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 Plan
- 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.

DID YOU KNOW?

Maintaining biodiversity can enhance agricultural productivity and stability.

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.

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:

1. native areas,
2. semi-natural areas,
3. locations, patterns, and seasonal availability of habitats,
4. connections between native and semi-natural areas,
5. structurally diverse habitats,
6. healthy ecosystems,
7. species and genetic diversity, and
8. 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 tos" 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,
- examples of agriculture and biodiversity projects in BC,
- 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.

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

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 Climate Change 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.

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.

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.

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.

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.

Ecosystem Diversity
PHOTO: THE LAND CONSERVANCY

Species Diversity

Genetic Diversity
PHOTO: AVIAN RESEARCH CENTRE AGASSIZ

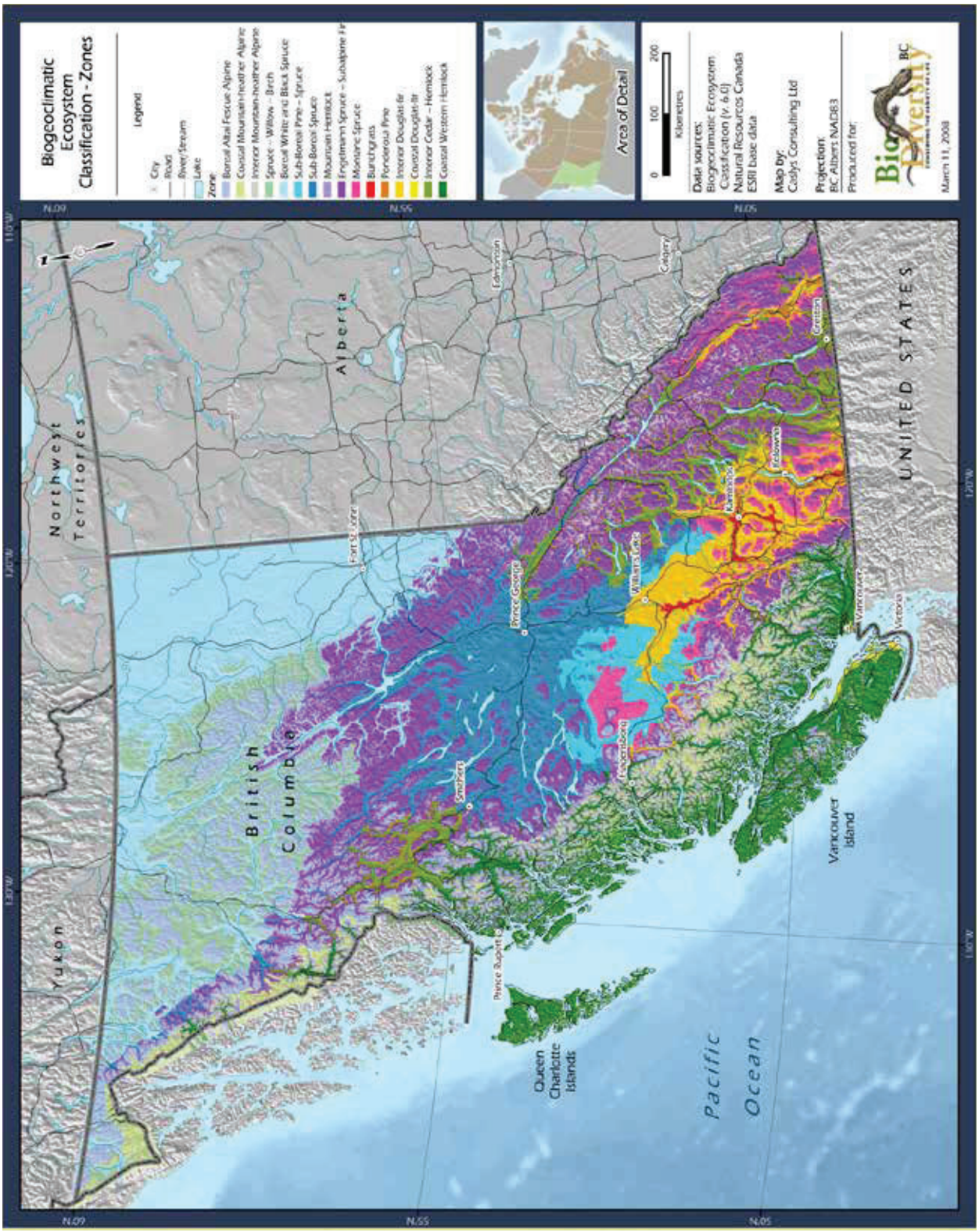

Figure 1 Biogeoclimatic Ecosystem Classification Zones in BC

Biodiversity in BC

BC is a biologically diverse region. It has:

- 468 species of fish;
- 22 species of amphibians;
- 18 species of reptiles and turtles;
- 142 species of mammals;
- 488 species of birds;
- 2,790 species of vascular plants, which includes trees, shrubs, grasses and ferns;
- 1,600 species of lichens;
- 10,000 species of fungi;
- 35,000 species of insects;
- 714 species of mosses.[1]

Fall migration of Salmon
PHOTO: ISABELLE GROC

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]

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[1] BC Conservation Data Centre. Species and Ecosystems Explorer. Available at: http://a100.gov.bc.ca/pub/eswp/ (Accessed March 30, 2018) and Biodiversity BC http://www.biodiversitybc.org/EN/main/20.html (Accessed March 30, 2018).

[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 Coltumbia. 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.

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.

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

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.

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:

- 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.

Productive forage land

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:

- Native bees generally spend more hours during the day pollinating than honeybees.
- Native bees are usually more active in cold and wet weather than 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]

Pollination

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.

