Ecosystems for the Future

Ecosystems for the Future

DIVISION OF CONTINUING STUDIES - UNIVERSITY OF VICTORIA

This book was produced with Pressbooks (https://pressbooks.com) and rendered with Prince.

Contents

Intro to the Adaptation Learning Network

Welcome to the Adaptation Learning Network (ALN). This course is one of ten courses developed for working professionals. These courses are designed for people who are addressing climate adaptation risks and impacts in their communities and jobs.

WHY DOES THIS MATTER?

Climate change adaptation requires expertise from many perspectives. The ALN is committed to connecting people, professional interests, and regions to advance skills, knowledge and solutions.

JOIN THE NETWORK

To join the network, sign up for our monthly newsletter here, and follow us on social media (Twitter, LinkedIn) to get adaptation news and hear about our latest course offerings and events.

LEARN MORE

To learn more about the Adaptation Learning Network read this 5-minute introduction.

Unit 1: Introduction to the course

Introduction to Unit 1

How often have you heard in the past five years the expression "I have never seen a ….fire/flood/drought/rainstorm/insect infestation/sea level rise…of this magnitude, ever."? The world's climate is out of balance, and in this state, is driving ecosystem changes that few of us have seen in our lifetimes. What is the scale of these changes now and into the future? How can we adapt or adjust?

The practice of ecological restoration can point the way to positive actions at the ground level that can ameliorate some of these ecosystem changes and provide a means for professionals to be involved. The United Nations General Assembly has proclaimed 2021–2030 as the Decade on Ecosystem Restoration, following a proposal for action by over 70 countries from all latitudes. The UN Decade positions the restoration of ecosystems as a major nature-based solution towards meeting a wide range of global development goals and national priorities.

This course will bring into focus the practice of restoration of ecosystems at the local, regional level in British Columbia. First, First Nations' perspectives on how the local ecosystems are changing will set the stage. The theory and practice of ecological restoration will be explored, and how ecological restoration can be used to begin the process of recovery for naturally or humanly disturbed ecosystems. This will be followed by a discussion of the basic drivers of change in ecosystems – concepts such as climate change, nitrogen

deposition, the arrival of invasive species, and human impacts of land conversion. The complexity of biodiverse ecosystems in British Columbia will highlight the challenge of dealing with these issues. Climate change models in BC will focus on what the future scale of change might be for the atmosphere, the hydrosphere, the lithosphere, the biosphere and the sociosphere – humans. Historic, hybrid and novel ecosystems will be examined to understand the range of ecosystems types that might be addressed by ecological restoration.

Finally, interviews with professionals working in land use planning, climate change, landscape architecture and ethnobotany will show how ecological restoration is being used in these fields. The importance of integrating the natural environment into professional practices will assist course participants in their own work.

Participants will take away an understanding of the First Nations role in ecological restoration, of ecosystem functioning, of ecosystem changes being experienced, and of practices of cultural and ecological restoration that can produce a positive impact in their fields of discipline.

Unit 2: First Nations Perspectives on Future Ecosystems

Introduction to Unit 2

Understanding the cultural context of southern Vancouver Island is best learned through meeting and hearing from First Nations peoples who have lived here since time immemorial. For example, what was life like among the different cultural tribes that lived and visited southern Vancouver Island?

- What was and is their relationship to the natural world?
- How has that relationship changed since the arrival of European explorers and settlers over 200 years ago?
- How have First Nations people seen the natural world here change in relation to European settlement and climate change in past decades?
- What do the First Nations people think of the future of the natural world here?

It is important for course participants to understand this cultural and ecological context, which predates our arrival here , because it can inform us about what strategies might be used to survive into the future in light of climate change, arrival of invasive species, and arrival of more settlers here.

Learning Objectives

After successfully completing this introductory unit, you will be able to:

- Recognize local First Nations cultural and ecological context on the Saanich Peninsula
- Relate to significance of First Nations relationship to their traditional territories and its plant and animal species

Unit 3: Principles and Objectives of Ecological Restoration

Introduction to Unit 3

In this unit we will be listening to a presentation by Dave Polster, a plant ecologist with over 40 years of experience in vegetation studies, ecological restoration and invasive species management.

The purpose of this unit is to understand the importance of ecological restoration and be able to look for answers to the following questions:

- What is ecological restoration practice?
- What is the importance of a “reference ecosystem”?
- What are the common mistakes restorationists make?
- What should we look for?

