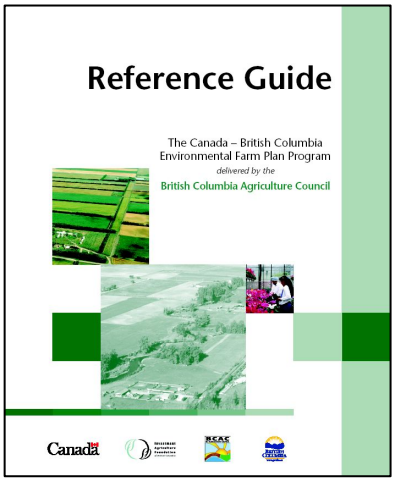
1 OVERVIEW

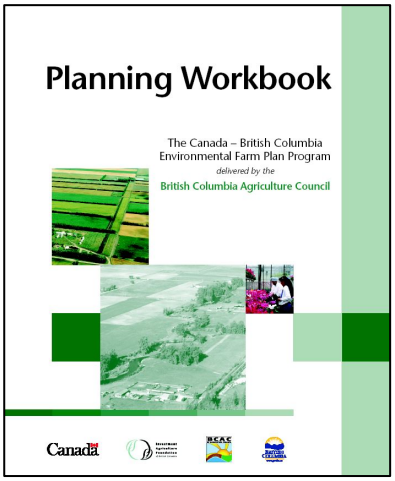
INTRODUCTION TO THIS GUIDE

Planning for Biodiversity: A Guide for BC Farmers and Ranchers (the guide) is designed for farmers and ranchers who wish to increase their understanding of biodiversity and what it means to their operations. It offers ideas on how agricultural producers can manage for biodiversity, and it provides some tools for doing so. The guide can be used in designing, implementing, and monitoring a Biodiversity Management Plan. The information is intended to apply primarily to privately owned farm and ranch lands in BC.

HOW DOES THIS GUIDE FIT WITH MY ENVIRONMENTAL FARM PLAN?

The Canada–BC Environmental Farm Plan (EFP) Program was designed to help producers identify environmental risks associated with their operations and opportunities to reduce those risks. The EFP *Reference Guide* provides information on various environmental regulations and makes suggestions for implementing environmentally sound practices. It is the main reference for completing the worksheets in the EFP *Planning Workbook*. Those worksheets ask some basic questions about biodiversity on agricultural lands.

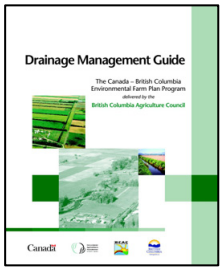


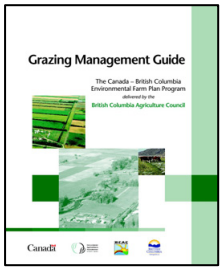


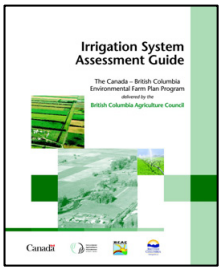
This biodiversity planning guide is the next step beyond the EFP process. It is not intended to address regulatory issues specifically. The guide will be revised over time as science and on-farm experience provide additional information on biodiversity and related agricultural management practices.

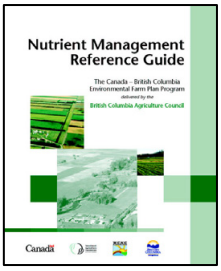
This guide is intended to be used along with the other publications in the EFP series:

- *Drainage Management Guide*
- *Grazing Management Guide*
- *Irrigation System Assessment Guide*
- *Nutrient Management Reference Guide*
- *Riparian Management Field Workbook*









WHAT IF I HAVEN'T DEVELOPED AN ENVIRONMENTAL FARM PLAN YET?

Although this guide can be used independently of the EFP *Reference Guide* and *Planning Workbook,* it is intended to complement those documents and complete the package of supplemental publications that are part of the EFP process. Producers are encouraged to complete an Environmental Farm Plan as part of enhancing their overall farm stewardship.

HOW DO I USE THIS GUIDE?

This guide provides a step-by-step approach to developing a Biodiversity Management Plan. By working through the guide, producers will enhance their understanding of biodiversity and the role they play in helping maintain it.

The guide includes six main sections:

- Overview
- Biodiversity Principles
- Developing a Biodiversity Management Plan
- Sample Biodiversity Management Plans
- Glossary
- Appendices

Overview: Producers are encouraged to read this section before starting work on their management plan. The section provides general background information on biodiversity. It begins by highlighting the importance of maintaining biodiversity at the local (farm and ranch) scale and ends with a discussion of the current challenges to, and efforts involved in, biodiversity conservation worldwide.

This section:

- defines what biodiversity is,
- highlights the benefits it can provide to agricultural operations,
- outlines the role agricultural landscapes play in maintaining biodiversity,
- discusses the potential conflicts between agriculture and biodiversity,
- lists the global benefits of, and threats to maintaining biodiversity, and
- identifies current national and international efforts to conserve biodiversity.

Did You Know…

Maintaining biodiversity can enhance agricultural productivity and stability.

By reading through the Overview, producers will gain a greater appreciation of their role in biodiversity conservation.

Biodiversity Principles: This section outlines eight basic principles involved in managing for biodiversity, and it gives examples of actions producers can take to address them. The principles focus on:

- native areas,
- semi-natural areas,
- locations, patterns, and seasonal availability of habitats,
- connections between native and semi-natural areas,
- structurally diverse habitats,
- healthy ecosystems,
- species and genetic diversity, and
- control over invasive alien species.

Reading through the Biodiversity Principles section will help producers formulate ideas about where they can most effectively focus their efforts when managing for biodiversity on their farm or ranch.

Developing a Biodiversity Management Plan: This section provides the actual "how to's" of developing a biodiversity management plan. They include:

- assessing opportunities to manage for biodiversity,
- creating an action plan by setting priorities for management, selecting related Beneficial Management Practices, and setting goals to achieve,
- implementing the selected Beneficial Management Practices, and
- monitoring and evaluating the effects of practices that are implemented.

The following materials have been provided to help producers develop their biodiversity management plan:

- worksheets for recording assessment opportunities,
- a list of Beneficial Management Practices that can be implemented to address those assessment opportunities, and
- worksheets to record the outcomes of the Beneficial Management Practices that are implemented.

Producers can use the worksheets to keep a written record of their management decisions and actions, and can use the work plan to generate ideas about how to manage for biodiversity on their land.

Sample Biodiversity Management Plans: This section provides examples of biodiversity management plans created by producers who worked through the process outlined in this guide.

Glossary: This section provides definitions for many of the terms used in this guide.

Producers can use this section to familiarize themselves with the terminology used in biodiversity conservation or to gain a greater understanding of those terms.

Appendices: This section provides:

- additional sources of Beneficial Management Practices and other related information,
- contact information for agencies involved in biodiversity management,
- summaries of legislation related to biodiversity, and
- other sources of information related to biodiversity.

Producers can use the information in these appendices to support the development and implementation of their biodiversity management plan.

Landowner Regulatory Responsibilities

All landowners have a responsibility to follow federal and provincial statutes that have been enacted to protect the environment. Appendix 3 of this guide provides summaries of the key Acts and Regulations that relate to protecting biodiversity on private agricultural lands. More details about this legislation can be obtained by accessing the links provided in the appendix or by referring to the Canada – BC Environmental Farm Plan *Reference Guide*.

Aquatic areas are particularly sensitive to any modification. If you are considering altering aquatic habitat on your farm or ranch, you will likely require approvals such as permits or other authorizations to undertake the work. You may also need to have your project reviewed by an appropriate environmental professional before beginning any work. Your regional Ministry of Environment and DFO Community Advisors can help by providing technical assistance and guidance on the legal requirements associated with working in and around water. Conservation organizations, such as Ducks Unlimited Canada, and industry associations may be able to help with project design and implementation.

You will find this "caution" symbol in the guide when evaluating a biodiversity opportunity that is likely to require a permit or approval.

King Campbell photo

Sharpe Lake Ranch owners work with agencies to develop a new river crossing with fencing to keep cattle out of the watercourse.

WHAT IS BIODIVERSITY?

Biodiversity is defined as *the variety of all life forms plus the habitats and natural processes that support them.* It includes all forms of life from bacteria, viruses, and fungi to grasses, forbs, shrubs, trees, worms, insects, amphibians, reptiles, fish, birds, mammals, agricultural crops and livestock, and humans. Natural processes include pollination, predator-prey relationships, and natural disturbances such as floods and wildfires.

There are three basic levels of biodiversity: ecosystem, species, and genetic diversity.

The Land Conservancy

Ecosystem Diversity

- **Ecosystem diversity:** refers to the variety of ecosystems in a given area and the different ways they function. Ecosystems are all the living (e.g., plants, animals) and non-living things (e.g., soil, water, air) in a given area, plus the interactions that occur among them. Ecosystems can be managed or unmanaged. Most agricultural landscapes are managed ecosystems.

It is important to note that ecosystems exist at different scales. You can find an ecosystem within a single tree, or it can extend across a field, an entire farm, or a large region like a major river basin. Interactions between living and non-living things occur at all these scales at the same time.

Species Diversity

Ecosystems develop in response to local conditions, which are influenced by such things as climate patterns, soil types, and topography. Figure 1 shows some of the natural ecosystem diversity that exists in BC.

- **Species diversity:** refers to the variety of species that occurs within an area or ecosystem. Different types of birds and different types of trees are examples of species diversity. Generally, the greater the number of species in an ecosystem, the more stable it is.

