THE SCHOOL FOR FIELD STUDIES

Patagonian Ecology
SFS 3781

Syllabus

The School for Field Studies (SFS)
Center for Climate Studies (CCS)
Puerto Natales, Chile

This syllabus may develop or change over time based on local conditions, learning opportunities, and faculty expertise. Course content may vary from semester to semester.

COURSE CONTENT SUBJECT TO CHANGE

Please note that this is a copy of a recent syllabus. A final syllabus will be provided to students on the first day of academic programming.

SFS programs are different from other travel or study abroad programs. Each iteration of a program is unique and often cannot be implemented exactly as planned for a variety of reasons. There are factors which, although monitored closely, are beyond our control. For example:

- Changes in access to or expiration or change in terms of permits to the highly regulated and sensitive environments in which we work;
- Changes in social/political conditions or tenuous weather situations/natural disasters may require changes to sites or plans, often with little notice;
- Some aspects of programs depend on the current faculty team as well as the goodwill and generosity of individuals, communities, and institutions which lend support.

Please be advised that these or other variables may require changes before or during the program. Part of the SFS experience is adapting to changing conditions and overcoming the obstacles that they may present. In other words, the elephants are not always where we want them to be, so be flexible!

Course Overview

This course focuses on ecology as a discipline, biodiversity, and the Patagonian ecoregions and habitats that have evolved with short growing seasons, tenacious southwesterly winds, and fierce winters. We will examine the ecology and evolution of faunal species such as Guanaco (related to the llama), Magellanic and King penguins, and the flightless Rhea, most of them endemic to the region, and the largest animal of them all, the Blue Whale. We will explore ecological succession, including primary succession, which is how life recruits into new environments, such as bare rock after glacial retreat, or new, igneous rock after volcanic eruption. Though flora is not particularly diverse here in southern Patagonia (save for the lichens and bryophytes), the floral structural complexity is fascinating.

We will explore a remarkable latitudinal gradient—from Cape Horn in the south to Chiloé Island's milder, temperate climate—a latitudinal change equivalent to traveling from Massachusetts to Florida. Thematically, we will traverse alpine ecology, exposed terrestrial ecology, coastal ecology, marine ecology, and fire ecology. From the central focus on the theory and practice of ecology, we will expand to investigate relationships between people and nature in conservation, resilience, and environmental challenges. We will explore the role of protected areas in conservation, including private protected areas that have emerged in Chile; invasive species; human history on landscapes; agriculture, plantation forests, and aquaculture; and current and predicted changes due to climate change.

The course is constructed so that the lens of climate shifts and perturbations will be central to discussions and observations; it will encompass not only climate threats, but an understanding of the role of nature in climate adaptation and mitigation, and the role of Chilean climate policy and commitments in an international community.

Learning Objectives

A fundamental skill in ecology is the ability to identify organisms, in order to document their interactions with each other and the environment. Field and lab practicums will feature plant, bird, and mammal identification portions. In a shared goal with the Earth Systems and Climate course, students will be able understand and articulate the mechanism of global warming where heat is trapped within the atmosphere, and identify the anthropogenic signature of climate change.

Student Learning Outcomes

1. Understand the constraints of life at high-latitude, starting with the energetic constraints of a short growing season, in a steep elevation gradient from sea level to high alpine environments.
2. Gain the ability to "read" landscapes for the climate and ecological relationships that shape them, skills that will be put into play when reading the vastly different landscapes on different field expeditions.
3. Demonstrate your ability to identify a new suite of plant, animal, bird, and marine organisms in the field.
4. Integrate multiple forms of learning in a field notebook – observation, expert knowledge, and mapping of concepts onto real landscapes and seascapes – and use this documentation to develop new questions, hypotheses, and research.