Learning Objectives

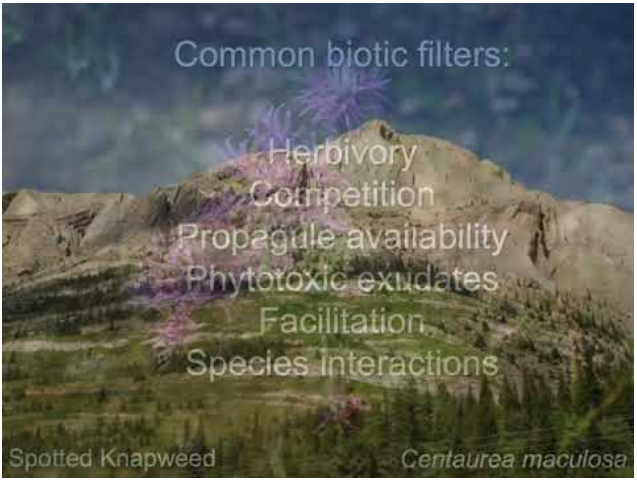
After successfully completing this unit, you will be able to:

- Describe and explain the purpose of ecological

restoration

- Recognize importance of UN Declaration of Decade of Ecological Restoration

As you watch and listen to the presentation, think about how ecological restoration impacts, or could impact, your work now and in the future. While some of the case studies may not pertain to the work you do now, the principles behind the practice are fundamental and inform work on all scales.



A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=26

Video attribution: "Let Nature Do the Work" is licensed under CC BY-NC-ND 4.0.

Summary of key points

What is Ecological Restoration Practice?

Ecological restoration is the process of assisting in the recovery of an ecosystem that has been degraded, damaged, or destroyed. (SER 2004). A fundamental distinction between ecological restoration and other forms of ecosystem repair is that ecological restoration seeks to 'assist recovery' of a natural or semi-natural ecosystem rather than impose a new direction or form upon it. That is, the activity of restoration places an ecosystem on a trajectory of recovery so that it can persist and its species can adapt and evolve. (SER 2016).

What is the importance of a "reference ecosystem"?

A fundamental principle of ecological restoration is the identification of an appropriate reference model, commonly called a 'reference ecosystem', taking environmental change into account. The reference ecosystem is meant to represent the site's ecosystem as it would have been had degradation or damage not occurred, while incorporating the capacity for the ecosystem to adapt to existing and anticipated

environmental or climatic change. The reference ecosystem serves as a target for a restoration project, a target based on analysis of local plant and animal species and other biotic and abiotic conditions. A shared vision of restoration targets and specific ecological attributes of the restoration site provides the basis for setting goals and objectives and monitoring and assessing restoration outcomes over time.

What are the common mistakes?

A common mistake in selecting a reference ecosystem is to look at a later successional stage ecosystem and its species, and to then plant species from that late successional stage. Reference ecosystems did not start out with the species that exist there now – those species evolved over time and many generations. To properly take the first steps of ecological restoration, look at starting with the early successional species first, and plan to work toward the later successional species and ecosystems over time.

What should we look for?

Nature has been restoring itself on drastically disturbed sites for millennia, and can show us a natural path or trajectory of ecosystem recovery over time. Observe on a disturbed site the following processes: what pioneering species are arriving, and through what means? What may be preventing natural ecological recovery? What natural processes are assisting in the

recovery? The next steps are to remove impediments to natural recovery, and to assist (if necessary) in establishing the pioneer species that will start the ecosystem trajectory into recover over time. And allow time and patience to be present, and be open to unexpected positive change

The United Nations Decade on Ecosystem Restoration 2021-2030

The United Nations Decade on Ecosystem Restoration 2021–2030 was conceived as a means of highlighting the need for greatly increased global cooperation to restore degraded and destroyed ecosystems, contributing to efforts to combat climate change and safeguard biodiversity, food security, and water supply. How can First Nations peoples, citizens and professionals working around the globe become involved with the goals and objectives of the upcoming UN Decade on Ecological Restoration?

Unit 4: Ecological Complexity and Biodiversity in B.C.

Introduction to Unit 4

In this unit we will be listening to a presentation by Dr. Brian Starzomski, of University of Victoria School of Environmental Studies.