Avian Research Centre Agassiz

Genetic Diversity

- **Genetic diversity:** refers to the variety of genes within a species. Genes determine individual characteristics such as size, shape, and colour. The different characteristics that exist among breeds of chickens are an example of genetic diversity. It allows species to adapt to changes in their ecosystem or environment.

All these levels of diversity are intricately connected. Change in one part of the ecosystem can affect the functioning of other parts.

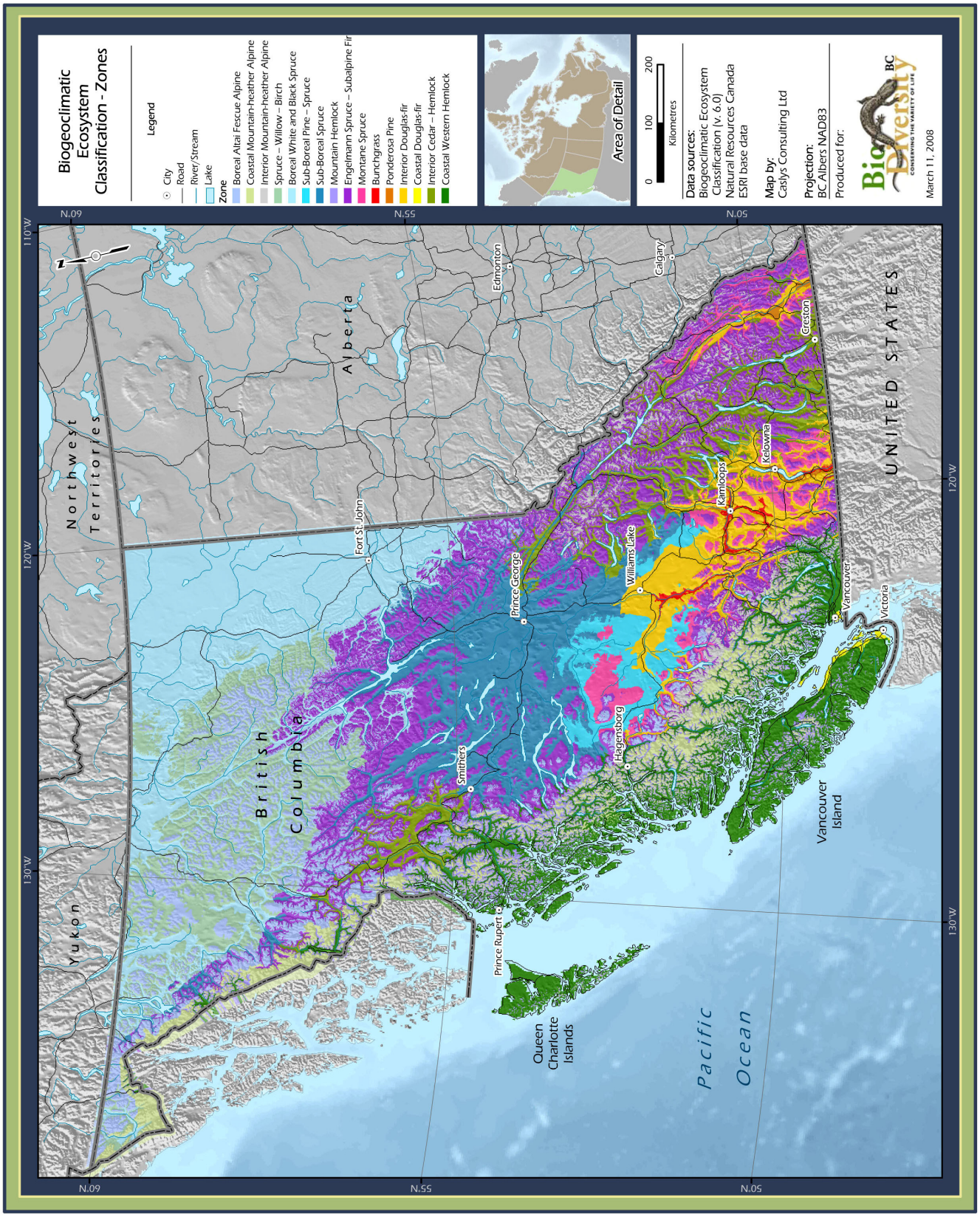


Figure 1 Biogeoclimatic Ecosystem Classification Zones in BC

Biodiversity in BC

BC is a biologically diverse region. It has:

- 78 species of freshwater fish
- 20 species of amphibians
- 15 species of reptiles and turtles
- 129 species of mammals
- 348 species of birds
- 2143 species of vascular plants, which includes trees, shrubs, grasses and ferns
- 714 species of mosses[1]

BC is one of the most biologically diverse provinces in Canada.[2] It is home to:

- 63% of Canada's insect species
- 73% of Canada's mammal species
- 78% of Canada's bird species
- 77% of Canada's vascular plant species [3]

BC has global responsibility for the conservation of many species and ecosystems. For example:

- BC has more than 50% of the world's mountain goat population.[2]
- Most of the world's population of western sandpipers migrates along BC's coast every year.[2]
- More than 95% of the world's mountain caribou live in BC.[2]
- BC has 100% of the world's Vancouver Island marmots.[2]
- The Fraser River is the world's most productive salmon river.[4]

[1] BC Conservation Data Centre. Species and Ecosystems Explorer. Available at: http://a100.gov.bc.ca/pub/eswp/ (Accessed September 10, 2009)
[2] Austin, M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. *Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC*, Victoria, BC. Available at: www.biodiversitybc.org
[3] Modified from Cannings, R.J., and S. Cannings. 2004. *British Columbia: A Natural History*. Douglas and McIntyre, Vancouver, BC.
[4] Environment Canada. 2007. The Fraser River salmon. *The State of Canada's Environment*. Retrieved on June 7, 2007 from http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-6-3-9-4-1.cfm

Isabelle Groc photo

Fall Migration of Salmon

WHY SHOULD I MANAGE FOR BIODIVERSITY ON MY FARM?

BENEFITS OF BIODIVERSITY TO AGRICULTURE

Biologically diverse ecosystems provide a number of critically important goods and services that benefit humans. While conserving and enhancing biodiversity may come at a cost to producers, there are immeasurable benefits to farmers and ranchers, including:

- soil formation and retention processes – maintain soil productivity and prevent soil loss due to wind and water erosion
- nutrient breakdown, storage and cycling – makes nutrients available to domestic and native plants, prevents organic debris from accumulating, and helps maintain water quality
- reduction of pest populations – helps reduce crop losses
- pollination services – enhance yields for pollinator-dependent crops such as fruit trees

These goods and services can reduce the need for inputs such as pesticides and fertilizers, increase the productive capacity of the land, and reduce production risks; therefore, they have the potential to maintain or even increase farm profitability. In addition, maintaining biodiversity on agricultural lands can increase land value and provide opportunities to develop agri-tourism and other niche marketing activities.

Did You Know…

One of every three mouthfuls of food we eat comes from plants that were pollinated by insects.

Buchmann, S.L. and G.P. Nabhan. 1996. The Forgotten Pollinators. Island Press, Washington, DC.

Managing for biodiversity ensures that agricultural lands can continue to receive the benefits provided by natural systems. Some of those benefits are discussed below.

Enhancing Production

Biologically diverse ecosystems tend to be healthy and productive. Diverse plant communities are generally more productive than communities with little diversity. In modern cropping systems, increased soil biodiversity has been associated with increased soil fertility. Soils with greater biodiversity tend to process and store nutrients and use water more efficiently, and are often less likely to leach nutrients beyond the root zone. Maintaining biologically diverse vegetation and soils can improve productivity by:

Productive Forage Land

- improving soil fertility through enhanced nutrient cycling
- improving water infiltration and water holding capacity of soils
- reducing plant and soil pathogen populations
- reducing levels of pollutants
- reducing weed populations
- increasing grazing capacity

Agricultural productivity also benefits from the presence of diverse populations of wild pollinators, such as hummingbirds, moths, native bees, and other insects. Maintaining a diversity of pollinators increases the quantity, reliability, and duration of pollination services to crops. For example, there are several advantages to maintaining healthy populations of native bees in addition to honeybees:

Courtesy Photo

Pollination

- Native bees generally spend more hours during the day pollinating than honeybees.
- Native bees are usually more active in cold and wet weather than are honeybees.
- Many native bees use “buzz” pollination, which allows them to pollinate crops that honeybees cannot.
- When native bees compete with honeybees for the same plant, honeybees can become more efficient pollinators.
- Native bees have greater species diversity than honeybees; therefore, they are less susceptible, as a group, to pests and disease.
- Native bees tend to be more efficient at distributing pollen than honeybees.[i]

Agricultural landscapes that have a good mix of cropped and non-cropped, natural and semi-natural areas tend to have higher rates of pollination than less complex landscapes.

Jared Hobbs photo

Barn Owl (blue-listed)

Stability in Production

Managing for biodiversity creates the foundation for sustainable agriculture. Generally, the more diverse a production system is, the more stable it tends to be. For example:

Did You Know…

An adult barn owl is an effective predator. It can eat more than 700 rodents per year.

http://www.barnowlvideo.com/index.html

- Diverse systems are more resistant to variations in climate, invasive alien species, outbreaks of diseases, and natural disturbances such as floods, wildfires, and windstorms.
- Increasing the genetic diversity of crop and/or livestock varieties can reduce the risk of production failures.
- Maintaining diverse bird and insect communities can help in controlling agricultural pests. Studies indicate that birds can suppress insect and rodent populations, at least at medium to low infestation levels. For example, in certain grassland environments, birds can effectively control grasshopper numbers. A greater diversity of beetles and spiders in a landscape has been shown to lower the incidence and magnitude of certain pest outbreaks.

