

Environmental Best Management Practices for Urban and Rural Land Development



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Section Seven

AQUATIC AND RIPARIAN ECOSYSTEMS

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Summary

Best management practices for the protection and enhancement of aquatic and riparian ecosystems during land development include:

DETAILED SITE INVENTORY

- Identify all aquatic and riparian ecosystem on or near the proposed development site

SITE PLANNING AND DESIGN

- Retain wide riparian protection areas
- Design the development to protect aquatic and riparian features and functions
- Manage stormwater carefully

PROTECTION DURING DEVELOPMENT

- Consult the Instream Works Best Management Practices guide
- Protect riparian vegetation during construction
- Protect water quality during construction
- Avoid water level fluctuations in amphibian habitat
- Daylight culverted streams where possible

PROTECTION AFTER DEVELOPMENT

- Protect riparian vegetation after development
- Protect water quality and quantity after development

RESTORATION AND ENHANCEMENT

- Restore and enhance damaged aquatic and riparian ecosystems

HUMAN ACCESS TO AQUATIC AND RIPARIAN ECOSYSTEMS

- Control access to aquatic and riparian ecosystems

ECOSYSTEM-SPECIFIC BEST MANAGEMENT PRACTICES

- Protect wetlands, vernal pools, lakeshores and marine sensitive zones

Aquatic and Riparian Ecosystems

Aquatic ecosystems¹ are ‘wet’ ecosystems such as watercourses, lakes, ponds, **vernal pools** and **wetlands**. Some of these ecosystems may be dry during the summer months or frozen in the winter. **Riparian ecosystems** are the areas beside these aquatic ecosystems, supporting vegetation that can tolerate damper conditions and occasional flooding. Riparian ecosystems also occur in wet or dry gullies. Both aquatic and riparian ecosystems are extremely biologically diverse and productive. **Marine sensitive zones** (**estuaries** and their foreshore areas) are also important for biodiversity.

In many urban and suburban areas the remaining aquatic and riparian ecosystems play a critical role in helping to maintain biodiversity as they provide habitat and **wildlife corridors** for many terrestrial and aquatic species.

Aquatic and riparian areas are often home to special wildlife and species at risk. See **Section 6: Special Wildlife and Species at Risk** for further information on best management practices for these species.

7.1 BENEFITS OF HEALTHY AQUATIC AND RIPARIAN ECOSYSTEMS

Aquatic and riparian ecosystems are a vital part of our communities, providing a source of water, viewsapes and home for a wide variety of aquatic and terrestrial species.

For more information, see **Appendix A: Benefits of Environmental Protection**.

BENEFITS OF AQUATIC AND RIPARIAN ECOSYSTEMS

- **A multi-million dollar industry:** 500,000 licensed and juvenile anglers spend about \$500 million each year on freshwater sport fishing (*Bridges 2002*).
- **Increased property values:** Properties next to healthy aquatic and riparian areas sell quickly and for higher prices (*Quayle and Hamilton 1999*).
- **Flood and erosion protection:** Riparian areas slow and soak up floodwaters, and the roots of vegetation strengthen the stream banks to reduce erosion.
- **Stormwater management:** Natural riparian vegetation along streams and wetlands can dramatically reduce the need for expensive storm sewer infrastructure (*Habitat Acquisition Trust 2004*).
- **Drinking water supply:** Watercourses are an important water supply for many communities. Even where the stream is not directly used as a drinking water source, aquatic and riparian areas provide a significant source of groundwater recharge, especially in urbanised areas where much of the watershed is paved over, and stormwater is piped directly to the stream. Groundwater recharge is important for communities that rely on wells, and helps to maintain stream flows for surface water extraction.
- **Pollution filtration:** Wetlands and streamside vegetation act as water filters that clean pollutants from the water before they reach our creeks and streams
- **Wildlife havens:** Many species at risk—including insects, amphibians, reptiles, birds and mammals as well as fish—rely on aquatic and riparian habitats for at least part of their life cycle.

For more information, see **Appendix A: Benefits of Environmental Protection**.

