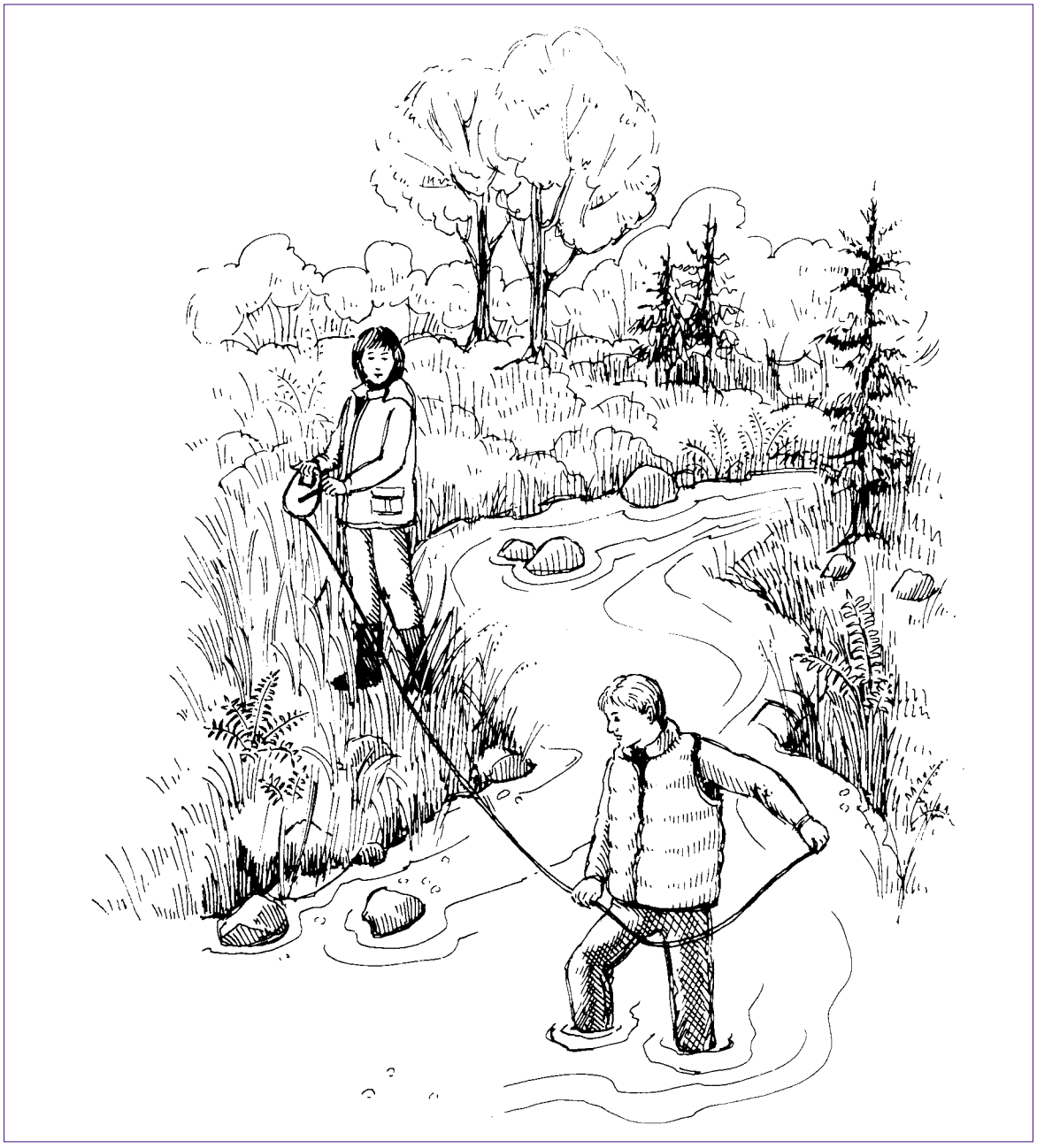
The **Stewardship** Series

The Streamkeepers Handbook

A Practical Guide To Stream And Wetland Care



Canada

Province of British Columbia

The Streamkeepers Handbook

A practical guide To stream and wetland care

Fisheries and Oceans | Pêches et Océans
Fraser River Action Plan | Plan d'action du Fraser
Environment Canada | Environnement Canada
Ministry of Environment, Lands and Parks

The Streamkeepers Handbook:

a Practical Guide to Stream and Wetland Care

Community Involvement Division
Salmonid Enhancement Program
Department of Fisheries and Oceans
555 West Hastings
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V6B 5G3

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FOREWORD

Welcome to the Streamkeepers Program! This program provides guidance for people who wish to help protect and restore local waterways in British Columbia. Support for this program is supplied by the Department of Fisheries and Oceans (DFO) Salmonid Enhancement Program (SEP). SEP's Community Involvement staff are the initial contacts for people interested in the program. Other government agencies and private organizations are involved as well. Projects are organized in modules, permitting easy updating of information and adding of new projects. We encourage you to share your suggestions for future development of this program.

The Streamkeepers Program is modeled after stream stewardship programs in the United States. We are grateful to the Oregon Department of Fish and Wildlife for permission to use material and graphics from Stream Scene: Watersheds, Wildlife and People, to the Izaak Walton League Save Our Streams program, and to the Adopt-A-Stream Foundation of Everett, Washington for permission to use their material. Alaska Water Watch and a number of county agencies in Washington State also provided useful information.

INTRODUCTION

British Columbia's streams, lakes, and wetlands are valuable natural resources. Stream corridors are particularly important. They support more species of plants and animals than any other habitats and provide important refuges and migration routes for birds and wildlife. Streams also are essential for maintaining our renowned salmon and trout runs.

Streams respond rapidly to the pressures of residential and industrial activity in surrounding drainage areas or watersheds. Streams are good indicators of watershed health. Since we all live within a watershed, be it coastal rain forest or interior dry land, we all share the responsibility of maintaining the quality of the natural resources within them.

The Fraser River basin is an example of a very large watershed. It drains one-quarter of the land area and is home to two-thirds of the province's population. This basin supports the largest salmon runs in the world. The Fraser River is our largest and most valuable river, but its condition has deteriorated steadily over the years. The task of cleaning up such a large river may seem formidable. However, we can start by taking care of the small watersheds that feed it.

Pressures from development will continue to increase as our population expands in many areas of the province. Habitat will continue to be lost when we do not appreciate fully the value of our aquatic resources. Plant and animal populations which depend on undisturbed land will be threatened. In some locations, their numbers may fall to dangerously low levels.

The growing number of volunteers committed to working to protect and restore aquatic habitats in our province will find support and information in the Streamkeepers Program.

ORGANIZATION OF THE HANDBOOK

The Handbook is organized into five sections:

Section 1 Introduces you to the Streamkeepers Program and provides information on how you can get involved.

Section 2 Provides a summary of avilable projects.

Section 3 Contains basic information on watersheds, the water cycle, and stream ecology.

Section 4 Is a guide to the agencies responsible for managing various watershed resources.

Section 5 Contains the appendices: references and resources, a list of Community Advisors offices, glossary, and useful household tips for keeping our streams clean.

SECTION I

About The Streamkeepers Program

Introduction

The Streamkeepers Program has been developed in response to the concerns of the many volunteers working on stream enhancement projects. In spite of volunteer efforts and government regulations, development pressures from our expanding population continue to threaten our aquatic habitats. Everyone, from residents to land developers, foresters, and farmers, needs to become aware of how important good watershed practices are to the long term protection of our environment.

Objectives of the Streamkeepers Program

to provide volunteers with the training and support required to protect and restore local aquatic habitats

to educate the public about the importance of watershed resources

to encourage communication and cooperation in watershed management

Becoming Involved

The Streamkeepers Handbook describes several projects, ranging from simple to complex. Some take half a day, others several days a year. Your first step is to contact the nearest Department of Fisheries and Oceans Community Advisor. In areas far from a Community Advisor's office, Water Management, Fisheries, or Habitat Protection staff at the nearest Ministry of Water, Land and Air Protection, Lands, and Parks office may provide assistance.

Your Role

As a volunteer, you can share the responsibility for protecting aquatic habitats in your community. Some projects require formal approval or technical training, but many can be started right away. Always remember to ask for the permission of landowners when you wish to work on privately owned land.

The information you collect will help you assess the health of your local streams and watershed and detect long-term changes. You will learn to recognize habitat problems and help design and undertake restoration projects in local streams and wetlands. You may need to work with local government, private companies, or residents to ensure that land use does not threaten local waterways. The data you collect also will be useful to government agencies, who do not have the resources to survey and monitor every stream.

You can help increase awareness of watershed issues in your community and involve other people in your projects. Long term improvements in watershed health will be achieved only with community understanding and support. You may wish to start your own Streamkeepers Group. The Fraser Basin Management Program has developed a guide to establishing community stewardship groups (Anon., 1995). This guide provides information about community resources, funding sources, and organizing techniques. You also may wish to consider these five steps of stream adoption developed in Washington State:

Forming a Streamkeepers Group

(source: Adopt-A-Stream Foundation, Everett, Washington).

1. *Investigate:*
Find out historical and current information about your stream.
2. *Establish a streamkeepers group:*
Involve the people who share the watershed.
3. *Establish short and long-term goals:*
Decide how you want your stream to look in the future.
4. *Create an action plan:*
Design and schedule activities to reach your goals.
5. *Become a streamkeeper:*
Get your feet wet and continue to monitor your stream's health.

Community Advisor's Role

DFO Community Advisors provide technical assistance to volunteer groups working on stream enhancement projects. There are Community Advisors in fifteen locations in the province. Appendix 2 lists their addresses and telephone numbers. Community Advisors will help you get started on Streamkeepers projects and put you in contact with other resources and active Streamkeepers in your watershed. Community Advisors can provide you with assistance in many areas:

- connecting you with a supply of project modules
- supplying current information about your watershed
- helping secure project approval
- advising you about training courses
- providing technical assistance
- referring you to other agencies, technical experts, and Streamkeepers groups in your area
- helping communicate information between Streamkeepers groups and various agencies

Streamkeepers Training

Capilano College (continuing education program) offers the three credit college course at many locations in the province, wherever there are at least ten interested people. This course has a 22 hour classroom component and a 36 hour stream survey practicum. Students do the practicum on their own and submit the work for credit. For information, contact Capilano College.

The Pacific Streamkeepers Federation offers a similar course, but without college accreditation. They also offer mini-courses on individual modules. For information, contact the Pacific Streamkeepers Federation at the number listed.