Niels Holbek photo

Shelterbelt

Flexibility in Production

Maintaining both native areas and a mix of crop varieties on the farm can maintain biodiversity while providing flexibility in production. For example, creating a shelterbelt that has a diversity of plants can provide:

- wood fibre
- windbreaks
- reduced risk of erosion
- habitat for pollinators and desirable wildlife species
- habitat connections across landscapes

Diverse Mix of Cropped and Uncropped Land

- favourable growing conditions for crops that require shelter or certain microclimates
- buffers against nuisances such as dust, noise, and odours

Additionally, maintaining a diversity of crop and/or livestock varieties may provide flexibility in marketing opportunities for agricultural products. Similarly, using environmentally-friendly management practices may provide an opportunity to market specialty products to consumers who are concerned about the environment and how their food is produced.

Agriculture, Biodiversity and Climate Change

Biodiversity provides resilience, which allows agriculture to adjust to climate change. For example:

- Crops and livestock may need to adapt to changes in temperature, rainfall, pests, and diseases. Maintaining genetic diversity in both domesticated and wild varieties provides opportunities for adaptive breeding.
- High levels of soil biodiversity are associated with increased soil fertility and nutrient and water retention. This can make soils more resilient to extreme conditions, such as droughts and floods.
- Managing for biodiversity by adding or maintaining different kinds of uncultivated areas such as shelterbelts, hedgerows, and uncultivated fencelines can improve microclimates by buffering winds, regulating water tables, and providing shade for crops and livestock.[ii]
- Maintaining natural hydrological processes, native vegetation, and genetic diversity within riparian ecosystems supports their natural resilience to disturbance. In turn, healthy riparian areas provide a strong link between aquatic and terrestrial ecosystems, making them both resilient to climate change.[iii] This can ensure that healthy water and forage sources are retained, which will add to stability in agricultural production.
- Maintaining connected habitats across landscapes is the most common recommendation for protecting biodiversity from climate change.[iv] Corridors between habitats can also benefit agricultural operations by controlling erosion, retaining water, filtering runoff, and acting as windbreaks.

Flooding

Mountain Pine Beetle Infestation

AGRICULTURAL LANDSCAPES ARE IMPORTANT TO BIODIVERSITY

Agricultural producers play a significant role in providing features that are essential for conserving biodiversity. These include:

- an adequate supply of habitat
- structurally diverse habitats
- connections between habitat patches
- healthy, functional habitats
- storehouses of genetic diversity

Jared Hobbs photo

Tree cavities provide important habitat for species such as the Northern Flicker

Did You Know…

About 50% of Canadian farmers and ranchers have contributed to the conservation or restoration of natural areas through activities such as planting trees.

http://www.stewardshipcanada.ca/index.php/ecological_goods_and_services

Habitat

Habitats in agricultural landscapes provide the things that all species need to survive: water, food, shelter from predators and adverse weather conditions, and places to safely breed, and rear young.

Aquatic and Riparian Areas

All habitats within the agricultural landscape are important, but aquatic and riparian areas are especially significant to both biodiversity and agricultural production. Aquatic areas are considered to be some of the most productive ecosystems on Earth.[v] Collectively, rivers, streams, lakes, and wetlands provide habitat for at least 25% of BC's vertebrate, invertebrate, and vascular plant species.[vi]

Riparian Area

Aquatic ecosystems interact closely with riparian zones—the areas of lush, green, moisture-loving vegetation that surround wetlands, lakes, streams, and rivers. Riparian areas form a transition zone between aquatic and dry, upland habitats. In their natural state, these areas typically have higher biodiversity than other habitats in agricultural landscapes because they provide shelter, food, breeding and rearing habitat, and safe access to water. The riparian areas along streams and rivers also provide travel corridors for a whole range of organisms that use aquatic and uplands areas. In some intensively farmed areas of the province, retained aquatic and riparian areas provide the only opportunity for connecting habitats.

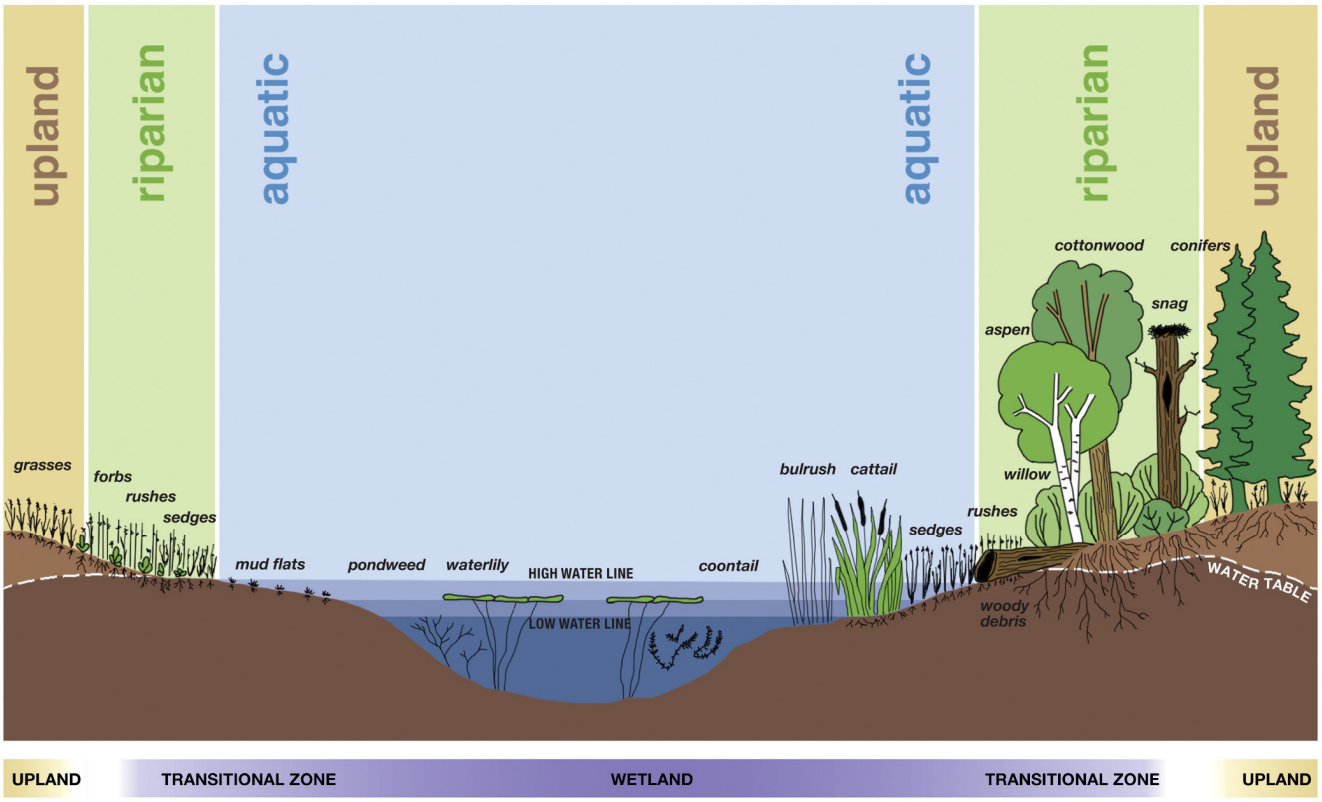
Jared Hobbs photo

Wetland and Upland Habitat

Terrestrial Areas

In agricultural landscapes, terrestrial habitat consists of both native areas, such as forests and grasslands, and semi-natural areas, such as farm woodlots, pastures, hedgerows, and cultivated fields. While native areas within and around farms provide the best opportunity for conserving biodiversity, land that is used for agricultural production is also important.

Ducks Unlimited Canada



Relationship among Aquatic, Riparian, and Terrestrial Habitats

Lisa Zabek photo

Structurally Diverse Riparian Habitat

Structurally Diverse Habitats

Structurally diverse habitats have a mix of vegetation types with different heights and forms. This variation in structure provides different types of important habitats for a variety of native species. Farms and ranches that have a mix of cultivated and uncultivated fields, woodlands, hedgerows, fencerows, shelterbelts, and aquatic and riparian areas provide greater structural diversity than operations that have only cultivated fields or native pastures. As a result, they are able to support greater biological diversity.

Corridors between Native and Semi-natural Areas

Connections between Habitat Patches

Corridors that connect patches of native and semi-natural areas provide safe, sheltered travel routes for animals when they are migrating or searching for food and mates, and they provide routes for pollen and seeds to disperse. These corridors also help maintain ecosystem services by controlling erosion, filtering contaminated runoff, acting as windbreaks, and providing opportunities for economic diversification. Grasslands, shelterbelts, hedgerows, woodlands, fencerows, uncultivated areas, gullies, intact riparian areas, and rock outcroppings can be used effectively to provide connections between habitat patches both within an individual farm and between neighbouring properties. Corridors can include different kinds of habitats and can be used to connect different habitat types.

The Land Conservancy

Off-stream Watering Helps to Maintain Healthy Ecosystems

Healthy, Functional Habitats

Habitats that are healthy and functioning properly support higher levels of biodiversity than habitats that have been compromised. For example, if lakes and streams are to support viable populations of native fish species, they must be free of excess nutrients, sediments, and other pollutants, and they must have an adequate supply of cool, clean water. Agricultural management practices such as conservation tillage, off-stream watering, and nutrient management can help maintain the health of both native and semi-natural habitats on the farm.

