Species at Risk
Voluntary Stewardship Practices for:

Drainage Maintenance in Agricultural Waterways

Produced in partnership by:

STEWARDSHIP CENTRE
FOR BRITISH COLUMBIA

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This report was written by **Mike Pearson,** PhD, RPBio; and **DG Blair**, M.Sc.

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STEWARDSHIP CENTRE FOR BRITISH COLUMBIA

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The Stewardship Centre for BC (SCBC) was created to assist governments, businesses, conservation and environmental organizations, and citizens carry out stewardship activities in the most efficient, effective, and rewarding ways. A leader in promoting stewardship values as the foundation for sustainability, the SCBC wants to help make "shared stewardship" – the voluntary adoption of environmentally sustainable practices by all sectors of society – a reality in British Columbia.

We are committed to champion science-based best stewardship so that British Columbians 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. For more information about the Stewardship Centre, go to www.stewardshipcentrebc.ca.

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Preface

This Stewardship Practices guide for species at risk and other wildlife affected by agricultural drainage activities presents options and examples of good stewardship practices to reduce impacts to these species. The guide describes different activities people can undertake to help conserve wildlife and their habitat and also provides links to resources to take action. This guide is one of a series of guides developed by the Stewardship Centre to address threats to wildlife and species at risk. Other guides in this series include:

- Species at Risk Voluntary Stewardship Practices for*: **Riparian Areas in Settled Landscapes***
- Species at Risk Voluntary Stewardship Practices for: ***Guidance for Restoration Activities in Riparian Areas***
- Species at Risk Voluntary Stewardship Practices for: ***Climbing***
- Species at Risk Voluntary Stewardship Practices for: ***Reducing Domestic and Feral Cat Predation***
- Species at Risk Voluntary Stewardship Practices for: ***Reducing Small Animal Road-kill.***

About this Document

This guide was designed to provide:

- Private landowners with information they can use to inform their actions to conserve species at risk
- Industry specific stewardship practices that the agricultural sector can consider when making land use decisions and developing land management plans
- Local governments with information to consider when developing mechanisms, such as bylaws and community plans, that help protect species at risk
- Information for conservation and stewardship organizations that can facilitate their work.

This guide encourages people to take **voluntary stewardship actions**, called stewardship practices, to safeguard wildlife and species at risk. Stewardship can be broadly defined as an ethic that promotes the responsible use, protection, and management of the natural environment through conservation and sustainable best practices.

This guide describes stewardship practices for wildlife and species at risk that addresses the common threat they face by agricultural drainage activities. Following an overview of this threat, various actions are described to conserve, enhance, and restore habitat that is impacted. To help implement these stewardship practices additional information resources are provided at the end of the guide.

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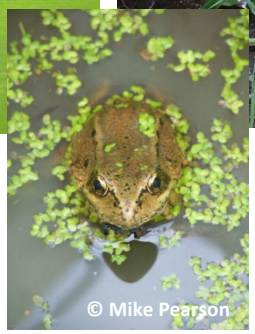
The Current Situation

Agriculture and Sensitive Habitats

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

Species at risk in British Columbia (BC) are concentrated in the same warmer, lower elevation lands favoured for agriculture, in particular the Fraser Valley, the Okanagan Valley and southern Vancouver Island. Agricultural waterways and lands adjacent to them contain some of the most valuable salmon and species at risk habitat in the Province. Ditches are often the last remnant of natural wetland habitats that have been drained.

Drainage works are often required on agricultural lands. Saturated root systems and standing water reduce crop growth and high water tables restrict the agricultural potential of the land by limiting the range of crops that can be grown. It is also required to protect buildings, infrastructure and other assets. Effective drainage is usually achieved by using a combination of surface and subsurface drainage systems. However, poorly designed, constructed or maintained drainage systems can negatively impact species at risk. Ditches can provide valuable habitat which can be kept healthy through the stewardship practices presented in this guide. These practices will enable farmers and land managers to maintain needed drainage while maintaining the quality of their local environment and ensuring species at risk have the habitat they need to survive.