5. Understand the richness of life forms and their interactions – herbivory, predation, parasitism, mutualism, co-evolution and facilitation – and how the nature and timing of interactions may be shifting with climate change.
6. Employ field methods and analytical tools – qualitative and quantitative – that are used in ecology and social-ecological studies.
7. Articulate climate-change impacts and solutions at multiple scales, from local to global. Understand the role of nature in climate adaptation and mitigation, and the role of Chilean climate policy and commitments in an international community.

Thematic Components and Research Direction

The overarching question we address in the CCS curriculum is:

How can Chile respond to local and global challenges while securing the functionality of its natural and human systems?

Assessment

The evaluation breakdown for the course is as follows:

Assessment Item	Value (%)
Participation	10
Quizzes	15
Field Exercise 1	10
Field Exercise 2	15
Field notebook	20
Exam	30
TOTAL	**100**

Participation and topic discussions (10%)

Everybody should be prepared for each academic session. This implies reading the materials for each session with enough detail to be able to ask relevant questions; and to participate in analytical discussions about the key issues. Active participation during classes, discussions, assignments and hikes is expected.

Quizzes (10%)

Three short quizzes will be used to evaluate the classroom and field lectures.

Field Exercises (FEX) (25%)

Two field exercises will be conducted. With these FEXs students will gain experience for the Directed Research component at the end of the semester. The FEXs require field observation, data collection and report writing.

Context: Science is based on intuition, logic and reason. The scientific method begins with an *observation*; we seek *patterns* and then formulate *hypotheses* that could explain those patterns. We can

also use experiments to test hypotheses. Finally, we conclude on the results thus contributing to a broader theory.

Objective: Our objective is to develop observation skills in the field and to learn the process of the scientific method.

FEX 1 (10%)

Subject: Observational skills, hypothesis testing, and animal census techniques
Methods: We will use the dramatic range of Torres del Paine National Park as a natural laboratory, from the high-alpine rock, ice, and glaciers, to the lower-elevation steppes where we can observe guanaco, Andean condor, and other wildlife. Students will be provided with theory during the orientation hikes and guidance in the process of observation, hypothesis formulation, analysis and writing. Learn skills on bird and mammal identification, wildlife count methods, and understand the influence of habitat on species distribution and diversity.

FEX 2a and 2b (20%)

Subject: a) introduction to experimental design and monitoring in ecology and b) qualitative methods in social-ecological systems (boat expedition)
Methods: We will use the boat expedition for the experiment setting and execution. Students will receive a handout on the subject along with a list of potential topics for the project. In addition, students need to discuss the project with the professor to receive feedback about the theory, logistics and equipment involved during the field data collection. Potential topics include observing human-wildlife interactions in the penguin colonies; exploring the nature of community science via interviewing the boat crew on their partnership with research scientists; or participating in long-term monitoring efforts such as the phenology of flowering plants or the impacts of invasive species on nesting seabirds.

Field Notebook (20%)

You will develop a comprehensive program field notebook that documents and captures your on-the-ground learning experiences and serves as your primary record of content and reflections during the course. This notebook should accompany you at all times: in the classroom, guest lectures, and the field. All class notes, field notes, data from field exercises, reflective comments and questions on course material, notes from discussions, and short written assignments should be contained in this notebook, which will serve as your main study tool. You may want to develop sections for observations during travel, translations or words in local languages, notes to remember for your directed research, cultural notes, and reflective writing on how this experience is reshaping your understanding of people and the environment. Keep this separate from personal journaling you may do. Additional course handouts should be kept in the folder provided.

When using citable material from your field notebook in written assignments, use the following format to acknowledge the source: (Person you spoke to (or your own observation), Field notes, Place, Date). Whenever possible, use the name of the person providing the information; if not possible, cite descriptively, for example: “Coastal manager on Chiloé Island.”

Exam (30%)

An exam will be given based on material covered in lectures, readings, and field experiences. Although the exam will be given before the last field expedition, students are still immersed in an academic experience, and will complete their field notebooks (see “Field Notebook” above) and turn them in for assessment at the very end of the course.