¹**Definitions** are provided in Appendix 7-1 and in the Glossary

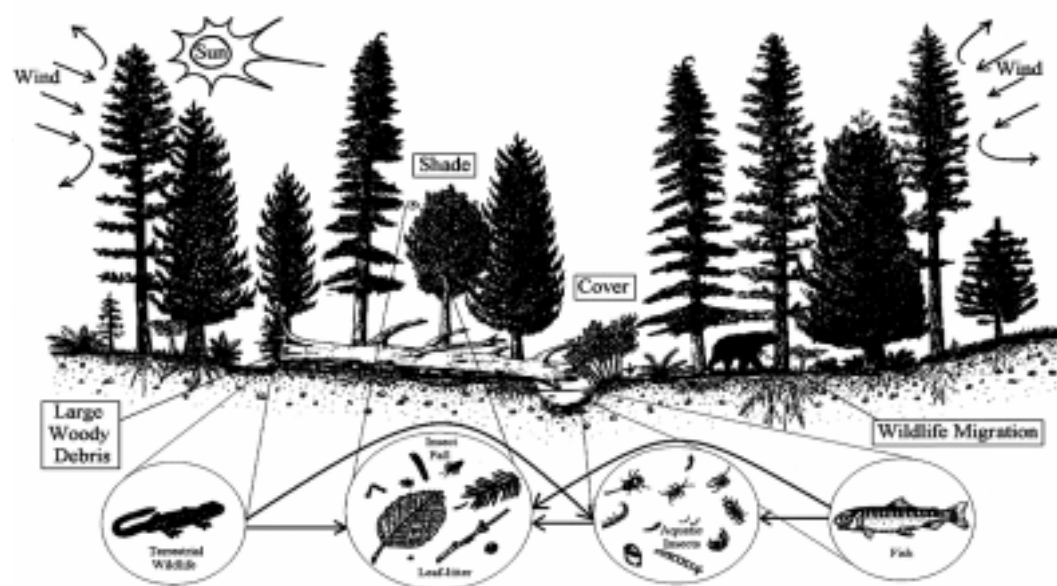


Figure 1: Ways in which healthy riparian areas help to ensure healthy fish populations
(MINISTRY OF WATER, LAND AND AIR PROTECTION)

7.2 OBJECTIVES

Aquatic and riparian ecosystems need to be protected from development. Local governments and the development community should meet the following environmental objectives during urban and rural land development:

- Identify all aquatic and riparian values, **features** and **functions**¹ prior to any development;
- Protect, restore and enhance the **ecological integrity** of aquatic and riparian ecosystems, including the natural ecosystem features and functions;
- Protect the water quality and quantity in aquatic ecosystems;
- Maintain, restore or enhance aquatic and riparian ecosystems as wildlife corridors through urban and rural areas, including connections to terrestrial habitats.

Local governments should address these issues within their Official Community Plan and other planning and public consultation processes. Developers should be able to demonstrate to local governments and the public how they have addressed these concerns and incorporated them into their development before, during and after the construction process.

7.3 LEGAL REQUIREMENTS

Land development around aquatic and riparian ecosystems are governed by the following legislation and regulations;

- The Canada [*Fisheries Act*](#) (Section 35 (1)) notes that “...no person shall carry on work or undertaking that results in the harmful alteration, disruption or destruction of fish

¹ See [Appendix 7-2: Ecological Features and Functions of Aquatic and Riparian Ecosystems](#)

habitat.” Two elements of this legislation must be met before Fisheries and Oceans Canada or Ministry of Water, Land and Air Protection will pursue a charge against a landowner:

- The site must be fish habitat
- The habitat must be harmfully altered, disrupted or destroyed. Fish habitat as defined by the *Fisheries Act* includes any area which sustains a fish life cycle either directly or indirectly. This may include: spawning areas; feeding areas for any stage of the life cycle; living/holding areas; fish food producing areas where food can form part of the life cycle, even if fish are not present; and migration routes.

The importance of streamside/riparian vegetation as fish habitat has been successfully brought before the courts, and legal judgements have identified riparian vegetation as fish habitat. For more information see http://www-heb.pac.dfo-mpo.gc.ca/habitat_policy/charges_e.htm.

- The B.C. *Fish Protection Act* designates sensitive streams for fish sustainability, and provides for the development of recovery plans for these streams. It also includes provision for riparian setbacks in the Streamside Protection Regulations.
- The *Streamside Protection Regulations* of the Fish Protection Act are currently under review. Updated information will be posted on the Ministry website when new regulations are in place.
- The B.C. *Water Act*, Part 7 ‘changes in and about a stream’ regulation (Water Act Regulation 204/88) allow persons to carry out specified activities in and about streams (such as installation of culverts, clear span bridges and pipeline crossings) without the need to obtain a formal approval under the *Water Act*, so long as the activity is carried out in compliance with the regulation. Applications are available at <http://wlapwww.gov.bc.ca/vir/es/instream.html>.

7.4 BEST MANAGEMENT PRACTICES

Best management practices for aquatic and riparian ecosystems centre on protection of these ecosystems from adverse impacts associated with the conversion of the natural landscape to urban/rural land uses. Opportunities may exist to restore or enhance aquatic and riparian ecosystems during the process of developing adjacent lands.

These best management practices apply to all types of riparian areas. For additional ecosystem-specific guidelines see [Section 7.4.7: Ecosystem-Specific Best Management Practices](#).