Agricultural Waterways Provide Many Benefits to People

Waterways are a landscape's circulatory system. With the vegetation on their banks, known as a riparian zone, waterways link habitats together. They are the pathways through which water, nutrients, fish, wildlife, pollinators and even plants move through the landscape. These pathways are especially important when natural habitats are scattered and fragmented, as they often are in agricultural landscapes.

As pathways, links and remnant habitats, agricultural waterways and their riparian zones provide a wide range of benefits from nature to people; also called 'ecosystem services', without which our health, well-being, and economy would suffer. Ecosystem services of agricultural waterways include:

Drainage	Essential for agricultural production. Convey water from upstream agricultural, urban, industrial, and natural areas.
Fisheries	Produce a significant proportion of BC's salmon. Provide food, nutrients and water to all downstream fish habitats.
Pollinator production	Essential for agricultural fruit and berry production. Essential for maintenance of biodiversity.
Biodiversity	Many species at risk depend on agricultural waterways. Benefit pest control, bird watching, hunting, scientific research and a wide variety of other nature based activities.

Ditches and Biodiversity

Ditches may comprise a large portion, even the majority, of aquatic habitat area within intensively farmed watersheds. They provide essential movement corridors, food sources and refuge habitat for animals inhabiting agricultural landscapes or travelling between natural habitats.

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 ditches may have species richness similar to streams depending upon how close they are to natural waterways, the land use practices around them, and the complexity of habitat within them. Finally, waterways are open systems - contaminants that enter ditches, flow directly into rivers, streams, estuaries and may even make their way into drinking water supplies. Ditches are inseparable components of our aquatic ecosystems.

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

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

Causes for Concern

Loss of Habitat

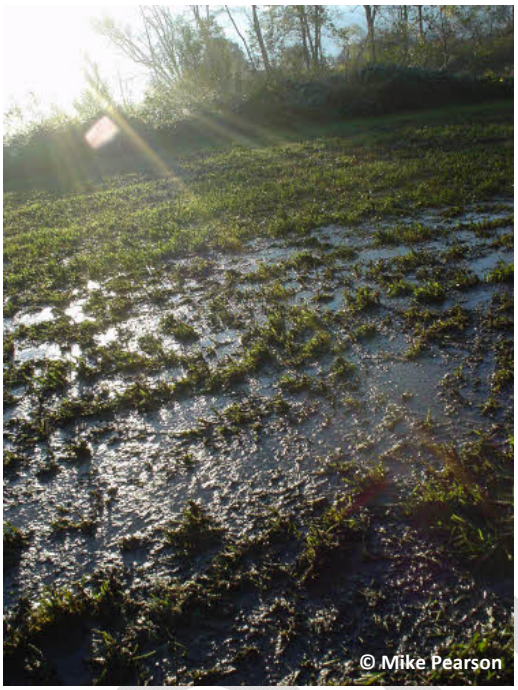
Ditches and channelized streams have replaced natural streams and wetlands as the dominant aquatic features on many intensively farmed landscapes. This conversion greatly reduced the area of natural habitats, particularly wetlands, increased flood frequency, reduced low flows and degraded water quality in downstream habitats. The changes are less dramatic, but often locally significant in less intensively farmed areas like BC's interior.

A growing human population has increased demands for inexpensive, high quality food and BC producers have responded by increasing and diversifying production through more intensive land use and more efficient farm practices. More intensive land use of any sort usually increases impacts to surface waters, fish and wildlife populations. For example riparian vegetation may be removed to allow easy access to the channel for machinery used in drainage maintenance. The loss of natural vegetation, however, often increases the need for (and costs of) maintenance as invasive plants populate and overgrow the unshaded channel.

Loss of riparian vegetation leaves waterways vulnerable to erosion, overheating, and the entry of agricultural nutrients and chemicals.

