



THE ICELAND PROGRAM  
ARCTIC ECOSYSTEMS & CLIMATE CHANGE  
SUMMER 2023  
June 23 – August 5

## ACADEMIC SYLLABUS

**Faculty:** Jenna Spackeen, PhD

**Contact Hours:** We will be in close contact for the duration of the course, and there will be plenty of opportunities for students to meet with the faculty. Additionally, there will be a number of “check-in days”, where we will arrange student-faculty meetings. Students are encouraged to engage with faculty to discuss assignments or any other personal issues or concerns as needed.

**Class Meetings:** The Wildlands Studies Program in Iceland involves seven days per week of instruction and field research with little time-off. Faculty and staff work directly with students 6-10+ hours a day and are available for tutorials and coursework discussion before and after scheduled activities. Typically, scheduled activities for the day will begin at 9 am, with breaks for meals, however; our day may begin much earlier and end much later so students need to have a flexible mindset while on the program. Scheduled activities will include a variety of things including but not limited to lectures, discussions, hikes, and field research. Students should also expect to spend a few hours a day studying, writing in their journals, and completing readings. It is necessary for students to have a flexible mindset and to be able to accommodate a variety of class, activity, and independent study times. Iceland has approximately 20 hours of sunlight during the summer. We will use this dynamic environmental factor to our advantage when planning activities so that we can experience unique learning opportunities and accommodate for weather.

**Course Credit:** Students enrolled in a Wildlands Studies Program receive credit for three undergraduate courses. These three courses have distinct objectives and descriptions, and we integrate teaching and learning through formal learning situations (lectures and seminars), field work, field surveys and hands-on activities. Academic credit is provided by Western Washington University. Extended descriptions follow in the course description section of this syllabus.

1. **ESCI 437A, Environmental Wildlands Studies (5 quarter units / 3.35 semester credits)** – Field study of the ecology, geology, and environmental challenges of our study region, including the role of human interactions.
2. **ESCI 437B, Environmental Field Survey (5 quarter units / 3.35 semester credits)** – Study and application of field surveys, sampling methodologies, ecosystem restoration techniques, data management, including on-site data collection, assessment, and analysis.
3. **ESCI 437C, Wildlands Environment and Culture (5 quarter units / 3.35 semester credits)** – Study of social-ecological systems, drawing on locally relevant cultural perspectives and historic and present-day human relationships with the landscape, the environment, and wildlife. Includes group dialogue and personal reflection to track one’s own learning.

**Readings:** Students will be required to complete readings from a course reader. The course reader, including primary literature, excerpts, and technical reports, will be compiled and sent to students in advance of the program. Students are encouraged bring their own personal copy with them, and it is best to print it out (it’s easiest to print it double sided and have it bound). You may also bring an electronic copy downloaded on a tablet/device; however, the opportunity to charge devices will not always be available so it is recommended that you bring a printed copy. Additional field guides and texts that are used to supplement field activities will be carried around in a shared reference library.

## **Contents of this syllabus:**

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### **I. Program Overview**

Iceland, referred to as the land of fire and ice, is situated on the edge of the Arctic Circle, and it is the most sparsely populated European country, home to approximately 375,000 people. The small island nation, which has an area (40,000 sq. mi) similar to the size of Kentucky, features a dramatic landscape and fascinating culture that have been shaped by the island's geographical location—directly on top of the mid Atlantic ridge. Due to its unique position on the ridge, Iceland is considered to be geologically young with an average of 20-25 volcanic eruptions per century.

Iceland's active geologic landscape has given rise to striking coastlines and cliffs that provide nesting grounds for numerous species of birds, recent lava flows that provide substrate for early colonizers, and geothermal features that are decorated with colorful bacteria. In addition to Iceland's impressive geology, the latitude of the country (65° 00' N), just below the Arctic Circle, make this country a land of extremes. Approximately 10% of the island is covered in glaciers, and the highlands and northern regions of the country are characterized by tundra. Despite being an Arctic Nation and supporting glacial and tundra environments, the country has a relatively mild subarctic climate due to the influence of the Gulf Stream. Summer temperatures typically fall between 40 to 60°F with more than 20 hours of sunlight; however, high winds and rain can make the Icelandic weather brutal at times.

Although Iceland is relatively isolated, humans have changed the landscape. Colonization of the island in the 9<sup>th</sup> century resulted in intensive deforestation, and less than 1% of the original forest that existed on the island remains. This has resulted in erosion challenges as well as a surge of reforestation efforts by the country. Additionally, Iceland, like the rest of the Arctic, is undergoing change at an unprecedented rate, and the effects of warmer temperatures are already being felt. As glaciers continue to melt and permafrost thaws, the unique flora and fauna that thrive in this incredible environment will likely be threatened, which highlight the importance of research and monitoring efforts that can establish ecological baselines for biological and physical parameters. As Icelandic people try to mitigate human impacts that have already occurred while facing unprecedented climatic shifts, they are also becoming world leaders with innovative renewable energy solutions.

### **Team Activities & Program Itinerary**

For the Iceland Program, we will meet at the Keflavík International Airport in Reykjavík and spend the first week staying at the Suðurnes Science and Learning Centre. During this first week, we will introduce the concepts that will be focused on during the program, explore geologic sites within the Reykjanes UNESCO Geopark, and learn from scientists at the Suðurnes Science and Learning Centre about their ongoing avian research.

From the Reykjanes Peninsula, we will head toward Þingvellir National Park, where the boundary between the North American and Eurasian tectonic plates is situated. Here, we will study seismology and the early history of Iceland. As we make our way to the southeast, we hope to embark on a backpacking study along the Fimmvörðuháls trail, learn about how volcanic eruptions have shaped the flora and fauna of Iceland, and immerse ourselves in a glacial landscape to understand how glaciers are being impacted by a warming climate. In East

Iceland we will observe puffins and seals, discuss criteria for sustainable fisheries, and learn about the challenges that Iceland has faced due to deforestation and the damming of glacial rivers. We will hike to the Skálanes Nature and Heritage Centre, where we will spend several days assisting with reforestation efforts and complete a marine debris study.

Next, we will head north to learn about geothermal energy in the geologically active Myvatn region, and we will spend some time on the Melrakkasletta Peninsula, the northernmost region of Iceland. Here, we will interact with researchers at the RIF field station while immersed in a tundra landscape, and we will analyze how carbon cycling, climate, and Arctic ecosystems are impacted by thawing permafrost and melting sea ice. We also hope to include a second backpacking study during our time in the North.