Learning Objectives

After successfully completing this introductory unit, you will be able to:

- Understand the unique situation of British Columbia re biodiversity
- Understand the complexity of biodiversity in local and regional ecosystems

Context

Of all the Canadian provinces and territories, British Columbia is home to the richest diversity of vascular plants, mosses, mammals, butterflies and breeding birds, and the

largest number of species of reptiles, tiger beetles and amphibians found only in one province or territory. This species richness is exemplified by the complex Biogeoclimatic Zone system, which divides the province into 14 separate BEC zones. A biogeoclimatic zone is defined as "a geographic area having similar patterns of energy flow, vegetation and soils as a result of a broadly homogenous macroclimate." The BEC zones are further broken down into subzones for relative moisture and temperature levels.

Although the reasons for the existence of this rich assemblage of species can be attributed largely to topographic and climatic diversity, other factors are in British Columbia's favour as well. The intricate topography of the province juxtaposes mountains, alpine plateaus, valleys and coastal plains with their associated lakes, rivers and wetlands to form a myriad of complex and varied ecosystems. Many species of plants and animals are endemic to BC, meaning that they are found nowhere else in the world. Despite this uniqueness, B.C. has more species at risk than any other province and is one of only three provinces that lack stand-alone legislation to protect endangered species.

The situation on southern and eastern Vancouver Island is one of the most unique: here winter rainfall is considerably less and the summer drought longer and hotter (i.e. Mediterranean conditions). The resulting natural forest is a mixture of open savanna with Garry Oak, Arbutus and Douglas-fir trees. This habitat, largely disturbed by two centuries of European colonization, is one of the most endangered ecosystems in Canada. Because so much habitat has been lost or degraded, more than 100 species of plants, mammals, reptiles, birds, butterflies and other insects are officially listed as "at risk" in these ecosystems.

Less than 5% of the original Coastal Douglas-fir and Garry Oak ecosystems remain undisturbed in our local area, stretching from Victoria north to the Comox Valley. Efforts to

protect and restore these ecosystems have been ongoing for more than 30 years, however the relentless pressures of land use change, human population increase, arrival of invasive species, and more extreme climatic cycles have made protection and restoration very challenging. The Garry Oak Ecosystem Recovery Team (GOERT) led these protection and restoration efforts for many years; now volunteers and environmental non-profit groups and private landowners have taken up the torch to protect the small amount of Coastal Douglas-fir ecosystem still intact.

A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=28

Video attribution: "biodiv RestoCourse Starzom2020V2 video" is licensed under CC BY-NC-ND 4.0.

Summary of Key Points

- Scientists distinguish three different types of biodiversity: alpha/beta/gamma;
- Biodiversity extinction on the planet is affecting mainly gamma biodiversity – the number of species on the entire planet
- Many species exist in the world which have not been described, especially insects and bacteria;
- British Columbia holds almost half of the diverse number of species in Canada, due to: landscape diversity; climate diversity; elevation diversity; geology variation; glacial history; and peripheral habitats (northern ranges of habitats).
- The Coastal Douglas-fir Biogeoclimatic Zone is one of the most heavily impacted ecosystem types in the province;
- The main threats to biodiversity are: land use change; climate change; introduced and invasive species; overexploitation of species; and nitrogen deposition.
- All these threats combine as cumulative impacts to change ecosystems.

Unit 5: Climate Change Models Now and in the Future

Introduction to Unit 5

In this unit we will be listening to a presentation by Richard Hebda, who served as Curator (Botany and Earth History) at the Royal British Columbia Museum for 38 years and adjunct faculty at the University of Victoria for 33 years.

The purpose of this unit is to understand...

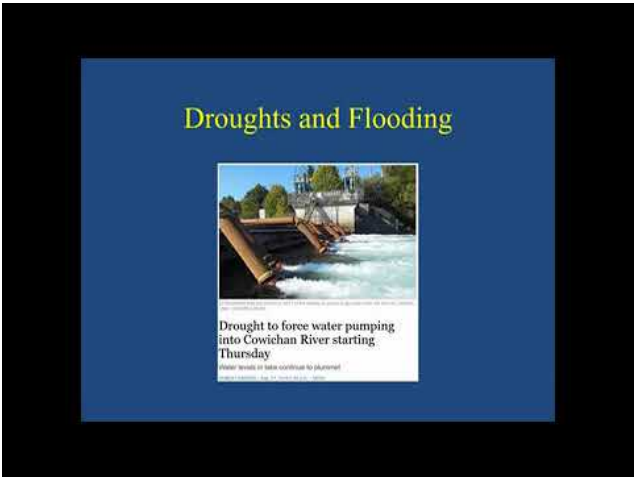
- The complexity of the climate in BC and how it is changing
- How the climate is influencing your work
- Ways that you can assist in adapting to the impacts of climate change

Learning Objectives

After successfully completing this unit, you will be able to:

- Understand changing climate situation in BC
- Predict what will happen with ecosystem

change response



A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=30

Video attribution: "Hebda 2020 Dynamic Ecosystems compressed" is licensed under CC BY-NC-ND 4.0.