Eutrophication

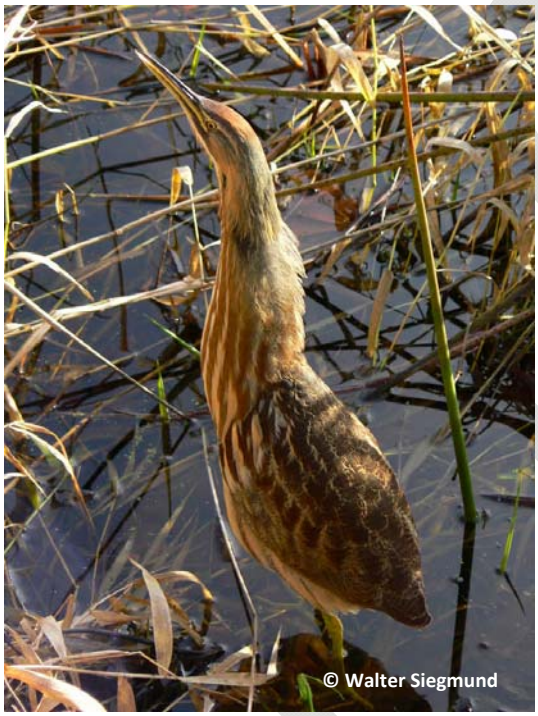
In natural streams, oxygen levels are typically adequate for salmon and most native aquatic plants grow submerged in the water column. In contrast, waterways in intensively farmed areas are commonly overgrown with mats of algae and invasive plants and lack enough dissolved oxygen to support fish. This condition, known as eutrophication, is caused by excessive nutrients in the water. The nutrients, primarily nitrogen and phosphorous, most commonly come from over-application of fertilizers such as manure, and enters waterways in runoff or through groundwater or is attached to sediment that enters the water from bank erosion.



At high nutrient levels, floating plant and emergent plant species (like duckweed and reed canary grass) replace submerged species, sometimes completely overgrowing waterways. Plants like duckweed and reed canary grass 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 continues to remove oxygen from the water column reducing the concentration to levels below those required by sensitive species like fish.

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

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



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

Erosion

Topsoil is being lost much faster than it forms in most of the world's agricultural areas, including parts of British Columbia. When soil is washed into streams, it is typically deposited downstream, where it may clog spawning riffles, fill pools and reduce the number and variety of invertebrates, upon which fish and amphibians feed.

Topsoil loss following upstream drainage maintenance work and riparian vegetation loss the Fraser Valley

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Woody riparian vegetation stabilizes soil with roots and helps filter sediment out of runoff. Without it, more erosion occurs and more soil and sediment enter waterways. Livestock access to waterways and banks also accelerates erosion

Which species at risk are most vulnerable and why?

A full list of species at risk impacted by drainage maintenance in agricultural waterways appears at the end of this document.

Fish

Most of British Columbia's native fish are adapted to clear cold water and require consistently high levels of dissolved oxygen to breath. When the amount of oxygen dissolved (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 asphyxiate and die. These conditions are common in the waterways of some intensively farmed areas of British Columbia.

Fish are found in most agricultural waterways in British Columbia, at least seasonally. In autumn many species of fish leave the main channels of rivers for habitat with less current and more cover protection from predators to overwinter. In agricultural landscapes, small ditches often harbour large concentrations cutthroat trout, coho salmon and a variety of other species.

The shade of streamside trees and shrubs keep water temperatures cool in summer. The removal of this vegetation along many agricultural waterways allows water temperatures to rise to levels intolerable to native fish, particularly salmon and trout. Most of our native fish spawn in riffles – 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. They may be harmed or die if sediment from upstream erosion settles, clogging the gravel and reducing 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 any contaminants in the water through their skin directly into their bloodstream. For this reason amphibians are exceptionally vulnerable to pollution. Riparian buffers or grassy leave strips can significantly reduce the entry of agricultural chemicals to waterways. Removal of aquatic vegetation can also deprive them of 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 by waterway maintenance activities.

Aquatic Invertebrates and Plants

Native aquatic plants 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 the dredging of silts.

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 creeks of all sizes. Both are vulnerable to channel dredging.

Existing Regulations and Policy

Timing of Work

In wetted channels, work is 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. The exact window varies among regions and watersheds. The Provincial Ministry of Environment, and Fisheries and Oceans Canada, should be consulted to determine precise local work windows.