In the West Fjords we will study iconic species such as the Arctic Fox, discuss and debate sustenance hunting as we interact with communities founded on whaling, and learn about the importance of farming in Iceland. We will continue observing birds and sea life along vast stretches of beach and striking cliffs. Finally, we will head south toward the capital region, and return to the Suðurnes Science and Learning Centre, our first field site, where we will celebrate the successful completion of the program, and, finally go our separate ways.

The entire Icelandic landscape has so much to offer. To experience as many of the landscapes and ecosystems as possible, we'll spend a good amount of time traveling, starting in the southwest and circling the island in a counterclockwise direction. **We will use rental vans to make our way around the country. The program will essentially include staying at a few research stations in different regions of the country, interspersed with camping and backpacking in between.** The program is guaranteed to provide unparalleled learning opportunities and an adventure of a lifetime.

## **II. Learning Objectives**

We have multiple goals for our Iceland Program. We will circle the island to learn about coastal and terrestrial ecosystems, participate in research, and engage with local communities and various stakeholders to understand pressing environmental challenges, conservation success stories, the connection between science and policy, and Icelandic culture. Students will have the opportunity to participate in ecosystem monitoring and they will complete individual and group research projects. We will be based out of field stations, national parks, remote campgrounds as we hone our skills as naturalists and learn through observation, discussions, journaling, and lectures. The overarching themes that will be covered during the program are described below.

### **1) High Latitude Environments, Climate, Carbon Cycles, and a Changing Arctic**

What ecosystems and geological features exist in Iceland, and how are high latitude environments being impacted by climate change? What unique adaptations and strategies have evolved to allow wildlife to thrive in this region? Students will be able to explore these question by studying glaciers, trekking across the tundra, observing organisms, and participating in ecosystem monitoring and research. Using Iceland as a natural laboratory, students will learn how high latitude environments and the ocean play a critical role in regulating the planet's climate, why these ecosystems are sensitive to change, and the global implications of melting ice and the loss of tundra and permafrost.

### **2) The Importance of Monitoring, Research, Collaborations, and Critical Thinking**

How are monitoring efforts being coordinated and implemented across the Arctic Nations? Why is marine debris a central theme that Iceland has focused on while it held the chairmanship role of the Arctic Council? Students will have the opportunity to spend extended periods of time at field stations that are part of the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT) network of research bases that are scattered throughout the Arctic. Students will critically analyze scientific manuscripts, complete a project focused on marine debris, and assist with ongoing monitoring efforts. Students will ask their own questions, collect data, analyze results, consult scientific literature, and work in small groups to develop their own research projects.

Through active participation in the scientific process, coupled with field observations, unique wildlife encounters, and potentially engaging with experts, students will learn to think critically about complex environmental issues.

### **3) Icelandic Culture and Society: Past, Present, and Future**

Who were the first settlers in Iceland? How has regional geography inspired Icelandic cultural traditions and beliefs? How do people persist in an extreme environment and how will they adapt to future changes? From the early colonization of the country to modern Iceland, a society that is navigating the challenges associated with climate change and a booming tourism industry, students will gain an in depth understanding of Iceland's culture and society. Students will engage with local communities, study historical sites and museums, and become familiar with Icelandic traditions and sagas.

### **4) Environmental Policy, Sustainability, Conservation, and Social Science**

Will Iceland be able to recover from severe deforestation that occurred when the country was first colonized? Will whaling continue to persist in the future? How did the cod fishing industry become a model for sustainability? Questions pertaining to conservation challenges, environmental pressures, and sustainability will be discussed and analyzed. Students will engage with stakeholders, critically analyze environmental policy case studies, and investigate the human element of environmental science.

### **5) Energy and the Environment**

How is energy being revolutionized in Iceland? Students will learn about Iceland's innovative geothermal and hydropower energy solutions and the country's ambitious goals to become global leaders in renewable energy.

### **6) Basic backcountry skills, including backpacking and field navigation**

Although not the focus of this course, students will gain experience in planning for a backpacking trip, how to travel safely and mitigate risk, and how to cook in a backcountry setting.

These topics will be addressed through lectures, group discussion, course readings, field activities, interacting with local experts, participating in ongoing research and conservation efforts, and field research projects. Our overarching goal is to have students leave the course with an extensive knowledge of our region, a set of broader skills, and an understanding of various aspects of ecology, geology, oceanography, environmental science, and social science. The knowledge and skills that are gained during the program will allow students to critically evaluate information in other settings in their future lives and careers. ***Note that prior field research experience is not required. All necessary skills will be taught on-site in Iceland.*** Our primary requirement is that you are enthusiastic, adaptable, genuinely open-minded, and ready and willing to learn. We look forward to you joining us and sharing this once-in-a-lifetime experience together.

## **III. Course Descriptions**

We teach these three courses in an integrated format in the field. However, students will receive transcript credit for the following three courses, as introduced on page 1:

**ESCI 437A, Environmental Wildlands Studies (5 quarter / 3.35 semester credits)** – Field study of the flora, fauna, ecology, marine systems, geology, geography, and natural history that characterize Iceland, including historical, current, and future environmental challenges associated with humans.

**Experiences/Activities:** In this course, students will learn about different geologic features and the dominant flora and fauna that are found throughout Iceland. They will also become familiar with Iceland's marine ecosystems, and they will learn how the ocean, carbon cycling, and climate are intrinsically connected. Several complicated environmental issues will be analyzed during the program, and students will learn directly through attentive observation, hands-on experience, as well as through guidebooks, lectures, peer presentations, discussions, and stakeholder interactions.

Before the start of the program, students will be required to prepare an oral presentation on an assigned topic that relates to Icelandic flora and fauna. Students will deliver their presentations on-site, acting as the local “expert” on the topic. Additionally, students will create a detailed field journal during the course as they record their observations and personal accounts of the places that they learn about and explore. Finally, students will choose an environmental case study, write a report that critically analyzes all sides of the issue, and formulate their own opinion with respect to the issue.

**Outcomes:** Students will develop their skills as naturalists and they will be able to demonstrate an understanding of the ecology and geology of Iceland and the human impacts that have shaped the country over time. Students will be able to critically analyze complex environmental challenges pertinent to Iceland and to the Arctic as a whole.

**Evaluation/Assessment:**

Field Journal	35%
Oral Presentation	15%
Case Study Report	10%
Field Quizzes	10%
Final Exam	20%
Participation & Discussions	10%

**ESCI 437B, Environmental Field Survey (5 quarter units / 3.35 semester credits)** – Study and application of field surveys, sampling methodologies, ecosystem restoration techniques, including on-site data collection, assessment, and analysis at various coastal and terrestrial sites in Iceland.

