RANGELANDS & GRASSLANDS

Envirothon Study Guide 2013

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PREFACE

This report was written by Rochelle Archibald, Leah Gooyers, Gillian Holmes, and Helen Turner as a requirement for the Credit for Product II course in the third year of the Ecosystem Management Technology Program, 2012, at Sir Sandford Fleming College. This guide was written for Kristina Quinlan of the Ontario Forestry Association and was submitted as a deliverable assigned to be completed during the term our team spent working for the Ontario Forestry Association.

This study guide contains information on rangelands, case studies, activities, questions for discussion, a glossary, and references. The information on rangelands is catered to the core topics of forestry, aquatics, soil and wildlife. Also included are links for finding additional information and resources.

The objective of this study guide is to provide Ontario Envirothon participants with information on the 2013 topic: Rangelands and Grasslands. Activities and case studies are highlighted throughout the study guide to ensure a comprehensive understanding and hands on learning pertaining to rangelands in Ontario and North America.

We would like to thank our faculty advisor, Sara Kelly, for her guidance and input throughout the length of the project. A special thanks also goes out to Carm Hamilton, John Kinghorn, Jack Kyle and Doug Plaunt for taking the time to answer questions and share resources relating to our area of study. Thank you Kristina Quinlan for being a great mentor, she was very supportive and on top of communication throughout the entire project. We hope this study guide is beneficial to Envirothon participants and encourages educational development, environmental understanding and inspires environmental stewardship. Please feel free to contact us through email if you have any questions, comments or concerns.

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1.0 INTRODUCTION TO RANGELANDS AND GRASSLANDS

Land on which the plant community is comprised predominantly of native or indigenous grasses, grass-like species, forbs and/or shrubs.

1.1 Introduction

Students will:
- Be able to differentiate between different types of rangelands
- Understand the importance of rangelands and their environmental, social, and economic role in society
- Understand the effects climate change and human influences have on rangelands
- Learn the role society plays in rangeland restoration and conservation

Rangeland and grassland ecosystems cover approximately 40% of the Earth's terrestrial surface. Australia, the Russian Federation, China, the United States, and Canada contain the world's largest grasslands (World Resource Institute, n.d). In Canada, the majority of rangelands and grasslands are found in Alberta, Saskatchewan, and Southern Ontario (See Figure 1). Rangeland and grassland ecosystems provide us with many ecological goods and services, but have been damaged since the introduction of the industrial revolution. Rangelands were impacted heavily by European colonization, with this came the beginning of land degradation through agriculture and urbanization. This led to the suppression of fire and the introduction of invasive species. These landscapes have been misunderstood and under valued by the public due to a lack of awareness. Increased education of the importance of rangeland ecosystems is essential for a sustainable future.
Rangeland: land on which the

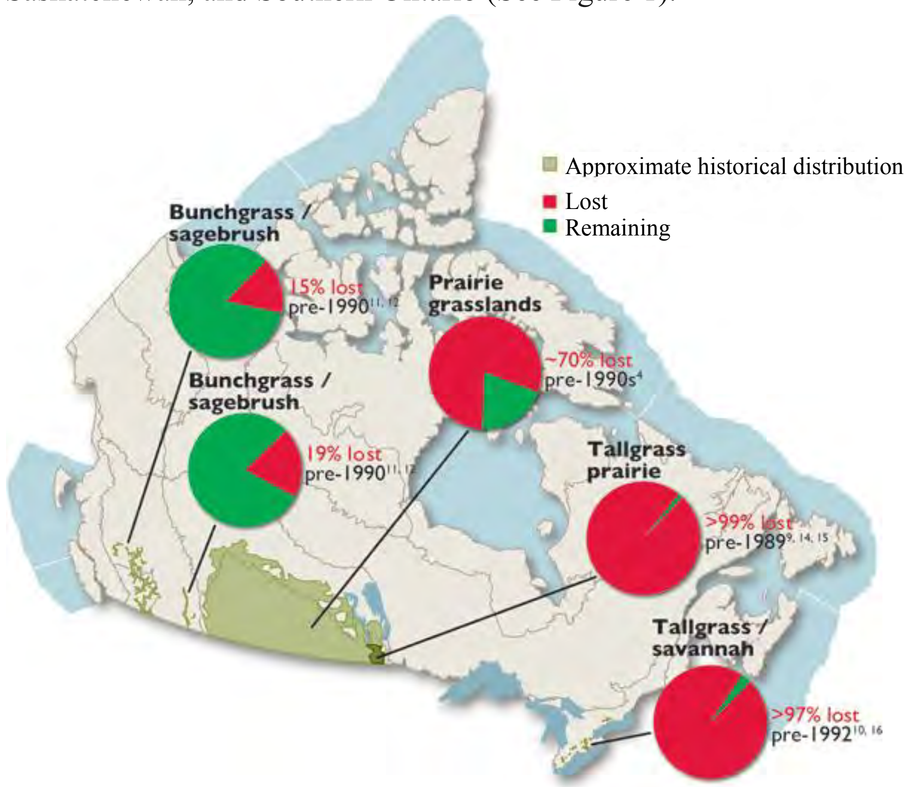

Figure 1: Historical and existing grasslands in Canada.(Biodiversity Canada, 2012)

plant community is comprised predominately of grasses, grass-like species (e.g. sedges) with forbs and/or shrubs. Rangelands include: pasturelands, natural grasslands, savannas, shrublands, tundra, coastal marshes and wet meadows. These areas are dependent on disturbance such as fire, floods, drought, or being grazed by domestic or wild herbivores.

Types of Rangelands
Ontario is home to many different types of rangeland and grassland ecosystems which make up the mosaic of the Ontario landscape. These ecosystems include:

Tallgrass prairie: dominated by perennial tall grasses, shrubs, and forb species. Tallgrass prairies are one of North Americas most diverse and productive types of ecosystem. These areas are prone to drought, fire, and over grazing but rebound quickly from disturbance if the system is in balance.

Alvar: a naturally open habitat with thin to no soil cover over a bed of limestone or dolostone. These unique conditions result in sparse grassland vegetation.

Hayfield: an artificially open area managed by humans to grow grass, legumes or other herbaceous plants.

Coastal Marsh: usually found where a river drains into a larger body of water. Sediments eroded from the watershed are deposited at the river mouth creating an enriched bay. This provides for a diverse plant community and habitat for wildlife including fish, birds, and mammals.

Wet Meadow: a meadow with soil that is saturated with water throughout much of the year. Poor drainage or large amounts of water from rain or snow melt are the cause. They may also occur in riparian zones. Wet meadows do not have standing water present except during brief to moderate periods of oversaturation during the wet season.

Shrubland: a biological community characterized by vegetation dominated by shrubs but grasses and herbs are also present.

Savanna: savannas are grasslands that have 10-35% tree cover. They are sometimes a prairie opening within large forested area or forested patches within a prairie setting.


Figure 2: Canadian tundra. (Queen's University, n.d.)

1.2 The Value of Rangelands

Rangelands and grasslands provide social, cultural, economic and environmental benefits. These lands are tied closely with aboriginal culture throughout history (See Figure 3) and they continue to provide a livelihood through hunting and gathering today. Prairie ecosystems provide economic benefits through carbon sequestration, supplying resources for biofuel, and offering space for cattle ranching. Grasslands add an extra source of income through hay and honey production, hunting, and eco tourism opportunities such as bird watching. These ecosystems also provide a wide range of ecological goods and services for humans, such as water filtration, conservation of soil moisture, the prevention of erosion and an increase of biological diversity. Grasslands provide wildlife habitat, corridors and shelter. These areas include nesting opportunities and migration stopovers for birds. Overall grasslands are aesthetically pleasing and hold significant value within Ontario.

1.3 Threats to Rangelands

Figure 3: Painting of Assiniboine First Nations hunting buffalo in the grasslands. (Kane, 1856)

Historically, rangelands covered approximately 1000 Km2 of Ontario. It is now estimated that these ecosystems make up less than 3% of the Ontario landscape (Tallgrass Ontario, n.d.). The main contribution to the loss of habitat is due to the conversion of land into agriculture and urbanized areas (See Figure 4). Other threats to these ecosystems also include invasive species, suppression of fire, soil degradation, and a lack of awareness.

When European settlers arrived, rangeland ecosystems were seen as a prime location for development due to the flat landscape and minimal tree coverage. Agricultural land is being bought and sold by developers for further urbanization. This is generally known as urban sprawl and does not contribute to a sustainable future. Urbanization and the lack of research into ecological processes has lead to the suppression of fire. This has allowed for the colonization of invasive species, which in turn has led to the reduction of habitat for native species which rely on ecosystem compositions that are shaped by fire disturbance. Agriculture and development cause an abundance of disturbed edges. These induced edges promote the development and growth of invasive species. The loss of native species leads to soil degradation. Native grassland plants tend to have deep root systems that maintain soil moisture and prevent erosion, whereas invasive species cannot perform these functions with their shallow roots. To mitigate the threats that face these

Figure 4: Urbanization in Toronto, Ontario. This may have been a natural grassland at some point, it is now an urban ecosystem. (Maze, 2009)

ecosystems, it is imperative for the public to be educated on the importance of rangelands in Ontario.

1.4 Global Change and Rangelands

The Earth's climate is dynamic and is the result of interacting systems and processes. Global climate change is influenced by both natural and human factors. Naturally, climate change happens over centuries, yet due to anthropogenic activities climate change is occurring at a much faster pace. People have the responsibility to assess their impact on climate change and to identify effective courses of action to reduce this impact. Climate change affects humans and natural systems in a variety of ways. The frequency and severity of extreme events such as droughts and floods are likely to increase as the Earth's climate warms. It is during these types of extreme events that rangeland degradation is more likely to occur. Climate is responsible for maintaining the abiotic factors such as precipitation and temperature that highly influences vegetation communities in rangeland ecosystems. Impending changes in climate are likely to propel changes in vegetation that favours a change in wildlife composition.

Figure 5: Rangeland degradation caused by drought. Climate change may cause these conditions to magnify in some areas. (MMIX, 2009)

The transfer of invasive species have become more prevalent in the world because of the high amount of trading and connectivity between nations. Increases in invasive species such as black locust, common buckthorn, knapweed, Canadian thistle and white sweet clover (See Appendix E for Plant descriptions and characteristics) have dramatically reduced the productivity of rangelands by garnering more of the limited resources like water, nutrients and sunlight (Society for Range Management, n.d.).

The changes in land use and productivity frequently present irreversible changes in ecosystem function. With land use change comes the use of chemicals which may have a negative impact on the environment but they can also be used to address environmental challenges. One benefit of using chemical spray is to combat the challenges caused by invasive species, if methods such as hand pulling and mowing are not effective. Irrigation and the use of herbicides and pesticides on agricultural land has polluted water sources and reduced the availability of nutrients in the soil.

1.5 Solutions for Rangeland Preservation and Recovery

People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations. Solutions to combat the degradation of grassland ecosystems include: education, better management practices, restoration, conservation and protection. Community involvement is very important in the conservation of rangelands and grasslands. It is important for people to understand the power a community has on the health of an ecosystem. Not only is there a beneficial effect on rangeland condition, the community is brought together and all of their accomplishments instill pride within their community. Proper management of these areas provide measurable benefits to both people and the environment. Grasslands provide livelihood for nearly 800 million people globally (Leisher et al, 2012) and they are crucial to grazing livestock and wildlife habitat. It has been found that three quarters of the world's grazing lands are degraded. Some benefits to proper management include a longer growing season and higher vegetation density in managed areas. Implementing best management practices such as the rotation of agricultural crops to prevent nutrient loss, planting wind breaks, and conducting prescribed fires to promote new growth will give people the initiative to become stewards of rangeland systems. The importance of grasslands and rangelands is becoming widely known. Some conservation and restoration efforts currently taking place in Ontario include The Tallgrass Prairie Initiative, Rice Lake Plains Joint Initiative, Tallgrass Ontario, and Nature Conservancy of Canada.

Figure 6: Restoration of a prairie ecosystem. Plugs for the prairie Conservation Volunteers event, Rice Lake Plains, Ontario. (NCC, 2011)

1.6 Rangelands Case Study: Biofuel

R A N G E L A N D S

Biofuels

A fuel derived directly from living matter.

Case Study **Envirothon 2013**

There are significant agricultural benefits relative to planting perennial grasses:

Increased *water holding capacity and water infiltration through the soils*

Reduced *soil erosion and runoff, improving the soil texture and promoting soil conservation*

Increased *incorporation of soil carbon, and a reduction in atmospheric releases of CO2*

Reduced *use of agricultural chemicals*

Increased *nutrient conservation and availability in the soils*

With the growing concern about rising greenhouse gases combined with rising oil, gas and electricity prices, bioenergy crops (primarily perennial grasses) are gaining environmental as well as economic importance. One partial solution to Canada's commitment to reduce its greenhouse gas emissions could be to implement bioenergy crops on agricultural soils. Growing and harvesting these crops has a number of environmental benefits when compared to conventional row cropping or methods for obtaining other types of fuel.

There are two types of energy that can be generated from "herbaceous biomass production"; indirect biochemical/thermochemical conversion into various biofuels including ethanol, methanol, methane, and pyrolysis oils or from direct combustion including heat, steam or electricity generation.

Increasing the production of biofuels provides a practical way in which farmers and other landowners may be able to re-integrate some indigenous tallgrass species into their lands, and possibly generate income at the same time.

Switchgrass can grow up to five feet tall. (R.E.A.P. Canada, n.d.)

Biomass crops have the potential to store carbon above ground in the vegetation as well as below ground, in roots and natural oils. The perennial nature of these grasses requires less fieldwork to be carried out such as seeding and tilling, which reduces fossil fuel consumption of farm machinery use.

Switchgrass has shown to be more productive for biofuel production than corn or soybean, which are the most commonly used (See table below). The average yields of established stands of switchgrass varieties are approximately 7 tons of dry matter per acre, which results in over 500 gal/acre ethanol with 75% conversion efficiency.

Biofuel Crop Efficiency	Corn	Soybeans	Switchgrass
Average Total Production Costs ($/acre)	417	278	231
Average Yield Per Acre (tons/acre/year)	4.2	1.3	7.25
Average Fuel Yield (gal/acre)	403	64	630

Biofuels

Using waste biomass to produce energy can reduce the use of fossil fuels, reduce greenhouse gas emissions and reduce pollution and waste management problems

— Energy Facts, 2009

(Greb, n.d)

(CGR, n.d.)

(R.E.A.P. Canada, n.d.)

(OMAFRA, 2010)

There are some negative aspects to creating a biofuel crop. Many farmers in Ontario are beginning this practice, although, the majority of it is monoculture switchgrass production. Even though it is a native grass, planting switchgrass as a monoculture crop compromises the ecological value in terms of tallgrass recovery. Monocultures of tallgrass cultivars would not contribute to natural tallgrass systems in any way, and might actually be detrimental to them if there was genetic exchange between the cultivars and the indigenous populations. There is also the danger of large-scale disease and pest problems. Growing polycultural tallgrass communities can offer more usable energy per acre than corn, grain, or soybean fuels since they grow in unfavourable soil conditions. They also increase carbon sequestration as well as provide habitat for bird species and insect pollinators and do not require pesticides and fertilizers due to their nutrient efficiency.

Since 2003, Don Nott, from Nott farms in the Huron county, has planted more than 300 acres of switchgrass. He sees a brighter future growing energy crops, like switchgrass, other than from traditional crops such as soybeans, corn, and wheat. Don combines generating power and heat combustion to optimize the energy in the biofuels.

Direct combustion is an emerging biomass energy market opportunity in our environment of rising energy prices. In this process densified biomass fuels are used for heating, primarily in wood pellet stoves. Compared to other biofuels, switchgrass pellet heating offers the highest net energy yield per hectare, the highest energy output to input ratio, the greatest economic advantage over fossil fuels, and the most significant potential to offset greenhouse gases. Switchgrass pellet heating is "environmentally friendly", and estimated to reduce greenhouse gas emissions by 93% compared to oil heating.

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For References Please see the 2013 Envirothon Study Guide

1.6 Activity: Can You Have It All?

The purpose of this activity is to provide students with an opportunity to examine their views and beliefs on a variety of rangeland values and uses.

Students will:

- examine their values and beliefs related to rangeland and its uses and values
- examine the values and beliefs of others around them as they relate to rangeland uses and values

Materials:

- Handout: “Can You Have It All?” See Appendix A

Procedures:
Hand out the worksheet, “Can You Have It All?” and go over the rangeland resources and uses and give an example of each. You will need RED, GREEN, and BLUE pens, pencils, or markers.

1. Ask students to rank their personal preference for each rangeland use. A rank of 1 = lowest or least preferred use and rank of 10 = highest or most preferred use. Graph personal rankings on the Line Graph in RED.

2. Arrange students into small groups of three or four. For each use, total the ranks for the small group. Then, rank the totals from 1 to 10 with 1 being the lowest total and 10 being the highest total. Graph small group rankings on the line graph in BLUE.

3. Bring the students back together as a class. Based on the group rankings, sum the ranks for each use to create a whole class total for each use. Then, rank the whole class totals from 1 to 10 with 1 being the lowest and 10 for the highest. Graph whole class ranking on the line graph in GREEN.

Also see Appendix B for a Rangeland and Grassland Crossword

1.8 Questions for Discussion

1. What are the different types of rangelands?

2. Why are rangelands important?

3. Are there rangelands located near you? Are they pastureland or a natural ecosystem?

4. What can you do to protect rangelands?

2.0 AQUATICS

Relating to, living in, or growing in water.

Students will:

- Understand the importance of water within all ecosystems, with special recognition pertaining to rangelands
- Understand the hydrologic cycle
- Understand the significance of coastal wetlands and wet meadows
- Understand the importance of water management on pasturelands
- Be able to identify the best management practices for natural and cultural rangelands

2.1 Introduction to Aquatics

Without water no ecosystem can survive. Businesses, communities, and ecosystems everywhere depend on clean freshwater to survive and prosper. As with any ecosystem, water is a fundamental element within the rangeland system. Although some parts of rangelands can be very dry, groundwater, precipitation, and vegetation combine to create the hydrologic cycle. The hydrologic cycle is the transportation of water through an ecosystem. Some types of rangelands such as coastal marshes and wet meadows contain higher amounts of water year round. These areas are significantly important to certain species as breeding areas and habitat.

It is extremely important to protect the water within rangelands (See Figure 7). Aquatic areas such as coastal marshes and wet meadows are at higher risk of contamination through runoff from agricultural fields and pasturelands. Degradation of rangelands can cause erosion and evaporation of water stored in the soil which in turn causes desertification and the loss of an important ecosystem.

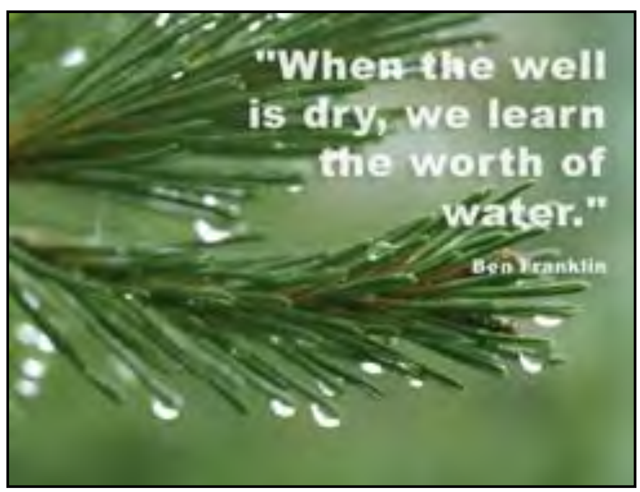
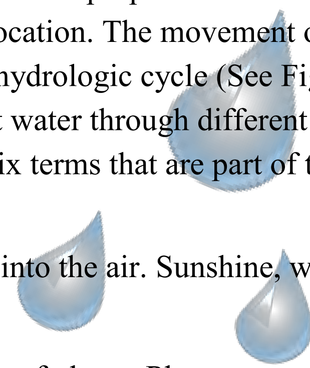


Figure 7: Water protection is valuable. (GEMI, 2012)

The proper management of water on pasturelands is critical for the sustainability of farming practices. Water quality and quantity are important for the livestock being raised as well as for the health of the environment. Pollution and contamination must be prevented in order to maintain the use of the area as a pastureland.

2.2 The Hydrologic Cycle

All living things depend on the unique physical and chemical properties of water for survival. Water never disappears, it simply moves to another location. The movement of water through plants, animals, soil, and the atmosphere is called the hydrologic cycle (See Figure 8). This cycle involves several different processes which transport water through different mediums in order to keep ecosystems hydrated and healthy. Below are six terms that are part of the hydrologic cycle:



Evaporation: Water changes from a liquid to a vapor and rises into the air. Sunshine, wind and warmer air can speed up the rate of evaporation.

Transpiration: Water vapor is released into the air by the leaves of plants. Plants transpire more on hot, sunny days.

Condensation: Water vapor cools and forms around small dust particles as small droplets. These droplets are attracted to each other and become clouds.

Precipitation: Water droplets in clouds eventually become too heavy for the air to support and fall to the ground as rain, snow or sleet.

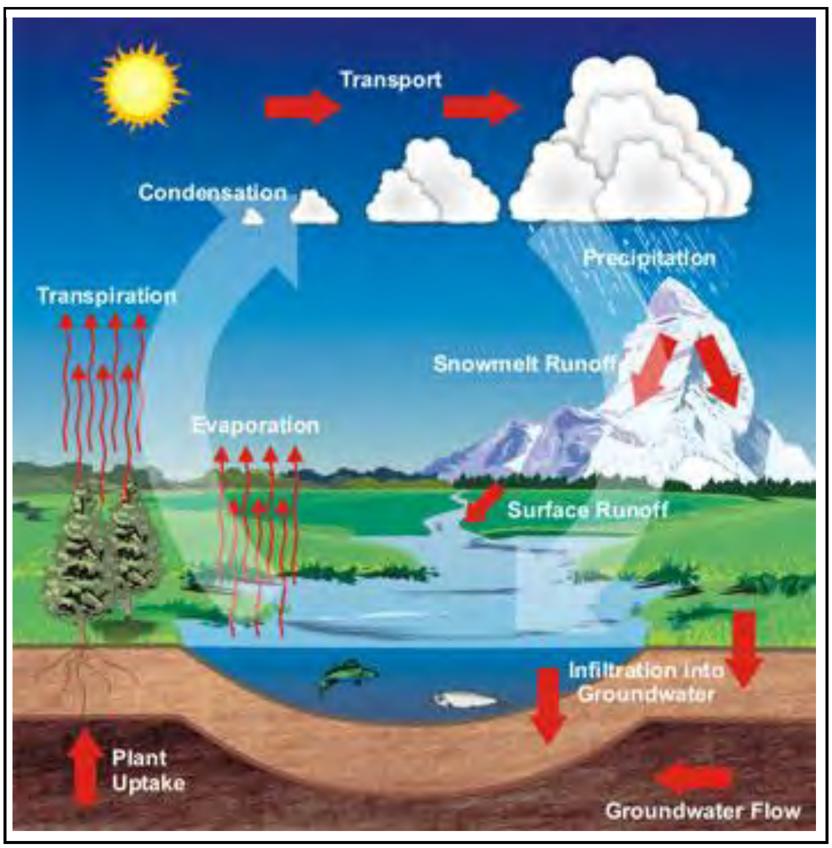


Figure 8: The Hydrologic Cycle. (Forman, 2012)

Runoff: Water travels downhill and enters into rivers and lakes.

Percolation: Water soaks directly into the ground through openings into the soil.

Water is used by all living organisms, including humans, therefore people have a responsibility to protect the integrity of Earth's water resources. By understanding the hydrologic cycle and the risks associated with the contamination of our water sources we can all make the right choices to ensure water quality and quantity in the future.