Permits and Authorizations

Compliance is required with applicable aquatic related legislation, including those noted below. Depending on the type and location of work, a number of Provincial or Federal permits may be required. Local governments should also be contacted as many 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. Regional BC Ministry of Forests, Lands and Natural Resource Operations, Fisheries and Oceans Canada, and Environment Canada offices may be contacted for advice on what is required. **Depending on project complexity and resources available, it may be advisable to engage professional consultants to handle permit applications.**

Government	Legislation	Permits/Authorizations
BC	Water Act	Section 9 Authorization required for works 'in or about' a stream. Water license required for water diversions, withdrawals or detentions.
	Wildlife Act	Fish collection permit required for fish salvages. Wildlife act permits required for salvages other wildlife (e.g., amphibians).
Federal	Fisheries Act	Collection licences may be required under section 51 of Part VII of the *General Fisheries Regulations* for salvage if salmon are present in watercourses where works are proposed. For information on fish collection licences refer to DFO's website http://www.pac.dfo-mpo.gc.ca/habitat/permits-permis-eng.htm. An introduction and transfer permit may also be required if fish are to be moved. For information on these permits refer to DFO's website: http://www.dfo-mpo.gc.ca/aquaculture/regions/pac/introduction-eng.htm. Drainage maintenance work has the potential to harm fish habitat and depending on the circumstances may require authorization under the habitat protection provisions of the *Fisheries Act*. For the most current information on *Fisheries Act* reviews and permitting processes refer to DFO's website: http://www.dfo-mpo.gc.ca/habitat/habitat-eng.htm.
	Species at Risk Act (aquatic species)	Killing, harming, harassing, capturing, taking, collecting or possessing any aquatic Endangered, Threatened or Extirpated aquatic species protected under the Species at Risk Act is prohibited. As a result, a permit may be required for in-stream activities including fish salvage that could affect a species at risk http://www.dfo-mpo.gc.ca/species-especes/permits-permis/permits-eng.htm Destruction of an aquatic species at risk's identified and protected critical habitat is also prohibited. Activities such as drainage maintenance can take place in critical habitat, but these activities must occur in ways that do not result in destruction. For information on critical habitat refer to DFO's website: http://www.pac.dfo-mpo.gc.ca/consultation/sara-lep/orders-decrets-eng.htm.

	Species at Risk Act (terrestrial species)	It is prohibited to kill, harm, harass, collect or possess 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. Critical habitat is identified in final recovery strategies and action plans for all groups of listed species at risk. 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. Some activities may take place in critical habitat, but must occur in ways that do not result in destruction of critical habitat. For more information contact your regional Environment Canada office and visit www.sararegistry.gc.ca
	Migratory Bird Protection Act	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. Environment Canada recommends that you: 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. 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. 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

Stewardship Practices

Following are various actions, called Stewardship Practices, which help to conserve, enhance, and restore species at risk and wildlife habitat that is impacted by drainage maintenance. Waterways cross property lines and political boundaries. By working together to manage waterways at the landscape or watershed scale, greater results will be seen. Stewardship Practices are most beneficial when implemented on all of the channel length. Action typically starts on one or a few properties and every stewardship effort counts towards improving these waterways. The following volunteer stewardship practices for riparian areas will enhance habitat for wildlife and species at risk.

Protect Existing Riparian Areas

Protecting existing riparian habitat should always be the first priority; this is far more cost effective than restoring lost or degraded areas. It 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 functions of riparian zones, including moderating stream temperature and filtering nutrients.

Permanent protection can be achieved by registering a restrictive covenant on the land title. Contact your local Land Trust for details on how this might be accomplished through the Land Trust Alliance of British Columbia (www.ltabc.ca). 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 attractive income tax reductions (www.ec.gc.ca).

Conserve, Enhance, or Restore Riparian Buffers

Riparian buffers consisting of native vegetation should be restored adjacent to waterways where it has been removed. They should also be established along constructed ditches to reduce the entry of sediment, nutrients and chemicals – as anything that enters a ditch, will typically end up in a river.

