**Course Name:** **Complex Systems Science for Environmental Sustainability**

**Course Number:** GEOG 513

**Credits:** 3

**Instructor name:** James Watson

**Instructor email:** [james.watson@oregonstate.edu](mailto:james.watson@oregonstate.edu)

**Office hours**: TBD

**Prerequisites**: None

# Course Description

This graduate discussion course explores the principles, dynamics, and applications of complex adaptive systems (CAS) with a focus on environmental challenges and sustainability. Through an interdisciplinary approach, participants will analyze how ecosystems and socio-ecological systems function as CAS, characterized by emergent behaviors, adaptation, and nonlinear interactions.

Participants will *remember* foundational theories, *understand* key features of CAS, and *apply* these concepts to environmental case studies. Weekly discussions will encourage participants to *analyze* scientific papers, *evaluate* diverse perspectives, and *create* conceptual frameworks for addressing pressing environmental issues.

Key topics include modeling ecosystem dynamics, governance of socio-ecological systems, biodiversity, ecosystem functioning, and sustainability frameworks. Each session emphasizes critical thinking and collaborative dialogue, enabling students to articulate connections between CAS theory and real-world applications.

By the course’s conclusion, participants will be able to:

1. *Describe* the defining characteristics of complex adaptive systems.

2. *Interpret* key processes driving ecosystem and socio-ecological dynamics.

3. *Critique* methodologies for studying CAS and their implications for environmental policy.

4. *Develop* innovative solutions for environmental problems using CAS principles.

This course prepares participants to navigate the complexities of sustainability science, empowering them to contribute thoughtfully and creatively to research, policy-making, and management in diverse ecological and social contexts.

# Communication

# All course announcements will be posted via Canvas; any scheduling updates and reminders will appear there. I will use Canvas 'conversations' (inbox button, Canvas main menu on left side) if I need to contact you individually. I ask that you do the same when contacting me directly. I will reply to course-related questions sent via Canvas conversations within 24-48 hours.

Office Hours: by appointment, phone or Zoom.

# Time Expectations

This course includes 3 hours per week of in person discussion for 3 credits.

# Technical Assistance

If you experience any errors or problems while in your online course, contact 24-7 Canvas Support through the Help link within Canvas.  If you experience computer difficulties, need help downloading a browser or plug-in, or need assistance logging into a course, contact the IS Service Desk for assistance. You can call (541) 737-8787 or visit the [IS Service Desk](https://oregonstate.teamdynamix.com/TDClient/Requests/TicketRequests/NewForm?ID=Dr9c0T7BaSI_) online.

# Learning Resources

*All learning materials will be posted in Canvas. There is no textbook required for this course.*

# Measurable Student Learning Outcomes

Measurable student learning outcomes for this discussion-based include:

**Knowledge Acquisition and Recall:** Students will **define and explain** the key principles and characteristics of complex adaptive systems as they relate to environmental science.

**Understanding and Interpretation:** Students will **interpret and summarize** scientific literature on complex adaptive systems and their application to socio-ecological challenges.

**Critical Thinking and Analysis:** Students will **critically evaluate** methodologies and research findings related to complex adaptive systems, including their implications for environmental policy and management.

**Communication and Collaboration:** Students will **articulate and defend** their insights and proposed solutions through structured discussions, presentations, and collaborative group research.

## Weekly Participation

Students are expected to participate in all in person discussions.

**Evaluation of Student Performance**

Participation – 80%

End of term essay - 10%

End of term presentation - 10%

**Grading Scale**

100—93 = A

92—90 = A-

89—87 = B+

86—83 = B

82—80 = B-

79—77 = C+

76—73 = C

72—70 = C-

69—67 = D+

66—63 = D

62—60 = D-

0—59 = F

**Academic Calendar**  
All students are subject to the registration and refund deadlines as stated in the Academic Calendar: <https://registrar.oregonstate.edu/osu-academic-calendar>

**Student Bill of Rights**  
OSU has twelve established student rights. They include due process in all university disciplinary processes, an equal opportunity to learn, and grading in accordance with the course syllabus: <https://asosu.oregonstate.edu/advocacy/rights>

## Expectations for Student Conduct

Student conduct is governed by the university’s policies, as explained in the Student Conduct Code (<https://beav.es/codeofconduct>). Students are expected to conduct themselves in the course (e.g., on discussion boards, email postings) in compliance with the university's regulations regarding civility.

## Academic Integrity

Integrity is a character-driven commitment to honesty, doing what is right, and guiding others to do what is right.  Oregon State University Ecampus students and faculty have a responsibility to act with integrity in all of our educational work, and that integrity enables this community of learners to interact in the spirit of trust, honesty, and fairness across the globe.

Academic misconduct, or violations of academic integrity, can fall into seven broad areas, including but not limited to: cheating; plagiarism; falsification; assisting; tampering; multiple submissions of work; and unauthorized recording and use.

