THE STATE OF Rivers and Watersheds IN BRITISH COLUMBIA 2003

BRITISH COLUMBIA

Ministry of Water, Land and Air Protection

On the cover

The extensive network of rivers, streams, lakes and wetlands in British Columbia is home to a remarkable array of plants and animals and provides water, food, recreation and other services to British Columbians.

Photos and photographers, clockwise from bottom left: Fishing on the Morice River, Ray Pillipow; Small stream, Andrew Wilson; Canoeing in Tweedsmuir Provincial Park, Rowena Rae; Common Goldeneye Ducks, Dick Cannings; Kokanee Salmon, Ministry of Water, Land and Air Protection.

Photo on the title page, opposite: A small stream in Golden Ears Provincial Park in the Lower Mainland, Ministry of Water, Land and Air Protection.

Title: The State of Rivers and Watersheds in British Columbia 2003

National Library of Canada Cataloguing in Publication Data

Main entry under title:
The state of rivers and watersheds in British Columbia,
2003.

Also available on the Internet.
Includes bibliographical references and index.
ISBN 0-7726-5051-9

1. Rivers – British Columbia. 2. Watersheds – British Columbia. 3. Watershed management – British Columbia. 4. Ecosystem management – British Columbia. 5. Wetland management – British Columbia. I. British Columbia. Living Rivers Strategy.
GB992C3 S722 2003 333.91'62'09711 C2003-960207-9

Production team

Project direction: Jamie Alley, Ministry of Water, Land and Air Protection.

Project coordination, research and writing: Rowena Rae, Ministry of Water, Land and Air Protection.

Cartography and GIS-based analysis: Dave Nicolson, Natalie Work, Mike Shasko, Taryn Musgrave and Rob Flemming, Clover Point Cartographics Ltd.

Database consultation and GIS contract management: Malcolm Gray and Robert Gowan, Ministry of Sustainable Resource Management.

Design, production and editing: Frances Hunter, Annie Weeks and Judith McDowell, Beacon Hill Communications Group Inc.

Copies of this report may be:

downloaded from the Internet at www.gov.bc.ca/wlap,

picked up from the Biodiversity Branch, Ministry of Water, Land and Air Protection, 2975 Jutland Road, Victoria, BC,

ordered from Living Rivers, Biodiversity Branch, Ministry of Water, Land and Air Protection, PO Box 9338, Stn Prov Govt, Victoria, BC V8W 9M1.

Technical documents presenting methodologies and the data behind the indicators will be available on the Internet at www.gov.bc.ca/wlap.

THE STATE OF Rivers and Watersheds IN BRITISH COLUMBIA 2003

"A river is water in its loveliest form; rivers have life and sound and movement and infinity of variation…"

— Roderick Haig-Brown
excerpt from "To Know a River"
in *A River Never Sleeps*, 1944

BRITISH COLUMBIA

Ministry of Water, Land
and Air Protection

Acknowledgements

Numerous people contributed to the development of this report with their time, ideas and support. Many provided data and technical papers, assisted in accessing and interpreting data or reviewed drafts of some or all of the text. Others helped to organize or participated in a workshop to review a draft version of the report. Contributors are staff of the Ministry of Water, Land and Air Protection unless otherwise noted.

Mark Angelo [21]
John Arber
Ken Ashley
Matt Austin
Scott Babakaiff
Barry Bartlett [8]
Vic Bartnik [12]
Dan Bate
Warren Bell
Shauna Bennett [9]
Dennis Besler [15]
Doug Biffard
Brian Blackman [25]
Pat Bluemel [18]
Bruce Boyd [29]
Bob Brown
Don Cadden
Tom Cadieux [13]
Carmen Cadrin [29]
Randy Cairns [15]
Karen Calla [13]
Clive Calloway [14]
Glen Carlson
Marlene Caskey
Alan Caverly
Sean Cheesman [16]
Tony Cheong [29]
Kristy Ciruna [19]
Dave Clark [29]
Bob Cook [29]
Warren Cooper
Nick Cottam
Ken Cunningham
Patrick Daigle
Alec Dale
Glen Davidson [15]
John Deniseger
Andy Dolberg [1]
Ted Down
Wilf Dreyer [29]
Orville Dyer
Laurie Edward [21]
Phil Epp
Lloyd Erickson
Tom Ethier
Angelo Facchin [29]
Jenny Feick
Mike Fenger
Deepa Filatow [29]
Jenny Fraser
Laura Friis
Ted Fuller
Grant Furness
Sarah Gergel [30]
Linda Gilkeson
David Gooding [29]
Colin Gray [12]
Jennifer Grenz [21]
Bob Gunn [5]
Rick Hardy [15]
Kelvin Hicke
Catriona Hickley
Bob Hooton
Lynn Husted
Brian Jantz
Vic Jensen
Will Jolley [15]
Dave Jones
Greg Jones
Rob Knight
Al Kohut
Rick Kool [27]
Lynn Kriwoken
Mike Ladd
Arne Langston [25]
Susan Latimer
Ted Lea
Jack Leggatt
David Leman [31]
Bruce Letvak [29]
Tony Litke [10]
Vicki Marshall
Steve Matthews
Jennifer Maxwell
Steve McAdam
Brian McCloy [2]
Donald McCubbing [9]
Bruce McFarlane
Ian McGregor
Angus McKay [23]
Tracy Michalski
Judy Millar
Les Molnar
Brent Moore
Kathleen Moore [12]
Maureen Moore [29]
ZoAnn Morten [24]
Ute Muller [29]
Tina Neale [30]
Charles Newcombe
Bob Nicholson [29]
Bill Obedkoff [29]
Craig Orr [33]
Ian Parfitt [8]
Eric Parkinson
Richard Penner [15]
Jenifer Penny [29]
Nellie Peppin [29]
Burke Phippen [9]
Ray Pillipow
Ted Pobran
Juanita Ptolemy
Ron Ptolemy
James Quayle
Leah Ramsay [29]
George Reid
Stu Reynolds [15]
Eva Riccius [6]
Brian Riddell [22]
Beth Rogers [29]
Kevin Ronneseth
Marvin Rosenau
Jordan Rosenfeld
Rick Routledge [28]
Steve Rowe [15]
Tom Saare [5]
Wendy Schebel [11]
Gil Scott
Dale Sebastian
Ian Sharpe
Dave Smith [13]
Gail Smith
Hugh Smith [4]
Risa Smith [12]
Stuart Smith [34]
Tory Stevens
Les Swain
Julie Swinscoe
Brian Symonds
Art Tautz
David Tesch [29]
Judy Teskey
Bruce Thomson
Dave Tredger [29]
Mauro Vescera [32]
Bruce Ward
Robyn Wark [7]
Roger Warnatsch [26]
Rob Way [3]
Garth Webber Atkins [17]
Mike Wei
Ted White [15]
Paul Whitfield [12]
Bob Williams
Andrew Wilson
Norma Wilson [21]
Andy Witt
Howie Wright [20]
Karen Yearsley [29]
Pamela Zevit
Ted Zimmerman

1. BC Agriculture Council
2. BC Business Council
3. BC Federation of Fly Fishers
4. BC Hydro
5. BC Institute of Technology
6. Canadian Parks and Wilderness Society
7. City of Burnaby
8. Columbia Basin Fish and Wildlife Compensation Program
9. Consulting biologist
10. Co-op student
11. Ducks Unlimited Canada
12. Environment Canada
13. Fisheries and Oceans Canada
14. Living By Water
15. Land and Water BC, Inc.
16. Ministry of Agriculture, Food and Fisheries
17. Ministry of Forests
18. Ministry of Management Services
19. Nature Conservancy of Canada
20. Okanagan Nation Fisheries Commission
21. Outdoor Recreation Council
22. Pacific Fisheries Resource Conservation Council
23. Pacific Salmon Foundation
24. Pacific Streamkeepers
25. Peace/Williston Fish and Wildlife Compensation Program
26. Recreational Canoeing Association of BC
27. Royal Roads University
28. Simon Fraser University
29. Ministry of Sustainable Resource Management
30. University of British Columbia
31. University of Northern British Columbia
32. Vancouver Foundation
33. Watershed Watch
34. Whitewater Kayaking Association of BC

Photo on Contents page: Kokanee Creek, Kokanee Glacier Park, Rob Cannings.

CONTENTS

MESSAGE FROM THE MINISTER

The State of Rivers and Watersheds in British Columbia 2003 is a comprehensive report on the state of our province's rivers and watersheds. It is the first-ever assessment of its kind, and examines the health and vitality of our rivers, lakes, aquifers and streams.

This report is part of our government's commitment to using sound science in assessing the state of B.C.'s environment. A comprehensive assessment of this nature is critical if we are to fully understand what steps we must take to protect and enhance our ecosystems.

Our assessment tells us that, in general, the state of water in B.C. is good.

The report's highlights include the following findings:

- Seventy-one per cent of measurement sites for surface water – which includes rivers, streams, lakes and wetlands – were rated Good or Excellent.
- 13 percent of lakes and 6.8 per cent of wetlands are within protected areas.
- Water conservation must become more widespread.
- Watershed conditions vary around the province.
- Some species associated with fresh water are at risk.
- We all rely heavily on British Columbia's freshwater ecosystems and we must all share the responsibility of looking after them.

Although this report reveals that B.C.'s water is generally good, it also shows that more work is required. In order to address the challenges documented in this report, Premier Campbell has directed me, together with the Minister of Sustainable Resource Management, to develop a Living Rivers Strategy. This strategy will coordinate actions across government to address the challenges we face and provide substantive solutions.

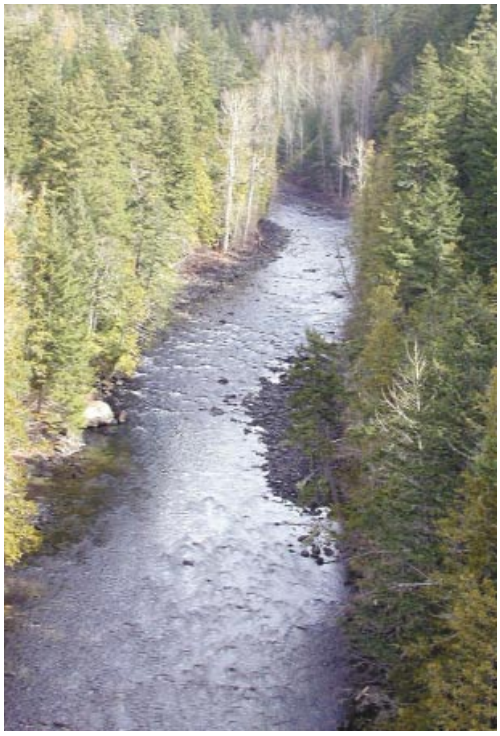
On Rivers Day 2002, our government took a first step towards this strategy by establishing a $2 million trust fund committed to Living Rivers. The State of Rivers and Watersheds report is a key component of the strategy. The report shows us how conditions in BC's watersheds have changed over time, and provides baseline data from which to measure future changes. It helps us to increase our understanding and awareness of freshwater ecosystems and identifies areas where action is required.

I encourage you to read the "What Can I Do?" section at the back of the report to learn more about the general and specific actions that each and every one of us, individuals, businesses and governments alike, can take to make a difference.

Best regards,

Joyce Murray,

Minister of Water, Land and Air Protection



INTRODUCTION

British Columbia contains one third of Canada's fresh water in its rivers, streams, creeks, lakes, ponds, wetlands and groundwater. These freshwater ecosystems are home to a myriad of animals and plants and provide numerous ecosystem services such as water purification, contaminant reduction and flood and erosion control. Many of BC's freshwater ecosystems are pristine. Others are facing increasing pressures as BC's population grows and development expands.

Greater and greater demands on freshwater resources are occurring worldwide. Many countries face critical shortages of clean water for people; when people have insufficient water, freshwater ecosystems and the species they support also suffer. As a result, the United Nations declared 2003 the International Year of Fresh Water. The aim is to increase awareness of the vital role fresh water plays for everyone in the world, celebrate existing contributions to sustainable freshwater use and encourage action to protect, restore and respect freshwater resources.

Canada is actively participating in the International Year of Fresh Water with the two-year "Wonder of Water" initiative featuring the cultural and ecological importance of water to Canadians. One of British Columbia's contributions to the worldwide recognition of the importance of fresh water is to implement a Living Rivers Strategy. As a component of this, *The State of Rivers and Watersheds in British Columbia 2003* report will provide a reference against which the condition of BC's freshwater ecosystems can be compared in future.

Above: The Atnarko River flows into the Bella Coola River on the West Coast of BC.
PHOTO: Ron Ptolemy, Ministry of Water, Land and Air Protection.

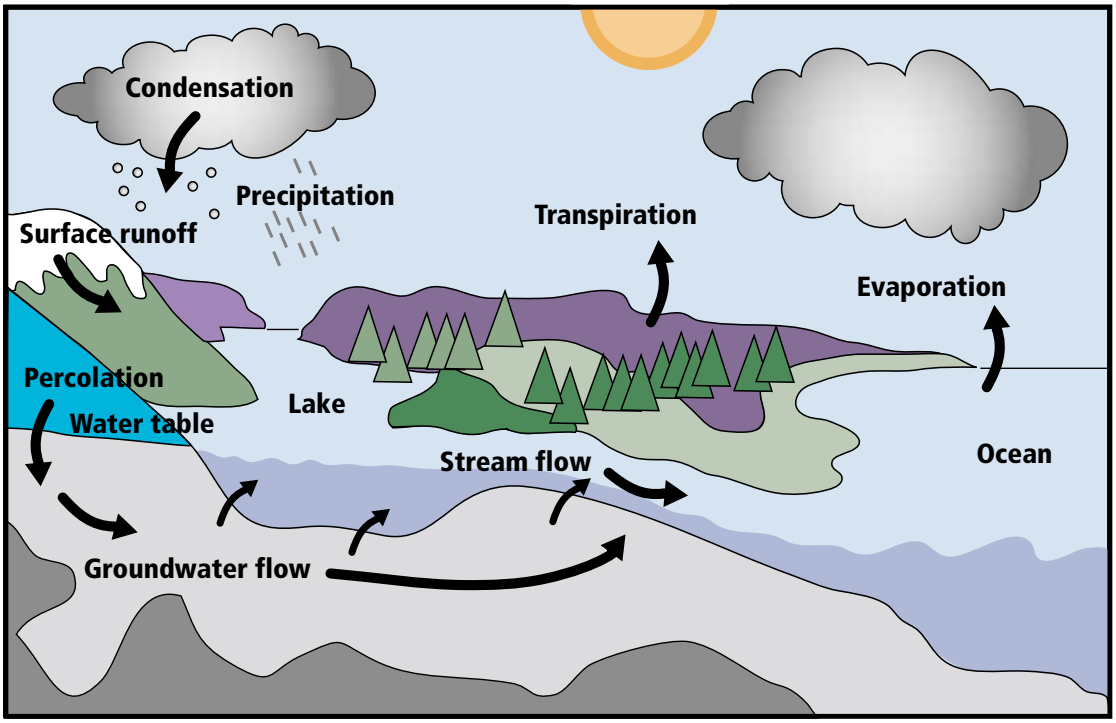
The importance of fresh water to British Columbia

Just over four million people inhabit British Columbia. Three quarters live in the southwestern part of the province and most of the rest occupy its numerous valleys and coastlines. Throughout the province, communities rely on the fresh waters that flow both over and below the ground. British Columbians are intimately connected to the province's rivers and watersheds.