Barn Owl (blue-listed)

DID YOU KNOW?

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

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:

- 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.

Shelterbelt
PHOTO: NIELS HOLBEK

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;
- 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.

Diverse mix of cropped and uncropped land

Agriculture, Biodiversity and Climate Change

Biodiversity provides resilience, which allows agriculture to adapt 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, and/or minimize crop losses as a result of extreme weather events.
- 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, increasing their resilience 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.

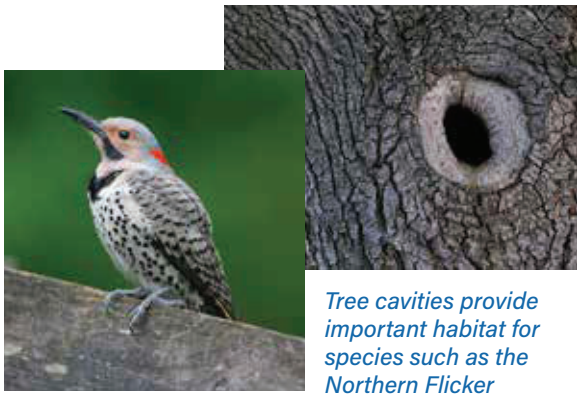
Flooding

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.



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

DID YOU KNOW?

In 2011, nearly one-third (30.2%) of agricultural land in Canada was wildlife habitat, which represented 19.6 million hectares.

- Three-quarters of wildlife habitat reported by Canadian farmers was natural land for pasture (75.0%), and the remainder was woodlands and wetlands (25.0%).
- Two in five farms (40.3%) reported natural land for pasture while one in two farms (49.9%) reported woodlands and wetlands in 2011.
- Agriculture and wildlife: A two-way relationship. 2012. Statistics Canada.
- http://www.statcan.gc.ca/pub/16-002-x/2015002/article/14133-eng.htm

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]

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 upland areas. In some intensively farmed areas of the province, retained aquatic and riparian areas provide the only opportunity for connecting habitats.

Riparian area

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.

A report by Statistics Canada (2012) noted that the majority of wildlife habitat reported by Canadian farmers was natural land for pasture, which represented 22.7% of all agricultural land, and the remainder was woodlands and wetlands, which accounted for 7.6% of all agricultural land.

Natural land for pasture is largely found in Alberta (6.4 million hectares), followed by Saskatchewan (4.8 million hectares), Manitoba (1.5 million hectares) and British Columbia (1.4 million hectares). British Columbia reported the largest area of natural land for pasture as a proportion of total agricultural land (53%).

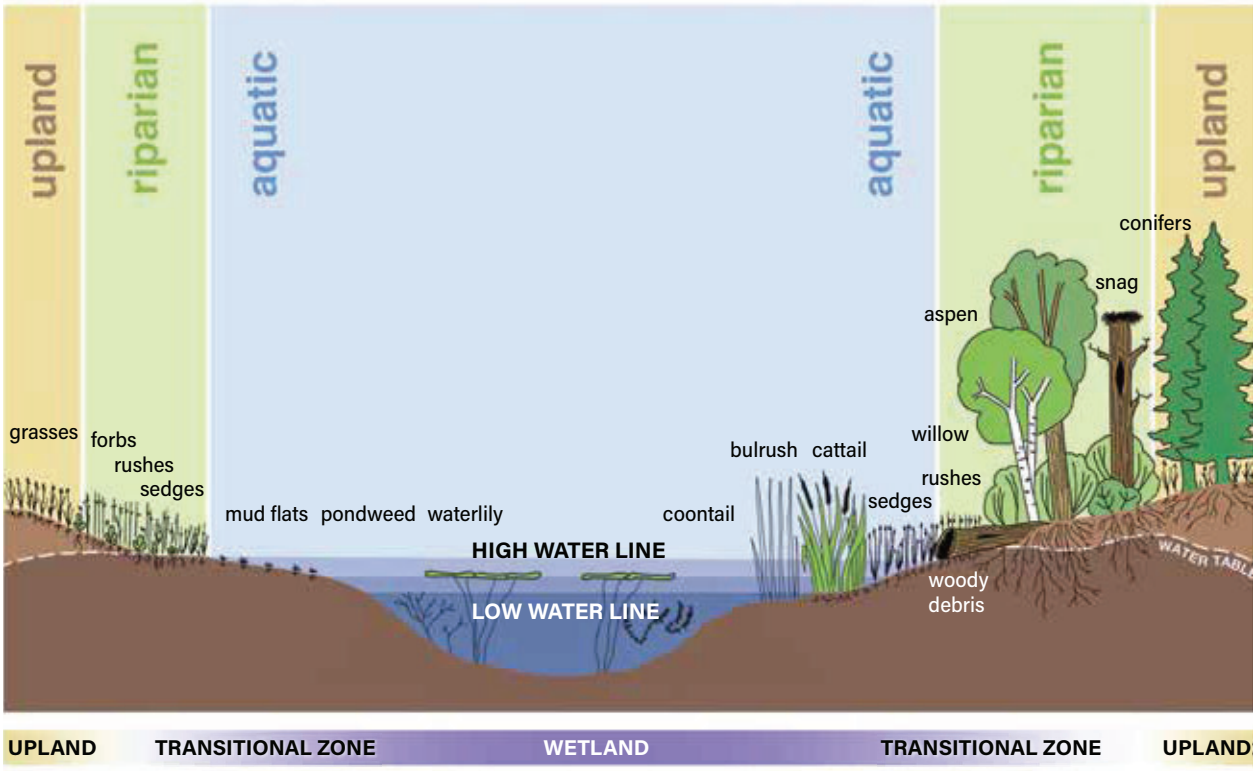


Figure 2: Relationship among aquatic, riparian, and terrestrial habitats

IMAGE: DUCKS UNLIMITED CANADA

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.