See Appendix C for Hydrologic Cycle Cue Cards

2.3 Coastal Marshes

Coastal marshes are wet grasslands derived from salt marshes or other intertidal habitats (See Figure 9). These areas are very important for wetland biota including many bird species which use these areas for breeding grounds. When these ecosystems are healthy and balanced they promote sediment deposition and reduce erosion which helps to mitigate flooding in the area. One acre of wetland can store one million gallons of water, these areas serve as reservoirs for water purification and water sustainability (Elliot, 2012).

Figure 9: A coastal marsh on the eastern coast of Georgian Bay, Ontario. (OMNR, 2011)

Coastal marshes also provide protection to coastal communities; they act as a buffer to coastal hazards such as severe weather. With climate change causing sea level rise and ocean warming, it is predicted that the frequency and magnitude of coastal hazards will increase. Many communities establish sea walls, jetties, or groins in place of coastal marshes but these are expensive and not as resilient or easy to rebuild in comparison to coastal marshes. It is important for coastal planners and managers to understand the importance and function of coastal marshes for assistance in coastal hazard mitigation and climate change adaptation. Coastal wetlands have significant impacts on wave attenuation, shoreline stabilization, and floodwater attenuation (Shepard et al., 2011). Coastal marsh vegetation has a positive effect on wave attenuation and shoreline stabilization which is measured through accretion, erosion reduction and marsh surface elevation change. The vegetation density, biomass production and marsh size play a large role in the effectiveness of the marsh as a buffer. Not only do marshes play a huge role in hazard mitigation, they also have a significant influence on the hydrologic cycle with regards to water quality and quantity.

Coastal wetlands are threatened by agricultural intensification and conversion to arable land; this usually includes draining the water from these areas. Not only does this displace the wildlife that lives in these areas, it also interrupts the natural hydrologic cycle in that region.

2.4 Wet Meadows

A wet meadow is a semi-wetland meadow which is saturated with water throughout much of the year. The ground in a wet meadow is typically damp and squishy, like a well-soaked sponge. Although the soil is saturated with water there is not likely to be any standing water except during brief periods due to storms or springtime snow melt. Wet meadows may occur as a result of poor drainage in areas such as shallow lake basins, low-lying farmland, and the land between shallow marshes and upland areas. Some wet meadows are found high in the mountains on poorly drained soil or they may also be located in riparian areas.

Wet meadows do not usually support aquatic life such as fish, however, they are a very productive environment and attract large numbers of birds, mammals and insects. Vegetation in wet meadows includes a wide variety of species including sedges, rushes, forbs and grasses. Woody plants if present, account for a minority of the total area cover. The soils in wet meadows are highly fertile and often consist of silty and clay-like materials in depressional areas.

During periods of high rainfall, wet meadows collect runoff, reducing the likelihood of seasonal flooding to downstream low-lying areas. In the process of collecting and storing runoff, the vegetation of wet meadows removes the excess nutrients accumulated by the water, acting as a natural filter. Due to the concern with damage that excessive stormwater runoff can cause to nearby lakes and streams, many people are creating wet meadows to capture stormwater. The idea is to capture and store rainwater onsite and use it as a resource to grow native plants that thrive in such conditions. A recent project taken on by Waterfront Toronto in collaboration with the federal, provincial, and municipal governments is the construction of an 18 acre park along the Don River. The Don River Park will include a 7.9 acre prairie with the lowland areas becoming a wet meadow (See Figure 10) creating ecological diversity as well as a park-wide stormwater management system (Waterfront Toronto, 2010).

Figure 10: An artist interpretation of the future Don River Park lowland wet meadow in Toronto, Ontario. (Waterfront Toronto, 2010)

2.5 Riparian Pastures

Proper management is necessary for sustainably grazing livestock in pastures. Sustaining pasture quality and minimizing environmental impacts ensures a healthy ecosystem and benefits everyone. Grazing in riparian areas can pose some challenges as well as many benefits when properly planned and managed.

Riparian areas are the transitional zones between bodies of surface water and upland areas. They include banks or shores, floodplains, and ravine slopes. Riparian areas help to recharge aquifers, store water, reduce the impact of floods, filter sediments, improve water quality, reduce erosion, and provide habitat for many species (Lane, 2007).

There are several problems that livestock can cause in riparian areas (See Figure 11). Overgrazing vegetation, damaging what can't be eaten and trampling the roots of trees and shrubs diminishes the area's filtering ability. Hooves can compact the soils which decreases infiltration and increases runoff. Hoof pressure above the banks or on shores can cause these areas to collapse, this leads to further erosion, flooding, and channel widening also creating a hazard for livestock. Allowing livestock access to the water source stirs up silt and livestock wastes are deposited directly into the water causing contamination.

Figure 11: Cattle grazing in a riparian pasture. (Prichard, 2012)

Some practices that should be considered regarding the protection of riparian areas are animal stocking rates, rotational grazing, fencing for exclusion, creating shoreline buffers, adding alternative water sources, and creating shade, shelter and feeding areas a distance away from any water sources. Some of these practices are demonstrated in Figure 12 created by the Long Point Region Conservation Authority in Simcoe, Ontario. This figure also demonstrates other management solutions for areas of concern along riparian zones in agricultural or residential areas.

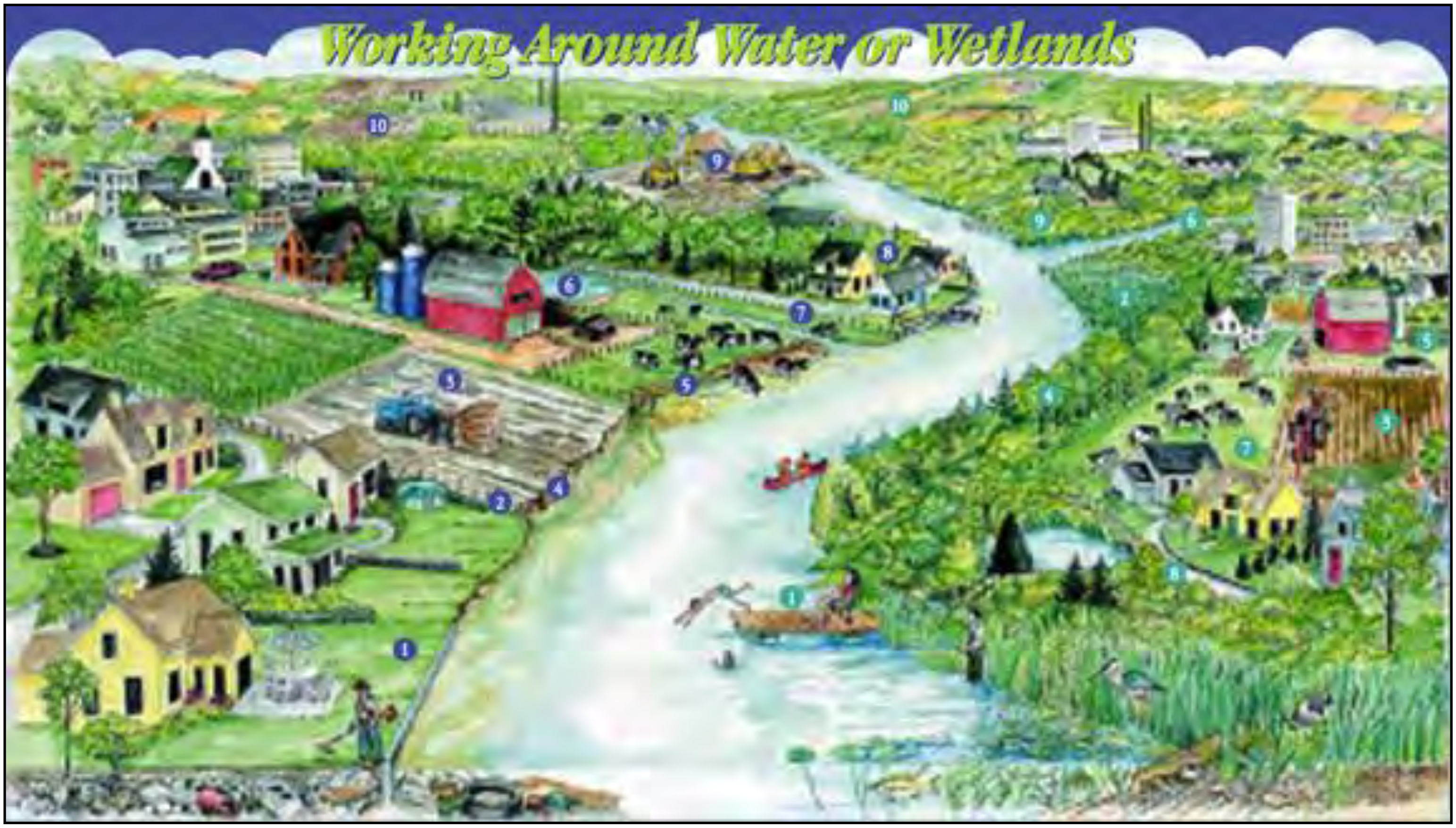


Figure 12: A diagram showing proper management and improper management in a riparian area. (LPRCA, 2008)

LET'S PROTECT

1 Hardened, artificial shoreline with concrete wall
2 Drainage ditch - poor design accelerates water flows and carries sediment and contaminants to the river
3 Poor nutrient management - manure spreading on field too close to watercourse with no buffer
4 Erosion - no buffer, plowing too close to waterway and in wrong direction
5 Runoff/Seepage - water quality issues
6 In-stream pond - warming of cold water stream - cattle access, no buffer
7 Cattle in water - erosion and water quality issues
8 Buildings too close to a watercourse - potential flooding and surface water impacts
9 Illegal dumping of fill and alteration of a watercourse - increases flooding and erosion and disturbs aquatic habitat
10 Clear cut operations - loss of habitat and exposed soil

LET'S TALK

1 Natural shoreline with recreational access
2 Protection of wetlands and natural drainage systems
3 Proper nutrient management - preparation of a plan and correct application methods
4 Excellent buffer - filters impurities and keeps shoreline intact
5 Contained manure storage using proper facilities
6 A natural waterway
7 Livestock kept away from watercourses - fencing and natural vegetation
8 Protection of floodplain lands - development set back from watercourse, pond collects stormwater runoff
9 Houses set well back from shoreline - natural vegetation and habitat left intact, no filling
10 Good forest management- tree planting, habitat protection, soil conservation

2.6 Best Management Practices

Best management practices are proven, practical and affordable approaches to conserving soil, water and other natural resources in rural areas. Farmers, researchers, natural resource managers, regulatory agency staff, and agribusiness professionals must all work together to create management practices that accommodate everyone equally (Lane, 2007).

Figure 13: Comparison between a riparian zone that does or does not permit cattle access. (Scott, n.d.)

Rangelands must be managed to maintain soil and water quality. Planting deep rooted plant species improves soil quality along with helping to filter the water. Tallgrass prairie species do a much better job than shallow rooted species. There are several variables that can be manipulated by landowners for management including: grass height, frequency and size of tussocks, surface wetness, and the amount of arable land versus grassland.

Controlling the access between livestock and water sources is very important in the protection of water quality. Fencing off aquatic areas is the best management practice for the prevention of erosion and water contamination. Figure 13 demonstrates the significant difference between letting cattle have access to riparian areas and fencing them out. If complete exclusion from an aquatic area is not feasible controlled access should be maintained or specific crossing areas should be created for the minimization of land degradation and water contamination.

Alternative water sources offer drinking areas for livestock that are far enough away from nearby watercourses to prevent contamination. Alternative water may be drawn from streams, wells, or groundwater springs. If a barn is nearby, this is the easiest approach to accessing groundwater through an existing well and creating a permanent trough. Solar powered pumps are becoming more and more popular (See Figure 14). New designs with a combination of a pump and solar panel are highly efficient and allow the water source to be placed virtually anywhere the sun shines. In areas without a visible water source, a dugout pond can be excavated to collect surface runoff or groundwater to be pumped to another location. Buffer areas or fencing should be considered to protect the water quality in the pond.

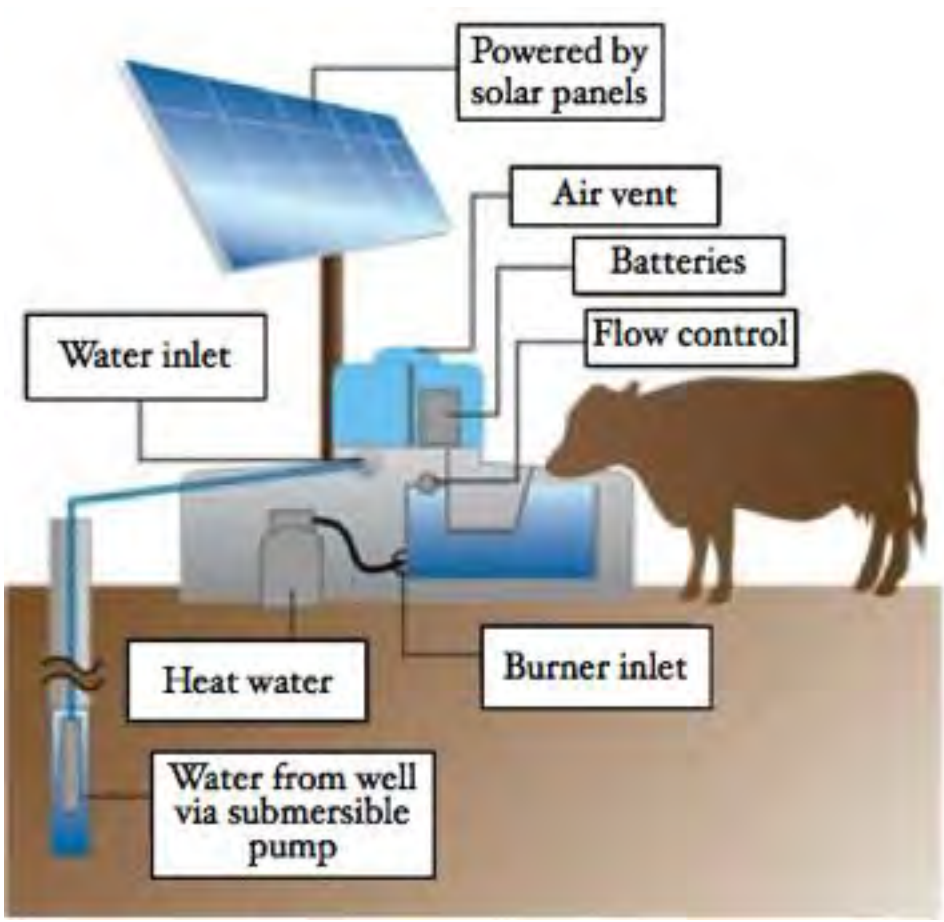


Figure 14: How a solar pump system works, these are used as an alternative water source in pastureland. (Blackstone Energy Solutions, 2011)

By following management practices, time and money are saved through the prevention of environmental destruction and the degradation of rangelands. Creating a healthy pastureland benefits the rancher, the livestock, and the environment. This is seen in reduced veterinary bills and higher quality livestock due to the improved health of the livestock.

2.7 Aquatic Case Study: Hurricane Katrina

HURRICANE KATRINA
CASE STUDY

Coastal Wetlands	Coastal Wetlands	Coastal Wetlands	Coastal Wetlands
Prevent coastal erosion by trapping and holding sediments around the vegetation.	*Purify water as it filters through all the aquatic plants and sediments.*	*Buffer the impact of waves and prevent flooding during storms.*	*Are the home or migration grounds for thousands of different species.*

NEW ORLEANS, LOUISIANA

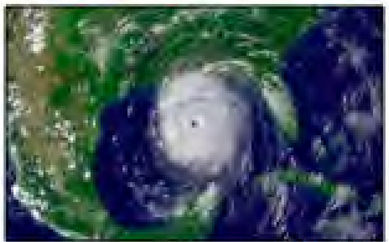
The City of New Orleans, Louisiana (See below), was founded by the French in the 1700s, because of its long history it is considered one of the most significant Cities in the US for cultural and historical purposes. The City originally sat above the level of Lake Pontchartrain and the Mississippi River but has slowly been sinking deeper beneath the water level. It has been thought that oil drilling, groundwater pumping, and the young soft sediments that the city sits on could be to blame for the sinking but a new study examines the deep shifting of tectonic plates under the city (Unger, 2006). To mitigate the occurrence of severe flooding from Lake Pontchartrain and the Mississippi River levees have been built to protect the City.

(LeBlanc, 2012)

(McGuinness, 2006)

New Orleans is located on the Mississippi River delta which is the sixth largest delta in the world. The Mississippi River watershed is the third largest in the world and covers more than 1.2 million square miles. The river empties 406 000 000 tons of sediment into the Gulf of Mexico each year which is equal to 200 000 dump trucks per day. Deposition has created 5 million acres of coastline including 40% of the salt marshes along the coast and 3 million acres of coastal wetlands. There are more than 400 species of wildlife that are native to the region including 40% of the migratory waterfowl in North America. More than 5 million waterfowl overwinter in the delta annually, this area is invaluable to the preservation of biodiversity. (Elliot, 2012)

HURRICANE KATRINA



(NOAA, 2007)

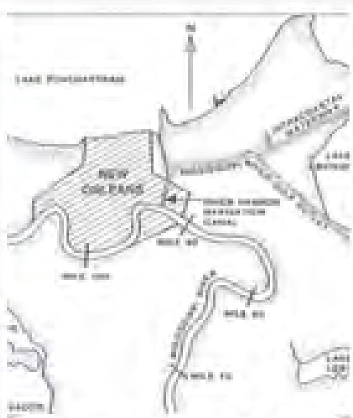
(Stewart, 2005)

Currently more than 13 000 km of channels have been cut through the delta which causes a variety of problems (see above). The intrusion of saltwater into freshwater systems leads to habitat and species loss. The river sediments no longer replenish barrier islands or build up coastal wetlands, they continue past the delta and end up in the deeper ocean. Everyday 50 acres of coastal wetlands are lost.

(Pernanen, 2006)

References: See the Envirothon 2013 Study Guide.

On August 29, 2005 hurricane Katrina made landfall just east of New Orleans with winds of over 240 km/h. There were $130 billion USD in damages including the contamination of soil sediments due to flooding. The loss of life was even greater, over 1800 people perished. The severe impact of the hurricane can be related to the loss of coastal wetlands. The natural buffering system of coastal wetlands reduce storm surges through wave attenuation, shoreline stabilization, and floodwater attenuation. The wetlands act as a natural speed bump to the storm. The Mississippi River Gulf Outlet (MRGO), a shortcut channel for large ships to enter the port of New Orleans, is blamed for increasing the severity of the storm. MRGO (see below) raised the height of the storm surge by eight metres and increased the speed of the surge by 2-3 times.



Mississippi River Gulf Outlet

(Global Security, 2012)

(Zambio, 2011)

The current rate of land loss may result in a 30% drop in fish harvests as well as job losses in fisheries, agriculture, and the petroleum industry. The Gulf of Mexico will move 30 miles inland which increases the susceptibility of New Orleans to see large storms more frequently. There is a critical need for the restoration of coastal wetlands and barrier islands. This will soften the blow of future storms and create more resilience within New Orleans. Right now, New Orleans is still in a very vulnerable state 8 years after the hurricane. There is a thirty year coastal plan in place that supports the development of pipelines and pumps to return some of the sediment back to the coastal wetlands (Elliot, 2012).

2.8 Aquatics Activity: Water Purification

The purpose of this activity is to provide students with an opportunity to learn how the hydrologic cycle removes different elements from water. Students will create their own freshwater source by "contaminating" some water then purifying it again in a way that demonstrates how the hydrologic cycle works in nature.

Students will:

- examine the value of water and why purification is necessary
- examine the processes of the hydrologic cycle

Materials:

- Handout: "Water Purification" See Appendix D

Procedures:
Hand out the worksheet, "Water Purification" and go through the experiment

1. Have all the necessary materials gathered prior to class.

2. Prepare students by making sure they are familiar with the hydrologic cycle.

Figure 15: Water purification experiment. Creating clear, freshwater from a "contaminated" source using techniques derived from the hydrologic cycle. (Archibald, 2012)

2.9 Questions for Discussion

1. Why is the hydrologic cycle important?

2. What benefits do coastal marshes bring to the local environment?

3. What are ways that we can protect the water sources in our rangelands?

4. Are there water protection measures in place for the rangeland areas near you? This may include governmental regulations and legislation, committees, or other organizational involvement.

5. What are some precautions that must be considered in riparian pastures?

There are several different organizations that take initiative to restore aquatic communities. These organizations are always looking for volunteers to take part in shoreline clean ups, planting, and other restoration activities.

Here are a few to get you started:

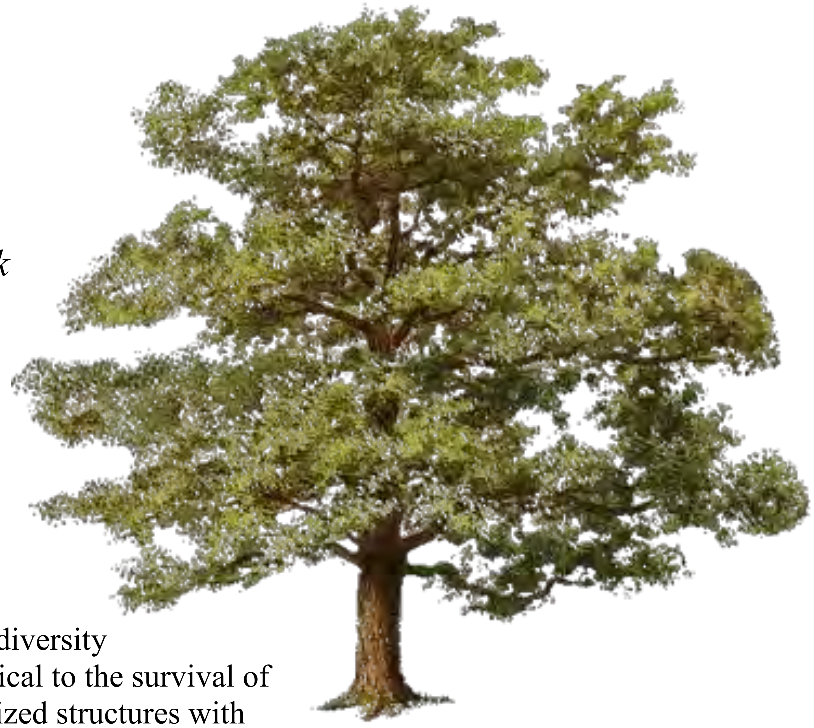
Central Lake Ontario Conservation: http://www.cloca.com/volunteer/index.php

Ducks Unlimited: http://www.ducks.ca/helpduc/volunteer/youth.html

Great Canadian Shoreline Cleanup: http://shorelinecleanup.ca/

Kawartha Conservation: http://www.kawarthaconservation.com/resources/volunteer.html

Toronto and Region Conservation Authority: http://www.trca.on.ca/get-involved/



3.0 FORESTRY

A large wooded area having a thick growth of trees and plants.

Students will:

- Understand the effects of human impacts on grassland forest ecosystems
- Understand the importance of rehabilitation and management of grassland forest ecosystems for biodiversity
- Understand that plant variety is critical to the survival of ecosystems and plants have specialized structures with distinct functions that enable them to respond and adapt to their environment
- Understand the technology that enables humans to manipulate the development of species has economic and environmental implications
- Understand that modern agriculture can have positive and negative consequences for rangeland ecosystems

3.1 Introduction to Forestry

Forest ecosystems are habitats that have trees as the dominant vegetation type. Forests are highly productive and diverse systems that are vital to the health of grassland ecosystems. Grasslands are considered dynamic ecosystems that are constantly in a stage of succession, potentially becoming a forest. Within these stages of succession, there are a variety of diverse ecosystems that provide goods and services for numerous flora and species (See Figure 16).