Riparian zones are as diverse as the landscapes they traverse. Layout, plant species selection, site preparation, timing of planting, and protective measures must be tailored to site conditions to be successful - see companion document *Guidance for Restoration Activities in Riparian Areas.* Specific guidance can be obtained from published material associated with the Riparian Area Regulation and the Environmental Farm Plan Program (see WEB Resource below), or by retaining a qualified professional (typically a Registered Professional Biologist, or Forester). Care must be taken to allow access for drainage maintenance work. Neighbours and the local government should be consulted in the planning process.

Buffer strips of native trees and shrubs naturally occur along waterways. These strips, referred to as riparian areas, are highly effective in moderating stream temperatures, intercept significant amounts of nutrients, stabilize banks to reduce erosion, and provide habitat for a wide variety of native species. Conservation of existing riparian buffers is the most effective and inexpensive stewardship practice.

Along agricultural waterways, such as ditches, riparian areas have often been altered or removed. Adding native plants to enhance the existing vegetation or restoring the riparian area can be highly effective in reducing the frequency with which heavy equipment is required for maintenance by stabilizing banks, reducing siltation, and shading out invasive plants such as reed canary grass.

Companion documents entitled *Stewardship Practices for Riparian Areas in Settled Landscapes* and *Guidance for Restoration Activities in Riparian Areas* provide more detailed information on the design and establishment of effective riparian buffers that minimize impacts to operations.

Use Sensitive Methods to Work in Waterways

Despite good riparian stewardship practices, work within agricultural waterways is sometimes necessary to maintain drainage function. **Professional advice is strongly recommended for any in-stream 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.

Manual Work

In small, shallow streams with hard bottoms vegetation 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. Grass and herbaceous material is 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 material can be hay-mounded within the stream at collection points 30 m apart and removed with machinery from these points. Downed trees or willow branches can be trimmed with a chainsaw to minimize their impact on drainage, while avoiding damage to the bank and preserving their habitat value. 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 saves money or is at least revenue neutral.

Crews need to be trained in techniques and plant identification to avoid damage to in-stream habitat features and native vegetation. Regulatory agencies need to be consulted prior to starting, and work should generally occur within the in-stream work window (see above), regulatory requirements for this work are far less onerous than those for working in the channel with machinery. A number of commercial consulting firms in British Columbia do this type of work.

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.

Stabilize Banks using Bioengineering Methods

Bank stabilization is sometimes necessary, even in waterways with vegetated banks. Inexpensive, durable, self-repairing structures can be built, often by hand, using trees and shrubs that root easily from cut branches. Any or our 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 (Nov-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 and active erosion 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.

Willow whips can be used to construct live fences to stabilize erosion-prone banks (left), or simply be planted individually (right).

See also Appendix B for further guidance for drainage maintenance and restoration activities including:

- Fish and Wildlife Salvages
- Isolation of Work Area
- Tips for Material Removal
- Inset Channels.

Restore Aquatic Habitats

Restoration projects should be designed in consultation with a qualified professional and with regulatory agencies and local governments as permits and authorizations are likely to be required.

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 life stages. Adding complexity to waterways greatly increases their value as habitat, and where possible should be incorporated into maintenance works. Examples include adding floodplain benches along the channel edge, or well-anchored logs that protrude into the waterway. Use logs without root-wads in flowing waters and angle the logs in the downstream direction to avoid creating debris jams. If the banks are too high to efficiently 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 the habitat diversity while maintaining channel capacity.

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

Constructed Wetlands and Stream Channels

Constructing wetlands by widening ditches and planting wetland vegetation, and re-meandering and naturalizing channelized waterways have been shown to significantly improve water quality and biodiversity. Great care must be taken in designing and siting these projects to avoid damaging downstream habitats. These projects are relatively expensive to construct, usually take land out of production and may not improve drainage. Implementing them on private lands will likely require that society allocate public funds to help landowners offset the costs of achieving the ecosystem service benefits they provide.

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

Avoid Over-application or Poor Storage of Manure

Over application of manure is a major contributor to eutrophication and lack of oxygen in agricultural waterways. **Consult British Columbia's Nutrient Management Reference Guide for recommended application rates for various crops and recent Ministry of Agriculture manure spreading advisories and the Environmental Farm Plan Reference Guide for additional information.** Avoid major applications in fall after crop growth has slowed with lower temperatures. Consider alternative uses of manure through participation in manure composting or digester pilot projects.

