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The Arctic: Changing Ecosystems and Resilience

ENVI 3000 (3 credits / 45 hours)

Iceland: Climate Change and the Arctic

This syllabus is representative of a typical semester. Because courses develop and change over time to take advantage of unique learning opportunities, actual course content varies from semester to semester.

Description

Gradual and rapid shifts are occurring in ecosystems worldwide. The Arctic, a region of major importance to the world, is changing more rapidly than any other area of the planet. This seminar makes the effects of climate change in this unique part of the world and the rest of the world a subject of discussion. It addresses the conditions of change in the Arctic, spanning ecological, social, and political-economic contexts. The seminar also considers community adaptation to the changing environment. Sessions will take place in different parts of Iceland in cooperation with program partners and working groups of the Arctic Council, as well as in Rovaniemi and Helsinki, Finland, at the University Lapland's Arctic Centre. Students will learn from experienced scientists, competent instructors, and experts of the Arctic Council.

Learning Outcomes

The Arctic: Changing Ecosystems and Resilience course comprises 45 hours of instruction (3 credits) with the following learning outcomes. Upon completion of this course, students will be able to:

- Clarify the physical processes of climate forcings and generate potential feedback loops under various climate scenarios;
- Reflect on the main ways a specific ecosystem or organism is responding to changing global climate.
- Judge the efficacy and limitations of climate-driven ecosystem impact research.

Language of Instruction

This course is taught in English, but students will be exposed to vocabulary related to course content through in-country expert lectures and field visits in a wide range of venues and regional locales.

Course Schedule

Students will be provided a detailed course schedule during orientation on the program. Please be aware that topics and excursions may vary to take advantage of any

emerging events, to accommodate changes in our lecturers' availability, and to respect any changes that would affect student safety. Students will be notified if this occurs.

Module 1: Ecosystem impacts in terrestrial systems
This module introduces students to the terrestrial landscape and recent issues related to changing climate. Topics span the range of individual physiological constraints to biome shifts. Different levels of organization are explored across different scales to give a general understanding of major processes at work in terrestrial systems. Major Arctic feedback loops, especially those related to carbon loss from permafrost thaw, will be examined as well.

Required Reading:
Sistla, S. A. et al. (2013). Long-term warming restructures Arctic tundra without changing net soil carbon storage. *Nature* 497: 615-618.

Suggested readings:
Heskel, M. et al. (2013). Differential physiological responses to environmental change promote woody shrub expansion. *Ecology and Evolution* 3: 1149-1162.
Settele, J. et al. (2014). Terrestrial and inland water systems. In: Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 271-359.
Swanson, D. K. (2015). Environmental limits of tall shrubs in Alaska's Arctic National Parks. *PLoS ONE* 10: 1-34.
Tape, K. D. (2016). Range expansion of moose in Arctic Alaska linked to warming and increased shrub habitat. *PLoS ONE* 11: 1-12.
Walker, D. A. (1987). Height and growth rings of *Salix lanata* ssp. *richardsonii* along the coastal temperature gradient of northern Alaska. *Canadian Journal of Bottany* 65: 988-993.

Module 2: Ecosystem impacts in freshwater systems
This module addresses consequences of climate variability in fresh waters. Topics will include things like groundwater recharge rates and resource management, nutrient release and eutrophication in northern systems, and impacts from changes in precipitation and snowpack.

Suggested Readings:
Hannesdóttir, E. A. et al. (2013). Increased stream productivity with warming supports higher trophic levels. *Advances in Ecological Research* 48: 285-342.
Jiménez Cisneros, B. E. et al. (2014): Freshwater resources. In: Climate Change 2014: Impacts,Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R.

Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 229-269.
Milner, A. M. et al. (2008). Colonization and development of an Alaskan stream community over 28 years. *Frontiers in Ecology and the Environment* 6: 413-419.
Reist, J. D. et al. (2006). General effects of climate change on Arctic fishes and fish populations. *Ambio* 35: 370-380.
Woodward, G. et al. (2010). Climate change and freshwater ecosystems: impacts across multiple levels of organization. *Philosophical Transactions of the Royal Society B* 365: 2093-2106.

Required Reading:

Winder, M., and Schindler, D. E. (2004). Climatic effects on the phenology of lake processes. *Global Change Biology* 10: 1844-1856.

Module 3: Ecosystem impacts in marine systems

The most visible and informative indicator of climate change in the Arctic is the change in sea ice cover. Arctic sea ice extent has declined over the past decades with far-reaching consequences for ecosystems and humans. In addition to sea ice thickness and extent, there have been rapid changes to salinity, temperature, and pH in several areas or the oceans worldwide. We will look at observed and projected changes to marine ecosystems from myriad perspectives related to global change.