**Experiences/Activities:** Students will learn the essentials of conducting research in the field, and they will become familiar with the overall research process. This course will teach some common techniques and methodologies that are used by scientists to monitor ecosystem structure and function. Students will identify species and geologic features, conduct surveys along transects, complete population counts of certain species, and study marine debris. Students will also gain an understanding of how monitoring efforts are being coordinated between the Arctic Nations by staying at a few field stations that are part of the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT).

Observation logs, participation in data collection and analysis, and completion of student research projects will be evaluated for effort, critical analysis, concept, and clarity. Students will also complete a class research project and lab write-up focused on marine debris.

**Outcomes:** Students will develop skills in field observation, research methodologies, data collection, and data interpretation. Students will be able to critically read, evaluate, and discuss primary literature and reports, and they will gain a thorough understanding of designing, implementing and conducting research. Through assisting researchers with monitoring and conservation efforts, and by designing their own research projects, students will become familiar with the process of scientific investigation and collaboration.

**Evaluation/Assessment:**

Field Data Notebook	30%
Marine Debris Class Project	15%
Research Project	15%
Field Quizzes	10%
Final Exam	20%
Participation & Discussions	10%

**ESCI 437C, Wildlands Environment and Culture (5 quarter units / 3.35 semester credits)** – Study of social-ecological systems of Iceland and the Arctic, drawing on locally relevant cultural perspectives and historic and present-day human relationships with the landscape, the environment, and wildlife. Includes group dialogue of the readings and personal reflection to track one's own learning.

**Experiences/Activities:** In this course students will learn about the culture of Iceland and how it is deeply tied to the environment and the land. Students will learn about the history of Iceland spanning from early Viking settlements to modern culture, they will become familiar with common Icelandic traditions and livelihoods, and they will learn about Icelandic sagas and myths. Students will become aware of the resiliency of Icelandic communities, and how its people have faced unique challenges from volcanic eruptions and avalanches to mitigating the impacts of increased tourism and climate change.

During this course, the cultural journal will be used to record key information provided by local guest speakers, and it will be a safe space for students to reflect on cultural interactions, think critically about the complex relationships that exists between humans and the environment, and gain an awareness of their personal worldview. Students will also build a cultural dictionary of words and expressions that they learn during their time in Iceland. Additionally, as we make our way through the cultural readings, students will be assigned certain sections to provide thoughtful dialogue and summaries to the rest of the class.

**Outcomes:** Students will gain a deep appreciation and respect for Icelandic culture and society and for people who inhabit the northern most regions of the world. They will understand how historical events and the landscape have shaped the way that Icelandic society is structured and how traditions and beliefs have evolved. They will become familiar with common Icelandic words, particularly descriptive words that explain geographical features (e.g. foss, fell, jökull). They will be able to critically assess the strategies that Iceland is practicing to minimize environmental impacts while meeting the demands of a modern world. Students will also develop a heightened awareness of their own worldview through thoughtful reflections.

**Evaluation/Assessment:**

Cultural Journal	40%
Reading Summary Narrative	10%
Final Reflection	10%
Field Quizzes	10%
Final Exam	20%
Participation & Discussions	10%

#### IV. Assessment

Below is an overview of the academic requirements for the program. Some of the assignments are ongoing (e.g. journals, readings, presentations, quizzes) and others have specific dates (e.g. exams, essays, projects). Due dates are subject to change in response to local variables. Final grades will be based on the following items:

Course Number	Assessment Item	Due Dates <i>*specific dates assigned during course</i>	Percent of Grade
ESCI 437A	Field Journal	Checks throughout and in the last week	35
	Oral Presentations	Throughout	15
	Case Study Report	Last week of the course	10
	Field Quizzes	Throughout	10
	Final Exam	3-Aug	20
	Participation	Throughout	10
ESCI 437B	Field Journal	Checks throughout and in the last week	30
	Marine Debris Project	Week 4 of the course	15
	Research Project	Week 5 of the course	15
	Field Quizzes	Throughout	10
	Final Exam	3-Aug	20
	Participation	Throughout	10
ESCI 437C	Cultural Journal	Checks throughout and in the last week	40
	Reading Narrative	Throughout	10
	Final Reflection	Last week of the course	10
	Field Quizzes	Throughout	10
	Final Exam	31-Jul	20
	Participation	Throughout	10

## ESCI 437A, Environmental Wildlands Studies (5 quarter / 3.35 semester credits)

### **1. Field Journal – 35%**

The field journal is an integral part of the Iceland program and the ESCI 437A course. It serves as a learning tool and is an opportunity to closely become aware of the surrounding environment, document observations and places that we visit, and reflect on experiences. The field journal will be ongoing throughout the course, and students are encouraged to regularly keep up with entries. The field journal will consist of creating natural history journal entries adapted from the Grinnell Method, and other nature writing approaches (see Parker article).

Class notes and personal notes are not included as formal journal entries, although we do encourage students to take notes, as they will be useful for crafting journal entries, for other assignments, and for studying for exams. Students will be instructed on the best way to organize their journal at the start of the program, and the journal will be collected periodically during the program for review and in the last week of the program for a final review.

Field journals will consist of the following components:

**i) Grinnell Trip Logs (10%):** Approximately two entries from locations as prescribed by the instructors. This adapted Grinnell Trip Log is a structured, descriptive narrative that documents select hikes and field walks. The log is a careful summary of observations and field notes taken throughout the day. The entry usually takes about 2 hours to write-up, but may take longer depending on the length of the walk. Your entry should include the 10 essential elements outlined below:

1. <b>Date &amp; Times:</b> Head your trip log entry with the date(s) of the trip and the times (start and end)
2. <b>Location:</b> Give the name of the area and the name of the hiking trail/route. If available, include start/end GPS coordinates.
3. <b>Weather:</b> Start/end conditions and notable weather changes that occur during the trip, e.g. temperature, % cloud cover, rain, fog, wind direction, etc...
4. <b>Route Description &amp; Map:</b> Concise description of the route travelled, with distances, times, notable markers or changes in direction. Sketch route map with key features including north arrow.
5. <b>Habitat(s):</b> Broad description of the area's habitat types (e.g. glacial moraine, lava field, geothermal lands), noting changes in habitat type and ecological/geological changes that occur along the trail.
6. <b>Flora and Fauna:</b> Descriptions of dominant/notable vegetation that is found and sightings of any animals (Note any interactions/associations between the biological/physical landscape that you notice)
7. <b>Geography:</b> Descriptions (and names if available) of the prominent geological features (e.g. glaciers, mountains, waterfalls, etc.) that we see during the trip.
8. <b>General Commentary:</b> A brief personal summary that reflects on the hike and/or other notable observations (e.g. soils, debris, leaf litter, scat, etc..)
9. <b>Observation Descriptions &amp; Sketches:</b> Descriptions of 3-5 species/geological features that you observed, Sketch the species/feature and label.
10. <b>Two Questions:</b> Conclude with two detailed questions about ecological/geological phenomena encountered that got you wondering.