Lisa Zabek

Using Livestock to Manage Competing Vegetation

Storehouses of Genetic Diversity

Agricultural operations can act as sources of genetic diversity both by conserving native species and by managing a variety of crops and livestock species. Agricultural practices such as crop rotation, use of winter cover crops and perennial cover, intercropping, and agroforestry contribute to increased levels of biodiversity. Additionally, areas left in native pasture can support a greater diversity of soils microorganisms, native plants, and pollinators than tame pastures.

Crop and Livestock Diversity

Planting a diversity of flowering crops that bloom at different times can provide food and rest areas for native insects such as wild bees, which are important crop pollinators.

Multiple Species Grazing

Adding livestock to a crop-based agricultural production system can also provide many benefits. Manure can be used as a soil amendment. Livestock can be used to control weeds and promote desired plant species and structural diversity in pastures when their levels of grazing, trampling, and rooting are properly controlled. For example, pigs can be used to root weeds from cultivated lands, and sheep can be used to graze herbaceous plants that compete with newly planted trees in tree plantations.

Adding different kinds of livestock to a production system can also increase the effective use of pastures. For example, cattle and sheep have different plant preferences and tend to crop plants to different heights, thereby extending the useable amount of forage in a pasture.

Crop Rotation

Crop rotation provides crop diversity over time. Rotational cropping helps retain normal ecosystem functioning by curbing erosion, improving soil structure, conserving soil moisture, and disrupting insect, disease, and weed cycles. Rotations that include three or more crops usually have fewer problems with pests and require fewer crop inputs. Rotational cropping can also contribute soil nutrients. For example, legumes like alfalfa or sweet clover are an economical source of nitrogen.

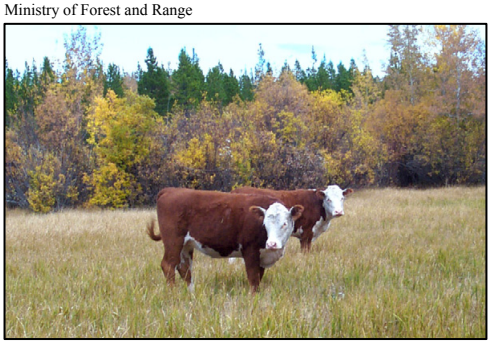
Crop Rotation

Cover Crop

Cover Cropping

Using cover crops during crop rotation supports beneficial organisms above and below ground. These organisms help build soils by decomposing organic matter and contributing to nutrient cycling. Additionally, organic matter is often lost from fallow fields that lack vegetation cover because the soil is exposed to wind and water erosion. Using cover crops, such as a fall rye, instead of letting fields remain fallow, can improve water infiltration, storage, and flow, and add to soil nitrogen content. Delayed seeding and the use of winter cover crops can also be beneficial to a number of species, particularly some species of waterfowl, shorebirds and grassland birds.

Ministry of Forest and Range



Perennial Cover

Perennial Cover

Perennial cover can make a larger contribution to biodiversity than annual crops can because there is generally less disturbance from farm activities such as tillage, seeding, and spraying. This allows plants and animals to follow their life cycles without disruption. Perennial cover can also provide a greater diversity of vegetation structure, which in turn supports more species. Perennial cover can include crops such as hay (tame or native vegetation) or berry bushes. It can also include native and semi-natural areas that have been left for beneficial insects and other wildlife.

Agroforestry – Alley Cropping

Intercropping

Intercropping provides crop diversity and can increase vegetation structural diversity. It can also provide habitat for beneficial insects. For example, sunflowers planted within one metre of vegetable crops can increase the number of beneficial insects found in crops.[vii]

Intercropping – Grass in a Harvested Corn Stand

Agroforestry

Agroforestry intentionally combines the production of trees with other crops and/or livestock. By integrating a diversity of crop and other plant species, agroforestry can contribute significantly to the structural diversity of habitats.

The Diminishing Diversity of Our Food Supply[viii]

About 90% of all plants and animals used for food were domesticated and/or cross-bred from wild stocks.

Almost 96% of commercial vegetable varieties available in 1903 are now extinct.

According to the United Nations Food and Agriculture Organization, humans now rely on just 15 species of mammals and birds to supply 90% of all animal-derived foods.

Twelve plant crops account for more than 3/4 of the food consumed in the world, and just three—rice, wheat, and maize—provide more than half of the world's food.

INTERACTIONS BETWEEN AGRICULTURE AND BIODIVERSITY

Every time humans interact with their habitat they interact with biodiversity. This is especially evident in any type of resource use, including agriculture. Therefore, it is important to understand the types of interactions that can occur between agriculture and biodiversity and the impacts they may have.

Did You Know…

7 in 10 farmers expressed interest in adopting environmentally-sound practices. Improving water quality, enhancing soil productivity, and promoting rural values ranked highest.

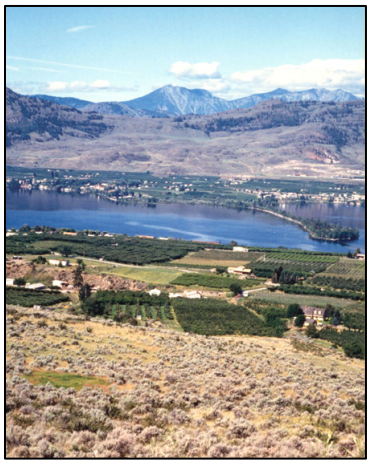
Environics Research Group. 2006. National Survey of Farmers and Ranchers: Ecological Goods and Services. Prepared for Wildlife Habitat Canada. Environics Research Group Limited, Toronto, Ontario.

Impacts of Agriculture on Biodiversity

Habitat Loss and Fragmentation

Regions that support agricultural production are among the most altered ecosystems on the planet. For example:

- Roughly 15% (~85,000 ha) of the grasslands in BC's Southern Interior have been converted to agricultural use (11%) and urban development (4%).[ix]
- More than 75% of the wetlands in the Okanagan Valley and Fraser River delta have been converted by agricultural, urban, and commercial development.[x]
- Since 1800, 63% of the black cottonwood/water birch riparian shrub forest in the Okanagan has been lost due to flooding, and rural, recreational, and agricultural development.[xi]



Endangered Grassland Ecosystem

Loss of habitat to agricultural development is associated with a disproportionately high number of species at risk in agricultural areas. Agricultural land makes up approximately 7.5% of Canada's land base,[xii] yet more than half of the terrestrial species at risk are found in agricultural areas.[xiii] Accordingly, agricultural producers, who play an important role in land management, are increasingly being asked to consider practices that help conserve biodiversity.

Agricultural activities can also affect biodiversity by altering the size and shape of habitats and the distances between them. Large areas of connected native vegetation tend to support the highest levels of native biodiversity. However, smaller patches of native and semi-natural vegetation can also support many species and populations. This is particularly true where patches are close to one another or are connected by corridors of perennial cover that allow wildlife to move safely between them.

Soil Conservation - No Till Drill

Tillage Impacts

Tillage tends to degrade the diversity of soil micro-organisms found throughout the soil profile. This reduces the efficiency of nutrient cycling, the breakdown of toxins, and the maintenance of soil structure, which are all needed to sustain the productivity of agricultural soils.

Mycorrhiza fungi play an important role in maintaining above- and below-ground biodiversity and soil productivity. These fungi form associations with approximately 80% of the terrestrial plant species in the world, including legumes, flax, sunflowers, corn, and fruit trees.

Did You Know…

Networks of mycorrhiza fungi are disrupted by tillage and must be re-established after every major tillage operation.

Generally, the fungi make nutrients (i.e., phosphorus, nitrogen, potassium, magnesium, and some micronutrients) available for plant growth. Undisturbed, mycorrhiza fungi grow into long, intricate networks in the soil. They transport nutrients through these networks to the plants' roots in exchange for carbon.

Irrigation Impacts

Drip Irrigation

Many aquatic species, such as fish and amphibians, rely on the maintenance of certain water regimes throughout the year. Changes in water levels, due to control structures and/or irrigation withdrawals, may negatively impact habitat and water quality. In addition, over-irrigating not only depletes surface water and groundwater, it can drown plant roots. It can also reduce nutrient uptake, cool soils, reduce crop quality, and increase erosion as well as nutrient and chemical runoff into watercourses.[xiv] These impacts affect both aquatic and terrestrial ecosystems and can be detrimental to biodiversity.

Input Impacts

Production inputs include fertilizers and pesticides. Depending on the timing and intensity of their use, production inputs can have significant effects on biodiversity. Repeated additions of nutrients in excess of what crops use can destabilize soil conditions, reduce soil organism diversity, and impair soil processes. Improper use of production inputs can also cause water and air pollution. Nutrients, such as nitrogen and phosphorus, can reduce surface water quality by causing overgrowth of aquatic plants and algae.[xv] When these plants decompose, the resulting loss of oxygen can be lethal to fish and other aquatic organisms. Overgrowth of some types of blue-green algae can result in the release of toxins that are harmful to a variety of species.

Fertilizing Corn

Did You Know…

Leaf-cutting bees can be harmed by insecticide residue on the leaves they use to line their nests.

The use of pesticides (particularly insecticides) can have toxic effects on soil organisms, which can impair soil biological processes. Some pesticides can also have adverse effects on beneficial insects, including pollinators such as bees. Most pollinating insects are especially vulnerable to insecticide applications in the cool of the early morning and when their forage plants are flowering. They can also be affected by chemical drift into non-cropped areas where they nest.