It is important that you understand what student actions are defined as academic misconduct at Oregon State University.  The OSU Libraries offer a [tutorial on academic misconduct](https://guides.library.oregonstate.edu/c.php?g=286121&p=3896378), and you can also refer to the [OSU Student Code of Conduct](https://beav.es/codeofconduct) and [the Office of Student Conduct and Community Standard’s website](https://studentlife.oregonstate.edu/studentconduct/student-info) for more information.  More importantly, if you are unsure if something will violate our academic integrity policy, ask your professors, GTAs, academic advisors, or academic integrity officers.

# Statement Regarding Students with Disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval, please contact DAS immediately at 541-737-4098 or at <http://ds.oregonstate.edu>. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

## Statement Regarding Religious Accommodation

Oregon State University is required to provide reasonable accommodations for employee and student sincerely held religious beliefs.  It is incumbent on the student making the request to make the faculty member aware of the request as soon as possible prior to the need for the accommodation. See the [Religious Accommodation Process for Students](http://eoa.oregonstate.edu/religious-accommodation-policy).

## Guidelines for a Productive and Effective Online Classroom Students are expected to conduct themselves in the course (e.g., on discussion boards, email) in compliance with the university’s regulations regarding civility. Civility is an essential ingredient for academic discourse. All communications for this course should be conducted constructively, civilly, and respectfully. Differences in beliefs, opinions, and approaches are to be expected. In all you say and do for this course, be professional. Please bring any communications you believe to be in violation of this class policy to the attention of your instructor.

Active interaction with peers and your instructor is essential to success in this online course, paying particular attention to the following:

* Unless indicated otherwise, please complete the readings and view other instructional materials for each week before participating in the discussion board.
* Read your posts carefully before submitting them.
* Be respectful of others and their opinions, valuing diversity in backgrounds, abilities, and experiences.
* Challenging the ideas held by others is an integral aspect of critical thinking and the academic process. Please word your responses carefully, and recognize that others are expected to challenge your ideas. A positive atmosphere of healthy debate is encouraged.

# Student Evaluation of Courses

During Fall, Winter, and Spring term, the online Student Evaluation of Teaching system opens to students the Wednesday of week 8 and closes the Sunday before Finals Week. Students will receive notification, instructions and the link through their ONID email. They may also log into the system via Online Services. Course evaluation results are extremely important and used to help improve courses and the learning experience of future students. Responses are anonymous (unless a student chooses to “sign” their comments, agreeing to relinquish anonymity) and unavailable to instructors until after grades have been posted. The results of scaled questions and signed comments go to both the instructor and their unit head/supervisor.  Anonymous (unsigned) comments go to the instructor only.

**Reach Out for Success**  
University students encounter setbacks from time to time. If you encounter difficulties and need assistance, it’s important to reach out. Consider discussing the situation with an instructor or academic advisor. Learn about resources that assist with wellness and academic success at [oregonstate.edu/ReachOut](https://counseling.oregonstate.edu/reach-out-success). If you are in immediate crisis, please contact the Crisis Text Line by texting OREGON to 741-741 or call the National Suicide Prevention Lifeline at 988

# COURSE CONTENT

Below is a curated list of eight papers that touch upon distinct foundational concepts, each accompanied by a brief description and a link to access the full text. These readings are organized to progressively build understanding over the course of eight weeks.

**Week 1: Introduction to Complex Adaptive Systems in Ecology**

* **Title:** "Ecosystems and the Biosphere as Complex Adaptive Systems"
* **Author:** Simon A. Levin
* **Description:** This foundational paper introduces the concept of ecosystems as prototypical examples of complex adaptive systems, highlighting the emergence of patterns from localized interactions and selection processes.
* **Link:** [Ecosystems and the Biosphere as Complex Adaptive Systems](https://link.springer.com/article/10.1007/s100219900037)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 2: Key Features of Complex Adaptive Systems**

* **Title:** "Key Features of Complex Adaptive Systems"
* **Publisher:** Stockholm Resilience Centre
* **Description:** This document outlines the essential characteristics of complex adaptive systems and discusses their implications for guiding practice in socio-ecological systems.
* **Link:** [Key Features of Complex Adaptive Systems](https://www.stockholmresilience.org/download/18.761fdfb217fe034b93e16e7/1662712574198/CST_Policy_Complex-Adaptive-Systmes-Web.pdf)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 3: Complexity Economics and Sustainability**

* **Title:** "**Role of economics in analyzing the environment and sustainable development**"
* **Authors:** Steve Polasky et al.
* **Description:** This paper presents a framework for understanding the role of economics in social-ecological systems.
* **Link:** [Role of economics](https://www.pnas.org/doi/abs/10.1073/pnas.1901616116)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 4: Modeling Social-Ecological Systems**

* **Title:** "Social-Ecological Systems as Complex Adaptive Systems: Modeling and Policy Implications"
* **Authors:** Simon Levin et al.
* **Description:** The authors discuss the challenges of modeling social-ecological systems due to their complex adaptive nature and explore the policy implications of these models.
* **Link:** [Social-Ecological Systems as Complex Adaptive Systems](https://www.cambridge.org/core/journals/environment-and-development-economics/article/abs/socialecological-systems-as-complex-adaptive-systems-modeling-and-policy-implications/C02DE8F7767B295C3289F51E83D845B4)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 5: Biodiversity and Ecosystem Functioning**