Grading of Grinnell Trip Log entries will use the following criteria:

- **Organization:** Entries are written in an organized way and should follow a logical format that is consistent with the established criteria listed above.
- **Completeness:** Includes the essential elements and prescribed entries have been completed.
- **Accuracy of Content:** Provides an accurate and comprehensive reflection of phenomena encountered during the trip (e.g. correct descriptive data, features seen, species encountered).
- **Clarity:** The entry should be well-written, easy to read, and should be prepared so that others can use it as reference.
- **Effort:** The entries should demonstrate that concerted effort has been invested into the process.

**ii) Nature Writing (20%):** From locations as prescribed by the instructors, approximately four to five entries. These entries involve deeper and more creative reflection and require students to focus in on the ecological and physical aspects of their sensory experiences. The emphasis is on the phenomena that the student actually senses and experiences, it is not meant to be a summary of information that they learned or read that day. Entries should be inspired by and related to the specific place and will typically be completed on site (e.g. silent observation while sitting in a single spot).

Grading of Nature Writing entries will use the following criteria:

- Use of Language: Using rich creative language (e.g. metaphor, simile, alliteration, onomatopoeia).
- Diversity of Expression: Employing a diversity of writing/journaling techniques (e.g. poetry, dialogue).
- Sensory Detail: Encapsulating a range of sensory detail (sight, sound, smell, touch, etc.).
- Natural Descriptions: Making clear links to ecological observations with your writings.
- Wider Reflection: Using the scene and your observations to generate wider reflections on nature.

**iii) Other Assignments (5%):** Refers to any other specific journal activity or assignment given by the instructors throughout the program, and may include field survey exercises, ethology exercises, sketches, and opportunistic observation activities.

## **2. Oral Presentations – 15%**

Students will be assigned a topic approximately a few weeks before the start of the program. Leading up to the program, students will research their assigned topic and come prepared to give a presentation (10-15 minute presentation + 5 minutes for questions/discussion). Topics will relate to the flora and fauna of Iceland, and students will have to answer a research question related to their topic. On the day that the presentation is given, students will turn in a 1-2 page summary of bulleted information.

Grading of Oral Presentations will use the following criteria:

- Content: Information delivered is relevant, accurate, original, creative, and coverage is appropriate.
- Structure: Presentation has a logical flow and adheres to the time limit.
- Delivery: Student gives presentation in an engaging manner with good posture and is well spoken.
- Discussion: Student is able to answer questions and generate/facilitate discussion around the key points.
- Bullet Point Summary: 1-2 page overview of key points of their assigned topic. The summary can be handwritten or typed/printed out. The summary must include a reference list (e.g. articles, books, websites, personal sources, etc.), and students must use a minimum of three different primary sources. Plagiarism (i.e. cut/paste verbatim) will not be accepted.

## **3. Case Study Report – 10%**

During the course we will cover historical, current, and future environmental issues and concerns. Many of these environmental challenges are considered ‘wicked problems’ (see Bentley Manuscript), where solutions are complex and there are many stakeholders involved. Students will pick one of the environmental issues that we have discussed during the course and write a report on it. The report should clearly describe the environmental problem, present all sides of the issue (e.g., stakeholder positions, pros and cons of the issue, etc.), and discuss a solution to the issue that is the best-case scenario. The solution to the problem can be opinion-based, but it needs to have strong supporting arguments to back it up. The report should include the following sections:



**I. Executive Summary:**

A short paragraph that concisely summarizes the rest of the paper (comparable to an abstract)

**II. Introduction:**

Paragraph that introduces the environmental issue, provides background information, and context.

**III. Analysis and Evaluation:**

A few paragraphs that analyzes the issue from all sides. This section should discuss stakeholder views, list pros and cons, and analyze costs/benefits. Students can make tables/figures if helpful.

**IV. Conclusions and Recommendations:**

A final paragraph or two that concludes the report and that recommends a solution for the issue that would be a best-case scenario. The recommendation should be supported with strong arguments.

\*If a conclusion to the issue you chose has already occurred, you can offer a different solution and discuss how the outcome may have been different

Grading of the Case Study Report will use the following criteria:

- **Organization:** Report is written in an organized, logical way that follows the above format.
- **Content:** Provides an appropriate amount of information to fully present the issue, and demonstrates that the student has thoroughly thought about and analyzed the issue from all angles.
- **Clarity:** The entry should be well-written, easy to read, with concrete arguments.
- **Effort:** The report demonstrates that concerted effort has been invested into the process.
- **References:** If literature was used, it needs to be cited.

**4. Field Quizzes – 10%**

During the course at least two field quizzes will be administered to test the student's knowledge of the ecological, geological, and environmental concepts that have been covered during the course.

**5. Final Exam – 20%**

In the last few days of the program, students will take a written exam to assess their understanding of key themes and concepts related to ecology, geology, oceanography, geography, and environmental issues that were addressed throughout the course. The exam will include short and long essay questions that assess the student's ability to demonstrate thorough comprehension of themes covered during the program.

**6. Participation & Discussions – 10%**

Includes general engagement with the subject matter, attentiveness during peer presentations and lectures, and active participation in group readings and discussions.

**ESCI 437B, Environmental Field Survey (5 quarter / 3.35 semester credits)****1. Field Journal – 30%**

The field journal is an integral part of the Iceland program and the ESCI 437B course. It is used to document our various field activities, and as a way to keep track of the different ecosystems, flora, fauna, and geological features that we encounter along our journey.

Students will be instructed on the best way to organize their field journal at the start of the program, and the journal will be collected periodically during the program for review and in the last week of the program for a final review.

The field journal will consist of the following components:

- Field Study Log (25%):** The field study log will be used to keep track of the regions that we visit during our time in Iceland, to note an interesting observation from each region, and to document notable flora, fauna, and features that we encounter at each study locale. The log is not meant to include everything that we see. It is a tool to

describe the regions that we visit, hone our observation skills, and document species that are dominant, that you find interesting, or are rare sightings (e.g. whales, foxes, etc.). You may also include geological features (e.g. glaciers, waterfalls, etc.) in your log. The log should be organized by region where we camped or spent extended periods of time (e.g. SW Iceland, S Iceland, SE Iceland), listing the date(s) that we spent in region with a description of the region followed by an “In this region I noticed....” entry, and species/notable features that were encountered in the area. Approximately 5 species/notable features should be included per region, and some students find that sketches and/or pressing plants into the notes section is useful.