For additional information on best management practices that benefit aquatic and riparian ecosystems and can result in savings to a development project, refer to the sections on Stormwater Management and Erosion and Sediment Control in [Section 3: Environmental Planning at a Community Level](#) and [Section 4: Environmental Planning and Development at the Site Level](#).

Streamside Protection Regulations: At the time of writing (May 2004), the provincial government is reviewing the Streamside Protection Regulations that govern riparian setbacks. For more information, see <http://wlapwww.gov.bc.ca>

7.4.1 Detailed Site Inventory

IDENTIFY ALL AQUATIC AND RIPARIAN ECOSYSTEMS ON OR NEAR THE PROPOSED DEVELOPMENT SITE



Identify aquatic and riparian ecosystems.

PHOTO: SUSAN LATIMER

- ☑ Gather available information from community or regional level mapping and inventories (see [Appendix B: Sources for Environmental Mapping and Inventory](#) and [Section 4.4.2: Detailed Site Inventory](#)). Other useful sources include the [Fish Wizard](#), the [Sensitive Habitat Inventory and Mapping \(SHIM\)](#), the [B.C. Wetlands Atlas](#), [Fisheries Inventory Summary System \(FISS\)](#), [South Coast Cutthroat Atlas](#) and [Eelgrass Bed Mapping Atlas](#). The [Conservation Data Centre \(CDC\)](#) can provide information on known locations of species at risk. Note that coverage by the CDC is not equally good in all areas so be aware that a lack of CDC listing does not mean that species at risk are not found in that location. If the available information is inadequate, have a detailed bio-inventory of the site prepared by an appropriately qualified professional. See [Section 4.4.2: Detailed Site Inventory](#), and [Appendix C: Terms of Reference for Bio-Inventory](#). Note that the timing of the bio-inventory is important, as some species may only be visible or may only use the area at certain times of year. In some cases it may be necessary to inventory the site in more than one season to fully assess its ecological values.
- ☑ Ensure that the report identifies the ecosystem features and functions of aquatic and riparian ecosystems, site hydrology, and recommended riparian buffers as well as links to terrestrial information.
- ☑ Gather baseline data on pre-development hydrological conditions.
- ☑ Provide the results of the bio-inventory to the local government, and any findings of species at risk to the [Conservation Data Centre](#) and [regional Ministry of Water, Land and Air Protection](#) species at risk staff.

7.4.2 Site Planning and Design

RETAIN WIDE AREAS

The best available science around establishment of effective riparian buffers continues to evolve. Most earlier studies focused on requirements for various life stages. However, in recent years more effort is being placed on the riparian requirements of other species such as amphibians and birds. The use of this best available science also continues to evolve. In Washington State application of new science is altering the riparian buffers in a number of counties. Site specific habitat management plans may reduce the buffers by 50% where an appropriately qualified professional determines there will be no net loss of functions or values. This approach is similar to the Riparian Area Regulation soon to come into effect in British Columbia. Specific details of some of the proposed changes to county critical areas ordinances and updates to best available science can be found at www.kitsapgov.com/dcd/cao and <http://www.ecy.wa.gov/programs/sea/wetlan.html>.

Many local governments have defined these setbacks in Development Permit Areas and Zoning Bylaws. Note that these setbacks are primarily designed to protect aquatic species and may not be sufficient to retain other sensitive species such as amphibians and birds. Advice from an appropriately qualified professional can provide direction on appropriate width for the **riparian protection area**.

- ☑ Establish effective riparian buffers at an early stage in site planning.
- ☑ Ensure riparian buffer areas meet the needs of terrestrial as well as aquatic species that use these areas.
- ☑ Take advantage of opportunities to re-create and widen riparian buffer areas during land re-development.
- ☑ Recognise that fire-proofing plans may suggest removal of shrubby vegetation in riparian areas—design the development to keep dwellings well away from these areas to avoid having to remove vegetation.



This perched culvert is a barrier to fish passage
T. CASHIN PHOTO

DESIGN THE DEVELOPMENT TO PROTECT AQUATIC AND RIPARIAN FEATURES AND FUNCTIONS

- ☑ Do not develop in the riparian protection area. This may involve increasing density on a less sensitive part of the site in order to protect riparian ecosystems.
- ☑ Avoid or minimise stream crossings.
- ☑ Where stream crossings are required, ensure that they continue to provide passage for fish and wildlife, and that they are located where there will be least impact to the stream and riparian vegetation.
- ☑ Place utility crossings at stream crossing locations and use directional drilling where possible to minimise disturbances to riparian vegetation. For more information refer to the [*Fish-stream Crossing Guidebook*](#).
- ☑ Do not create lots that straddle the watercourse and riparian zone. This would increase the number of stream crossings and likely damage the riparian protection area as owners access the different parts of their property.
- ☑ Consult local government bylaws and permitting processes to identify additional local restrictions and requirements.
- ☑ For more information see [*Stream Stewardship: A Guide for Planners and Developers*](#) and [*Land Development Guidelines for the Protection of Aquatic Habitat*](#).