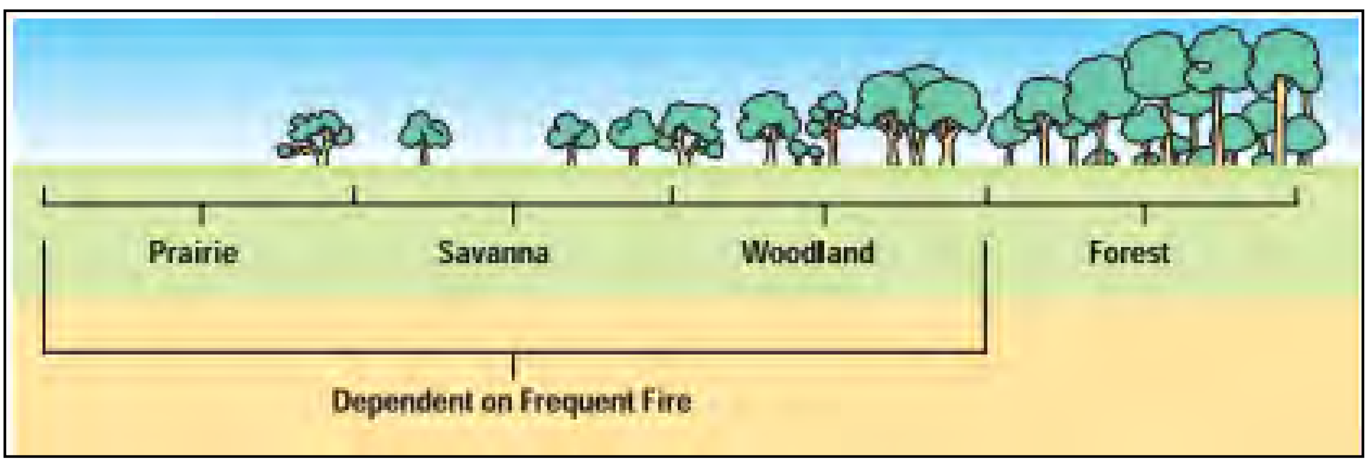


Figure 16: Succession from a prairie to forest. (EPA, n.d)

These ecosystems include: prairies, meadows, savannas, woodlands, shrublands, and forests.

Plant structure in all forest ecosystems is important for biodiversity. Forest structure is composed of a ground layer, an understory, a sub-canopy and a canopy (See Figure 17). In homogeneous ecosystems, such as red pine plantations, the forest structure is simplified and the biodiversity is compromised.

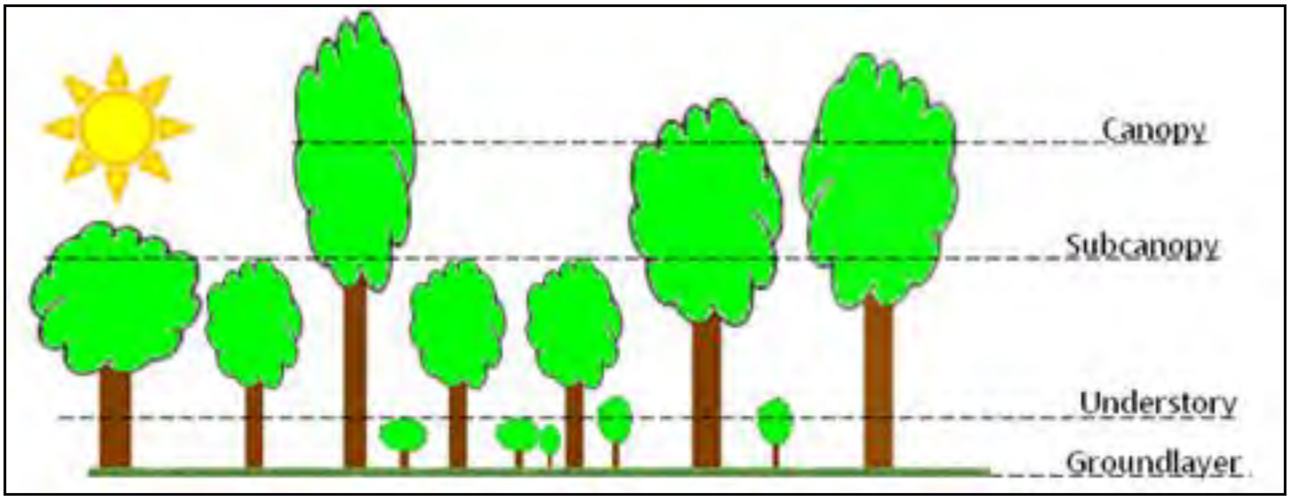


Figure 17: The vertical structure of a forest. (Turner, 2012)

3.2 Rangeland and Grassland Forestry in Ontario

Tallgrass Communities

Tallgrass communities refer to tallgrass prairie and savannas. In Ontario, these ecosystems are found in southern and northwestern Ontario. In North America, tallgrass communities are the most endangered ecosystems.

Tallgrass prairie ecosystems are dominated by native grasses and have less than 10% canopy cover (See Figure 18). They also include a variety of sedges and forbs. Typical grass species found in these ecosystems include:

- Big Bluestem
- Little Bluestem
- Indian Grass
- Switchgrass
- Showy Tick-trefoil
- Round-head Bush-clover
- Butterfly Milkweed
- Slender or Cylindrical Blazing-star

See Appendix E for Identification and Characteristics

Figure 18: Little Blue stem and a Black Oak at Alderville First Nations Tallgrass Prairie and Black Oak Savanna (Alderville First Nations, n.d)

Within grasslands, there are areas of scattered trees, these are savannas (See Figure 19). Savannas are natural grasslands with canopy cover ranging from 10-35% (MNR, 1998). They are usually referred to as ecozones or transitional ecosystems between a grassland and forest. These transition zones are important to wildlife because they provide shelter, protection, and food for grassland and forest species. In Ontario, the tree types usually associated with savannas are oak, hickory and pine. Savanna plant communities are similar to that of prairies, although some species that are more exclusively found in savannas are false foxglove, rattlesnake hawkweed, and New Jersey tea. Prairies can grow on a range of soils from sand to clay, but savannas tend to occur on sandy soils. These ecosystems are reliant on disturbances such as flooding, drought, grazing and fire.

Figure 19: Savanna at the Ojibway Prairie Provincial Nature Reserve, Windsor, Ontario. (Ojibway Nature Reserve, 2005)

Warm Season and Cool Season Grasses

Grasses that make up tallgrass communities include warm season (C4) and/or cool season (C3) grasses. The classification is based on the way the plants assimilate carbon in the form of carbon dioxide. C4 grasses fix carbon in a four carbon compound and C3 grasses fix carbon into a three carbon compound. Warm season grasses grow optimally in late spring and summer, while cool season grasses grow optimally in the beginning of spring. Warm season grasses are mostly native to tallgrass communities in Ontario and most cool season grasses are non-native.

Figure 20: Kentucky bluegrass is a common grass for landscaping. (Randall, 2003)

C4 grasses: big bluestem, little bluestem, switchgrass and indian grass

C3 grasses (native): Canada Wild Rye, June Grass, Canada bluegrass, Kentucky bluegrass (See Figure 20) and various sedges

C3 grasses (non-native): Smooth Brome, Orchard Grass, Timothy and Fescues

Prairie vs. Meadow

Prairies and meadows are different ecosystems and can be defined based on their characteristics. Prairies are old, climax communities while meadows are temporary ecosystems and are usually formed from a disturbance in a forest.

If a forest in Ontario is cleared or burned, it will one day become a forest again through the process of succession. The beginning stage of succession allows pioneer species such as goldenrod, teasel, giant ragweed and Queen Anne's lace to move in, these plants do not benefit from fire. This creates a meadow. Eventually, other shrubs and sun loving trees will move in and create optimal conditions for shade trees such as maples and beeches to establish further into a forest ecosystem.

A prairie is a long-lived grassland ecosystem that is dominated by native grasses and forbs. These ecosystems are prone to disturbance which prevents them from succeeding into other ecosystems. Since prairie plant roots go deep, they are protected underground and survive fire, unlike the plants that establish in a meadow. A prairie ecosystem can become a meadow through human disturbance such as tilling or plowing. This destroys the root systems which allows for meadow plant species to establish and succeed into a forest.

Oaks in Savanna Ecosystems

Oak trees have evolved and adapted to survive the conditions of disturbance prone to tallgrass communities. Special features that allow oaks to survive in savanna ecosystems include having a thick seed shell, deep root systems, and thick bark. Acorns, produced by oak trees, have adapted to have a hard shell to protect them from being damaged by fire. The fire helps weaken the shell for germination. To germinate, oaks need sunlight; therefore they do well in open ecosystems. Most oak trees are also equipped with a tap root that reaches far into the water table. This allows oak trees to survive in drought conditions. In Ontario, the majority of savannas are Black Oak Savannas. When it comes to fire, mature Black Oaks are not killed by low-intensity burns because they develop a fire resistant, insulating bark, although the lower branches may be affected. Young Black Oak trees tolerate fire by exhibiting a unique ability to re-sprout stems following top kill by fire. These adaptations have allowed for Oak trees to grow optimally and out compete other species in prairie and savanna ecosystems.

Black Oak trees are important for wildlife since they provide food and shelter for many mammals, birds and insects. Some species that use the acorns from Black Oak trees as a food source include: Eastern gray squirrel, meadow vole, wood duck, downy woodpecker and Duskywing Butterflies. Birds that use oak trees as shelter include: woodpeckers, blue jay, eastern bluebird and owls.

(Tallgrass Ontario, 2004b)

Oak Woodlands

Oak Woodlands are denser than savannas and have canopy cover ranging from 35-60% (See Figure 21)(MNR, 1998). Woodlands also require disturbance (i.e. fire, grazing, drought, insects, herbivory) but less frequent and/or intense than prairie or savanna. With no disturbance, other plant species will be given the opportunity to establish which will eventually reduce the amount of light reaching the ground layer. This will change the species composition of woodland to shade loving plant species. This change in species composition results in succession towards a forest ecosystem.

Figure 21: Black Oak Heritage Park in Windsor contains a variety of savanna and woodland species. (Ojibway Nature Centre, 1999)

Alvars

Alvars are naturally open habitats with thin or no soil over a base of limestone. The thin soil only allows for sparse vegetation, which results in 5 main alvar type: salvar shrublands, alvar grasslands, alvar savannas, alvar pavements and alvar woodlands (See Figure 22). These unique areas are known to house a variety of rare flora and fauna that can only be found in alvars. Due to this, alvars are considered one of the most species rich ecosystems in the world. The majority of alvars in North America are found in the Great Lakes Basin. Approximately 75% of the alvars in the Great Lakes Basin are found in Ontario (NCC, n.d.a).

Figure 22: Alvar on the Carden Plain. (NCC, n.d.b.)

3.3 Benefits of Grasslands

Grasslands have a variety of environmental, social, and economic benefits. Grassland ecosystems are recognized provincially, federally, and nationally for their ecological importance. They increase biodiversity, soil stability, and water quality.

The aesthetics of grassland ecosystems is invaluable. These ecosystems have a variety of native prairie grasses and wildflowers that create a sea of colours from early spring to late fall (See Figure 23). These landscapes usually consist of flat or rolling topography which provides accessible and scenic nature trails and areas for social recreation.

Figure 23: The Ojibway Prairie in Windsor has a nice show of flowers in the late summer (Pratt, 2005)

Tallgrass communities are a large part of North America's cultural heritage. These lands served as hunting and gathering grounds by providing plants and animals that were essential to Aboriginal existence. Some of the plants collected also served ceremonial and medicinal purposes. Vegetation in these communities that can be used for medicinal purposes include: white pine trees, black snake weed, butterfly milkweed, and bearberry (See Figure 24). Butterfly milkweed roots have been used to treat sores and respiratory problems such as whooping cough, pneumonia and pleurisy. Seneca snakeroot was used to treat headaches, stomach aches and congestion. It is still used in cough medicines such as lozenges and cough syrups today.

Figure 24: Bearberry, a medicinal plant that was used for urinary tract infections. (Fyon, 2007)

Grassland also serve economic purposes through providing seeds banks, land to grow biofuel, and pasture land. As restoration projects for tallgrass communities in Ontario increase, the demand for native tallgrass seeds have also increased since many of the species are rare. This has created a market for tallgrass seeds in North America. Tallgrass communities can be used to produce biofuel. This is a new initiative that is starting to be practiced because it is believed that using polyculture prairies for biofuel is a sustainable and profitable alternative for landowners. It has also been shown that tallgrass prairie plants provide nutrient rich lands for grazing domestic animals.

3.4 Rehabilitation & Management of Forested Grasslands

There are many efforts to restore grassland ecosystems back to their historical state. After a site has been rehabilitated, it is important that it is maintained to ensure it remains a grassland. Rehabilitation and management of grasslands and savannas include planting native species (See Figure 25) and controlling invasive species through the introduction of disturbance.

Interseeding and Planting

Since many tallgrass remnants are isolated from other communities, the potential for natural seed exchange is limited or non-existent. Therefore, interseeding and planting is a common practice for the restoration of tallgrass communities. This is done to increase the abundance of native species and reintroduce species that have been extirpated from the area. If possible when planting, the seed source should be taken from the site itself. In situations where the plant has been extirpated from the area, seeds will need to be brought in. A seed source from the Midwest United States may not fare well in a Southern Ontario zone even if it is considered a native species. Particular plants have evolved and acclimatized to the conditions they have been growing in (ex. warmer climate, dry soils). These species will still grow in similar ecosystems but may struggle to establish against other species already accustomed to the ecozone. To ensure that the plants are well adapted to the conditions of Ontario, it is important to try and obtain seeds from a local source. Common volunteer activities for the restoration of tallgrass communities involves seed collecting (See Figure 24).

Figure 25: These volunteers are collecting seeds to be spread on the site. (Alder, 2001)

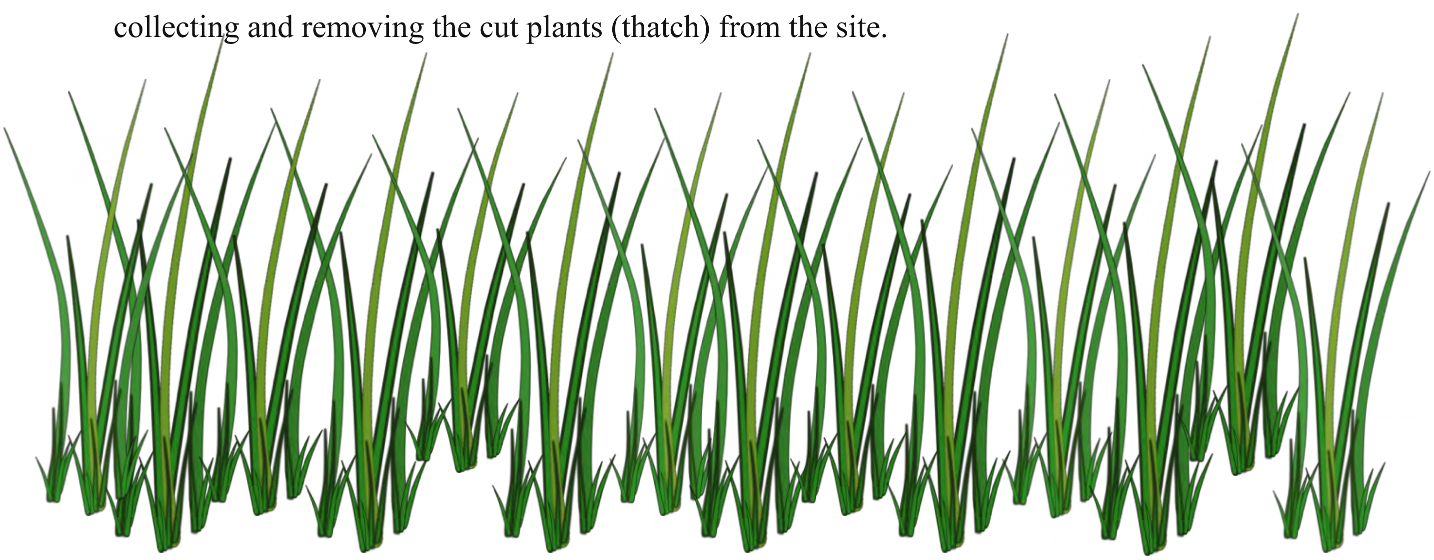
Invasive Species

Figure 26. Common buckthorn is native to Europe and is a common invasive species found in Ontario. (Invading Species. n.d.)

Invasive plants pose a large threat to tallgrass communities. Many of these plants were brought over accidentally or deliberately (usually from Europe or Asia). Invasive plants have many strategies that allow them to out compete other plants. Some plants produce hundreds of thousands of seeds per individual. Many invasive plants get a head start by starting their growth early in the spring while native plants are still dormant. Non-native plants have no natural predators in their new habitat to keep their populations levels down. Also, most invasive plants tolerate disturbed sites with full sunlight. Techniques used to remove invasive species in small areas include girdling, stem cutting, frilling, spot burning, pulling, blanketing, and herbicide application. For mature trees, girdling, frilling, and stem cutting are effective, while for shrubs and smaller vegetation, spot burning, pulling and blanketing with a black tarp are commonly used. For larger areas burning, mowing and haying are usually used.

Mowing and Haying

Mowing and haying is usually used in areas where there is a concern with the risk of using fire. Mowing requires cutting plants relatively close to the ground while haying involves collecting and removing the cut plants (thatch) from the site.



Mowing/haying is usually done once every few years, similar to a prescribed burn schedule. It is not necessary to mow the entire site each time. Weedy areas may need to be mowed more frequently than the rest of the site. This mowing/haying rotation also mimics grazing and leaves suitable habitat for insects and other wildlife. Mowing can be done at different times of the year depending on the desired results. Mowing and haying in the spring to late summer can be used to reduce invasive plant species. This can be done more than once per season if a large number of unwanted species are present. Mowing in the fall can be done to reduce the intensity of a prescribed burn for the next spring.

Figure 27: The bark on black oak trees allows them to withstand fire. (Ennis, 2009)

Fire and Prescribed Burns

Fire is known to play a major role in the survival of ecosystems around the world, including the Jack Pine forests found in Canada's boreal region. Historically, tallgrass communities were either burned through natural causes or through aboriginal cultural practices. In tallgrass communities, fire blackens the soil, increases moisture availability and creates suitable conditions for prairie and savanna plant species to out compete invasive species. Due to development, fire has been suppressed in many of these systems and is rarely a natural occurrence, therefore, to maintain these ecosystems prescribed burns are essential.

Prescribed burns are controlled fires that are deliberately set and burn close to the ground. The dead standing material that is burned, allows for moisture to reach the ground as well as provides nutrients such as calcium, magnesium, potassium and phosphorus that become available in the ash and acts as fertilizers. The blackening of the soil also increases light absorption from the sun, warms the soil and increases the germination time of native plants (See Figure 28). The burning of this plant

Figure 28: An example of blackened soil at Alderville First Nations (Alderville First Nations. n.d.)

material also releases nitrogen into the atmosphere. Since prairie species are adapted to low nitrogen levels, this gives them an advantage over weedy species that require more nitrogen.

Figure 29: Prescribed burn being carried out by professionals at the Dutton-Dunwich Railroad Prairie in Ontario. (Mackie, 2005)

Burns are not conducted every year. Studies are still being conducted to determine the best burning frequencies. Tallgrass Ontario has stated that tallgrass prairies that only contain a small amount of invading plants will benefit from a burn once every 3-10 years and savannas benefit from a burn once every 10-15 years (MNR, 1998). Sites with poorer, drier soils usually do not need to be burned as often due to slower growing conditions and less vegetation build up. These burns are usually done in sections every few years. This is to allow for juvenile trees to mature as well as provide habitat and protect species at risk.

Prescribed burns are usually conducted in the early spring. Warm season plants are still dormant at this time while cool season plants (mostly invasives) are starting to grow and are affected by the fire. Also, most grassland birds have not begun to nest and reptile and amphibians have not emerged. To promote wildflower growth, burning can also be conducted in the summer.

Warning: prescribed burns are carried out by professionals and must never be conducted on your own. Conditions must meet standards for a prescribed burn to be carried out to ensure there are minimal safety risks.

There are several different organizations that take initiative to restore tallgrass communities. These organizations are always looking for volunteers to take part in seed collecting, planting, and other restoration activities. Here are a few to get you started:

Trees Ontario: http://www.treesontario.ca/news/index.php/plantingweekend

North American Native Plant Society: http://www.nanps.org/index.php/events/restorations

Earth Day Canada: http://www.earthday.ca/pub/events/search/shell_summary_public.php?prov=ontario&accessibility=public

Tallgrass Ontario: http://www.tallgrassontario.org/New%20Website/Website%202011%20Pages/VolunteersNeeded.htm

Nature Conservancy of Canada: http://www.natureconservancy.ca/en/what-you-can-do/conservation-volunteers/

3.5 Forestry Case Study: Fire Management in High Park, Toronto

Forestry Case Study

ENVIROTHON 2013 FORESTRY

(Toronto Parks, Forestry, and Recreation, N.D.)

(Yukich, 2012)

(Wilcox, 2012)

Prescribed burns maintain savanna and prairie ecosystems

Fire Management in High Park, Toronto

High Park Toronto, Ontario

High Park is the most significant area of prairie and savanna plant communities in the Toronto region and contains approximately 23ha of fragmented Black Oak savanna. This area was designated as an Area of Natural and Scientific Interest (ANSI) in 1989. Since then, the City of Toronto has developed a plan of restoration that includes weed control, native species planting, and annual burning.

Since 2000, the City of Toronto Urban Forestry group has been using fire as a management tool to help restore and expand High Park's native plant communities such as the Black Oak savanna ecosystem. Prescribed burns are carried out by a Fire Boss and a crew that is trained and certified by the Ministry of Natural Resources.

Six months before the burn, the Fire Boss visits to assess the area and take note of features such as the type of fuel, topography, and proximity to buildings and private property. After a plan is prepared and reviewed, weather conditions such as daily rainfall, temperature, humidity levels, dryness of the site and wind patterns are studied. All this information is used to predict weather conditions to determine the appropriate day to conduct the burn.

Prescribed burns remove exotic plants and grasses from the area as well as return essential nutrients to the soil

Since weather is difficult to predict, the burn is set within 48 hours of the selected day. At High Park, the burns usually take approximately 2 hours to complete. If weather conditions do not permit, it is possible for there to be a year in which a burn does not occur, although at High Park, they have been successful implementing burns every year since 2000.

For references please see the 2013 Envirothon Study guide.

Ontario Forestry Association

More info about Envirothon at:
http://www.ontarioenvirothon.on.ca/

(Toronto Wildlife, 2010)

After a burn, staff monitors the burn areas over many years to determine the positive and negative impacts on different plant and wildlife species. The desired effect is to see an increase in vitality and population densities of native prairie plants, and a decrease in invasive and non-prairie plants. Increased oak regeneration is a good indicator of success. In the '70s and '80s, studies in High Park revealed a lack of oak seedlings naturally regenerating. This was of great concern as many of the mature oaks were in the GTA are in decline. In Toronto, studies have shown that there is an increase in oak regeneration in areas that have received prescribed burn treatments.

One of the largest success stories from the burning of High Park involves the story of the wild blue lupine. After the first burn, the wild blue lupine displayed immediate response with an increase in patch size and seed production. Wild blue lupine is an important species due to its relationship with the extirpated Karner blue butterfly. Karner blue butterflies are dependent on wild blue lupine as it is the only food source the larva eats. Although it is unlikely that the Karner blue butterfly would be reintroduced to a highly urbanized park like High Park, the wild blue lupine plants at High Park could be used as a seed source for other sites and research.

(Toronto, 2012)

How to get involved in the restoration of High Park

The High Park Citizens' Advisory Committee (HPCAC) is made up of members from the community. Urban Forestry Services meet monthly with the Natural Environment Subcommittee to discuss projects. The Volunteer Stewardship Program (VSP) also contributes to the restoration of High Park through planting, weed control, education and monitoring of changing conditions in the park.

For more information:
www.highparknature.org or www.highpark.org

(High Park Nature, 2012)

Get out there! Help make a difference!

