rainforests
- Learning Objectives: (I) Understand how nutrients cycle through the tropics and limit productivity; (II) Articulate why tropical soils are nutrient poor; (III) Be able to state who the key players in soil formation, decomposition, and nutrient cycling

Lecture 10 (10/26/2022): Mutualism

- Readings: (I) Razafindratsima (2014) *Madagascar Conservation and Development*;
- In class activity: (I) Defining species interactions
- Learning Objectives: (I) How does coevolution influence mutualism?; (II) Articulate how mutualisms break down and the ensuing consequences

Section 6: Basic data analysis

- Learning Objectives: (I) differentiate between dependent and independent variables; (II) Implement basic linear regression and ANOVA

WEEK 7

Lecture 11 (10/31/2022): Predation and trophic cascades

- Reading*:* Hughes (1994) *Science*
- In class activity: Trophic cascades interactive exercise
- Learning Objectives: (I) Understand how color is used as a defense in the tropics; (II) Differentiate between plant defenses; (III) Create diagrams depicting how species losses can reverberate through ecosystems

Lecture 12 (11/02/2022): People in the tropics

- Readings: Berkes *et al*. (2000) *Ecological Applications*
- Activities: Discussions about (1) whether tropical forests are 'pristine' and why it matters; (2) traditional ecological knowledge versus conventional resource management; (3) how traditional ecological knowledge could be useful for conservation
- Learning Objectives: (I) Be able to discuss the historical and current impacts of local people on tropical ecosystems; (II) Articulate how we know that traditional ecological knowledge is declining and why that could be a problem for conservation

Section 7: Making figures

- Learning Objectives: (I) learn how to interpret graphs; (II) create a figure using real data to depict a statistical analysis

WEEK 8

Lecture 13 (11/7/2022): Deforestation and fragmentation

- Readings*:* Arroyo-Rodríguez *et al.* (2020) *Ecology Letters;* Betts *et al.* (2017) *Nature;*
- Activities: (1) Debate about local diversity loss; (2) How to arrange human-dominated landscapes to optimize biodiversity conservation
- Learning Objectives: (I) Argue (both sides) as to whether habitat conversion leads to local

diversity loss AND whether fragmentation constitutes a severe threat to biodiversity

Lecture 14 (11/9/2022): Managing tropical forests

- Readings*:* Reyes-García *et al*. (2019) Restoration Ecology; Karp *et al.* (2019) *Journal of Applied Ecology*
- Activities: (I) Forest monitoring videos; (II) Protected area prioritization discussion; (III) Why should local and indigenous people be incorporated into restoration efforts?
- Learning Objectives: (I) Articulate the challenges and benefits associated with establishing tropical protected areas; (II) Discuss tradeoffs involved in pursuing conservation on private lands; (III) Debate the merits of active versus passive restoration

Section 8: How to communicate science to scientists

- Learning Objectives: (I) clearly articulate the building blocks of scientific papers and posters; (II) understand how to use visuals to attract and maintain attention

WEEK 9

Lecture 15 (11/14/2022): Tropical Working Landscapes

- Readings: Kremen, C. & Merenlender, A.M. (2018). *Science*; Murgueitio, E*. et al.* (2011). *For. Ecol. Manage.*
- Activities: (I) Discussion of silvopastoral systems and why they are not more commonly implemented
- Learning Objectives: (I) Articulate the impacts of agriculture, rangeland, and timber forestry systems on tropical biodiversity; (II) Propose possible solutions to conserving biodiversity across a variety of tropical working landscapes

Lecture 16 (11/16/2022): Climate change in the tropics

- Readings: Sheldon (2019) *Annual Review in Ecology, Evolution, and Systematics.*
- Activities: (I) Comparing climate sensitivity of tropical versus temperate species; (II) How to study fingerprints of climate change
- Learning Objectives: (I) State the unique impacts and threats that climate change poses to tropical ecosystems; (II) Differentiate between when forests act as carbon sources versus sink; (III) List out the fingerprints of climate changes, as applied to tropical ecosystems

Section 9: The Matrix Matters- in class activity

- Learning Objectives: (I) learn how to evaluate, test, and differentiate among multiple hypotheses; (II) interpret scientific results and graphs

WEEK 10

Lecture 17 (11/21/2022): Overexploitation

- Readings: Redford (1992) *BioScience*; Benítez-López *et al.* (2017) *Science.*
- Activities: (I) Discussion of defaunation science, then and now; (II) Debate about whether trophy hunting and conservation are compatible
- Learning Objectives: (I) Articulate the key drivers of overhunting and overfishing; (II) Evaluate the benefits and downloads of different mitigation strategies