Starting with European contact, the development and growth of British Columbia resulted largely from the use and manipulation of the province's natural resources. Aquatic resources played a key role in this growth. Wetlands in valleys were drained and converted for agricultural use, commercial salmon fisheries displaced traditional First Nations fisheries, trees were felled from stream sides, timber and other goods were transported along river channels and dams and water diversions were constructed to store and redistribute water. As settlements grew, more and more land became urbanized and frequently this land was alongside or near rivers, streams, lakes and wetlands.

Development and growth continue in British Columbia and freshwater ecosystems continue to provide important services. They can only do so, however, if they are healthy and functioning properly. The drought experienced this year in many parts of BC underscores the vital role fresh water plays for British Columbians.

The hydrologic cycle



SOURCE: Environment Canada, "Water – Nature's Magician," Freshwater Series A-1. Freshwater Website (www.ec.gc.ca/water). Reproduced with the permission of the Minister of Public Works and Government Services, 2003. © Her Majesty the Queen in Right of Canada. All rights reserved.

Freshwater resources

Despite the fact that water covers much of the earth's surface, only a miniscule portion of it – less than one hundredth of one percent – is fresh water in a form available for plants and animals, including humans, to use. The hydrologic cycle connects all the water on earth (*see diagram*). Clouds release water as rain or snow and this precipitation either runs over land as surface runoff or percolates into the ground. Surface runoff feeds lakes, streams and wetlands. Percolation feeds groundwater aquifers, many of which also contribute to lakes and streams from below. Groundwater flow and stream flow ultimately enter the ocean. Plants that have taken water from the ground transpire and this water returns to the air and repeats the cycle. The ocean, lakes and streams also return water to the air through evaporation.

Within this ongoing cycle, people rely on fresh water for a huge range of daily activities: we drink water, grow food with water, funnel our wastes into water, generate electricity with water, manufacture all sorts of products using water and spend recreational and spiritual time around water. For people to continue these activities and thrive, freshwater ecosystems must be healthy. Every British Columbian can make an important contribution towards helping protect and restore freshwater ecosystems – for ourselves, for our children and for the plants and animals with which we share the province.

ABOUT THE STATE OF RIVERS AND WATERSHEDS IN BRITISH COLUMBIA REPORT

Given the cultural, economic and ecological importance of freshwater ecosystems, we need to understand how they function and how our actions affect them. To ensure that we are aware of how our freshwater ecosystems are faring, we need to monitor and report on their health. This report is British Columbia's first *State of Rivers and Watersheds* report, which will serve as a foundation to increase our understanding of the health of BC's freshwater ecosystems.

Rivers defined

Rivers are just one part of the freshwater landscape. The title of this report includes "river" as an easily identifiable part of the continuum of fresh water that starts with rain and snow and then flows overground and underground into creeks, streams, ponds, wetlands, lakes and groundwater aquifers and ultimately to the ocean.

Goals

The goals of this report are to inform British Columbians about the province's watersheds, to help people understand the effects that their actions and choices have on them, and to provide scientific information about freshwater ecosystems.

Many organizations, businesses, community groups, landowners and individuals contribute significant resources, time and effort to caring for freshwater resources. This report is intended to encourage even more people to participate in stewardship and make a difference for BC's freshwater ecosystems.

The 23 watershed groups used in the State of Rivers and Watersheds report

SOURCE: Ministry of Sustainable Resource Management, 2003. Ministry of Water, Land and Air Protection, 2003.

NOTES: Major watersheds with large populations were divided into smaller watershed groups. For example, the Fraser River watershed was divided into the Nechako, Thompson, and Upper, Middle and Lower Fraser plus the Lower Mainland. Several of the coastal watersheds include streams that flow directly to the ocean rather than into a single major river.

Geographic scale

Within its 950,000 square kilometres, an area larger than most nations of the world, British Columbia boasts scores of rivers and streams flowing in all directions to ultimately reach the Pacific and Arctic oceans. The province's nine major drainage basins contain close to 400,000 lakes and over 400,000 wetlands. Together, rivers, streams, lakes and wetlands cover an area of approximately 75,000 square kilometres or nearly 8% of BC. Below the land, unseen water flows in groundwater aquifers.

To present an overview of the state of rivers and other freshwater ecosystems in British Columbia, 23 watershed groups have been identified (*see map*). Some of these are complete major watersheds, some are portions of major watersheds and others, particularly along the coast, contain several smaller watersheds. Each map in the report shows the 23 watershed groups to help orient readers to different locations in the province.

Environmental indicators

The information in the report is presented in five sections: Water Quality and Quantity, Aquatic Species, Aquatic Habitat, Pressures and Responses. Within each section are several themes with background information and the status of a related environmental indicator. In some cases, the report documents the current status of the indicator and in others, change in the indicator over time.

Governments and other organizations use environmental indicators to gauge the health of the environment, determine human impacts on the environment and measure progress towards environmental targets. Reports that use environmental indicators help the public, stewardship groups, educators and students access scientific information and also help bring environmental information into decision making.

The most helpful indicators are scientifically credible, representative of the environment and responsive to change so that they provide an early warning of negative impacts. They should also be comprehensible to non-specialists, relevant to environmental targets, based on accurate data and comparable both from year to year and to data used by other jurisdictions or organizations.

Much of the data presented in this report comes from provincial government sources. Information from other levels of government, non-government organizations, community groups, First Nations and academic literature has also been included in several instances. A technical background document containing the data presented and details about the methods used to collect and analyze the data for each theme will be available on the Ministry of Water, Land and Air Protection web site (www.gov.bc.ca/wlap).

Limitations and next steps

By taking a province-wide view, this report is necessarily general. A "top-ten" list of most severely affected freshwater ecosystems has not been included, nor has a list of criteria for ranking the health of a particular river, lake or wetland because this is not possible with the diversity of geographies, climates and ecosystems in British Columbia. Nonetheless, with the information in each theme and the list of resources at the end of the report, readers can begin to assess the health of their local freshwater ecosystems.

This report is intended to be the first in a series to be produced at regular intervals of three or five years to document changes in trends and progress toward protecting and restoring BC's freshwater ecosystems. The ultimate goal is to have a web-based tool that can be used to find information and data related to specific watersheds. As with other reports that present scientific data and trend indicators, some of the information and indicators in the *State of Rivers and Watersheds* report will need to be refined as more data become available. Long-term monitoring and data collection are particularly important for gauging progress towards protecting and restoring the province's freshwater ecosystems.

How you can help

- Gain more understanding of freshwater ecosystems and how human activities affect them. This report will help you do this.
- Read through the section called "What Can We Do?" at the end of the report (*see page 48*) and choose some of the actions listed. Make a personal commitment to follow through with them in your home and work environments.
- Pass the word to your friends, neighbours and colleagues at work. Let others know about freshwater ecosystems and how to get involved in helping to protect or restore them.

Thank you for your interest in British Columbia's freshwater ecosystems. Together, British Columbians can make a difference and leave a legacy of living rivers, lakes, wetlands and watersheds for future generations.

WATER QUALITY AND QUANTITY

SURFACE WATER

Surface water includes all rivers, streams, lakes and wetlands. Surface-water quality was rated Good or Excellent at 71% of measurement sites in British Columbia. Trend data indicates an improvement at 17 sampling sites and deteriorating conditions at only five locations.

Surface water and its importance

- British Columbia's surface water exists in rivers, streams, lakes and wetlands. More is in glaciers and ice caps, but this water is not readily available. Rivers, streams and lakes cover an area of about 18,000 square kilometres. Wetlands cover more than 50,000 square kilometres.
- Surface waters are the drinking source for most wild and domestic creatures. About 80% of British Columbians also get their drinking water from surface sources; the rest use groundwater.
- Many human activities – urban development, agriculture, logging, mining and recreation – rely on fresh water. They can also pollute water through both point and non-point sources. Point sources include industrial effluents and sewage outfalls. Non-point sources include overland runoff from urban, agricultural and forestry activities.

Status of surface water quality

- Many variables can be measured to test the quality of water. These most commonly include temperature, pH, dissolved oxygen, nutrients such as phosphorus and nitrogen, trace elements such as copper, iron and arsenic and organisms such as fecal coliform bacteria.
- The Canadian Water Quality Index (CWQI) uses combinations of these variables to indicate water quality. The index compares measurements with specific objectives that are set at each site depending on the local conditions and uses of water.
- The CWQI was calculated with 2000 and 2001 data for 41 sites in the province (*see map*). The CWQI ranked water quality as follows: Excellent at 19 sites, Good at 10, Fair at 3 and Marginal at 9.
- Two sites with Marginal ratings are rivers on Vancouver Island. The Tsolum River frequently has high dissolved copper, which threatens fish. The Koksilah River is a tributary to the Cowichan River and occasionally has high counts of fecal coliform bacteria.
- Two Marginal ratings are sites on the Fraser River. One is near Quesnel where dissolved oxygen in the water sometimes gets low. The other is in the middle arm near the mouth of the Fraser River where high copper and manganese are occasionally measured in the water.
- Lakes account for five Marginal ratings (Williams, Kalamalka, Wood, Okanagan and Osoyoos lakes). These lakes have high phosphorus, a nutrient that comes from both natural and human sources. In the Okanagan, erosion of phosphorus-rich sediments contributes to high phosphorus in the lakes. Human sources include municipal sewage, septic tanks, agriculture and forestry.

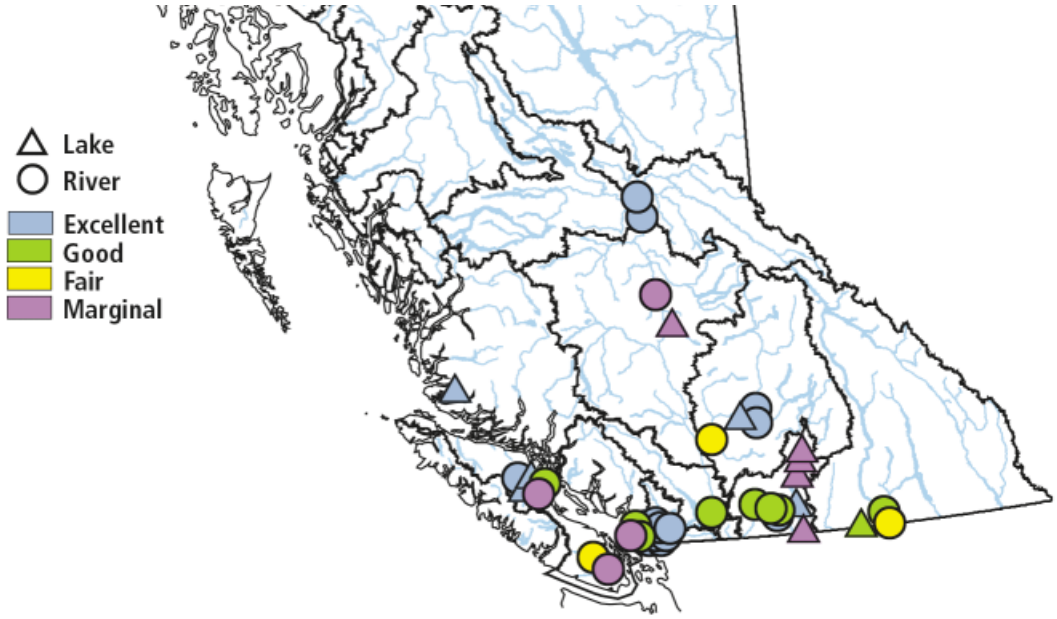
Trends in surfacewater quality

- Trend assessments at 52 sampling stations measured from the mid-1980s to the mid-1990s show that water quality is improving at 17 sites and did not change at 30. (*see chart*).
- Only five locations sampled show deteriorating conditions. The Salmon River at Salmon Arm has high turbidity from non-point sources. Quamichan Lake has fecal contamination from waterfowl. The Quinsam and Elk rivers have high nutrients and trace elements from coal mining. The Kootenay River has low phosphorus caused by a dam; this limits fish production in Kootenay Lake (*see page 33*).

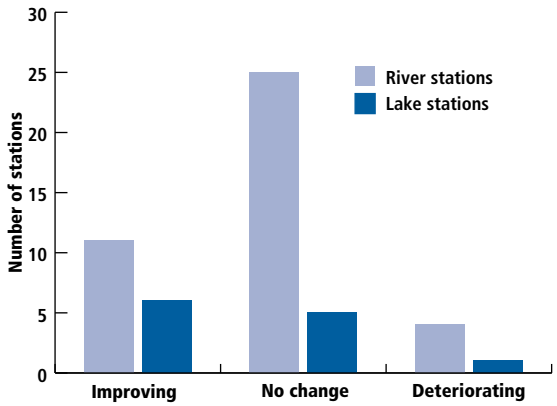
Canadian Water Quality Index ratings in British Columbia, 2000 and 2001

SOURCE: Ministry of Water, Land and Air Protection, 2003.

NOTES: Each CWQI rating was calculated from data collected in 2000 or 2001. The water quality variables measured at each site differ depending on specific conditions and uses of the water.



Water quality trends for 52 stations monitored from the mid-1980s to the mid-1990s



SOURCE: *Environmental Trends in British Columbia*, Ministry of Water, Land and Air Protection, 2002.

NOTES: The stations shown in the chart differ from the sites on the map. The trends data were collected as part of the Canada-British Columbia Water Quality Monitoring Agreement. The trend analysis for most stations is based on ten years of data collected from the mid-1980s to the mid-1990s (exact years differ by site). The five stations listed as deteriorating have been updated to 2000; updates are in progress for the other stations.

What is being done?

- Water quality sampling in BC focuses on rivers and lakes where problems are likely to arise because of human activities. Many water bodies have had little or no monitoring. Therefore, CWQI ratings and trends monitoring do not reflect the overall quality of BC's thousands of lakes and rivers.
- The CWQI warns of water quality problems and helps focus remediation efforts where they are needed. The Province sets water quality objectives to protect specific water bodies and water uses such as aquatic life, drinking, irrigation, livestock and recreation. Revisions or new objectives may be made as land use activities change.
- The Province has an Action Plan for Safe Drinking Water to protect British Columbians' water from source to tap. Source water protection includes assessing threats, setting water quality guidelines, monitoring water quality and carrying out compliance activities.
- Data collection and analysis continue through the Canada-BC Water Quality Monitoring Agreement.