3.6 Forestry Activity: Plant Press

The purpose of this activity is to teach students how to build a plant press, press plants and the importance of plant documentation (See Appendix F for activity sheet).

Students will:

- learn how to build a plant press and press plants
- understand the value that preserved plants serve in the scientific community

30: Pressed plants. (Oakland Museum, 2012)

Materials

- several old newspapers
- corrugated cardboard
- 2 pieces of plywood
- cardstock paper
- two straps with buckles that can be secured (can use c-clamps or weights)
- plants or leaves collected from outside
- white glue

Procedures

1. Students will be required to go out and collect plants or leaves (if possible grassland plants should be collected).
2. Students will then learn how to build a plant press. A large press can be built as a group or smaller presses can be built individually.
3. After plants are pressed, students will be required to mount plants with proper documentation: common name, scientific name, date collected, collector's name, location and habitat type.

3.7 Questions for Discussion

1. What are the different stages of succession from a grassland to a forest?
2. What makes up forest structure and why is it important?
3. What are some adaptations that prairie and savanna plants have that allow them to thrive in disturbed ecosystems?
4. What benefits do forested grasslands provide economically, socially and environmentally?
5. What are some rehabilitation and management methods used for tallgrass communities and in what situations would particular management techniques be used instead of another?

4.0 SOILS

The portion of the earth's surface consisting of disintegrated rock and humus.

Students will:
- Understand the different Rangeland soil types and classification of soil horizons throughout Ontario
- Learn the role of soils in rangeland ecosystems
- Understand management practices of rangeland soils
- Gain hands on experience with soil texture
- Understand the complex chemistry and nutrient cycles of rangeland soils

4.1 Introduction to Soils

Soils are formed by the physical and chemical weathering of bedrock and glacial parent material, and are continually modified and shifted by water, wind, and gravity. Glacial action has scoured away overlying deposits leaving exposed bedrock in many areas across Ontario. As a result the soil composition in Ontario closely reflects this underlying bedrock. Other soils reflect the tills and other morainic and lacustrine materials deposited by advancing and retreating ice sheets and their melt water. The Canadian System of Soil Classification (Agriculture Canada 1987) is a standard series of orders and great groups by which soils can be identified and described. Six of the soil orders in this classification are predominant in Ontario (See Figure 31). These soil classifications relating to rangelands will be discussed further in the text.

The nature of soil development in Ontario depends on five local combinations over time, these include:

· climate
· parent material
· terrain
· vegetation
· other organisms

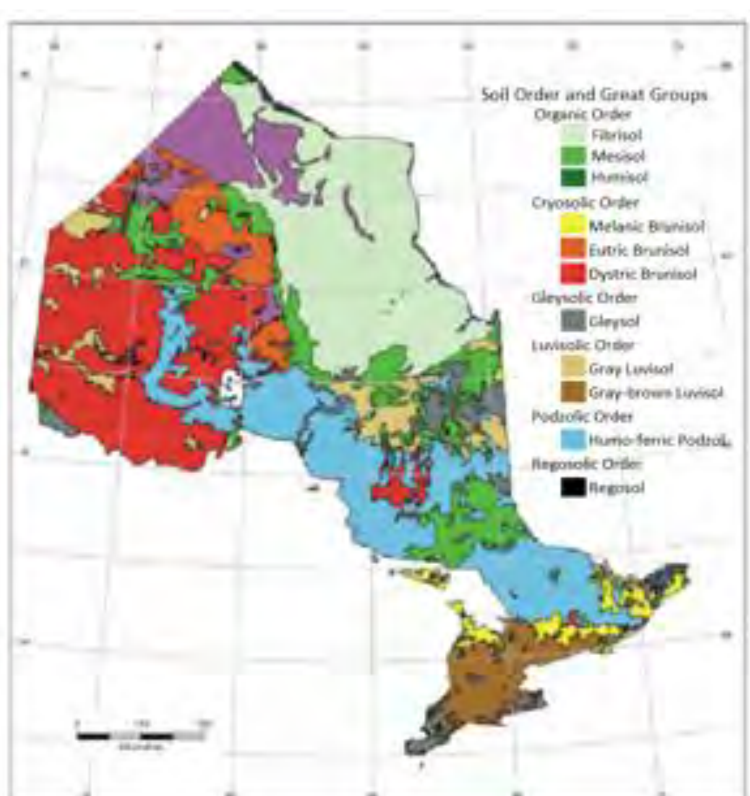


Figure 31: Dominant soil orders and great groups in Ontario based on Soil Landscapes of Canada units (Baldwin et al, n.d.).

The physical, chemical and biological processes that occur in rangeland soils supply vegetation with the resources they need to survive and thrive in their existing ecosystem. Microorganisms in the soil break down plant litter, releasing nitrogen, phosphorus and other nutrients essential to plant growth. The composition of soil determines how much nutrients and moisture are available for plant life to survive. Soils store water and nutrients for plants to draw from when they need them. The soil is a living system that is linked to nutrient cycles, energy flows, and other ecological processes of rangeland ecosystems. We must remember that humans are a part of these systems and must take a responsible role in the management and conservation of soil resources. For further information of soil terms and horizons, refer to the Appendix G.

4.2 Rangeland Soil Composition

Soil composition is determined by the region and factors that affect the soil in that area. Soil composition is made up of texture, structure, and drainage. These components are the determinants of the type of ecosystem that can be supported. The soil composition present in rangelands is important to both the kind and amount of forage produced and the type of management that is appropriate. The chemical and physical characteristics of soil determine:

- its ability to provide plants with nutrients
- the rate and depth of water penetration
- the amount of water the soil can hold and its availability to plants

Texture

Texture refers to the relative proportions of sand, silt and clay that make up the soil material. The texture in most soils change from horizon to horizon and extremes are often present when one kind of deposit overlies another. The classes of soil texture include sand, silt, and clay. Soil texture can be determined by using a Soil Texture Triangle. Scientists use the Soil Texture Triangle (See Figure 32) to determine soil structure. The percentage of clay, sand and silt must be known and the intersection of the three lines coming from the percentage indicates the soil type. Refer to activities (See Appendix I) to learn more about the Soil Texture Triangle through the soil activity.

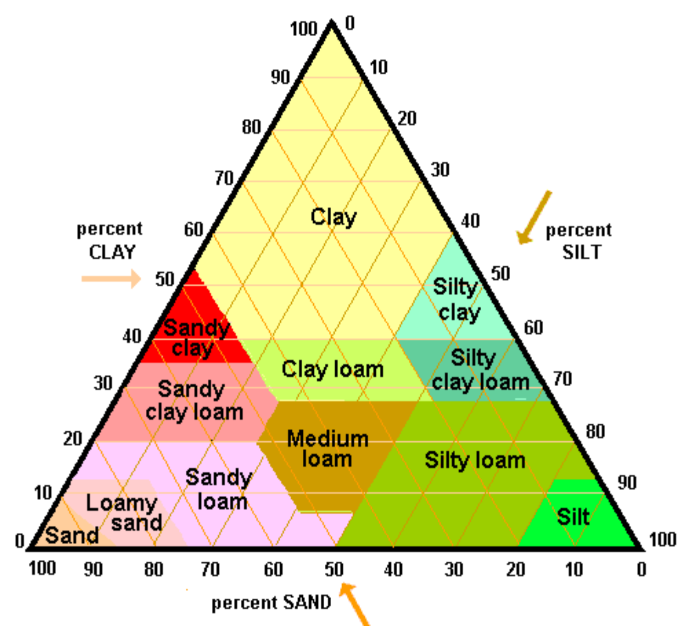


Figure 32: Soil Texture Triangle. (Idaho Association of Soil Conservation Districts, 2010)

Structure

Structure refers to individual soil particles — sand, silt or clay — grouped to form various kinds of aggregates which comprise the soil structure and determine permeability. The ideal soil structure for grassland and rangeland ecosystems are soils that are small and soft, such as granular and blocky aggregates (See Figure 33), the permeability for these structures are well to moderately drained. They also allow water and roots to navigate easily through the soil. Deep root systems in tallgrass prairies break down the soil column, continually rotating the soil and adding large amounts of organic matter. This creates deep, nitrogen rich soils. Prairies are commonly found in sandy soils, sand is unable to bond together unless there is organic matter. In cultivated soils, such as agricultural lands, crops are continually being removed, this causes little return of organic material to the soil.

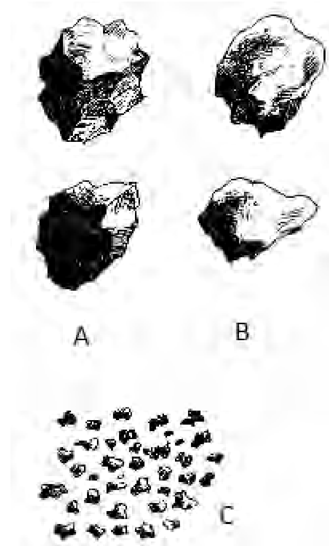


Figure 33: Soil structures associated with rangelands: a. angular blocky b. subangular blocky c. granular (Idaho Association of Soil and Conservation Districts, 2010).

Soils include biotic components called microorganisms. These soil organisms consume organic matter and nutrients, by doing so they release energy for plants to consume. Each organism has a role in the decomposition of plant residue, dead roots, and animal remains (See Table 1).

Table 1: The roles of soil biota.

CLASSIFICATION	SPECIES	ROLE
Large	millipedes, earthworms	shred dead litter and residue to mix it within the soil
Predatory	centipedes, spiders, mites, some ants and beetles	control the population of soil biota
Small	mites, springtails, nematodes, one-celled protozoa	Graze bacteria and fungi. Feed on dead roots, shredded residue, and fecal by-products of larger organisms.

Classification	Species	Role
Smallest	microscopic bacteria, fungi	Finish the process of decomposition by breaking down the remaining material and storing its energy and nutrients in their cells.

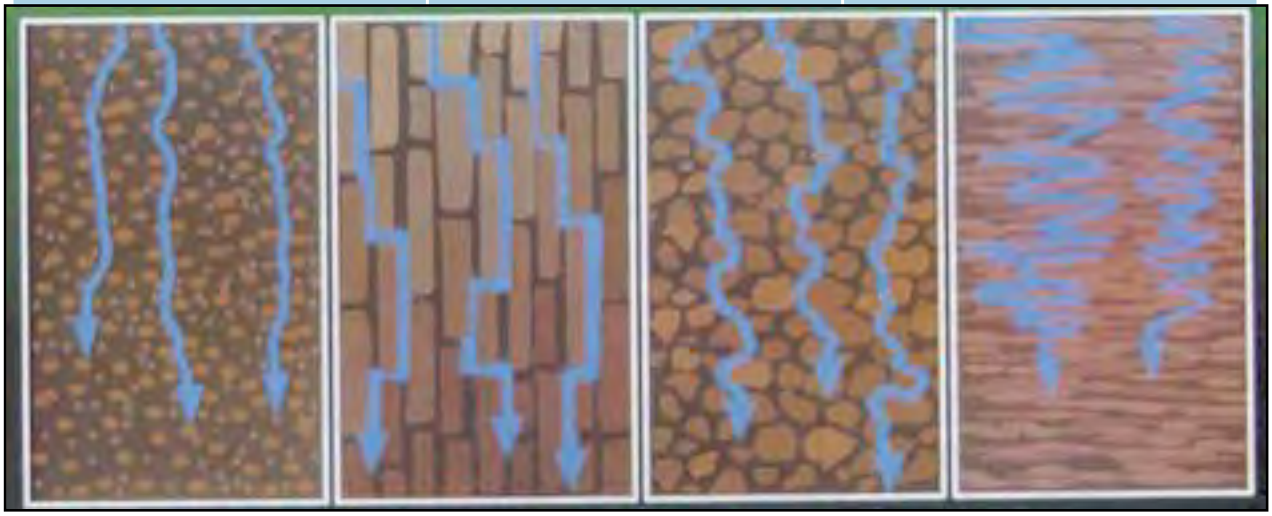


Figure 34: Illustrating the affects of structure on drainage, such as permeability. (Idaho Association of Soil Conservation Districts, 2010)

Drainage

Drainage has a huge affect on rangeland ecosystem types. Drainage depends upon topography and permeability (See Figure 34). Drainage is the measure of how well water can pass through the soil, and the length of time a soil remains saturated. For example, fine textured soils, especially without plant cover, tend to reduce water infiltration. Coarse-textured soils may have high infiltration rates but remain dry at deeper depths than do the fine-textured soils. This is because fine textured soils hold moisture more effectively than course textured soils. Classes for drainage include rapid, moderate and slow. Inadequate drainage most often occurs in areas of level or depressional topography but may also occur on undulating land where semi-permeable materials exist (See Table 2). Often there is little evidence on the surface soil of poor drainage beneath. Therefore, an examination of the soil profile, such as digging a soil pit, is important.

Figure 35: Mottles in soil. (Critical Zone Exploration Network, 2006)

Drainage conditions are indicated fairly reliably by soil colors. Bright, solid colors of brown or yellow suggest fairly good drainage; but in low ground, gray and mottled horizons indicate poor drainage (See Figure 35).

Soil moisture is the water contained in soil. Soil moisture regime is determined by the physical properties and arrangements of soil particles, also known as structure. It can be classified as dry (moderate dry to moderate fresh), fresh (very fresh to moderate moist) and moist (very moist).

Table 2: Connections between drainage and ecosystem type

Drainage	Class	Time Frame	Ecosystem Type	Soil Classification
Very poorly drained	Slow	Soil saturated 11 months of the year	Coastal marshes	Gleysols
Poorly drained	Slow	Soil saturated 9 months of the year	Wet meadows	Gleysols
Imperfectly drained	Moderate	Soil saturated 8 months of the year	Alvars	Brunisols
Well drained	Rapid	Soil saturated 6 months of the year	Tallgrass prairie and savannas	Podzols

Soil structure, texture and drainage have direct impact on the plant composition of rangelands (See Table 3). For example, it is one of the main factors in determining whether an area will be a tallgrass prairie or savanna. Prairies can grow on a range of soils, but are mostly associated with sandy to sandy loam with rapid drainage and moist to fresh moisture regime. Savannas tend to occur on sandy soils, with rapid drainage and moist to fresh moisture regime. Savanna vegetation tends to be less dense on the drier sand soils providing open ground for acorns and tree seeds to germinate. On heavier wetter soils, grasses form dense mats, limiting the amount of open soil available for tree seeds to germinate.

Alvars occur on flat limestone or dolostone bedrock where soils are thin or absent; plants which survive in these conditions are adapted to shallow soils and the harsh conditions that alvars offer (See Figure 36). Alvars are frequently flooded due to their very poor drainage, this causes extreme conditions of flooding and drought. Due to the lack of organic soil, moisture is lost easily during warmer seasons.

Figure 36: Black Bay Alvar, Manitoulin Island, Ontario (Black Bay, 2010).

Coastal marsh soils contain mineral and organic components; the amount is dependent on location and the age of the marsh, as well as conditions in the prevailing area. Mineral components of the soil consist of silt and clay particles. They reflect the type of material eroded from the upland watershed and deposited by rivers or washed from the floor of the sea, and deposited by waves and tides.

Table 3: Soil Orders Associated with Rangelands

Order	Photo	Features	Ecosystem
Brunisolic	 (Agriculture and Agri-Food Canada, 2011)	• imperfectly drained and well-drained sites • over course to medium glacial till or outwash • rolling terrain • sandy soil that is moist but well-drained • strongly acidic	• forest • savanna • woodland • shrubland • grassland • tundra
Gleysolic	 (Agriculture and Agri-Food Canada, 2011)	• dominant feature of the Claybelt • poorly drained areas or saturated • contains gleyed and mottled layers • lowland areas	• wet meadow • coastal wetland
Luvisolic	 (Agriculture and Agri-Food Canada, 2011)	• mixed in with most other soils • well to imperfectly drained • dominant in the lacustrine deposits	• all ecosystems
Podzolic	 (Agriculture and Agri-Food Canada, 2011)	• develop in shallow layers in the Shield environment • well-drained sites • contains mostly organic matter • coarse textured, stony, glacial tills and outwash, and on glaciofluvial sand lying on acidic parent material	• forest • woodland • shrubland • savanna • grassland • alvar

4.3 Rangeland Soil Chemistry

The Nutrient Cycle

Like energy, nutrients cannot be created or destroyed, they are basic elements and can only be moved or transformed into inaccessible forms. Nutrients are cycled or moved slowly from one point to another through various processes, creating a global nutrient cycle. Nutrient content at a particular site can be altered by geological processes such as volcanic, glacial, or erosion action or through industrial processes such as the mining of nutrients or industrial fixation of nitrogen. In Canada, the relatively recent glaciation has had an important impact on soils. Soils in Canada are young compared to those in other areas of the world. Therefore, they are less weathered and are richer in essential nutrients.

Nutrients are held by the mineral or organic elements in the soil. Water is the necessary transporting agent in this system. The ease of this removal of nutrients from their chemical bonds with the soil particles depends strongly on soil pH. As a soil becomes either more acidic or more basic nutrients get held up, or other reactions are favoured and the nutrients become inaccessible.

The major plant nutrients are carbon (C), oxygen (O), hydrogen (H), nitrogen (N), phosphorous (P), and potassium (K). Carbon, oxygen, and hydrogen are available through the atmosphere. The availability of the other three nutrients can also strongly influence the growth rates of the plants. If the soil cannot provide an adequate supply of nitrogen, phosphorous and potassium, to sustain the plant communities, the vegetation will change. Prairie plants tend to thrive in nutrient poor soils because they have the ability to fix nitrogen.

Nitrogen is needed in plant development because it is essential in the production of proteins, nucleic acids, and chlorophyll for photosynthesis. The cycling of nitrogen in soil is easily understood by looking at the nitrogen cycle (See Figure 37). It is important to understand that all

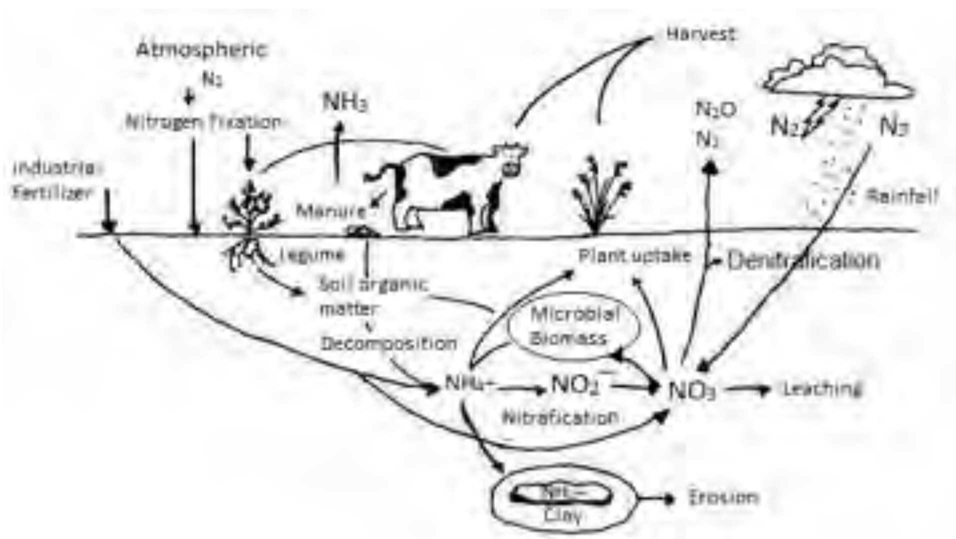


Figure 37: The nitrogen cycle. (Long Point Biosphere, 2010)

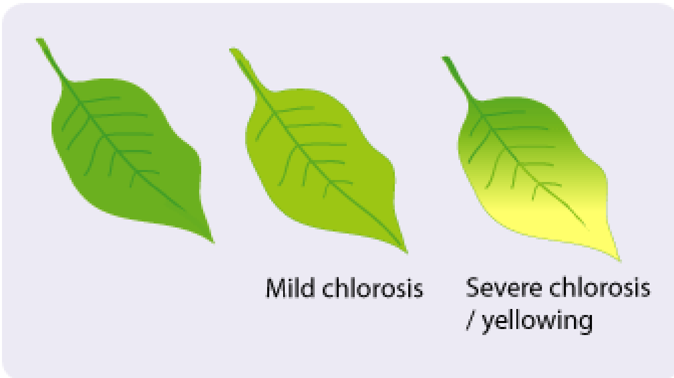


Figure 38: Photo illustrating chlorosis. (Ole Segaard Lund, 2010)

nitrogen, regardless of where it comes from, will move through the cycle using the same processes. About 95% of the nitrogen in soil is a component of organic matter or plant litter, and is unavailable for plant uptake (Ole Segaard Lund, n.d.). Only NH4+ (ammonium) and NO3- (nitrate) are taken up by plants. Plants that are deficient in nitrogen are easily identifiable as the plants that undergo ‘chlorosis', and turn yellow (See Figure 38).

Losses of nitrogen from the cycle occur only:

1) when there is an export of plant or animal products out of the system, eg. harvested
2) when gaseous forms of nitrogen are released into the atmosphere and the cycling time increases
3) from the export of soil in the form of erosion of clay and organic matter where exchangeable ammonium ions exist
4) from the leaching of nitrate into the groundwater, which then leaves the system

Phosphorous is essential to plant development because it creates the compounds that store the energy needed by the plants (ATP and ADP). It is also used with nitrogen in the formation of the nucleic acids. The phosphorous content of soil depends on the parent material and the extent of weathering of the soil.

Like all nutrients, there is no natural way to increase the phosphorous in a system, the only way is to artificially increase levels by adding a fertilizer. When importing organic fertilizer to increase phosphorous levels, the phosphorous cycle (See Figure 39) is simply moved from another part of the world, shifting the global nutrient balance. Virtually all of the phosphorous used as fertilizer in Canada is imported from either the United States or North Africa, making those systems deficient.. Phosphorous cannot be

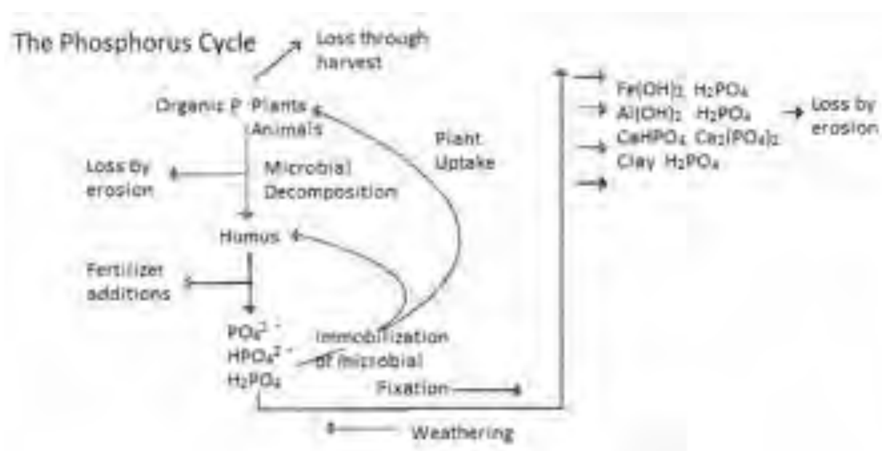


Figure 39: The phosphorus cycle. (Long Point Biosphere, 2010)

lost from the soil, except by human removal. Although, phosphorous deficiencies can still occur naturally because phosphorous can take form in a less soluble compound and become inaccessible to plants. These less soluble forms may be transformed as more of the soluble forms are taken up by plants. When a plant is deficient in phosphorous, the leaves start to turn a deep purple.