The log should follow the example template below:

<b>Region:</b>		<b>Dates:</b>
<p><b>Description:</b> <i>A broad description (paragraph or two) that provides an overview of the region. Where is this region located? Are there any prominent geographical features that characterize the region? What type of ecosystems exist in the region? What is the climate like in this region?</i></p> <p>• <b>"In this region I noticed...."</b> Description of a specific ecological or geological phenomena that you observed in the region (e.g. species interaction) that ignited your sense of curiosity or newfound learning. Describe the observation and explain why you think this observation occurred.</p>		
<b>Species/Features from the Region</b>		
<u>Species/Feature Name</u>	<u>Specific Site</u>	<u>Notes</u>
Include latin name if available.	If known, include the specific site within the general region	Relevant notes about the observation (e.g. behavior, appearance, key characteristics, etc.). You may include a sketch if you'd like.

Grading of the Field Study Log will use the following criteria:

- **Organization:** The log is neat and is organized according to the above format.
- **Consistency of Use:** Includes each region that we visit and demonstrates attention to key species and features that we see.
- **Effort:** Reasonable effort has been invested into the process (i.e. Latin names are included when possible and thoughtful, detailed descriptions, observations, and notes are provided)

**ii) Other Assignments (5%):** Refers to any other specific journal activity or assignment given by the instructors throughout the program, and may include field survey exercises, ethology exercises, sketches, and opportunistic observation activities.

## 2. Marine Debris Project – 15%

At select coastal locations, students will complete a class marine debris project as they participate in a beach cleanup. Students will use field survey techniques to quantify the presence of debris, and we will categorize the debris according to type. Students will be required to write an individual lab write-up for the class marine debris project that includes an introduction, methods, results, and discussion section. More details for the project will be provided on site.

Grading of the Marine Debris Project will use the following criteria:

- **Organization:** The write-up is organized and structured with the appropriate sections.
- **Concept:** Student demonstrates an understanding of why and how the project was completed.
- **Interpretation:** Data is neatly presented, analyzed, and the results are adequately discussed.
- **Effort:** Student demonstrates that concerted effort has been invested into the process.
- **Group Participation:** Contributed to the project in the field, collecting, sorting, and analyzing debris.

## 3. Research Project – 15%

The importance of establishing research/monitoring projects and protocols is one of the themes that will be focused on during our time in Iceland. With this in mind, students will develop a research and/or monitoring proposal with the vision that it will be implemented in the future by researchers, students, or citizen scientists. The

project can draw on theory provided in lectures, articles, field activities, and practice from other monitoring exercises conducted during the program. Students will work in small groups (~3 students) to draft a proposal and present their plan to the rest of the class. The proposal should include the following sections:

<b>I. Project Summary</b> A short synopsis that concisely summarizes the project (comparable to an abstract)
<b>II. Background Information:</b> Description of the system (study area, feature, species, etc...).
<b>III. Study Objectives</b> Presents the objectives, key questions, hypotheses, and goals of the study.
<b>IV. Methods and Materials</b> Describes the experimental approach of the proposed study. What field and lab methods will be required, what materials and equipment are needed, how often will sampling occur.
<b>V. Data Analysis:</b> What kind of data will be produced, and how will it be analyzed, managed, and disseminated. *Address any limitation that there might be in your study in this section
<b>VI. Expected Significance and Broader Impacts</b> Why is this research important and what will be gained from it. What are the broader impacts (e.g. will it provide student opportunities, benefits to the community, any products/technology developed from the work)

Grading of the Research Project will use the following criteria:

- **Organization:** Project is organized and presented in a logical way that follows the above format.
- **Content:** Provides an appropriate amount of information that fully presents the proposed study. The proposal convinces the reader why it is important and necessary, and demonstrates that the students have thoroughly thought through the *what* will be done, *how* it will be done, and *why* it will be done.
- **Clarity:** The proposal should be easy to understand, with concrete objectives and a clear plan.
- **Effort:** The proposal demonstrates that concerted effort has been invested into the process.
- **Written Summary and References:** Group completes the written summary as instructed (written summary instructions provided on site) and literature that was used is cited.
- **References:** If literature was used, it needs to be cited.
- **Presentation Style:** Groups can comfortably articulate their study to the rest of the group and answer questions.
- **Group Participation:** Individuals are active participants in the group process, and work is evenly shared.

#### 4. Field Quizzes – 10%

During the course at least two field quizzes will be administered to test the student's knowledge of species and geologic features they have observed, field survey methods, research and conservation techniques, and data analysis and interpretation.

#### 5. Final Exam – 20%

In the last few days of the program, students will take a written exam to assess their understanding of key themes and concepts related to research methodologies, the process of undertaking scientific investigations, data analysis and interpretation, and the role that science plays with informing policy and management decisions. The exam will primarily include short and long essay questions that assess the student's ability to demonstrate thorough comprehension of themes covered during the program.

#### 6. Participation & Discussions – 10%

Students will be evaluated based on their general engagement and enthusiasm with all field activities, particularly when assisting with research and conservation efforts at the field stations and their contribution to group/peer projects. It is important for students to have a positive attitude and to be respectful to each other and anybody else who they are working with in the field. Students will also be evaluated based on their willingness to participate and engage in discussions regarding the scientific literature that we read. During the course, students may be assigned certain papers where they will assume the leader role of the discussion.

## ESCI 437C, Wildlands Environment and Culture (5 quarter / 3.35 semester credits)

### **1. Cultural Journal – 40%**

The cultural journal is an integral part of the Iceland program and the ESCI 437C course. It is used to document interactions with local experts, and as a way to keep track of one's own personal development, awareness, and socio-cultural insights that are gained during the program. It will also include a dictionary of Icelandic words.

Students will be instructed on the best way to organize their cultural journal at the start of the program, and the journal will be collected periodically during the program for review and in the last week of the program for a final review.

The field data notebook will consist of the following components:

**i) Guest Speaker Summaries (10%):** We expect to be learning from local researchers and experts during the program. For certain interactions, students will be instructed to complete a guest speaker summary in their cultural journal. These entries are not meant to be time consuming and should only take 10-15 minutes to complete. The summary should include the following elements:

<b>Name of Presenter:</b>	<b>Date:</b>
<b>Topic:</b>	<b>Location:</b>
<ul style="list-style-type: none"><li>• Provide 3 - 4 bullet points describing key information that you learned during the presentation.</li></ul>	
<b>Question :</b> Write one question that came to your mind related to the presentation topic.	