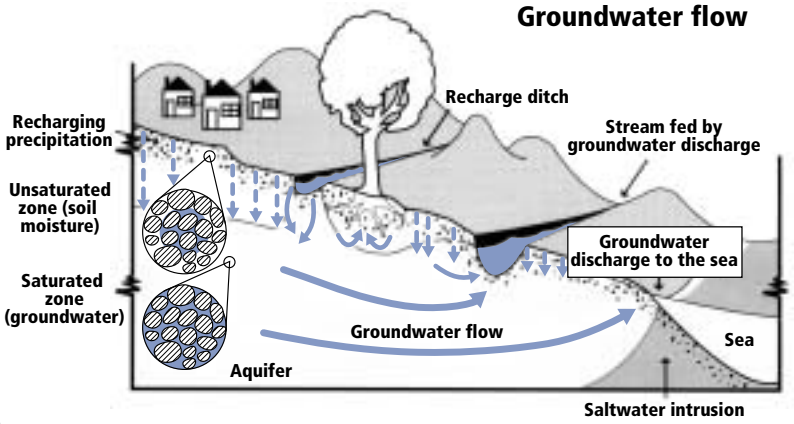
GROUNDWATER

Groundwater feeds into lakes and streams from aquifers below the earth's surface. Twenty-nine percent of BC's groundwater aquifers are considered highly vulnerable to contamination. Only 14% of observation wells have declining water levels, down from 24% a decade ago.

Groundwater and its importance

- Water exists nearly everywhere beneath the ground, filling spaces between rocks and sediments (*see diagram*). Aquifers are underground geologic formations with enough water moving through them to provide wells with a fairly reliable water supply. Precipitation seeping into the earth replenishes groundwater.
- Groundwater feeds many lakes and streams, some of which rely entirely on groundwater for their base flow levels. Groundwater also affects the temperature and water quality of lakes and streams.
- Most of BC's groundwater supply comes from within 100 metres of the ground surface. More than 600 aquifers provide water for industries, municipalities and rural homeowners in BC. An estimated 750,000 British Columbians drink groundwater. Drilling and withdrawal of groundwater is not currently regulated in the province.
- Groundwater contamination from human activities can occur when fertilizers or septic discharges leach into aquifers. Other contributors to groundwater contamination include poorly sited landfills, leaking underground storage tanks, spills of hazardous materials, acid-mine drainage and improperly abandoned wells. Contaminated groundwater can pollute surface waters – often far from the site of initial contamination – and affect organisms living in or drinking the water.
- Groundwater levels decline – also called a dropping water table – when water removal is greater than the natural recharge of aquifers. Aquifer depletion can lead to wells that go dry, deteriorating water quality and stream flows that drop below levels required by fish for migration and spawning.

Groundwater flow



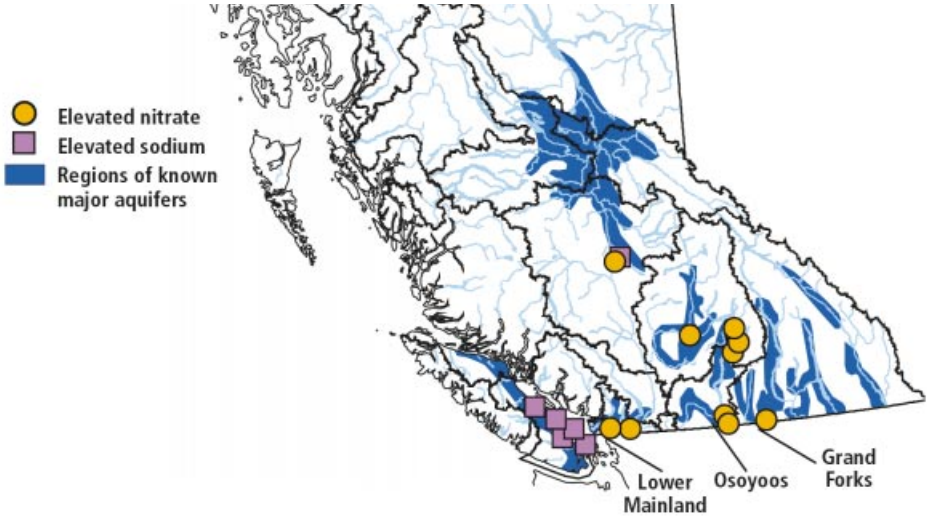
SOURCE: Environment Canada, "Water – Nature's Hidden Treasure," Freshwater Series A-5. Freshwater Website (www.ec.gc.ca/water). Reproduced with the permission of the Minister of Public Works and Government Services, 2003.

Status of groundwater quality

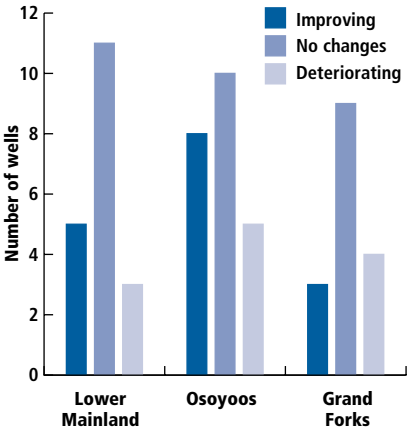
- Overall, groundwater quality in BC is considered to be good. Wells in some rural communities have elevated levels of nitrate-nitrogen and sodium (*see map*). Elevated nitrate in groundwater often indicates the effects of human activities. In coastal areas, saltwater intrusion into aquifers can occur with declining groundwater levels.
- Monitoring of nitrate levels in groundwater was done for three locations during the 1990s (*see chart beside map*). In the Lower Mainland, Osoyoos and Grand Forks 84%, 78% and 85% of wells had improving water quality or had no changes in water quality based on nitrate levels.
- While the majority of BC's aquifers are considered safe from contamination at this time, 29% are considered particularly vulnerable to contamination from human activities.

Location of rural areas where groundwater contains elevated levels of nitrate and sodium

SOURCE: Ministry of Water, Land and Air Protection, Water, Air and Climate Change Branch, 2003.



Groundwater quality trends in nitrate, 1992 to 1998

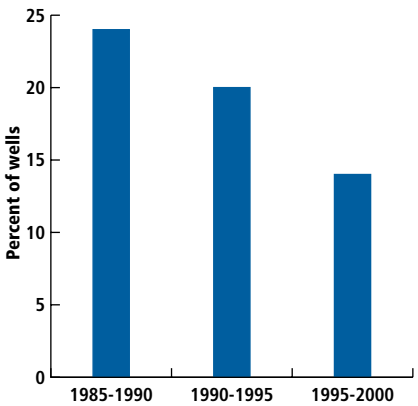


SOURCE: *Water Quality Trends in Selected British Columbia Waterbodies*, 2000, Ministry of Water, Land and Air Protection and Environment Canada.

Status of groundwater quantity

- Since 1985, the percentage of observation wells in BC with declining water levels due primarily to human activities has gone down from 24 to 14% (*see chart below*). This decrease is believed to reflect changes in demand for groundwater and changes in well locations.
- All the wells with declining water levels in 1995-2000 are in the Okanagan, Lower Mainland, southeast Vancouver Island and Gulf Islands. These are areas with high population growth (*see page 34*) where a greater number of wells being drilled may lead to interference between wells. For example, a deep well located near shallower wells can interfere by drawing down the water table and causing water levels to decline in the shallower wells.

Observation wells with declining water levels due primarily to human activities



SOURCE: Ministry of Water, Land and Air Protection, Water, Air and Climate Change Branch, 2001.

NOTES: The total number of observation wells with data suitable for this analysis increased in each 5-year time period shown. There were 108 wells included for 1985-1990, 125 for 1990-1995 and 139 for 1995-2000.

What is being done?

- The Province currently has a network of 163 observation wells in BC to monitor groundwater levels in developed aquifers. Mapping and classification of aquifers also continues to add to this inventory.
- Monitoring of groundwater quality is being expanded to include 12 additional aquifers in BC.
- The Province of British Columbia is currently developing regulations to better protect groundwater quality.
- The BC Community Aquifer Awareness Program has helped 49 communities put up "groundwater protection zone" signs for important drinking water aquifers.
- Over 20 million litres of used oil and millions of used oil filters and contaminants that used to end up in landfills or storm drains will now be recycled as a result of a new end-of-life stewardship program.

RIVER FLOW

The volume and timing of river flow affect animals, ecosystems and human uses of water. South Coast and Interior rivers in British Columbia are particularly vulnerable to low flow conditions in late summer.

River flow and its importance

- The hundreds of thousands of streams in British Columbia account for one quarter of the fresh flowing water in Canada. A few of the major BC rivers – the Fraser, Columbia, Stikine, Peace, Liard and Skeena – account for most of the recorded flow (*see map*).
- The different climates in BC dictate when and how much water falls as precipitation, runs over land, seeps into groundwater and feeds rivers and streams. Flow volume and timing vary around the province and from season to season.
- Variability of flow is important for healthy river ecosystems. Periods of very high flow, or floods, help maintain connections between a river and its riparian (riverside) habitat. Floods also help form and shape river channels. Extreme floods may alter the stability of a river system.
- Groundwater is closely tied to base flows in streams, especially small streams (*see page 12*). If groundwater levels decline, a stream can dry up at times of the year with low precipitation.

Stream flowing through Kakwa Park, Upper Fraser watershed.

PHOTO: Gail Ross, Ministry of Water, Land and Air Protection.

- The volume and timing of seasonal flow affects the quality of river water. For example, a river with less volume has a lower capacity to absorb and dilute what enters it.
- Animals that live in rivers are affected by river flow volume and timing. If water volume is too high at the time when salmon migrate upstream to spawn, the fish may become exhausted and die before spawning. With too little water, they may be unable to migrate at all.
- British Columbians rely on the province's rivers for drinking water, hydroelectricity, irrigation, industries such as fishing, mining and pulp mills, transportation and recreation. All of these activities depend on adequate amounts of water being available at the right time.

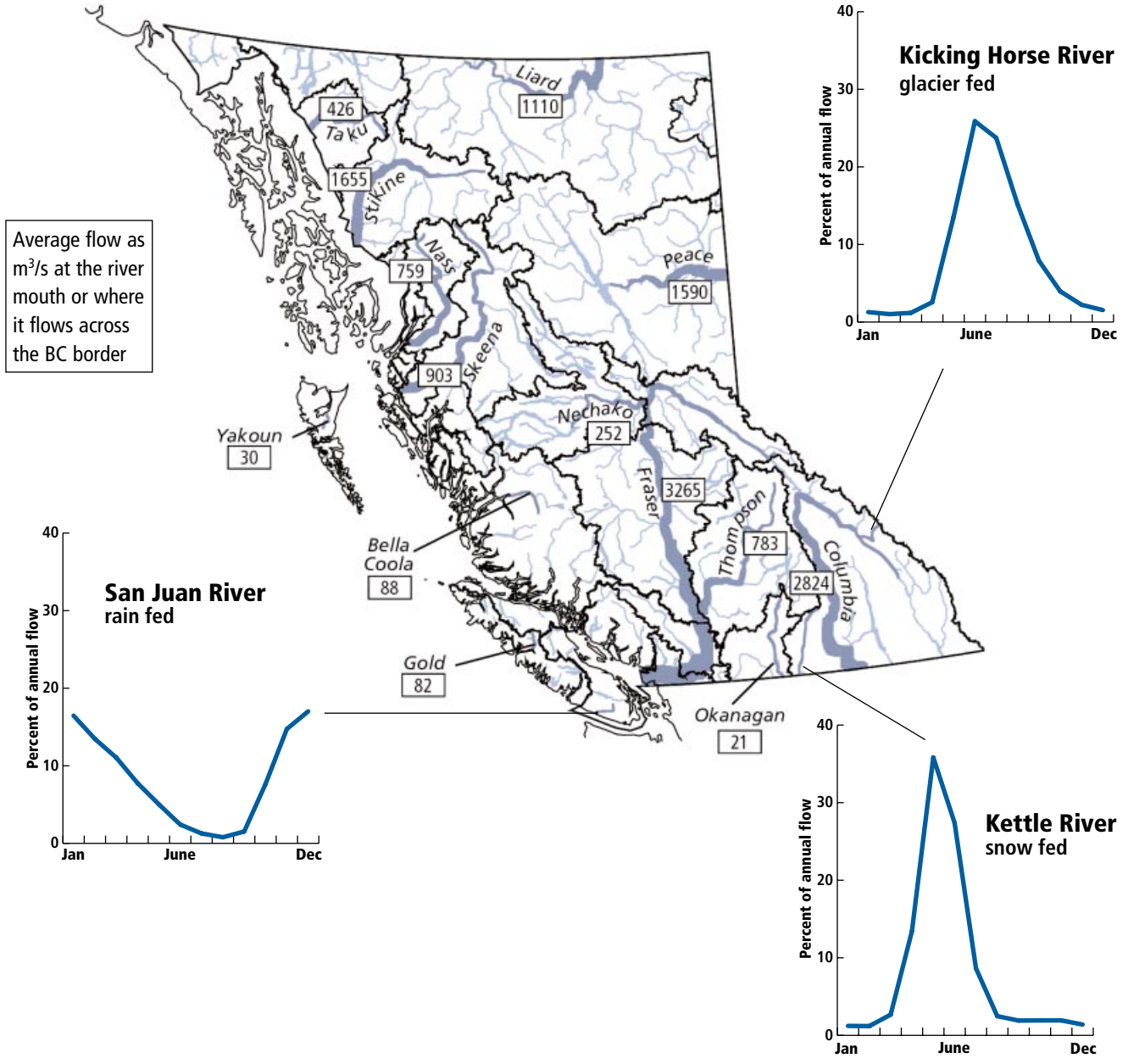
Timing of river flow

- Both year-to-year seasonal fluctuations and longer-term climate trends affect annual river flow regimes (hydrographs) by altering the amount and timing of rainfall, snowfall, snow melt and glacial melt in different areas. Changes in the timing of river flow affect both ecosystems and human water uses.
- Coastal watersheds tend to receive lots of rain all winter and therefore most of the annual flow in these rivers occurs in winter. Little rainfall in summer means low flow (*see San Juan River hydrograph on map*).
- Southern and Northern Interior rivers have low winter flow and a spike – called the freshet – in spring or early summer when snow melts. Two thirds of a river's annual flow can occur in just two months and by mid- to late summer, flow is low again (*see Kettle River hydrograph on map*).
- Rivers fed by glaciers also have low winter flow and a sustained peak in summer as glaciers slowly melt (*see Kicking Horse River hydrograph on map*).

Average annual river flow measured as cubic metres per second (m^3/s), 1970-2000

SOURCE: Environment Canada, Water Survey Branch, 2000; Ministry of Water, Land and Air Protection, 2003.

NOTES: Data from 1970s to 2000, except Taku and Stikine from 1980s and Peace from 1992.