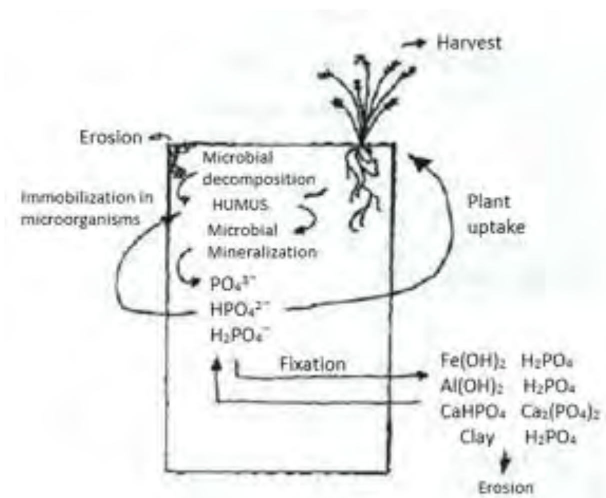


Figure 40: The potassium cycle. (Long Point Biosphere, 2010)

Potassium is essential to plant development as it regulates the opening and closing of the stomata, the structures within the plant which release the oxygen by-products of photosynthesis. Also, when combined with nitrogen, potassium is a key in the creation of some proteins. The potassium content of the soil is a direct reflection of the mineral composition of the bedrock underneath the soil. Losses are due to the harvesting of plant material and the erosion of soil from a site. If there is a deficiency, it can only be amended by the addition of fertilizer. Deficiencies in potassium are not as easily detectable as the other two major nutrients (See Figure 40).

Erosion and Weathering in Rangelands

<u>Erosion:</u> the wearing away of land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep (See Figure 41).

<u>Weathering:</u> the physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Figure 41: Photo illustrates the effects of erosion in rangeland ecosystems. (Pearson Education, 2010)

Figure 42: Soil crust is caused by continuous tread on an area which compacts the soil. (ManagingWholes.com, 2010)

Soil degradation affects not only soil attributes but can also degrade other ecological processes and often cause an irreversible loss of rangeland health. Soil degradation is accelerated through erosion by wind and water. Loss of organic matter in the soil reduces nutrient stores and interrupts nutrient cycles. Accelerated soil erosion reduces the total organic matter and total nitrogen content and the capacity of rangeland soils to hold moisture. The formation of soil crusts and the development of erosion pavement (a hard, impermeable soil surface caused by erosion) can impede germination and the growth of seedlings (See Figure 42). Reduced water infiltration and water storage can reduce total vegetative biomass production and can result in shifts in species composition, such as the introduction of non-native invasive species. In addition, soil degradation damages watersheds, which leads to further degradation of rangeland ecosystems and water pollution.

Coastal marshes benefit from the erosion of upland ecosystems. Sediments are deposited in shallow coastal waters, this sediment is derived from several sources and forms the soil or substrate on which marsh plants initially become established to grow (See Figure 43). Sediment carried by rivers forms the substrate of many marshes and is deposited when velocities of currents decline to the point that silt and clay particles can no longer be held in suspension.

Figure 43: Coastal Marsh showing the river bringing in sediments which creates land forms through vegetation establishment (Ducks Unlimited, 2005)

4.4 Soil Disturbances and Human Activity within Rangelands

All living organisms that interact with rangeland ecosystems have an effect on the development of ecosystem soils. Plants, through the process of photosynthesis capture energy from the sun and make it available for other organisms in the soil. These organisms decompose litter and organic matter. Plant roots hold the soil in place which prevents erosion, they also filter water and uptake nutrients. Large organisms such as cattle graze and remove vegetation, giving them the nutrients they need. Overgrazing of vegetation impacts the roots which creates weathering. Soil compaction is a negative side affect of overgrazing; it prevents root growth, hinders germination of seeds and decreases water infiltration, in the end affecting soil and the microbial community.

Rangeland soils are frequently impacted by anthropogenic activity, making it a suitable indicator of overall soil quality (Card and Quideau 2010). Humans disturb soil by altering its natural cycles through agriculture and poor management practices. For example, much of Ontario's wet meadow sites have been converted to agriculture through the creation of drainage canals and the tiling of agricultural fields (See Figure 44).


Figure 44: Photo of tile drainage on an agricultural field (Royer, 2010)

Soil degradation affects not only soil attributes but can also degrade other ecological processes. Loss of organic matter in the soil reduces nutrient stores and interrupts nutrient cycles. Grazing integrates both the physical and chemical aspects of the soil environment.

There are also several communities that have gardens where you can get your hands dirty and grow some of your own food. Here are a few to get you started:

Ontario Soil and Crop Improvement Association: http://www.ontariosoilcrop.org/en/programs/programs.htm
Toronto Community Garden Network: http://www.tcgn.ca/wiki/wiki.php?n=TorontoGardens.FrontPage
Toronto Botanical Garden: http://torontobotanicalgarden.ca/
Community Garden Network of Ottawa: http://www.justfood.ca/community-gardening network/
Community Gardens: City of Kingston, ON:http://www.cityofkingston.ca/residents/recreation/community-gardens/
Durham Organic Gardeners: Bowanville, ON: http://durhamorganicgardeners.com/?p=191
Hamilton Community Garden Network: http://hcgn.ca/garden-directory/
London Community Resource Centre: http://www.lcrc.on.ca/garden_locations.html

4.5 Soils Case Study: Litter and Defoliation Impacts on Soil

SOILS CASE STUDY

Envirothon 2013

Soil moisture and plant growth responses to litter and defoliation impacts in Parkland grasslands

Most water available to plants is held in pores, these pores range in size between 0.02mm and 0.005mm. (Agricultural Bureau of South Australia, n.d.)

Soil moisture is a limiting factor for plant growth and production in cool-temperature grasslands, particularly under recent increases of drought and predictions of future climate change. A study conducted by the University of Alberta and Agriculture and AgriFood Canada researched soil moisture and plant growth responses of native and domesticated grassland species in lowland sites within the Aspen Parkland ecoregion, Alberta during 2007 and 2008. These tests included:

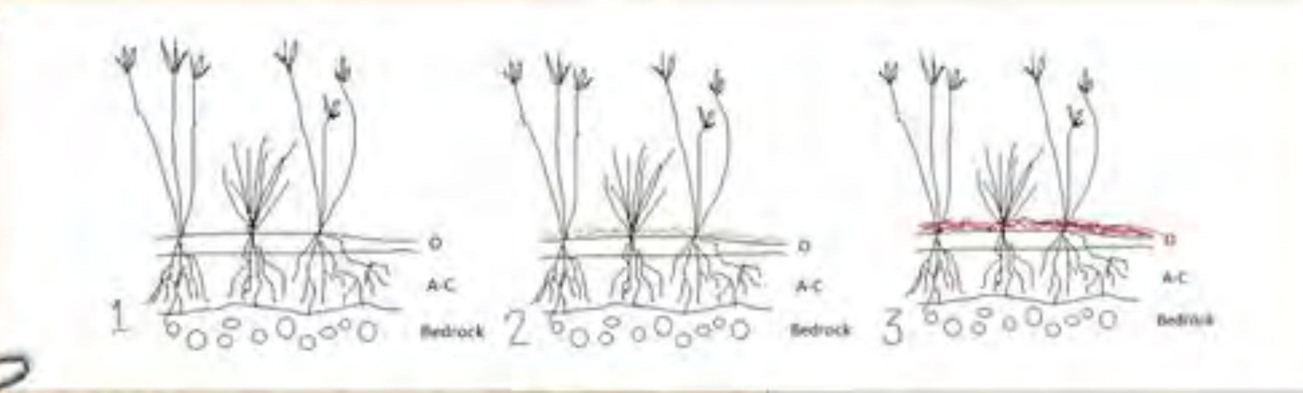
1. testing how litter and defoliation (as a substitute for grazing disturbance) alter micro-environment at the soil surface
2. whether litter, in combination with defoliation, alters forage production
3. whether production changes can be linked to observed micro-environmental changes created by litter modification.

Naturalized native grassland, Alderville (North American Native Plant Society, 2011)

Tamed grassland (US Fish & Wildlife Service, 2011)

Tamed grassland. (QGC, 2008)

Sands allow for well to moderately drained soils, this is beneficial for plant roots because they are able to penetrate the soil to take up water and nutrients without becoming overly saturated. On the other hand, soils with high clay content hold water so strongly that about half of the water cannot be extracted by plants. (Agricultural Bureau of South Australia, n.d.)



Illustrating September litter treatments (Holmes, 2012)

This study reassures the importance of shade and litter presences on soil to ensure moisture conservation and stabilized temperature in the soil. The in situ litter mass at the native site appeared to produce optimal conditions for leaf re-growth following defoliation in mid-June, through reducing evaporation and maintain adequate soil moisture during the drier months. It also suggests that litter has a key influence in the reduction of evaporation after a rainfall by maintaining moisture in the organic matter. Litter had more of an effect on soil moisture at the domesticated site than at the native site, with higher moisture in litter removal plots, likely related to lower interception rates. The study showed that too much litter can affect the penetration of light, but improves the moisture content in the soil. Whereas too little litter leaves the soil dry but maintains a steady flow of light to young plants.

The litter layer demonstrated a positive relationship with plant production, influencing re-growth of defoliated vegetation through the retention of soil moisture and optimal penetration of light. Therefore, litter is likely to increase yearly production stability in a moisture-deficit environment such as grasslands.

When rainfall or irrigation soaks into the soil, a certain amount is temporarily retained in the soil pores, and the remainder gradually percolates downward to the water table. The amount of moisture held in the upper soil depends on the amount of organic matter and the size, shape, and arrangement of mineral particles. In general, the more organic matter the soil contains, the more water it will be able to absorb. (Cornell University, 2012)

Illustrating September June defoliation treatments (Holmes, 2012)

4.6 Soils Activity: Soil Texture, Moisture, and Porosity

The purpose of this activity is to provide students with an opportunity to examine soil profiles including horizons, structure, porosity and moisture. They will also gain experience in observation and note taking. (See Appendix I for activity sheet)

Students will:

- Examine a soil profile and identify where horizons begin and end, as well as determine soil colours and hues.
- Conduct hands on field tests for soil texture for each horizon.
- Examine soil compaction and understand the indicators and affects.
- Understand structure of soils by observing landscapes over long periods of time.

Materials:

- Large shovel
- Trowel or hand shovel
- Three containers to hold soil samples
- Pencil
- Notebook
- One cup of water

Procedures:

1. Students will dig their own soil pit, producing a soil profile.
2. Identify horizons and conduct soil field tests for determining soil texture.
3. Examine soil structure and porosity through examining the affects of soil compaction.
4. Examine soil moisture and drainage by observing a landscape over seasons and during heavy rain fall.
5. Students will gain experience with writing observations and monitoring landscapes.

4.7 Questions for Discussion

1. What roles do plants and microorganisms play in the development of soil?

2. What factors make up soil composition, how do they determine the rangeland ecosystem type?

3. What Canadian Soil classes are associated with rangeland ecosystems in Ontario?

4. Explain the differences between erosion and weathering, give examples of what ecosystems benefit and some that do not benefit from weathering and erosion.

5. What effects do human activities have on rangeland ecosystems?

5.0 WILDLIFE

Undomesticated animals living in the wild.

Students will:
• Understand the species composition in rangeland ecosystems
• Understand the role of each species and trophic levels
• Understand the importance of wildlife in rangeland ecosystems
• Understand food webs and the cycle of energy through a system
• Understand the importance of natural disturbances to rangeland ecosystems
• Understand the affect invasive species have on an ecosystem
• Understand how species become at risk and identify rangeland species at risk

5.1 Introduction to Wildlife

Wildlife exists in all natural and non natural ecosystems and flourishes wherever suitable habitat occurs. Grasslands provide the perfect habitat for a diverse number of species all working together to create a functioning and healthy ecosystem. The wildlife that exists on Earth's ecosystems are vital to our survival. They provide natural beauty, but they also help to produce medicines, food, and industrial products. The intangible cultural value of wildlife can be seen through activities such as bird watching and wildlife tracking. These activities provide stress relief to an overly active lifestyle. Wildlife also offers the opportunity for hunting. Hunting is an excellent example of sustainable resource use that has proven to create conservation stakeholders, motivate conservation incentives, and create operating revenue for conservation budgets. Wildlife is economically, socially, and environmentally important to our ecosystems and without them, the productivity and function of ecosystems would severely decline.

As mentioned, there are many types of ecosystems that fall under the heading "rangelands". In each ecosystem there are trophic levels and each species falls under one of these categories. The categories are: primary producer (plant), primary consumer (herbivore), secondary consumer (omnivore), tertiary consumer (carnivore) and decomposers (fungi, bacteria). Within trophic levels species hold various roles that contribute to ecosystem function such as decomposers, scavengers, prey, and predators (See Table 4).

Three hundred trout are needed to support one man for a year. The trout, in turn, must consume 90,000 frogs, that must consume 27 million grasshoppers that live off 1000 tons of grass.
- G. Tyler Miller, Jr., American Chemist (1971)

Two rules about energy moving up through trophic levels:

1. Only a fraction of the energy available at one trophic level is transferred to the next trophic level. Usually around 10% but that number can vary (UMichigan, 2005).
2. Typically the species biomass decreases as your ascend the food chain.

mass of hawks < mass of snakes < mass of mice < mass of seeds

Table 4. Each species has a role and function to play in the ecosystem

Species Role	Examples of Species Types	Role in Ecosystem Function
Decomposers	• insects • worms • beetles	• break down organic matter to return nutrients to the soil •act as indicators of biodiversity and ecosystem health
Scavengers	• birds • rodents • reptiles • mammals	• feed on dead and decaying matter in the ecosystem • speed up decomposition
Prey	• songbirds • rodents • reptiles • amphibians • butterflies	• primary consumers, provide food for predators • maintains the habitat by removing excess plant material and insects
Predators	• mammals • birds of prey • reptiles • amphibians	• secondary consumers • keep prey populations in balance • occupy the top level in the food chain

5.2 Species at Risk on Rangelands

Ontario is home to a very diverse number of species, of these species 190 are at risk (MNR, 2010). Species can become at risk for a number of reasons: habitat loss, pollution, climate change, or the spread of invasive species. This has landed many rangeland and grassland species on Ontario's Species at Risk list. In order for data to be collected on species and displayed to the public someone has to be in charge. COSEWIC is The Committee on the Status of Endangered Wildlife in Canada and is responsible for determining the national status of wild Canadian species (See Table 5). All native mammals, birds, reptiles, amphibians, fish, arthropods, molluscs, vascular plants, mosses and lichens are included in COSEWIC's mandate (Cosewic, 2009).

Table 5: There are 6 categories for species at risk

Categories of Species at Risk (SAR)	
Special Concern (SC)	display characteristics that make it particularly sensitive to human activities or natural events
Threatened (T)	a species that is likely to become endangered if nothing is done to reverse that factors leading to its extirpation or extinction
Endangered (E)	a species facing imminent extirpation or extinction
Extirpated (XT)	a species that no longer exists in the wild in Canada, but occurs elsewhere
Extinct (X)	a species that no longer exists

Grasslands are home to the majority of Ontario's Species at Risk (See Figure 45). These species also inhabit other ecosystems where they perform important natural functions. The loss of prairie habitats and prairie species will have a domino effect on all other Ontario ecosystems. Due to birds' ability to fly, they make use of a large range of ecosystems where they forage for food and nesting materials. Grassland birds have seen a sharp decline with an annual decline of 2% -4% over the past decade (Reid, 2011). Open grassland habitats support the highest density of songbird species but recent studies in Ontario's most significant grassland community, the

Figure 45: Pair of Red Headed Woodpeckers at their nest. Status in Ontario: threatened. (Field Guide, 2002)

Table 6. Species diversity on the Carden Plain (Reid, 2011)

Year	Number of Species
2006	85
2007	74
2008	71
2009	69

Carden Plain, show that the overall species diversity seen during monitoring visits is declining (See Table 6).

It is important to conserve, protect and restore habitat for species at risk. Biodiversity in ecosystems is very important, by losing species the genetic availability becomes limited, and the integrity of the system declines. Each species has a role to perform, and each role is a thread within a web.

5.3 Wildlife Composition on Rangelands

Rangelands and grasslands tend to exhibit similar types of wildlife because most species are very adaptable and can live in a variety of ecosystems that have similar plant communities. There are, however some species that require specific habitat, which is where species composition differs between rangeland ecosystems. This section will discuss habitat, species composition by trophic levels, and provide an example of a species at risk in each ecosystem.

Tallgrass Prairie: The amount of disturbance that occurs is one reason why tallgrass prairies are home to a diverse wildlife and plant community.	
Producer:	Little Bluestem, Big Bluestem
Herbivore:	White-tailed deer
Omnivore:	Spotted salamander
Carnivore:	Cooper ’s hawk
Species at Risk:	Bobolink (Threatened)

(Stevens, 2012)

Shrubland: The low lying landscape of shrubland is beneficial to wildlife. Grasses and herbs are prominent in this landscape which provides a seasonal food supply for small mammals, reptiles, birds, and insects. Vegetation growth is determined by soil moisture and impacts the amount of forage available for herbivorous rodents, birds, and insects that feed off of plants, nuts, and berries.		
Producer:	Sedges	 (Istockphoto, 2010)
Herbivore:	Woodchuck	
Omnivore:	Black Bear	
Carnivore:	Coyote	
Species at Risk:	American Badger (Endangered)	

Savanna: Necessary habitat for bobwhite quail, wild turkey, white-tailed deer, ring necked pheasant, woodcock, various species of waterfowl, and hundreds of species of song birds, small mammals and insects. These ecosystems are important because they provide edge and transitional habitat that allows wildlife to prosper from aspects of prairie and forested habitat.		
Producer:	Black Oak, White-haired Panic Grass	 (Istockphoto, 2010)
Herbivore:	Insects	
Omnivore:	Eastern Chipmunk	
Carnivore:	Great Horned Owl	
Species at Risk:	Barn Owl (Endangered)	

Wet Meadow: Many bird and amphibian species feed on the abundant invertebrate life found in wet meadows. Swamp sparrows, yellowthroats, and blue winged teal nest among the sedges, while small amphibians use the fertile cover to hide from potential predators such as raptors. The abundant food and juicy sedges make these ecosystems perfect for large mammals such as black bears, moose and elk.

Producer:	Sedges, Baltic Rush
Herbivore:	Monarch Butterfly
Omnivore:	Sandhill Crane
Carnivore:	Northern Harrier
Species at Risk:	Yellow Rail (Special Concern)

(Bruce, 2010)

Coastal Marsh: The combination of upland and aquatic characteristics of the Great Lake coastal marshes provide a diverse habitat to support plants, fish, and wildlife. They are significant for wildlife migration patterns in spring and autumn for marsh birds and waterfowl.

Producer:	Cattail, Algae
Herbivore:	Beaver
Omnivore:	American Bittern
Carnivore:	Bald Eagle
Species at Risk:	Blanding's Turtle (Threatened)

(Bolton, 2011)

Grassland: The species of flora in grasslands can be very diverse which offers an abundance of digestible plant species for large mammals such the white-tailed deer. Due to the lack of cover on grasslands, many species have evolved to live underground. The sandy soil is easily dug up by species such as moles, voles, and earth worms which create elaborate tunnels.

Producer:	Prairie Chord Grass, Switchgrass	 (Antinsrkn, 2012)
Herbivore:	Cottontail Rabbit	
Omnivore:	Meadow Vole	
Carnivore:	Wolf	
Species at Risk:	Milksnake (Special Concern)	

Rangeland/Pastures: Cattle, goats, horses, and domesticated elk or bison all use pasture lands. These animals graze the different types of grasses that grow in pasture lands. Good pastures are built on sites with a good water supply, and free of pollutants and noxious weeds. The fact that wildlife also use these pasture lands has led to the development of best management practices that accommodate the habitat needs of wildlife and livestock.

Producer:	Cultivated and natural grasses	 (Moon, 2008)
Herbivore:	Domesticated species	
Omnivore:	Coyote	
Carnivore:	Weasel	
Species at Risk:	Gray Fox (Threatened)	

5.4 Human Impacts on Rangelands

At one time, Ontario enjoyed an abundance of native grasslands, however human activities have affected the diversity of living things in ecosystems. Grasslands are imperative habitat for a large variety of non game and game species. The availability of habitat is shrinking in Ontario, old fields and buffer zones are becoming impacted and isolated or replaced with monoculture cropping. Wild cultural rangelands are often mistaken and considered messy or dangerous places. Native vines, shrubs and wild flowers which are important wildlife food and cover are targeted for removal or chemically sprayed by people who are unaware of their useful role in the system. Ecosystems are dynamic and have the ability to recover from disturbance, but ultimately humans have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations (See Figure 46).

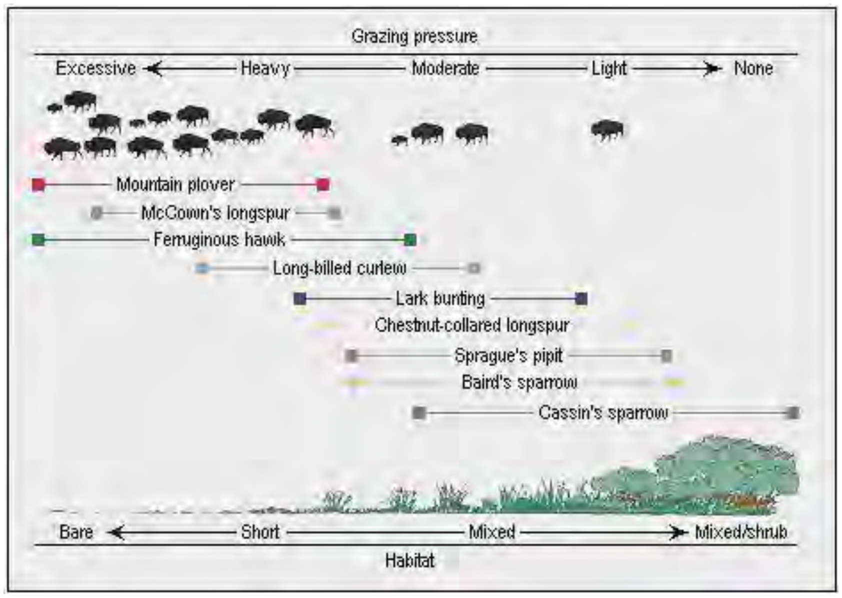


Figure 46: Grazing Pressure represents how the level of disturbance, in this case, grazing, impacts the availability for habitat for different species. Some species prefer a lot of disturbance, where as others need less disturbance in order to thrive in an area. (TutorVista, 2010)

The resulting loss of huge tracts of habitat has had a large impact on grassland composition and function. A number of grassland animals are currently mistaken as forest inhabitants, but in reality have been confined to forests by necessity rather than by choice. This occurred as existing local grasslands and grassland borders were destroyed or invaded by forests due to a lack of disturbance on the landscape. However, adaptable species will always find a way to thrive in any habitat available. For example, opportunistic common predators have taken advantage of the open spaces of scrubland that are now surrounded by human civilization. Power lines, buildings, and other human structures become favourite hunting perch spots for crows, ravens, and raptors such the Red-tailed hawk. Rodents, like the vole, survive by taking advantage of low lying vegetation in these areas. Specialist species have the most trouble surviving because many require very specific habitat needs that are increasingly becoming less common due to intensified human impact.

5.5 Alien or Invasive Species on Rangelands

Ecosystems are dynamic and have the ability to respond to change, within limits, while still maintaining their ecological balance. Invasive species come from other countries or regions and are called ‘exotic’ or ‘alien’. Not all exotic species are harmful to the environment, but ones that are known as ‘invasive species’ are. Almost all ecosystems have seen the introduction of invasive species and face the challenges imposed by them.

Two ways species come to dominate:
1. Greater access to limited resources by competition
2. Superior defense mechanisms against factors such as fire, flooding, and temperatures compared to other species

Understanding how invasive species come to dominate ecosystems requires determining the connection between the factors causing an abundance of the dominant species and those limiting the occurrence of the other species.

Fragmentation of grassland and rangeland ecosystems in Ontario has been extensive. They have been degraded due to agriculture, forestry, and urbanization. Agriculture and development cause an increase in disturbed edges. Disturbed areas promote the development and growth of pioneer species. Pioneer species thrive in disturbed areas, produce high quantities of offspring or seeds and grow very quickly. Most invasive species tend to hold these characteristics.