Summary of Key Points

Over the next century, plants and animals on land in BC might be in for a wild and ultimately devastating ride. Warming temperatures, changing precipitation patterns, and extreme weather and climate events are likely to increase at a rate and magnitude not seen in more than 65 million years. Global surface temperatures have risen about twice as fast over land as they have over the ocean, a trend likely to continue into the next century. Based on current emissions trajectories, temperatures are projected to rise as much as 90 F over much of the Earth's land. The last time that the Earth warmed that much was around 55 million years ago, and it did so over a period of 10,000 years. The projected change over the next century provides a small window in which life on Earth, including humans, will need to adapt to a similar change in temperatures.

The global climatic system is a series of connections between the atmosphere, the hydrosphere, the lithosphere, the biosphere and the sociosphere – us humans. This global climatic system has been disrupted through huge impacts by humans, and is no longer in equilibrium. This dis-equilibrium is now causing the extreme weather and climate events that are the subject of evening news stories around the globe. For example, in the past 6 months in British Columbia, we have experienced the driest November on record, the wettest January on record, the fifth driest March on record and the driest April on record. Ecosystems and the species that compose them are now subjected to dramatic swings away from 'normal'

climatic conditions and are in the process of adaptation. The changing climatic conditions will favour some plant and animal species and discourage others; some plant and animal species will be able to expand and occupy newly favourable habitats, while others will not have that ability, and may disappear.

The relationship between ecosystems and climate in BC is a complicated one, because BC has the highest level of ecological biodiversity in the country. The climate models that are being developed for the province cannot easily predict the impacts of changing climatic conditions on the wide range of biodiversity here. How can citizens respond to this complexity in a productive and positive way at the local level?

By gaining a basic understanding of ecological restoration principles, of ecological mitigation and of ecological adaptation, citizens can learn important tools to respond to the changing climatic conditions. We know that the globe is connected ecologically, and that the global climatic system affects ecosystems down to the local level. The rate of these changes is now unprecedented. However, by applying ecological principles and concepts on the ground, through direct local actions such as invasive plant removal, re-establishment of local native species, and protection and enhancement of rare plants, animals and ecosystems, the effects of climate change can be reduced. Citizens can learn about their local ecosystems, and adapt and restore as a learning opportunity. Local ecological actions can help to overcome the sense of helplessness that occurs in the face of the scale of global climatic changes.

Essential Points

- Widespread climate change is already underway;
- Ecosystem change is now underway;
- Past climate changes will foster widespread ecosystem changes in the future;
- Natural ecosystem change takes place at the species level from within, through immigration, and through local species loss;
- Ecosystem change lags behind climate change and may not be gradual (could be sudden);
- Amplitude and rate of ecosystem change have few recent precedents;
- Ecosystem instability is likely to occur for many decades/centuries;
- General features of future ecosystems can be projected but composition and structure and trajectory of change is difficult to foresee;
- Restoration from preservation to active manipulation provides adaptive strategies but cannot stop widespread ecosystem change;
- Support assisted migration of species now, without delaying because of moral uncertainty.

Unit 6: Drivers of Ecosystem Change

Introduction to Unit 6

In this unit we will be listening to a presentation by Dr. Nancy Shackelford, Director of the Restoration of Natural Systems Programs and ES Faculty at UVic.

The purpose of this unit is to understand:

- The many different influences of natural ecosystems around the globe
- How these ecosystems are responding to these influences

Learning Objectives

After successfully completing this unit, you will be able to:

- Examine complexity of ecosystem responses to change agents.
- Determine how individuals might assist in the recovery of ecosystems in their areas.

As you watch and listen to the presentation, think about the following questions:

- What are the primary goals of management in your site?
- What are the social, ecological, or environmental changes you expect will influence these goals in the next year? Five years? Twenty?
- At what scales are these changes occurring? Within your site? In the surrounding landscape? Regionally or globally?
- What are the possible actions that you could take, as a manager, to mitigate the impact of these changes on your goals? Are there even ways to incorporate these changes into your goals?

