

Agricultural Waterways

Drainage Maintenance and Stewardship

Stewardship Practices Series



STEWARDSHIP CENTRE

FOR BRITISH COLUMBIA

Agricultural Waterways

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This guide is part of the **Stewardship Practices Series**.

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This guide is meant to complement but not replace other existing resources, including the BC Ministry of Environment's Develop with Care series and Best Management Practices (BMPs) that have been developed for individual species. Using the guide also does not replace the need for due diligence regarding the legislative and regulatory requirements for projects involving species at risk.

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The project was overseen by an Advisory Committee whose purpose was to foster shared environmental stewardship. The Committee focused on building a positive working relationship between the Stewardship Centre for BC and other organizations interested in species at risk stewardship by: providing assistance with quality assurance; ensuring relevancy and consistency

with other species at risk guidance/initiatives; promoting collaboration; and undertaking promotion and outreach to key audiences.

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This document does not necessarily represent the views of all individual members of the Advisory Committee, the land managers profiled, the official positions of the organizations in which they are associated, or the official positions of the organizations with which the individual committee members are associated.

Successful stewardship practices in and around agricultural waterways can be achieved through a variety of means, including planting riparian vegetation and managing sediment.



The Stewardship Centre for BC

The Stewardship Centre for BC (SCBC) was created to assist governments, businesses, conservation and environmental organizations, and citizens to carry out stewardship activities in the most efficient, effective, and rewarding ways.

A leader in promoting stewardship values as the foundation for sustainability, SCBC wants to make “shared stewardship” – the voluntary adoption of

environmentally sustainable practices by all sectors of society – a reality in British Columbia.

We champion science-based best practices so that British Columbians can understand, enjoy and sustain healthy ecosystems through stewardship.

As good stewardship relies on good decision-making, we work closely with our partners to develop innovative technical, educational and capacity building resources.

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Introduction

Protecting and enhancing agricultural waterways through stewardship actions provides benefits to landowners, habitat, and wildlife, including species at risk. Working with waterways can be challenging yet rewarding. This guide will help landowners or managers benefit from a better approach through the use of the stewardship practices introduced in this guide. Broadly defined, stewardship practices are actions that help to conserve, enhance, and restore habitat for wildlife and species at risk.

Some Definitions

Agricultural Waterway: any stream, ditch, river, lake, or wetland that runs through or is adjacent to agricultural lands

Natural Waterway: a stream/river/wetland/lake with naturally formed channels and banks

Modified Waterway: a former Natural Waterway that has been straightened, dredged, partially infilled, moved, or restored

Constructed Ditch: a channel constructed to provide drainage to an area where there was no previous channel

Wildlife: includes all native fish and other animals


This guide was designed to provide landowners and managers with information they can use to conserve wildlife and species at risk while maintaining land drainage. It is a valuable resource for:

- The agriculture sector with industry-specific stewardship practices they can consider when developing drainage maintenance plans and undertaking works;
- Local governments undertaking drainage projects to protect public infrastructure private lands; and
- Conservation and stewardship organizations with information that supports their work with landowners and managers.

One of a series

This guide is one of our Stewardship Series of guides intended to encourage people to take **voluntary stewardship actions**, called stewardship practices, to safeguard wildlife and species at risk.

This series includes another guide for the agriculture sector called *Lands Near Water: Riparian Restoration and Enhancement* (see Web Resources).

A photograph of a person standing in a grassy field, looking at a clipboard. In the background, there are trees and a mountain range under a clear sky.

Stewardship is about taking responsibility to promote, monitor, conserve, and restore ecosystems for current and future generations of all species.

The Importance of Agricultural Waterways

All agricultural waterways, including constructed ditches, can provide valuable habitat for wildlife and species at risk. The stewardship practices presented in this guide will enable farmers and land managers to maintain needed drainage while maintaining the quality of their local environment.



Healthy waterways support human health and reduce costs associated with erosion, flooding, and pollination.

Agricultural Waterways Provide Benefits to People

Much of British Columbia's (BC) agricultural land is located on valley bottoms adjacent to rivers, lakes, streams, and wetlands. Many of these natural waterways have been modified to protect developed areas and to improve drainage for farming. Thousands of kilometres of modified waterways and constructed drainage ditches connect directly to natural waterways. Collectively, we refer to all of these aquatic habitats as agricultural waterways.

Drainage works are often required on agricultural lands because saturated root systems and standing water reduce crop growth. High water tables limit the range of crops that can be grown and the amount of land available for spreading manure. Enhanced drainage is also required to protect buildings, infrastructure, and other assets. Effective drainage is usually achieved by using a combination of above and belowground drainage systems. However, some drainage design, construction, and maintenance practices can negatively impact wildlife and species at risk.

Agricultural waterways and their riparian areas provide a wide range of benefits for nature and people. These benefits are also called 'ecosystem services' because our health, well-being, and economy depend on them.



Benefits to People	Role of Agricultural waterway
Better Drainage	Essential for agricultural production. Moves water away from upstream agricultural, urban, industrial, and natural areas.
Flood Control	Stores excess water and reduces damage during floods – especially important considering impacts of climate change.
Healthier Fisheries	Produces a significant proportion of BC's salmon. Provides food, nutrients, and water to all downstream fish habitats.
Pollinator Production	Essential for agricultural fruit and berry production. Essential for maintenance of biodiversity.
Increased Biodiversity	Waterways support pest control, bird watching, hunting, scientific research and a wide variety of other nature-based activities.



Top Benefits of Healthy Waterways for Farmers:

1. Reduces loss of land to erosion
2. Improves flood control
3. Enhances drainage
4. Provides cleaner water for irrigation
5. Improves herd management (with riparian fencing)
6. Improves herd health (better weight gains, less foot rot)
7. Increases income opportunities (Farmland Advantage, agroforestry)
8. Reduces maintenance costs (control of reed canary grass and blackberry)
9. Increases pollinator habitat
10. Increases biodiversity
11. Improves public image of land management (assurance program compliance)

Agricultural waterways provide a range of ecosystem services from flood control and better drainage to pollinator production and increased biodiversity.



Agricultural Waterways Provide Benefits to the Environment



Ditches like this one in Chilliwack often provide important refuges for fish seeking escape from strong currents during periods of high stream flow.