Grazing Impacts

When the intensity and timing of grazing and browsing are not properly managed, biodiversity can be negatively affected. When grazing is too intense or too frequent, individual plants become less vigorous. Over time, plant diversity decreases, and grazing-resistant or less preferred species increase in abundance. These impacts can lead to a loss of food and habitat for beneficial insects, amphibians, reptiles, birds, and mammals.

Heavily Grazed Landscape

Different species require different types of vegetation structure. Historically, vegetation structural diversity across the landscape was created by fire and a variety of wild herbivores. In agricultural systems, structural diversity can be achieved by managing grazing intensity to maintain mosaics of lightly grazed, moderately grazed, and more heavily grazed areas. This can support greater biodiversity than areas that are grazed uniformly or left ungrazed.

Grazing that is too intense or that occurs at the wrong time of year can affect soils and site productivity by impacting soil organisms, reducing infiltration of water and associated minerals and nutrients, and affecting the exchange of oxygen, carbon dioxide, and other gases in the root zone. Unmanaged grazing can also create areas of bare soil, which can be prime sites for invasive plants to establish, and soil compaction, which can lead to an increased risk of erosion and reduced water quality for fish and aquatic insects.

The timing of grazing activities must also take into consideration the fact that plants and animals can be especially sensitive to disturbance at certain periods during their life cycle. Some animal species may also be vulnerable during certain times of the day.

Did You Know…

A genetically modified bent grass pollinated other plants of the same species that were located 21 km downwind of where it had been planted.

IUCN. 2007. Current Knowledge of the Impacts of Genetically Modified Organisms on Biodiversity and Human Health: An Information Paper.

http://cmsdata.iucn.org/downloads/ip_gmo_09_2007_1_.pdf

Impacts of Genetically Modified Organisms

Genetically modified organisms (GMOs) are plants, animals, bacteria, or viruses whose genetic makeup has been deliberately altered in a way that does not occur naturally through mating or natural gene recombination[xvi]. Modification is often designed to improve yield and production by making the organism resistant to disease, insects, and/or pesticides, but it can also be used to enhance or reduce certain traits such as fat content or fibre quality.

The growing of monoculture crops reduces biodiversity because many plant species are replaced by a single species. The growing of GMOs further reduces biodiversity because all the plants within a single species come from a genetically modified source plant, so they are all genetically identical.[xvii] Unintentional cross breeding of GMO species with non-GMO species has the potential to reduce genetic diversity or introduce undesirable traits. On the other hand, GMOs may enhance yields, reduce pesticide use, and improve the nutritional value of crops. The overall effects that GMOs have on biodiversity are not fully understood, and they can differ among crops, environments, and the types of modifications made to the organism.[xviii]

Niels Holbek photo

Spray Tower Reduces Pesticide Drift

Impacts on Wildlife

Agricultural activities can have negative effects on native wildlife species aside from causing habitat loss. For example:

- wild sheep and goats that come into contact with domestic sheep, llamas, or alpacas can be exposed to diseases that do not naturally occur in wild populations
- agriculture activities can disturb wildlife and cause them to move or be displaced, or can upset their normal life cycle
- livestock can trample bird nests
- equipment used for haying, cultivating, tree harvesting, etc., can injure or kill wildlife

- fencing can cut off wildlife access to travel corridors, winter/spring ranges, feeding areas, and water. Animals can also be injured or killed when trying to jump over or go under fences; birds can be harmed by accidently flying into fences
- runoff polluted with manure or fertilizer can harm fish and amphibians
- pesticide sprays can injure or kill native pollinators

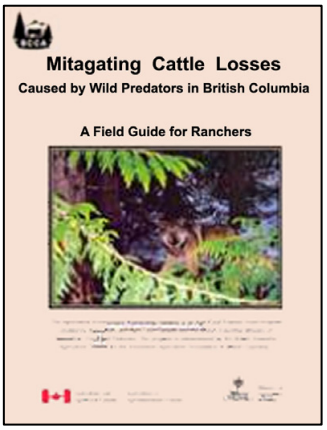
Potential Wildlife Conflict

Impacts of Wildlife on Agriculture

While there are many benefits of managing for biodiversity, it is important to recognize that not all species have a positive effect on agricultural production. There a number of animal species, both native and introduced, that can cause significant impacts on agricultural operations, including damage to infrastructure, loss of growing or stored crops, transmission of diseases, and harassment, injury, or death of livestock. The type of impact often varies by species. For example:

- deer and rabbits can damage fruit trees
- coyotes can damage drip irrigation lines and emitters
- birds can raid fruit crops
- deer and elk can consume standing crops and stored forage
- bears can damage apiaries
- predators can attack livestock
- waterfowl can consume standing crops and compact soils of cropped fields, particularly during fall migration
- waterfowl can also transmit infectious disease
- bats, starlings, rodents, skunks, and raccoons can damage buildings by roosting and nesting in attics, digging and denning under foundations, or sheltering within walls

When viewed on a provincial scale, most wildlife do not negatively affect agricultural production, but when they do, the impacts to individual producers can be significant. It is important to note that producers can manage for biodiversity without necessarily increasing the risk of wildlife-related conflicts. The key is to find an acceptable balance between the benefits and potential costs of managing for biodiversity.



THINKING BEYOND THE FARM

THINKING REGIONALLY

While it is important to manage for biodiversity on the farm, it is equally important to consider how an individual farm can contribute to biodiversity at the regional scale. Areas with different climate regimes, elevations, landforms, and soils (Figure 1) tend to support different plant and animal communities. Because of this, some parts of the province naturally contain greater concentrations of native plant and animal species than others. The number of species present in a given area is often referred to as species richness (Figure 2).

Much of BC's farmland is located within the Agricultural Land Reserve (Figure 3), which tends to overlap areas of higher species richness. Many species of plants and animals prefer valley bottoms because they have favourable climates, fertile soils, and easily accessible water sources. However, these same features make these areas some of the most suitable land for agricultural and urban development in the province. As a result, the needs of agriculture often compete with those of native biodiversity. In areas of the province that have high species richness, such as the lower Fraser Valley, southeast Vancouver Island, the Gulf Islands, and the Okanagan Valley, there is an increasing need to find ways to ensure that farmland remains productive while providing habitat for biodiversity. Agricultural lands in areas of the province that have lower species richness are also critical to ensuring the survival of native plants and animals, and they help connect areas of higher species richness.