Grade corrections in any of the above items should be requested in writing at least 24 hours after assignments are returned. No corrections will be considered afterwards.

Grading Scheme

A	95.00 - 100.00%	B+	86.00 - 89.99%	C+	76.00 - 79.99%	D	60.00 - 69.99%
A-	90.00 - 94.99%	B	83.00 - 85.99%	C	73.00 - 75.99%	F	0.00 - 59.99%
		B-	80.00 - 82.99%	C-	70.00 - 72.99%		

General Reminders

Plagiarism – using the ideas or material of others without giving due credit – is cheating and will not be tolerated. A grade of zero will be assigned for anyone caught cheating or aiding another person to cheat either actively or passively.

Deadlines – Deadlines for written and oral assignments are instated to promote equity among students and to allow faculty ample time to review and return assignments before others are due. As such, deadlines are firm; extensions will only be considered under extreme circumstances. Late assignments will incur a penalty of 10% of your grade for each day you are late. After two days past the deadline assignments will not be accepted anymore. Assignments will be handed back to students after a one-week grading period.

Participation – Since we offer a program that is likely more intensive than you might be used to at your home institution, missing even one lecture can have a proportionally greater effect on your final grade simply because there is little room to make up for lost time. Participation in all components of the course is mandatory, it is important that you are prompt for all activities, bring the necessary equipment for field exercises and class activities, and simply get involved.

Course Content

Type: L: Lecture and discussion, **FL:** Field Lecture, **GL:** Guest Lecture, **FEX**: Field Exercise, **FLAB**: Field lab, **GP**: Group project

*Readings in **Bold** are required.

No	*Title and outline*	*Type*	*Time (hrs)*	*Required Readings*
PE 1	**Commitment to diversity, inclusion and equity – making the classroom a place that enhances all students' learning.** Orientation, discussion, and exploration of equity in different learning styles, perspectives, and lived experiences. (Shared class session with	L	2.5	(Crosby 2018, hooks Hooks 1994, Barnes, Marín-Spiotta and Morris 2018, Prescod-Weinstein 2017)

No	Title and outline	Type	Time (hrs)	Required Readings
	Earth Systems and Climate.)			
PE 2	**Introduction to Ecology:** Introduction to ecology as a discipline, and to high-latitude Patagonian ecology. Review syllabus, field exercises, questions and expectations for the semester.	L	1.5	(Smith and Smith 2015g, Smith and Smith 2015a) (Rozzi et al. 2012) Review syllabus
PE 3	**Overview of land, freshwater, and ocean environments:** constraints and opportunities for life in each environment	L	1.5	(Smith and Smith 2015d, Smith and Smith 2015c, Smith and Smith 2015j)
PE 4	**Plant adaptations to harsh, high-latitude environments in Patagonia;** plant biogeography; ecoregions of Patagonia **Animal adaptations to harsh, high-latitude environments in Patagonia.** Mammals endemic to Patagonia. Birds of Patagonia, including the flightless rhea.	L	2.0	(Smith and Smith 2015i) (Smith and Smith 2015b) Selections from (Moreira-Muñoz 2011)
PE 5	**Natural History of Chile** a) Geologic formation of coastal Chile and plate-tectonic activity b) Climate and topography of southern Patagonia, Chile c) Biogeographic consequences of tectonic activity and steep, alpine environments for terrestrial and marine biota. d) Life Zones, habitats and species richness. e) Humans and the environment.	L	1.5	Connection with readings from Earth Systems and Climate course
PE 6	**Properties of populations and population growth** Population structure, survivorship curves, environmental and demographic stochasticity	L	1.0	Selection from (Smith and Smith 2015e)
PE 7	**Life history patterns** Reproductive strategies, fecundity,	L	2.0	Population studies in the Chilean context (Corti, Wittmer and Festa-Bianchet 2010, Dans et al. 2003)