A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=32

Video attribution: "Drivers of Ecosystem Change" is licensed under CC BY-NC-ND 4.0.

Summary of Key Points

Major ecosystem drivers globally:

1. Habitat loss and fragmentation
2. Edge effects on altered ecosystems
3. Invasion by introduced species
4. Global climate change
5. Human population increases

Key Points

- Restoration projects must consider the impacts of these key drivers on ecosystems at the landscape and site levels
- SER describes (8) key principles of ecological restoration
- Ecological restoration process can be treated as an ecosystem risk analysis: strengths/weaknesses/opportunities/threats on each restoration site
- Landscape scale and site scale factors should be assessed for each restoration project
- New examples of planning tools to apply to ecological restoration, such as Miradi
- Adaptive management involves active learning, data collection and monitoring

In Summary

Several major forces are at play in driving ecological change around the globe – the movement of invasive species; human land use patterns; habitat loss; and climate change. In combination, these drivers of ecological change are transforming the world as we know it.

Terrestrial ecosystem function is governed largely by the composition and physical structure of vegetation communities, and climate change impacts on vegetation can potentially cause disruption of ecosystem services and loss of biodiversity. Ecosystem transformation generally involves the replacement of dominant plant species or functional types by other species, whether recruited locally or migrating from afar. Climate change is interacting with movement of invasive species, changing fire regimes, changing land use, and increases in CO2 to drive vegetation changes in many regions of the globe.

Vegetation composition and structure are sensitive to changes in mean annual temperature (and precipitation) and vegetation transformations will become increasingly extensive as temperatures increase. Although many ecological responses (species migration, colonization and succession) will lag behind climate changes, ecosystem transformations will be accelerated by the other drivers of ecological change – changes in land use, movement of invasive species, and climatic disturbance events. Without reduced CO2 levels, terrestrial vegetation over the entire planet is at risk of major compositional and structural changes. Emerging ecosystems may be novel in composition, structure and function, and there may be replacement of dominant or keystone species, changes in trophic levels and changes in species interactions. Species biodiversity, habitats and resource use may change drastically (Nolan et.al, 2018, Science 361, 920-923).

What can be done from a resource managers' perspective

to respond to or adapt to these proposed changes? There is a need to maintain and enhance ecosystem biodiversity and complexity by protecting key ecological processes, diversity of species, and diversity of cultural practices. Management should be done at multiple scales to ensure this protection. Managers should look beyond species-specific prescriptions and practices, to ensure that ecosystem processes and functions are protected and enhanced. Without ecosystem functions and processes in place, no ecosystem services or products will result. Ecosystem resilience will be maintained by protecting the widest range of species possible, and connections between habitats and across landscapes, to allow these species to move and adapt to climate changes (Harris, et.al. 2006, Restoration Ecology 14, No. 2, 170-176.)

At the local level, citizens, volunteers and resource managers can take similar forward-thinking actions: protect and restore sites of rare and endangered species, and build ecological connections between these sites to enhance genetic movement. Protect not just species per se, but the processes and functions that produce these species, to ensure that the sites can become self-sustaining as ecological changes continue in light of climate change and other ecological drivers.

Unit 7: Historic/Hybrid/ Novel Ecosystems Concepts

Introduction to Unit 7

In this unit there is a presentation by Dr. Eric Higgs, faculty, and Sonia Voicescu, PhD Candidate, School of Environmental Studies, UVic. [Note: this presentation is unavailable in the Creative Commons licensed version of this course]

The purpose of this unit is to understand:

- What types of ecosystems you encounter in your daily life, and:
- What are the characteristics of these ecosystems and how does climate change affect them?

Learning Objectives

After successfully completing this unit, you will be able to:

- Differentiate between different ecosystem types
- Recognize local examples of ecosystem types

- Identify your role in assisting their recovery.

As you watch and listen to the presentation, think about the ecosystems you encounter every day and what you could do to assist in their recovery. [Note: this presentation is unavailable in the Creative Commons licensed version of this course]

Summary of Key Points

There is an increasing consensus that global climate change occurs and that potential changes in climate are likely to have important regional consequences for biota and ecosystems. Ecological restoration, including (re)-afforestation and rehabilitation of degraded land, is included in the array of potential human responses to climate change. However, the implications of climate change for the broader practice of ecological restoration must be considered. In particular, the usefulness of historical ecosystem conditions as targets and references must be set against the likelihood that restoring these historic ecosystems is unlikely to be easy, or even possible, in the changed biophysical conditions of the future. (Harris et.al. 2006).