CAPILANO COLLEGE
Fisheries Science Department,
PO Box 1609,
Sechelt, B.C.,
V0N 3A0
Telephone:
1-604-987-1535
Fax:
1-604-885-9350
E-mail:
dave_bates
@sunshine.net

Pacific Streamkeepers Federation

The Pacific Streamkeepers Federation (PSKF) has been incorporated as a nonprofit society. It provides support for more than 150 volunteer groups in B.C. and the Yukon. The aims of the Federation are:

- to provide for exchange of information among streamkeeper groups
- to provide a coordinated voice for streamkeeper concerns
- to facilitate education and training of volunteers
- to support streamkeeper and enhancement groups
- to help form new stream stewardship groups
- to foster cooperation among the various stakeholders in a watershed
- to promote the management of aquatic resources at the local level

The Federation handles sales of the Streamkeepers Hand- book and Modules. It has produced a directory of streamkeeper groups. It also has an on-line forum for exchange of information and ideas.

PACIFIC STREAMKEEPERS FEDERATION
720 Orwell Street,
North Vancouver, B.C.,
V7J 2G3
Phone/Fax:
1-604-986-5059
Toll Free:
1-800-723-7753
E-mail:
pskf@direct.ca
On-Line
http://www.pskf.ca/

The Streamkeepers Database

There is little information available on small streams, lakes, and wetlands, so any data you collect is valuable. Many people will find it useful, including members of your own group, other Streamkeepers groups interested in similar projects, and government agencies. People can monitor changes in the health of our watersheds and assess the effectiveness of restoration and protection projects. Data sheets for summarizing your information are provided with project modules.

The Streamkeepers Program has begun to develop a database to store the information you collect and provide easy access by interested groups. You can mail or fax the data sheets to the Database. In time,

STREAMKEEPERS DATABASE
Department of Fisheries and Oceans
Suite 400,
555 W. Hastings St.,
Vancouver, B.C.,
V6B 5G3
Fax:
1-604-666-0292

people with computers and modems will be able to send or retrieve information from the database by e-mail.

Reliability of the results is an important aspect of data collection. Often this is called QA/QC or Quality Assurance/ Quality Control. For Streamkeepers, this means that other people should be able to recognize and find the location of your stream and any sampling sites. Data sheets often ask for references to NTS map numbers, measured distances, and watershed codes, to provide this geographic information. You should use standard methods, as outlined in the modules.

The procedures described in the project modules rely on many simplifications and generalizations that may not be applicable in all situations. The following steps provide quality control guidelines to help you investigate unexpected results:

Quality Control Steps

(source: Adopt-a-Stream Foundation, Everett, Washington)

1. Repeat the test or measurement, taking care to follow procedures correctly.
2. Make certain your testing equipment is clean and in good working order.
3. Remember that parameters vary throughout the year, and sometimes daily. Make sure you conduct your test or measurement at the same time of day (or year) as previous tests you want to compare it to.
4. Compare your results with previous data you have collected on the stream. Remember to check studies conducted by others, also. See if your measurement is within previously measured variation.
5. Look at other parameters. Do they seem abnormal, as well? Can you make any correlations?

As you compare your results with those from other sites in the area, you can recognize typical conditions. If the results still seem unusual, talk to your Community Advisor or someone at an appropriate government agency before jumping to conclusions. Some apparent problems result from natural occurrences. When the whole province is considered, characteristics of undisturbed habitats are quite variable. What is normal in one part of the province may be rare in another.

Streamkeepers Equipment Kits

Some equipment used in aquatic surveys is expensive or must be ordered from specialty stores. The Streamkeepers Program has assembled equipment kits at several locations in the province. These kits contain benthic invertebrate samplers, water quality test kits, and surveying supplies. Contact your Community Advisor to find out if an equipment kit is available for loan in your area.

SECTION II

Project Modules for Streams

Introduction

This section summarizes Streamkeepers project modules. The level of commitment required, the best time of year to do the project, and training or formal approval requirements are described. Each module describes the project in detail, and provides the following information:

how the project benefits the watershed
approvals or training required
volunteer effort required
time of year and work conditions
safety concerns
materials and equipment
project procedure
collecting, reporting, and evaluating data
identification guides and other resources

Project Timing

Surveys of physical and chemical characteristics are best done during times of very high and very low stream flows. Habitat problems are most likely to be found at these times. The low flow period in late summer usually occurs in August and September, when high temperatures and long spells of dry weather combine to reduce water levels. Water quality and flow problems often show up during this period. The high flow period, or freshet, occurs during heavy autumn and winter rains in coastal areas and during the spring snow melt in inland and northern areas. Damage from flooding, erosion, and sedimentation usually shows up during high flow. Plant and animal surveys are best done during spring, summer, or fall, when organisms are abundant and easily sampled. Restoration projects are best done during the summer low flow period. Often, restoration projects require some alteration of the stream channel or banks. Environmental damage can result if they are done at the wrong time of year.

MODULE 1 Introductory Stream Habitat Survey

Collecting available watershed information and surveying your stream provides a useful starting project for a Streamkeepers group. You will collect maps, historical information, and current data, then walk your stream to identify and map undocumented conditions. As you become familiar with your stream, you can select the best locations for reference sites or sampling stations. Some of the more detailed surveys described in other modules will be done at these locations.

The mapping process helps you relate land and water use with stream health in your watershed. You will be able to identify habitats in need of protection or restoration. Documenting habitat problems, such as erosion, insufficient stream bank vegetation, pollution sources, or stream barriers, helps you choose appropriate restoration projects.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
No	**recommended**	**2 days or more**	**2 or more**	**High flow and low flow seasons**

MODULE 2 Advanced Stream Habitat Survey

This module provides instructions for establishing a permanent reference site and conducting a detailed habitat assessment. You will establish a benchmark, do cross-sectional and longitudinal surveys, and measure water discharge of the stream. You will then examine or measure the individual parts of the stream channel and bank that comprise the habitat. These include streambed material, embeddedness of the substrate, instream cover, percent pool habitat, off-channel habitat, bank stability, stream bank vegetation, overhead canopy, and riparian zone. The final step will be to combine these observations into an assessment that ranks the habitat at that location as good, acceptable, marginal, or poor.

These reference sites are the locations used for habitat assessments and surveys described in other modules. The sites also may be used for long-term monitoring programs.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
No	**recommended**	**½ day per site**	**2 or more**	**Late summer early fall**

MODULE 3 Water Quality Survey

Water quality measurements provide basic information about your stream. Measuring a few important stream characteristics in selected locations, at critical times of the year, can help you detect watershed problems.

You will be given detailed instructions for measuring turbidity, dissolved oxygen, pH, and temperature using simple equipment. You will sample at least twice a year, when stream flow is very high and very low, and more often if you can.

Human activities in your watershed alter water quality and stream flow. Often, natural vegetation is removed and urban development covers the soil with impermeable surfaces. When this happens, runoff from precipitation flows directly into streams rather than being absorbed by the soil and then slowly released. Flood, drought, sedimentation, contaminant addition, and fluctuations in water temperature often result.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
No	**recommended**	**2 days to ongoing**	**2 or more**	**High flow and low flow seasons**

MODULE 4 Stream Invertebrate Survey

You will be given instructions for sampling, counting, and identifying benthic invertebrates. These are small, spineless animals such as insect larvae, worms, snails, clams, and crustaceans that live in or on the stream bottom.

Invertebrates play an important role in the aquatic food chain. They eat algae, leaves, or organic debris and are food for fish, birds, amphibians, reptiles, and other insects in the stream ecosystem. The various kinds of invertebrates you find in your stream tell a lot about the health of your watershed. Some invertebrates tolerate organic pollution, and their abundance may suggest water quality problems. Others require good water quality, so their presence suggests a healthy stream.

This survey is thorough enough to detect moderate to severe stream degradation and is relatively quick, easy, and inexpensive.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
No	**recommended**	**2 days to ongoing**	**2 or more**	**Early spring early fall**

MODULE 5 Storm Drain Marking

Storm drain marking involves painting a yellow fish symbol beside roadside storm drains to remind people that water entering these drains flows into a nearby creek.

You will be provided with carts containing all the necessary materials. While marking drains, you also will distribute brochures that explain the significance of the yellow fish and provide household tips for stream care.

Storm drains collect runoff from roads and parking lots and empty into the nearest stream. People sometimes dump toxic household wastes, such as paint and pesticides, down storm drains and these compounds flow into a nearby stream. Storm drain marking projects help educate people about the harmful consequences of their actions, while providing alternate suggestions.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
No	**Not necessary**	**½ day to ongoing**	**2 to many**	**Spring through fall**

MODULE 6 Stream Cleanup

Cleaning up a stream is a rewarding activity for any group and often is the first step in a stream restoration project. A very small group can spend just a short time cleaning up a local stream bank, or a large group can take on a major project.

When you undertake a large-scale cleanup, you want to be sure you do more good than harm. The stream cleanup module provides guidelines on personal safety, time of year, permission required, and project organization. It also tells you which materials to remove and which to leave in the stream.

Streamside areas often are used to dump unwanted household and commercial garbage. Garbage attracts more garbage. Unless this cycle is broken, habitat damage may occur and recreational value of the area will be lost.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	**Not necessary**	**30 minutes to ongoing**	**2 to many**	**Summer: instream All year: streambanks**

MODULE 7 Streamside Planting

Planting streamside vegetation is a valuable restoration project. This module provides information about the role of streamside vegetation and how to propagate, plant, and maintain native species along stream banks. Species suitable for both mild coastal climates and more harsh climates in the interior are described.

Riparian vegetation is critical in maintaining healthy aquatic ecosystems, particularly in small streams. The riparian zone provides food for aquatic and terrestrial organisms, stabilizes banks, regulates stream flow and water temperatures, and traps sediment and contaminants from upland sources. Wooded streamside areas provide nesting sites for birds and travel corridors for wildlife.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	**recommended**	**A few days**	**4 or more**	**Throughout the year**

MODULE 8 Streamside Fencing

Vegetation and banks are damaged when domestic animals are allowed unrestricted access to streams. When grazing removes stream bank vegetation, water temperatures rise, contaminants flow unchecked into streams, and stream health deteriorates. Also, animals often wear down banks, causing erosion and sedimentation. Animal wastes contaminate the water with organic and inorganic nutrients, bacteria and viruses.