MANAGE STORMWATER CAREFULLY

- ☑ Avoid changes to natural drainage patterns. Changes in overground or underground flow patterns can destabilise banks and impact on aquatic habitats.
- ☑ Do not use local streams or wetlands for unmanaged stormwater discharge. The increased flows can significantly increase erosion and damage wildlife habitats.

The Water Balance Model promotes a watershed-based approach that manages the natural environment and the built environment as integrated components of the same watershed.
<http://www.waterbalance.ca/sql/home/index.asp>

- ☑ For more information see [Stormwater Planning: A Guidebook for British Columbia](#) (Chapters 6 and 7) and the [Water Balance Model](#).

7.4.3 Protection During Development

CONSULT THE INSTREAM WORKS BEST MANAGEMENT PRACTICES GUIDE

- ☑ For all work in and around watercourses, follow the guidelines of the [Standards and Best Practices for Instream Works](#) and any other regional best management practices².
- ☑ Follow prescribed timing windows for construction in and around watercourses. The Ministry's [regional websites](#) provide some information on timing windows, and an appropriately qualified professional can provide site-specific advice. The Ministry of Water, Land and Air Protection is currently developing a Timing Windows Best Management Practices document, and this will be posted on the Ministry's [Best Management Practices](#) website when available. Timing windows for instream works are also discussed in [Standards and Best Practices for Instream Works](#).

PROTECT RIPARIAN VEGETATION DURING CONSTRUCTION

- ☑ Use the services of an appropriately qualified environmental monitor to undertake authorised work within aquatic and riparian ecosystems. Use of an environmental monitor can result in considerable cost and time savings and reduced liability, as it helps to ensure that regulatory requirements are met, and minimises the possibility that remedial work might be required. Many local governments require environmental monitors to be on site for such work as well as requiring development permits specific to the riparian area.
- ☑ Carefully survey, sign and clearly mark all riparian protection area boundaries including the drip line (root zone) of riparian trees.
- ☑ Erect easily visible fencing (temporary or permanent) to protect the riparian protection area from access by construction crews.
- ☑ Prevent all access inside the riparian protection area, except that authorised in the development plans and approvals and associated with authorised construction activities.
- ☑ Prevent damage to riparian vegetation and their root systems from machinery working on the development site.
- ☑ Maintain wildlife trees in riparian areas. If trees have been designated as a hazard, modify work areas to avoid the danger zone or consider topping the tree at 5 m or higher to retain some wildlife values. Where trees can not be topped, they should be felled and left lying in the riparian area as **coarse woody debris**. Note that a Hazard Tree Assessor is the only qualified professional for assessing danger trees but that this assessor may not be sensitive to wildlife needs. For more information see *Best Management Practices for Hazard Tree and Non-Hazard Tree Limbing, Topping or Removal*.

² Regional best management practices will be added to Version 2 of this document.

- ☑ When removing trees from outside of the riparian protection area, do not allow these trees to fall into the riparian zone, and do not haul them away through the protection zone.
- ☑ Do not clear native vegetation within the protection areas. The roots of these plants hold the soil in place and prevent excessive erosion, as well providing important habitat for a variety of wildlife. Rotting logs and other woody debris provide critical habitat for many species in riparian areas and recycle nutrients back into the soils.
- ☑ Conduct fuel reduction and management of **ladder fuels** without degrading riparian habitats by trimming lower dead branches but maintaining green shrubby vegetation.

PROTECT WATER QUALITY DURING CONSTRUCTION

- ☑ Control erosion and prevent the movement of sediment and other **deleterious substances** into the riparian protection area and/or the aquatic ecosystem. Failure to do so may result in charges or an Inspectors Order under the [Fisheries Act](#) and the [Waste Management Act](#). For more information see [Section 4.4.8 Erosion and Sediment Control](#) and the [Water Quality Municipal Best Management Practices for Construction Design](#) website.
- ☑ Keep all construction fuelling stations as well as mobile fuelling equipment well away (30 metres or more) from the riparian protection area to prevent the potential contamination of the aquatic and riparian ecosystems.
- ☑ Keep all fresh concrete and concrete equipment wash water well away from the riparian protection area, aquatic ecosystems and out of stormwater systems with connections to these areas.
- ☑ Do not allow fill or other construction materials to encroach on the riparian protection area.
- ☑ Avoid the use of pesticides and other toxins in riparian areas.
- ☑ For more information, see Appendix III of the [Standards and Best Practices for Instream Works](#).