Grading of the guest speaker summaries will use the following criteria:

- Organization: Entries follow the format established above.
- Completeness: Includes a completed entry for all guest speakers.
- Accuracy of Content: Provides an accurate overview of the presentation.
- Clarity: The entry should be well-written, easy to read, with concise bullet points, and a clear question.
- Effort: The entries should demonstrate that the student paid attention during the presentation.

**ii) Reflections/Creative Entries (20%):** At least 4 thorough entries or more if shorter more regular entries are preferred. Students will develop a “social-ecological autobiography” (See Hayes manuscript) in their cultural journal. This includes regular insightful reflections on learning experiences embedded within specific contexts, which can include but is not limited to interactions with guest speakers, local communities, other travelers, your peers, and the course readings. These entries are meant to challenge the student to tap into their creative side and to find awareness of how their own views and values have been brought into focus or shaped by the experience. Examples of themes that entries might highlight include 1) changes in personal beliefs, perceptions, worldviews and learning, possibly as part of comparative reflection to past experiences/knowledge/places encountered back in your homeland, 2) Key elements and information that finds resonance (appeal) or dissonance (conflict) within you, 3) creative writing about a location/experience that incorporates Icelandic cultural beliefs and traditions. Poetry and art are welcomed as individual shorter entries or to complement longer entries.

Each entry begins with the phrase: “*Right now I feel...*” before continuing on to whatever it is you wish to write about (the theme of the entry does not need to be related to your “*Right now I feel...*” statement).

Grading of reflections/creative entries will use the following criteria:

- Consistency of Use: Entries are completed regularly throughout the program (1 entry per week)
- Concept: Entries are creative and demonstrate a high level of contemplation. The theme or experience is explored in depth, from different angles, and incorporates philosophical, social, or creative reflection.

Entries use learning experiences to make insightful links between themes, readings, and experiences prior, during, and beyond the program.

- Style: Entries are well-written, and make use of narrative, prose, poetry, art, etc..
- Effort: A genuine effort to write thoughtful, creative reflections is demonstrated.

### iii) Cultural Dictionary (10%):

The cultural dictionary is a list of Icelandic words and phrases as well as unique cultural components that are commonly encountered during the program. When possible, students should be sure to translate and dissect geographical names of the places that we visit during the program, and they should include significant cultural elements and describe their significance. The dictionary should be organized in the back of the cultural journal using the table format below.

<i>Word, Phrase, Name</i>	<i>English Translation and/or Cultural Significance</i>
Ísland	Iceland
Ódinn	Chief god, the All-Father, sire of all gods and men

Grading of the cultural dictionary will use the following criteria:

- Accuracy: Student makes an effort to spell accurately and use appropriate Icelandic characters.
- Consistency of Use: Student demonstrates an attention to new words/phrases/cultural elements that are encountered throughout the program.
- Effort: Reasonable effort has been invested throughout the program.

## 2. Reading Summary Narratives – 10%

As a group, we will make our way through reading selections that are focused on Icelandic culture and people who live in the Arctic. We will periodically get together for “storytelling” sessions. During this time, we may read certain selections out loud, and students will take turns being in charge of guiding a discussion based on the reading or by providing a synthesis of the material. More information regarding reading groups and assignments will be provided during the program.

Grading of Reading Summary Narratives will use the following criteria:

- Synthesis: Student groups successfully synthesize readings and are able to pull key concepts/ideas/information from their assigned sections and reiterate them to the rest of the class in a logical way that can be easily understood.
- Narrative: Student groups deliver the information to the rest of the group in an engaging way and are able to divide the narrative between individuals in the group so that everybody participates in the “storytelling” process. During group narratives, students demonstrate that they are comfortable and familiar with the information that they are sharing with the rest of the class, including being able to answer questions.
- Group Participation: Individuals are active participants in the group process.

## 3. Final Reflection – 10%

Students will prepare a final reflection (3-4 pages) on the development of their worldview throughout the program that serves as a synthesis of elements included in their cultural journal. Students will detail their worldview and place it in context alongside other (cultural and ecological) worldviews studied or encountered during the program. Students may integrate their ideas about where and how their own perceptions and beliefs were challenged, dislodged, or reinforced. Students are encouraged to make links with ideas about their own evolving naturalist intelligence and/or social-ecological connectedness, and to refer to the people (i.e. from peers, presenters, locals, researchers, travelers, etc..), relevant readings, and personal experiences that have been of significant influence throughout the program. The final reflection serves as an additional and final entry for the cultural journal.

Grading of the Final Reflection will use the following criteria:

- **Organization and Structure:** Ideas are logically ordered and cohesive
- **Analysis:** Clearly identifies key contrasting perspectives encountered during the program and explains the role they have played in contributing to one's own worldview.
- **Synthesis:** Integrates different perspectives and articulates a distinct set of values or way of looking at the world.
- **Style:** Reflection is well-written, writing is succinct and engaging, and key points are effectively conveyed.
- **Effort:** A genuine effort to write a thoughtful, creative final reflection is demonstrated.

#### 4. Field Quizzes – 10%

During the course at least two field quizzes will be administered to test the student's knowledge of Icelandic culture and history, information provided by local experts, and social/environmental issues that have been discussed.

#### 5. Final Exam – 20%

In the last few days of the program, students will take a written exam to assess their understanding of key themes and concepts related to Icelandic culture, history, traditions, and how the landscape has shaped the Icelandic way of life. The exam will primarily include short and long essay questions that assess the student's ability to demonstrate thorough comprehension of themes covered during the program.

#### 6. Participation & Discussions – 10%

Students will be evaluated according to active participation in everyday activities as well as their attitude and involvement when engaging with guest and local hosts. In this particular course, it is important that the student demonstrates a genuinely open mind, a willing attitude, and a respectful etiquette in interacting with team members and local groups. Finally, the student's consistent and positive contribution to the team dynamic (e.g. by embracing assigned roles and responsibilities) will be taken closely into account.

### V. Grading Scheme

To convert final grade percentages to letter grades for each course that will appear on your transcript, we will use the following grading scheme:

Grade	Percentage	Grade	Percentage	Grade	Percentage	Grade	Percentage	Grade	Percentage
		B+	87.5 - 89.9	C+	77.5 - 79.9	D+	67.5 - 69.9	F	< 59.9
A	92.5 - 100	B	82.5 - 87.4	C	72.5 - 77.4	D	62.5 - 67.4		
A-	90.0 - 92.4	B-	80.0 - 82.4	C-	70.0 - 72.4	D-	60.0 - 62.4		

### VI. General Reminders

**Academic Integrity** is as relevant in this field course as it is at your home institution. Plagiarism, using the ideas or materials of others without giving due credit, cheating, or putting forth another student's work as your own will not be tolerated. Any plagiarism, cheating, or aiding another to cheat (either actively or passively) will result in a zero for the assignment. Cases of academic dishonesty may be reported to your home institution.