No	Title and outline	Type	Time (hrs)	Required Readings
	survival and fitness **Intraspecific population regulation; population dynamics; and interspecific competition**			Life history (Smith and Smith 2015f)
Multi-day trip to Torres del Paine National Park				
PE 8	**Field exercises** (Torres del Paine National Park (TDP) **Generating and testing hypotheses**. a) How to create a field notebook to support field observations and experience; how the field notebook will be assessed	FL	1.5	
PE 9	**Alpine ecology** Adaptations, modifications and modulations; life zones, elevational and species diversity; global change and alpine communities	FL	1.0	Chapters 1-2 in Körner (2003) Grabherr, Gottfried and Pauli (2011) Optional reading: (Arroyo et al. 2003)
PE 10	**Mammals and predator-prey interactions** (TDP) Evolutionary adaptations and counteradaptations, Lotka-Volterra model (and its limits) and population modeling	FL	1.0	(Cofre and Marquet 1999, Altmann 1974, Altmann and Altmann 2003, Ortega and Franklin 1995, Marino and Baldi 2008)
PE 11	**FEX 1: Animal observation and census techniques** Hike "Safari trail" in TDP, observe guanaco; more elusive wildlife includes the puma (mountain lion) and the endangered Huemul deer. Bird life includes the Andean condor.	FEX	4.0	(Altmann 1974, Altmann and Altmann 2003) Optional reading: (Vila et al. 2006)
PE 12	**Parasitism and mutualism** Diversity of host-parasite relationships, evolutionary adaptations and arms races, cost-benefit of mutalisms	L	1.0	(Smith and Smith 2015h) Optional reading: (Silliman et al. 2011)
Multi-day boat expedition: fjords, Strait of Magellan, Cape Horn, and penguin colony				
PE	**HIKE** (Strait of Magellan Park/Museum,	FL	2.0	

No	Title and outline	Type	Time (hrs)	Required Readings
15	before boarding the ship): **Wind-shaped forests of Patagonia**, under the south-southwest (SSW) winds; human history of the region, including the indigenous Yaghan people			
PE 16	**Ecological succession** What are the stages of life recruiting onto bare rock after glacial recession or volcanic eruption? (Boat expedition)	FL	1.0	(Chapin et al. 1994, Vitousek et al. 1993)
PE 17	**FEX 2a: Phenology of plants** a) changing phenology under climate change, and b) effects on plant pollinators or other mutualists (throughout boat expedition)	FEX	6.0	(Arroyo, Armesto and Villagran 1981) Optional reading: (Muñoz et al. 2005, Arroyo, Armesto and Primack 1985, Arroyo, Primack and Armesto 1982)
PE 18	**FEX 2b: Magellanic and King penguins**: biology, life history, and current threats (Boat expedition)	FL	1.0	(Radl and Culik 1999, Stokes and Boersma 2000, Forcada and Trathan 2009)
PE 19	**Invasive species**: a) How climate change influences invasion; b) The case of the invasive American mink and Canadian beaver in Chile. (Boat expedition)	FL	1.0	(Schüttler et al. 2009, Walther et al. 2009)
PE 20	**Life in the ocean**: Marine Ecology and Conservation 1 (Boat expedition)	FL	1.0	(Jackson 2008, Weimerskirch et al. 2003) Selection from chapter 5 in Denny (2008)
Mid-semester break				
PE 21	**Soil ecology**: microbial communities and plant-soil interactions	L	1.0	(Hobbie 1992, Ritz and van der Putten 2012) Optional reading: (Nuñez, Horton and Simberloff 2009)
PE 22	**Coevolution and pollination ecology** Two species coevolution vs diffuse coevolution; niche partitioning; phenotypic divergence	L	1.0	(Smith and Smith 2015h, Muñoz and Arroyo 2004) Optional reading: (Muñoz et al. 2005, Arroyo et al. 1985, Arroyo et