AVOID WATER LEVEL FLUCTUATIONS IN AMPHIBIAN HABITAT

Changes in surface water levels and flows can have significant impacts on amphibian habitats and water quality.

- ☑ Follow the guidelines in *Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia*.

DAYLIGHT CULVERTED STREAMS WHERE POSSIBLE

- ☑ Take advantage of opportunities to 'daylight' culverted streams during re-development. The benefits of doing so include the creation of visual amenities, passive parks for human use and stormwater management opportunities, as well as habitat enhancement.



Let people know they are in a sensitive area.

PHOTO T. CASHIN

7.4.4 Protection After Development

PROTECT RIPARIAN VEGETATION AFTER DEVELOPMENT

- ☑ Construct permanent fences to minimise access to riparian protection areas.
- ☑ Leave fallen and topped trees on the ground to provide habitat for salamanders and a wide variety of insects. Coarse woody debris plays a critical role in riparian habitats. Removal of fine fuels will help fireproof fallen logs and topped trees.
- ☑ When pruning trees to improve sightlines, prune selected branches rather than cutting the main tree trunk. This will allow the tree to continue to grow and its roots to hold the bank in place.
- ☑ Remove **invasive species** (such as purple loosestrife and Himalayan blackberry) that are found in the riparian protection area, being careful not to damage the native riparian vegetation. Invasive species can seriously degrade aquatic and riparian ecosystems and are most easily dealt with before they become widespread. Removal of invasive species should only be undertaken with expert advice, as improper removal can encourage the spread of invasives. Persistence is required when dealing with invasive species as re-growth is common until native species can again establish.
- ☑ Provide signage that lets people know they are in a sensitive area.

The American Bullfrog is an invasive alien species that has taken over many lakes and wetlands in British Columbia. It is a voracious predator that eats other frogs and amphibians, fishes, small snakes, and even small songbirds and baby ducks.

PROTECT WATER QUALITY AND QUANTITY AFTER DEVELOPMENT

- ☑ Follow the guidelines set out in [Stormwater Planning: A Guidebook for British Columbia](#) (Chapters 6 and 7) and [Water Balance Model](#) to protect water quality and quantity.

7.4.5 Restoration and Enhancement of Damaged Aquatic and Riparian Ecosystems

RESTORE AND ENHANCE DAMAGED AQUATIC AND RIPARIAN ECOSYSTEMS

- ☑ Enhance or restore the vegetation within riparian protection areas where clearing has occurred. Appropriately qualified professionals can provide advice on suitable species and planting patterns. The use of potentially invasive species in restoration work (such as reed canary grass *Phalaris arundinacea*) may result in significant damage to the aquatic and riparian ecosystem and should be avoided.
- ☑ For information on aquatic and riparian restoration, see [Streamline](#), the Watershed Restoration Technical Bulletin.
- ☑ Consider the consequences of beaver activities on restored wetlands and plan to mitigate potential plant losses prior to undertaking restoration work. For more information see [Best Management Practices for Instream Works. Specific Standards and Best Practices: Beaver and Beaver Dam Management](#) and [Beaver Management Guidelines](#).

The Wetlands Institute offers a seven-day field experience where stewardship coordinators, city planners, teachers, First Nations, ministry and municipality staff, NGO staff, business leaders and others come together to learn wetland conservation skills. For information contact wetlands@netidea.com

7.4.6 Human Access to Aquatic and Riparian Ecosystems

CONTROL ACCESS TO AQUATIC AND RIPARIAN ECOSYSTEMS

- ☑ Avoid providing access to particularly sensitive areas such fish spawning areas, turtle nesting areas, heron rookeries or habitats with species at risk. Some species are far more sensitive to human disturbance than others. A species inventory can assist in planning access to riparian areas.
- ☑ For more information on designing access near aquatic areas, see [*Access Near Aquatic Areas: A Guide to Sensitive Planning, Design, and Management*](#).

7.4.7 Ecosystem-Specific Best Management Practices

WETLANDS

“Wetlands” include many different types of wetted area, including bogs, swamps, shallow water wetlands and marshes. For information on wetland classification, see [*“The Ecology of Wetland Ecosystems.”*](#)

Even small wetland areas can help protect water quality. Simple practices such as these can help maintain the integrity and effectiveness of wetlands.