Required Reading:

Anderson, P. J., and Piatt, J. F. (1999). Community reorganization in the Gulf of Alaska following ocean climate regime shift. *MEPS* 189: 117-123.

Suggested Readings:

Anthony, M. E., and Richardson, A. J. (2004). Impact of climate change on marine pelagic phenology and trophic mismatch. *Nature* 430: 881-884.
Beaugrand, G., and Kirby, R. R. (2010). Spatial changes in sensitivity of Atlantic cod to climate-driven effects in the plankton. *Climate Research* 41: 15-19.
Doney, S. C. et al. (2012). Climate change impacts on marine ecosystems. *The Annual Review of Marine Science* 4: 11-17.
Perry, A. L. et al. (2005). Climate change and distributional shifts in marine fishes. *Science* 308: 1912-1915.
Pörtner, H.-O. et al. (2014). Ocean systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 411-484.

Module 4: Arctic Resilience and Adaptation

This module broadly examines Arctic biological and physical systems, as well as observed changes and how they will affect those living in the Arctic. This section of the course content is an interdisciplinary mix of topics designed to introduce students to the Arctic. This module is delivered primarily in Finland. The Arctic has always undergone change, and indigenous peoples in the Arctic have depended on and adapted to their

environment. Their knowledge of their surroundings is a vital resource for their well-being. Adaptation to climate change is a key challenge for Arctic peoples and the world. The module is also based on knowledge and information derived from field visits and interaction with local communities in Finland.

Evaluation and Grading Criteria
Papers will be graded on style and structure, depth of analysis, and synthesis of secondary and primary sources.

Description of Assignments

Oral Quiz (10%):
This quiz assesses if students can identify and competently explain climate drivers and create potential feedback loops and their subsequent large- and small-scale ecosystem impacts.

Oral Presentation (20%):
Each student will give an oral presentation on a paper of his/her/their choosing that looks at ecosystem impacts of climate change. The paper can focus on any scale from organism to ecosystem. The paper must describe the climate scenarios applied to the study system. Students must have a thorough enough understanding of the impacts and scenarios to build critiques to the study into the presentation and answer audience questions. All papers are approved by the Academic Director in advance.

Paper Analyses (3) (60%):
Each student will analyze three peer-reviewed papers. The papers are assigned, and they cover the topics of climate change impacts in terrestrial, freshwater, and marine ecosystems. The analyses are one page, and they consist of four roughly equal sections: summary of the study and findings, broader significance of the paper, strengths, and weaknesses. A discussion of the paper will take place when these ecosystem levels are covered in class.

Participation (10%):
Participation will be graded by timely arrival, active involvement in class discussions, and culturally appropriate behavior on excursions.

Assessment:

Oral quiz	10%
Oral presentation	20%
Paper analyses (3)	60%
Participation	10%

Instructions and rubrics will be provided for all assignments.

Grading Scale:

94-100%	A
90-93%	A-
87-89%	B+
84-86%	B
80-83%	B-

77-79%	C+
74-76%	C
70-73%	C-
67-69%	D+
64-66%	D
below 64%	F

Expectations and Policies

- Show up prepared to discuss. Be on time, have your readings completed and points in mind for discussion or clarification. Complying with these elements raises the level of class engagement for everyone.
- Have assignments completed on schedule and done according to the specified requirements. This will help ensure that your assignments are returned in a timely manner.
- Ask questions in class. Engage the lecturer. These are often very busy professionals who are doing us an honor by coming to speak.
- Comply with academic integrity policies. There is no tolerance for plagiarism or cheating.
- Respect differences of opinion (classmates, lecturers, local constituents we engage with on-site visits). You are not expected to agree with everything you hear, but you are expected to listen across difference and consider other perspectives with respect.

Academic Policies: SIT prides itself on providing students with an experientially based program; we hold ourselves, and our students, to the highest of academic standards. Students are asked to refer to the **SIT Study Abroad Handbook** for policies on academic integrity, ethics, academic warning and probation, diversity and disability, sexual harassment and the academic appeals process.

Disability Services: Students with disabilities are encouraged to contact Disability Services at disabilityservices@sit.edu for information and support in facilitating an accessible educational experience. Additional information regarding SIT Disability Services, including a link to the online request form, can be found on the Disability Services website at http://studyabroad.sit.edu/disabilityservices.