Figure 47: Brown-headed cowbird. (WildBirds, 2012)

One invasive species that has had a particular impact on grassland ecosystems is the brown-headed cowbird (See Figure 47). The brown-headed cowbird thrives due to the creation of fragmented habitat by humans. They are a very adaptable species and will live in woodlands, forest edges, grasslands, orchards, agricultural areas, pastures and suburbs.

The cowbird has been linked to the decline in songbird diversity in grassland ecosystems across North America. The brown-headed cowbird does not make a nest or tend to its young.

They are referred to as brood parasites, the female will lay a single egg in another birds nest and leave it for the host bird to incubate and raise. One female may lay eggs in up to 10-36 nests in one season and it has been documented that cowbirds use over 220 different bird species as hosts for their young. Common nest hosts for the cowbird are yellow warblers, song sparrows, red-eyed vireos, eastern towhees and spotted towhees (Mayntz, n.d.).

When hatched brown-headed cowbirds are generally stronger and larger than the other young. Therefore it out competes for food and often times the other young will starve or go underfed. This behavior affects the next generations' success as well as affects the biodiversity of grassland bird species.

Invasive species have had a huge effect on Ontario's grasslands and rangelands. Invasive species have made it difficult to restore disturbed areas, and have contributed to the loss in biodiversity of plant and animal life. Ontario is taking action against invasive species, some ways to help fight invasive species include: monitoring and research, prevention, management and control, policies and regulations.

5.6 Importance of Disturbance to Wildlife

Rangelands and grasslands depend on disturbance in order to maintain the integrity of the ecosystem. Disturbance comes in many forms, but the two most important types of disturbance are grazing and fire. Grazing and fire both have positive impacts on grassland ecosystems, including the wildlife that thrives there.

Figure 48: Cattle grazing on a management intensive grazing system in a pasture land. (Madga Farm, 2012)

Farming is an important disturbance in the landscape, and contributes to the success of grassland ecosystems. Many remaining fragments of grassland and rangeland ecosystems that exist in Ontario today are due to farming practices. Many farms have large pasturelands where livestock such as cattle, goat, bison, llama and horses graze. When grazing is managed correctly it allows for plant growth to be cut back and provides valuable habitat for a variety of species (See Figure 48). In Ontario, managed grazing provides great nesting habitat for ground nesting birds that return to Manitoba in the spring before the growth of new foliage. Most notably ducks take advantage of the leftover plant material during early spring migration. Grazing creates habitat for species by creating a landscape with varying vegetation height. The spatial pattern of grazing creates habitat dispersed across grassland ecosystems which allows for greater biodiversity in a system.

There are a number of threatened species, mostly birds, which heavily rely on farmed environments for habitat. One way this habitat is being created and maintained by farmers is through a new land management plan called Management Intensive Grazing (MIG).Management Intensive Grazing works to produce a lot of high quality forage vegetation that is capable of sustainably feeding a herd of livestock over time. MIG uses rotational grazing, which means only one section of pasture at a time is being grazed while the remainder of the pasture 'rests'. In order for this system to work properly, rotation time must be adjusted to the growth stages of plants. The environmental benefit gained from managing pastureland using MIG is improved riparian zone management and improvement of wildlife habitat. Since animal grazing is controlled, animals cannot overgraze and overuse land near water sources. This will benefit stream and water quality and will also see the return of fish and wildlife to the area. The economic benefit of MIG can be seen in the reduction of money spent on fertilizers, drainage, and reseeding. MIG effectively manages pastures with environmental and economic benefits. If these systems are not managed and are heavily grazed with poor farming practices the land can become very degraded. The quality of nearby water sources will decline and the compaction of soil will increase. When abiotic factors such as soil and water are heavily impacted by human activity, the biota in turn will suffer. The amount of wildlife surrounding the farm will also decrease as habitat disappears.

Figure 49: Ruffed Grouse in grassland habitat. (Brent, 2010)

Fire is another example of disturbance on rangeland and grassland ecosystems. The burning of grasslands affects wildlife directly and indirectly. Fire may burn bird nests initially but the long term benefit is positive. Fire rids the landscape of dead grass, sedges, and shrubs and allows succession to start over again, creating habitat, and food availability. Old shrubs and grasses are burned away and nutrients become available in excess from the ash and new shoots grow and are used by birds, furbearing mammals, and insects as a food source. An example of a species that benefits from fire disturbance is the Ruffed grouse (See Figure 49). They will inhabit a burn the year after the fire occurs and live on the burn for up to 12-14 years after the fire. This may be because key plants of the grouse's diet are fire induced plants, and they prefer nesting sites with little to no vegetation around. A fire also creates more edges which become very productive areas as a higher percentage of species prefer to live on edges rather than on interior landscapes. Ecosystems have co-evolved with the presence of fire and as a result fire actually benefits the ecosystem and all organisms that live there.

5.7 Wildlife Case Study: The Eastern Loggerhead Shrike

WILDLIFE

CASE STUDY

EASTERN LOGGERHEAD SHRIKE

ENVIROTHON 2013

The Eastern Loggerhead Shrike is an Ontario Species at Risk and at one time teetered on the edge of extinction. The species was once present throughout Manitoba, Ontario, Quebec and into the Maritimes and are now found only in isolated areas in Ontario. Each species plays an important role in the functioning of an ecosystem. Biodiversity is like a web, when one thread is removed the whole ecosystem is vulnerable to collapse because everything is intertwined. In 1997 only 18 pairs of Eastern Loggerhead Shrike remained in the Canadian wild.

The recovery team working to bring back the Loggerhead Shrike set up a captive breeding program. The original goal was to make sure the species survived, even if only in captivity. With luck the team hoped to breed enough birds to release some back into the wild. Today both goals have been achieved. In 2005 the team achieved the first return ever of a captive bred migratory songbird. Since that first encounter they have seen more and more captive bred shrikes returning, mating and bearing new young.

continued on page 2

(Moul, 2007)

Ways You Can Help:

- Maintain existing pastureland or expand it if possible
- Plant trees and shrubs at the edges of pastures and fields
- Leave some dead trees standing
- Avoid using pesticides on your land when possible
- Avoid approaching trees with nests in them
- Let cattle graze, this creates hunting grounds for the Loggerhead Shrike

FLYING

Their flight pattern is distinct, characterized by wing fluttering and then a glide. (Dudley, 2011)

NESTING

Females lay 5-7 eggs, once they hatch both parents share the feeding responsibilities. The young begin to fly 18 days after hatching. (Bersten et al, date unknown)

EATING

As an omnivore, these birds eat a wide range of food including: insects, amphibians, small reptiles, birds, and mammals. (Dudley, 2010)

The Eastern Loggerhead Shrike ID

(NatureServe, 2007)

According to Environment Canada, the captive breeding and release program has helped sustain Eastern Loggerhead Shrike populations in Ontario, and in particular the Carden Plains. In the 2010 season 23 breeding pairs were seen, which is 25 percent less than what was recorded in 2009. This is thought to be due to harsh winter conditions in the Southeastern United States where shrikes spend the winter. These number figures show how real the threat of extirpation for this species is. Population recovery is a numbers game. Although the shrike population is on the rise, there is still a long way to come.

Environmental stewardship and habitat restoration has been a huge success, with more than half the wild shrike population nesting on improved or restored land. These efforts have not only been beneficial to Loggerhead Shrikes. If you help to conserve shrike habitat you are also helping conserve habitat for bobolinks and meadowlarks and other species of concern.

The next step in the process is to start implementing the use of geolocators. Since 2009 ninety-two birds wearing geolocators have been released from the captive breeding site. This technology will provide vital information on migration routes and wintering grounds for the reasons behind shrike decline. Hopefully the 2013 season will see the return of more geolocator birds so the information can be retrieved from the devices. If some of these questions can be answered it will lead to a substantial positive impact in conserving the wild shrike populations of North America.

1. Black Beak
2. Grey Head Cap
3. Black Eyes
4. Black Eye Mask
5. White Cheeks & Chin
6. White Belly
7. Grey Back
8. Black & White Wings
9. Black Tail
10. Black Legs & Feet

SPECIES AT RISK

The Eastern Loggerhead Shrike is classified as Endangered.

This means that as a species it faces imminent extirpation or extinction if no action is taken to protect shrike habitat.

REFERENCES

Please see the 2013 Envirothon Study Guide for a complete list of references including photo citations.

Ontario Envirothon

Ontario Forestry Association

5.8 Wildlife Activity: Design a Food Web

The purpose of this activity is to provide students with an opportunity to examine the importance of the food web in ecosystems.

Students will:

- examine how food webs and food chains function in nature
- examine the importance of food webs in maintaining the balance of ecosystems

Materials:

- Handout: "Rangeland Species" See Appendix J

Procedures:

Hand out the worksheet, "Rangeland Species" and go over the different species

1. Students will use the knowledge gained from the Envirothon manual, as well as additional resources such as books and the internet to determine trophic levels and food webs in a savanna ecosystem.
2. Students will cut out the savanna animals on the worksheet.
3. Students will arrange the animals by trophic levels to determine where they should be placed in the food web.
4. Students will glue the animal pictures onto a piece of paper to create a food web.

5.9 Questions for Discussion

1. What are two ways an invasive species comes to dominate a system?
2. What are the two most important types of disturbance on grassland ecosystems?
3. Which species is considered a "brood parasite"?
4. What are the main reasons leading to species becoming at risk, and what are the 6 categories of species at risk?
5. Typically, how much energy is transferred from one trophic level to another?
6. Name two bird species that have adapted very well to urban landscapes.

Volunteer opportunities are a great way to get involved, meet people with similar interests, and make a difference! Listed below are some volunteer opportunities taking place in Ontario to help get you started.

Christmas Bird Survey:
http://www.bsc-eoc.org/

Things that Go 'Hoot' in the Night roadside Owl survey:
http://www.bsc-eoc.org/

Great Backyard bird Count:
http://www.bsc-eoc.org/

Great Lakes Marsh Monitoring Program:
http://www.bsc-eoc.org/

Adopt a Species at Risk:
http://wildernesscommittee.org

6.0 RANGELANDS IN ONTARIO

Visit one near you!

6.1 The Carden Plain

A significant rangeland in Ontario is The Carden Plain. It is located north-east of Lake Simcoe and includes diverse communities of alvar, grasslands, as well as wetlands and forested areas. Low human population density, the unique characteristics of alvar communities, and large un-fragmented areas allow the Carden Plain to support extraordinary species richness. South Western Ontario and the Carden Plain have been recognized by Bird International as an important bird area of national significance because of the amount of species at risk that can be found there.

The Carden Plain, Northumberland County:
http://www.cardenplainimportantbirdarea.com/

6.2 Alderville Black Oak Savanna

Alderville Black Oak Savanna is located in the Great Lakes Plains about 50 minutes south east of Peterborough. Depending on what tree is most abundant on the site dictates what kind of savanna it is. For example, Alderville has an Oak-Pine Savanna because they are the most abundant trees. One of the oldest Hawthorn savanna's in Ontario is part of the Clear Creek Forest Nature reserve in Chatham-Kent; it is the result of abandoned field in the 1950's. Many rangeland ecosystems re establish when agricultural land is abandoned.

Alderville Black Oak Savanna, Northumberland County:
http://www.aldervillesavanna.ca/index.html

6.3 St.Williams Conservation Reserve

The St. Williams Conservation Reserve is a 1035 hectare area of Crown land located in Norfolk County, Ontario within the Long Point World Biosphere Reserve. The Reserve is recognized regionally, provincially and nationally because it contains rare oak savanna and prairie communities that are important for preserving biological diversity and natural heritage.

Williams Conservation Reserve, Norfolk County:
http://swcr.ca/

6.4 The Ojibway Prairie Complex

The Ojibway Prairie Complex is located in Windsor, Ontario. It is one of the most significant remnants of tallgrass communities. There are five situated natural area: The Ojibway Park, Tallgrass Prairie Heritage Park Black Oak Heritage Park, Ontario Prairie Provincial Nature Reserve and Spring Garden Natural Area. These areas make up approximately 349 hectares (834 acres). The total area is continually growing as the City of Windsor and the Ministry of Natural Resources acquire more land for protection. Altogether, these sites are designated as the Ojibway Prairie Remnants Area of Natural and Scientific Interest (ANSI).

The Ojibway Prairie Complex, Windsor, Essex County:
http://www.ojibway.ca/complex.htm

6.5 Port Franks Wetland and Forested Dunes

The Port Franks Wetland and Forested Dunes is an Area of Natural and Scientific Interest. Due to it's the topography of the area, the complexes contain a variety of wetland communities amongst many forested dunes ecosystems. These include ecosystems such as wet meadow, oak savannas, oak swamps and pine oak woodlands. The area also contains a Karner Blue Butterfly sanctuary established in 1988.

Port Franks Wetland and Forested Dunes, Lambton County:
http://www.carolinian.org/CarolinianSites_PortFranks.htm

6.7 Stone Road Alvar Conservation Area

Stone Road Alvar Conservation Area is designated as a provincially significant Area of Natural and Scientific Interest and is located on Lake Erie, Pelee Island. The area contains approximately 178 hectares of natural land that is owned and operated by the Nature Conservancy of Canada, Ontario Nature and Essex Region Conservation Authority. This diverse area contains Oak-Hickory woodland, Oak savanna, Red Cedar savanna, old-field thicket, prairie, and open alvar communities. Over 50 provincially rare plant species have been recorded at Stone Road Alvar, making it one of the most botanically significant sites in Ontario. This mix of communities found Peele Island occurs nowhere else in Canada or in any of the adjacent U.S. states.

Stone Road Alvar Conservation Area, Essex County:
http://www.erca.org/conservation/area.stone_road_alvar.cfm

6.8 Bronte Creek Provincial Park

Bronte Creek Provincial Park is an Area of Natural and Scientific Interest since it is known to house a variety of rare flora such as the Dense Blazing Star. Prior to European settlement much of the landscape was predominantly oak, maple, hickory, and pine forests with pine and oak savannas in the Bronte Creek area. Various areas within Bronte Creek are being restored to these ecosystems.

Bronte Creek Provincial Park, Halton County:
http://www.ontarioparks.com/english/bron.html

6.8 Dundas Valley

Dundas valley is one of the largest wooded corridors along the southern portion of the Niagara Escarpment Biosphere. Restoration of native savannas and woodlands are being implemented to improve connectivity and prove rare habitat. These efforts are being reached by planting tallgrass prairie and oak savanna plant species.

Dundas Valley, Wentworth County:
http://www.conservationhamilton.ca/dundas-valley

6.9 Brant Prairie and Savanna

Brant County has remnants of prairie and savanna ecosystems, where homes are provided for rare and endangered plant and animal species such as the dwarf chinquapin oak and the cerulean warbler. The Brant Resource Stewardship Network's goal is to protect the area and promote connectivity with other ecosystems. Landowners participate in prescribed burns to control invasive species and to plant native species allowing for more connectedness. These efforts create habitat and natural travel corridors for rare and endangered species.

Brant Prairie and Savanna, Brant County:
http://www.ontariostewardship.org/councils/brant/index.php/current_projects

7.0 GLOSSARY

Acclimatize: respond physiologically or behaviorally to changes in a complex of environmental factors.

Accretion: the process of growth or increase, typically by the gradual accumulation of additional layers or matter.

ADP: adenosine diphosphate.

Aggregate: a group of soil particles cohering in such a way that they behave mechanically as a unit.

Ammonium: the cation NH_4^+, present in solutions of ammonia and in salts derived from ammonia.

Anthropogenic: occurring because of, or influenced by, human activity.

Arable: (of land) used or suitable for growing crops.

Aster: under the genus *Aster,* a plant having radiate flower heads with white, pink, or violet rays and a usually yellow disk.

ATP: Adenosine-5'-triphosphate.

Attenuation: reduce the force.

Aquifer: porous rock or sediment that holds water and is used to supply wells.

Bedrock: the solid rock that underlies soil and the regolith or that is exposed at the surface.

Biodiversity: the number and variety of organisms found within a specified geographic region.

Biota: living organisms.

Blanketing: using a black tarp to overheat and eliminate invasive species.

Carbon Sequestration: the prevention of greenhouse gas build-up in the earth's atmosphere by methods such as planting trees to absorb carbon dioxide

Canopy: the average crown height of the tallest trees in the forest

Coastal Marsh: usually found where a river drains into a larger body of water. Sediments eroded from the watershed are deposited at the river mouth creating an enriched bay. This provides for a diverse plant community and habitat for wildlife including fish, birds, and mammals.

Composition: all types of plant and animal species that make up an ecosystem.

Community: in ecology, the species that interact in a common area.

Compaction, soil: the process in which a stress is applied to a soil causing it to become dense as air is displacing from the pores between soil particles.

Condensation: water vapor cools and forms around small dust particles as small droplets. These droplets are attracted to each other and become clouds.

Crust: a surface layer of soil from a few millimeters to 2.5cm thick, that when dry is much more compact, hard, and brittle than the material under it.

Degradation: the changing of a soil to a more highly leached and weathered state, usually accompanied by morphological changes.

Deposit: material left in a new position by a natural transporting agent such as water, wind, ice or gravity or by the activity of man.

Desertification: the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture.

Drainage: also refers to the average wetness or dryness of a soil and may be a clue to soil permeability.

Ecosystem: the interacting populations of plants, animals, and microorganisms occupying an area, plus their physical environment.

Erosion: the process whereby materials of the Earth's crust are loosened, dissolved, or worn away and simultaneously moved from one place to another.

Evaporation: water changes from a liquid to a vapor and rises into the air. Sunshine, wind and warmer air can speed up the rate of evaporation.

Fauna: the wildlife that are found in an area.

Fertilizer: any organic or inorganic material of natural or synthetic origin that is added to the soil to supply certain elements essential to the growth of plants.

Floodplain: the area of land next to a river that is subject to flooding.

Flora: the plants that are found in an area.

Forb: an herbaceous flowering plant other than a grass.

Frilling: stripping bark on mature trees to provide a direct pathway for herbicides to penetrate.

Function: refers to an ecosystem conducting natural functions. This happens when every abiotic and biotic component are intact and working together to perform natural ecological functions.

Fungi: the allphytic plants that lack chlorophyll and are filamentous in structure: molds.

Girdling: killing a tree or shrub by removing the bark around the circumference.

Grassland: a biological community that contains very few trees or shrubs. It can be characterized by non-woody herbaceous cover, and is dominated by grasses or grass-like plants.

Ground layer: dominated by herbaceous plants such as grasses, ferns, wildflowers, and other ground cover.

Horizon: a layer of soil or soil material approximately parallel to the land surface; differs from adjacent genetically related latters in properties such as colour, structure, texture, consistence, and chemical and biological composition.

Infiltration rates: a soil characteristic determining or describing the maximum rate at which water can enter the soil under specified conditions, including the process of excess water.

Integrity: the ability of an ecosystem or species to bounce back after disturbance. Integrity is influenced by the relative health of an ecosystem. A healthy ecosystem has high integrity, a degraded ecosystem has low integrity.

Lacustrine: material deposited in lake water and later exposed either by lowering of water level or by uplifting of the land.

Landscape: all the natural features such as fields, hills, forests, and water that distinguish one part of the earth's surface from another part.

Leaching: the flushing or percolation of chemicals, minerals, or other substances through soil. Pesticides, fertilizers, and poisons from mines or feedlots, and wastes from industrial plants something leach into ground water.

Microorganisms: a form of life of microscopic size.

Monoculture: the cultivation of a single crop in a given area.

Mottled: soil marked with spots of blotches of different colour or shades of colour.

Morainic: an accumulation of earth, generally with stones carried and finally deposited by a glacier.

Nitrate: an ion consisting of nitrogen and oxygen (NO3-). Nitrate is a planet nutrient and is very mobile in soils.

Nitrogen fixation: the conversion of elemental nitrogen to organic combinations or to forms readily utilizable in biological processes.

Nutrient: element or compound essential for animal and plant growth. Common nutrients in fertilizer include nitrogen, phosphorus and potassium.

Organic matter: the organic fraction of the soil; includes plant and animal residues at various stages of decomposition.

Pastureland: land suitable for animal grazing. Used by domesticated animals, it can be a grassland or any other suitable type of rangeland determined by the species of livestock using it. Some pasturelands are modified to suit the needs of the livestock or prevent environmental degradation.

Parent material: the unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes.

Percolation: water soaks directly into the ground through openings into the soil.

Pioneer Species: the first species to establish in an area after a disturbance. These are usually fast-growing, shade-intolerant and short-lived species.

Permeability: the ease with which gases and liquids penetrate or pass through a bulk mass of soil or layer of soil.

pH: the logarithm of the reciprocal of the hydrogen ion concentration (activity) of a solution; a measure of the acidity (Ph less than 7) or alkalinity (pH greater than 7) of a solution; a pH of 7 is neutral. Scale ranges from 1-14.

Phosphorus: a nutrient essential for growth that can play a key role in stimulating aquatic growth in lakes and streams.

Photosynthesis: synthesis of chemical compounds by organisms with the aid of light. Carbon dioxide is used as raw material for photosynthesis and oxygen is a product.

Polyculture: using multiple crops in the same space, in imitation of the diversity of natural ecosystems, and avoiding large stands of single crops.

Potassium: mineral for the proper function of all cells, tissues and organs of living organisms.

Plant residue: refers to the microscopic parts of sticky bits left over from the decomposition of organic matter.

Precipitation: water droplets in clouds eventually become too heavy for the air to support and fall to the ground as rain, snow or sleet.

Profile: a vertical section of the soil through all its horizons and extending into the parent material.

Rangeland: land on which the plant community is comprised predominately of native or indigenous grasses, grass-like species (e.g. sedges), forbs and/or shrubs. Rangeland includes natural grasslands, savannas, shrublands, tundra, alpine communities, coastal marshes and wet meadows.

Ravine: a deep and narrow gorge that was carved by running water.

Raptors: large predator birds such as bald eagle, or red tailed hawk. They feed on small mammals such as voles, mice etc.

Runoff: Water travels downhill and enters into rivers and lakes.

Saturate: to fill all the voids between soil particles with a liquid.

Savanna: found adjacent to grasslands savannas are grasslands that are scattered with trees and brush. They are sometimes a prairie opening within largely forested area.

Sediment: particles, derived from rocks or biological materials that have been transported by a fluid or other natural process, suspended or settled in water.

Shrubland: a biological community characterized by vegetation dominated by shrubs but grasses and herbs are also present. This is an ecosystem that is regularly disturbed by fire.

Soil classification: the systematic arrangement of soils into categories on the basis of their characteristics.

Soil moisture: water contained in the soil.

Species richness: Simply a count of the different types of species present in a location

Structure: structure of the ecosystem, this is the physical structure such as plant communities and heights, density etc. Also refers to the combination or arrangement of primary soil particles into secondary particles, units or peds.

Sub-canopy: immature trees and small trees that are shorter than the main canopy level of the tree.

Succession: the natural process of change that occurs in an area over time as one community of living organisms replaces another one

Tallgrass prairie: dominated by perennial tall grasses, shrubs, and forb species. Tallgrass prairies are one of North Americas most diverse and productive types of ecosystem. These areas are prone to drought, fire, and over grazing but rebound quickly from disturbance if the system is in balance.

Texture: the relative proportion of the various soils separates in a soil as described by the classes of soil texture.

Topography: the physical features of a distinct or region, such as those represented on a map.

Transpiration: water vapor is released into the air by the leaves of plants. Plants transpire more on hot, sunny days.

Trophic levels: the feeding position in a food chain such as primary producers, herbivore, carnivore, etc. Green plants form the first trophic level, the producers. Herbivores form the second trophic level, while carnivores form the third and even the fourth trophic levels.

Tundra: a treeless area between the icecap and the tree line of Arctic regions. This type of rangeland has permanently frozen subsoil and supports low-growing vegetation such as lichens, mosses, and stunted shrubs.

Tussock: a small area of grass that is thicker or longer than the grass growing around it.