**Assignment deadlines** are established out of fairness to other students and they are necessary so the instructors can get the grading done on time. Therefore, deadlines are firm and work that is turned in late will be penalized and receive a 5% deduction. If the assignment is more than 2 days late, an additional 10% will be taken off. If you think circumstances may keep you from completing your work on time, talk to the instructor as soon as possible and certainly before the assignment is due.

**Participation and attendance** are crucial throughout this program. Because of the demanding schedule and limited time, all components of the program are mandatory (unless indicated) and missing even one lecture can have a proportionally greater effect on your final grade. Hence, it is important to be prompt and prepared with the needed gear and equipment for all activities.

Students with special needs or disabilities should meet with the lead faculty member as soon as possible to discuss any special accommodations that may be necessary.

## VII. Required Materials

- **Two durable notebooks for coursework— one (1)** for ESCI 437A and ESCI 437B assignments (i.e. for your field journal assignments) and **one (1)** for ESCI 437C (i.e for your cultural journal assignments). We strongly recommend Rite in the Rain notebooks: hardcover products: #370F, <https://www.riteintherain.com/4-75x7-5-hard-cover-book> or: softcover products #374; <https://www.riteintherain.com/4-625x7-25-soft-cover-book>. These notebooks will be periodically turned in to be graded.
- **Additional durable notebook(s) for personal field/lecture notes—** To be successful in the program you will want to take notes during lectures and while we are in the field. For your lecture notebooks, we recommend Rite in the Rain products as well. Up to you how many to bring. Students are often surprised by the quantity of notes they take. Consider bringing a few smaller notebooks: [https://www.riteintherain.com/4-625x7-stapled-notebook#cover-colors\\_yellow\\_page-patterns\\_universal#371FX](https://www.riteintherain.com/4-625x7-stapled-notebook#cover-colors_yellow_page-patterns_universal#371FX) or a larger notebook similar to the notebooks described in the previous bullet point . You will use your field/lecture notes to complete the graded assignments that are completed in the above coursework notebooks. All notebooks are available directly from Rite in the Rain or Forestry Suppliers or other channels.

Alternative compact hardback or tough softback bound notebooks may be suitable for all the above. Whatever your choice, ensure the notebooks for your coursework contain at least **80 pages**, are durable, and can fit in a large Ziploc bag. Avoid cubic grid line formats. Your field/lecture notebook(s) should be weather resistant and durable. For all books, avoid flimsy wire spiral bound notebooks and soft cardboard covers. They deteriorate quickly and frustrate you when writing in them and us when grading them.

**-Pen(s), Pencil(s):** Check what is best for your notebooks (e.g. Rite in the Rain often works best with pencil).

**-Clipboard (\*recommended):** Good to have a hard surface for writing in your journals and for securing paper in the wind.

**-Folder:** To safely store any handouts or pamphlets. Bring some loose leaf sheets of paper in your folder for field quizzes and to use as scratch paper.

## VIII. Academic Schedule & Course Content

Below is the schedule that we anticipate following during the Iceland program. Reading discussions listed here are included in the reading list (section IX). Selections that will be used for the 'reading summary narratives' for ESCI 437C will be added to the schedule during the program. Dates for individual oral presentations will also be added at a later date, and specific dates for journal reviews will be determined on site. Please note that activities and due dates are subject to change. The exact schedule will be reviewed with students 1-3 days ahead of time, however, students should come with a flexible mindset and be willing to adapt to necessary changes.

Dates (2023)	Location	Lecture Topics & Activities	Reading Discussions	Assignments Due
Jun 23	Reykjanes Peninsula (Suðurnes)	<u>Activities:</u> Students arrive and are picked up from the airport Group Dinner  <u>Academic Themes:</u> Introductions Orientation (Program Structure and Expectations; Health Protocols; Camping Basics; Risk Management)		
Jun 24 - 27	Reykjanes Peninsula (Suðurnes)	<u>Activities:</u> Journal Set Up Birding Surveys Suðurnes Science and Learning Center Reykjanes UNESCO Geopark Fagradasfjall Volcano  <u>Academic Themes:</u> Academic Requirements and Syllabus Overview of Iceland and Early Settlement Introduction to Natural History How to Read Scientific Articles Intro to Field Sampling Techniques/Types of Data Plate Tectonics Volcano Dynamics and Magma Types	R1 – Jun 24 R2 – Jun 24  R3 – Jun 25  R4 – Jun 26	
Jun 28 - 30	Suðurland (Geysir)	<u>Activities:</u> Travel from Suðurnes to Geysir (Jun 28) Þingvellir National Park Geysir Geothermal Area Gulfoss Ljosafoss Exhibit  <u>Academic Themes:</u> Geothermal Features Hot Spots Intro to Energy in Iceland Althing and the Introduction of Christianity	R5 – Jun 28  R6 – Jun 29  R7 – Jun 30	
Jul 1 - 3	Suðurland (Skógar)	<u>Activities:</u> Travel from Geysir to Skógar (Jul 1) Fimmvörðuháls Backpack  <u>Academic Themes:</u> Habitat Types and Plant Adaptations Atmospheric Circulation and Climate Zones Climate Change Basics Legend of Thor	R8 – Jul 2	



Jul 4 - 8	Austurland (Höfn)	<u>Activities:</u> Travel from Skogar to Höfn (Jul 4) Vatnajökull National Park Stocksness Peninsula  <u>Academic Themes:</u> Icefield Environments Glacier Dynamics Phytoplankton and Zooplankton Biological Carbon Pump	R9 – Jul 5  R10 – Jul 6  R11 – Jul 7  R12 – Jul 8	
Jul 9 - 11	Austurland (Egillstaðir)	<u>Activities:</u> Travel from Höfn to Egillstaðir (Jul 9) Hallormsstaður National Forest Karahnjúkar Dam  <u>Academic Themes:</u> Hydropower and Dams Reforestation	R13 – Jul 10  R14 – Jul 11	Field Quiz – Date TBD
Jul 12 - 16	Austurland (Seyðisfjörður)	<u>Activities:</u> Travel from Egillstaðir to Seyðisfjörður (Jul 12) Skálanes Nature and Heritage Center Marine Debris Project Tree Surveys  <u>Academic Themes:</u> Fjord Systems Marine Debris Oceanic Circulation Scientific Process and Analysis	R15 – Jul 12  R16 – Jul 13  R17 – Jul 14	Journal Review – Date TBD
Jul 17 - 19	Norðurland (Reykjahlið)	<u>Activities:</u> Travel from Seyðisfjörður to Reykjahlið (Jul 17) Krafla Geothermal Center Lake Mývatn Birding  <u>Academic Themes:</u> Island Biogeography Ecological Succession Flora and Fauna Adaptations Geothermal Energy	R18 – Jul 18  R19 – Jul 18	