No	Title and outline	Type	Time (hrs)	Required Readings
				al. 1982)
PE 23	**Human-environment interactions at multiple scales**: land-use and land cover (local); visit nearby *estancias*, farms and ranches) **Human-environment interactions: protected areas in Chile.** Land-use and land-cover (national and international scales); protected areas; private protected areas; native forests and pine plantations.	FL	3	(Armesto et al. 1998, Holmes 2014, Pliscoff and Fuentes-Castillo 2011, Klubock 2014c) Optional reading: (Klubock 2014a)
PE 24	**Ecosystem services** Connecting to pollination ecology, valuation of nature, incorporation of ES into land management and conservation policy	L	1.0	(Lara et al. 2009, Chaplin-Kramer et al. 2016)
PE 25	**Biocultural diversity**: Indigenous land management through the present	L	1.0	(Rozzi et al. 2006, Rozzi 2015) Optional reading: (Klubock 2014b)
Multi-day expedition to Perito Moreno Glacier and Glaciarium Museum in El Calafate, Argentina				
PE 26	**Environmental justice and climate justice** Defining the terms, roots and shoots of justice movements, applications in law and policy	FL	1.0	(Schlosberg and Carruthers 2010, Our_Children's_Trust 2018, Bullard and Wright 1993) Optional reading: (Pulido and Peña 1998, Bullard 1999)
PE 27	**Chilean climate commitments:** Expected benefits of meeting climate goals and commitments (1.5°C) across the globe for biodiversity, ecosystem services, habitats, and human well-being	L	2.0	(Siemens 2015, Davenport 2018, IPCC 2018a, IPCC 2018b, Plumer and Popovich 2018)
PE 28	**Climate solutions**: natural infrastructure. How nature contributes to both climate mitigation and adaptation, including ocean contributions to climate mitigation, adaptation, and solutions **Climate solutions**: students report	L/GP	3.0	(Ministerio_de_Relaciones_Exteriores_de_Chile and Ministère_de_l'Écologie_France 2015, Ozment, DiFrancesco and Gartner 2015) Optional reading:

No	Title and outline	Type	Time (hrs)	Required Readings
	back			(Langridge et al. 2014) Optional reading: (Myhre 2018)
PE 29	**Climate grief and ecological grief** Emotional and mental health costs of climate change and environmental awareness; coping strategies (Shared class session with Earth Systems and Climate)	L	1.5	(Cunsolo and Ellis 2018, Sinclair 2018, Holthaus 2018, Lin 2018) Optional reading: (Macy 1991)
PE 30	Review for Exam		2.0	
PE 31	Exam		3.0	
Multi-day trip to Puerto Montt region: La Arena; Osorno Volcano; and Chiloé Island				Optional reading for trip: Blue whale biology and migration (Branch et al. 2007, Hucke-Gaete et al. 2004)
PE 32	**Fire ecology** (Puerto Montt): volcanoes aren't the only fire in "Fire and Ice", how fire shapes landscapes, ecology, land use patterns and management	FL	1.0	(Veblen et al. 2011) Optional reading: (Moreno et al. 2018, Veblen et al. 2009, Veblen et al. 1999)
PE 33	**Forests and watersheds** (Puerto Montt region): linking terrestrial and freshwater systems, connections with ecosystem services discussion	FL	1.0	(Astorga, Moreno and Reid 2018)
PE 34	**Agriculture and aquaculture** (Puerto Montt region): small to industrial scales, diversity of management approaches, impacts of both on coastal ecosystems and climate	FL	2.0	(Naylor et al. 2000, Naylor et al. 2009, Buschmann et al. 2009) Optional reading: Agriculture readings assigned in Earth Systems and Climate; (Zedler and Kercher 2005)
PE 35	**Human-wildlife conflicts**: sea lions and salmon in La Arena (Puerto Montt region)	FL	1.0	Optional reading: (Goetz et al. 2008)
PE 36	**Marine ecosystem-based management** (Puerto Montt region): Challenges and approaches	FL	1.0	(Leslie and McLeod 2007) Optional reading: (Arkema, Abramson and Dewsbury 2006, Cárcamo, Garay-Flühmann and