Undulating: move with a smooth wavelike motion.

Understory: woody vegetation that grows relatively close to the ground.

Weathering: the physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Wet Meadow: a meadow that is saturated with water throughout much of the year. Poor drainage or large amounts of water from rain or snow melt are the cause. They may also occur in riparian zones. Wet meadows do not have standing water present except during brief to moderate periods in the wet season.

APPENDIX

LIST OF APPENDICES

Can you have it all?

Objective

Students will:

- examine their values and beliefs related to rangeland and its uses and values
- examine the values and beliefs of others around them as they relate to rangeland uses and values

Materials

You will need:

- The worksheet "Can you have it all?"
- Red, green, and blue markers

Procedures

Hand out the worksheet, "Can You Have It All?" and go over the rangeland resources and uses and give an example of each.

1. Ask students to rank their personal preference for each rangeland use. A rank of 1 = lowest or least preferred use and rank of 10 = highest or most preferred use. Graph personal rankings on the Line Graph in RED.
2. Arrange students into small groups of three or four. For each use, total the ranks for the small group. Then, rank the totals from 1 to 10 with 1 being the lowest total and 10 for the highest total. Graph small group rankings on the line graph in BLUE.
3. Bring the students back together as a class. Based on the group rankings, sum the ranks for each use to create a whole class total for each use. Then, rank the whole class totals from 1 to 10 with 1 being the lowest and 10 for the highest. Graph whole class ranking on the line graph in GREEN.

Can You Have it All?

Name:____________________

Rangelands include grasslands, shrublands, tallgrass prairies, savanna, coastal marshes, and any other land not covered by dense forests, rock, or concrete. Ontario's rangelands are very diverse, and mean different things to different people. How do you value rangeland? How do the people you know value rangeland?

Rank of 1 = **lowest** or **least** preferred
Rank of 10 = **highest** or **most** preferred

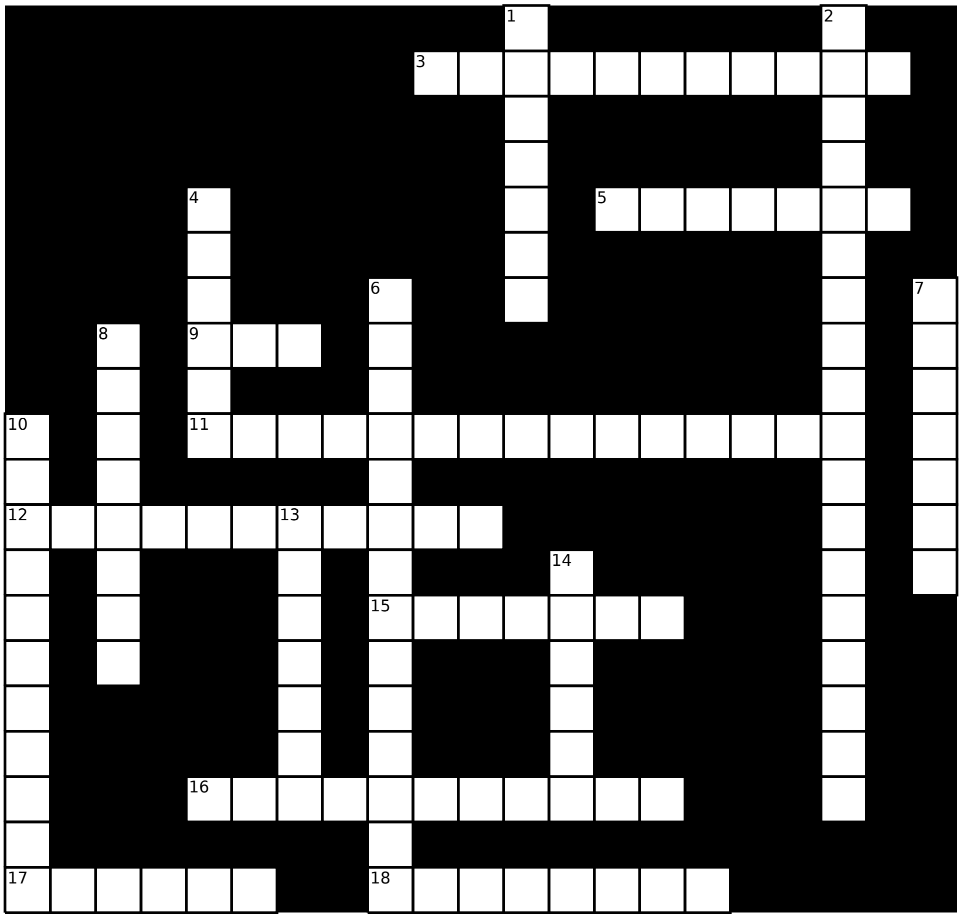
Land Use	Examples	Individual Ranking	Group Ranking	Class Ranking
Wildlife Habitat	Deer, Birds, etc.			
Livestock Grazing	Sheep, Cattle, etc.			
Native Plant Harvest	Collecting native seeds or herbs for medicine			
Hunting/ Fishing	Access and places to hunt and fish			
Non-motorized Recreation	Skiing, hiking, mountain biking			
Motorized Recreation	Snowmobile, 4-wheeler, dirt bikes			
Aesthetics	Natural, untouched beauty			
Rural Housing Development	Summer homes, ranchettes, lodges, cabins			
Agriculture	Farming, food production			
Urban Development	Golf courses, shopping malls, suburban homes			

Student Ranking Line Graph

10										
9										
8										
7										
6										
5										
4										
3										
2										
1										
0										
	Wildlife Habitat	Livestock Grazing	Native Plant Harvest	Hunting/ Fishing	Non-motorized Recreation	Motorized Recreation	Aesthetics	Rural Housing Develop-ment	Agriculture	Urban Develop-ment

Rangeland and Grassland Crossword

Envirothon 2013



Across

3 Rangelands are threatened because of urbanization and ___________

5 Grassland with 10-35% tree cover

9 These types of trees are most commonly associated with savannas

11 The different levels in a forest describes this (2wrds)

12 This type of ecosystem buffers the impact of waves

15 A type of fuel that can be created from switchgrass

16 Land suitable for animal grazing

17 Rangelands provide economic, environmental and ______ benefits

18 Major plant nutrients include carbon, oxygen, hydrogen, ________, phosphorous and potassium

Down

1 The wearing away of land from running water

2 This bird lays its eggs in other birds' nests

4 Water that travels downhill into rivers and lakes

6 A common management technique carried out in High Park, Toronto

7 Refers to the proportion of sand, silt and clay in soil

8 Known as exotic or alien species

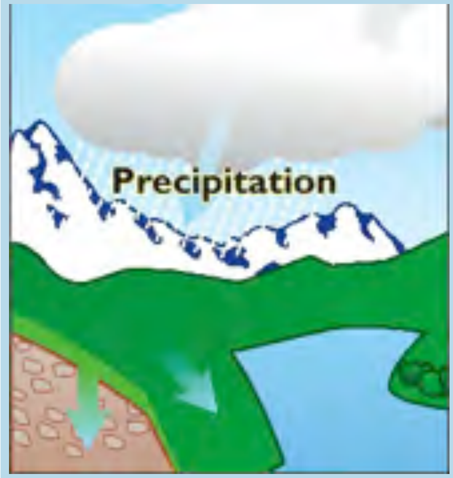
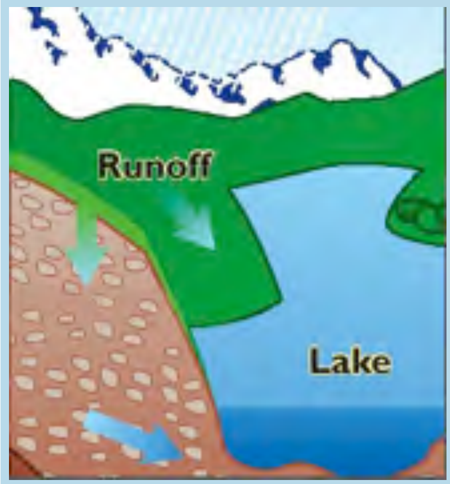
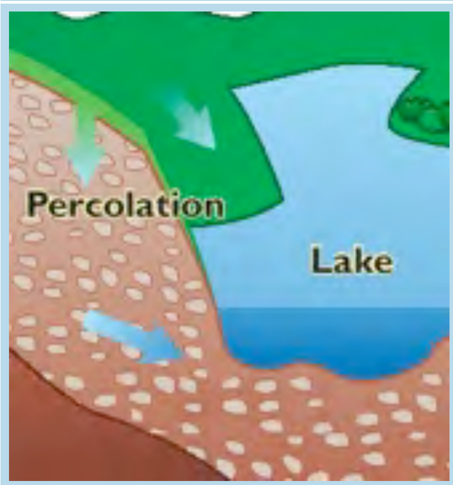
10 The role of these species in an ecosystem is to break down organic matter

13 Indicators of poor drainage

14 Treeless area in the Arctic regions

Use these cue cards to test your knowledge of the hydrologic cycle.

Evaporation	Water changes from a liquid to a vapor and rises into the air. Sunshine, wind and warmer air can speed up the rate of evaporation.	
Transpiration	Water vapor is released into the air by the leaves of plants. Plants transpire more on hot, sunny days.	
Condensation	Water vapor cools and forms around small dust particles as small droplets. These droplets are attracted to each other and become clouds.	

Precipitation	Water droplets in clouds eventually become too heavy for the air to support and fall to the ground as rain, snow or sleet.	
Runoff	Water travels downhill and enters into rivers and lakes.	
Percolation	Water soaks directly into the ground through openings into the soil.	

Water Purification

Objective

Students will:

- examine the value of water and why purification is necessary
- examine their processes of the hydrologic cycle

Materials

You will need:

• The worksheet "Water Purification"	• Food colouring
• Large clear bowl	• Small rock
• Plastic wrap	• Drinking glass
• Large rubber band or tape	• Salt
• Water	• Sun or heat lamp

(Archibald, 2012)

Procedures

Hand out the worksheet, "Water Purification" and go over the items being used in this experiment.

1. Fill the bowl halfway with water. Ask students to add food colouring and salt to the water. Make sure enough goes in to the water to make it look undrinkable (Figure 1).

Figure 1: Mix salt and food colouring into the water. (Archibald, 2012)

2. Ask a student to place the glass in the middle of the bowl. Make sure it is stable and will not tip over (Figure 2).

3. Ask a student to apply the plastic wrap to the top of the bowl and secure it with the rubber band or tape. It should be tight but with some give.

Figure 2: Place a glass into the water. (Archibald, 2012)

4. Ask a student to place a rock on top of the plastic wrap directly above the glass. The rock should cause the plastic to dip and hang over the glass for the water to drip into but not touch the glass (Figure 3).

5. Carefully set the bowl outside in the sun or under a heat lamp. The heat will turn the water into gas but not the food colouring or salt. When the H2O gas hits the cooler plastic, it will condense and turn back to water, dripping back into the glass. The salt and food colouring will be left behind in the bowl.

Figure 3: Place a rock on top of the plastic wrap over the glass. (Archibald, 2012)

6. Check the experiment every hour. Once the glass has enough water for the kids to see and taste, take the glass out and show the students.

Caution: Do not put the bowl too close to the heat lamp because the plastic may melt.

Water Purification

Name: ____________________

All living things depend on the unique physical and chemical properties of water for survival. Water never disappears, it simply moves to another location. The movement of water through plants, animals, soil, and the atmosphere is called the hydrologic cycle. This cycle involves several different processes which transport water through different mediums in order to keep ecosystems hydrated and healthy. This process also helps purify water providing us with freshwater for drinking, cooking, bathing, and several other uses. Sketch your observations of the experiment at the beginning and again at the end and answer the questions below:

Procedure	Sketch	Questions	Answers
Before		What types of toxins or chemicals might end up in our water sources? Why is water purification important?	
After		What processes of the hydrologic cycle did you witness in this experiment? Did you expect these results?	

Native Grasses

(Breault, n.d)

(Muma, n.d)

(Breault, n.d)

(NCAGR, n.d))

Big Bluestem

Andropogon gerardii

Description: one of the most dominant grasses in Ontario prairies; has long and slender leaves that are shades of red, brown and dark purple

Height: 2.5m

Flower/seed: flower clusters are arrangd in 2-3 short spikes

Benefits: excellent foraging plant for livestock

Interesting Fact: common name for this grass is "turkey foot" due to the apperance of the flower clusters

Little Bluestem

Schizachyrium scoparium

Description: one of the shorter prairie grasses; the young shoots are a blue-green colour; the mature plant has a mixture of tan, brown and red

Height: 0.7m

Flower/seed: feathery apperance

Benefits: Many butterfly larvea (such as crossline, dusted, Indian and Leonards skipper) feed on leaf blades

Interesting Fact: the scientific name reflects the apperance of the flowering head, derived from the latin word, *scoparius*, meaning broom

Indian Grass

Sorgastrum nutans

Description: common dominant plant in Ontario prairies; the leaves are up to 2' long ; they are dull green to dark green, flat, and hairless

Height: 2m

Flower/seed: seed head is golden/yellow in colour; plants tend to drop from the weight

Benefits: nutrious for livestock

Interesting Fact: The latin name *nutans,*meaning to nod, comes from the plants "nodding" tendenancies when the seed head becomes too heavy

Switch Grass

Panicum virgatum

Description: common species in tallgrass prairies; tan in colour; grows in big leafy clumps and on a range of soils

Height: up to 2.1m

Flower: purple with a diamond shape

Benefits: good foraging crop for cattle

Interesting Facts: the latin name *virgatum* means wandlike becuse in the winter switch grass stands straight up like a wand

Native Forbs/Shrubs

(Breault, n.d)

(Breault, n.d)

(Tallgrass Ontarion, n.d)

Round-head Bush-clover

Lespedeza capitata

Description: Hairy stem with long, narrow leaflets; grows in dry, sandy soils

Height: 0.6-1.5m

Flower/seed: creamy-white flowers with purple spot (bloom in summer or fall); flowers grow in clusters at top of stem

Benefits: has nitrogen-fixing bacteria on roots that convert nitrogen to usable forms

Interesting Fact: host plant for bees and butterflies

Butterfly Milkweed

Asclepias tuberosa

Description: small plant with narrow leaves

Height: 0.6m

Flower/seed: cluster of orange flowers; a few flowers produce heavy seed pods that contain seeds on silky white hairs

Benefits: provide habitat for many butterfly species, especially monarch butterflies

Intersting Fact: butterfly milkweed seeds can drift 7.5 to 30m fron original plant

New Jersey Tea

Ceanothus americanus

Description: one of the few shrubs that is common in Ontario tallgrass communities; has egg-shaped , finely toothed leaves

Height: 1.2m

Flower/seed: tiny five-petaled flowers grow in clusters at the end of the stalk (bloom in summer)

Benefits: host plant for the duskywing butterfly

Interesting Fact: as the name suggest, leaves can be dried and used to make tea

Native Forbs/Shrubs/Trees

(Breault, n.d)

(Woodliffe,n.d)

(Tallgrass Ontarion, n.d)

Showy Trick-trefoil

Desmodium canadense

Description: member of the pea family; leaves are clover like and divided into three leaflets

Height: 1.8m

Flower/seed: large (1cm) rose-purple flowers in dense arrangments

Benefits: food source for bees and pollinating insects

Interesting Fact: Seed pods become very sticky when mature and cling to things easily such as clothing

Slender or Cylindrical Blazing-star

Liatris cylindrcea

Description: long and narrow leaves grow along the stem

Height: 0.75m

Flower/seed: rose-purple, button-like flowers; very few flowering heads; each head contains 20-30 florets

Benefits: attracts adult butterflies; the corms (root-like structure) are food for many rodents

Interesting Fact: This feather-like look of the flowers is why the blazing star is commonly known as gayfeather

Black Oak

Quercus veluntina

Description: dominant tree of southern Ontario savannas; grows in full sunlight; bark is dark in colour and deeply furrowed; leaves are a shiny dark green with tiny hairs along the veins and have 5 to 7 lobes that are seperated by deep U shapes

Height: approximatly 20m

Seed: acorns are small (12-20mm long)

Benefit: important food source for small mammals

Intersting Fact: known to adapt well to open contidions with less branching and thicker sun leaves

Invasive Species

(Sandoval, 2008)

(MNR, 2011)

(Stephen, 2007)

Scot's Pine

Pinus sylvestris

Description: Coniferous tree species; needles are found in bundles of two and approximatley 5cm long; bark on lower stem is grey-brown; bark on upper stem is flakey and an organge-red colour

Height: 20m

Seed/Flower: Males cones are 0.8-1.2cm long and are yellow or pink; female cones are 3-6cm long and are green and then brown when matured

Control: Hand clip juveniles, cut down mature trees

Black Locust

Robinia pseudoacacia

Description: Deciduous tree species; small green oval-shaped leaflets grow on stalks 20 to 30 cm long; bark is dark brown and cracked

Height: 25m

Seed/Flower: Bunches of white flowers

Control: Cutting or herbicide application

Common Buckthorn

Rhamnus carhartica

Description: Shrub/small tree; leaves are egg shaped with rounded teeth on the edges

Height: 7.5m

Seed/Flower: flowers are green-yellowish and small; have green berries that become blackish in late summer

Control: herbicides are usually needed, burning, girdlnig and cutting have been used but have mixed results

Invasive Species

(Cranston and Ralph, 2002)

(Mathias, n.d)

(Northern Bushcraft, n.d)

Spotted Knapweed

Centaurea birbersteinii

Description: perennial forb; slender hairy stem; elongated taproot

Height: 1m

Seed/Flower: single thistle-like pinkish flowers; seeds are brownish in colour

Control: manual removal and herbicide application

Canada Thistle

Cirsium arvense

Description: perennial plant with prickly leaves, stems are sometimes prevelant

Height: 1m

Seed/Flower: Rose-purple, lavender and sometimes white flowers in clusters

Control: manual removal and herbicide application

Sweet Clover

Melilotus spp.

Description: biennial forage plant; leaves are 1/2 to 1" long and have three leaflets

Height: 1.5m

Seed/Flower: white or yellow flowers, at the end of each floret a seed pod will develop containing one or two seeds

Control: manual removal, cutting and bruning

Build a Plant Press

Plant presses have been used for hundreds of years to dry and preserve specimens for research. Pressed plants are known as herbarium specimens. They are important for a variety of reasons such as:

- allowing accurate identification
- providing biological material for taxonomists, ecologists and other researchers
- providing a permanent record of a species occurring at a particular time and place
- forming a basis of distribution, habit and habitat information
- documenting the introduction and spread of invasive weeds over time
- being reference points for the application of the scientific names

Objective

Students will:

- learn how to build a plant press and press plant
- understand the value that preserved plants serve in the scientific community

Materials

You will need:

- several old newspapers
- 2 pieces of plywood
- 2 straps with buckles that can be secured (can use "C" clamps or weights
- white glue
- corrugated cardboard
- cardstock paper
- plants or leaves collected from outside (if possible, rangeland plants should be collected)

Procedures

1. Collect plants or leaves from the area.
2. Find two pieces of pieces of plywood or boards.
3. Select one board to be the base.

4. Placing three layers of cardboard onto the base, then add three single sheets of folded newspaper on top of the cardboard.

5. Arrange the plants on the paper. Make sure that they do not touch each other.

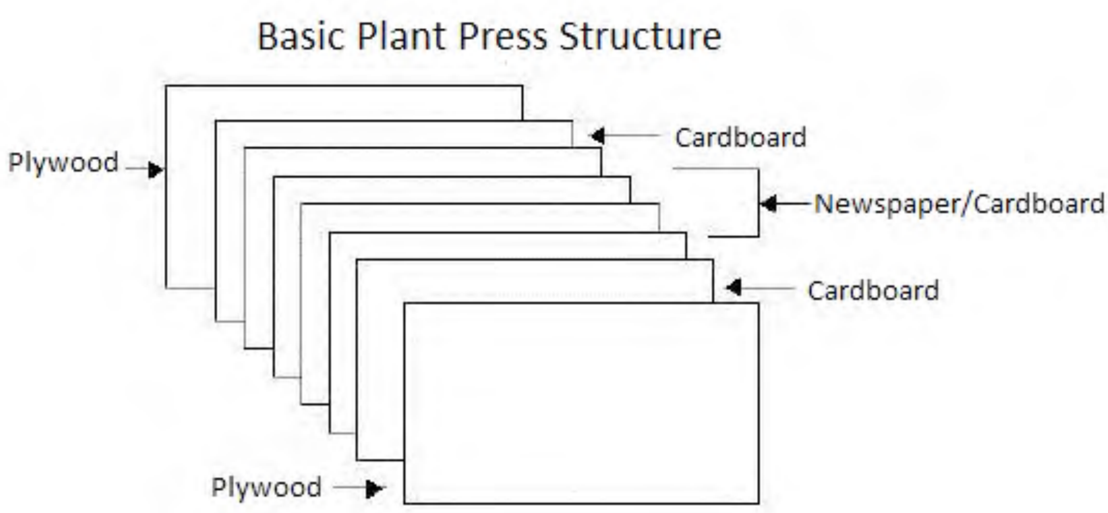
6. Place three more layers of newspaper on top of the plants.

7. Secure two straps around the width of the boards to hold it all together (c-clamps or weight will also do).

8. If the plants contain lots of moisture carefully replace the newspaper after 24 hours. Repeat if necessary; otherwise wait at least a week before removing the plants.

9. Once plants are pressed, mount the plant on cardstock paper.

10. In the right hand corner, include the following information for documentation:
    - Common name
    - Scientific name
    - Date collected
    - Collected by
    - Habitat type
    - Location



(Green-Adelsberger, n.d)

Soil Glossary

A: a mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension, or maximum situ accumulation or organic carbon, or both.

AB: a transition horizon from A to B

Ah: dark coloured mineral surface horizon, enriched with organic matter.

Ap: dark coloured mineral surface horizon with organic matter, man modified, or plough layer.

B: a mineral horizon characterized by one or more of the following:
1. An enrichment in silicate clay, iron, aluminum or humus.
2. A prismatic or columnar structure that exhibits pronounced coatings or staining associated with significant amounts of exchangeable sodium.
3. An alteration by hydrolysis, reduction, or oxidation give a change in colour or structure from the horizons above or below, or both.

BC: a transition horizon from B to C.

Bedrock: the solid rock that underlies soil and the regolith or that is exposed at the surface.

Brunisolic: An order of soils where horizons are developing under a wide variety of climatic and vegetation conditions.

C: a mineral horizon comparatively unaffected by the pedogenic processes operative in A and B. Relatively unweathered material from which the soil profile has developed.

Chernozemic: an order of soils that have developed under grass and fords, or under grassland-forest transition vegetation, in a cool or cold sub humid climates.

Control section: the vertical section upon which the taxonomic classification of soil is based.

Clay: a particle-size term: a size fraction less than 0.002 mm in equivalent diameter.

F: a horizon characterized by an accumulation of partly decomposed organic matter derived mainly from leaves, twigs and woody materials; some of the original structures are difficult to recognize.

Gleysol: a great group of soils in the Gleysolic order. A thin Ah horizon underlain by mottled gray or brownish gleyed material.

H: a horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible.

L: a horizon characterized by an accumulation of mainly leaves (and needles), twig s and woody materials in which the original structures are easily discernible.

LFH: organic horizons commonly found at the surface of mineral soils and developed mainly from leaves, needles and twigs (litter layer).

Loam: soil material that contains 7 to 27% clay, 28% to 50% silt, and less than 52% sand.

Loamy sand: Soil material that contains 85% to 90% sand and the percentage of silt plus 1.5 times the percentage of clay is not less than 15%.

Luvisolic: an order of soil which silicate clay is the main accumulation product. Developed under forest or forest-grassland transition zones in moderate to cool climate.

Podozlic: an order of soils which amorphous combinations of organic matter.

Sand: a soil particle between 0.05 and 2.0 mm in diameter.

Sandy clay loam: soil material that contains 20 to 35% clay, less than 28% silt and 45% or more sand.