A manure pile inappropriately stored, uncovered within a riparian area

Monitor and Evaluate Projects

To measure the effect of a Stewardship Practice, data should be collected before and after it is implemented at the project site and at a control site that is similar to, but beyond the influence of the project. Basic monitoring would include seasonal measurements of dissolved oxygen concentration, water temperature, and specific conductivity, fish and amphibian presence and density. Watershed scale monitoring is needed to understand the cumulative impacts of multiple projects. 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 in-stream works.


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Finding the Money

Maintaining and improving riparian areas and drainage maintenance can be costly. There are a number of existing and emerging financial assistance options:

- The Environmental Farm Plan Program will provide partial funding for the establishment of riparian vegetation, fencing livestock and many other beneficial management practices. For more information see the ARDCORP website
- Many landowners and local governments have partnered with local stewardship groups, such as Streamkeepers, who have access to government or other funding for habitat improvements, especially for fish and species at risk. Often these groups can access volunteer labour and grant funding for materials and volunteer labour to implement the project.
- Environment Canada can support landowners financially to protect critical habitat and species at risk through:
    a. The Habitat Stewardship Program (HSP) which provides funding for projects that protect and restore habitat for species at risk. Multi-year and multi-partner projects are encouraged. Private landowners should aim to develop their funding application with: stewardship groups, local government, and/or provincial government
    b. Landowners can also negotiate financial support to offset some of their costs as part of a stewardship agreement with Environment Canada.
    c. Landowners can access attractive tax benefits by protecting habitat on their land through the Ecological Gifts Program
- Annual payments to farmers for the value of the ecosystem goods and services their land or management practices provide are just emerging as a practice in British Columbia. The Delta Farmland and Wildlife Trust (http://www.deltafarmland.ca/) is probably the best known program, but several other projects involving riparian areas and/or species at risk are being piloted
- Individuals can ask their local government if their community has a conservation fund that supports stewardship. If not, they can encourage their local government to establish a conservation fund to support conservation in the region. The Kootenay Conservation Fund is one example (kootenayconservation.ca).

Appendix A: WEB Resources

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

http://www.crd.bc.ca/watersheds/protection/howtohelp/bioengineering.htm

Center for Wetlands and Stream Restoration

http://www.wetlandsandstreamrestoration.org/

In-Stream Works, BC Ministry of Environment

http://www.env.gov.bc.ca/wld/instreamworks/index.htm

Drainage Management Guide, BC Ministry of Agriculture

http://www.agf.gov.bc.ca/resmgmt/EnviroFarmPlanning/EFP_Drainage_Mgmt_Guide/Drainage_Mgmt_Guide_toc.htm

Environmental Farm Plan Program

http://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program

Working Near Water, Fisheries and Oceans Canada

http://www.dfo-mpo.gc.ca/habitat/habitat-eng.htm

Species and Ecosystems at Risk Local Government Working Group

http://www.env.gov.bc.ca/wld/searl_gwg/index.html

Species at Risk Act Public Registry

http://www.sararegistry.gc.ca

British Columbia Conservation Data Centre

http://www.env.gov.bc.ca/atrisk/toolintro.html

SARA and You private landowner information:

www.sararegistry.gc.ca/involved/you/privland_e.cfm

BC Ministry of the Environment Stewardship Resources:

http://www.env.gov.bc.ca/wld/info.htm#

Stewardship Center for BC provides information and links to local stewardship groups across BC: http://www.stewardshipcentreforbc.ca/

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/

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 http://ltabc.ca/

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

Appendix B: Guidance for Restoration Activities

Fish and Wildlife Salvages

Salvages should be conducted 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 above).

The recommended protocol for fish salvages is:

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, or low-voltage shocking 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 1 Feddes trap and one Gee trap per 10 m of channel length. Note that Gee traps alone are insufficient as larger fish do not enter them. Lift traps 6 to 24 h 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.
4. 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

Isolation of Work Area

Any work with heavy machinery in the water disturbs sediment and causes turbidity to rise far above acceptable levels. Consequently, the worksite should be isolated from adjacent 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.