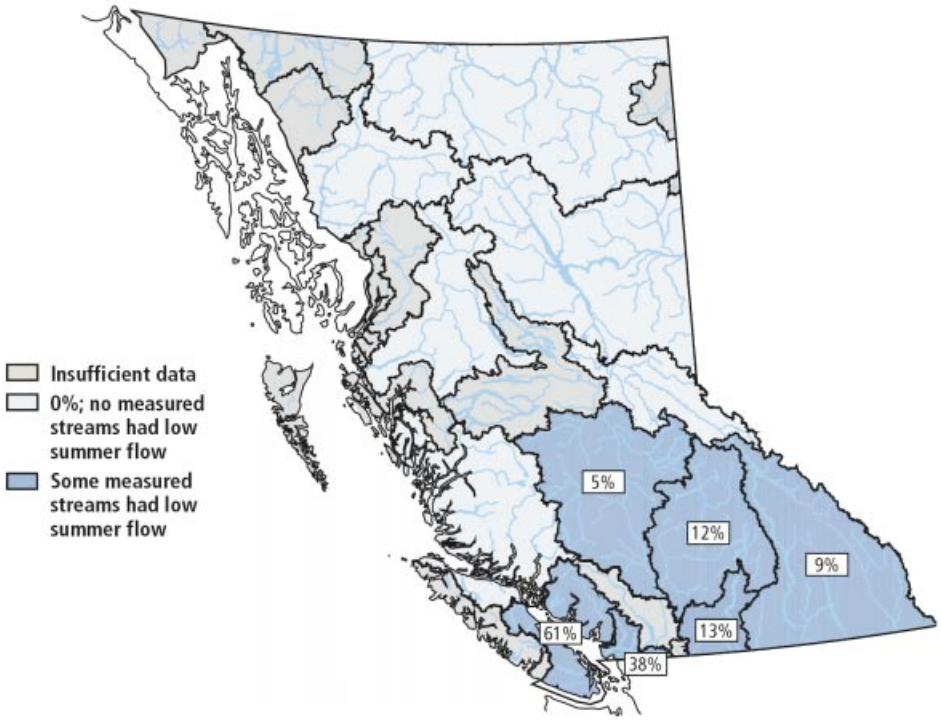
RIVER FLOW continues on page 16

WATER QUALITY AND QUANTITY

Percentage of measured streams in each watershed with naturally low flow in summer

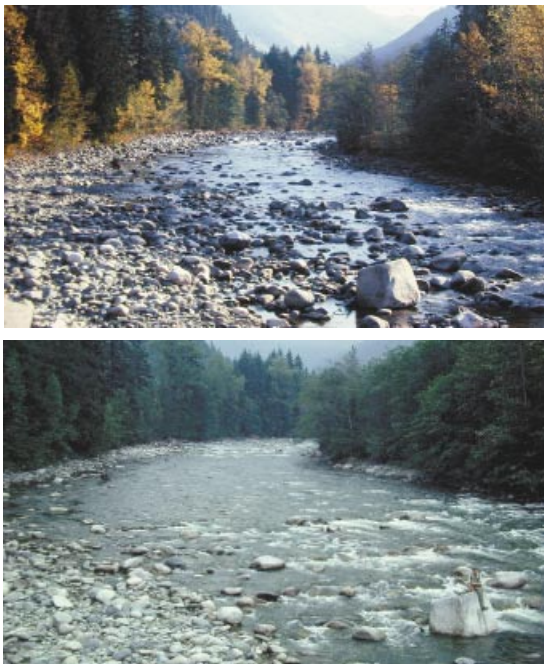
SOURCE: Environment Canada, Water Survey Branch, 2000; Ministry of Water, Land and Air Protection, 2003.

NOTES: Low flow in summer was defined here as an average monthly flow that drops below 20% of mean annual discharge (average annual flow) in at least one month during June-September. Only stations in the "British Columbia Streamflow Inventory, 1998" were included. These stations were chosen for having natural or near-natural flow.



Streams with naturally low flow in summer

- Some streams are naturally prone to low flow in summer. Parts of the province with these streams include the east coast of Vancouver Island, the Georgia Basin, the Lower Mainland and the Central and Southern Interior (*see map*). These parts of the province also have the highest population growth rates (*see page 34*) and therefore increasing demands for water.
- Of 165 east coast Vancouver Island streams examined during the summer low-flow period in the mid-1990s, 98% had very low flow (defined as less than 20% of their average annual flow).
- Particularly high water demands occur in the summer months (June-September) when we irrigate pasture, crops and gardens. The combination of naturally low flow and high water demand for human use can put local water users and stream ecosystems in conflict.
- The period from June through September is critical for fish growth, migration and spawning. At very low flow conditions, water temperature can increase and put stress on fish.



PHOTOS: Ron Ptolemy, Ministry of Water, Land and Air Protection.

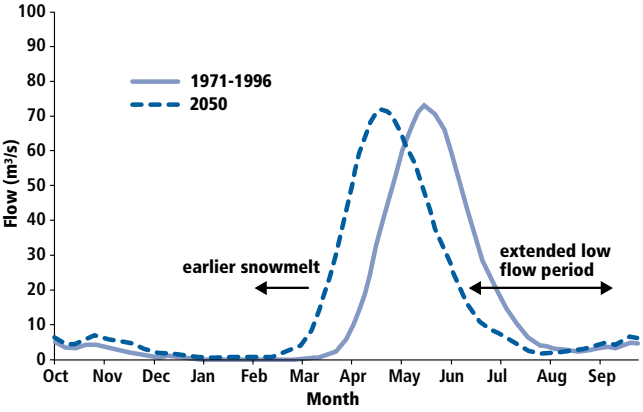
Low and moderate flow in the Coquihalla River

In the top photo the river has only 16% of its average annual flow. Many fish thrive in flow conditions above 20% during their rearing period – when juveniles grow into adults. The bottom photo shows flow conditions at 70% of average annual flow.

Climate trends

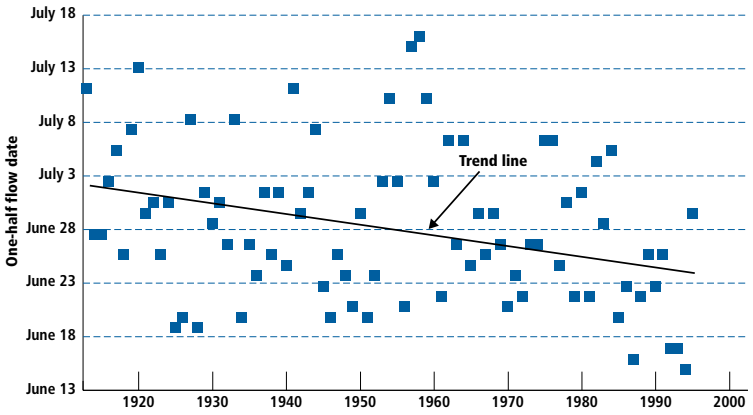
- Year-to-year variability in climate can affect the timing of river flow. In years when spring is warmer, snow and ice melt and enter river systems earlier. Peak river flow therefore occurs earlier and the period of low summer flow lasts longer. This may create shortages of water for fish, irrigation and community use in late summer.
- Historical data suggest that, on average, spring in BC is warmer now than it was a century ago and ice on lakes and rivers melts earlier.
- Recently, scientists used climate and water models to develop possible future scenarios for several snowmelt-fed Okanagan Valley streams. Their data suggest that peak spring flow will occur four to six weeks earlier within the next 50 to 80 years (*see graph below*).
- This potential shift adds to existing concerns about water availability as a result of population growth and industrial expansion.

Past and projected water flow in Whiteman Creek, which enters Okanagan Lake near Vernon



SOURCE: S. Cohen and T. Kulkarni (Editors), 2001, *Water Management and Climate Change in the Okanagan Basin.* Environment Canada and University of British Columbia.

Date by which one half of annual flow volume in the Fraser River passed Hope, 1913-1995



SOURCE: *Indicators of Climate Change for British Columbia 2002*, Ministry of Water, Land and Air Protection. NOTES: The data were analyzed for the Ministry of Water, Land and Air Protection by John Morrison, Institute of Ocean Sciences using data from the Water Survey of Canada, Environment Canada. The trend line is statistically significant, R^2=0.093, p=0.005.

Timing of Fraser River flow

- The date by which one half of the Fraser River's annual flow passes the town of Hope has been getting earlier over the time period 1913 to 1995 (*see graph, top right*). This translates into a rate of nine days earlier per century.
- Most rivers and streams that flow into the Fraser River are snowmelt fed. Trends toward higher spring temperatures and earlier spring thaw in BC are resulting in higher volumes entering these streams earlier in the year (earlier spring freshet). Analysis suggests that long-term climate change caused this trend.
- Other rivers and streams may react differently to climate change depending on their location, the source of the water that flows into them and how regulated they are by humans.

What is being done?

- The Province has a joint program with the federal Water Survey of Canada to gauge river flows at hydrometric stations around BC.
- The Province is developing in-stream flow standards to protect river ecosystems by ensuring sufficient water flow for aquatic plants and animals.
- Governments, academia, industry and other stakeholders continue to examine water resources and opportunities for adapting water management practices towards conservation where water quantity is an issue.

AQUATIC SPECIES

SPECIES AT RISK

Of British Columbia's 3,300 recorded native species of amphibians, birds, butterflies, dragonflies, fish, mammals, reptiles and vascular plants, over one quarter are listed as vulnerable, threatened or endangered. Forty percent of these live in or alongside fresh water.

Native species and their importance

- Compared to other parts of Canada, British Columbia has high biological diversity, or biodiversity. Biodiversity is the variety and number of living things, how they fit together in an ecosystem and how they and the ecosystem work. Ecosystem functions begin to break down when the number of fauna and flora diminish.
- Aquatic species spend all or part of their life cycle in water. Riparian species breed or forage in vegetation growing along the margins of streams, lakes and wetlands (the riparian zone).
- In BC, the Conservation Data Centre (CDC) assesses the conservation risk for species. The CDC ranks species and lists them as Red, Blue, Yellow or Introduced (*see box for list definitions*).

Status of species at risk

- Over one quarter of BC's 3,300 known native species are included on the Red or Blue lists. These species include amphibians, birds, butterflies, dragonflies, fish, mammals, reptiles and vascular plants. Forty percent of these Red- and Blue-listed species live in or alongside fresh water.
- Of the groups of animals recorded by the CDC, amphibians and fish have particularly high percentages of species at risk – 45% of native amphibians and 46% of native fish (*see graph on this page*).
- The CDC also lists ecosystems at risk and defines them by their vegetation, such as Black Cottonwood-Water Birch. Terrestrial ecosystems associated with water have been assessed, but aquatic ecosystems have not.

Conservation Data Centre species listings

Red list: Species that are at risk of becoming or are already Threatened, Endangered or Extirpated (no longer exists in BC but lives elsewhere).

Blue list: Species of Special Concern that are particularly sensitive to human activities or natural disturbance.

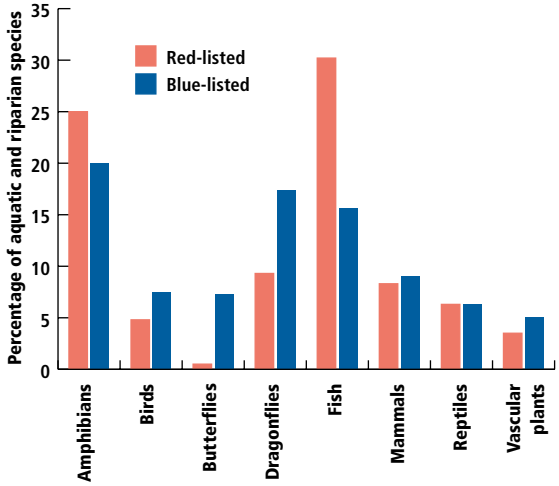
Yellow list: Species that are currently considered to be secure.

Introduced list: Species that humans took to an area not previously in the species' geographic range. Introduced species are also known as exotic, alien or non-native.

Northern Leopard Frog, Red-listed

PHOTO: Andy Bezener.

Aquatic and riparian species at risk in BC as a percentage of recorded native species that live in aquatic and riparian habitats

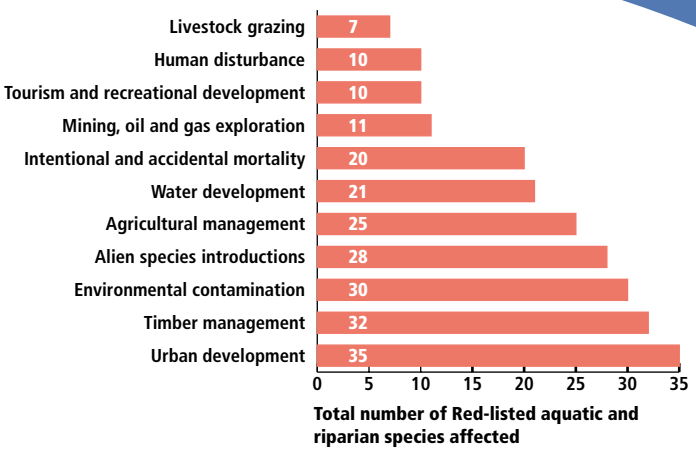


SOURCE: Conservation Data Centre, Ministry of Sustainable Resource Management, 2003.

Relative importance of threats to Red-listed aquatic and riparian species in BC

SOURCE: Ministry of Water, Land and Air Protection, 2002. Based on Conservation Data Centre species assessment records and on expert opinion.

NOTES: This analysis includes mammals, birds, amphibians, reptiles, fish, butterflies and dragonflies that use aquatic or riparian habitat for breeding or foraging. Some species are affected by more than one threat. **Environmental contamination** includes any chemical introduced to the environment that affects species at risk; **Intentional and accidental mortality** includes illegal or intentional killing, road kill, pest control, mortality of prey species and incidental take in fish nets; **Human disturbance** includes intentional or deliberate disturbance to animals; **Water development** includes the diversion of water for agriculture, livestock, residential use, industry use, dams, reservoirs and barriers to flow.



Threats to species at risk

- Urban development, timber management, environmental contamination and alien species introductions each threaten more than 25 Red-listed aquatic and riparian species in BC *(see graph on this page)*.
- Many species at risk in BC are listed by the CDC because their habitat is disappearing. Habitat loss, damage, fragmentation and conversion occur with resource exploitation and land use change.
- Environmental contamination and pollution affect some species more than others. For example, many amphibians absorb air and water through their skin and are therefore sensitive to small changes in their environment. Acid rain changes the delicate chemical balance in water. Some pollutants work their way through food webs getting more and more concentrated as they pass from prey to predator.
- Alien species introductions (*see box*), intentional and accidental mortality, livestock grazing, water diversions and climate change also contribute to species receiving at-risk status.

What is being done?

- The CDC continues to record, assess and track species at risk in BC. The data and information are publicly available so that they can be used to help make decisions.
- The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assigns national ranks to species. Last year, the federal *Species at Risk Act* was passed into legislation by the Canadian parliament and will be fully implemented by June 2004.
- Recovery plans are being developed for individual species, groups of species or whole ecosystems to detail what needs to be done to help remove species from the at-risk lists.
- The provincial *Water Protection Act* prohibits large-scale water transfers between major watersheds. This helps to prevent the spread of alien species.

Alien species introductions

- Whether introduced intentionally or accidentally, alien species often out-compete native species for food or habitat. They begin to dominate, which disrupts native species interactions and can unbalance an ecosystem, putting more native species and the whole ecosystem at risk.
- Examples of alien species in BC's aquatic and riparian ecosystems are Common Carp, Pumpkinseed Sunfish, Bullfrogs, Eurasian Water Milfoil and Purple Loosestrife.
- Fourteen alien fish species have been introduced into BC's fresh waters. At least 10 of these live in lakes.
- Eurasian Water Milfoil is an alien aquatic plant that was first found in BC lakes in 1970. Fragments are easily transferred between lakes on boats. They then spread rapidly and grow densely in near-shore water, replacing native plants. As well as affecting the ecosystem, they are a recreational and economic problem.