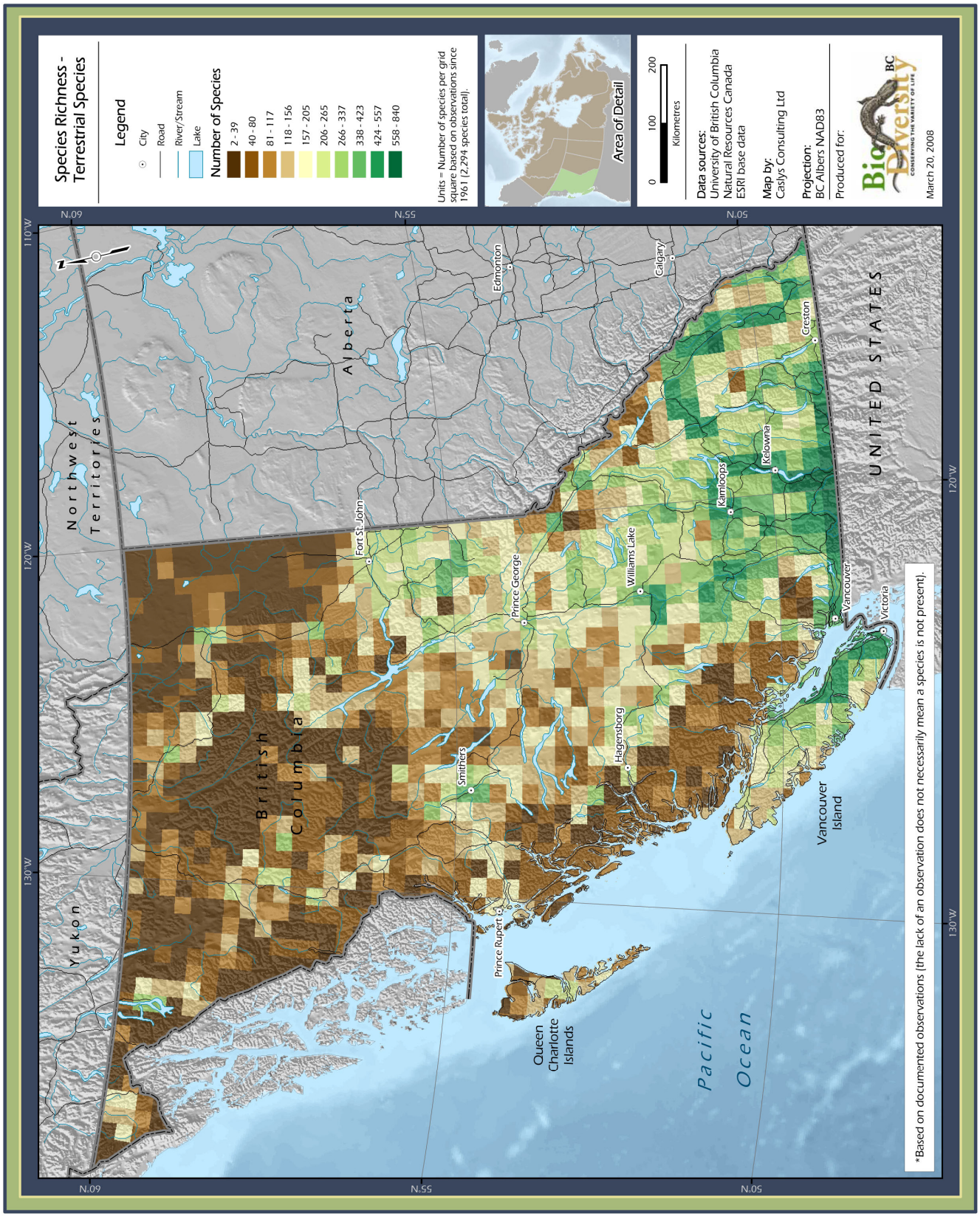


Figure 2 Species Richness – Terrestrial Species in BC

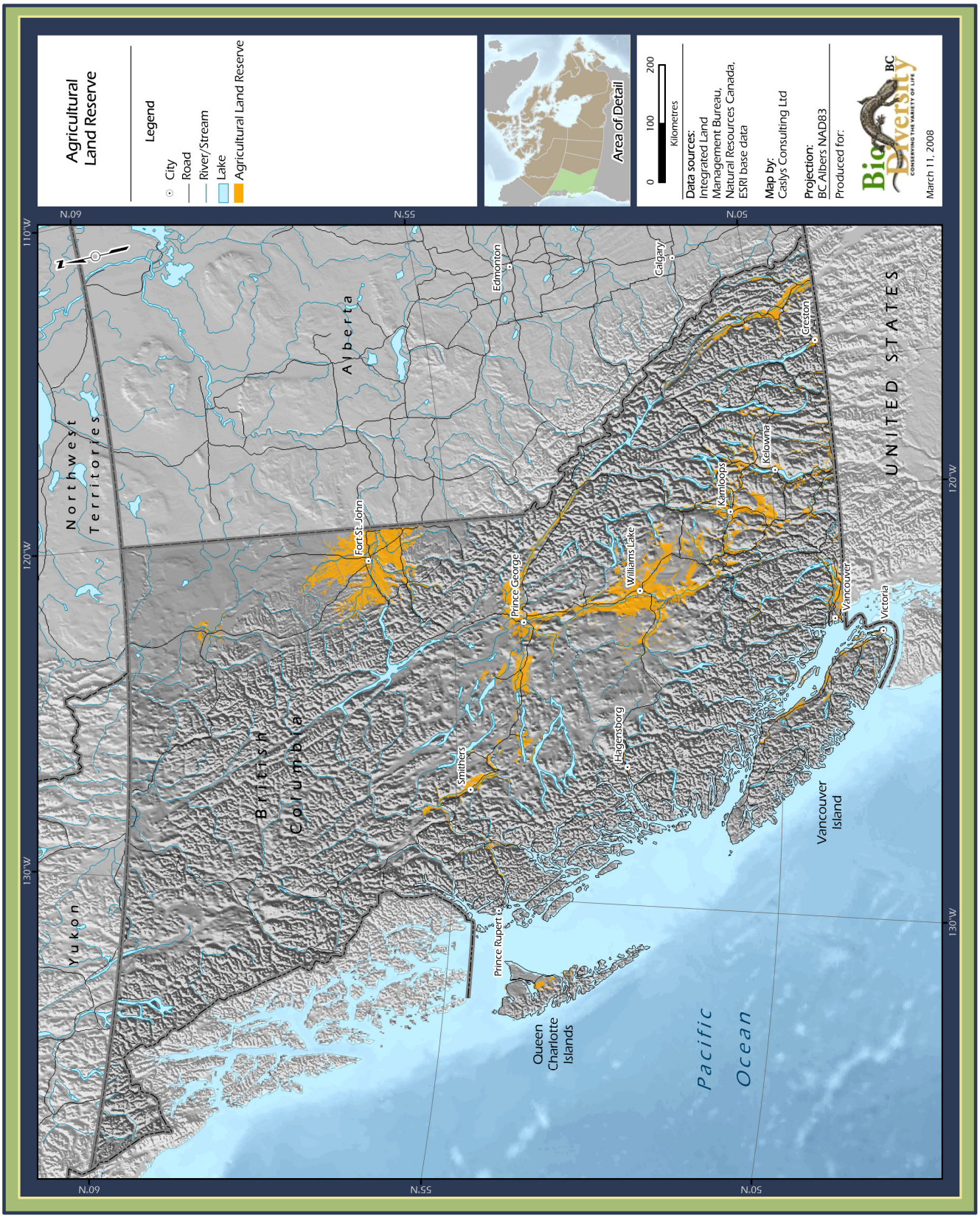


Figure 3 Agricultural Land Reserve

Building Connections across Landscapes

Agriculture and Agri-Food Canada

Treed Corridor

Considering the farm in a regional context is important because pollen, plant seeds, and animals often move over large areas that extend well beyond the farm boundary. For example, migratory birds may travel thousands of kilometres between their breeding and wintering habitats, and may rely on farmland along the way for resting and feeding. Other species with large home ranges may use farmland as a corridor to travel between isolated patches of native habitat as they search for food, shelter, or mates. Species also move across landscapes in response to disturbances such as drought, fire, or disease. Meeting the needs of wide-ranging species requires management strategies that operate at the landscape scale.

Connecting habitats across the landscape can also help rebuild populations of a species that have become isolated or reduced in size. Connected habitats allow individuals to join other populations, which results in increased genetic diversity. Maximizing the value of farmland to biodiversity depends on understanding how actions at the farm scale contribute to larger scale processes.

Niels Holbek photo

Stream Banks and Fish Passage Protected

The responsibility for conserving biodiversity is shared across the landscape. BC's network of parks and protected areas plays a key role in maintaining habitat for a variety of species, as do conservation practices used on Crown lands. Individual farms and ranches play an important role in retaining and enhancing biodiversity, but the power to make a difference increases by working collaboratively with other producers, community members, and organizations. There are numerous coordinated efforts underway in BC to conserve habitat and protect biodiversity. Some are driven by government; others are driven by stewardship groups in which agricultural producers have key roles. The following are examples of regional and landscape-scale biodiversity conservation initiatives that rely, in part on the agriculture community to achieve their goals:

- The Biodiversity Conservation Strategy for the Greater Vancouver Region was developed for an area that encompasses both the largest population base in the province and some of the most productive agricultural land in BC. The strategy addresses a number of biodiversity conservation needs including habitat mapping and making recommendations for linking agricultural lands to forested areas, aquatic habitats and parks.

Rob Butler photo

Snow Geese

- The Pacific Coast Joint Venture and the Canadian Intermountain Joint Venture are regional-scale efforts that focus on conserving habitat and sustaining species and populations of waterfowl and other birds that migrate across North America. Established as part of the North American Waterfowl Management Plan, these cooperative ventures between governments, stewardship organizations and private landowners work to establish and achieve targets for bird conservation, often by securing important wetlands and adjacent upland habitat. The agriculture sector plays an important role in these Joint Ventures.

David Shackelton Photo

Delta Farmland and Wildlife Trust

- The Delta Farmland and Wildlife Trust works to conserve wildlife habitat in the Fraser Delta, an area that contains both internationally significant wildlife habitat and highly productive farmland. The delta is recognized as one of Canada's Important Bird Areas due to the large numbers of migratory and resident birds that congregate in the delta at various times throughout the year. It is estimated that at least 1.5 million birds from 20 countries travel through the delta on an annual basis. At the same time, the combination of rich soils and optimal climate make the region one of BC's most productive agricultural areas; it produces a wide variety of vegetables, berries and dairy products. The Trust includes members of the agriculture community, stewardship groups, government agencies and universities. Among other activities, the Trust provides funding for set-asides, winter cover crops and management of field margins to enhance habitat values.

The Land Conservancy

Snake Barrier Fencing Project

- The South Okanagan-Similkameen Stewardship Program (SOS Stewardship Program) works to protect and enhance species at risk, plant communities, and habitats in the South Okanagan-Similkameen, an area that is one of the four most endangered ecosystems in Canada. Private landowners, including farmers and ranchers, play a vital role in protecting biodiversity in this area. The SOS Stewardship Program helps them:
  - find information on native plants and wildlife
  - prepare conservation plans, habitat assessments, and management plans
  - provide information on potential wildlife interactions
  - complete habitat restoration projects
  - protect habitat through the use of stewardship agreements and conservation covenants

South Okanagan-Similkameen Stewardship Program

Salmon River Roundtable

Salmon River Stream Bank Restoration

- The Salmon River Watershed Roundtable was formed out of concern over the deterioration of the Salmon River, located in the North Okanagan/Shuswap, and its salmon population. Two key factors were impacting water quality and salmon: urban development and agriculture. In 2007–2008, the Roundtable delivered an Equivalent Agri-Environmental Plan on a watershed basis under the Canada – BC Environmental Farm Plan Program. The objective was to work with individual farms and ranches to complete EFPs and adopt specific Beneficial Management Practices (BMPs) to mitigate agricultural impacts on the river. The BMPs selected for the watershed included using fencing to exclude cattle from the river and providing off-stream watering systems.

Salmon River Watershed Roundtable

Jared Hobbs photo

Burrowing Owl (red-listed)

- The Burrowing Owl Recovery Program began in 1990 with a goal of re-establishing self-sustaining populations of Burrowing Owls within their historic range in BC's southern interior. The program includes the captive-breeding and release of owls, construction of artificial burrows in release habitats, and field monitoring of released owls, their offspring, and migrant returns. The success of the program relies heavily on the support of private landowners, including farmers and ranchers. In addition to providing access to their properties for recovery activities, contributing landowners have modified their grazing regimes and are using management practices that support a healthy grassland ecosystem. The program has also raised public awareness about the difficulties of trying to reverse environmental change and the need to ensure effective conservation measures are developed for grassland species and habitats.[xix]

THINKING GLOBALLY

What Are the Global Benefits of Maintaining Biodiversity?