* **Title:** "Revisiting Biodiversity and Ecosystem Functioning through the Lens of Complex Adaptive Systems"
* Authors: Alexandra M. Correia and Luís F. Lopes
* **Description:** This paper examines biodiversity and ecosystem functioning from the perspective of complex adaptive systems, emphasizing the dynamic processes that emerge from local interactions.
* **Link:** [Revisiting Biodiversity and Ecosystem Functioning](https://www.mdpi.com/1424-2818/15/8/895)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week
* **Additional Reading**: Indicators for Monitoring Biodiversity: A Hierarchical Approach. Noss 1990, Conservation Biology 4:355-364

**Week 6: Sustainability Frameworks**

* **Title:** " **The right incentives enable ocean sustainability successes and provide hope for the future**"
* **Authors:** Jane Lubchenco et al.
* **Description:** The chapter describes key features of complex adaptive systems and discusses their implications for sustainability frameworks.
* **Link:** [Complex Adaptive Systems and a Sustainability Framework](https://www.pnas.org/doi/abs/10.1073/pnas.1604982113)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 7: Risk and International Relations**

* **Title:** “**Dealing with femtorisks in international relations”**
* **Authors:** Frank et al.
* **Description:** This paper discusses how complex adaptive systems thinking helps us think about international relations and risk.
* **Link:** [Risk](https://www.pnas.org/doi/abs/10.1073/pnas.1400229111)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 8: Regime Shifts and Human Well-being in Socio-Environmental Systems**

* **Title:** "Maintaining Human Well-being as Socio-Environmental Systems Undergo Regime Shifts"
* **Authors:** Andrew R. Tilman et al.
* **Description:** This study explores how global environmental changes push socio-environmental systems toward critical thresholds, leading to regime shifts. It examines the phenomenon of 'flickering'—where systems vacillate between alternative stable states—as an early warning signal of irreversible transitions. The paper discusses the challenges flickering poses for human adaptation and highlights the importance of governance interventions that enhance adaptive capacity to maintain human well-being during such transitions.
* **Link:** [Maintaining Human Well-being as Socio-Environmental Systems Undergo Regime Shifts](https://www.sciencedirect.com/science/article/pii/S0921800924000910)

**Week 9: Rate-Induced Transitions in Networked Complex Adaptive Systems**

* **Title:** "Rate-Induced Transitions in Networked Complex Adaptive Systems: Exploring Dynamics and Management Implications Across Ecological, Social, and Socioecological Systems"
* **Authors:** Vítor V. Vasconcelos et al.
* **Description:** This study presents a framework capturing rate-induced transitions in complex adaptive systems and discusses the dynamics and management implications across various systems.
* **Link:** [Rate-Induced Transitions in Networked Complex Adaptive Systems](https://arxiv.org/abs/2309.07449)
* **Student podcast:** Students will choose a podcast from the Santa Fe institute complexity podcast to listen to and discuss next week

**Week 1-10: Your Complex Systems Research**

* Students will undertake the process of conceptualizing their own research through the lens of Complex Adaptive Systems Science.
* Assessment will include:
  + An **essay** describing their research through the lens of Complex Adaptive Systems Science, and a critical analysis of this framework, and how other frameworks (from various disciplines including Geography) might contribute alternative perspectives on their research.
  + A **presentation** to the class on the kernel of their essays.

**Weekly Discussion Instructions**

**Class Duration:** 1–2 hours  
**Discussion Leader(s):** Assigned in advance  
**Preparation Time:** At least 1 week ahead of discussion

### Before Class

**For All Students:**

* Read the assigned paper thoroughly.
* Review any guiding questions or themes provided.
* Submit 1–2 reflection points or questions about the reading 24 hours before class.

**For the Discussion Leader(s):**

* Prepare a brief summary of the paper (5 minutes max).
* Research and share 3–5 discussion questions with the class at least 48 hours in advance.
* Identify a few key figures or sections to highlight and clarify.
* (Optional) Meet briefly with the instructor to review your plan.

### Class Structure

**1. Opening (5–10 min)**

* The facilitator (instructor or student leader) introduces the paper and its context.
* Each student offers a 1-sentence reaction to the paper.

**2. Summary & Clarification (10–15 min)**

* The discussion leader presents the paper's main contributions and methods.
* Students ask clarifying questions (focus on methods, definitions, figures).

**3. Thematic Discussion (30–60 min)** The leader guides the class through deeper discussion. Focus areas may include:

* What are the underlying assumptions?
* Are the methods appropriate and clearly explained?
* Are the conclusions justified?
* How does this paper fit into the broader literature?
* What are the implications of this work?

Tools and strategies:

* Think-Pair-Share
* Devil's Advocate (assign one student to challenge arguments)
* Comparative Discussion (if multiple papers)

**4. Reflection (10–15 min)**

* Discuss takeaways: what did we learn?
* Reflect on how this paper may influence your own research.