FRESHWATER FISH

Freshwater fish include small sculpin and dace and the better known salmon and trout. All depend on freshwater habitat. Forty-six percent of BC's native fish are provincially listed as "at risk."

Freshwater fish and their importance

- Fish are a key part of aquatic food webs. Some feed on smaller fish and others eat invertebrates, which include aquatic and terrestrial insects and zooplankton. Fish are themselves eaten by bigger fish, birds of prey and some mammals.
- Resident freshwater fish spend their entire lives in BC's lakes or streams. Many salmon spend part of their life cycle in fresh water and part in the ocean (*for more about Pacific salmon, see page 22*).
- Game fish such as salmon and trout species are fished recreationally. However, game fish represent only a fraction of the fish species that live in BC's fresh waters. Other species include the Salish Sucker, Rocky Mountain Sculpin, Giant Black Stickleback, Brassy Minnow, Nooksack Dace and Emerald Shiner.

Native fish at risk

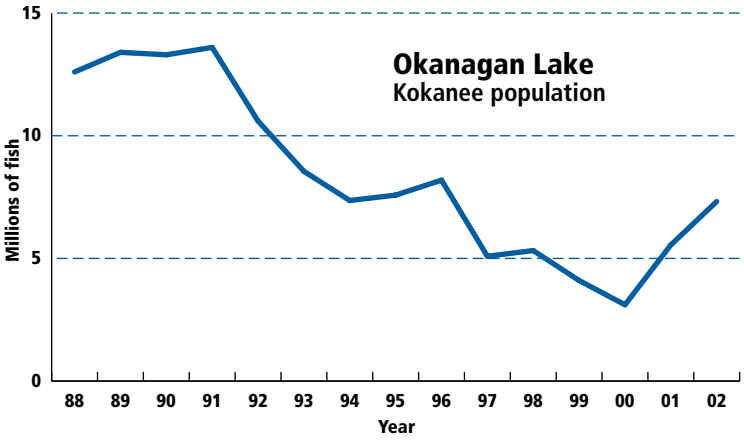
- Of BC's 96 native fish species that spend all or part of their life cycle in fresh water, 44 are considered "at risk" and are on the provincial Red or Blue lists (*see page 18*). A serious threat to many freshwater fish is the introduction of alien species such as predatory bass, pike, perch, catfish and crayfish. Habitat alteration and destruction also threaten the continued existence of many native fish at risk.
- Some of BC's rare freshwater fish exist in only a handful of locations. For example, six stickleback species have distributions limited to only one or a few lakes. Two more are already extinct as a result of introduced catfish.
- Nooksack Dace and Salish Sucker are both Red-listed in BC. They are also listed nationally as Endangered, which means they face imminent extirpation (no longer found in BC) or extinction. In BC, both species are found only in a few streams in the Fraser Valley.

An adult Salish Sucker, 20 cm long, Red-listed.
PHOTO: Mike Pearson, Pearson Ecological.

- Arctic Grayling live in much of northern Canada west of Hudson Bay. In BC, only the populations isolated in Williston Reservoir are Red-listed. The W.A.C. Bennett Dam, constructed on the Peace River in 1968, changed the large flowing river preferred by Arctic Grayling into a reservoir.
- Despite their occurrence in many rivers around the province, Bull Trout are Blue-listed. They are particularly vulnerable to habitat changes. Bull Trout favour rivers with cold water, deep pools, log jams and overhanging streambank vegetation. For spawning, they like clean gravel with groundwater seeping through.

Kokanee Salmon

- Kokanee are Sockeye Salmon that don't migrate to sea. Kokanee live in many of BC's lakes and spawn either along the lakeshore or in inflowing streams.
- The species as a whole is not Red- or Blue-listed. However, certain populations – such as those in Okanagan Lake – have recently experienced declines. Fifteen years ago, Okanagan Lake boasted a population of about 13 million Kokanee (*see graph, top right*). By 2000, their numbers had dropped to 3.1 million. The most recent estimates of 7.3 million fish in 2002 are encouraging.



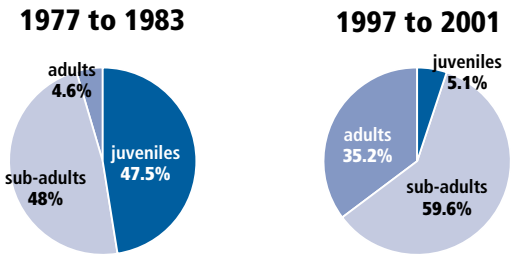
SOURCE: Okanagan Lake Action Plan, Ministry of Water, Land and Air Protection, 2003.

- Both lake and stream habitat have problems in the Okanagan. The Opossum Shrimp (*Mysis relicta*) was introduced into Okanagan Lake and other large BC lakes in the 1960s. The shrimp competes with young Kokanee for food. Land use changes have reduced the amount of good quality spawning habitat both in streams and along the lakeshore.

White Sturgeon

- White Sturgeon can live for over 100 years and most grow to between two and three metres long. A few individuals historically reached more than six metres. They live and spawn only in the Fraser, Columbia and Sacramento river systems. Five separate populations exist in BC: the Nechako, Upper and Lower Fraser, Columbia and Kootenay. All are Red-listed.
- Healthy White Sturgeon populations are made up mostly of young fish (juveniles and sub-adults) and few adults. This indicates successful spawning and rearing. The Lower Fraser population with more than 80% young fish is considered reasonably healthy. The Nechako population with only 20% young fish is critically endangered.
- Between 1977 and 1983, 95% of all captured and measured fish from the Kootenay White Sturgeon population were young. Two decades later, from 1997-2001, 65% were young (*see pie charts*). This indicates poor spawning success or poor survival from hatching to juvenile and sub-adult stages.
- The greatest threat to White Sturgeon is habitat change, especially from dams and altered river flow. Until recently, overfishing was a significant threat but White Sturgeon can no longer be kept.

Change in age structure of the Kootenay River White Sturgeon population



SOURCE: Idaho Department of Fish and Game.

NOTES: White Sturgeon were placed into age categories based on their length, with juveniles <1.0 metres long, sub-adults 1.0-1.5 metres and adults >1.5 metres.

What is being done?

- The provincial *Fish Protection Act* focuses on ensuring sufficient water for fish and protecting and restoring fish and riparian habitat.
- Habitat restoration for fish and other aquatic species is ongoing in BC. The Province, First Nations, non-government organizations and stewardship groups carry out this work.
- Recovery plans are being developed for the Nechako and Columbia White Sturgeon populations. A Recovery Team that includes BC and the USA is working with the Kootenay population.
- The Okanagan Lake Action Plan began in 1996 and targets both Kokanee spawning habitat and growth conditions in the lake, including reducing the number of shrimp. Lake restoration with nutrient additions is underway on Kootenay Lake, which has similar problems (*see page 33*).

PACIFIC SALMON

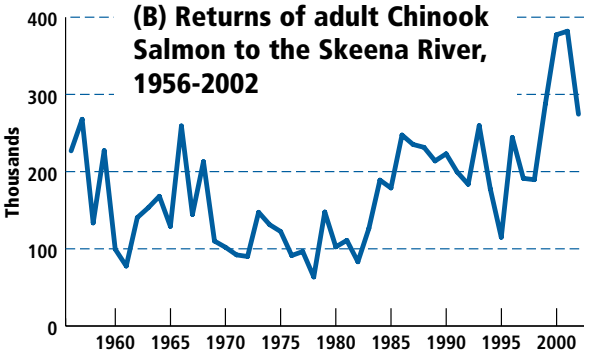
British Columbia is home to six species of Pacific salmon: Coho, Chinook, Chum, Pink, Sockeye and Steelhead. Over 9,000 distinct spawning populations of these species exist in BC.

Pacific salmon and their importance

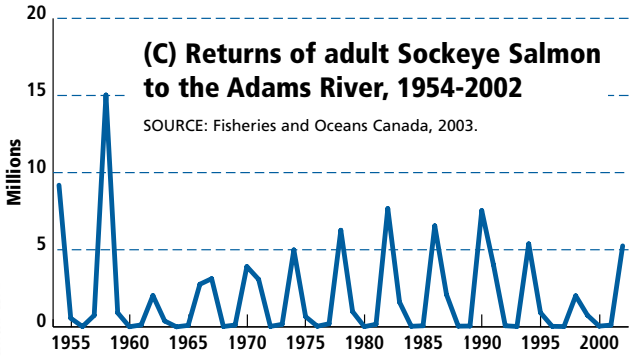
- Pacific salmon include eight species, six of which are found in BC. These are Coho, Chinook, Chum, Pink, Sockeye and Steelhead. Despite their name, Steelhead Trout (and also Rainbow and Cutthroat) belong to the salmon family.
- Salmon have a dual existence: they hatch in fresh water, migrate to the ocean anywhere from a few days to a year later depending on the species, grow to maturity in the ocean and return to their birth stream to spawn. The length of time spent in the ocean varies among species, from less than two years for Pinks to four or more years for Chinook.
- Pacific salmon are key ecological species because after spawning, they die. The only exception is Steelhead, which can live, return to the ocean and spawn again in subsequent years. The bodies of adult salmon are full of ocean nutrients. After they die, these nutrients feed an amazing array of animals and plants both in the stream and on the surrounding land. Terrestrial animals known to feed on salmon carcasses include bears, coyotes, eagles, foxes, jays, mice, mink, shrew, squirrels, weasels and wrens, to name a few.
- Migrating adult salmon return to more than small coastal streams to spawn. Many swim for hundreds of kilometres upstream (*see map*) and therefore they distribute ocean nutrients to many different Interior ecosystems.

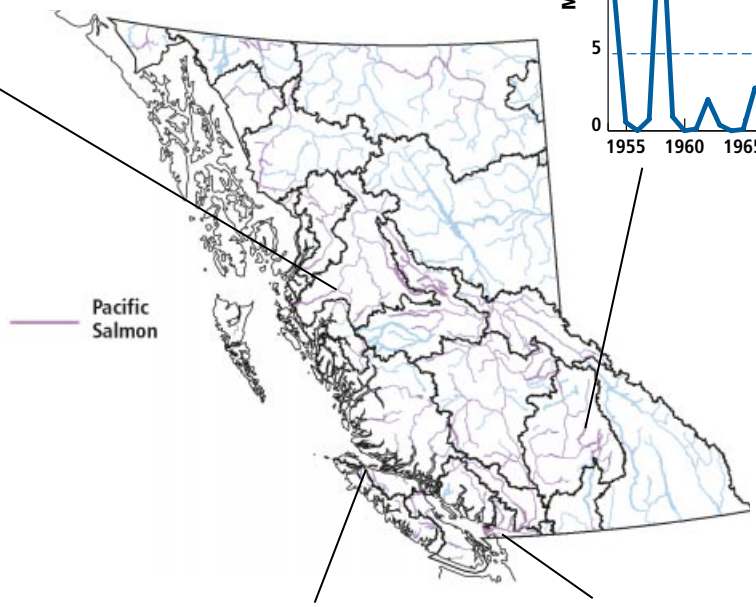
Status and trends for Pacific salmon

- Assessing the status of Pacific salmon in BC rivers is difficult with thousands of spawning populations. Scientists monitor certain populations as examples of changes over time and identify key populations that are conservation concerns. Examples of monitoring programs are given here.
- Because salmon live in both fresh water and the ocean, they are vulnerable to environmental changes and human interference in either habitat. Of all the juvenile salmon that go to the ocean (smolts), only a small percentage survive and return as adults to fresh water. For example, during the past 40 years an average of only 4.3% of Sockeye Salmon smolts returned as adults to Babine Lake (Skeena watershed).
- Poor ocean survival is thought to be the reason why particularly low numbers of Steelhead Trout adults have been returning to spawn in the Keogh River, Vancouver Island since the early 1990s (*see graph A*).
- Adult returns of salmon to the Skeena River have been measured every year since 1956 using the same fishing methods. Fewer Chinook Salmon returned to the river in the 1970s than in earlier years (*see graph B*). The increase in the 1980s reflects the benefits of the 1985 USA-Canada Pacific Salmon Treaty. This reduced ocean exploitation with the result of higher adult returns.
- Every year a run of Sockeye Salmon returns to spawn in the Adams River. Every four years, the run is very large (*see graph C*). The long series of data helps monitor changes in the cycle but does not answer why this consistent pattern exists. The cyclical dominance of most Fraser River Sockeye Salmon remains a biological mystery.
- Sockeye Salmon that return to Cultus Lake in the Fraser Valley are in danger. Since the early 1990s the number of adults returning to spawn each year has been consistently low at less than 100,000 salmon (*see graph D*). In spring 2003, this stock of Sockeye Salmon was listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered. They face imminent extinction unless actions are taken to restore production and protect the adults returning to Cultus Lake.



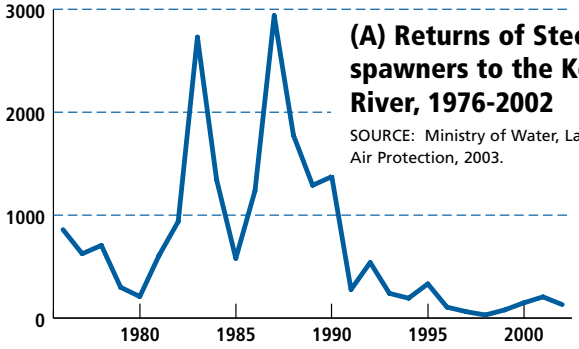
SOURCE: Fisheries and Oceans Canada, 2003.
NOTES: The index is based on how many fish were caught in a one-hour period on each day of measurements. The index is a sum of values obtained for each day.

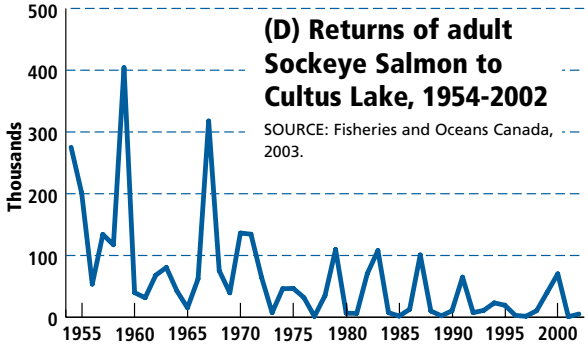




The known distribution of Pacific salmon in BC

SOURCE: Ministry of Water, Land and Air Protection, 2003; Ministry of Sustainable Resource Management, 2003.





What is being done?

- The Pacific Salmon Treaty was signed in 1985, and renewed in 1999, between the governments of Canada and the USA to conserve and manage Pacific salmon.
- The Pacific Salmon Foundation is involved in salmon recovery planning with a current focus on watersheds in the Thompson, Georgia Basin and Central Coast. A recovery plan has been developed in conjunction with the Province for the Greater Georgia Basin Steelhead.
- The Pacific Fisheries Resource Conservation Council provides information and advice to governments and the public about Pacific salmon stocks and their conservation.
- Many volunteers and environmental groups are involved in work to protect habitats and conserve Pacific salmon.

IN-STREAM HABITAT

Three key parts of in-stream habitat are deep pools, smooth glides and choppy riffles. A survey of 14 Vancouver Island streams showed that more than 40% lacked critical habitat features.