Fencing streams in agricultural areas solves many of these problems. It also helps protect vegetation that has been planted in an attempt to restore habitat. The streamside fencing module provides information on approaching landowners, designing fences, and incorporating cattle watering areas.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	**Not necessary**	**several days**	**2 or more**	**Spring through fall**

MODULE 9 Observe Record Report

This module provides information about using the Observe Record Report system (ORR). You may witness habitat destruction or other environmental violations. This module provides guidelines on assessing each situation and taking appropriate action.

Minor situations often are handled effectively through education. However, gather evidence discretely and do not intervene in more serious situations. You do not wish to become involved in a potentially dangerous situation. The ORR system provides steps to gather evidence safely and tells you who to call in various emergency and non-emergency situations.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
no	**Not necessary**	**½ day to ongoing**	**2 per team**	**Any time**

MODULE 10 Community Awareness

This module offers a variety of approaches to heightening community awareness of the value of your stream. These methods include:

installing road signs at stream crossings

developing and distributing information brochures or newsletters

organizing community meetings

organizing public displays

accessing the media effectively

making media productions

You can clean up streams, monitor their condition, and undertake enhancement projects, but you must have the support of your community to ensure the long-term health of your watershed.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
no	**Not necessary**	**A few days per project**	**2 to 4 to organize, more to implement**	**Any time**

MODULE 11 Juvenile Fish Trapping and Identification

This module shows you how to select sampling locations and trap juvenile fish in your stream, using Gee traps. These live-traps are baited and placed in the stream for several hours or overnight. A key is provided to help you identify salmonids and other kinds of fish likely to enter these traps.

Trapping provides information about fish species native to your stream, where they live, and their relative abundance.

The kinds of fish you find will tell you about the quality of the stream habitat. Salmonids are considered indicators of a healthy watershed because they require good water quality and habitat. Documenting their presence helps identify and protect good quality streams and watersheds. Their absence may indicate the need for restoration projects.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	recommended	½ day or more	2 or more	Spring through fall

MODULE 12 Salmonid Spawner Survey

This module describes how to count spawning salmonids on a stream. Survey teams walk the length of the stream, using the same procedures Fisheries Officers use to count spawners. This process is repeated a few times during the spawning season and total spawning populations are estimated from the counts. A key is included to help you identify fish species.

Spawner surveys provide information about the status of breeding populations. These fish must survive various fisheries, as well as environmental hazards, to return to their spawning grounds. Monitoring the abundance of spawning populations is essential to maintaining future generations of fish.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
no	Not necessary	1 day or more	2 or more	Year round

MODULE 13 Creel Survey

A statistically reliable method of sampling the angling effort on a stream is described in this module. You will count the number of anglers, fish caught, and hours fished at each fishing spot on your stream. Surveying a stream during all the daylight hours is extremely labour-intensive. This module describes a survey design that samples during one-sixth of the available potential fishing time. Data then are expanded to estimate total angling effort and catch.

Creel survey data can be used to provide information about the impact of angling on a particular fish population. Fisheries managers can use the data to provide estimates of population abundance when there are no other estimates available. They also use the information to set appropriate fishing regulations.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	Not necessary	A few weeks or more	2 or more	Year round

MODULE 14 An Introductory Handbook for Instream Habitat Restoration Projects

The Streamkeepers assessment and monitoring activities help you get to know your stream very well. Over time, you may discover opportunities to restore habitat within the channel. However, this type of work involves a high risk of failure, potential stream channel damage, and possible personal liability. Such projects should be attempted only with professional guidance.

You will be introduced to techniques for restoring spawning and rearing habitat and migration access. Techniques include bank stabilization, fish passage improvement, and placement of boulder clusters, weirs, large woody debris, and spawning gravel.

This module focuses on assessing the suitability of your stream for these types of projects. It also provides guidance for selecting appropriate installation sites and structure designs.

Project approval required	Training	Time Commitment (per year)	Number of people	Time of year
yes	recommended	1 week or more	2 or more	summer

SECTION III

The Wetlandkeepers Handbook

Wetlands play an essential role in the well-being of our environment. For centuries, people have lived beside them, taken advantage of their many resources, and developed a rich folklore about them. Today, most of us know little about wetlands and often regard them as wastelands, of little value in their undrained state. Environment Canada and the B.C. Wildlife Federation have developed the following training modules to enhance public awareness of the value of wetlands and encourage participation in wetland monitoring. Modeled after the Streamkeepers Program, each module provides information on a specific monitoring or restoration activity.

Wetlandkeeepers is designed for community groups interested in conserving a local wetland. For more information on the handbook and program activities, contact:

Theresa Southam,
1420 Falls Street, telephone: 1-250-354-1088
Nelson, B.C., V1L 1J4 fax: 1-250-354-1033
e-mail: tsouth@netidea.com web site:
www.siass.com/wetk.htm

1. Introduction

Module 1 Introducing Wetlands and the Wetlandkeepers Program

This module introduces the functions and values of wetlands and the philosophy behind the program. It also discusses land ownership, safety practices, and equipment.

2. Wetland Assessment and Monitoring

Module 2.1 The Initial Wetland Assessment

The first step in understanding your wetland is to assess its characteristics. Start by examining air photos and topographical maps of the wetland and surrounding area. Then study the vegetation and soils at the site to determine the class or type of wetland. You will produce a detailed map to document your results and use in subsequent surveying and monitoring activities.

Module 2.2 Conducting a Survey of Wetland Plants

You learn how to identify plants and estimate the proportion of area each species occupies. This information helps you monitor changes in species composition, review your data, and find causes for the changes. It builds on data collected in Module 2.1 and provides baseline data for long-term monitoring and restoration activities.

Module 2.3 Conducting a Wetland Bird Survey

This module shows you how to design, conduct, and evaluate a bird survey. Bird surveys provide useful information about wetland health and help you document the value of a particular wetland. You can use these data in public education programs and as part of an application for funds to conserve the wetland.

3. Wetland Restoration Planning

Module 3.1 The Law Relating to Wetlands

This module briefly reviews federal, provincial and municipal laws useful in protecting wetlands. It also discusses conservation covenants and other options for protecting privately owned lands. If you want to protect a public wetland legally, find out which laws apply, then check that they are being followed. If you suspect violations, enlist the aid of the government in enforcing the laws. You also may decide to explore legal options with a non-government organization.

Module 3.2 Developing and Implementing a Public Education Program

Public education programs at a wetland site are important in garnering public support for wetland conservation. This module discusses forming a community based steering committee, designing and promoting a program, maintaining a motivated volunteer force, and preparing a site.

4. Restoration Activities

Module 4.1 Wetland Cleanup

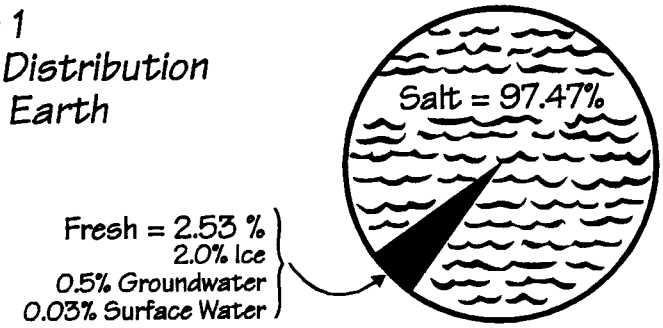
Industrial activity and unplanned urban development continue to damage and destroy wetlands. Logging and other industrial debris destroys plants. Removing the debris exposes the land and allows plants to grow again. This module provides information on cleanup methods, obtaining permits, finding funds, motivating volunteers, and disposing of debris.

SECTION IV

Watershed Ecology

Water covers three-quarters of the Earth's surface. However, only 2.5% is fresh water, and 0.03% surface water that people can use (Figure 1). Fresh water is an essential resource for all living things.

Figure: 1
Water Distribution on the Earth

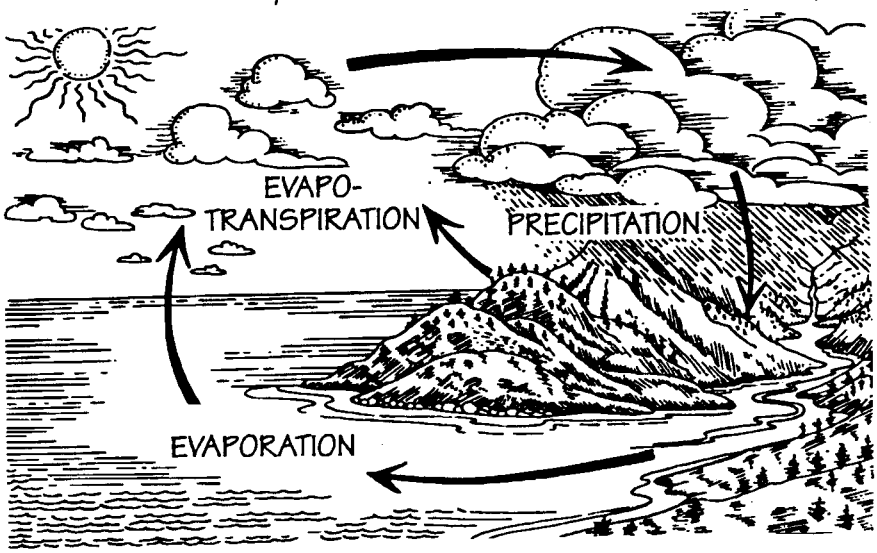


The Water Cycle

Water moves continuously from the air to the land and back again through the water cycle. Energy from the sun drives this cycle (Figure 2). Precipitation falls to earth, drains into streams, lakes, and rivers, and then enters the ocean. Water evaporates back into the air from the water and land. Plants add water vapour to the air through evapotranspiration. Water falls again as precipitation. In fact, water is cycled through the atmosphere every nine to twelve days! Human activities can disrupt this cycle of water transport and purification.

Figure 2 Water Cycle

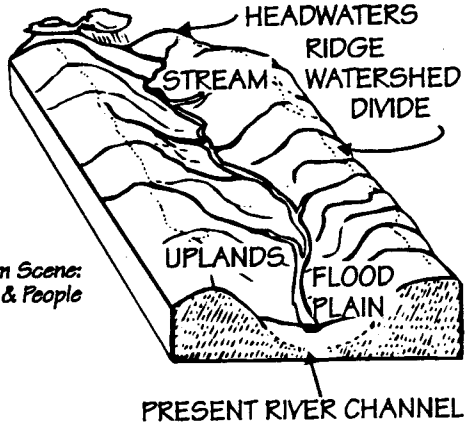
adapted from the Stream Scene: Watersheds, Wildlife & People



Watersheds

A watershed drains water into a stream, which drains into a larger stream, lake, or ocean (Figure 3). The boundaries of a watershed are the highest elevations of surrounding hills and ridges. Surface water occupies only a small portion of the total watershed area; most of the area is land.