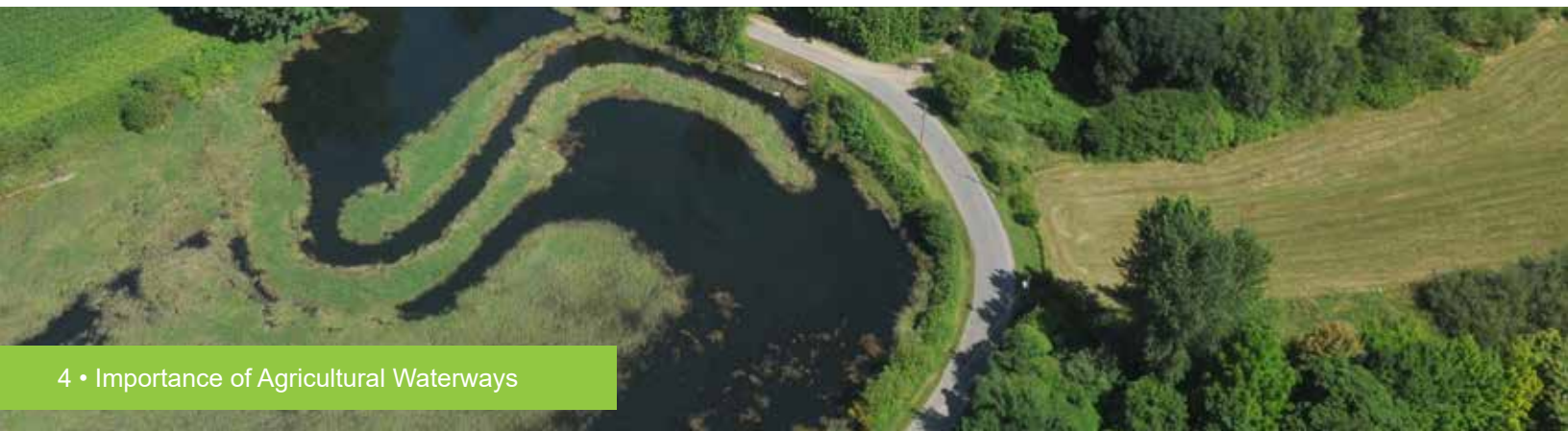
Waterways are a landscape's circulatory system. They link habitats and are the pathways through which water, nutrients, fish, wildlife, pollinators, and plants move through the landscape. These pathways are especially important when natural habitats are scattered and fragmented, as they often are in agricultural landscapes. Agricultural waterways and lands adjacent to them contain some of the most valuable salmon and species at risk habitat in the Province.

Seasonally wetted ditches are less diverse than streams or ponds but often support uncommon species including species not found in permanent water bodies. They also provide important seasonal habitats. For example, large numbers of Cutthroat Trout and Coho Salmon migrate into seasonal farm and roadside ditches in the Fraser Valley during winter to escape high flows in the main channels.

Permanently-wetted constructed ditches may have diversity similar to natural streams depending on distance to natural waterways, land use practices around them, and the complexity of habitat within them.



Tall beggarticks is a species at risk found in seasonally wetted ditches of the southern interior.



Agricultural Waterways and Species at Risk

Species at risk in BC are concentrated in the warm, low-elevation lands favoured for agriculture: the Fraser Valley, the Okanagan Valley, and southern Vancouver Island. In addition to fish, many species of amphibians, birds, mammals, invertebrates, and plants rely on aquatic habitats for all or parts of their lives.

Fish

Most of British Columbia's native fish are adapted to clear cold water and require consistently high levels of dissolved oxygen (DO) to breathe. When the amount of DO in water becomes too low, fish growth and reproduction is reduced and vulnerability to predation increases. If DO levels fall below a critical level fish must leave or they will die. These low DO conditions are common in intensively farmed areas of British Columbia, particularly the Fraser Valley. Nutrients entering the water can cause excessive growth of algae or other plants, a process known as eutrophication. The plants consume oxygen at night and as they decompose after dying, DO is removed from the water.

Fish are found in most agricultural waterways in British Columbia, at least seasonally. In the fall, many species of fish leave the main channels of rivers to overwinter in habitat with slower currents and more protection from predators. In agricultural landscapes, small ditches may have large concentrations of Cutthroat Trout, Coho Salmon, and a variety of other species.

The shade of streamside trees and shrubs keep water temperatures cool in summer. Removing vegetation along agricultural waterways allows water temperatures to rise higher than native fish, particularly salmon and trout, can tolerate. Most of our native fish spawn in riffles, i.e. shallow turbulent, gravel-bottomed sections of stream. The survival of the eggs depends on a constant flow of cool, oxygen-rich water through the gravel. Developing fish can die if sediment from upstream erosion clogs the gravel and reduces the supply of water and oxygen.



The Nooksack Dace requires flowing water with lots of oxygen and rocky stream bottoms without too much silt or sediment. These are the same areas in which salmon and trout spawn.





Amphibians

Amphibians breed in waterways, their larvae (tadpoles) develop there, and the adults of some species remain in the water for most or all of their lives. Amphibians absorb oxygen and contaminants in the water into their bloodstream directly through their skin. This is why amphibians are exceptionally vulnerable to pollution. Riparian buffers or grassy “leave strips” can significantly reduce the amount of chemicals in agricultural waterways. Aquatic vegetation provides amphibians with essential cover and egg laying sites.

Oregon Spotted Frogs live in agricultural waterways and breed in localized areas with very specific characteristics. They are vulnerable to disturbance resulting from drainage maintenance activities.



Aquatic Plants and Invertebrates

Native aquatic plants provide food, refuge and oxygen to aquatic wildlife, but are typically removed along with invasive species during channel maintenance work.

Aquatic invertebrates such as dragonfly larvae and molluscs are vulnerable to physical removal and loss of key habitats during machine clearing of vegetation and silt dredging.



The Autumn Meadowhawk dragonfly breeds and rears in slow moving streams with dense emergent plants, while the Rocky Mountain Ridged Mussel occurs in rivers and lakes in the Okanagan basin. Both are vulnerable to channel dredging or maintenance.



Common Impacts of Drainage Maintenance Work

Removal of Riparian Vegetation

Riparian vegetation may be removed to allow easy access to a channel for machinery used in drainage maintenance. The loss of natural riparian vegetation, however, often increases the need for (and costs of) drainage maintenance as invasive plants like Himalayan blackberry and reed canary grass colonize and overgrow the unshaded channel.

Ditches and channelized streams have replaced most natural streams and wetlands on many intensively farmed landscapes, including portions of the Fraser and Okanagan valleys. This conversion has greatly reduced the area of natural habitats, particularly wetlands, increased flood frequency, reduced low flows, and degraded water quality in downstream habitats. The extent of conversion to ditches and channelized streams is less dramatic, but still significant in less intensively farmed areas in BC's interior.

The pictures below show waterways that have had the native trees and shrubs removed. Loss of riparian vegetation leaves waterways vulnerable to erosion, overheating, and the entry of agricultural nutrients and chemicals.



Channel Dredging or Straightening

Agricultural waterways are often dredged to remove excess sediment and vegetation. When heavy machinery is used, logs, native aquatic vegetation and other habitat features used by fish, wildlife and species at risk are also removed. Habitat structure is simplified. Variation in depth, width, and current speed are typically reduced. This loss

of habitat diversity reduces the number of species that can use the waterway. In some cases channels are straightened or moved to simplify agricultural operations. This further reduces the diversity of habitats and species unless mitigated using stewardship practices.

Topsoil Entering Agricultural Waterways

Topsoil is being lost much faster than it forms in most of the world's agricultural areas, including parts of BC. This degrades both agricultural land and agricultural waterways. Soil is washed into streams and deposited downstream where it may clog spawning riffles, fill pools, and reduce the number and variety of invertebrates, upon which fish and amphibians feed. Loss of topsoil into waterways impacts farmers by reducing land productivity, decreasing water quality, and increasing the frequency of drainage maintenance.



Topsoil loss (above) following drainage maintenance work and riparian vegetation loss (below) in the Fraser Valley.



Woody riparian vegetation (above) stabilizes soil with roots and helps filter sediment out of runoff. Without it, more erosion occurs and more soil and sediment enter waterways.



Factors that Increase the Need for Drainage Maintenance



Livestock access to waterways and banks also accelerates erosion

Livestock Access to Waterways

Livestock access to waterways reduces drainage through bank erosion. Channels become wider and shallower. The impacts of livestock on wildlife habitat include trampling the stream bed, removing aquatic plants and invertebrates, and depositing sediment to downstream areas. Access to agricultural waterways is also bad for livestock, causing foot problems and even mastitis.