Lecture 18 (11/23/2022): International conservation

- Readings: Prathapan *et al*. (2018) *Science;* IPBES (2018) Americas Regional Assessment. *You can skim the Americas Regional Assessment reading!*
- Activities: (I) Discussion about the merits of the Nagoya protocol; (II) Essential Biodiversity Variable exercise; (III) Utility of regional IPBES assessments
- Learning Objectives: (I) articulate strategies for solving cross-border conservation problems; (II) learn about key players in the international conservation science/policy landscape

No Section: Thanksgiving Holiday

WEEK 11

Lecture 19 (11/28/2022): Tropical museum science (Andy Engilis and Irene Engilis)

- Readings: TBD.
- In class activity: (I) getting familiar with tropical museum specimens
- Learning Objectives: (I) learn about the role of museum science in documenting tropical diversity; (II) understand the challenges of tropical fieldwork

Lecture 20 (11/30/2022): Research symposium

Section 10: Final review session

- Learning Objectives: (I) solidify understanding of tropical ecology and conservation; (II) appreciate the conservation challenges facing tropical biomes; (III) clearly articulate solutions for enhancing tropical diversity without compromising rural livelihoods

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Course-based Research Project:
What traits do bird-watching tourists value in Neotropical birds?

Beyond the essential goods and services that directly support human livelihoods, nature also provides us with many intangible benefits that enrich our lives. People around the world spend vast sums of money every year to interact with nature and biodiversity in zoos, in protected areas, and in their backyards. For example, nearly 15 years ago, researchers estimated that 50 million people spent >$30 billion per year in the United States alone on birdwatching related activities. Indeed, nature-based tourism industries have grown to encompass substantial fractions of some countries' economies, especially in tropical countries like Costa Rica. Beyond providing joy and inspiration to millions of people worldwide, responsible nature-based tourism can also result in remarkable conservation gains. In Peru, for example, researchers showed nature-based tourism was far-and-away the most profitable use of tropical rainforest land, much more so than replacing forests with mining, timber, or industrial agricultural operations. Thus, when designed responsibly, incentivizing nature-based tourism can represent a win-win for rural communities and local wildlife.

Unfortunately, however, climate change, deforestation, and other global environmental changes now threaten many of the species that drive nature-based tourism industries. Protecting these species is critical for ensuring that nature-based tourism lodges and nature reserves are not replaced with mines, farms, or other land uses. But what makes one species more desired by tourists over another? Are there key traits (*i.e.,* species characteristics) that most tourists value in wildlife over others? For example, do they tend to prefer more colorful, larger, or endemic wildlife? Do they prefer at-risk species, meaning that biodiversity loss may rapidly degrade nature-based tourism industries? Or are preferred species resilient, meaning nature-based tourism industries may be as well?

By determining which species tourists value most, and which characteristics they tend to share, biologists could help prioritize conservation efforts to ensure nature-based tourism continues to bring joy to tourists, which simultaneously incentivizing conservation and sustaining local livelihoods. One approach is to look to the experts— the nature-based tourism guides and tour companies— to determine which species elicit the most joy in their customers. To capture prospective customer's imaginations and spur them to travel, tour companies often post detailed trip itineraries, complete with descriptions of the locations that their customers would visit and the wildlife that they may encounter. For the advertising to be effective, it would be expected that the most desired species would be highlighted, and the disliked species would be ignored.

In WFC 125, students will be charged with building a database of the tourism value associated

with different Costa Rican bird species by visiting birdwatching tour company websites and noting how many times each Costa Rican bird species appears in advertised travel itineraries. By quantifying the fraction of trip itineraries in which each species is mentioned, students will be able to develop an index of the value of each species to birdwatching tourists. With this database in tow, students will divided be into groups of ~4 and asked to develop original research questions surrounding what traits birdwatching tourists value in Costa Rican birds. Groups will generate a multitude of hypotheses. Two examples are:

1. Birdwatching tourists tend to prefer species that are more colorful and larger.
2. Birdwatching tourists tend to prefer species that are rarer.

Each group will work with Prof. Karp and TA Lauck to narrow down their study to 1-2 research questions and associated hypotheses. Then, students will be provided with an extensive database of traits related to the appearance, vocalizations, behaviors, diet, conservation, and life-history of species in the Guanacaste region of Northwest Costa Rica (where Prof. Karp works) as well as a more limited dataset for all the species that occur throughout Costa Rica. It is possible that testing a group's hypothesis may require collecting more data. If this is the case, Prof. Karp and TA Lauck will help groups find data sources to answer their question. Once the datasets are assembled, students will be trained in basic statistical techniques and asked to analyze their data and produce figures depicting their results. Each student will also be asked to produce a short, annotated bibliography summarizing at least 5 scientific papers that are relevant to their research question. Finally, each group will design a poster to be presented during an in-class poster symposium to communicate their work and findings.