Figure 3
The Watershed

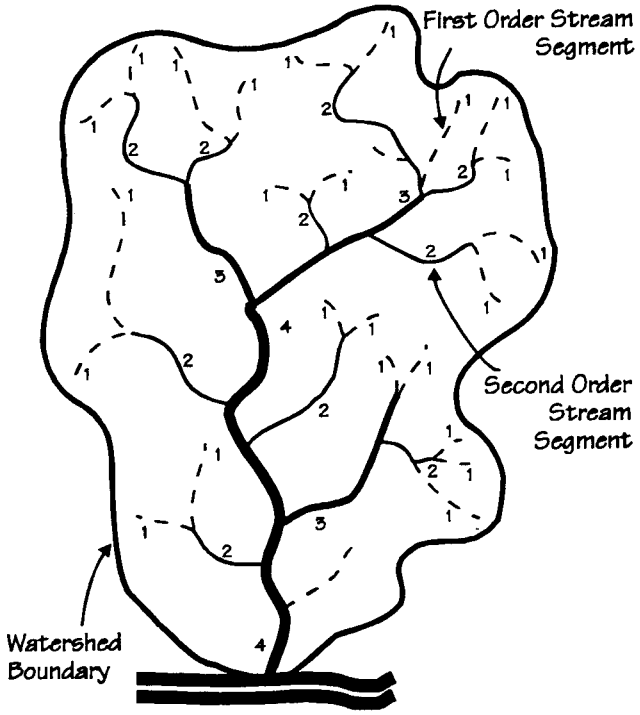


adapted from the Stream Scene: Watersheds, Wildlife & People

One method of describing the network of streams in a watershed is shown in Figure 4. First order streams are the headwater creeks with no tributaries. Second order streams form when two first order streams merge, and so on. Rivers often are sixth order or greater.

Figure 4
Stream Order

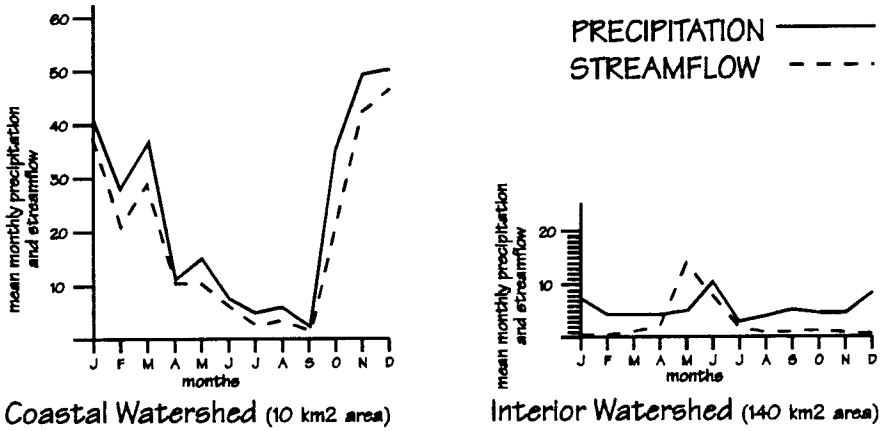
adapted from A Handbook for Fish Habitat Protection on Forest Lands in British Columbia



Streams are perennial (flow year round), intermittent (flow for less than half the year), or ephemeral (flow only during times of heavy rainfall). Ephemeral and intermittent streams provide seasonal habitat for fish and other wildlife, and areas of refuge during high flow in main channels.

Climate, topography, soil, and vegetation control the volume and rate of water flow through a watershed. Climate is the predominant factor that controls seasonal patterns and quantities of water flow in a watershed. The relationship between precipitation and stream flow in coastal and interior watersheds is very different (Figure 5). On the coast, stream flow increases dramatically after rainstorms. In the interior, winter precipitation is stored as snow, and stream flow is greatest when the snow melts during the spring. Generally, more precipitation falls in coastal watersheds, so more water is cycled through them than through interior watersheds.

Figure 5 Annual Streamflow Patterns



Watershed topography affects stream flow. Surrounding mountains modify climate, affecting amounts and types of precipitation in a watershed. Steep sided watersheds have more rapid runoff, greater erosion, and wider fluctuations in flow than watersheds with more gentle slopes. Orientation to the sun and prevailing winds also influences runoff patterns.

Soil structure and depth affect rates of runoff. Deep, porous soils absorb runoff well and release it slowly. Compacted or shallow soils absorb much less water, so rapid runoff and erosion are more likely to occur. Soils also influence basic water chemistry. Streams that pass through coastal forest soils have very different nutrient concentrations, pH levels, dissolved minerals, and natural turbidity than those flowing through arid mineral soils.

Vegetative cover greatly affects the volume and rate of water flow through a watershed. In a forested watershed, evapotranspiration returns great quantities of water to the air. When plant cover is removed, water flows more directly into streams. Vegetation enhances the soil's ability to absorb water by providing spongy humus and root systems that make the soil more porous. The forest canopy helps to break the force of falling raindrops and reduce the rate of snow melt. Removing watershed vegetation can result in major changes to both volume and rate of runoff.

The Stream in its Natural State

It is common to view streams only from the perspective of human use. However, streams unaltered by human activity have natural cycles and complex food webs.

In an undisturbed watershed, runoff is absorbed by plants and soil. Water is stored in the ground, lakes and ponds, then released slowly, even during dry spells. Stream flows fluctuate, but there are few extremes of flood and drought. Impurities and sediment are absorbed by the soil, purifying water before it enters streams.

Natural vegetation stabilizes stream banks. Plants provide shade, food (leaves, twigs, fallen insects), and cover for many animals. Logs fall into streams and provide diverse habitat. This large woody debris also dissipates a stream's erosive energy.

Sunlight filters through trees. Algae grow on streambeds. Bacteria and fungi partially decompose leaf litter and other organic matter. In streams, some invertebrates eat plant material, breaking it down into organic material for other species. Small predators, such as fish, birds, amphibians, and aquatic insects, feed on these invertebrates. Otters, mink, and large birds feed on the smaller predators.

Downstream of shaded headwater areas, streams widen and open to more sunlight. Species adapted to these changed conditions replace some upstream species. Further downstream, species suited to growth in major rivers become common.

Human activities can upset stream ecosystems. Some organisms can adapt, but others perish. Species tolerant of poor conditions tend to replace those that require good water quality.

Salmonid Ecology

Salmonids are good indicators of stream and watershed health. They are relatively easy to see, are adapted to particular habitats, and are important links in aquatic and terrestrial food webs. Salmonids need very high quality water to thrive.

Salmonids in British Columbia waters include:

salmon - chinook, coho, sockeye, chum, pink

trout - steelhead, rainbow, cutthroat, brown

char - dolly varden, lake trout, brook trout

grayling

whitefish

Sculpins, sticklebacks, squawfish, dace, shiners, sturgeon, and lampreys are some other kinds of fish found in British Columbia streams and rivers.

Salmon and some trout and char species spend part of their life in the ocean, but return to their natal stream or lake to spawn. The early phase of their life cycle is spent in streams and rivers.

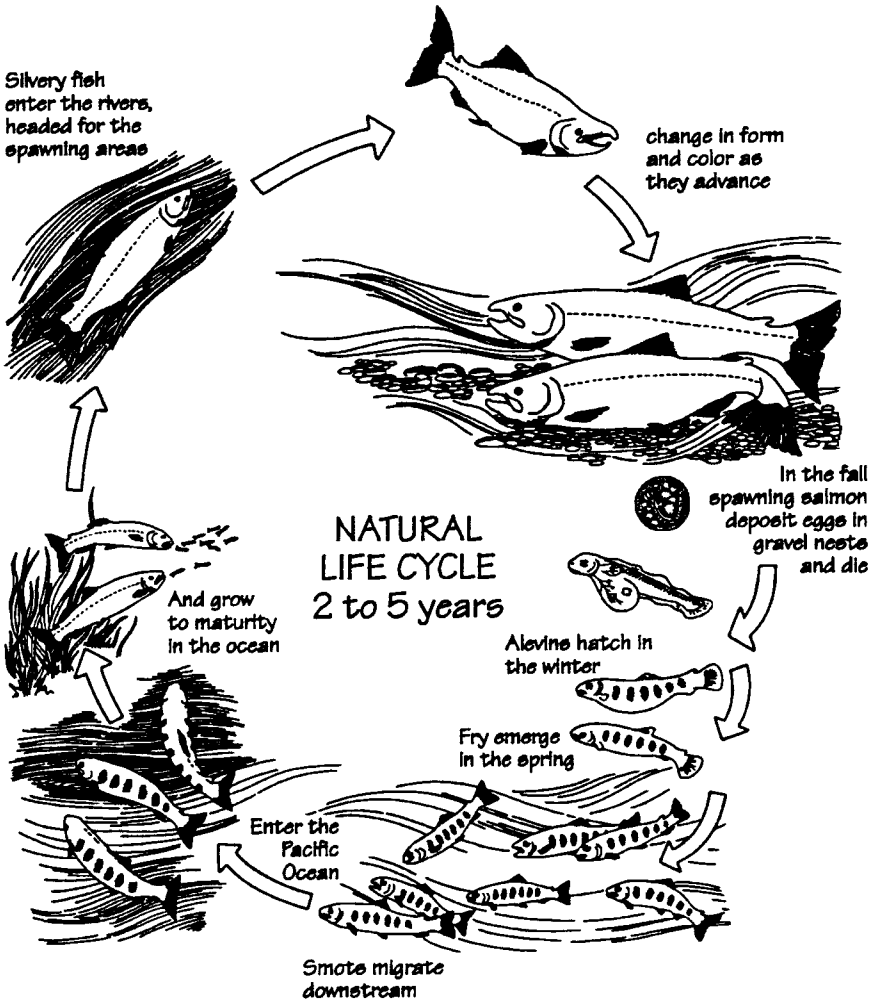
A generalized salmon life cycle is shown in Figure 6. Each species has its own timetable for adult migration, spawning, egg development, juvenile rearing, and migration to the sea. This helps partition the environment, so that species that would otherwise have to compete for similar food and space resources can survive.

Salmonids require cool, well-oxygenated water, clean gravel, abundant cover, shade, and adequate stream flow. After spawning, the eggs and alevins (larvae) spend from two to nine months in the gravel, depending on the species and location. Eggs and alevins need clean water to supply oxygen and remove wastes, and die if gravel becomes clogged with sediment.