Within the next 100 years, and much sooner in some regions, prescribing restorations using purely historical references will prove increasingly challenging at best, and at worst lead to failure, due to changes in climatic

conditions. In addition to potential changes in climate, there are also increasingly changed species mixes available to colonize disturbed or stressed sites.

The combination of novel species mixes and altered biophysical settings is resulting in the development of a range of novel or emerging ecosystems that have unknown functional characteristics and that may be difficult or impossible to return to a prior condition (Harris et.al. 2006).

Many landscapes now consist of a diverse array of ecosystems with varying characteristics and management emphases, all of which provide various ecosystem services. Accelerating rates of climate and land-use change and species invasions result in rapidly evolving spatial dynamics among multiple landscape patches. These patches have differing sets of services and management challenges, and accounting for these complex dynamics and attributes is essential for effective conservation and restoration planning (Hobbs et. al. 2014).

A range of options is available for the management of ecosystems identified as historical, hybrid, and novel. The options depend on the goals selected, which may include the protection of biodiversity, conservation of ecosystem functioning and services, maintenance of historical continuity, and provision of natural resources for local human livelihoods. Regardless of terminology used – novel, emerging, recombinant, no-analog – ecosystems that challenge conventional conservation and restoration are a present reality. Managing for the whole landscape – mosaics of historical, hybrid, and novel ecosystems – allows for a comprehensive and

transparent approach to managing for a range of goals (Hobbs et.al. 2014).

Unit 8: Applying Ecological Restoration Principles to Different Disciplines

Introduction to Unit 8

In this unit we will be listening to a series of interviews with professionals working in the fields of planning, climate action, landscape planning and ethnobotany, who will discuss their relationships with the natural world and the application of ecological restoration to their professions.

The purpose of this unit is to understand how ecological restoration can be applied to different disciplines, to assist with combatting climate change and in assisting ecosystems that have been degraded, damaged and destroyed to return toward a healthy state.

As you watch and listen to the presentation, think about your own discipline:

- Is there a possibility to use and apply ecological restoration to your work?
- What could be the role of First Nations peoples in assisting with your work?
- How can cultural and ecological diversity be incorporated into your discipline and its practices?

Learning Objectives

After successfully completing this final unit, you will be able to:

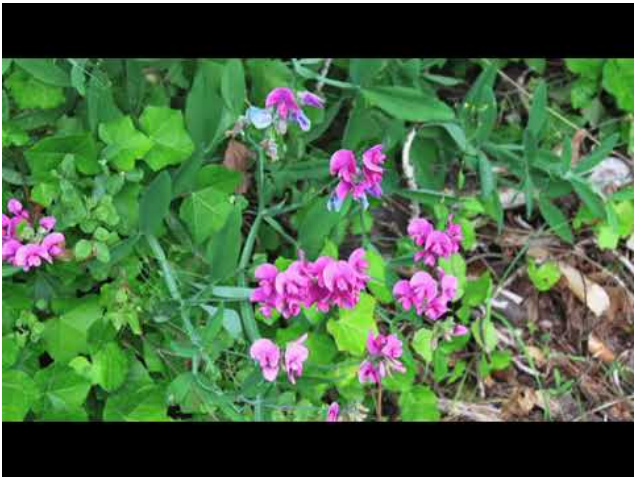
- Identify how ecological restoration can be applied to different disciplines that work with the natural world
- Explain how cultural diversity is important as a component of ecological restoration work

Adriane Pollard

A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=36

Video attribution: "Adriane Pollard v2" is licensed under CC BY-NC-ND 4.0.

Judith Lyn Arney



A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=36

Video attribution: "Judith Lyn Arney compressed" is licensed under CC BY-NC-ND 4.0.

Bev Windjack

A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=36

Video attribution: "Bev Windjack Final compressed" is licensed under CC BY-NC-ND 4.0.

Chris Krasowski

A YouTube element has been excluded from this version of the text. You can view it online here: https://pressbooks.bccampus.ca/ecosystemsfuture/?p=36

Video attribution: "Chris Krasowski V2 compressed2" is licensed under CC BY-NC-ND 4.0.