In-stream habitat and its importance

- Streams naturally vary in depth, shape and structure all along their length, from headwater to mouth. The three main types of habitat are pools, glides and riffles. In an undisturbed river the pool-glide-riffle sequence repeats at fairly regular intervals along its length.
- Pools are often created by fallen streamside vegetation, log jams and boulders that cause water to scour a depression in the river bed. The slow-moving water of pools is critical summer habitat for growing juvenile fish and for adults. Pools also provide refuge in winter. Leaves, twigs and other materials accumulate in pools and provide an important food source for insect larvae that ultimately serve as prey for fish.
- Glides are stretches of river where water flows without a broken surface. They are transitions between pools and riffles.

Riffles – stretches of choppy water – are important for spawning and fish-food production.

PHOTO: Andrew Wilson, Ministry of Water, Land and Air Protection.

- Riffles occur where swiftly moving water flows over shallow rocks or debris, breaking the surface. Riffles provide important spawning habitat and are also food factories for fish. Many fish feed on the aquatic insects that thrive in riffles.
- Side channels of slow-moving water at the edges of rivers and streams provide fish, particularly juveniles, with important habitat for growth and shelter from predators. Fish also use side channels as winter habitat and refuge during periods of very high flow or floods.

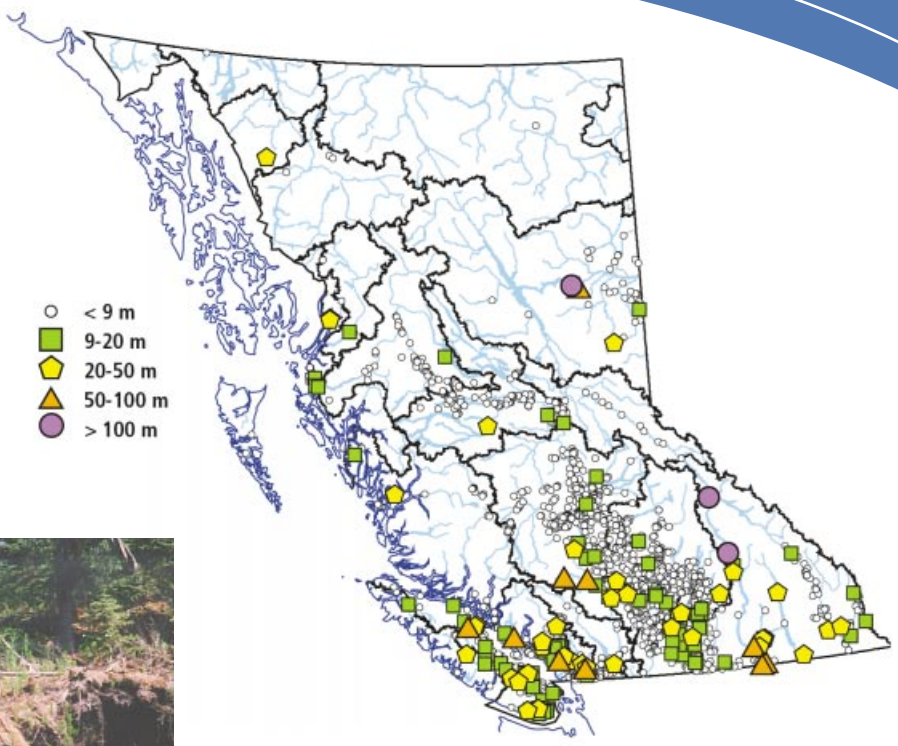
Lost habitat

- A mid-1990s survey of habitat in 14 urban and rural east Vancouver Island streams found that 13 lacked large pieces of wood such as logs, seven had insufficient cover for growth and shelter and six had too few pools. Eight of nine streams had too much sediment, which can fill pools and clog gravel. Elsewhere in the province, streams have suffered similar habitat loss to that surveyed on Vancouver Island.
- Land use – urban development, agriculture, mining and forestry – all contribute to this type of habitat loss in streams. For example, past forest harvesting practices in BC included logging to the stream banks of both large and small streams. Current practice prohibits logging to the banks of fish-bearing streams greater than 1.5 metres wide. However, many streams and rivers were logged to the stream banks prior to the 1990s, leaving a legacy of poor habitat.
- Clearing vegetation from stream banks removes in-stream cover as well as the next crop of trees that can fall into the water and help create new habitat. In-stream habitat may continue to degrade for

The location and height of the nearly 2,200 registered dams in BC

SOURCE: Land and Water BC, Inc., 2003.

NOTES:The dams shown on this map are registered with Land and Water BC, Inc. Illegal dams and small structures not classified as dams exist but there are no estimates of numbers.



Mature trees along this river's banks were cut. Without tree roots to hold the bank in place, high water flow undercuts it and sweeps sediments into the river. Eventually chunks of the bank fall into the water.

PHOTO: Andrew Wilson, Ministry of Water, Land and Air Protection.

decades and sometimes centuries as older logs rot or are carried downstream without being replaced. Loss of streamside vegetation also increases soil erosion because roots no longer hold the soils in place.

Dams on streams

- BC has about 2,200 registered dams, ranging from small, private irrigation dams to structures tens of metres high that create large reservoirs and help generate power. About 90% of BC's dams are less than 9 metres high. Nearly 150 dams are higher than 9 metres; the highest is the 243-metre Mica Dam that created the Kinbasket Reservoir in the Columbia watershed. The majority of BC's dams are in the Central and South Interior and along the South Coast (*see map*).
- Dams are built for numerous purposes, but mainly for water supply, flood control, erosion control and hydroelectricity. The River Recovery Project estimates that up to 10% of BC's 2,200 dams are obsolete or have only marginal benefits.
- Dams divert and hold back water, thereby changing the variability of flow that helps maintain in-stream habitat and adjacent floodplains. Storing water in reservoirs reduces the amount of flowing water and therefore the amount of habitat available to aquatic species. This is particularly evident in small streams in dry Interior regions where there are already water shortages in late summer when flow is typically low.
- Dams tend to trap sediments, decreasing the amount of channel-forming sediment carried by rivers. Dams can also hold nutrients back, reducing the productivity of downstream sections of river or downstream lakes.

IN-STREAM HABITAT continues on page 26

AQUATIC HABITAT

The W. A. C. Bennett Dam and G. M. Shrum Generating Station, located on the Peace River near Hudson's Hope, create Williston Reservoir. The station's 10 generating units produce 2,730 megawatts of electricity. Together, the G. M. Shrum and Peace Canyon generating stations produce 29% of BC Hydro's electricity requirements.

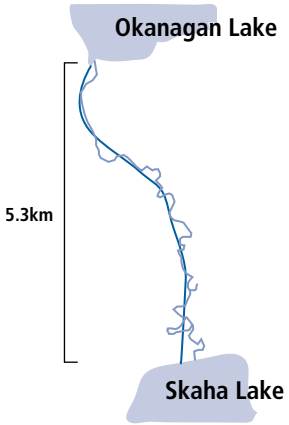
PHOTO: BC Hydro.

Channelizing streams

~ Channelizing, or straightening and confining a river channel, robs a river of its natural habitat, removing meanders, side channels, pools and riffles. Much of Okanagan River on the BC side of the Canada-USA border has been channelized – only 7% of the natural river remains. Many of the river's side channels are no longer connected to the main stem, which is now a series of straight sections (*see diagram below and photos on page 28*).

The Okanagan River channel between Okanagan and Skaha lakes is a series of straight sections and no longer includes any of the meanders that were once part of this river.

SOURCE: Ministry of Water, Land and Air Protection, 2003.



~ Channelization is often accompanied by the building of dykes – big banks along the edges of rivers – for flood control. By isolating the river channel from its floodplain and reducing the overall length of the river, channelization and dyking decrease the capacity of the system to store water and this can increase the severity of extreme floods.

Trout Creek in the Okanagan has been turned into a straight channel with no variation in habitat.

PHOTO: Ron Ptolemy, Ministry of Water, Land and Air Protection.

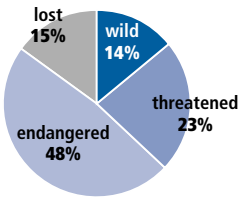
The Fraser Valley's lost streams

- In some areas, in-stream habitat is not only degraded but disappears altogether. For example, a survey was done in 1997 to evaluate the condition of streams in the lower Fraser Valley. Of 779 streams, 15% were lost, meaning that they had been paved over, drained or filled in so that they no longer existed as surface streams. Fourteen percent were wild and the rest, 71%, were endangered or threatened (*see pie chart*).
- The criteria used to classify the endangered and threatened streams included loss of riparian vegetation, straightening or dyking of the channel, diversion of water from the stream and water quality. All of these affect the quality of in-stream habitat.

Existing and lost streams in the Lower Fraser Valley, 1997

SOURCE: Fraser River Action Plan, Fisheries and Oceans Canada, 1998.

NOTES: The study included streams from Hope to the Strait of Georgia and from the US border to the North Shore Mountains.



What is being done?

- Throughout BC, stewardship groups have been actively involved in watershed restoration projects. A challenge for the future will be ensuring adequate resources for this type of work.
- A new Living Rivers Trust Fund has been established by the BC government as a catalyst to attract funding from a variety of sources.
- The Province is currently developing a new Streamside Protection Regulation under the *Fish Protection Act* to protect riparian lands in settled areas of the province.
- Several dam decommissioning projects are in progress or being planned, including dams on the Theodosia (near Powell River), Whiskey Creek (Vancouver Island), Kitsault (near Alice Arm, northeast of Prince Rupert) and Coursier (near Revelstoke). Dam decommissioning of abandoned or obsolete dams helps restore natural flows and ecological function to the affected rivers.
- More examples of efforts to restore in-stream habitat are described on pages 42 and 43.

Culverts that are too small for a stream restrict the channel, causing water to move very fast – often too fast for fish to swim upstream along the culvert's length. In other situations, as in this photo of a creek in the Nechako watershed, culverts end up above the downstream water surface. For fish unable to make the leap, upstream habitat is cut off.

PHOTO: Andrew Wilson, Ministry of Water, Land and Air Protection.

RIPARIAN HABITAT

Riparian areas border fresh water and are important habitat for many animals and plants. Although only 1% of the land in BC is considered to be riparian habitat, 40% of species at risk use these areas.

Riparian habitat and its importance

- Riparian habitat borders rivers, streams, lakes, ponds and wetlands and can range from a few to hundreds of metres wide. They are important corridors through forests and also function as connections between lowland areas and higher elevations.
- Riparian areas contain distinctive vegetation, which is essential to the adjacent water body. Riparian vegetation provides shade that keeps water cool, fallen branches and logs that help create new habitat, and fallen twigs, leaves, needles and insects that are important nutrient sources for the stream and food for fish and insects.
- Roots and vegetation stabilize the bank or shore, reducing erosion and sedimentation. Riparian plants also filter nutrients and chemicals from runoff water.
- Numerous wildlife species use riparian areas extensively for shelter, refuge, breeding or food. These include Long-toed Salamanders, Pacific Tree Frogs, Hooded Mergansers, Moose and the Little Brown Myotis – a bat.

A section of the Okanagan River channel where it drains into Skaha Lake in 1949 (left) and 1982 (right) showing the straightening of the channel and loss of riparian habitat.

PHOTOS: Left: BC 800:31, Right: BC 82024:204.

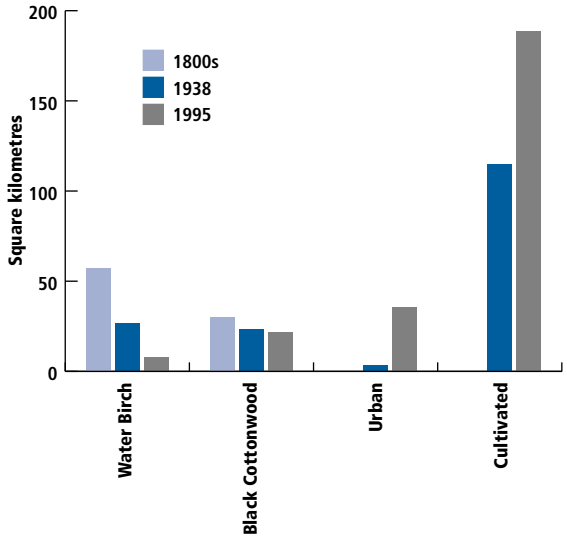
- Many plants prefer to grow in riparian areas because of the moisture. Examples are Water Birch, Meadow Willow, River Bulrush and Smooth Willowherb.

Status of riparian habitat

- Riparian habitat only covers an estimated 1% of the land in BC. However, 40% of BC's Red- and Blue-listed species at risk depend upon riparian habitat at some point during their life cycle (*see Species at risk, page 18*).
- Historical air photos of the Okanagan River valley show that riparian habitats have suffered. From the 1880s to 1995, Black Cottonwood habitat decreased by 27% and Water Birch habitat by 86% (*see graph*).

Riparian habitat and land use in the Okanagan River valley, 1800s-1995

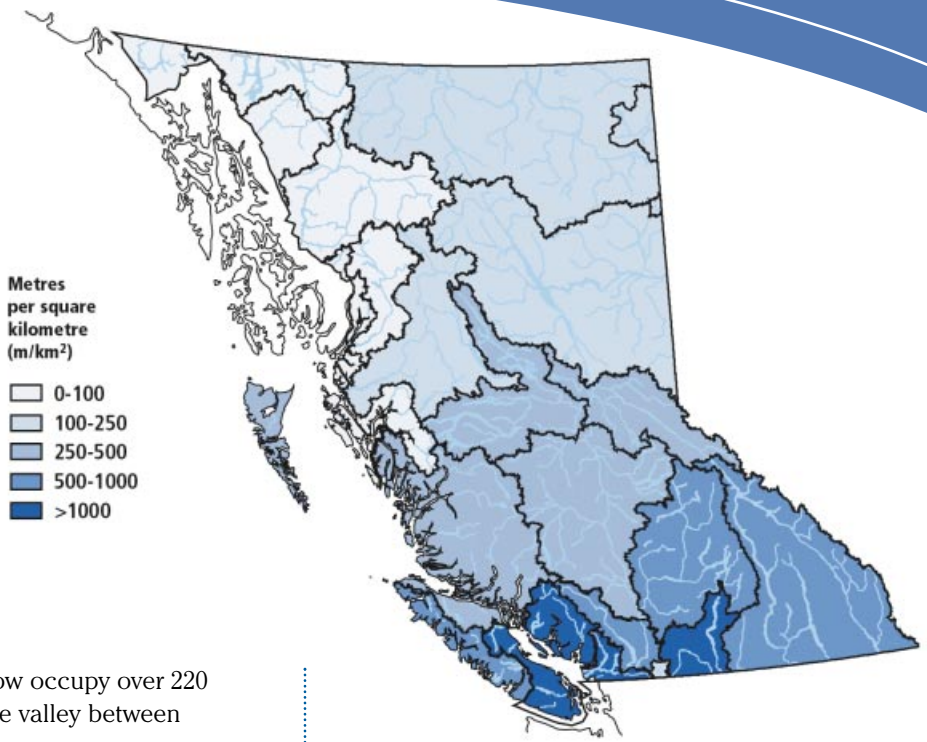
SOURCE: Ministry of Water, Land and Air Protection, 2003. NOTES: The land area used for this analysis was 1,770 square kilometres extending from Kelowna to the USA border.