Structurally diverse riparian habitat

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.

Corridors between native and semi-natural areas

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.

Off-stream watering helps to maintain healthy ecosystems

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.

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.

Using livestock to manage competing vegetation

PHOTO: LISA ZABEK

Multiple species grazing

Crop rotation

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.

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.

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.

Perennial cover

PHOTO: MINISTRY OF FOREST AND RANGE

Intercropping – grass in a harvested corn stand

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]

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.

Agroforestry – alley cropping

The Diminishing Diversity of Our Food Supply[viii]

Since the 1900s, some 75% of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties.

Today, 75% of the world's food is generated from only 12 plants and five animal species.

Of the 4% of the 250 000 to 300 000 known edible plant species, only 150 to 200 are used by humans. Only three - rice, maize and wheat - contribute nearly 60% of calories and proteins obtained by humans from plants.

Animals provide some 30% of human requirements for food and agriculture and 12% of the world's population live almost entirely on products from ruminants.

Source:

FAO. 1999. Women: users, preservers and managers of agrobiodiversity
http://www.fao.org/docrep/x0171e/x0171e03.htm

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.

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:

- Agriculture and urban development continue to impact the grasslands of Southern Okanagan. [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]
- More than 30% of BC's Species at Risk depend on grasslands for their survival. [xii]

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 7.3% of Canada's land base[xiii] , yet more than half of the terrestrial species at risk are found in agricultural areas.[xiv] 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, density, connectivity, 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: 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.[xv] These impacts affect both aquatic and terrestrial ecosystems and can be detrimental to biodiversity.

Drip irrigation

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.[xvi] 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 tbe 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.

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 (see description of "structural diversity" on p 17 and in the Glossary). 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.

Heavily grazed landscape

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.

https://pdfs.semanticscholar.org/3498/f30c6f61f79d15285a772aadaf2a9972161e.pdf?_ga=2.226081881.253763449.1583357755-1818849551.1583357755

Spray tower reduces pesticide drift
NIELS HOLBEK PHOTO

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.[xvii] 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.[xviii] 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.[xix]

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

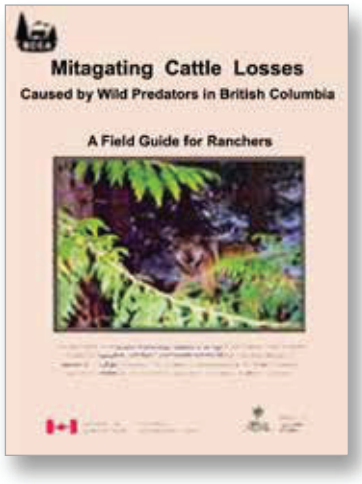
While there are many benefits of managing for biodiversity, it is important to recognize that not all species have a positive effect on agricultural production. There a number of animal species, both native and introduced, that can cause significant impacts on agricultural operations, including damage 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;
- elk and other large mammals can damage fencing;
- 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.

Fencing damaged by elk.



Species at Risk and Agriculture

A species at risk is defined by the federal *Species at Risk Act* (SARA) as an extirpated, endangered or threatened species or those species that may become threatened or endangered due to a combination of their biological characteristics and identified threats. SARA protects species at risk by providing legal protection to listed species under the Act and their residences. Listed aquatic species (e.g., fish and marine plants) and migratory birds are protected on all lands and water in Canada. However, individuals of other listed species are only protected on federal land, including indigenous reserves and national parks, unless an order is made under the Act. Orders typically occur in cases where provincial action is deemed insufficient to protect listed species; provisions of the federal *Species at Risk Act* (known as the 'safety net') could then be invoked at the provincial level on crown and private land.

There are several species listed as either endangered or threatened in BC through SARA. A significant number of these occur in areas that could be impacted by agriculture. See the *Species at Risk Public Registry* and *Aquatic Species at Risk* resources for more information.

There is no stand-alone legislation for protection of species and ecosystems at risk in British Columbia. Management of SAR in BC is coordinated through the *Canada-BC Agreement on Species at Risk*. Provincially threatened and endangered species are listed in Schedule D and E of the *BC Wildlife Act: Designation and Exemption Regulation*. The province's *Conservation Data Centre (CDC)* provides information on BC's wildlife, plants, and ecosystems, including their conservation status using terms such as "red-listed", "blue-listed", and "yellow-listed". Other provincial laws applicable to SAR include the *Forest and Range Practices Act*, the *Oil and Gas Activities Act*, the *Water Sustainability Act*, and the *Land Act*.

The *Riparian Areas Protection Act* and *Riparian Areas Regulation* were enacted to protect riparian areas from development to better support fish and fish habitat. The regulation applies to those developments under Local Government authority (e.g., construction of a residential dwelling) in certain geographic regions, and most normal farm practices are exempt.

The provincial and federal governments work together on recovery planning to ensure species do not become extinct due to human activity. Recovery means stopping or reversing declines in a species' population and removing threats to a species' recovery so it can persist in its natural environment.

The recovery process for BC is fully described in the *British Columbia Guide to Recovery Planning for Species and Ecosystems at Risk.*

The federal recovery process is described in the *Species at Risk Public Registry – Recovery Strategies.*

Recovery Plans identify survival and recovery habitat for threatened or endangered species, and list specific threats and mitigation strategies. They can be complemented with Action Plans that guide implementation of the recovery strategy. Management Plans describe specific conservation measures and land use activities to ensure species of special concern do not become endangered or threatened.