Over-application of manure on fields loads stream water with nutrients, causing excessive growth of invasive plants, poor drainage, and poor water quality.

Over Application of Fertilizers

In natural streams, oxygen levels are typically adequate for salmon and other aquatic life, and most native aquatic plants grow beneath the water surface. Waterways in intensively farmed areas, however, are commonly overgrown with mats of algae and invasive plants that slow drainage and reduce dissolved oxygen below levels necessary to support aquatic life. This condition, known as eutrophication, is caused by excessive nutrients in the water. The nutrients – primarily nitrogen and phosphorous – commonly come from over-application of fertilizers such as manure. Nutrients enter waterways in runoff, through groundwater, or attached to sediment that enters the water from bank erosion.



At high nutrient levels, floating plants and plants that grow above the water's surface (like duckweed and reed canary grass) replace submerged species, sometimes completely overgrowing waterways. Plants like duckweed and reed canary grass (called "emergent" plants) release the oxygen they produce through photosynthesis to the atmosphere rather than the water column. Decomposition of dead plant material on the channel bottom also removes oxygen from the waterway. Maintaining drainage in these waterways is typically done by dredging every few years, which further damages habitat.



Lack of oxygen from eutrophication is a major threat to the Salish Sucker (left) and the Coastal Cutthroat Trout (right) in the Fraser Valley.



Species like the American Bittern (left) and the Great Blue Heron (right) that depend on stream fish and aquatic invertebrates for food are also affected.

Agricultural Waterways: Impacts and Best Practices

The growing human population has increased demands for inexpensive, high-quality food and BC producers have responded by increasing production through more intensive land use and more efficient farm practices.

More intensive land use increases impacts to surface waters, fish, and wildlife populations. Many of these impacts can be mitigated with good stewardship practices.

Stewardship Practices can help mitigate impacts to the fish and wildlife that spend time in or around agricultural waterways.

Activity	Impacts to Habitat and Species	Good Stewardship Practice
Removal of riparian vegetation (Drainage maintenance)	Erosion, sediment deposition, degraded water quality, increased water temperatures, removal of food sources.	Protect existing riparian area. Restore degraded riparian area. Plant low growing shrubs on south or west bank to allow machine access.
Dredging channel (Drainage maintenance)	Loss of suitable habitat (pools, spawning riffles). Loss of invertebrates and native aquatic plants (species at risk, food for fish and wildlife).	Hand maintenance. Restore riparian area to shade channel and prevent sediment entry. Create inset low-flow channel with stronger current to flush sediment. Increase habitat complexity with strategic addition of wood, riffles, and other habitat features.
Straightening or moving channel (Drainage improvements)	Loss of suitable habitat (pools, spawning riffles). Loss of invertebrates and native aquatic plants (species at risk, food for fish and wildlife).	Restore habitat complexity with addition of wood, riffles, and other habitat features. Restore riparian vegetation.
Poor erosion control (Drainage maintenance)	Sediment deposition can smother eggs, reduce food availability. Abrasion of fish gills with high sediment levels.	Use of silt curtains, check dams, silt fences, erosion control matts etc. Isolation of work from flow. Place spoil away from channel.
Uncontrolled livestock	Trampling of stream bed. Increased erosion and sediment. Loss of aquatic plants and invertebrates. Increased nutrient input from manure.	Prevents excessive erosion as riparian vegetation stabilizes banks.
Bare fields	Increased erosion and sediment. Increased nutrient input.	Cover crops Restore riparian vegetation. Grass leave strips.
Over-fertilization	Increased nutrient input. Excess algae and plant growth. Low dissolved oxygen.	Reduce application rates. Shade waterway with riparian trees and shrubs.

Steps to a Successful Stewardship Practices Project for Drainage Maintenance

Stewardship Practices are actions that help to conserve, enhance, and restore wildlife including species at risk and their habitat. There are many different practices that can help protect, restore, and enhance habitat during drainage maintenance work in agricultural waterways.

Stewardship Practices along waterways are most beneficial when implemented along the whole length of a waterway. However, waterways cross property lines and political boundaries so working together to

manage waterways at the landscape or watershed scale will have greater results. Action typically starts on one or a few properties with every stewardship effort contributing towards improving the health of waterways and the species that depend on them.

Integrating Stewardship Practices into drainage maintenance work can be complex, however, there is help available to plan and implement projects. This section of the guide provides concrete information on how to successfully plan and implement stewardship practices in a drainage project.

6 Steps to a Successful Drainage Maintenance Project

1. **Get help with project planning.**
2. **Determine which wildlife and habitat could be impacted by the project.**
3. **Determine which Stewardship Practices would work for the project.**
4. **Obtain permits for the project, if necessary.**
5. **Implement the Stewardship Practices project.**
6. **Monitor, maintain, and improve the project.**



STEP 1: Get Help with Project Planning

Agricultural waterways are as diverse as the landscapes they cross. To be successful, it is important to tailor project design, site preparation, timing, and other protective measures to the site's unique conditions. Specific guidance can be obtained from resources such as the Environmental Farm Plan Program, local government, local environmental or stewardship organizations, or by hiring a qualified professional (typically a Registered Professional Biologist or a Registered Professional Forester who is knowledgeable and competent in the field) (see Web Resources).

It is a good idea to consult neighbours and the local government early in the planning process. Many regional districts and municipalities have programs in place that help with drainage. They can also help direct people to a local stewardship group who may be able to assist the project. There may be opportunities to coordinate larger scale projects or multiple projects along a specific waterway. This will help to better manage projects on a landscape or watershed scale. Every stewardship effort will contribute towards improving these vital areas.

Get Help to Assess the Site

There are many site assessment tools available. Assessments are best completed with the help of experts. The same groups listed above may be able to help complete an assessment; for example, a riparian health assessment may be completed for free if completing an Environmental Farm Plan. Many communities have a local Streamkeepers group that volunteer time to monitor and evaluate stream conditions. The resources described below can help you choose and implement the right drainage maintenance and stewardship practices for the site.

Some examples of assessment methods and resources include:

- The *Streamkeepers Handbook and Modules* are designed as an easy to use resource to understand and monitor stream health. Module

1 (Introductory Stream Habitat Survey), Module 2 (Advanced Stream Habitat Survey) and Module 3 (Water Quality Survey) may be especially helpful.

- The Cows and Fish *Riparian Health Assessment for Streams and Small Rivers Field Workbook* is a very useful tool to help agricultural producers to pinpoint what actions are needed to improve riparian health along streams and rivers.
- The BC government's *Riparian Area Regulation* (RAR), which applies to some areas of BC, includes an assessment methodology for properties proposing development or redevelopment of areas adjacent to watercourses. Although not directly applicable to drainage projects, RAR assessments may be useful in identifying valuable habitat features and methods of protecting them. These assessments must be completed by a qualified professional.

See Web Resources for links to these tools and other resources.

Get Financial Help

There are a number of financial assistance options to help with planning and completing projects in or nearby agricultural waterways:

- The BC Agricultural Research and Development Corporation (ARDCorp)'s [Environmental Farm Plan Program](#) will help assess the site and may provide partial funding for the establishment of riparian vegetation, fencing livestock and many other stewardship practices.
- Many landowners and local governments have partnered with local stewardship groups, such as Streamkeepers or local conservation organizations. Often these groups can access funding for materials and help with volunteer labour to implement stewardship practices, especially for fish and species at risk.

Consider Farmland Advantage to protect waterways and their associated riparian areas on agricultural lands.