The density of roads built by the mid-1980s

SOURCE: Decision Support Services, Ministry of Sustainable Resource Management, 2003.

NOTES: The data are from air photos taken over the period 1981-1988. Updates from 1996-1999 air photos have been made to about 40% of the province, but have not been included here. Both paved and unpaved roads are included in this analysis; however, seismic lines are not included.



Urban and cultivated areas now occupy over 220 square kilometres (12%) of the valley between Kelowna and the US border.

- Being next to water and often at lower elevations, riparian areas are particularly vulnerable to disturbance from land uses such as road building, damming, logging, mining, agriculture, industrialization, urbanization and recreation.
- Land use practices that took place decades ago are still affecting rivers and their shoreline vegetation. Once the disturbance is removed, rivers still take decades, and sometimes centuries, to recover.

Road density

- Road density – the length of roads in every square kilometre of land – indicates some of the extent of human disturbance to riparian habitat. Roads are often built in valley bottoms, also the location of many riparian areas. Roads fragment and degrade habitat and increase animal mortality through roadkill. They alter water flow patterns over land and increase the amount of sediment that enters streams. Roads also provide easier access to riparian and aquatic ecosystems for anglers, hunters, poachers and alien species introductions.
- The Georgia Basin, Lower Mainland and Okanagan watersheds have the highest density of roads with over 1000 metres of roads per square kilometre (*see map*). Note that this data is current to the mid-1980s. From then to the mid-1990s updates to the data have been made for 40% of the province, mainly in parts of the Liard, Peace, Upper, Mid- and Lower Fraser and Okanagan watersheds. In the updated portion, there was a 45% increase in total road length.
- Research shows negative effects on Bull Trout, among other aquatic species, at road densities above 100 metres per square kilometre. This is likely because fragmented riparian areas affect streamside vegetation and in-stream habitat, as well as provide easier stream access for anglers.

What is being done?

- Regulations under the *Forest and Range Practices Act* will contain standards for several key values, including riparian habitat. They will strive to protect riparian areas during forest harvesting, planting, road building and range operations.
- Federal and provincial agencies are working together through an agriculture-environment partnership to develop programs for BC farms and ranches to lessen their impacts on ecosystems, including riparian areas.
- The Province and other organizations are working to protect the remaining Okanagan River riparian habitat and restore additional sites.
- Regular road maintenance, road deactivation and access restriction can reduce some of the negative impacts of roads on riparian and stream habitats.

WETLANDS

Wetlands are nature's sponges – they absorb water fast and release it slowly. In the Okanagan and Fraser valleys, 85 to 90% of wetlands have been drained, filled in or otherwise destroyed.

Wetlands and their importance

- Wetlands have soils with more moisture than the surrounding land and plants adapted to growing in these wet soils. Wetlands include shallow open water, marshes, swamps, fens and peatbogs. Within these wetland types, many variations exist depending on differences in water and soil minerals, nutrients and acidity.
- Ephemeral ponds, which dry up completely for portions of the year, are wetlands whose importance for aquatic species is often overlooked. For example, the Blue-listed Great Basin Spadefoot, an amphibian, typically breeds in ephemeral ponds.
- Like riparian areas, wetlands are very productive and contain high biodiversity. They are essential habitat for many species. Most migratory birds depend heavily on wetlands along their migration routes.
- Wetlands provide numerous ecosystem services, including absorbing floods, slowing fast flowing water, storing moisture and filtering sediments, nutrients and toxic materials from incoming water. Though difficult to calculate, estimates of the monetary value of ecosystem services from BC's wetlands amount to over $100 billion per year.
- Historically, wetlands have not been well understood or appreciated for their important ecological functions. Of all the wetlands that existed around the world in 1900, half are now gone. Canada has roughly one quarter of the world's existing wetlands.

Status of wetlands

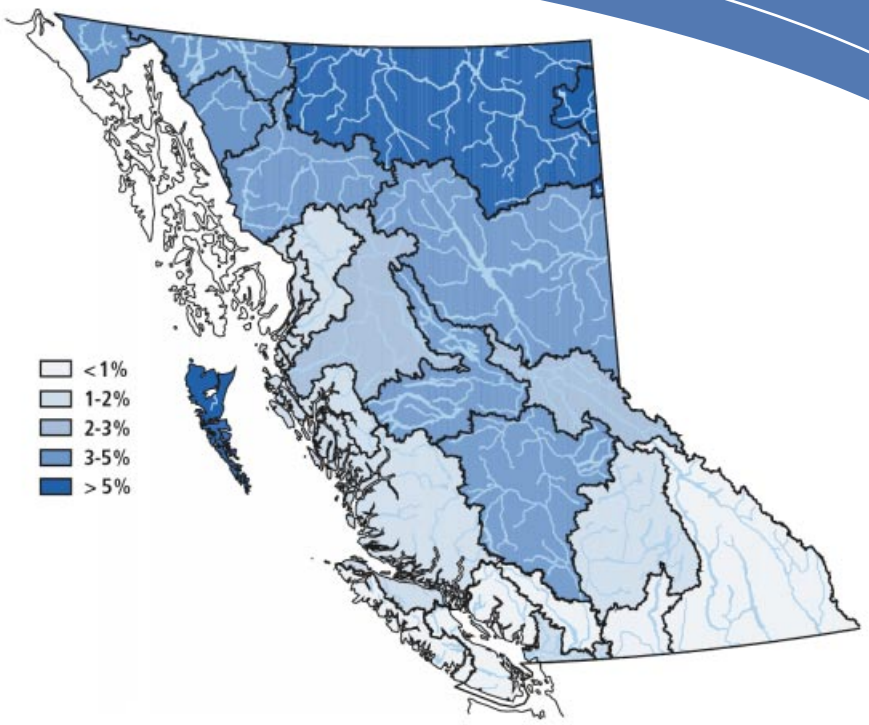
- Wetlands cover over 50,000 square kilometres or nearly 6% of BC (*see map*). However, the amount of wetland varies greatly around the province. Wetlands cover less than 1% of the watershed area in each of the Columbia, Okanagan, Lower Fraser, Georgia Basin and West Coast of Vancouver Island. Both the Queen Charlotte Islands and the Liard watershed have 12% of their area covered by wetlands.
- In the early 1990s, a Sensitive Ecosystem Inventory for the East Coast of Vancouver Island and Gulf Islands mapped over 2,500 sites with 70 square kilometres of wetlands. In 1999, a reassessment of one quarter of these sites found that nearly 8% of the wetlands had been disturbed or destroyed.
- Wetlands are often found in valley bottoms and other easily accessible areas. This makes them especially vulnerable to draining and infilling for conversion to urban, industrial and agricultural lands. Those wetlands that remain can be overloaded with nutrients and toxic materials, and have their water regimes altered. Invasive species can also compete with native plants and animals. These threats alter how wetlands function and reduce the number and diversity of plants and animals they can support.

The emergent vegetation around the edges of this wetland is adapted to growing in water-logged soil.
PHOTO: Andrew Wilson, Ministry of Water, Land and Air Protection.

Wetlands as a percent of land area in each watershed, mid-1990s

SOURCE: Decision Support Services, Ministry of Sustainable Resource Management, 2003.

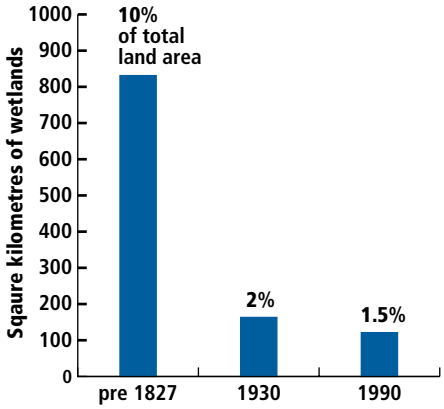
NOTES: The data are from 1:250,000 base maps BTM) and satellite images from the mid-1990s. From these sources, the smallest detectable wetland is approximately 15 hectares (0.15 square kilometres).



The Fraser Valley's wetlands

~ Before European settlement in 1827, 10% of the land in the Fraser Valley was wetland, including fens, swamps, bogs and marshes. In the 1860s, settlers started building dykes to reduce the annual spring flooding of the Fraser River and develop agricultural lands. By 1930, the wetland area had been reduced to 2% of the total land area (*see graph*).

Wetlands in the Lower Fraser Valley, 1827-1990



SOURCE: C. A. Boyle and coauthors, 1997, Changes in land cover and subsequent effects on lower Fraser Basin ecosystems from 1827 to 1990, Environmental Management, Vol. 21, pp. 185-196.

NOTES: The study covered an area of 8,282 square kilometres from Hope to Vancouver and the US border to the mountains north of the Fraser River.

The Great Basin Spadefoot breeds in ephemeral ponds – those that exist temporarily and then dry up.

PHOTO: Andy Bezener.

What is being done?

~ The Wetland Working Group includes members of municipal, provincial and federal governments, several non-government organizations and industry groups. Their mission is to maintain and restore wetlands throughout BC by promoting wetland protection and encouraging partnerships among government and non-government organizations.

~ Ducks Unlimited Canada conserves wetlands across the country through purchase, long-term leases, conservation covenants and stewardship agreements. Since 1969 they have conserved close to 650 square kilometres of wetlands and associated habitats in BC. This is roughly equal to the area of 164 Stanley Parks.

~ The National Round Table on the Environment and the Economy chose to use wetland coverage as one of six indicators to help track the effects of Canada's economic activities on the environment and focus attention on wetland productivity, diversity and ecosystem services.

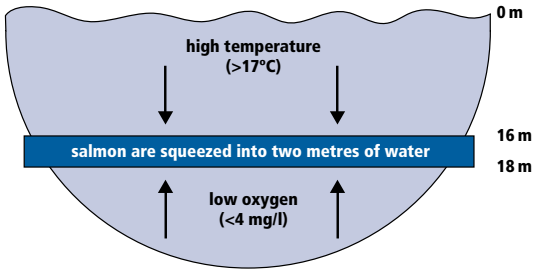
LAKES

British Columbia has about 385,000 lakes dotted across its landscape. Of the 88,000 at low elevations – where human impacts are often greatest – 52% remain undisturbed.

Lakes and their importance

- Lakes are an integral part of BC's landscape and are closely tied to rivers. Some lakes are the headwaters of rivers, while others separate rivers along their journey.
- BC's roughly 385,000 lakes are home to numerous animals and plants. Some of these depend heavily on lakes and are seldom found in or near fast-flowing streams and rivers. These include Lake Whitefish, Tiger Salamanders, Painted Turtles, Moose and Green Herons.

The North Basin of Osoyoos Lake, September 2001



In summer, many lakes develop stable layers of warm water on top and cold at the bottom. This isolates the bottom water, which sometimes runs low on oxygen. Sewage effluent and runoff from developed land contribute to oxygen loss by adding nutrients and organic material into lakes. Bacteria use up oxygen while decomposing this material. Kokanee and Sockeye Salmon cannot live at high temperature or at low oxygen. In late summer, salmon in the North Basin of Osoyoos Lake get squeezed into a small layer of middle water that is cool enough and has sufficient oxygen for their survival (*see diagram*). In the South and Central Basins of this lake, the zone of middle water disappears altogether for periods up to three months and the salmon must leave or die. Osoyoos Lake is the last remaining lake for juvenile Okanagan Sockeye Salmon to grow before migrating to the ocean.

SOURCE: Okanagan Nation Fisheries Commission.

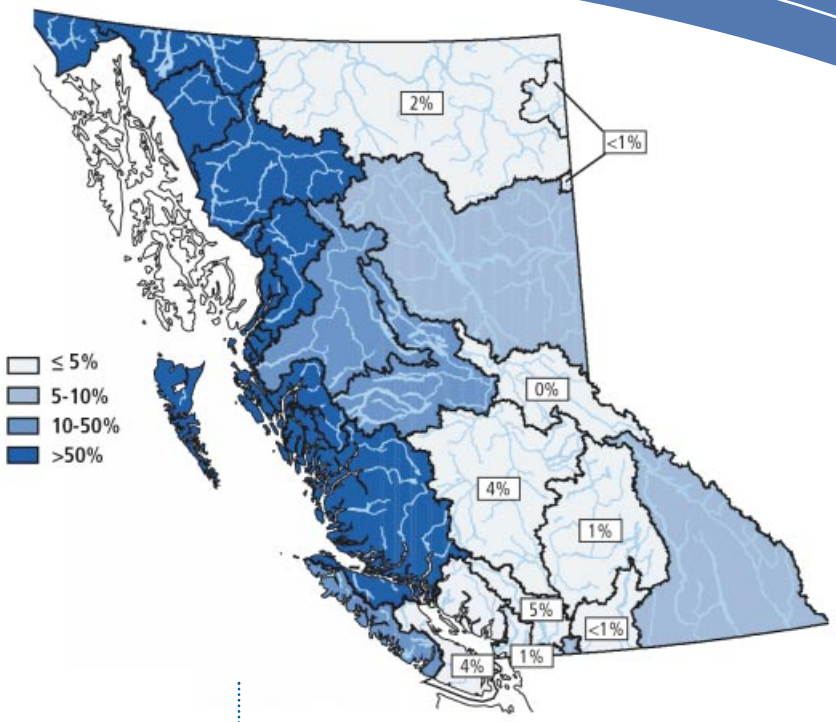
Status of natural, low-elevation lakes

- British Columbia has approximately 88,000 low-elevation lakes. Low elevation was defined as the lowest 400 metres in each of the watersheds shown on the maps in this report. Lakes at low elevation are important for wildlife and are also the most vulnerable to human land and water use because people tend to settle in valleys.
- In BC, 52% of low-elevation lakes remain natural. Most are either along the Central Coast or in the northwest of the province (*see map*). Here, natural means a lake that has not been stocked with fish and that is more than one kilometre away from roads, transmission lines and pipelines.
- In the watersheds with large populations, few low-elevation lakes remain natural by these criteria. The low percentages in the Liard and Hay watersheds are likely due to road and pipeline construction associated with oil and gas exploration and drilling.
- Roads, transmission lines and pipelines are all man-made linear features that bisect the landscape. They fragment habitat, alter water flow over the land and increase access to lakes and other areas (*see Road density, page 29*).
- Stocking of lakes and streams with hatchery raised fish has been carried out for decades to create recreational angling opportunities. Many amphibians, birds and insects thrive in habitats where fish are not present. These animals, particularly amphibians, are vulnerable to fish stocking in previously fishless lakes. Many of the low-elevation lakes in BC contain naturally occurring fish that can also be affected by hatchery fish with a different genetic make-up.

Percentage of low-elevation lakes that remain in natural condition

SOURCE: Ministry of Water, Land and Air Protection, 2003; Ministry of Sustainable Resource Management, 2003.

NOTES: The lakes included in this data set are in the lowest 400 metres elevation within each watershed. Lakes were defined as natural if they are not stocked with fish and are greater than one kilometre from roads, transmission lines and pipelines.