Jul 20 - 24	Norðurland (Raufarhöfn)	<u>Activities:</u> Travel from Reykjahlið to Raufarhöfn (Jul 20) Whale Museum Arctic Hinge Jökulsárgljúfur Backpack  <u>Academic Themes:</u> Arctic Ecosystems Tundra and Permafrost Icelandic Fisheries Science in the Arctic	R20 – Jul 20  R21 – Jul 21  R22 – Jul 22  R23 – Jul 23	Field Quiz – Date TBD   Marine Debris Lab Report – Jul 24
Jul 25 - Aug 1	Vestfirðir (Isafjörður)	<u>Activities:</u> Travel from Raufarhöfn to Isafjörður (Jul 25) Arctic Fox Center Látrabjarg Cliffs Rauðisandur Beach  <u>Academic Themes:</u> Sea Ice Dynamics Physical Carbon Pump Ocean Warming Climate History and Dynamics Farming in Iceland Future of the Arctic	R24 – Jul 26  R25 – Jul 26  R26 – Jul 27  R27 – Jul 29	Research Projects – Date TBD  C Final – Jul 31  Final Journal Review – Date TBD
Aug 2 – 5	Reykjanes Peninsula (Suðurnes)	<u>Activities:</u> Return to Suðurnes (Aug 2) Course Wrap Up Final Dinner Student Goodbyes (Aug 5)  <u>Academic Themes:</u> Reflecting on Key Concepts Final Assignments and Exams		A/B Finals – Aug 3  Case Study Report – Aug 4

## IX. Reading List

The course reader, including the readings listed below, will be compiled and emailed to students in advance of the program. Additional readings and guide books will be carried in a shared library.

R1: Parker A (2007) Natural History and Naturalist Skills.

R2: Purugganan M, Hewitt J (2004) How to Read a Scientific Article. Rice University.

R3: Field Sampling Techniques: Fact Sheet. LiMPETS Rocky Intertidal Monitoring Program: Curriculum Guide.

R4: Þórisson B, Méndez V, Alves J, Gill J, Skarþjéðinsson K, Auhage S, et al. (2018) Population size of Oystercatchers *Haematopus ostralegus* wintering in Iceland. Bird Study, DOI: 10.1080/00063657.2018.1478797

R5: Gudmundsson M, Hrafnisdóttir H, Bjarnason J, Árnadóttir H (2021) Volcanic hazards and risk management in Iceland.

R6: Bjarnason IP (2008) An Iceland Hotspot Saga. Jökull 58:3-16

R7: Logadóttir HH (2015) Iceland's Sustainable Energy Story: A Model for the World? Sustainable Energy 3:LII

R8: Howe JP (2015) This is Nature; This is Un-Nature: Reading the Keeling Curve. Environmental History 20:286-293.

R9: Björnsson H, Pálsson F (2008) Icelandic Glaciers. Jökull 58:365-386

R10 : Icelandic Meteorological Office (2020) Overview of Icelandic Glaciers at the End of 2019. The Institute of Earth Sciences, University of Iceland. Newsletter.

R11: Milner AM, Khamis K, Battin TJ, Brittain JE, Barrand NE, Fureder L (2017) Glacier Shrinkage driving Global Changes in Downstream Systems. Proceedings to the National Academy of Science 1-9

R12: Falkowski P (2012) The Power of Plankton. Nature 483:S17-19.

R13: Aradóttir AL, Þertursdóttir T, Halldorsson G, Svavarsdóttir K, Arnalds O (2013) Drivers of Ecological Restoration: Lessons from a Century of Restoration in Iceland. Ecology and Society 18(4):33

R14: Bishop MV, Ólafsdóttir R, Árnason P (2022) Tourism, Recreation and Wilderness: Public Perceptions of Conservation and Access in the Central Highland of Iceland. Land 11:242

R15 Hayes M (2009) Into the Field: Naturalist Education and the Future of Conservation. Conservation Biology. 23(5):1075-1079

R16: Halsband C, Herzke D (2019) Plastic litter in the European Arctic: What do we know? Emerging Contaminants 5:308-318.

R17: Stefánsson H, Peternell M, Konrad-Schmolke M, Hannesdóttir H, Ásbjörnsson E, Sturkell E (2021) Microplastics in Glaciers: First Results from the Vatnajökull Ice Cap. Sustainability 13:4183

R18: Einarsson A (2004) Lake Myvatn and the River Laxá: An Introduction. Aquatic Ecology. 38:111-114.

R19: Gardarsson A, Einarsson Á (2004) Resource limitation of diving ducks at Myvatn: Food limits production. Aquatic Ecology. 38:285-295.

R20: The Icelandic Institute of Natural History (2001) Marine Resources, in Biological Diversity in Iceland: National Report to the Convention on Biological Diversity, pp 39-43.

R21: Post E, Forchhammer MC, Bret-Harte MS, Callaghan TV, Christensen TR, Elberling B, et al. (2009) Ecological Dynamics across the Arctic Associated with Recent Climate Change. *Science* 325(5946):1355-1358.

R22: Altizer S, Ostfeld RS, Johnson PTJ, Kutz S, Harvell CD (2013) Climate Change and Infectious Diseases: From Evidence to a Predictive Framework. *Science* 341:514-519.

R23: Bentley J (2018) Wicked Problems: An Idea whose Time has Come.

R24: Ogilvie AEJ. Sea-ice Stories from Iceland and Labrador.

R25: Ogilvie AEJ, Jónsdóttir I (2000) Sea Ice, Climate, and Icelandic Fisheries in the Eighteenth and Nineteenth Centuries. *Arctic* 53(4):383-394

R26: Post E, Bhatt US, Bitz CM, Brodie JF, Fulton TL, Hebblewhite M (2013) Ecological Consequences of Sea-Ice Decline. *Science* 341:519-524.

R27: Brigham LW (2007) Thinking about the Arctic's Future: Scenarios for 2040. *The Futurist*. 41, 27-34