Farmland Advantage pays farmers to maintain and enhance the riparian areas on their land. One example is the Bouchard farm at in Agassiz. In this case, Farmland Advantage contracted the Bouchards to maintain the stewardship practices they have implemented and pays them annually for their effort. Farmland Advantage is working with a team of experts to develop this into a long-term program that will be widely available to producers.

www.farmlandadvantage.com

- Environment and Climate Change Canada's **Habitat Stewardship Program** (HSP) can support landowners financially to protect terrestrial and aquatic species at risk and their critical habitat. The application-based program provides funding for projects that protect and restore habitat for species at risk listed under the federal *Species at Risk Act* (SARA), to prevent them from becoming a conservation concern. HSP encourages multi-year and multi-partner projects. Private landowners usually work with stewardship groups, local government, and/or the provincial government to develop a project funding application. The **Aboriginal Fund for Species at Risk** (AFSAR) is a similar funding program specifically for First Nations applicants.
- Landowners can access attractive tax benefits by protecting habitat on land through the federal Ecological Gifts Program.
- **Species at Risk Partnerships on Agricultural Land** (SARPAL) is a pilot program that supports producers to implement stewardship practices to enhance and conserve habitat for the Lewis's Woodpecker, Yellow Breasted Chat, and other species at risk.
- Incentive programs that include payments to

farmers for the value of the ecosystem goods and services their land or management practices provide are emerging in British Columbia.

Examples include **The Delta Farmland and Wildlife Trust** and **Farmland Advantage Project**.

- Some communities have a local community conservation fund that supports stewardship. The Kootenay Conservation Fund is one example. If no conservation fund is available locally, efforts to have one established to support future conservation in the region may be worthwhile.

Agricultural Assurance Programs

Many producer groups in Canada are initiating programs to assure consumers that their farmers are implementing Best Management Practices. These programs are intended to build consumer confidence in the practices used to produce food. Some examples include:

- Dairy Farmers of Canada and members initiated the development of proAction to show how farmers responsibly produce milk. With proAction, farmers will be able to offer proof to customers that they work to ensure milk quality and safety, and to continually improve animal health and welfare as well as environmental stewardship. Protecting and enhancing riparian areas will help producers meet these assurance program standards.
- The Canadian Cattlemen's Association initiated a program known as Verified Beef Plus. This program is demonstrating that Canadian beef products are high quality, safe and are produced in systems prioritizing animal care and the environment. This program includes a riparian care component and includes auditing to provide assurance to consumers.

See Web Resources for links to these tools and other resources.

STEP 2: Determine Which Wildlife and Species at Risk Would Benefit

Many species of fish, amphibians, birds, mammals, invertebrates and plants that rely on agricultural waterways and their riparian areas for all or parts of their lives may be affected by project activities in agricultural waterways or their riparian habitat.

Landowners can generate a list of plants and animals local to the project area using advanced search functions at the:

- BC Conservation Data Centre [Ecosystems and Species Explorer](#) for wildlife and species at risk,
- Government of Canada's [Open Maps](#) for federally listed species at risk,
- Fisheries and Oceans Canada's [maps of aquatic species at risk](#), or
- Stewardship Centre for BC's [Species at Risk website](#) for easy to access information on species at risk in BC.

STEP 3: Determine Which Stewardship Practices Would Work

Stewardship Practices are actions which help to conserve, enhance and restore species at risk and wildlife habitat. Stewardship Practices covered in this guide include:

- Protect Existing Riparian Areas
- Enhance or Restore Riparian Vegetation
- Use Sensitive Methods to Work in Waterways

- Stabilize Banks using Bioengineering Methods
- Restore Aquatic Habitats
- Avoid Over-application or Poor Storage of Manure

See the next section in this guide on Stewardship Practices for further information.

STEP 4: Obtain Permits for the Project, If Necessary

Permits and Authorizations

Compliance is required with applicable legislation. Depending on the type and location of work, a number of Provincial or Federal permits and authorizations may be required. Local governments should also be contacted as some exercise jurisdiction over drainage channels.

Protection of fish and other aquatic life includes practices that not only directly protect these species but also protect water quantity and quality, riparian areas, and habitats. BC Ministry of Forests, Lands

and Natural Resource Operations, Fisheries and Oceans Canada, and Environment and Climate Change Canada offices and/or their websites may be contacted for advice on permitting requirements.

Depending on project complexity and resources available, it may be advisable to engage qualified professional consultants to handle permit applications.

See Appendix B for a full list of regulations and permitting requirements that may apply to your project.



Timing of Work

Instream works should be restricted to periods when no native fish are spawning or have eggs developing and during periods when birds, amphibians and other wildlife are not reproducing. Late summer and early fall are typically the best times to do instream work, but the exact windows to conduct these works vary among species, regions, and watersheds. The Provincial [Ministry of Environment and Fisheries and Oceans Canada](#) should be consulted to determine precise local work windows.



STEP 5: Implement Stewardship Practices

The previous steps help to get assistance to plan the project, assess the site, identify the practices to implement, and ensure the appropriate permits are in place. Now it's time to begin the drainage maintenance work from the plan.

As noted earlier, there are funds and resources

available to help with implementing practices such as riparian planting and installing large woody debris. Make sure that details of the plan are followed to help ensure success. For instance, if the plan calls for planting larger trees and smaller stock is planted, then these smaller trees might fail to thrive due to aggressive grass species covering them.

STEP 6: Monitor, Maintain and Improve the Project

Although individual landowners typically do not have the resources to undertake or pay professionals for such monitoring, local governments, natural resource agencies, larger companies, and environmental groups could undertake this important work.

Monitoring is often required as a condition of permits for conducting instream works.

To measure the effect of a Stewardship Practice, data should be collected before and after it is implemented, both at the project site and at a

reference site that is similar to but beyond the influence of the project. Basic monitoring includes seasonal measurements of dissolved oxygen concentration, water temperature, and fish and amphibian presence and density. Photos are also very helpful for reports to funding bodies and they can demonstrate the success of the stewardship practices over time. Watershed-scale monitoring is needed to understand the collective impacts of multiple projects.



Stewardship Practices for Drainage Maintenance

The following are Stewardship Practices that will enhance habitat and protect multiple species during drainage maintenance projects in agricultural waterways. Select those practices that best suit project location and budget.

Protect Existing Riparian Areas

Strips of native trees and shrubs naturally occur along waterways, even in the driest of BC's landscapes. These strips, called riparian areas, are highly effective in moderating stream temperatures, intercepting nutrients, stabilizing banks to reduce erosion, and providing habitat for a wide variety of native wildlife species. Conservation of existing riparian vegetation is the most effective and inexpensive stewardship practice for drainage maintenance. This is especially important in intensively farmed or urbanized landscapes where little intact riparian vegetation remains. Continuity of riparian areas is more important than width in many of the ecological functions of riparian zones, including moderating stream temperature and filtering nutrients.

Permanent protection of riparian areas can be achieved by registering a conservation covenant on the land title. Contact local Land Trusts or the [Land Trust Alliance of British Columbia](#) for details on how to register a covenant. For farmland, the Agricultural Land Commission must approve covenants on lands within the Agricultural Land Reserve. Riparian habitat often qualifies as ecologically sensitive under Environment Canada's [Ecological Gifts Program](#), making it possible for donors of land and conservation covenants with riparian habitat to access significant income tax reductions.

How important are riparian areas?