- ☑ Consider the whole watershed function when attempting to preserve its critical components such as wetlands.
- ☑ Apply best management practices for sediment control (see [Section 4.4.8: Erosion and Sediment Control](#)) on all developments to reduce sediment inputs to wetland systems.
- ☑ Maintain vegetated buffers around wetland areas (see [Table 4-1](#) for suggested buffer distances). Buffers should be measured from the outer boundary of the wetland vegetation.
- ☑ Never divert water from wetland areas. Preserve existing drainage ways.
- ☑ Avoid crossing wetlands if possible. If required, use docks or boardwalks to cross a wetland rather than filling in.
- ☑ Design trails along high ground even if it means a longer walk to the shore
- ☑ For information on the care of wetlands, see [*Wetlandkeepers Handbook: A practical guide to wetland care*](#) or the [Wetkit](#) website.

VERNAL POOLS

Vernal pools are sensitive habitats that are often home to rare species. They are often undervalued as they only retain water on a temporary basis. Some are highly alkaline.

- ☑ Identify and protect vernal pools during and after development. See environmentally sensitive area section.
- ☑ Do not turn vernal pools into year-round water features. Local species have adapted to these habitats and the process can add predators such as fish or other species that require year round habitat that might out-compete species adapted to the drying



Canada Geese.
PHOTO: DAVE POLSTER

cycle. Year-round water can also change the water chemistry and impact species that have adapted to the alkaline conditions.

- ☑ For more information on creating vernal pools to provide wildlife habitat, see [*A Guide to Creating Vernal Ponds*](#).

LAKESHORES

- ☑ The publication [*Living By Water*](#) offers advice for shoreline homeowners on ways to protect and enhance their shoreline.
- ☑ For lakeshore stabilisation activities, refer to the *Best Management Practices for Lakeshore Stabilization*. Lakeshore stabilisation techniques can have a detrimental impact on fish, amphibians and other lakeshore species.

MARINE SENSITIVE ZONES

These recommendations focus on estuaries and adjacent upland areas only.

- ☑ For information on the protection of marine sensitive zones, see the [*Coastal Shore Stewardship: A Guide for Planners, Builders and Developers*](#), [*Shoreline Structures Environmental Design: A Guide for Structures along Estuaries and Large Rivers*](#) and [*Caring for Our Shores: A Handbook for Coastal Landowners in the Strait of Georgia*](#).

7.5 USEFUL SOURCES

For complete references and a more extensive reading list, see the *Bibliography*.

LEGISLATION:

For a full listing of **provincial government legislation**, see

http://www.qp.gov.bc.ca/statreg/list_statreg_1.htm

B.C. *Fish Protection Act*: http://www.qp.gov.bc.ca/statreg/stat/F/97021_01.htm

Streamside Protection Regulation: http://www.qp.gov.bc.ca/statreg/reg/F/FishProtect/10_2001.htm

B.C. *Waste Management Act*: http://www.qp.gov.bc.ca/statreg/stat/W/96482_01.htm

B.C. *Water Act*: http://www.qp.gov.bc.ca/statreg/stat/W/96483_01.htm

For a full listing of **federal government legislation**, see: <http://laws.justice.gc.ca/en/>

Canada *Fisheries Act* <http://laws.justice.gc.ca/en/F-14/index.html>

INVENTORY AND MAPPING:

Sensitive Habitat Inventory and Mapping (SHIM) website (part of the Community Mapping Network): <http://www.shim.bc.ca/maps.html>

Fisheries Inventory Summary System (FISS): <http://www.bcfisheries.gov.bc.ca/fishinv/fiss.html>

Fish Wizard: <http://www.fishwizard.com/>

SHIM data: <http://www.shim.bc.ca/shim/shimloginscreen2.htm>

B.C. Wetlands Atlas: <http://www.shim.bc.ca/wetland/main.htm>

South Coast Cutthroat Atlas: <http://www.shim.bc.ca/cutthroat/main.htm>

Eelgrass Bed Mapping Atlas: <http://www.shim.bc.ca/eelgrass/main.htm>

Conservation Data Centre report of findings: <http://srmwww.gov.bc.ca/cdc/contribute.html>

BEST MANAGEMENT PRACTICES:

These Best Management Practices documents will be posted on the Ministry of Water, Land and Air Protection website (<http://wlapwww.gov.bc.ca/wld/BMP/bmpintro.html>) in the near future. Some drafts are available for review on other websites, or from Ministry offices, as noted below. Comments on these drafts can be sent to Marlene Caskey (Marlene.Caskey@gems7.gov.bc.ca) or Dr. Grant Bracher (Grant.Bracher@gems2.gov.bc.ca).