Fry require a good supply of aquatic insects, cool water temperatures, and good cover from predators. Removing streamside vegetation affects these types of stream habitat and food supply. Mortality rates can be high for smolts migrating to the sea if they face physical barriers, pollution problems, and lack of cover for protection from predators. When adults return to their streams to spawn, they need good water quality, adequate stream flow and clean gravel for spawning.

Projects to enhance fish habitat should meet the needs of specific streams and the species found there. In some streams, increasing spawning habitat is beneficial. In others, creating additional rearing

habitat is more important. For streams suffering from pollution, improving water quality is an essential first step before considering any other enhancement options.



LENGTH OF LIFE CYCLE VARIES WITH SPECIES AND CONDITIONS

Human Impacts On Stream Ecosystems

Human activities often affect water quality negatively. Nonetheless, these impacts can be minimized by adopting management practices that protect aquatic environments. The reference section of this handbook lists several publications that provide habitat protection guidelines for several industries and activities. Some potentially disruptive human activities are described below.

Logging removes large amounts of plant cover, increasing the amount of runoff and sediment to streams. Although current regulations are designed to control logging activities in watersheds, logging has caused major problems in the past.

Agricultural activity often extends to stream banks. Removal of streamside vegetation causes water temperatures to increase during summer. When livestock have direct access to streams, erosion and runoff problems result. Also, runoff from agricultural land may contain fertilizers, manure, and pesticides.

Surface mining strips off surface soil and rock layers. Waste material is eroded and carried into streams. Tailings runoff can contain toxic materials from mineral processing.

Urban development involves clearing land, replacing natural landscapes with buildings, roads, parking lots, and storm drain systems. Runoff increases and groundwater storage decreases, resulting in wide fluctuations in stream flow. Also, urban runoff may contain toxic substances.

Point source pollution comes from specific locations, such as industrial or sewage outfalls. Although effluents can seriously degrade water quality, they are relatively easy to locate and control through legislation.

Non-point source pollution is diffuse and very hard to control, but is the major cause of degraded water quality in many communities. Pollutants come from various land uses throughout a watershed. Common pollutants include heavy metals and hydrocarbons from road runoff, contaminants from household compounds, sediment, and animal wastes.

Acid rain is not yet a serious problem in British Columbia. However, as air pollution from automobiles and industries increases, acid rain may become more common.

Dams, dikes, levees and engineered stream channels can seriously affect stream flow patterns, channel morphology, and water quality.

Minimizing Human Impacts

Maintaining healthy, productive watersheds is possible. We can begin by adopting land use practices that reduce disruption of the environment. Regulations already exist to govern point source pollutants and reduce the negative impacts of large scale developments. Non-point sources of pollution are more difficult to identify and control but must be dealt with to improve the conditions in many watersheds.

We as individuals must each start accepting responsibility for our own land use practices, whether we live on a farm or a city lot. Some useful hints are provided in Appendix 4: Home Tips for Clean Streams.

SECTION V

Streamkeepers and Government

Many government agencies are responsible for regulating land and water use. One of their aims is to reduce harmful impacts on the environment. You can ensure that your concerns are addressed by participating in resource decisions in your community. It helps to have a basic understanding of:

- the government agencies involved
- how decisions are made in your community
- where and how you can participate in the decision-making process
- information needed when you have concerns about your watershed
- how to best express your concerns

Who Manages Our Land?

More than 90% of British Columbia's 93 million hectares are classified as provincial Crown land. Land and water use on this land is regulated by provincial agencies. Much of the remaining 10% is privately owned and within municipal boundaries. Some landowners believe they have the right to develop their land any way they wish. However, municipalities can enact bylaws to regulate development. These bylaws can ensure the protection of a community's environmental assets.

How Decisions Are Made

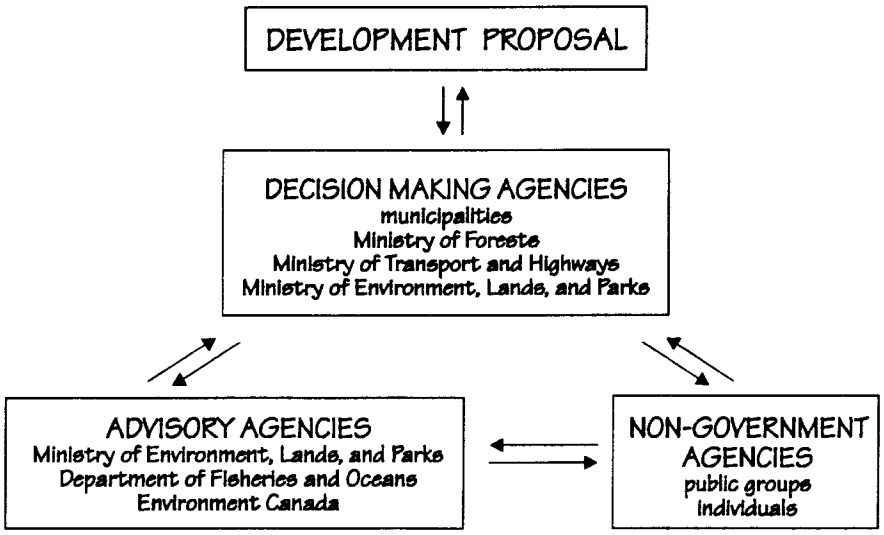
Canada's Constitution gives authority to the provinces for land and water management. Provincial and municipal agencies regulate the use of these resources. Federal agencies provide guidelines to ensure that developments comply with federal environmental protection laws. Table 1 lists the different agencies responsible for managing natural resources. The referral process shown in Figure 7 ensures that the concerns of the various agencies are considered in each development proposal.

TABLE 1
Watershed Activities and Responsible Government Agencies

Activity	Local Government	Provincial Government Ministry	Federal Government Department
Fisheries Management		WLAP Fisheries Branch (freshwater fish)	Fisheries & Oceans (marine and anadromous fish)
Wildlife Management		WLAP (Wildlife)	Environment (Conservation)
Forestry (timber harvest)	Planning (urban)	Forests (Crown land)	
Gravel Pits, Mines	Engineering & Operations	Energy, Mines & Petroleum	Energy, Mines, & Resources
Land Development	Planning	WLAP (Lands, Environmental Assessment)	
Roads	Engineering & Operations	Transport & Highways	
Agriculture		Agriculture, Fisheries & Food	Agriculture
Aquaculture		Agriculture, Fisheries & Food	Fisheries & Oceans
Environmental Emergencies, Spills	Fire Dept.	WLAP (ORR, Conservation Officers)	Environment (Protection), Fisheries & Oceans (Fisheries Officers)
Enforcement of Environmental Laws	Bylaw enforcement	WLAP (Conservation Officers)	Environment (Protection), Fisheries & Oceans (Fisheries Officers)
Sewage Disposal	Engineering & Operations	WLAP (Waste Management)	Environment (Protection)
Waste Disposal, Waste Discharge To Water	Engineering & Operations	WLAP (Waste Management)	Environment (Protection)
Flood Control	Engineering & Operations	WLAP (Water Management)	Environment (Conservation)
Water Use, Supply, Drinking Water	Public Health	WLAP (Water Management) Health	
Streamside Zoning and Adjacent Land Use	Planning	Forests (Crown land)	Fisheries & Oceans
Water Quality	Engineering & Operations	WLAP (Waste Management, Water Management)	Fisheries & Oceans, Environment

CHECK THE BLUE PAGES OF YOUR TELEPHONE BOOK FOR LOCAL NUMBERS

Figure 7 An Example of the Referral System



The federal Fisheries Act is one of the most powerful pieces of legislation designed to protect aquatic habitats. Section 35 of the Act prohibits any work or undertaking that may result in the harmful alteration, disruption, or destruction of fish habitat. Section 36 prohibits the deposition of deleterious substances into waters frequented by fish. However, the Act does not state how land and water should be used, and often can be applied only after habitat damage has occurred. The Act has limited power to prevent poor land and water use practices.

Environmental agencies have developed site-specific guidelines for avoiding habitat damage. These guidelines are more detailed than the broad provisions of the Fisheries Act. However, these guidelines are only recommendations and do not have the force of law behind them.

Some Acts and Guidelines to Protect Aquatic Habitats

- Fisheries Act
- Water Act
- Land Development Guidelines
- Stream Stewardship: A Guide for Planners and Developers
- British Columbia Coastal Fisheries/Forestry Guidelines
- Forest Renewal Act
- Forest Practices Code

Some municipalities have adopted as law the habitat protection guidelines provided by federal and provincial agencies. We all have the greatest opportunity to influence land use decisions at the local level.

How and Where You Can Participate

Officials are elected to govern and make decisions according to our needs and desires. Local, provincial, and federal governments rely more on public participation now than in the past. However, we need to make our opinions known, if we want our elected representatives to make wise land use decisions.

There are many opportunities to participate in local land use planning. The publication, Stream Stewardship: A Guide for Planners and Developers, provides information about how municipal land use decisions are made. Municipal Official Community Plans (OCPs) are reviewed about every five to seven years. Zoning applications must be publicized. Town Hall meetings and local environmental advisory councils invite public participation. Municipal planning staff and elected officials may respond to the concerns of Streamkeepers groups if they are brought to their attention.

All levels of government hold public meetings to survey public opinion on environmental issues. At these forums, you can present information your Streamkeepers group has collected about your watershed.

Information Needed

Several Streamkeepers project modules provide information about collecting data on stream conditions. Your data will help show your concerns are valid when you approach government agencies about protecting or improving habitats.

Effective Communication

Public education and cooperation with government agencies will help change attitudes toward aquatic habitats. An enthusiastic, well-informed spokesperson in your group can best get your message across. You may wish to consider public meetings and other ways of raising awareness.

APPENDIX 1: REFERENCES AND RESOURCES

Adopt-A-Stream Foundation. 1994. *Streamkeepers' Field Guide: Watershed Inventory and Stream Monitoring Methods. Available from:*

Adopt-A-Stream Foundation,
P.O. Box 5558,
Everett, Washington, 98206

Alaska Dept. Environmental Conservation. 1993. *Alaska Water Watch, Partners in Environmental Stewardship.* Handbooks available include:

Water Quality Sampling - Streams
Alaska Stream Survey
Stream Macroinvertebrates

Available from:

Alaska Department of Environmental Conservation,
Division of Environmental Quality,
Water Quality Management Section,
410 Willoughby Ave.,
Juneau, Alaska, 99801-1795

Anon. 1993. *British Columbia Coastal Fisheries/Forestry Guidelines.* Third Edition. a joint publication of B. C. Ministry of Forests, Ministry of Environment, Lands, & Parks, Department of Fisheries and Oceans, and Council of Forest Industries. Crown Publications Inc., Victoria, B.C.