It can be challenging to manage species at risk since we don't always know exactly where they exist within the landscape. Under SARA, the Committee of the Status of Endangered Wildlife in Canada (COSEWIC) assesses SAR and then lists them. After listing, the recovery planning can begin. In BC, the Conservation Data Centre conducts a status assessment, after which the SAR is legally listed and recovery planning begins at the provincial level. Critical habitat is also assessed during the recovery planning process. SARA defines critical habitat as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or action plan for the species". Critical habitat can be designated on both public and private land (e.g. farmland, grazing areas, range lands and pastures). For example, the *Recovery Strategy for the Oregon Spotted Frog*[xx] , includes critical habitat that has been described as:

- Areas of wetland, streams, or ponds where any life stage (e.g. tadpoles or adults) of Oregon Spotted Frog occurs or has been known to occur.
- Other suitable habitat connected by streams to known habitat (within 3 km), or other ponds and streams not connected, but close to known habitat (within 400 m).
- Other habitat, close by which is needed to maintain the necessary attributes of its habitat (extending out 45 m from the high water mark in agricultural land).

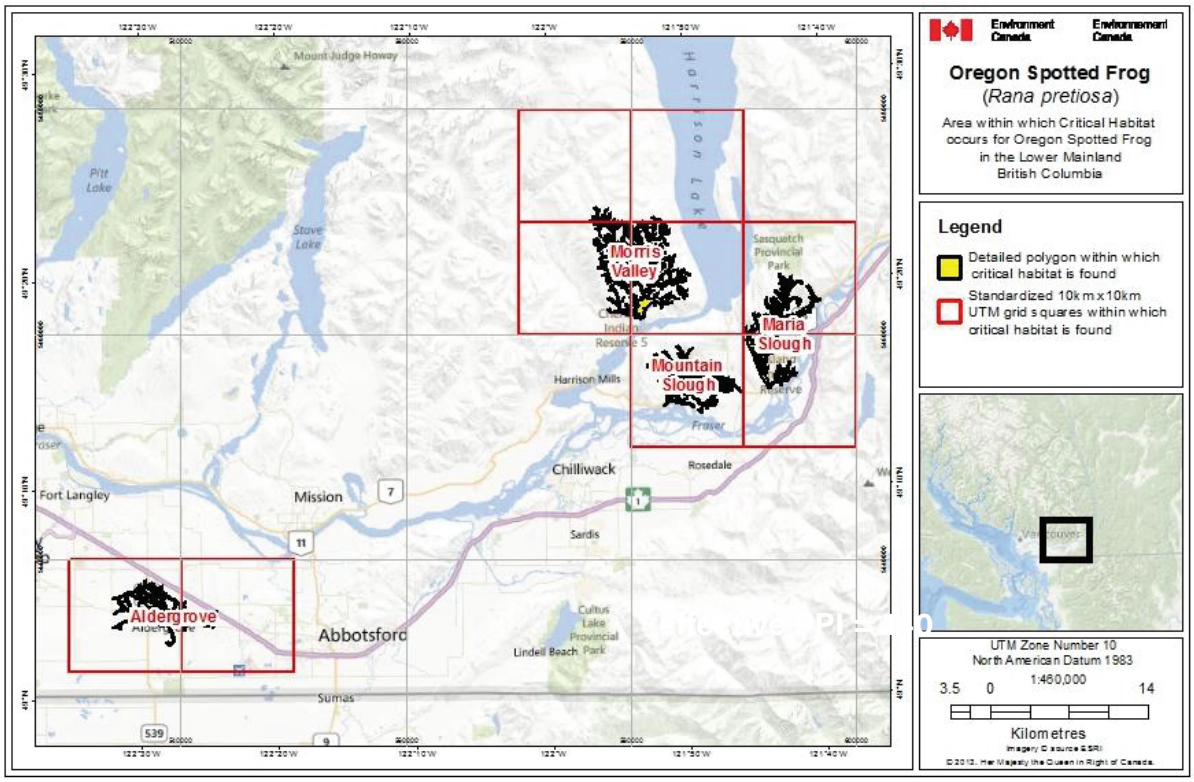


Figure 3: Area of critical habitat for Oregon Spotted Frog in B.C. (Source: Recovery Strategy for the Oregon Spotted Frog in Canada, 2015. Government of Canada).

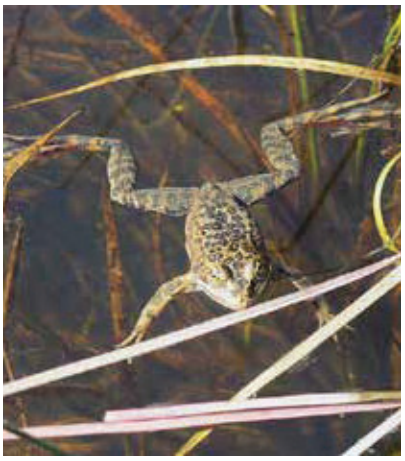
Habitat required by many SAR often covers a large area. Meeting this need means that cooperation between both public and private landowners is essential to protect SAR and their habitat. Voluntary cooperation of landowners through land stewardship is a key component of recovery strategies; even stewardship activities at the small scale can make a difference. The Stewardship Centre of British Columbia provides voluntary stewardship guides for species at risk management, some of which are specific to agriculture. Examples of beneficial management practices include:

- Protecting sensitive habitat by establishing covenants and conservation agreements;
- Timing activities to reduce potential disturbance during sensitive times of a species' life cycle, (e.g., breeding season);
- Restoring and enhancing sensitive habitat;
- Applying and storing manure responsibly;
- Using manual equipment rather than heavy equipment where appropriate to minimize habitat disturbance and damage; and
- Partnering with organizations that manage SAR.

If a landowner should discover a Species at Risk on their property, they are encouraged to notify the Canadian Wildlife Service, as new information on a listed SAR is highly valuable to recovery teams; however, this action is also voluntary.