No	Title and outline	Type	Time (hrs)	Required Readings
				Gaymer 2013, Gelcich et al. 2009)
	Comparison and synthesis: high-latitude, alpine-dominated environments, and the temperate environment of Chiloé Island (Puerto Montt region)	FL	2.0	Discussion during Puerto Montt field expedition
	Complete and turn in field notebook.			
	Total contact hours		**60**	

Reading List

*Readings in **Bold** are required

Altmann, J. (1974) Observational study of behavior: sampling methods. *Behaviour,* 49**,** 227-266.

Altmann, S. A. & J. Altmann (2003) The transformation of behaviour field studies. *Animal Behaviour,* 65**,** 413-423.

Arkema, K. K., S. C. Abramson & B. M. Dewsbury (2006) Marine ecosystem-based management: from characterization to implementation. *Frontiers in Ecology and the Environment,* 4**,** 525-532.

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Arroyo, M. T. K., J. J. Armesto & R. B. Primack (1985) Community studies in pollination ecology in the high temperate Andes of central Chile II. Effect of temperature on visitation rates and pollination possibilities. *Plant systematics and evolution,* 149**,** 187-203.

Arroyo, M. T. K., J. J. Armesto & C. Villagran (1981) Plant phenological patterns in the high Andean Cordillera of central Chile. *The Journal of Ecology***,** 205-223.

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Astorga, A., P. Moreno & B. Reid (2018) Watersheds and Trees Fall Together: An Analysis of Intact Forested Watersheds in Southern Patagonia (41–56° S). *Forests,* 9**,** 385.

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Bullard, R. D. (1999) Dismantling environmental racism in the USA. *Local Environment,* 4**,** 5-19.

Bullard, R. D. & B. H. Wright (1993) Environmental justice for all: community perspectives on health and research. *Toxicology and industrial health,* 9**,** 821-841.

Buschmann, A. H., F. Cabello, K. Young, J. Carvajal, D. A. Varela & L. Henríquez (2009) Salmon aquaculture and coastal ecosystem health in Chile: analysis of regulations, environmental impacts and bioremediation systems. *Ocean & Coastal Management,* 52**,** 243-249.

Cárcamo, P. F., R. Garay-Flühmann & C. F. Gaymer (2013) Opportunities and constraints of the institutional framework for the implementation of ecosystem-based management: the case of the Chilean coast. *Ocean & coastal management,* 84**,** 193-203.

Chapin, F. S., L. R. Walker, C. L. Fastie & L. C. Sharman (1994) Mechanisms of primary succession following deglaciation at Glacier Bay, Alaska. *Ecological Monographs,* 64**,** 149-175.

Chaplin-Kramer, R., L. Mandle, E. Rauer & S. Langridge. 2016. Introduction to Concepts of Biodiversity, Ecosystem Functioning, Ecosystem Services, and Natural Capital. In *Ecosystems of California,* eds. H. Mooney & E. Zavaleta, 265-283. Oakland, California: University of California Press.

Cofre, H. & P. A. Marquet (1999) Conservation status, rarity, and geographic priorities for conservation of Chilean mammals: an assessment. *Biological Conservation,* 88**,** 53-68.

Corti, P., H. U. Wittmer & M. Festa-Bianchet (2010) Dynamics of a small population of endangered huemul deer (Hippocamelus bisulcus) in Chilean Patagonia. *Journal of Mammalogy,* 91**,** 690-697.

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Forcada, J. & P. N. Trathan (2009) Penguin responses to climate change in the Southern Ocean. *Global Change Biology,* 15**,** 1618-1630.

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