Best Management Practices for Instream Works. Specific Standards and Best Practices: Beaver and Beaver Dam Management: <http://wlapwww.gov.bc.ca/wld/BMP/beaver.html>

Beaver Management Guidelines: <http://wlapwww.gov.bc.ca/vir/pa/Beaver-Guide.pdf>

Best Management Practices for Hazard Tree and Non-Hazard Tree Limbing, Topping or Removal. Ministry of Water, Land and Air Protection, Okanagan Region. Penticton, B.C. For a copy contact Susan Latimer, Susan.Latimer@gems1.gov.bc.ca

Best Management Practices for Lakeshore Stabilization. Ministry of Water, Land and Air Protection, Okanagan Region, Penticton, B.C. For a copy contact Susan Latimer, Susan.Latimer@gems1.gov.bc.ca

Best Management Practices for Amphibians and Reptiles in Urban and Rural Environments in British Columbia: <http://www3.telus.net/public/leahmalk/BMP.pdf>

Standards and Best Practices for Instream Works: <http://wlapwww.gov.bc.ca/sry/iswstdsbpsmarch2004.pdf>

To contact regional Ministry of Water, Land and Air Protection offices see <http://wlapwww.gov.bc.ca/main/prgs/regions.htm>

STEWARDSHIP AND RESTORATION OF AQUATIC AND RIPARIAN AREAS

All of the publications in the Stewardship Series are available at http://www.stewardshipcentre.bc.ca/sc_bc/stew_series/bc_stewseries.asp

Access Near Aquatic Areas: A Guide to Sensitive Planning, Design and Management.

Coastal Shore Stewardship: A Guide for Planners, Builders and Developers

Land Development Guidelines for the Protection of Aquatic Habitat

Stream Stewardship: A Guide for Planners and Developers

Shoreline Structures Environmental Design: A Guide for Structures along Estuaries and Large Rivers

The Streamkeepers Handbook: A Practical Guide to Stream and Wetland Care

Wetlandkeepers Handbook: A practical guide to wetland care

Banner, A. and W. McKenzie. 2000. "The Ecology of Wetland Ecosystems." B.C. Ministry of Forests Extension Note #45. <http://www.for.gov.bc.ca/hfd/pubs/docs/En/En45.pdf>

B.C. Lake Stewardship Society: <http://www.nalms.org/bclss/>

Cowichan Community Land Trust and Marine Ecology Station. *Caring for Our Shores: A Handbook for Coastal Landowners in the Strait of Georgia.* <http://www.island.net/~cclt/links.htm>

Living by Water. 2002. *On the Living Edge: Your Handbook for Waterfront Living.* <http://www.livingbywater.ca>

Land and Water B.C. "A User's Guide to Working in and around Water - Regulation under B.C.'s Water Act" Revised January 2001. http://lwbc.bc.ca/water/brochures/user_guide.pdf

B.C. Ministry of Agriculture, Food and Fisheries information on the management of fish and wildlife habitats: http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/activity/870218-39_Habitat_Management.pdf

B.C. Ministry of Forests. 1995. Riparian Management Area Guidebook. Forest Practices Code. <http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/riparian/Rip-toc.html>

B.C. Ministry of Forests. 2002. Fish-stream Crossing Guidebook. Forest Practices Code of British Columbia Guidebook. <http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/FishStreamCrossing/FSCGdBk.pdf>

B.C. Ministry of Water, Land and Air Protection – Lower Mainland Region. 2002. So, You Want To Cross That Stream On Your Property? Environmental Stewardship Standards and Recommended Best Practices - Instream Works Type No. 2. Information Bulletin. 13 p.

B.C. Ministry of Forests. *Windthrow Handbook for British Columbia Forests*.

<http://www.for.gov.bc.ca/hfd/pubs/Docs/Wp/Wp01.htm>

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<http://herpcenter.ipfw.edu/index.htm?http://herpcenter.ipfw.edu/outreach/VernalPonds/index.htm&2>

Wetkit website: <http://www.wetkit.net/>

STORMWATER MANAGEMENT

Stormwater Planning: A Guidebook for British Columbia

<http://wlapwww.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.html>

Water Balance Model website: <http://www.waterbalance.ca/sql/home/index.asp>

APPENDIX 7-1: DEFINITIONS

See also Glossary

Aquatic ecosystem: Any body of water, such as a stream, lake, estuary or wetland, and all of the organisms and non-living components within it, functioning as a natural system.

Coarse woody debris: Sound or rotting logs, stumps or large branches that have fallen or been cut and left in the woods; or trees and branches that have died but remain standing or leaning.

Deleterious substance: Any substance that, if added to water, would degrade or alter the quality of the water so that it becomes damaging to fish or fish habitat, or becomes unsuitable for human consumption or any other purpose for which it is legally licensed (such as irrigation and livestock watering).

Ecological integrity: A continuum of characteristics that a landscape should possess. These include ecosystem health, biodiversity, stability and sustainability through the maintenance of structural and functional components of the system in perpetuity.