Biodiversity not only benefits agricultural operations, it provides a range of goods and services that are of value to society as a whole.

These include:

- fresh water
- food, fibre, and fuel
- biochemicals
- genetic resources[xx]
- water purification and flow regulation - maintains drinking water supplies
- food and raw material production - maintains food and commodity supplies
- carbon storage and oxygen production - maintains air quality and reduces impacts of greenhouse gas emissions
- protection from natural hazards - provides flood control and recovery from drought and forest fires
- cultural services - provide educational, aesthetic, recreational and spiritual values[xxi]

NASA

Southwestern British Columbia

Conserving biodiversity is an efficient and effective means of maintaining these types of services. Replacing ecological goods and services with technology is frequently very expensive, rarely practical, and often not possible.

Maintaining biodiversity can be seen as an insurance policy for guarding against undesirable changes in ecosystem functioning on a global scale

Did You Know…

In 1997, the global economic value of 17 ecosystem services was estimated to average US$33 trillion per year compared to the global gross national product of US$18 trillion per year.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253-260.

Ducks Unlimited Canada

Deforestation

What Are the Broader Threats to Biodiversity?

The diversity of ecosystems, species, and genetic resources around the world is faced with significant threats associated with human activity. Over the last 50 years, humans have changed global ecosystems more rapidly and extensively than in any other period in human history. Deforestation due to urban development, resource extraction, and the conversion of forests to agricultural land and pasture threatens native forests. Urban development, resource extraction, and livestock grazing also place grasslands, wetlands, and other ecosystems under pressure.

In BC, more than half of the ecological communities identified in the province are classified as either "red-" or "blue-listed" by the BC Conservation Data Centre,[xxii] meaning they are extirpated, endangered, or threatened (red-listed), or are of special concern (blue-listed).

Doug Backlund photo

Yellow-breasted Chat (red-listed)

In terms of species and genetic diversity, a number of international studies have shown that the population size and geographic range of most of the world's native species are declining.[xxiii] Over the past few hundred years, species extinction rates due to human-related impacts increased by as much as 1000 times compared to the rates that occurred throughout Earth's history.[xxiv] In BC, approximately 1400 of the more than 4000 plant and animals species recorded in the province have been either red- or blue-listed by the BC Conservation Data Centre. Of these species, more than 200 are recognized by the federal Committee on the Status of Endangered Wildlife in Canada as being either endangered, threatened, or of special concern.[xxv] The continued existence of some of these species in BC is uncertain, especially where their population numbers have dropped to very low levels. For example, the entire population of the Yellow-breasted Chat in BC consisted of just under 200 breeding pairs in 2009, owing in part to continued loss of its riparian nesting habitat.[xxvi] While some native species may be uncommon, threatened, or endangered, they can be key components of healthy ecosystems. They are called "keystone" or indicator species. A keystone species has a disproportionate effect on its environment relative to its abundance.

Did You Know…

More than 30% of BC's species at risk are associated with grassland habitats.

http://www.bcgrasslands.org/grasslands/sar.htm

Threats to biodiversity, both globally and in BC, can be grouped into five categories.[xxvii]

- habitat loss and fragmentation
- introductions of invasive alien species
- overharvesting and accidental mortality
- nutrient loading and other pollution
- climate change

Most species will be exposed to more than one of these threats, and may be exposed to all of them, over the course of their life.

Habitat Loss and Fragmentation

Habitat loss and fragmentation is a major factor in the decline of ecosystem, species, and genetic diversity worldwide. In a study designed to identify the threats facing 488 species at risk in Canada, habitat loss was found to be a significant threat in 84% of the cases.[xxviii] Habitat loss can take many forms but is typically a result of the reduction or degradation of native habitat due

to any of the following activities: urban development (including residential, commercial, and industrial land uses), agriculture (crop production and livestock grazing), human disturbance (recreation, tourism, transportation), resource extraction (logging, mining, fishing, oil and gas exploitation), and infrastructure development (power lines, dams, diversions, pipelines, utilities).

Habitat Fragmentation

In general terms, the larger, more diverse, and less fragmented native habitat there is available, the greater the diversity of species present. Some species of plants and wildlife do very well on the edges of habitat patches (e.g., a forest bordering an area of cropland). However, as patches of habitat become smaller, some populations that depend on undisturbed habitat either become very small or vanish all together. The impact of net decreases in the amount of available habitat is compounded by fragmentation of the remaining habitat into isolated patches due to the building of roads, construction of utility corridors, or conversion to other land uses. Fragmentation of habitat makes it increasingly difficult for species to move safely across the landscape in search of shelter, food, or mates.

Streamside Degradation

Habitat loss and fragmentation is not restricted to terrestrial areas. Because riparian areas tend to be relatively small, they are particularly vulnerable to alteration. For example, the removal of streamside vegetation or the disturbance of stream banks can reduce the availability and quality of riparian habitat, and it can disrupt the ability of species to move freely along streamside corridors. Physical disturbances of stream beds and wetland bottoms, and straightening, damming, and dyking of watercourses can also impact both terrestrial and aquatic biodiversity.

Oxeye Daisy

Introductions of Invasive Alien Species

The introduction and spread of alien species poses a significant threat to ecosystems around the world. These species are sometimes also called "exotic," "introduced," "non-native," "non-indigenous", or "invasive" species. Invasiveness refers to the ability of a plant or animal species to spread beyond its introduction site and become established in new locations. Invasive alien species compete with native species for available resources, and in some cases, contribute to the decline or loss of native species. Invasive plant species, such as spotted knapweed, are well known for their ability to spread rapidly in disturbed and inappropriately grazed areas. They also compete with native plants for moisture and soil nutrients but often do not provide suitable forage for wildlife or livestock. Invasive alien plant species reduce native biodiversity and can be extremely difficult and costly to control once established.

Invasive alien animal species also take their toll on native ecosystems. For example, invasive aquatic species such as yellow perch, bass, black crappy, and carp threaten native fish stocks in BC; introduced bullfrogs present a serious threat to native amphibians; and European Starlings often compete

Did You Know…

Each year in BC, invasions of alien plants cause an estimated 50% loss in available livestock forage.

Cranston, R. 2001. Noxious Weeds and the B.C. Weed Control Act. Page 4 In: *B.C. Grasslands*. Grasslands Conservation Council of British Columbia Magazine, April 2001. Kamloops, BC.

with native bird species for nest sites. The Committee on the Status of Endangered Wildlife in Canada estimates that 25% of endangered species, 31% of threatened species, and 16% of species of special concern in Canada are negatively affected by invasive alien species.[xxix]

Additional information on the threats posed by invasive alien species can be found in Appendix 4.

Overharvesting and Accidental Mortality

Overharvesting through fishing, hunting, trapping, or direct harvesting for food, cultural, or medicinal purposes has been implicated in the decline of many native species. Fish are especially vulnerable to overharvesting, but terrestrial species, particularly certain top predator species, are also affected. Some of these species, such as wolves and bears, may also be killed as a result of conflicts with agricultural operations and urban populations. Accidental mortality resulting from road kills further threatens many native species, such as badgers and rattlesnakes.

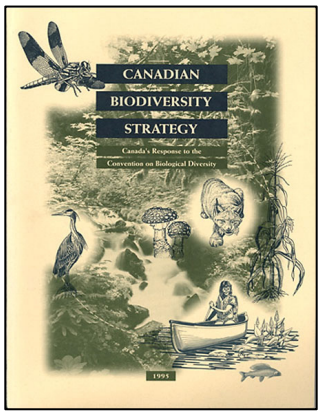
Nutrient Loading and Other Pollution

The availability of commercial synthetic fertilizers has allowed significant increases in agricultural production to be made worldwide, but it has also resulted in the accumulation of excessive levels of nitrogen and phosphorus in soils and water bodies. Excess nutrients in aquatic habitats can threaten biodiversity by reducing oxygen levels, causing toxic algal blooms, or altering ecosystems so that nutrient-tolerant species are favoured. Other agricultural and industrial contaminants, including pesticides, solvents, oils, and fuels can contribute to water and air pollution, which degrades habitat quality and threatens biodiversity. Amphibian species, in particular, are especially vulnerable to pollution. Their populations are known to be declining worldwide.[xxx]

Subsurface Manure Injection

Silage Leachate

Climate Change



The Earth's climate is changing as human activities and natural forces increase the amount of greenhouse gases in the atmosphere. Climate change is predicted to have significant impacts on the Canadian climate, whether it causes earlier snowmelt, increased summer temperatures, longer growing seasons, or reduced precipitation levels.[xxxi] These impacts, in turn, are expected to influence water availability, which will affect both aquatic and terrestrial biodiversity. It is also expected that in drier areas, climate change will lead to salinization, desertification, and increased rates of soil erosion and degradation, which can affect soil biodiversity and function.[xxxii] The frequency and severity of natural disturbances, such as fire and disease, is forecasted to change, which could expose ecosystems and species to increased mortality rates. Changes in climate patterns could also affect the natural distribution patterns of native species.

What Are the Broader Commitments to Conserving Biodiversity?