Anon 1994. *Stream Stewardship, a Guide for Planners and Developers.* Co-published by Dept. Of Fisheries and Oceans, Ministry of Water, Land and Air Protection, and Ministry of Municipal Affairs. 48 pp.

Anon 1995. *Community Stewardship: A Guide to Establishing your Own Group.* Co-published by Fraser Basin Management Program, Dept. Of Fisheries and Oceans, Environment Canada, and the Watershed Stewardship Working Group of Forest Renewal B.C.

Bologna, D. M. 1994. *How to Save a River: A Handbook for Citizen Action.* Island Press, Washington, D. C. 266 pp.

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FEESA,
320-9939 Jasper Ave.,
Edmonton, AB.,
T5J 2X5

Hoenig, E. and J. Carr. 1990. *Stream Team: A Volunteers Handbook.* (Olympia, Lacey, Tumwater, and Thurston County).
Available from:

City of Olympia, Public Works Dept.,
Water Resources Program,
P.O. Box 1967,
Olympia, Washington, 98507-1967

Hubbard-Gray, S. and S. Tilander. 1989. *Stream Team Guidebook.* City of Bellevue Storm and Surface Water Utility. Bellevue, Washington.

Mitchell, M.K. and W.B. Stapp. 1991. *Field Manual for Water Quality Monitoring; An Environmental Education Program for Schools.* Available from:

W.B. Stapp,
2050 Delaware Ave.,
Ann Arbour, Michigan, 48103

McClarin, M. And K. Fulton. 1995. *Water Stewardship: A Guide for Teachers, Students, and Community Groups.* Ministry of Water, Land and Air Protection, Victoria, 194 pp.

Oregon Dept. Fish and Wildlife. 1990. The Stream Scene: Watershed, Wildlife and People. Available from:

Oregon Dept. Fish and Wildlife,
P.O Box 59,
Portland Oregon, 97207

Resource Inventory Committee, B.C. Several publications are available or in press. Some of them discuss biodiversity and provide identification keys for many groups of terrestrial and aquatic species. Others describe survey techniques. Some titles are available in 1995 and others will be published in 1996. They are available from:

Resource Inventory Committee
840 Cormorant St.,
Victoria, B.C.
(telephone: 1-250-920-0661)

AQUATIC ECOSYSTEMS:
Aquatic Habitat Classification System for B.C.
Collecting and Preserving Aquatic Plants
Field Key to Freshwater Fishes of B.C.
Fish Collection, Preservation, Measurement and Enumeration Manual
Guide for Selection of Standard Methods for Quantifying Sportsfish Habitat
Capability and Sustainability in Streams and Lakes in B.C.
Identification Keys to the Aquatic Plants of B.C.
Lake Survey Procedures Manual
Physical/Hydrological Classification of Watersheds
Reconnaissance Stream Inventory Manual
Review of Habitat Capacity for Spawning Salmon and Rearing

ELEMENTS OF BIODIVERSITY
A Key to Small Mammals in B.C.
Amphibians in B.C.
Bats
Beaver and Muskrat
Bitterns and Rails
Capturing and Handling Protocol
Fast-streamed Amphibians (Tailed Frogs and Giant Pacific Salamanders
Forest and Grassland Songbirds
Freshwater - Colonial Nesters
Fungi
Geese, Ducks, and Sandhill Cranes (Waterfowl)
Hares and Cottontails
Large Mammals: Aerial Inventory Methods
Large Territorial Carnivores (Bears, Wolves, and Cougars)
Lizards and Skinks
Medium Territorial Carnivores
Moles and Pocket Gophers
Nighthawks and Poorwills
Pikas and Sciurids (Squirrels)
Pond-dwelling Herpetiles, Amphibians, and Painted Turtles
Raptors
Riverine Birds (Dippers and Harlequins)
River Otter and Mink
Slow-stream Amphibians (Northwest and Long-toed Salamander)
Small Mammals
Small Mustelids
Small Territorial Carnivores
Snakes
Swallows and Swifts
Terrestrial Amphibians
Terrestrial Arthropods
Ungulates: Ground-based Census Method
Upland Gamebirds
Vascular and Non-vascular Plants
Woodpeckers and Sapsuckers
Woodrat, Porcupine and Mountain Beaver

ECOLOGY
Ecoregion Mapping and Methodology
Range Interpretations
From Ecosystem Mapping
Soil Inventory Methods for B.C.
Terrestrial Ecosystems Mapping Methodology for B.C.
Terrestrial Vertebrate Capability And Sustainability Mapping Methodology

GROUNDWATER
Groundwater Mapping and Assessment in B.C.

VEGETATION
Procedures and Standards for Vegetation Classification
Procedures and Standards for Vegetation Sampling
Proposed Land Cover Classification Scheme

S.E.P. Community Projects Directory. Salmonid Enhancement Program, Department of Fisheries and Oceans, Vancouver, B.C. (published annually).

T. Buck Suzuki Environmental Foundation. 1994. *Resource Manual for Salmon Habitat Protection Activities.* Vancouver, B.C. 160 pp.

Toews, D. A. A. and M. J. Brownlee. 1981. *A Handbook for Fish Habitat Protection on Forest Lands in British Columbia.* Department of Fisheries and Oceans, Vancouver, B.C.

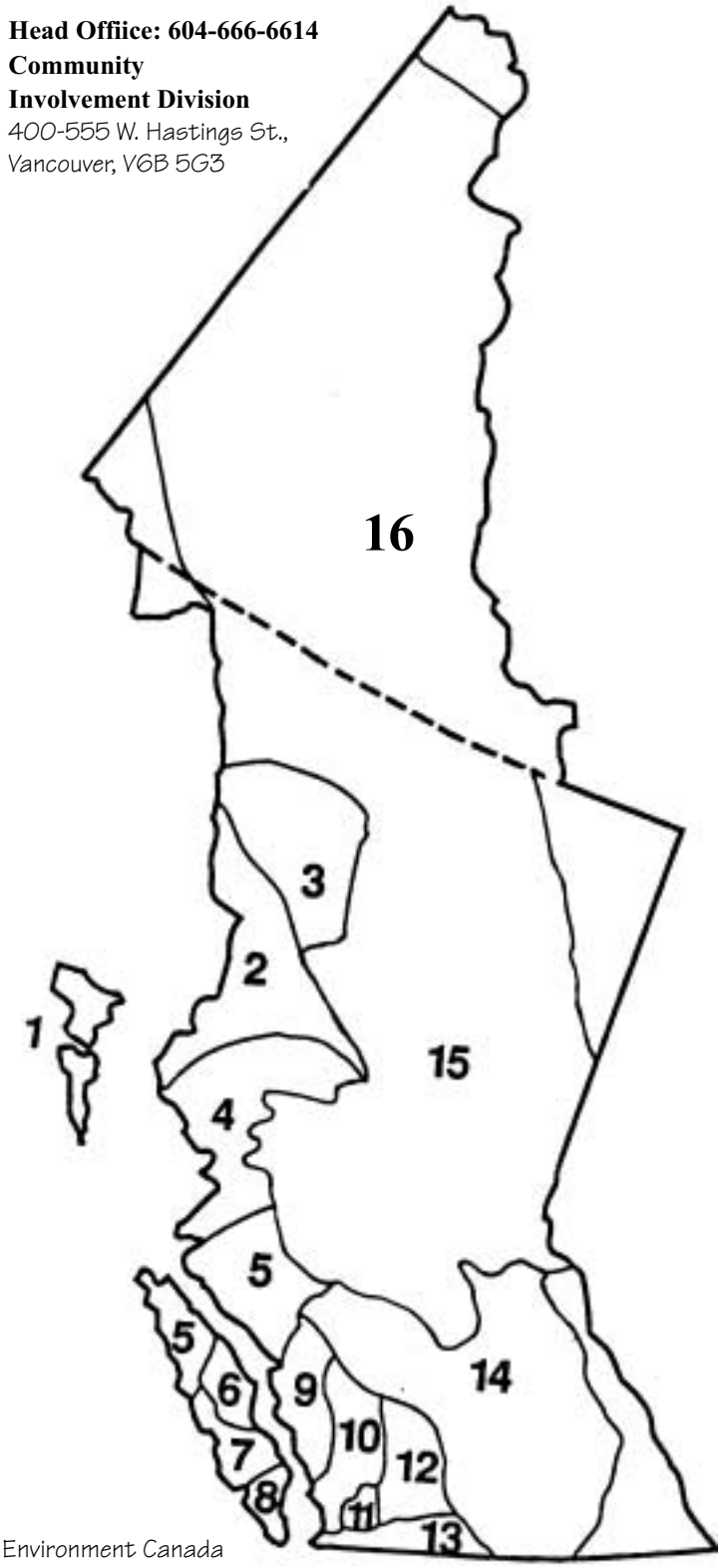
U.S. Environmental Protection Agency. 1992. *Streamwalk Manual. A*vailable from:
Water Division,
EPA Region 10,
1200 Sixth Ave.,
Seattle, Washington, 98101

Yates, S. 1988. *Adopting a Stream, a Northwest Handbook.* University of Washington Press, Seattle, Washington.

Yates, S. 1989. *Adopting a Wetland, a Northwest Guide.* Snohomish County Planning and Community Development.