A large body of scientific research on the effectiveness of riparian buffers in protecting the aquatic habitats has been published. The general consensus is that, to fully protect aquatic habitats from the impacts of adjacent land uses, buffers need to be at least 30 metres wide. Within this zone, it is also clear that the areas closest to the water are more important than those further out. For example, a 15 metre buffer provides much more than half the benefit of a 30 metre buffer. Even a narrow 5 metre buffer will provide important benefits for wildlife and species at risk.



Case Study: Beaver Meadows Farm

Beaver Meadows Farms produce Angus beef in the Comox Valley with over 500 head of cattle. The farm is run by the Smith family, who have worked to protect the riparian habitat on their farm for over 40 years. The Smiths' management practices, including the restoration and protection of riparian habitat, have created an environment where wildlife flourish. The farm is also home to bears, deer, frogs, birds, and a huge number of fish. At Beaver Meadows, a riparian buffer of approximately 5 m has been established and the area is fenced with a single strand electric fence to allow wildlife but not cattle to pass through.

“By learning to farm in this manner, we have improved our bottom financial line, by reducing costs phenomenally, and increasing our returns, so for us there is a financial benefit... we discovered a way that was financially more sound and more efficient.”

– Edgar Smith

See: <http://stewardshipcentrebc.ca/beaver-meadows-farm/>



Establish or Restore Riparian Vegetation

Native riparian vegetation should be planted next to waterways where it has been removed. Plants should also be established along constructed ditches to reduce the entry of sediment, nutrients, and chemicals. Anything that enters a ditch will typically end up in a river.

Restoring the riparian area or adding native plants to enhance the existing vegetation can be highly effective in reducing the frequency with which heavy equipment is required for drainage maintenance. Native riparian vegetation helps stabilize banks, reduce erosion and siltation, and shade out invasive plants such as reed canary grass.

Riparian zones are as diverse as the landscapes where they are found. Plant species selection, site preparation, timing of planting, and protective

measures must be tailored to site conditions to be successful. Specific guidance can be obtained from published material associated with the Riparian Area Regulation and the Environmental Farm Plan Program, from local environmental stewardship organizations, or by retaining a qualified professional (typically a Registered Professional Biologist, or Registered Professional Forester).

The SCBC companion document entitled *Lands Near Water: Riparian Restoration and Enhancement* provides detailed information on planning and planting effective riparian buffers that minimize impacts to agricultural operations.

See Web Resources for links to these programs and other resources.



Case Study: Amaral Farm



Amaral Farm, owned and operated by Lynn Amaral, was a small family farm that produced livestock, including pigs, ducks, and sheep as well as fruit and nut trees, grapes, raspberries and various vegetables. Working with the Fraser Valley Watershed Coalition, Lynn expanded and enhanced riparian habitat on her property, creating Oregon Spotted Frog habitat. They widened a ditch and pond then planted several hundred native trees, shrubs and grasses in the riparian area. Finally, the team fenced the pond and riparian area off to protect the plantings from Lynn's sheep and other animals.

See: <http://stewardshipcentrebc.ca/lynn-amarals-farm/>

Work by Hand in Agricultural Waterways

Work within agricultural waterways is sometimes necessary to maintain drainage function. **Getting advice from a qualified environmental consultant is strongly recommended for any instream work projects to avoid causing unintentional problems and to ensure compliance with existing laws and regulations.** Preference should be given to manual work, if possible, as these practices have the least impact on sensitive species.

See also Appendix C for further guidance for drainage maintenance and restoration activities such as fish and wildlife salvages.



Manual work with hand power tools can be used to clear channel obstructions while leaving habitat features intact or to clear invasive plants from the stream channel.

Manual Work

In small, shallow streams with hard bottoms vegetation that is seriously impeding flow can be cleared using small power or hand tools. These methods are not suitable in water more than one metre deep or if the channel bottom is soft as these conditions are unsafe for workers.

Grass and other invasive plants in the channel can be cut using a gas powered hedge trimmer. Removed material is either piled above the high water mark to compost or removed by machinery later. If banks are very high, the cut material can be mounded within the stream at collection points 30 m apart and removed with machinery from these points. Material should be removed from the channel the day it is cut.

Downed trees or willow branches can be trimmed with a chainsaw to minimize their impact on drainage, while preserving their habitat and avoiding

damage to the bank.

Several municipalities in the Fraser Valley have adopted these practices on suitable streams within their jurisdiction and have found that staff time is reduced in obtaining required permits. The need for fish and amphibian salvages and on-site environmental monitoring is avoided, which either saves money or is revenue neutral.

Crews need to be trained in hand techniques and in plant identification to avoid damage to desirable habitat features and native vegetation. Regulatory agencies need to be consulted prior to starting, and work should generally occur within the instream work window period (see Appendix B). Regulatory requirements for this work are far less difficult than those for working in the channel with machinery. A number of BC's commercial consulting firms do this type of work.



Stabilize Banks using Bioengineering Methods

Bank stabilization is sometimes necessary, even in waterways with vegetated banks. Inexpensive, durable, self-repairing structures can be built by hand using trees and shrubs that root easily from cut branches. Native willows, black cottonwood, and red osier dogwood can be used for bank stabilization.

The simplest method is to plant cut branches or saplings, known as whips, directly into the ground. Remove side branches and all leaves and insert the bottom of the whip as far as possible into the soil. An iron bar is very effective for creating deep holes. High densities of whips are very effective in stabilizing soils. Often live material can be cut from

the immediate area. Whips are best planted during the dormant season (November-March), but can be successfully established at any time of year if the base of the cut stalk is deep enough to be in the water table.

More elaborate methods that use live material to construct structures such as wattle fences, live palisades, and live brush layers can be used in areas like stream banks where steep slopes increase vulnerability to erosion.

Protection of whips and structures from beaver damage is often necessary for the first few years. Once the roots are well established, however, the plants will simply put out new shoots from any cut stumps.

Case Study: Yarrow EcoVillage



Despite the Yarrow EcoVillage's interest and dedication to riparian restoration, they lacked the funds and expertise to rapidly implement stewardship projects. That's where the Fraser Valley Watershed Coalition (FVWC) came in. FVWC secured grant funding and provided expertise in planning and implementing the projects. Later the Ecovillage worked with local bioengineering expert Dave Polster, who used their property as a demonstration site for workshops. Wattle fences stabilized the banks and a willow canopy formed a tunnel over the ditch, shading out reed canary grass. By stabilizing the drainage ditch banks with bioengineering methods, the ditch became an attractive habitat for amphibians and there is no longer a need to deal with the reed canary grass.

See: <http://stewardshipcentrebc.ca/yarrow-eco-village/>

Willow whips can be used to construct live fences to stabilize erosion-prone banks. Volunteers constructed this one in Yarrow BC in 2012 (below). By 2015 (right), the bank was stable and 5 m tall willows lined the bank.



Work Sensitive with Machinery in the Water

Getting advice from a qualified environmental consultant is strongly recommended for any instream work projects to avoid causing unintentional problems and to ensure compliance with existing laws and regulations.

Environmentally-friendly hydraulic fluid is available

and should be used in all machinery working near waterways.

If fish or amphibians are present, they must be 'salvaged' and moved to appropriate habitat prior to instream work. Guidance on conducting fish salvages is provided in Appendix C.

Sediment Control

Any work with heavy machinery in the water disturbs sediment and causes turbidity to rise far above acceptable levels. To prevent disturbance, the worksite should be isolated from nearby aquatic habitats. This is particularly important in flowing waters. Appropriate methods vary with water body width, depth, and especially current velocities. There are a wide variety of commercial products available to assist with sediment control and a number of best management practices for sediment control have been published for BC (see Web Resources).