Working as a team is essential in science but can be difficult if some team members monopolize the work and/or others do not contribute adequately. Importantly, people vary in work strategies which can also lead to conflict. Students will be asked to write a 2-paragraph reflection midway through the project to identify any sources of conflict within the group and discuss how they have contributed/plan to contribute. These reflections will be graded and can influence others' grades. They will also be used so that Prof. Karp and TA Lauck can facilitate constructive conversations about group dynamics and conflict resolution. At the very end of the project, students will turn in another 2-paragraph reflection that both outlines their contributions to the project and discusses group dynamics. This reflection will also influence grading.

Assessment Description

Note: These descriptions constitute broad overviews of the assignments. Refer to the actual assignment descriptions when preparing your assignments.

Quizzes: To ensure students are keeping up with online lectures and sections, online quizzes will be administered via Canvas and due by **Thursdays at 5:00 pm** each week. Quizzes will draw from the week's lectures and will be untimed.

Section participation: The course TA will give credit to students that actively participate in the debates and discussions that occur during course sections. Students are allowed to miss **ONE** section without it affecting their grades.

Questions and hypotheses: In section 2, students will learn how to develop research questions and hypothesis. Students will be divided into groups of ~4, and asked to outline at least **THREE** novel research questions (and associated hypotheses) that could potentially guide their student driven-research projects.

Database creation: In section three, students will learn how to collect data from birdwatching trip itineraries and enter it into a course database. Then, each student will be assigned different birdwatching tour websites, tasked with collecting associated data, and asked to turn in a

standardized Excel form with their data entered.

Midterm exam: An exam will be administered midway through the course. The midterm will cover all lectures and readings up to and including lecture 8 (from rivers to reefs).

Database quality control: To ensure quality data, each student will send their completed dataset to one other member of their research group. Upon receiving the completed dataset, the student will visit each itinerary's URL and carefully crosscheck the information in the itinerary with the data entered into the database. Errors will be corrected and flagged using the highlight tool. Once finished, the completed database will be uploaded as an .xls or .xslx onto Canvas.

Annotated bibliography: Each student will be asked to search the literature and identify **FIVE** scientific papers that are relevant to their group's research project. Students will need to coordinate with their group members such that no two students review the same article. The papers are allowed to contribute to background information and be broadly related to the topic. Each student will then compose a short, annotated bibliography that contains: (i) the full citation for each journal article, (ii) a 2-3 sentence summary of each article detailing the research question, the main method of analysis, and the core finding, and (iii) a short, 2-3 sentence description of how the article is relevant to their research project.

Graphs and captions: Each group will prepare and submit a document containing **two** figures reflecting the most important findings from their research project. Each graph must depict the raw data. Graphs must also either show trend lines (for regression analyses) or means/confidence intervals (for ANOVA analyses or t-tests). Graphs must be attractively formatted with axes clearly labeled. Finally, descriptive captions must accompany each graph.

Group work reflection 1: Each individual will write a two paragraph reflection about how their research group has functioned to date. The first paragraphs will constitute a self-reflection, discussing what the student has contributed to the team and how he/she plans to participate looking forward. The second paragraph will be a candid discussion of team dynamics. This will be confidential and represents a space for students to discuss whether or not any project members have been failing to pull their weight or are monopolizing the research process. Note: Dr. Karp and the TA reserve the right to change a student's group work grade if reflections from other group-members indicate that the student has not meaningfully contributed to the group.

Poster presentation: Each group will prepare a 36inX 48in poster with the following sections: abstract, introduction, methods, results, and discussion. The amount of text will be minimized in favor of attractive visuals. Groups will present their posters at a mini symposium.

Group work reflection 2: Each individual will submit a final TWO PARAGRAPH reflection. As before, the first paragraph will constitute a self-reflection, discussing what the student has contributed to the team and to the project. The second paragraph will again focus on group dynamics and provide space for students to discuss whether any team member did not sufficiently contribute to the team. If it is apparent that a student did not sufficiently contribute to the team, his or her grade on the reflection may be adjusted.

Final exam: The final exam will cover all course lectures and readings but emphasize the lectures and readings not covered in the first midterm.