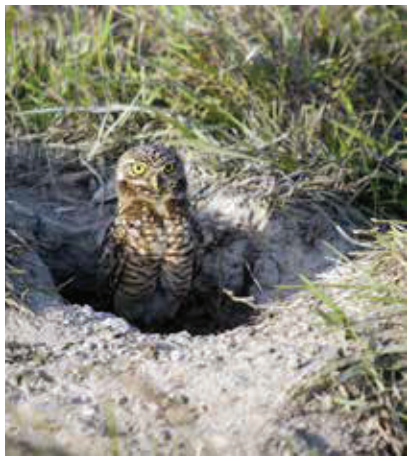
More information on Acts and Regulations pertaining to Species at Risk in BC can be found here:

Species At Risk legislation in BC - website



Oregon Spotted Frog. (Mid-Columbia River Refuges) (Red-listed by the BC Conservation Data Centre and designated as endangered by COSEWIC, and legally designated as an Endangered species under the federal Species At Risk Act (SARA)).

Nuttall's Cottontail. (Justin Wilde) (Blue-listed by the BC Conservation Data Centre and designated as a species of special concern by COSEWIC).



Burrowing Owl (Red-listed by the BC Conservation Data Centre and legally designated as an Endangered species under the BC Wildlife Act).

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 4).

Much of BC's farmland is located within the Agricultural Land Reserve (Figure 5), 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.