Floating silt curtains are highly effective and easy to deploy in deep water with little or no current or in

applications where the machine will be working along one shore and it is not necessary to block the entire channel. Note that these curtains should never be transferred between water bodies due to the risk of transferring introduced species or pathogens and the filter cloth in them cannot be adequately cleaned.

In small waterways, sites can be efficiently isolated using steel plates inserted using an excavator into the channel bed perpendicular to the flow at the upstream and downstream ends of a section. Water is then pumped around the enclosure while work occurs.

Excavation Techniques

- Channels should never be excavated below their current hard bottom.
- A straight edged 'cleanup' bucket rather than a toothed bucket should always be used as this avoids raking deeply into the substrate.
- Bank vegetation should be left intact. This can be accomplished by using the edge of the bucket to cut sod at or below the waterline plucking out the freed material with a thumb bucket rather than dragging the bucket up the bank.



A section of a small channel is isolated with a steel plate. Water is pumped around the work site and diffused over a sheet of plywood before re-entering the channel downstream of a second plate.



Diversify Aquatic Habitat

Habitat projects should be designed in consultation with a qualified professional and with regulatory agencies and local governments because permits and authorizations are likely required. Below are some beneficial stewardship practices to consider including in the project plan.

HABITAT COMPLEXING

Different species at their various life stages require a broad range of water depths, bottom materials, plants, and other habitat features. Complex, diverse habitats support more species because they are likely to contain the food sources and other conditions required to support their various needs. Adding complexity to waterways can greatly increase their value as habitat. Where possible, complexity should be incorporated into maintenance works. Examples include adding a low marshy area along the channel edge (see below) or well-anchored logs that protrude into the waterway. Use logs without rootwads in flowing waters and angle the logs downstream to avoid creating debris jams. If the banks are too high to bury large woody debris in place, boulders may be used. **Well-placed boulders and logs do not significantly impede flow and drainage, but greatly improve habitat values.** Water will scour underneath or beside them improving habitat diversity while maintaining channel capacity.

Well-anchored logs placed in the channel greatly increase fish habitat value by creating variations in water depth and current speed as in this constructed stream channel on a Fraser Valley blueberry farm. Vertical snags provide perches for riparian birds.



RESTORE WETLANDS AND RE-MEANDER STREAMS

Constructing wetlands by widening ditches, planting wetland vegetation, and naturalizing channelized waterways have been shown to significantly improve water quality and biodiversity. These constructed wetlands may improve drainage by increasing channel capacity. Great care must be taken in designing and siting these projects to avoid damaging downstream habitats.

An excavator places a stump as a habitat feature during construction of a wetland.



Case Study: Cedar Isle Farm



Jim Grieshaber-Otto and his family operate the Cedar Isle Farm, an 84-acre operation that produces 26 acres of organic grain in the District of Kent, Agassiz. They are enhancing the rich wildlife habitat on their land. They maintain wildlife corridors through their fields and have extensive wooded areas on the property. To increase species diversity in aquatic habitat, they worked with a local conservation organization to restore some wetlands on the property. The conservation organization arranged for an excavator and trucks filled with large woody debris to be brought to the site. The excavator was used to deepen the pond, increasing the available aquatic habitat.

The woody debris was added to the ponds to increase habitat complexity. They also created a natural filtration system by creating a series of channels for the water to flow through. Finally, the excavator removed invasive water lilies from one of the ponds.

“They dug out some of the grass, added some stumps and wood residuals to diversify the habitat, and [constructed a natural filtration system to remove] any excess nutrients. Another [pond] had become infested with water lily over the years. We used the long reach excavator to remove some of [the water lilies].”

– Jim Grieshaber-Otto

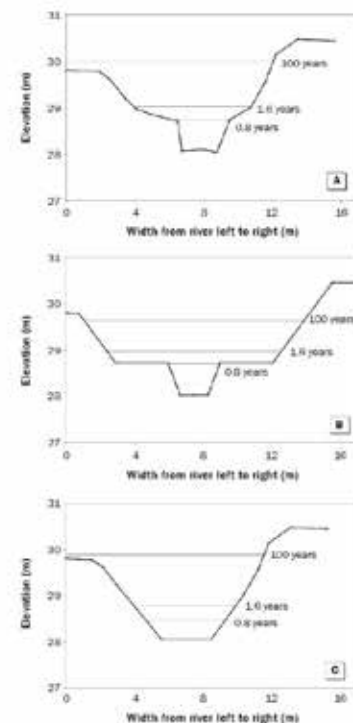
See: <http://stewardshipcentrebc.ca/cedar-isle-farm/>

Maintain an Inset Channel

An inset channel is a small channel designed to carry normal flows within a larger channel designed to convey the highest flows. The inset channel should meander within the wider channel bottom. The lower-flow channel can be managed for its habitat values and maintained without heavy machinery. It can include spawning riffles, cover logs, backwater eddies, and other habitat features. Advantages include reduced damage to habitat, reduced sediment release during excavation, and reduced regulatory requirements for maintenance (since machine work does not occur in the water). So far, this technique is rare in BC.

Inset low-flow channels preserve water depth and other habitat features within a broader channel capable of accommodating flood flows.

Cross sections of (A) naturally forming sloping profile with no maintenance, (B) maintained with an inset channel, and (C) after conventional maintenance. The banks of the inset channel in this example were not overtopped in a 100 year flood. (From Powell et al. 2007).



Avoid Over-application or Poor Storage of Manure

Over application of manure is a major contributor to eutrophication and low oxygen in agricultural waterways. **Consult British Columbia's Nutrient Management Reference Guide for recommended application rates for various crops, recent Ministry of Agriculture manure spreading advisories, and the Environmental Farm Plan Reference Guide for additional information.**

Avoid major applications in the fall after crop growth has slowed with lower temperatures. Consider alternative uses of manure through participation in manure composting or digester pilot projects. Manure should be stored in accordance with relevant agricultural waste control regulations under the *Environmental Management Act*.



A manure pile inappropriately stored, uncovered within a riparian area

Case Study: Holberg Farm



Holberg Farm is a 180-head dairy operation in the Fraser Valley. The farm has a comprehensive manure storage and spreading program. The manure from the dairy operation is gathered and stored as slurry in a covered pit with enough storage space for six months. This allows them to spread manure in spring when there is less risk of runoff and maximum nutrient uptake. They also use machinery to inject liquid manure straight into the soil, allowing it to be absorbed more easily and cutting down on the odour.