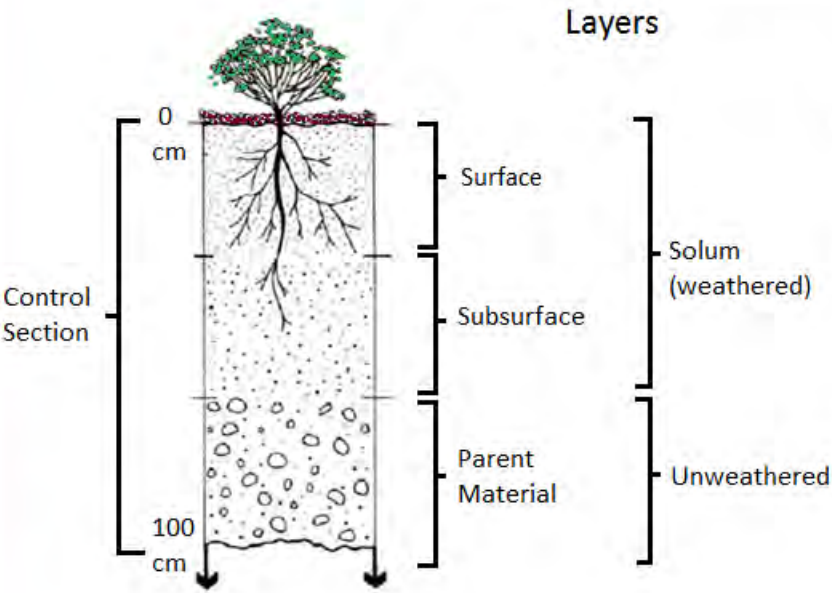
Sandy loam: soil material that contains either 20% or less clay with a percentage of silt plus twice the percentage of clay that exceeds 30% and 52% or more sand: or less than 7% clay, less than 50% silt and between 43% and 52% sand.

Sandy soils: containing large amounts of sand.

Silt: a soil separate consisting of particles between 0.05 and 0.002 mm in equivalent diameter.

Solum: the upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained.

Mineral Soil Profile Description



Horizons	Description
L, F, H	Organic layer
A	Where plants root ad where there is the most abundance of soil flora and fauna
B	Where leached minerals silicates and clay accumulate little, if any organic matter
C	Mostly parent material unaffected by the movements of water, minerals and soil particles

*Most plant root activity is in A and B layers. The depths of each layer varies. This profile is typical of mineral soils, as opposed to organic soil found in wetlands and flood plains.

Soil Texture, Moisture, and Porosity

Objective

Students will:

- Examine a soil profile and identify where horizons begin and end, as well as determine soil colours and hues.
- Conduct hands on field tests for soil texture for each horizon.
- Examine soil compaction and understand the indicators and affects.
- Understand structure of soils by observing landscapes over long periods of time.

Materials

You will need:

- Large shovel
- Trowel or hand shovel
- Three containers to hold soil samples
- Pencil
- Notebook
- Cup of water

Procedures

For the soils activity we will be focusing on the identification of soil horizons and texture of each horizon. We will also focus and conduct field tests on soil moisture, structure and porosity. For these activities students must dig a soil pit that is 30cm long by 30cm wide with a depth of 30cm. Horizons should be identified as O, A, B and C (if present) (See Figure 1). A sample of soil should be taken from horizons A, B and C (If present); students should test each sample and determine the texture. During the test, students should continuously make notes of their observations and results of tests.

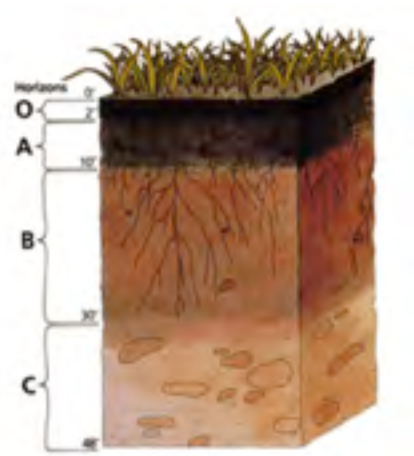


Figure 1: Soil Horizon illustrating O, A, B and C layers (USDA, 2012).

It is important to understand that soil profiles vary considerably from one region to the next, depending on geology, hydrology and climate. For example, sites with a history of construction or agricultural use such as mixing, tilling, filling or excavating may have significantly altered some horizons.

1. Soil texture

Soil texture is the relative proportion of sand, silt and clay particles that make up a given soil type in an area. These particles are graded according to their diameter, with sand particles being the coarsest and clay particles the finest. Soils are typically rated by their texture (Table 1).

A soil's texture directly influences its nutrient content, moisture and drainage capacity. Clay soils tend to be fertile, but are often wet and poorly drained. Sandy soils drain easily but can be drought-prone and infertile. Loams retain moisture and are fertile and friable (crumbly and easy-to-work). Loam soil contains about 40 per cent sand, 40 per cent silt and 20 per cent clay, along with plenty of humus. Many plants tolerate a variety of soil textures, while some have more specific soil requirements.

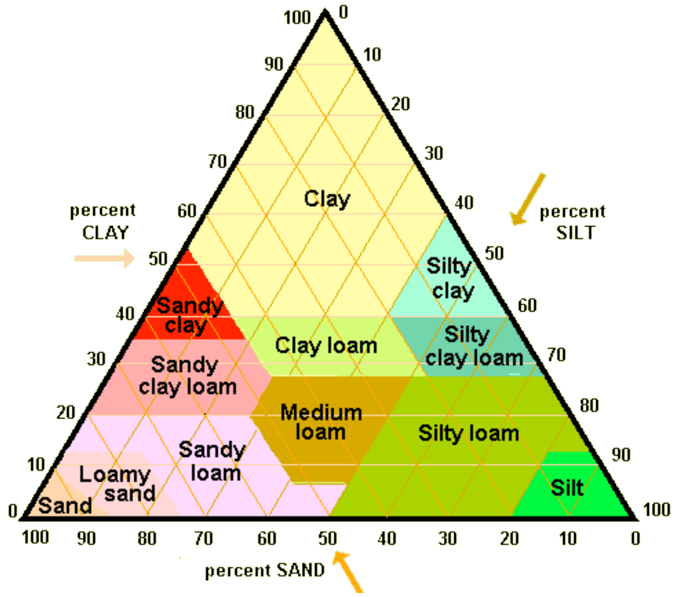


Figure 2: Soil Texture Triangle (Idaho Association of Soil Conservation District, 2010)

Field Tests: Soil Texture

These three simple tests can help you determine your soil's texture. See also Table 1 for soil test examples and the Soil Texture Triangle (See Figure 2). Examine the soil profile, indicate in your note book if there are any changes in colour or hues.

For the following tests, the soil specimen should be gradually moistened and thoroughly reshaped and kneaded to bring it to its maximum "plasticity" and to remove dry lumps. Do not add too much water, as the sample will lose its cohesion.

1. Feel test: Thoroughly dry and crush a small amount of the soil by rubbing it with the forefinger in the palm of your other hand. Then rub some of it between your thumb and fingers to measure the percentage of sand. The grainier it feels, the higher the sand content.

2. Moist cast test: Compress moist soil by squeezing it in your hand. When you open your hand, if the soil holds together (that is, forms a cast), pass it from hand to hand — the more durable the cast, the higher the percentage of clay (See Figure 3).

3. Ribbon test: Roll a handful of moist soil is into a tubular shape and squeeze it between your thumb and forefinger to form the longest and thinnest ribbon possible. Soil with high silt content will form flakes or peel instead of forming a ribbon. The longer and thinner the ribbon, the higher the percentage of clay (See Figure 3)

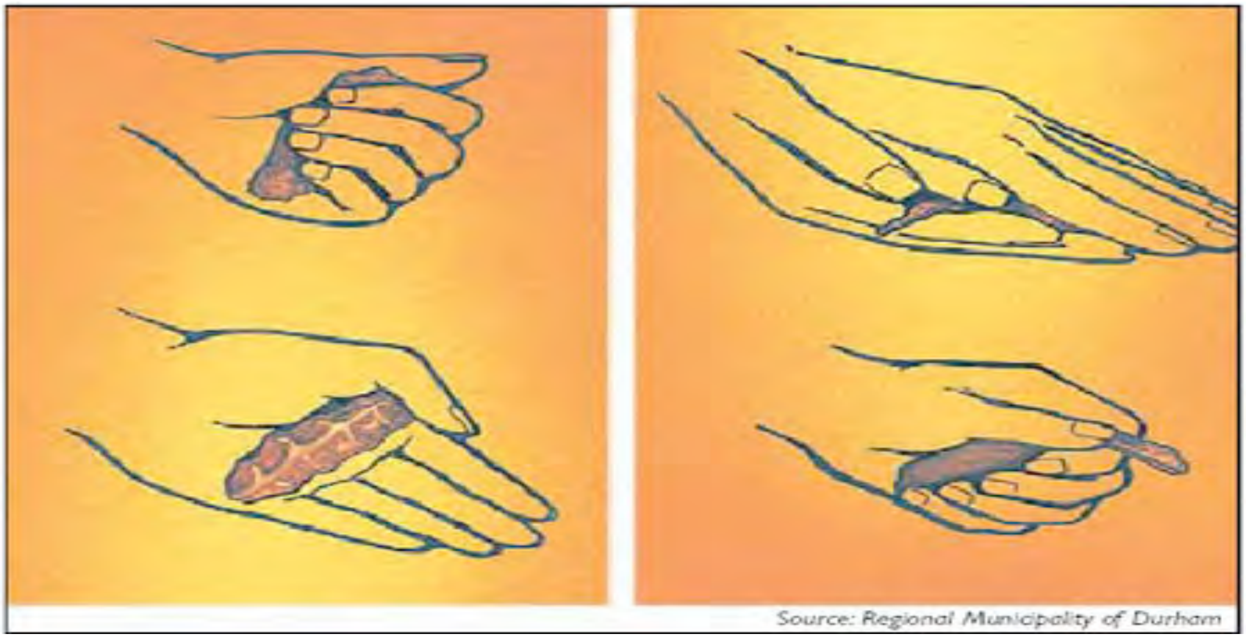


Figure 3: Examples of Soil Texture tests. The left is the Moist Cast Test, right is the Ribbon Test (CMHC, 2012).

2. Soil Structure and Porosity

Soil structure is the size and arrangement of particles in a soil. This arrangement determines the porosity of the soil, that is, the volume of air between particles.

Figure 4: Common Plantain (Beaulieu, 2012).

Healthy soil with good structure may contain up to 25 per cent air. Structure and porosity are functions of several key factors, including soil texture, the burrowing activities of earthworms and insects and the presence of bacteria, fungi and other micro-organisms. Adequate porosity is essential for the gas exchange between the root zone and atmosphere, to contribute to a capability to absorb, drain, and retain water, and to enable roots to easily penetrate the soil to access nutrients.

Compaction eliminates the vital air spaces between soil particles and is the single most significant impact on soil structure and porosity. Although most plants prefer soil that is porous, some species can grow in compacted soils.

Figure 5: Quack grass (Ontario Ministry of Agriculture, Food and Rural Affairs, 2011)

Field test: Soil compaction

1. Look for bare patches of soil where there are no plants or areas where water tends to puddle for a long time.
2. Certain plants, such as plantains (See Figure 4), quack grass (See Figure 5) ad dandelion indicate disturbance such as compacted soil.
3. Poor water onto the area of compaction. Observe the water and make notes.
4. Dig into the soil where the compaction is present, when soil is compact it is hard for the shovel to penetrate it.

3. Soil Moisture

Soil moisture depends on climate, topography and other soil characteristics, and is typically graded as wet, moist or dry. Some plant species are highly adaptable and can tolerate a range of moisture conditions.

Field test: Moisture levels

1. Choose your backyard or a natural area close to your home. Examine the property during different seasons, or even after a heavy rain fall or snow melt to identify where water accumulates or drains rapidly. Depressions, low areas and the base of slopes are generally wetter than slopes or elevated areas. Note areas that are particularly wet or dry, as these will demand appropriate plant selections.
2. Look for existing plant species that might indicate soil moisture levels. For instance, cattail is an indicator of wet soil, while heath aster indicates dry soil.
3. Compare plant heartiness in different locations. Thick, lush ground vegetation may indicate moister soils than areas with sparse, thin vegetation.

Figure 6: An example of what you may see during the Moisture level field test (Flickr, 2012).

Table 1: Field Tests for Soil Texture

Texture	Feel Test	Moist Cast Test	Ribbon Test
Sand	Grainy, little floury material	No cast	Can't form a ribbon
Loamy sand	Grainy with slight amount of floury material	Very weak cast, does not allow handling	Can't form a ribbon
Silty sand	Some floury material	does not allow handling	Can't form a ribbon
Sandy loan	Grainy with a moderate amount of floury material	Weak cast, allows careful handling	Barely forms a ribbon — 1.5 -2.5 cm (0.6 -1 in.)
Loam	Fairly soft and smooth with obvious graininess	Good cast, easily handled	Thick and very short - <2.5 cm (1 in.)
Silt loam	Floury, slight graininess	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Silt	Very floury	Weak cast, allows careful handling	Makes flakes rather than a ribbon
Sandy clay loam	Very substantial graininess	Moderate cast	Short and thick — 2.5 - 5 cm (1 - 2 in.)
Clay loam	Moderate graininess	Strong cast clearly evident	Fairly thin, breaks easily, barely supports its own weight.
Silty clay loam	Smooth, floury	Strong cast	Fairly thin, breaks easily, barely supports its own weight.
Sandy clay	Substantial graininess	Strong cast	Thin, fairly long, 5-7.5 cm (2 - 3 in.). Holds its own weight.
Silty clay	Smooth	Very strong cast	Thin and fairly long, 5 - 7.5 cm (2 - 3 in.). Holds its own weight.
Clay	Smooth	Very strong cast	Very thin and very long — >7.5 cm (3 in.)

Create a Food Web

Relationships in food webs are not isolated, they are very complex because one organism may be the food source of many predators. Instead of one linear food chain, many food chains connect together to form a web like food structure. This interconnected food system is called a food web. How food webs work is usually dictated by taste and food preferences of an organism, but availability of food and opportunistic compulsions are equally influential.

For this activity students are encouraged to view the ecosystem as a part of the rest of the world instead of viewing it in isolation deprived of linkages with other areas. Each of us makes a local contribution to increasing or decreasing global environmental problems. During the activity the students should keep this in mind, and be thinking about where humans fit into these systems and the impacts we have on the food web. Students should also keep in mind where decomposers fit into the system. Decomposers break down dead organic material. They recycle energy through the system to be used again. For example if a rabbit dies of natural causes, decomposers will begin to break it down and provide nutrients to the soil for plants too uptake. No system is complete without decomposers, they hold a very special niche in the ecosystem.

Food Chain: follows a single path as one organism consumes another

Food Web: Shows how plants and animals are interconnected by different paths. Food chains make up food webs.

Decomposer: An organism, often a bacterium or fungi, that feeds on and breaks down dead plant or animal matter, thus making organic nutrients available to the ecosystem.

Objective

Students will:

- examine how food webs and food chains function in nature
- examine the importance of food webs to maintain balance in ecosystems

Materials

You will need:

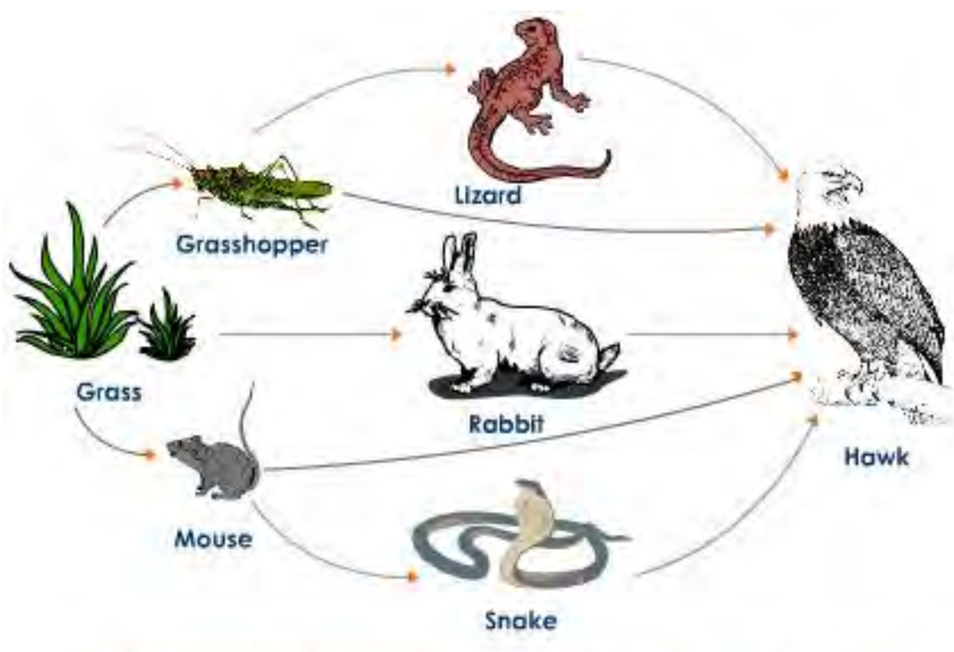
- The worksheet "Rangeland Species"
- Scissors
- Glue
- Paper

Procedures

Hand out the worksheet, "Rangeland Species" and go over the rangeland resources and uses and give an example of each.

1. Student will use the knowledge gained from the Envirothon manual, as well as additional resources such as books and the internet to determine trophic levels and food webs in a savanna ecosystem.
2. Students will cut out the savanna animals on the worksheet
3. Students will arrange the animals by trophic levels to determine where they should be placed in the food web.
4. Students will glue the animal pictures onto a piece of paper to create a food web.

Example:



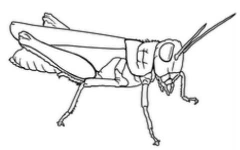
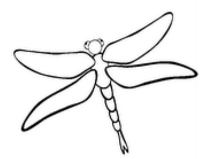
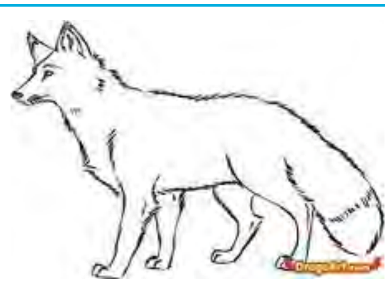
A Food Web in a Grassland Ecosystem With Five Possible Food Chains

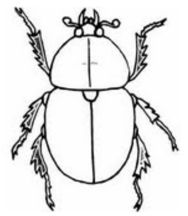
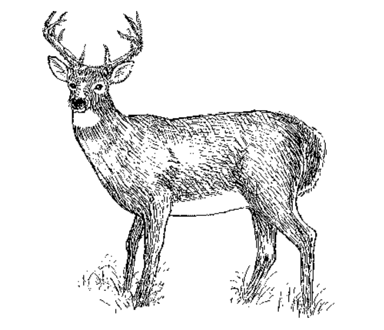
(TutorVista, 2010)

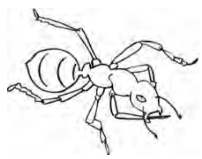
Rangeland Species

Name:____________________

Cut out the images to build your own savanna food web.

Species	Photo	Species	Photo
Weasel	 (Incog, 2012)	Short-eared Owl	 (Dechant at al., 2006)
Grasshopper	 (Super Colouring, 2012)	Dragonfly	 (Super Colouring, 2012)
Fox	 (How to draw, 2012)	Coyote	 (Varbeck, 2012)

Species	Photo	Species	Photo
Squirrel	 (Sibley, 2008)	Tumbling Flower Beetle	 (Super Colouring, 2012)
Fungi	 (Machen, 2004)	Striped Skunk	 (Barlow, 2008)
White-tailed Deer	 (Bassman, 2012)	Jack Rabbit	 (Centennial, 2006)
Red-bellied Snake	 (Luoma, 2007)	Monarch Butterfly	 (Photobucket, 2012)

Species	Photo	Species	Photo
Black Bear	 (Roger Hall, 2012)	Northern Harrier	 (Dechant et al., 2003)
Ant	 (Super Colouring, 2012)	Meadow Vole	 (Vogel, 1999)
Kentucky Bluegrass	 (Renz, n.d.)	Sedge	 (Saxby, 2009)

Envirothon 2013 Curriculum Links

Course	Big Ideas	Specific Expectations
Grade 9, Academic Science	Biology 1, 2 Chemistry 1, 2	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.5 C1.2
Grade 9, Applied Science	Biology 1, 2 Chemistry 1, 2	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.5 C1.2
Grade 10 Applied	Earth and Space Science - 1,2	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 D1.1, 2.1, 3.1, 3.7
Grade 11 Biology University Preparation	Diversity of Living Things – 1,2 Evolution – 1,3 Plants: Anatomy, Growth and Function – 1,2	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2, 2.1, 3.3, 3.4, 3.5 C1.1, 1.2, 2.1, 2.4, 3.2, 3.4 F1.1, 1.2, 2.2, 2.4, 3.4, 3.5
Grade 11 Biology College Preparation	Microbiology – 1,2 Anatomy of Mammals –3 Plants in the Natural Environment – 1, 2, 3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 C1.1, 3.3 F1.1, 2.1, 2.2, 2.3, 2.4, 3.4, 3.5, 3.6
Grade 11 Chemistry University Preparation	Matter, Chemical Trends, and Chemical Bonding – 2 Solutions and Solubility – 2,3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1 E1.1, 1.2
Grade 11 Environmental Science University/College Preparation	Scientific Solutions to Contemporary Environmental Challenges – 1,2 Human Health and the Environment – 1,2 Sustainable Agriculture and Forestry – 1 Conservation of Energy – 1	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2, 2.3, 2.4, 3.1, 3.3, 3.4, 3.5 C1.1, 1.2, 2.1 D1.1, 2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 F1.1, 1.2, 2.1, 3.2, 3.4
Grade 11 Environmental Science Workplace Preparation	Human Impact on the Environment – 1,2,3 Human Health and the Environment – 1,2 Energy Conservation – 1 Natural Resource Science and Management – 1,2 The Safe and Environmentally Responsible Workplace – 1	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 2.2, 3.1, 3.2, 3.3, 3.5, 3.6 C2.1, 3.1 D1.1, 1.2, 2.1, 3.2 E1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.5, 3.6 F3.5
Grade 11 Physics University Preparation	Waves and Sound - 3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 E1.2

Grade 12 Biology University Preparation	Biochemistry - 2,3 Metabolic Processes - 1,2,3 Molecular Genetics - 1 Population Dynamics - 1,2,3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B2.1, 3.1 C1.1, 2.1, 3.1, 3.2, 3.3, 3.4 D1.1 F1.1, 2.1, 3.1, 3.4, 3.5
Grade 12 Chemistry University Preparation	Organic Chemistry - 1 Energy Changes and Rates of Reaction - 1 Chemical Systems and Equilibrium - 1 Electrochemistry - 1	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2 D1.1, 1.2 E1.1 F1.1
Grade 12 Chemistry College Preparation	Chemical Calculations - 1 Chemistry and the Environment - 1, 2, 3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 E1.1 F1.1, 2.1, 3.1, 3.7
Grade 12 Earth and Space Science University Preparation	Recording Earth's Geological History - 1, 2 Earth Materials - 2, 3 Geological Processes - 1, 2, 3	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 D1.1, 2.2, 2.7 E2.1, 2.2, 2.5, 2.6, 2.7, 3.1, 3.2, 3.3, 3.4 F1.3, 2.1, 2.2, 3.4, 3.5, 3.6, 3.7
Grade 12 Physics University Preparation	Motions and its Applications - 1 Energy Transformations - 1	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 B1.1, 1.2 E1.1, 1.2
Grade 12 Science University/College Preparation	Biotechnology - 1	A1.1, 1.2, 1.5, 1.6, 1.10, 1.11, 2.1 F1.1

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