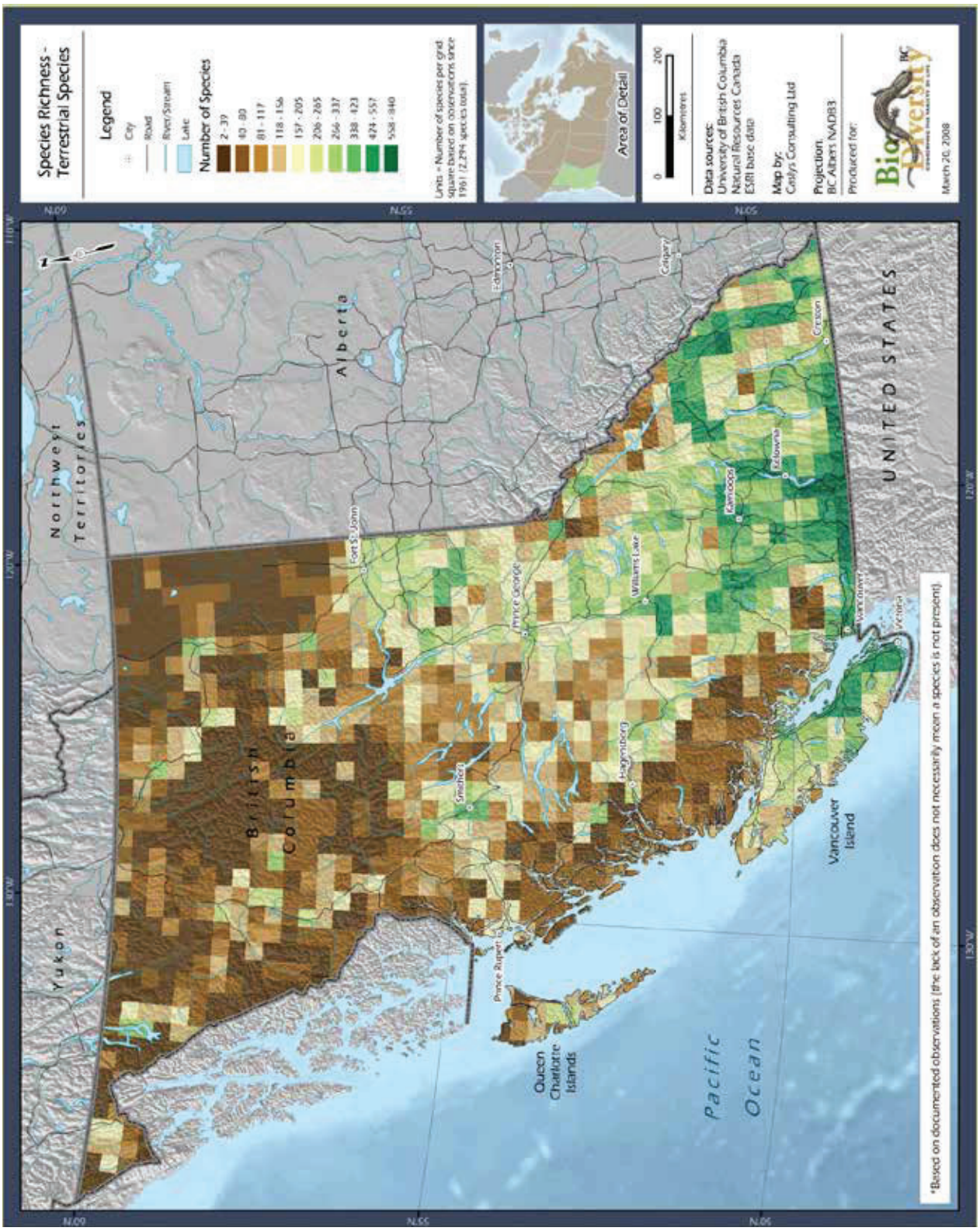


Figure 4: Species Richness – Terrestrial Species in BC

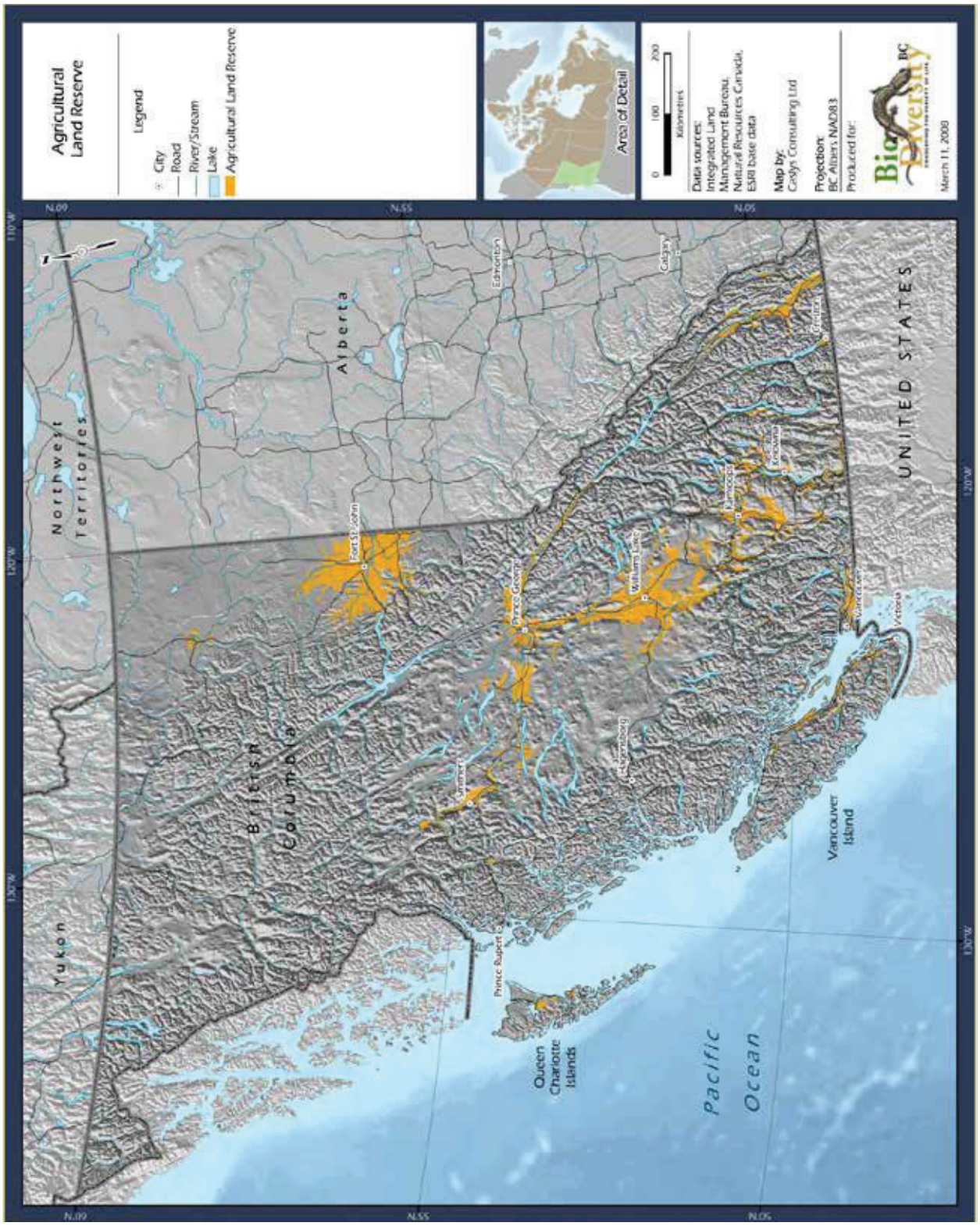


Figure 5: Agricultural Land Reserve

Building Connections across Landscapes

Treed corridor
AGRICULTURE AND AGRI-FOOD CANADA

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, millions of migratory birds may travel thousands of kilometres along the Pacific flyway between their breeding and wintering habitats, and may rely on farmland along the way as important stopover points for resting and feeding. One migrating species is the Tundra Swan, which breeds in Alaska and winters on the Pacific coast, in BC and California, migrating 6,000 km between these areas. 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. These strategies can also benefit us, as many of these species provide important services to agriculture, including pollination, pest control, and nutrient cycling.

Tundra swan. A blue-listed species in BC.
(OREGON DEPARTMENT OF FISH & WILDLIFE)

Agricultural land use activities can have impacts on connectivity, making it less suitable for wildlife (including species at risk). Tree clearing, vegetation maintenance, and drainage projects, for example, can affect connectivity by creating smaller, fragmented habitat patches. These small patches may not be big enough to support many species and can isolate populations, leading to a reduction in genetic diversity and population health. Habitat fragmentation has led to significant declines in populations of birds, mammals, fish, amphibians, reptiles, and insects and the benefits that these species can provide.

Maintaining or restoring habitat connectivity in fragmented landscapes is a beneficial management practice for wildlife. Connected habitat helps wildlife move across the landscape to meet their different life needs (e.g., find food, shelter, mates, and raise young). Corridors help bridge the gap between fragmented patches and larger natural areas, and increase effective habitat area and quality by making the whole greater than the sum of its parts. If establishing linear corridors is not possible, maintaining small patches in close proximity to one another can be of benefit, as they can act as natural stepping stones to improve connectivity. Management practices that improve connectivity are particularly important for migratory species, genetically isolated populations, species with large home ranges, and/or those species that are more reluctant to travel across disturbed or open areas.