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.

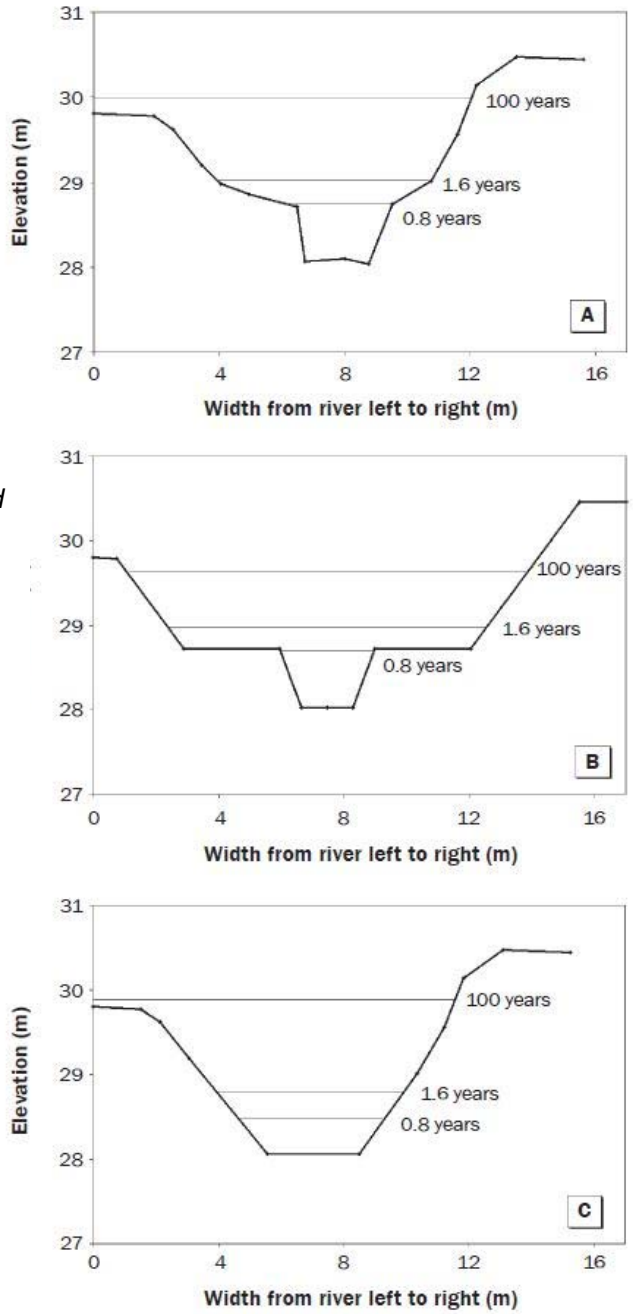
Tips for Material Removal

- 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 thumbed 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.

Inset Channels

An inset channel consists of a small channel designed to carry low flows and a larger channel designed to convey larger flows. An alternative to traditional approach of excavating a U-shaped channel large enough to carry expected flood flows is to excavate or leave intact a narrow low-flow channel and a larger high flow channel that is slightly wider than usual. The smaller inset channel can be managed more for its habitat values. 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). This technique is, so far, rare in British Columbia.



Water elevations for 0.8, 1.6 and100 year flood events for a ditch with (A) naturally forming sloping benches and no maintenance, (B) maintained with an inset channel, and (C) after conventional maintenance (From Powell et al. 2007).

Appendix C: Species at Risk Potentially Affected by Drainage Maintenance in Agricultural Waterways