Ecosystem features: The physical components of the ecosystem (such as snags and large woody debris) that help maintain the diversity and processes associated with a healthy ecosystem.

Ecosystem functions: The physical, chemical and biological processes that keep an ecosystem operating. Examples include infiltration of surface water, evapo-transpiration and nutrient cycling.

Erosion: A natural process of sediment movement as a consequence of water currents, rainfall runoff, or wind, which may be considered beneficial or detrimental, depending upon the associated environmental concerns.

Estuary: A partially enclosed body of water freely connected to the ocean, within which the seawater is diluted by mixing with freshwater and where tidal fluctuations affect stream water levels. The estuary is a dynamic system typified by brackish (mixed fresh and salt) water, variable and often high nutrient levels and by shallow water conditions often associated with marsh plants in upper tidal zones and eelgrass in lower tidal zones.

Feathering: A method of partially trimming trees so that they are windfirm (better able to resist windthrow).

Invasive species: Plants, animals and micro-organisms that colonise and take over the habitats of native species. Most invasive species are also alien (non-native) to the area, and can become predominant because the natural controls (predators, disease, etc.) that kept populations in check in their native environment are not found in their new location.

Ladder fuels: Fuels that provide vertical continuity between ground fuels and the crowns of trees, contributing to the ease of a tree igniting.

Marine sensitive zone: Marine-sensitive zones (MSZs) include herring spawning areas, shellfish beds, marsh areas, existing aquaculture sites, juvenile salmonid rearing areas, and adult salmon holding areas. For the purposes of this document, marine sensitive zones refer primarily to estuaries and their foreshore areas.

Riparian ecosystem: A terrestrial ecosystem where the vegetation complex and microclimate conditions are the product of combined presence and influence of perennial and/or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. The riparian ecosystem is influenced by, and exerts an influence on, the associated aquatic ecosystem.

Riparian protection area: The area adjacent to a stream that may be subject to temporary, frequent or seasonal inundation, and supports plant species that are typical of an area of inundated or saturated soil conditions, and that are distinct from plant species on freely drained adjacent upland sites because of the presence of water.

Stream: a natural watercourse or source of water supply, whether usually containing water or not, ground water, and a lake, river, creek, spring, ravine, swamp and gulch.

Top of bank: The points closest to the natural boundary (or high water mark) of a watercourse where a break in slope occurs such that the grade beyond the break is flatter than 3 (horizontal) to 1 (vertical) for a minimum of 15 metres measured perpendicularly from the watercourse. Small slopes beyond the initial break in slope that are steeper than 3:1 but are less than 1 meter in height can be included in the determination of the 15 metre distance from the top of bank. Where banks are not well defined (e.g. in the case of lakes, wetlands or ponds), the top of the bank is equivalent to the natural boundary or seasonal high water mark.

Vernal pool: A temporary body of freshwater that is filled by spring rains and snowmelt, only to dry up during the hot, dry summer months. Many vernal pools are filled again by autumn rains, and may persist throughout the winter.

Wetland: Land that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, fens, vernal pools and estuaries.

Wildlife corridor: A travel corridor for wildlife. This ranges from very wide, natural corridors for large mammals, to 'sky corridors' that offer a safe flight path between feeding and resting places for birds, to smaller man-made corridors (such as urban trails) that provide safe passage for smaller creatures. These corridors also provide year-round habitat for less mobile species.

Windthrow: A tree or trees uprooted or broken off by the wind. Also known as blowdown.

Woody debris: Sound or rotting logs, stumps or large branches that have fallen or been cut and left in the woods or water; or trees and branches that have died but remain standing or leaning. These provide cover for small animals and their predators (both fish and wildlife).

APPENDIX 7-2: ECOLOGICAL FEATURES AND FUNCTIONS OF AQUATIC AND RIPARIAN ECOSYSTEMS

To maintain the ecological integrity of aquatic ecosystems, it is important to maintain the ecological features and functions across the landscape. These include:

- The forest and ground cover adjacent to streams that moderates water temperatures, provides a source of food, nutrients and organic matter to streams, establishes root matrices that stabilise soils and streambanks thereby minimising erosion, and buffers streams from sedimentation and pollution in surface runoff;
- The presence of organic debris that falls into the stream or streamside area, including leaves and twigs, logs, and root wads;
- The exchange of nutrients between terrestrial and aquatic systems;
- Side channels, intermittent streams, seasonally wetted contiguous areas and floodplains;
- A natural source of streambed substrates;
- Areas for lateral channel migration (active floodplains); and
- Permeable surfaces that permit infiltration to moderate water volume, timing and velocity and maintain sustained water flows in streams, especially during low (base) flow periods.