A hedgerow connecting two forest patches.
PHOTO: HUGH VENABLES

Maximizing the value of farmland to biodiversity depends on understanding how actions at the farm scale contribute to larger scale processes. While it is understandable that farm operators and ranchers may want to maximize land availability for livestock or crop production, well-planned corridors can help meet the needs of both the farmer and wildlife. Corridors can be established along fencerows, roadsides, narrow fields, hillsides, wetlands, streams, or other existing natural features to connect existing habitat and help maximize land productivity. Although wider corridors are typically better and will get more use, even narrow vegetated strips can improve habitat connectivity and be of benefit to many species. For instance, riparian and grassland corridors in agricultural areas have been shown to increase the abundance and diversity of birds, mammals, reptiles and amphibians. Different species will have specific requirements or preferences for corridors (e.g. width, vegetation composition, etc.). In cases where a particular species is being managed for, the corridor's characteristics will need to reflect those specific needs. Farm operators may wish to consult with local wildlife agencies to help design effective corridors to meet individual species needs.

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:

Stream banks and fish passage protected
PHOTO: NIELS HOLBEK

Snow Geese
PHOTO: ROB BUTLER

- The Biodiversity Conservation Strategy for Metro Vancouver 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.
- 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.
- 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.

Delta Farmland and Wildlife Trust
PHOTO: DAVID SHACKELTON

Examples of other regional projects are provided under Where Can I Learn More about Biodiversity?, p 29-40.

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.

Ecosystem Services (ES) are any beneficial natural process arising from healthy ecosystems, such as purification of water and air, pollination of plants and decomposition of waste. They are services that are not traded on the markets but have great value to us all. Ecosystem Services also include the preservation of biodiversity necessary to maintain a specific environment.

DID YOU KNOW?

The global value of ecosystem services was estimated to average $33 trillion/yr in 1995 $US ($46 trillion/yr in 2007 $US). The estimate for the total global ecosystem services in 2011 was $125-$145 trillion/yr in 2007 $US

Costanza, R., et al. 2014. Changes in the global value of ecosystem services. Global Environmental Change 26: 152-158

ES includes:

- fresh water;
- food, fibre, and fuel;
- biochemicals;
- genetic resources[xxi];
- water purification and flow regulation - maintains drinking water supplies;
- food and raw material production - maintains food and commodity supplies;
- flood regulation through wetlands and floodplains;
- 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.[xxii]

Southwestern British Columbia
PHOTO: NASA

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.

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 100 years, humans have changed global ecosystems more rapidly and extensively than in any other period in human history. Oil and gas extraction and refining, deforestation, mining, urban sprawl, 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.

Deforestation
PHOTO: DUCKS UNLIMITED CANADA

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[xxiii] , meaning they are extirpated, endangered, or threatened (red-listed), or are of special concern (blue-listed).

Yellow-breasted Chat (red-listed)
PHOTO: DOUG BACKLUND

In terms of species and genetic diversity, a number of studies have shown that the population size and geographic range of most of the world's native species are declining.[xxiv] 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.[xxv] In BC, approximately 1,600 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 in 2018. This includes 431 animal species and 1196 plant species. 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, of special concern, or extirpated.[xxvi] 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 was estimated at 170 breeding pairs in 2014 owing in part to development, roadside vegetation removal, and livestock grazing.[xxvii] 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.

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

- 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.

DID YOU KNOW?

Despite covering less than 1% of the province, grasslands are associated with more than 30% of BC's species at risk.

Source: Grasslands of the Southern Interior. 2004.
BC Ministry of Sustainable Resource Management.
www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/species-ecosystems-at-risk/brochures/grasslands_southern_interior.pdf

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.[xxix] 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 or pollution and runoff associated with this development), agriculture (crop production and livestock grazing and associated nutrient and chemical inputs and runoff), human disturbance (recreation, tourism, transportation), resource extraction (logging, mining, fishing, oil and gas exploitation), and infrastructure development (power lines, dams, diversions, pipelines, utilities).

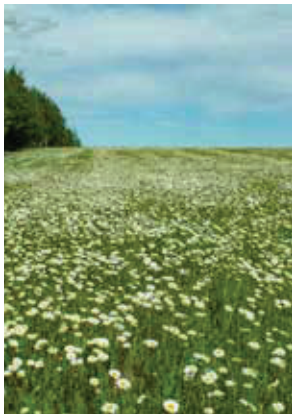
In general terms, the larger, more diverse, and less fragmented native habitat there is available, the greater the diversity of species present. Some species of plants and wildlife do very well on the edges of habitat patches (e.g., a forest bordering an area of cropland). However, as patches of habitat become smaller, populations that depend on undisturbed habitat either become very small or vanish all together. A decrease in the amount of available habitat is then compounded by fragmentation of the remaining habitat into isolated patches due to the construction of roads, utility corridors, or conversion of habitat 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.

Habitat fragmentation

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 (channelization), damming, and dyking of watercourses can also impact both terrestrial and aquatic biodiversity.

Streamside degradation

INTRODUCTIONS OF INVASIVE AND NOXIOUS SPECIES



Oxeye Daisy

The introduction and spread of invasive and noxious 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 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 plant species reduce native biodiversity and can be extremely difficult and costly to control once established.

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.[xxx]

Invasive species are a big risk to SAR, second only to human disturbance.

Examples of invasive species in BC include:

- yellow perch, bass, black crappy, and carp, which threaten native fish stocks;
- introduced bullfrogs, which present a serious threat to native amphibians; and
- European Starlings, which often compete with native bird species for nest sites
- Common burdock (Arctium minus) is a tall, invasive biennial herb known for clinging burs. The burs get tangled in manes and tails of horses, cows and other livestock, and can also damage or de-value the wool of sheep.
- Tansy ragwort (Senecio jacobaea) is a biennial to short-lived perennial. Tansy ragwort grows in grazed pastures, hay fields, and vacant non-crop lands.

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

OVERHARVESTING AND ACCIDENTAL MORTALITY

Subsurface manure injection

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 vehicles further threatens many native species, such as badgers and rattlesnakes.