See: <http://stewardshipcentrebc.ca/holberg-farm/>

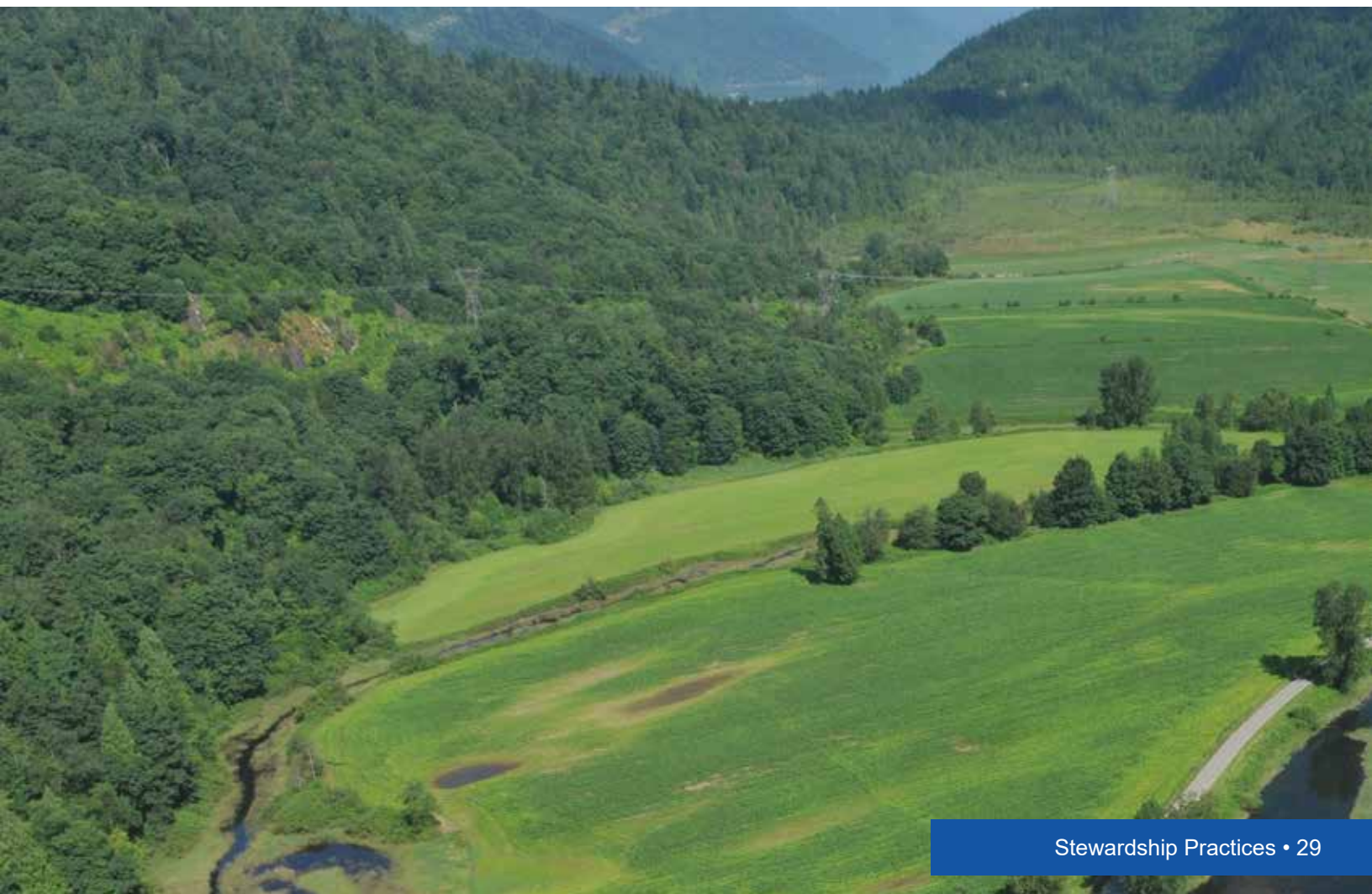
Conclusion

Practicing stewardship of land and water will protect and enhance agricultural waterways. The benefits for the landowner and their communities, as well as species at risk and other wildlife, can be significant.

By following the six step process outlined in this guide, a property owner, farmer, or other land manager can implement beneficial stewardship practices leading to restored and enhanced waterways and habitat for wildlife and species at risk.



“Progressive farmers and ranchers understand the value of managing environmental and economic sustainability for long-term profitability. As landowners, we have rights to utilize land to produce food. We also have responsibilities to practice best management practices and not damage our environment or those of our neighbors. Environmental stewardship is simply a good business decision.” - Silver Hills Farm



Appendix A: Web Resources

Riparian Stewardship

Best Management Practices for Agricultural Waterways, King County WA
<http://www.kingcounty.gov/environment/waterandland/stormwater/agricultural-drainage-assistance/waterway-maintenance-bmp-manual.aspx>

Bioengineering Techniques for Erosion Prevention: Capital Regional District
<https://www.crd.bc.ca/education/our-environment/concerns/erosion>

British Columbia Conservation Data Centre
<http://www.env.gov.bc.ca/atrisk/toolintro.html>

BC Ministry of the Environment Stewardship Resources:
<https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting>

Cows and Fish <http://www.cowsandfish.org/>

Cows and Fish Assessment tool: <http://cowsandfish.org/riparian/health.html>

Department of Fisheries and Oceans: Projects Near Water
<http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/measures-mesures-eng.html>

Drainage Management Guide, BC Ministry of Agriculture
<http://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/water/drainage/drainage-management-guide>

Environmental Farm Plan Program
<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/environmental-farm-plan>

Incentive funding program
<http://www.farmlandadvantage.com/>

Instream Works, BC Ministry of Environment
<http://www.env.gov.bc.ca/wld/instreamworks/index.htm>

The Pacific Streamkeepers Federation: Streamkeepers Handbook and Modules
<http://www.pskf.ca/publications/handbook.html>

Species and Ecosystems at Risk Local Government Working Group
<https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/species-ecosystems-at-risk/local-government-working-group>

Species at Risk Act Public Registry
<http://www.sararegistry.gc.ca>

SARA and You: Information for private landowners
<https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=96E43121-1>

Working Near Water, Fisheries and Oceans Canada
<http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html>

Stewardship Centre for BC

Stewardship Center for BC: Lands Near Water
www.stewardshipcentrebcc.ca/resources

Stewardship Centre for BC
www.stewardshipcentrebcc.ca

Stewardship Series, Stewardship Centre for BC
www.stewardshipcentrebcc.ca/bc-stewardship-series

Funding Sources

Habitat Stewardship Program funds stewardship activities on private land

www.ec.gc.ca/hsp-pih

EcoAction Community Funding Program provides financial support for projects that have measurable, positive impacts on the environment.

www.ec.gc.ca/ecoaction

Pacific Salmon Foundation supports volunteer organizations that undertake habitat projects, including riparian restoration, that benefit salmon through their Community Salmon Program.

www.psf.ca

Species at Risk Partnerships on Agricultural Land (SARPAL) pilot program assists cattle producers in adopting management practices that benefit their ranch operation as well as species at risk in the south interior.

www.cattlemen.bc.ca/SARPAL.htm

Habitat Conservation Trust Fund provides funding for projects that maintain, conserve or restore indigenous fish and wildlife species and their habitats.

www.hctf.ca

Farmland Advantage is a research and development project working to establish a program that pays farmers to take extra ordinary action to enhance the environment.

www.farmlandadvantage.com

Tax Incentives

Ecological Gifts Program offers significant tax benefits to landowners who donate ecologically sensitive land or a partial interest in land.

www.ec.gc.ca/pde-egp

Land Trust Alliance provides support for landowners to make charitable donations of ecologically sensitive land.

www.ltabc.ca



The Bearded Sedge is threatened by habitat loss associated, in part, with agricultural drainage.

Agricultural Assurance Programs

Dairy Farmers of Canada and members initiated the development of proAction to show how farmers responsibly produce milk.

www.dairyfarmers.ca/proaction

Verified Beef Plus is an assurance program initiated by The Canadian Cattlemen's Association that demonstrates quality, safety, and care in the production of Canadian beef.

verifiedbeefproductionplus.ca

Appendix B: Existing Regulations and Policies

Depending on the type and location of work, a number of Provincial or Federal permits and authorizations may be required for drainage maintenance and stewardship of agricultural waterways.