Actions to support biodiversity conservation at the farm scale are supported by strong national and international commitments to preserving ecosystem, species, and genetic diversity. At the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for sustainable

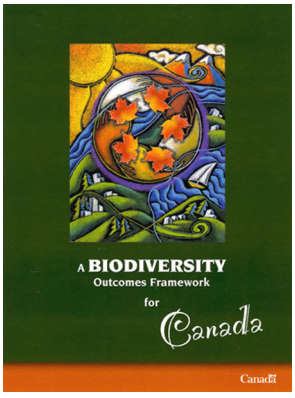
development, which included the Convention on Biological Diversity. Canada was the first industrialized country to sign and ratify the Convention, which officially came into force in 1993. The Convention establishes three main goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources. There are presently 189 Parties (member states) to the Convention worldwide. In April 2002, the Parties committed to a target of achieving a significant reduction in the current rate of biodiversity loss at the global, regional, and national level by 2010.

Mark Jennings photo

Red-legged Frog (blue-listed)

Another example of this strong international commitment is CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, whose aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES came into effect in 1975, and currently includes 172 Parties around the world. Although agreements like the Convention on Biological Diversity and CITES are legally binding on the Parties, they do not take the place of national laws. Rather, they provide a framework upon which each country can design its own legislation to ensure that its international obligations are met at the national level.

In Canada, the adoption of biodiversity conservation measures within agricultural landscapes has been guided by the Canadian Biodiversity Strategy (1995) and the Agriculture and Agri-Food Canada (AAFC) Biodiversity in Agriculture Action Plan (1998), and subsequent departmental sustainable development strategies. The Canadian Biodiversity Strategy is essentially a blueprint for the conservation and sustainable use of Canada's living resources. It recognizes existing constitutional and legislative responsibilities in Canada while promoting cooperation among different levels of government to advance biodiversity conservation goals. AAFC's 1998 plan outlined the department's specific commitments to biodiversity conservation as a component of achieving sustainable agriculture. It has since been reinforced by programs such as those contained within the Environment Chapter of the Agriculture Policy Framework (2003–2008). Provincial governments in Canada have also adopted various programs and policies in support of the goals of the Canadian Biodiversity Strategy.



The national and international commitments described above are supported by a legislative and regulatory framework in Canada, with the federal *Species at Risk Act* as the most obvious example. The Act came into force in Canada in 2003. Its primary aim is to protect species and their habitats from extinction. The Act also established the Committee on the Status of Endangered Wildlife in Canada as an advisory body charged with producing, updating and maintaining an official list of species at risk of extinction in Canada. Additional information on the *Species at Risk Act* and other relevant legislation and regulations is provided in Appendix 3. Additional background information on national and international obligations to conserve biodiversity is available from the following organizations. Their contact information is provided in Appendix 4:

- Convention on Biological Diversity
- Canadian Biodiversity Information Network
- *Species at Risk Act* Public Registry

WHERE CAN I LEARN MORE ABOUT BIODIVERSITY?

The process of developing a Biodiversity Management Plan begins on the farm, but it can lead to increased awareness about the role the farm plays in the larger landscape. You can learn more about biodiversity from the internet and the following resources. Their contact information is provided in Appendices 2 and 4.

Ducks Unlimited Canada

Wetland Ecosystem

Government Agencies

- Agriculture and Agri-Food Canada
- BC Conservation Data Centre
- BC Ministry of Agriculture and Lands
- BC Ministry of Environment
- BC Ministry of Forests and Range
- Environment Canada
- Fisheries and Oceans Canada
- Provincial Agricultural Land Commission

Jared Hobbs photo

Sage Thrasher (red-listed)

Specialists

- EFP Planning Advisors
- Registered Professional Agrologists
- Registered Professional Biologists
- Registered Professional Foresters
- Industry Specialists

Conservation Initiatives and Non-governmental Agencies

- Biodiversity Conservation Strategy for the Greater Vancouver Region
- Burrowing Owl Recovery Program
- Canadian Intermountain Joint Venture
- Delta Farmland and Wildlife Trust
- Ducks Unlimited Canada
- Grasslands Conservation Council of BC
- Invasive Plant Council of BC
- Pacific Coast Joint Venture
- Partners in Flight
- Salmon River Watershed Roundtable
- South Okanagan–Similkameen Conservation Program
- South Okanagan–Similkameen Stewardship Program
- Yellowstone to Yukon Conservation Initiative

Farmland and Semi-natural Areas within a Natural Landscape

Endnotes

[i] Wild Farm Alliance. (n.d.). Wild pollinators: Agriculture's forgotten partners. Briefing paper series. Retrieved on June 11, 2007 from the Wild Farm Alliance Website: http://www.wildfarmalliance.org.

[ii] Food and Agriculture Organization of the United Nations. (2007). Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and principles. Interdepartmental Working Group on Climate Change.

[iii] Seavy, N.L., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, R. Kelsey, S.L. Small, J.H. Viers, and J.F. Weigand. 2009. Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research. Ecological Restoration 27: 330–338.

[iv] Heller, N.E. and E.S. Zavaleta. 2008. Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation 142:14–32. Cited in Seavy, N.L., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, R. Kelsey, S.L. Small, J.H. Viers, and J.F. Weigand. 2009. Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research. Ecological Restoration 27: 330–338.

[v] Ducks Unlimited Canada. 1998. Understanding Wetlands: A Wetland Handbook for British Columbia's Interior. Ducks Unlimited Canada, Kamloops, BC.

[vi] Austin, M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC. Victoria, BC. Available at: www.biodiversitybc.org

[vii] Jones, G.and Gillett, J. (2005). Intercropping with sunflowers to attract beneficial insects in organic agriculture. Florida Entomologist, 81, 91-96.

[viii] Sustainable table. (n.d.). The issues: Biodiversity. Retrieved on May 14, 2007 from http://www.sustainabletable.org/issues/biodiversity/

[ix] Grassland Conservation Council of BC. 2004. BC Grasslands Mapping Project: A Conservation Risk Assessment Available at http://www.bcgrasslands.org/projects/conservation/mapping.htm

[x] Austin, M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. *Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC*, Victoria, BC. Available at: www.biodiversitybc.org

[xi] Austin, M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. *Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC*, Victoria, BC. Available at: www.biodiversitybc.org

[xii] Javorek, S.K., R. Antonowitxch, C. Callaghan, M. Grant, and T. Weins. 2005. Wildlife Habitat on Farmland. Chapter 24 *In* A. Lefebvre, W. Eilers, and B.Chunn (eds). Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series - Report #2. Agriculture and Agri-Food Canada, Ottawa, Ontario

[xiii] Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2004. Canadian Species at Risk. COSEWIC, Ottawa (Ont.). http://www.cosewic.gc.ca/eng/sct0/sar_2004_11_e.cfm.

[xiv] BC Ministry of Agriculture and Lands. (2005). Irrigation system assessment Guide. BC Agriculture Council.

[xv] Fisheries and Oceans Canada. (n.d.).

[xvi] http://ec.europa.eu/agriculture/glossary/index_en.htm

[xvii] http://www.scienceandsociety.emory.edu/GMO/Environment.htm

[xviii] IUCN. 2007. Current Knowledge of the Impacts of Genetically Modified Organisms on Biodiversity and Human Health: An Information Paper. http://cmsdata.iucn.org/downloads/ip_gmo_09_2007_1_.pdf

[xix] Mackintosh, M., E. Leupin, and D. Brodie. 2004. Burrowing Owls in B.C.—Science and Stewardship in Action. In T.D. Hooper (editor). Proceedings of the Species at Risk 2004 Pathways to Recovery Conference. 1 March 2–6, 2004, Victoria, B.C. Species at Risk 2004 Pathways to Recovery Conference Organizing Committee, Victoria, B.C.

[xx] Austin, M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. *Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC*, Victoria, BC. Available at: www.biodiversitybc.org

[xxi] Adapted from Costanza, R. et al. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 250-253.

[xxii] BC Conservation Data Centre. 2007. BC Species and Ecosystems Explorer. BC Ministry of Environment. Victoria, BC. http://srmapps.gov.bc.ca/apps/eswp Accessed January 28, 2008.

[xxiii] Convention on Biological Diversity. 2006. Global Biodiversity Outlook. Chapter 2: The 2010 Biodiversity Target: Establishing Current Trends. pp. 23-25.

[xxiv] Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute. Washington, DC.

[xxv] BC Conservation Data Centre. 2007. BC Species and Ecosystems Explorer. BC Ministry of Environment. Victoria, BC. http://srmapps.gov.bc.ca/apps/eswp Accessed January 28, 2008.

[xxvi] Christine Bishop, Environment Canada, pers. comm.., Feb. 16, 2010.

[xxvii] Adapted from Environment Canada. 2005. A Literature Review of Risks and Benefits of Agriculture to Biodiversity and Biodiversity to Agriculture. National Agri-Environmental Standards Initiative Technical Series Report No. 1-15. 149 pp.

[xxviii] Venter et al. 2006. Threats to Endangered Species in Canada. BioScience. 56: 1-8.

[xxix] Rankin et al. 2004. Invasive Alien Species Framework for BC: Identifying and Addressing Threats to Biodiversity. Prepared for: Biodiversity Branch, Ministry of Water, Land & Air Protection. Victoria, BC. 96 pp.

[xxx] Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute. Washington, DC.

[xxxi] Merritt et al. 2006. Hydrologic response to scenarios of climate change in subwatersheds of the Okanagan Basin, British Columbia. Journal of Hydrology. 326: 79-108.

[xxxii] Neilsen et al. 2006. Potential impacts of climate change on water availability for crops in the Okanagan Basin, British Columbia. Canadian Journal of Soil Science. 86: 921-936.