Click on species name to link to information on biology, status, and distribution within British Columbia. Click on BC List, COSEWIC, or SARA status for definitions.				
English Name	**Scientific Name**	**BC List**	**COSEWIC**	**SARA**
Mammals				
Pacific Water Shrew	*Sorex bendirii*	Red	E	E
American Water Shrew, *brooksi* Subspecies	*Sorex palustris brooksi*	Red		
Birds				
Nelson's Sparrow	*Ammodramus nelsoni*	Red	N	
Great Blue Heron, *fannini* Subspecies	*Ardea herodias fannini*	Blue	S	S
Great Blue Heron, *herodias* Subspecies	*Ardea herodias herodias*	Blue		
American Bittern	*Botaurus lentiginosus*	Blue		
Black-Crowned Night-Heron	*Nycticorax nycticorax*	Red		
Amphibians				
Western Toad	*Anaxyrus boreas*	Blue	S	S
Wandering Salamander	*Aneides vagrans*	Blue		
Northern Red-Legged Frog	*Rana aurora*	Blue	S	S
Oregon Spotted Frog	*Rana pretiosa*	Red	E	E
Fish				
Chiselmouth	*Acrocheilus alutaceus*	Blue	N	
Salish Sucker	*Catostomus* sp. 4	Red	T	E
Northern Redbelly Dace	*Chrosomus eos*	Blue		
Shorthead Sculpin	*Cottus confusus*	Blue	S	S
Columbia Sculpin	*Cottus hubbsi*	*Blue*	*S*	*S*
Brassy Minnow - Pacific Group	*Hybognathus hankinsoni - Pacific group*	Blue		
Pearl Dace	*Margariscus nachtriebi*	Blue		
Cutthroat Trout, *clarkii* Subspecies	*Oncorhynchus clarkii clarkii*	Blue		
Cutthroat Trout, *lewisi* Subspecies	*Oncorhynchus clarkii lewisi*	Blue	S	S
Nooksack Dace	*Rhinichthys cataractae - Chehalis lineage*	Red	E	E
Bull Trout	*Salvelinus confluentus*	Blue	S	
Bull Trout - Coastal Lineage	*Salvelinus confluentus - coastal lineage*	Blue	S	
Bull Trout - Interior Lineage	*Salvelinus confluentus - interior lineage*	*Blue*	*S*	
Dragonflies				
Emma's Dancer	*Argia emma*	Blue		
River Jewelwing	*Calopteryx aequabilis*	Red		

Beaverpond Baskettail	*Epitheca canis*	Blue		
Olive Clubtail	*Stylurus olivaceus*	Red	E	
Autumn Meadowhawk	*Sympetrum vicinum*	Blue		
Molluscs				
Rocky Mountain Ridged Mussel	*Gonidea angulata*	Red	E	E
Swamp Fingernailclam	*Musculium partumeium*	Red		
Rocky Mountain Fingernailclam	*Sphaerium patella*	Red		
Ashy Pebblesnail	*Fluminicola fuscus*	Red		
Attenuate Fossaria	*Fossaria truncatula*	Blue		
Barren Juga	*Juga hemphilli*	Red		
Umbilicate Sprite	*Promenetus umbilicatellus*	Blue		
Abbreviate Pondsnail	*Stagnicola apicina*	Blue		
Vascular Plants				
Scarlet Ammannia	*Ammannia robusta*	Red	E	E
Chaffweed	*Anagallis minima*	Blue		
Cut-Leaved Water-Parsnip	*Berula erecta*	Blue		
Tall Beggarticks	*Bidens vulgata*	Red		
Western Water-Milfoil	*Myriophyllum hippuroides*	Blue		
Ussurian Water-Milfoil	*Myriophyllum ussuriense*	Blue		
Toothcup Meadow-Foam	*Rotala ramosior*	Red	E	E
Pink Water Speedwell	*Veronica catenata*	Red		
Mexican Mosquito Fern	*Azolla mexicana*	Red	T	E
American Sweet-Flag	*Acorus americanus*	Blue		
River Bulrush	*Bolboschoenus fluviatilis*	Red		
Bearded Sedge	*Carex comosa*	Red		
Green-Sheathed Sedge	*Carex feta*	Blue		
Green-Fruited Sedge	*Carex interrupta*	Red		
Lakeshore Sedge	*Carex lenticularis*	Blue		
Pointed Broom Sedge	*Carex scoparia*	Blue		
Many-Headed Sedge	*Carex sychnocephala*	Blue		
Nuttall's Waterweed	*Elodea nuttallii*	Blue		
Marsh Muhly	*Muhlenbergia glomerata*	Blue		
Sheathing Pondweed	*Stuckenia vaginata*	Blue		

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