Please note that this list is current at time of

publication; people should contact local authorities to confirm required permits and authorizations.

Depending on project complexity and resources available, it may be advisable to engage qualified professional consultants to help with project planning and permit applications.

Government	Legislation	Permits/Authorizations
BC	<i>Water Sustainability Act</i>	To make changes in and about a stream you must hold a licence, use approval or change approval; or be in compliance with an order, or in accordance with Part 3 of the Water Sustainability Regulation https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/laws-rules/water-sustainability-act
	<i>Wildlife Act</i>	Fish collection permit required for fish salvages. Wildlife act permits required for salvages other wildlife (e.g., amphibians). http://www.env.gov.bc.ca/pasb/fw_permreg.html
	<i>Riparian Areas Protection Act</i>	The Riparian Areas Regulation (RAR) protects and may require restoration of riparian area vegetation during non-agricultural land development including activities such as adding decks or docks. Setbacks for agricultural buildings depend on the type of building and watercourse and vary from 5 to 30 m. Although RAR does not apply to agricultural land use and farming activities, the standard for agricultural building setbacks complements RAR. The RAR is provincial, but administered by local governments. For further information, contact your local government offices.
Federal	<i>Fisheries Act</i>	Drainage maintenance work that has the potential to cause serious harm to fish and their habitat, as defined under section 35 of the Fisheries Act, may require an authorization by the Minister of Fisheries and Oceans. For the most current information on Fisheries Act reviews and permitting processes refer to: http://www.dfo-mpo.gc.ca/pnw-ppe/index-eng.html DFO's measures to avoid and mitigate harm will help people conducting projects near water to comply with the <i>Fisheries Act</i> and <i>Species at Risk Act</i> (SARA). More information on these measures can be found at: http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/offset-harm-dommage-comp-eng.html A joint federal and provincial introduction and transfer permit may also be required if fish are to be moved. For information on these permits refer to: http://www.dfo-mpo.gc.ca/aquaculture/management-gestion/licen-permi-eng.htm .

	<i>Species at Risk Act (aquatic species)</i>	<p>It is prohibited to kill, harm, harass, capture, take, possess, collect, buy, sell or trade an individual or any part of an individual of a species listed under SARA as extirpated, endangered or threatened anywhere the species occurs in Canada.</p> <p>SARA also contains provisions that prohibit the damage or destruction of the residence of one or more individuals, and the destruction any part of the critical habitat of listed aquatic species. Critical habitat is the habitat necessary for the survival or recovery of the species, and is identified and described in the recovery strategy or action plan for that species.</p> <p>For some aquatic species at risk, riparian habitat is identified as critical habitat. Activities such as clearing riparian vegetation can take place in critical habitat, but these activities must occur in ways that do not result in the destruction of critical habitat. For information on critical habitat refer to: http://www.dfo-mpo.gc.ca/species-especes/sara-lep/act-loi/habitat-eng.html</p> <p>If you are planning to carry out activities that may trigger prohibitions under SARA, including any salvage activities associated with instream works (e.g., capture and relocation away from the project area), you will require a permit or authorization by the Minister of Fisheries and Oceans. For information on permits, refer to: http://www.dfo-mpo.gc.ca/species-especes/sara-lep/permits-permis/index-eng.html</p>
	<i>Species at Risk Act (terrestrial species)</i>	<p>It is prohibited to kill, harm, harass, collect or possess a terrestrial species, including a migratory bird that is listed as Endangered, Threatened or Extirpated. Destroying the nest or residence of those listed migratory birds is also prohibited. Permits may be issued for certain purposes: see http://www.sararegistry.gc.ca/sar/permit/permits_e.cfm for more information.</p> <p>Critical habitat is identified, to the extent possible, in final recovery strategies and action plans for all species listed as Endangered, Threatened or Extirpated. There are a variety of ways critical habitat may be protected on non-federal lands. Voluntary stewardship activities can help prevent destruction of critical habitat. Depending on the species, provincial laws may apply, or there could be a federal regulation or order in place which prohibits destruction of critical habitat. If protection under SARA is in place, some activities may still occur in critical habitat, but must occur in ways that do not result in destruction of critical habitat. For more information contact the regional Environment and Climate Change Canada office and visit www.sararegistry.gc.ca</p>

	<i>Migratory Bird Convention Act</i>	<p>General prohibitions under the Act and its regulations protects most species of migratory birds, and their nests and eggs, anywhere they are found in Canada, regardless of ownership. The deposit of substances harmful to migratory birds in waters or areas frequented by them is also prohibited.</p> <p>Environment Canada recommends that you:</p> <ol style="list-style-type: none"> 1. Know your legal obligations; 2. Avoid engaging in potentially destructive or disruptive activities in key sensitive periods and locations, in order to reduce the risk of affecting birds, their nests or eggs; 3. Develop and implement appropriate preventive and mitigation measures to minimize the risk of incidental take and to help maintain sustainable populations of migratory birds. <p>Note that appropriate measures need to be decided on a case-by-case basis. It is the responsibility of the individual or company undertaking the activities to determine these measures.</p> <p>For more information, please visit the information page on the MCBA: http://www.ec.gc.ca/Nature/default.asp?lang=En&n=7CEBB77D-1 and the EC Incidental Take website: http://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=C51C415F-1</p>
Local Government	Tree Bylaws and Development Permit Processes	Local governments may regulate removal of trees through a dedicated bylaw and/or through development permit processes. Details differ widely among jurisdictions, so it is prudent to check with the relevant municipality or regional district.

Appendix C: Fish and Wildlife Salvages

Salvages should be led by qualified professionals if fish, amphibians, or other wildlife species are present in areas where work is to occur. Appropriate methods depend upon the habitat and target species and should be selected in consultation with regulatory agencies. **Permits are required to capture or handle any fish or wildlife species** (see Appendix B).

Qualified professionals will use appropriate techniques, e.g. electrofishing and fyke netting (as shown)



Recommended Protocol for Fish Salvage:

1. If the work site is less than 100 m long, attempt to clear fish from area without capturing them prior to isolation. Install one stop net and use seine sweeps, splashing and physical disturbance, depending upon circumstances.
2. Isolate the work area in sections not exceeding 100 m using stop nets (0.25 inch or finer mesh). Welded wire mesh supported by rebar can also be used.
3. **a. If the site is shallow enough for wading, with a hard bottom and few obstructions,** use a beach seine of equal to or greater in length than the channel width to repeatedly sweep the isolated section.
b. if the site is deep and/or too soft-bottomed to wade or there are too many obstructions for efficient seining, set one fish trap per 5 m of channel length.
4. Following seining and/or trapping, if the section is shallow enough to wade, use a backpack electrofishing unit to remove remaining fish. Using a maximum of three passes. The electroshocker should be set to the minimum effective voltage. Direct DC current or gated bursts of AC current are preferred.
5. Captured fish should be held for the minimum time possible in well oxygenated water at ambient stream temperature. This is best accomplished using a perforated holding container partially immersed in the stream.
6. If relocation is necessary, fish should be released into the closest suitable habitat within the watershed in accordance with fish transplant regulations.

Commercially available Gee minnow traps alone are insufficient as fish larger than about 15 cm typically do not enter them. Use larger Feddes Traps (see Pearson 2015) to catch larger fish. Lift traps 6 to 24 hours later.

Catches are highest in overnight sets, but if hypoxia is a concern lift traps before dark to avoid asphyxiating fish. If salmonids or species at risk are caught, repeat trapping protocol until none are captured.

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