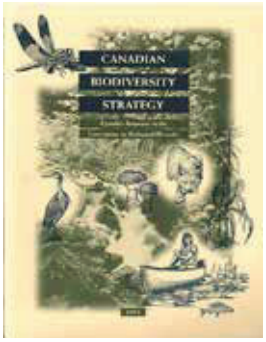
NUTRIENT LOADING AND OTHER POLLUTION

Silage leachate

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.[xxxi]

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.[xxxii] 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.[xxxiii] 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.



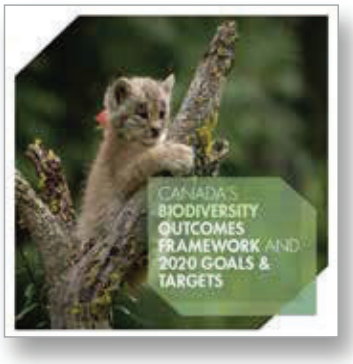
What Are the Broader Commitments to Conserving Biodiversity?

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 (CBD). 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 196 Parties (member states) to the Convention worldwide, 168 of which are Signatories. The Strategic Plan for Biodiversity was revised and updated in 2010, with new targets. Target 7 states that by 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

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 CBD 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 (1997), 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 1997 plan outlined the department's specific commitments to biodiversity conservation as a component of achieving sustainable agriculture. Provincial governments in Canada have also adopted various programs and policies in support of the goals of the Canadian Biodiversity Strategy.



In 2010, a Strategic Plan for Biodiversity was adopted at the Conference of the Parties for the United Nations Convention on Biological Diversity. This plan includes 20 global biodiversity targets, known as Aichi Targets, which each party to the Convention has agreed to contribute to achieving by the year 2020. In 2015, Canada adopted a suite of national targets known as the "2020 Biodiversity Goals and Targets for Canada". These 19 targets cover issues ranging from species at risk to sustainable forestry to connecting Canadians to nature. Target 7 aims for agricultural working landscapes to provide a stable or improved level of biodiversity and habitat capacity by 2020.

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 [see Species At Risk and Agriculture – p1-19]. 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.

Government Agencies

- Agriculture and Agri-Food Canada
- BC Conservation Data Centre
- BC Ministry of Agriculture
- BC Ministry of Environment
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- Environment and Climate Change Canada
- Fisheries and Oceans Canada
- Provincial Agricultural Land Commission

Wetland ecosystem
DUCKS UNLIMITED CANADA

Specialists

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

Sage Thrasher (red-listed)

Conservation Initiatives and Non-governmental Agencies

- Biodiversity Conservation Strategy for the Metro Vancouver
- 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
DUCKS UNLIMITED CANADA

Regional Projects

- **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

Snake barrier fencing project
THE LAND CONSERVANCY

- **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 stream bank restoration
SALMON RIVER ROUNDTABLE

- **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.[xxxii]

Burrowing Owl (red-listed)
PHOTO: JARED HOBBS

- **The Species at Risk Partnerships on Agricultural Lands (SARPAL)** is an Environment and Climate Change Canada initiative that is focused on working with farmers to support the recovery of species at risk on agricultural land. The BC Cattlemen's Association has received funding through SARPAL to deliver a pilot program that will enable cattle producers to implement Best Management Practices (BMP's) and projects that will protect habitat for the Yellow Breasted Chat and the Lewis's Woodpecker. The Yellow Breasted Chat can be found in valley bottom riparian areas in the southern Okanagan and Similkameen valleys, in dense riparian thickets. Wild rose bushes are considered a preferred nesting site for the Yellow Breasted Chat. The Lewis's Woodpecker prefers open forests, riparian woodlands and grasslands with scattered trees. Mature or old riparian cottonwood stands typically adjacent to grasslands, agricultural fields, shrub steppe or open woodlands are favoured by Lewis's Woodpeckers.

Lewis's Woodpecker

- **The Farmland Advantage Project:** This project is focused on developing a long-term program that pays farmers and ranchers to enhance ecosystems to produce benefits like clean drinking water and healthy wildlife populations. Farmland Advantage works with farmers to enhance the natural values on their land. These natural values are often referred to as "ecosystem services" — services of a natural environment that benefit humans that can include areas like wetlands that filter and purify water, and forests that clean the air and provide habitat for healthy wildlife populations. The project helps farmers identify the natural values that can be protected and enhanced, and develops recommendations and plans to preserve them. These plans can include actions such as water or stream setbacks, strategic fencing, reforestation, or rangeland enhancement. Farmers then carry out the recommendations and Farmland Advantage helps to provide compensation based on successful implementation. This phase of the project is focused on three targeted regions of BC: the Lower Mainland, Okanagan, and Kootenays. The Columbia Valley Farmland Advantage Stewardship Project, which received funding from the Columbia Valley Local Conservation Fund in 2017, is geared toward farmers who own much of the valley's critical habitat, and rewards those who demonstrate exceptional care for any land bordering wetlands, streams and rivers (riparian habitats). To date, the Columbia Valley project has resulted in 11 farm sites under contract with 252 acres of prime riparian habitat and 7,987 metres of shoreline conserved and enhanced.
- **The Langley Ecological Services Initiative:** This is the first program of its kind on B.C.'s west coast to reward farmers for maintaining eco-friendly areas on their lands. Such practices can be costly and the Ecological Services Initiative (ESI) was created to help farmers bear the cost of keeping waterways, forests, and other ecologically sensitive areas clean and healthy for current and future generations.

  The ESI is a farmer-led program that supports financial incentives for agricultural producers who contribute to a healthy ecosystem. Maintaining areas to include practices such as a clean water supply, erosion control, pest management, and habitat preservation creates sustainable food production that benefits everyone.

  The farmers currently participating in Langley ESI are maintaining a second growth forest along the creekside, removing invasive species, then planting native species.

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