APPENDIX 2: Salmonid Enhancement Program Community Advisors

Head Offiice: 604-666-6614
Community
Involvement Division
400-555 W. Hastings St.,
Vancouver, V6B 5G3



Environment Canada
Emergency Reports, Oil & Chemical Spills.....1-800-663-3456
ORR Ministry of Environment, Lands, & Parks.....1-800-663-9453
ORR Department of Fisheries and Oceans 1-800-465-4336

MAP AREA		TELEPHONE
1	**Queen Charlotte Islands** Box 208, Queen Charlotte City, V0T 1S0	**250-559-0039**
2	**Northern Interior and Northern Coast** 100-3219 Eby St., Terrace, V8G 4R3	**250-615-5353**
3	**Smithers and Area** Box 578,. Smithers, V0J 2N0	**250-847-5298**
4	**Central Coast** Box 340, Hagensborg, V0T 1H0	**250-982-2663**
5	**Northern Vancouver Island** Box 10, Port Hardy, V0N 2P0	**250-949-1558**
6a	**Vancouver Island, Cambell River** Quinsam Hatchery 4217 Argonaut Road, Campbell River, BC V9H 1B3	**250-287-9564**
6b	**Central Vancouver Island, East** 148 Port Augusta St., Comox, V9N 7Z4	**250-339-0431**
6c	**Central Vancouver Island, West** 3225 Stephenson Pt. Rd., Nanaimo, V9T 1K3	**250-245-7780**
7	**Robertson Creek Hatchery** Box 1100, Port Alberni, V9Y 7L9	**604-724-6521**
8	**Lower Vancouver Island** Box 241-5653 Club Road, Duncan V9L 3X3	**250-746-5137**
9	**Sunshine Coast, Howe Sound** Box 10, Madiera Park, V0N 2H0	**604-883-2613**
10	**West Vancouver, Howe Sound** P.O. Box 2360 1120 Hunter Place Squamish, B.C. V0N 3G0	**604-892-6395**
11	**Burrard Inlet, Indian Arm** Unit 3, 100 Annacis Parkway, Delta V3M 6A2	**604-666-0743**
12	**North of the Fraser to Boston Bar** Unit 3, 100 Annacis Parkway, Delta V3M 6A2	**604-666-2870**
13	**South of the Fraser to Boston Bar** Unit 3, 100 Annacis Parkway, Delta V3M 6A2	**604-666-0742**
13b	**Eastern Fraser Valley Mission/Abbotsford** 201-32335 Fletcher Avenue, Mission, V2V 4N3	**604-814-1076**
14	**Central Interior, South** 1278 Dalhousie Dr., Kamloops, V2C 6G3	**250-851-4954**
15	**Central Interior, Prince George** **Central Interior, Williams Lake** 3690 Massey Drive, Prince George, V2N 2S8	**250-561-5533** **250-398-6544**
16	**Yukon** 100-419 Range Road, Whitehorse, Yukon	**867-393-6721**

APPENDIX 3. GLOSSARY

acid: substance with pH less than 7.0; acidity is caused by high concentrations of hydrogen ions

acid rain: rainwater carrying acidic atmospheric pollutants (nitrous or sulfuric oxides)

alevin: newly hatched fish with yolk sac attached, larva

alkaline: substance with pH greater than 7.0; alkalinity is caused by high concentrations of hydroxyl ions; basic

anadromous fish: fish that migrate from salt water to fresh water for spawning

aquatic: refers to water

aquatic insect: insect species whose larval stages live in water

basic: alkaline

benthic: refers to the bottom of a body of water

benthic macroinvertebrates: spineless animals that inhabit the bottom of streams and lakes; visible to the eye; aquatic worms, snails, clams, immature stages of aquatic insects

biochemical oxygen demand (BOD): the amount of oxygen used up in biological decomposition and chemical oxidation of sediment, water, or effluent

boulders: rocks larger than 30 cm (12 inches) in diameter

canopy: upper layer formed by trees

carrying capacity: number of organisms a habitat can support throughout a year without damaging organisms or habitat

coarse particulate organic matter (CPOM): leaf and fine woody debris >1 mm in diameter

cobble: rock from 7 to 30 cm (3 to 12 inches) in diameter; rubble

collectors: aquatic invertebrates that feed on fine material

community: the plants and animals that interact in a habitat; the community of people who influence a habitat

coniferous: cone-bearing trees with needles

consumers: organisms that depend on other organisms for their food

cover: vegetation or other features that provide shelter for wildlife

deciduous: trees that shed their leaves in fall

decomposition: breakdown of organic materials

deposition: depositing of material by a stream, generally at points of reduced stream flow

discharge: the amount of water flowing past a given point on a stream; measured in cubic feet or cubic metres per second

dissolved oxygen: oxygen dissolved in water; the amount depends on water temperature, plant photosynthesis, plant and animal respiration, and physical aeration

dissolved solids: solid (generally inorganic) material in solution

diversity: number of species in a particular community or habitat

drainage basin: watershed

ecosystem: the organisms, physical environment, and climate in a given area

effluent: waste liquid from a house, industry, sewage treatment plant, etc.

engulfers: predators that eat their prey whole

ephemeral streams: ones that flow only during and shortly after extreme rainfall or snowmelt

erosion: movement of soil by water and wind

evaporation: conversion of water from liquid to vapour

evapotranspiration: water lost from plants through evaporation and photosynthesis

filtering collectors: aquatic invertebrates that feed by filtering small organic particles from the water

fine particulate organic matter (FPOM): organic material <1 mm in diameter

first-order stream: stream with no tributaries

fish ladder: a stepped fishway with water flowing over it

flood: stream flow greater than the channel can contain

floodplain: area along a stream or river subject to flooding; often the location of human development

freshet: a sharp rise in discharge or a flood event associated with rainfall or snow melt

fry: recently emerged fish, after the yolk sac has been absorbed

functional feeding groups: classification of aquatic invertebrates by their feeding method

gathering collectors: aquatic invertebrates that feed on particles on the bottom of a stream

gradient: degree of slope, or steepness of a geographic feature

gravel: rock 0.5 to 7 cm (0.2 to 3 inches) in diameter

ground water: water that sinks into the soil and collects over impermeable rock; it then flows laterally toward a stream, lake or ocean.

habitat: an area that provides food, water, and shelter for an organism

headwaters: unbranched tributaries of a stream

herbaceous: plants with soft rather than woody stems

humus: decayed organic matter in or on the soil

infiltration: drainage of water through soil

intermittent stream : one that does not flow year-round

invertebrate: an animal without a back bone

ion: an electrically charged atom or molecule

larva: immature stage in a life cycle between egg and adult

limiting factors: conditions that establish a population or range of a species

mg/l: milligrams of a substance per litter of water, parts per million (ppm)

midreaches: streams carrying the water from several tributaries

milt: sperm-filled milky substance released by male fish to fertilize eggs

monitor: track a characteristic over time, using uniform methods to evaluate change

non-point source pollution: pollutants that enter waterways from broad land areas as a result of the way the land is used (e.g. sedimentation, runoff)

nymph: immature form of insects such as stoneflies and mayflies that do not pupate

perennial streams: ones that flow throughout the year

periphyton: algae growing on surfaces in a stream, lake, or ocean

pH: measure of the hydrogen ion activity; measures the acidity or alkalinity of a solution: the pH scale ranges from 1 (strong acid) to 14 (strong base), with 7.0 as neutral

piercers: predators that feed by sucking fluids out of their prey

plankton: microscopic plants and animals suspended in the water

point source pollution: air or water pollutants entering the environment from a specific source

pool: deeper and slower flowing water in a stream or river

population: group of individuals of a specific kind, in a given area, at a given time

ppm: parts per million or milligrams per litre (mg/l)

precipitation: rain, snow, hail, or sleet falling to the ground

predator: an animal that hunts and kills other animals for food

primary production: organic material produced by plants from inorganic material and sunlight

producers: plants that manufacture food from inorganic nutrients

pupa: stage of a life cycle between larva and adult

reach: a stream section with fairly homogenous characteristics

rearing habitat: places in a stream that provide food, resting places, and shelter for young fish

redd: a nest in the streambed in which salmon and trout lay their eggs; the eggs incubate, then hatch in the gravel

riffle: relatively fast flowing, shallow water in a stream

riparian area: the border of the stream above its banks; wet soil areas influenced by the water of a stream, lake, or wetland

riparian area of influence: transition area between riparian area and upland vegetation

riprap: rock covering used to protect stream banks from erosion

river continuum: a conceptual model explaining changes in composition of aquatic invertebrate communities in streams and rivers

run: a part of the stream with smooth, slow to moderate flow, deeper than a riffle

salmonid: a fish of the Salmonidae family (salmon, trout, char)

scrapers: aquatic invertebrates that feed by scraping the surface of rocks for algae

secondary production: material that is transformed by consumers (eaten or decomposed)

shredders: aquatic invertebrates that feed on leaves or twigs that fall into a stream

silt: tiny, fine particles suspended in or deposited by water

siltation: the process of becoming clogged by fine sediments

smolt: a juvenile anadromous fish that has undergone physical changes to prepare for life in saltwater

spawning: laying and fertilizing eggs

spawning habitat: parts of a stream or lake that provide suitable areas for fish to spawn; usually gravel beds

streambed: part of the stream over which water moves; substrate

stream order: a system used to classify (and analyze) streams

stream flow: volume of water carried by a stream

substrate: inorganic material that forms the streambed

suspended sediments: particles carried in water without being dissolved

terrestrial: living on land

turbidity: degree to which light penetration is blocked because water is cloudy; measure of sediment suspended in water

water table: upper level at which the soil is saturated with water

watershed: all the land area that drains into a particular body of water

wildlife: any animal that is not tamed or domesticated

APPENDIX 4. HOME TIPS FOR CLEAN STREAMS

RECIPES FOR CLEANER WATER: Outdoor Alternatives

Information supplied by the King County Surface Water Management and Washington State Department of Ecology.

Pesticides

For ants:

Kill ants in the house with soapy water. Sprinkle boric acid on trails and where ants are found in nooks and crannies. Keep boric acid out of the reach of children and pets.

For caterpillars:

Apply Bacillus thuringensis (Bt) bacteria to them during warm weather when they are small, or gently sponge or mist/spray leaves with soapy water.

For insects on plants:

Spray infested leaves with a solution of 10 ml liquid soap in 1 litre (2.5 teaspoons in 1 quart) of water. After a few minutes rinse off with water.

Soak a large handful of pipe or cigarette tobacco in 5 litres (1 gallon) of water for 24 hours. Dilute with water to the color of weak tea and apply with spray bottle. Use caution when handling.

Fertilizers

Ingredients for organic fertilizers:

cottonseed meal: .....supplies nitrogen
bone meal: .....supplies calcium, phosphorus
dolomite: .....supplies potassium, calcium
greensand: .....supplies potassium
blood meal: .....potent source of nitrogen
fish meal: .....supplies nitrogen, trace minerals
kelp meal: ..supplies trace minerals, potassium
chicken/steer manure/guano:

supplies nitrogen, organic matter

Paint Strippers

Use safe commercial strippers with a "Caution" advisory on the label. Some old paints contain lead. Use precautions against breathing dust and dispose of paint scrapings in the trash.

Automotive Antifreeze

Buy propylene glycol-based antifreeze, it is significantly less toxic than ethylene glycol-based.

Degreaser (Automotive)

Use a water-based cleaner such as Simple Green, or citrus-based products with "Non-toxic", "Biodegradable", and "Non-flammable" on the label.

For grease spots on the garage floor, sprinkle kitty litter or cornmeal on the spot; sweep up after several hours and dispose in the garbage.

Car Cleaner and Polish

For car wash:

Use 30 ml (2 tablespoons) mild dish detergent or 250 ml (1 cup) soap flakes in 9 litres (2 gallons) of warm water.

For cleaning chrome:

Apply a paste of baking soda and water to the chrome with a sponge; let it set for a few minutes, then rinse and wipe dry with a soft cloth. Rub chrome with newspaper to make it shine brightly.

Glass Cleaner

250 ml vinegar (1 cup)
2 litres warm water (2 quarts)

Do not use this as a windshield wiper solution as it may damage the pump; use plain water for this purpose.

RECIPES FOR CLEANER WATER: Indoor Alternatives

All-purpose Household Cleanser

Recipe #1

1 litre warm water (1 quart)
5 ml liquid soap (1 teaspoon)
5 ml borax (1 teaspoon)
15 ml vinegar or lemon juice (1 tablespoon)

Recipe #2

2 litre water (2 quarts)
125 ml household ammonia (half cup)
125 ml white vinegar (half cup)
50 ml baking soda (quarter cup)

These cleansers will work on anything from countertops and wall to floors and carpets.

Furniture Polish

0.5 litre mineral oil (2 cups) with
a few drops lemon juice

Degreaser (kitchen)

30 ml TSP (2 tablespoons)
4.5 litres hot water (1 gallon)

Or use nonchlorinated scouring powder (e.g. Bon Ami) with an abrasive scouring pad or fine steel wool.

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30 ml TSP (2 Tablespoons)
4.5 litres hot water (1 gallon)

Or use nonchlorinated scouring powder (e.g. Bon Ami) with an abrasive scouring pad or fine steel wool.

Drain Cleaner

Pour 125 ml of baking soda (half cup), then 125 ml vinegar (half cup) down the drain, cover and let sit for 15 minutes, then rinse with 2 litres (2 quarts) boiling water. For a bad clog, remove the trap and clean out the obstruction with a plunger or a plumber's snake. Treating drains once a week with the recipe above prevents problems and keeps your drains smelling fresh.

Disinfectant/Mildew Cleaner

125 ml borax (half cup)
5 litres hot water (1 gallon)

To inhibit mold and mildew, do not rinse off borax solution.

Oven Cleaner

30 ml borax, baking soda or TSP (2 tbsps)
5 litres hot water (1 gallon)

Wear gloves and scrub with very fine steel wool (OOOO). For baked on spots, try scrubbing with pumice (available at hardware stores). As a last resort, use an aerosol cleaner that says, "No caustic fumes".

Laundry Bleach

125 ml of borax (half cup) per load of laundry will whiten and remove spots. If you must use a bleach, use an oxygen bleach like sodium perborate instead of chlorine bleach.

Laundry Detergent

Use soap flakes with 125 ml added borax (half cup).

Spot Removers

All-purpose:

125 ml borax (quarter cup)
1 litre cold water (2 cups)
Soak the stain before washing as usual.

Blood: Before rinsing with water, pour 3% hydrogen peroxide directly on the stain, then wash as usual.

Ink: Apply a paste of lemon juice and cream of tartar; allow it to dry, then wash as usual.

Household Products Hazardous to Stream Life:

Information supplied by the B.C. Ministry of Environment, Lands and Parks

Automotive Products

Motor oil
Antifreeze
Brake fluid
Carburetor cleaner
Gasoline
Gasoline additives
Transmission fluid
Degreasers
Sealers

Paint and Solvents

Paints
Rustproof coating
Shellacs
Paint thinners
Lacquers
Paint and varnish strippers
Varnishes
Enamels

Recreational Products

Swimming pool contents (chlorine)
Outboard motor products (gas, oil, etc.)

Pesticides

Disinfectants (bathroom, kitchen, etc.)
Insecticides (garden products, flea collars, etc.)
Fungicides (mold and mildew control)
Herbicides (weed killers)
Molluscides (slug baits)
Wood preservatives (creosote, pentachlorophenal)

Cleaning Products

Detergents
Drain and toilet cleaners
Rug and upholstery cleaners
Leather preservers
Dry cleaning agents
Car wash detergent
Shoe polish.

From Home Tips for Clean Streams, Fisheries and Oceans Canada, Habitat Management

Lawn and Garden Tips

Pesticides and weed killers create problems when they enter lake and streams. Some chemicals may stay active for a long time and accumulate in the environment. Others can kill desirable insects, animals and plants as well as pests. Fertilizers, chemical and organic, can cause excess weed and algae growth when they enter water reducing available oxygen for other forms of aquatic life. This excess growth not only looks and smells bad, but it can eliminate fish populations. Following these tips will not only be good for the environment, it's good for your pocketbook, too!

Encourage bug-eating birds & friendly insects

Attract birds with tree cover, food during the winter, and protection from cats. Spiders, ladybugs and lacewings all eat pest insects. Recognize and respect these useful insects.

Care for your plants

Healthy plants, properly cared for, are more resistant to pests and require fewer chemical "medicines".

Read and follow pesticide and herbicide directions

Applying more chemicals than directed may do more harm than good. Never spray near ditches, lakes, or streams. Spray on windless days when it is not too hot. Avoid spraying before or during rain.

Time chemical applications properly

Spray only when you will actually see the pest or disease and then spray only when the chemical will be most effective.

Water your treated lawn or garden carefully

Sprinkling too heavily will wash chemicals off and into drain tiles that lead to ditches and storm sewers, and eventually to aquatic environments.

Dispose of lawn and garden chemicals carefully

Follow instructions on the container. Never dump chemicals into ditches, down drains, into the gutter or near water. They can interfere with the workings of sewer treatment plants and septic tanks, or cause fish kills. If you have unused pesticides, please contact the nearest B.C. Ministry of Water, Land and Air Protection office (Waste Management Branch) for instructions on proper disposal.

Sidewalk and Drive Tips

Streets and driveways are sources of water pollution. Oil leaks from cars can contribute large volumes of oil pollutants. Antifreeze is highly toxic. Contaminants from car exhausts can wash off roads and into streams.

Recycle your used crankcase oil

Take it to the nearest gas station that has recycling capabilities. Companies pick up the used oil from these stations and recycle it as motor oil and home fuel oil.

Fix that leaky crankcase or transmission

If repair is not possible, put a tray under the car and recycle the oil that is collected.

Sweep your walks and driveways

Hosing and rainfall wash litter and dirt from the sidewalks and driveways into your streams; sweeping them is better.

Keep your exhaust clean

Tune-ups and anti-pollution devices reduce the fallout from your exhaust which is picked up by runoff on streets and parking lots.

De-ice with sand and cinders

Runoff carries salt and chemical de-icers into streams and rivers. Grit is safer, but remember to sweep it up before the next rainstorm or it may clog drains.

Keep suds out of gutters

Use low-phosphate soaps when you wash your car. Do not dump leftover detergents or cleaning compounds into local waterways or storm drains. Dry car wash products are available now.

Watch your construction projects

When pouring concrete, keep wet concrete away from fish bearing waters. It is very toxic.

Tips for Controlling Animal Wastes

Keep your animal wastes at home

No one appreciates other people's animal wastes in their yards, parks or streams. Wastes left on sidewalks or in gutters are flushed directly into your streams and lakes by runoff. Before having a large concentration of animals on your property, ensure that you have developed a program to keep their wastes out of nearby streams.

Lot Coverage Tips

Building homes, roads and commercial properties removes vegetation and results in extensive paved areas. The average city lot has 50 to 75 percent of its surface covered. The trend towards townhouse and condominium developments results in even greater lot coverage and less vegetation. Sealing the ground with concrete and asphalt is the major cause of increased amounts and greater force of runoff. As more land is paved, less rain can infiltrate the soil to recharge groundwater supplies. Infiltration through the ground cleans water and provides underground water to keep streams flowing during the summer. The result of increased paving is often increased flow in the summer

Plant another tree

Trees and shrubs capture and hold a lot of rain before it reaches the ground. Their roots hold water in the ground. Whenever possible, keep existing trees and bushes growing and try to plant more.

Recharge groundwater supplies

Redirect your roof down spouts away from the drain tiles, street and storm sewers, French drains (gravel-filled trenches), abandoned septic drain fields and cisterns all hold and slowly release water to the ground. Check with your local municipality.

Avoid landscaping plastic

Large plastic sheets used to prevent erosion and weed growth create as much runoff as paved streets. Landscape cloth is a good alternative that allows water to penetrate to the soil. Use burlap on hillsides and perforated plastic sheets on level areas to let water penetrate.

Limit use of bark mulch

Bark mulch creates toxic leachate that may enter water courses. Limit use of bark mulch to areas that do not drain directly into storm sewers or open water.

Avoid paving your lot

Leave as much of your lot as you can in grass and trees. Consider using the new porous asphalt or paving bricks for your driveway. Water seeps through them.

Tips for your Swimming Pool

Keep chlorine and other chemicals out of ditches and streams

Swimming pool chemicals are toxic to fish and animals. Pools should not be drained or vacuumed into water courses or storm drains. Direct the water into the ground or a domestic sewer to prevent direct entry into fish bearing streams.

Tips for Streamsiders

A lot depends on you. Unwise and careless use of stream banks and stream beds can lower water quality to the point where fish dies and the stream becomes an eyesore, not an asset.

Keep your stream shaded

Trees, bushes and grasses on the banks will shade the water, keeping it cool for fish in the summer, prevent streambank erosion and collapse and provide wildlife habitat and a food source for fish. Streambank vegetation also provides cover and shelters from predators. Leaves that fall into the stream break down over time and become an important part of the food chain.

Educate your children

Streams are valuable. Don't let children dam them, disturb the bottom mud or gravel, collapse the banks, destroy vegetation or harass fish and wildlife.

Keep livestock away from streams and marshes

Animal wastes degrade water quality and their hooves can cause banks to collapse, which leads to heavy siltation and can block water flows.

Keep litter out of streams

This includes tree branches, grass clippings, old appliances, and trash. Large objects can block the flow of water and fish and may destroy fish eggs. Organic matter will rot and reduce the amount of dissolved oxygen in the water. The oxygen is needed by fish and it helps keep the water smelling fresh.

Don't over-beautify

Despite good intentions, changes you make to your stream may destroy spawning beds and fish eggs or block fish migrations. Do not build ponds or dams without guidance and approval from Fisheries and Oceans Canada and the B.C. Ministry of Environment, Lands and Parks