Kootenay Lake restoration

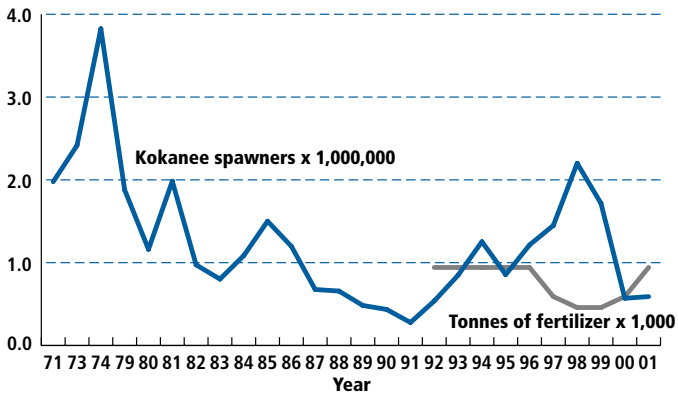
- The fish populations in Kootenay Lake in the Columbia watershed began crashing in the 1980s. By the early 1990s, the Kokanee Salmon that are food for Bull Trout, Rainbow Trout, Burbot and White Sturgeon had declined to about 20% of historical numbers and fewer adults were spawning each year (*see graph*).
- The problem was too few nutrients coming into the lake, chiefly because dams on the main inflowing rivers trapped them. The lake became less productive with less growth of algae to feed the plankton that Kokanee consume. The introduced Opossum Shrimp, *Mysis relicta*, added to the problem by competing with Kokanee for plankton.
- A program of nutrient additions started in 1992 and the Kokanee population began to rebound. After five years of fertilizing with nutrients, the amount was reduced. Number of spawners continued to increase but younger fish – the future spawners – declined again. Nutrient additions were then returned to the original levels.
- In 2002, the Kokanee population, which includes fish of all ages, was nearly at the historical level of 35 million fish. Nutrient additions are continuing along with monitoring of the fish and other species in the lake.

What is being done?

- Freshwater fisheries managers follow protocols to minimize the impacts of fish stocking and they place a priority on the protection of wild fish and natural diversity. Fish stocking programs support a significant percentage of angling activity, which takes pressure off wild stocks.
- The nutrient addition approach pioneered at Kootenay Lake is now being carried out in other large lakes that have similar problems.
- The Osoyoos Lake Water Quality Society is an active group of community members in the south Okanagan Valley working to improve the environment within Osoyoos Lake. They are members of the BC Lake Stewardship Society.

Kokanee Salmon in Kootenay Lake

SOURCE: Ministry of Water, Land and Air Protection, 2002.



POPULATION

Human population and activities can impact freshwater ecosystems and care must be taken to protect them. In the next 30 years, British Columbia's population is projected to grow by over 48% to reach 5.8 million people in 2031.

Population

- In the 10 years from 1991 to 2001, BC's population increased 19% from nearly 3.3 million to 3.9 million people.
- In that period, the three regional districts with the highest population growth rates were the Fraser Valley (33%), the Central Okanagan (Kelowna, Peachland and Lake Country; 35%) and the Squamish-Lillooet corridor (40%) (*see map*).
- Population projections by BC Statistics suggest that by 2031 BC will have 5.8 million people.
- About 80% of population increase is predicted to occur in urban areas, particularly in the Lower Mainland, Okanagan Valley and East Coast of Vancouver Island.
- More people means more pressure on freshwater ecosystems and more potential for their exploitation and pollution. Human threats to freshwater ecosystems vary in type and severity around the province. The number of people in a region, local land and water use and measures in place to limit or prevent pollution and other impacts all influence the effects on fresh water. *For more on land use pressures, see page 36; for water use pressures, see page 38.*
- With a growing population comes larger and more developed urban centres and one of their defining characteristics: impervious surfaces.

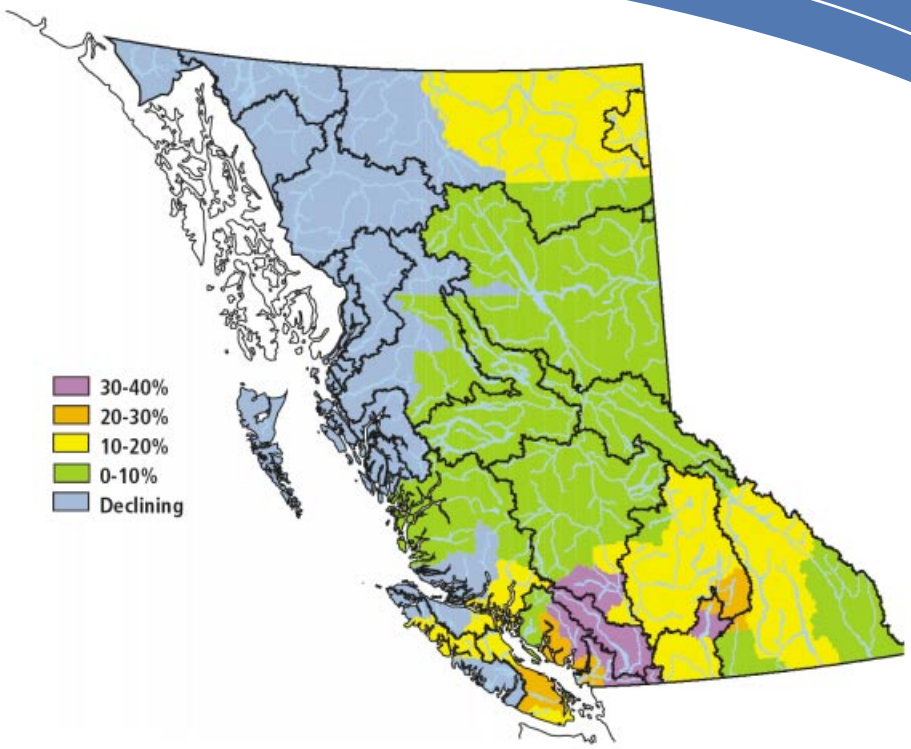
Roads, parking lots and rooftops are impervious surfaces in this lakeside community. PHOTO: Ministry of Water, Land and Air Protection.

Impervious surfaces

- Impervious surfaces are any surfaces that water cannot seep or percolate through. They are most commonly associated with urban areas and include roads, parking lots and roof tops. However, urban areas are not the only places with impervious surfaces. Any activity that compacts soils can create a surface that acts as a barrier to water.
- Research shows that watersheds with more than 10% of their area covered by impervious surfaces have impaired ecosystem function. A survey of 13 watersheds on the east coast of Vancouver Island found that the area covered by impervious surfaces varied from 0 to 19.6%. Four watersheds were above the 10% threshold considered harmful to streams, four more were marginal with 4-10% impervious areas and five had less than 4% impervious areas.
- When rainwater runs over impervious surfaces it collects oils, chemicals and other pollutants and carries them into storm drains. Storm drains are not linked to the wastewater treatment system but rather, they flow directly to a nearby creek, lake, wetland or the ocean. Thus, any materials picked up by rainwater end up in the aquatic habitat of fish, birds, amphibians and other species and also in our water supplies.
- Impervious surfaces also change the hydrology of a watershed by altering the location, timing and volume of water that flows into freshwater ecosystems. This occurs because rainwater can no longer seep into the

Estimated population growth by district from 1991 to 2001

SOURCE: BC Statistics, Ministry of Finance and Corporate Relations, 2003.
NOTES: When the data were obtained, only population estimates were available. The map is shaded according to regional districts used by BC Statistics, which do not correspond to the 23 watershed groups shown on the maps on this report.



ground or run in many directions across it. Instead, the water is channelled by roads and ditches and enters streams, lakes or wetlands in a concentrated burst.

- By reducing the amount of water that seeps into the ground, impervious areas limit the replenishing of groundwater. This indirectly affects surface waters and uses that depend on groundwater.

What is being done?

- Several regional districts in BC have developed strategies to more carefully manage growth so that environmental, social and economic goals are met as communities expand. Sixty percent of British Columbians live in an area covered by a Regional Growth Strategy. More information is available from the Ministry of Community, Aboriginal and Women's Services.
- Smart Growth BC, a non-government organization, was started in 1999 to promote responsible land use and development in BC's urban and suburban areas. It works with community groups, businesses, municipalities and the public to address growth and sprawl issues, including the protection of ecological values.
- Alternatives to impervious pavement are being developed. For example, the recently built Vancouver Island Technology Park incorporated a permeable parking lot into its site design. Vehicles drive on gravel and park on grass, but the grass is not simply a field. A grid of strong cylinders below both the gravel and the grass reinforce the parking lot and allow water to seep into the ground (*see photo*).

A permeable parking lot at the Vancouver Island Technology Park. PHOTO: Aqua-Tex Scientific Consulting Ltd.

LAND USE

Impacts from human activities cover, on average, about 10% of British Columbia's land. In the Lower Mainland the average is as much as 40%. Logging, agriculture and urban development make up most human land use by area.

Land cover in British Columbia

- Forests dominate British Columbia, covering about 60% of the land. Other terrestrial ecosystems include grasslands, shrublands and alpine areas.
- Among all of BC's terrestrial ecosystems, fresh water is a common theme. In fact, all ecosystems are part of a watershed, and all parts of a watershed are linked. Whatever takes place at the highest point in a watershed will eventually funnel down to the lowest point – which is invariably water.
- By the mid-1990s, about 10% of the land in BC had been altered by human activity in the forms of urban and industrial development, agriculture, recent logging (previous 20 years), mining and recreation. This is most likely an underestimate because some roads and seismic lines (pathways through the bush made during oil and gas exploration) are not included in this figure.
- The amount of land influenced by human activities in the north and along much of the West Coast is below average for the province. It rises to 20% in the Thompson watershed, 25% in the Okanagan and 40% in the Lower Mainland (*see shaded watersheds on map*).
- Urbanization, agriculture and recent logging are the three human activities that occupy the most land in BC (*see pie charts on map*).

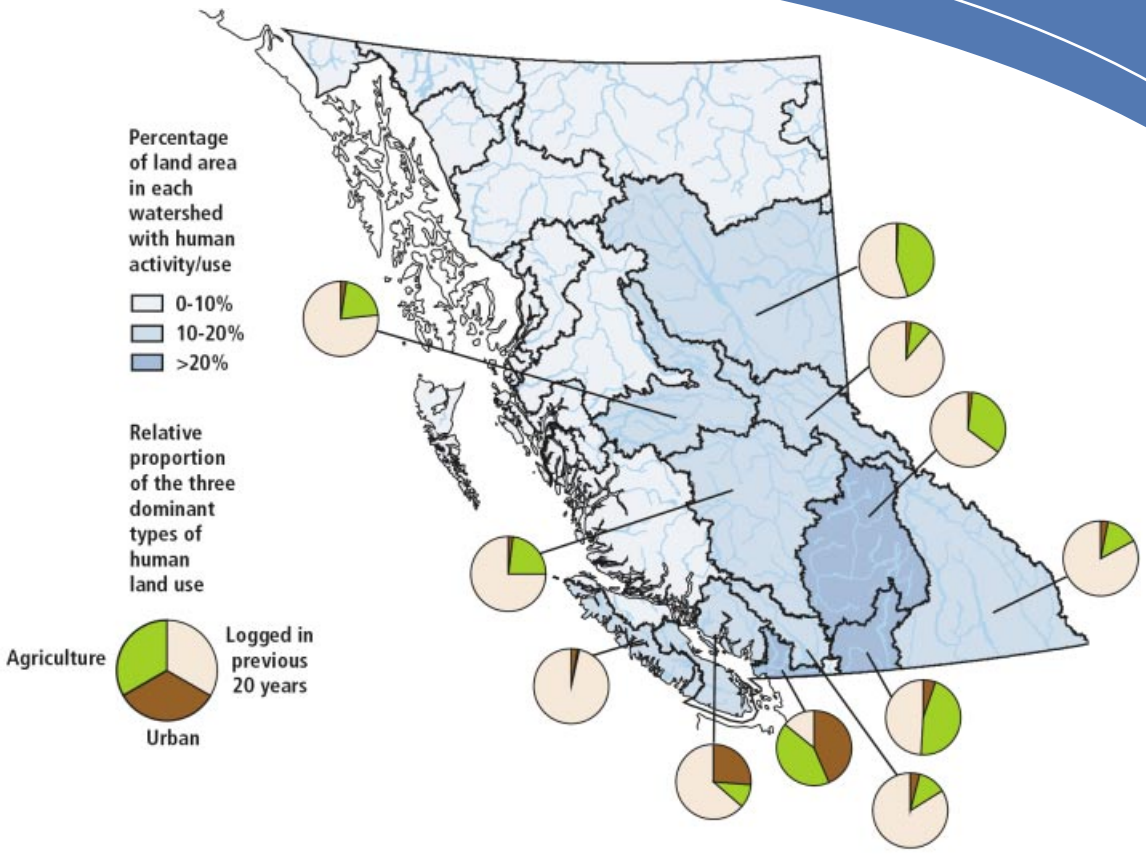
Human activities and land use

- Urban development alters land surfaces. Stormwater runoff through urban areas picks up oils and other contaminants from paved areas and funnels them into water bodies (*see Impervious surfaces, page 34*).
- Logging and mining can also alter land surfaces so that water runoff carries more soils, nutrients and minerals into creeks and streams.
- Industrial activities such as pulp mills, smelters and mines use water during their processing and other operations. The release of this "used" water in the industries' effluent can introduce pollutants into the receiving water bodies (*see Pulp and paper mill effluent, page 39*). Airborne emissions of contaminants can also find their way into surface waters.
- Livestock allowed to walk into creeks trample the banks, increasing erosion and damaging riparian vegetation. They can also introduce nutrients and pathogens from their feces directly into the water. Some types of agriculture use fertilizers and other chemicals that can contaminate water if incorrectly applied.
- Sewage and septic system effluents ultimately flow into surface water or seep into groundwater. Both can introduce excess nutrients and organic material to waterways if the wastewater treatment or system maintenance is inadequate (*see Wastewater treatment, page 38*). Pharmaceuticals and other chemicals in wastewater threaten the reproductive capabilities of some species.
- Recreational activities also impact freshwater ecosystems. For example, boat motors can add hydrocarbons from oil and gasoline into water.
- The end point of all of these activities and land uses is damage to freshwater ecosystems, including reduced water quality and quantity and lost habitat. If the damage is intense, ecosystems can become overwhelmed and collapse.

Human land use in the mid-1990s

SOURCE: Decision Support Services, Ministry of Sustainable Resource Management, 2003.

NOTES: The data are from satellite images taken over the period 1996-1999. In the shaded watersheds, human activity/use includes urban, agriculture (combining agricultural, mixed agricultural-residential and rangeland), logged (recently logged and selectively logged areas in the previous 20 years and recently burned areas), recreational and mined areas. The land cover excluded from the human activity/use category includes old forest (>140 years), young forest (<140 years), wetlands, fresh water, glaciers, avalanche chutes, alpine, snow covered, barren surface and shrub growth areas.



What is being done?

- The *Forest and Range Practices Act* will ensure that forest management plans achieve sustainable harvesting and address biodiversity.
- The BC Agriculture Council is implementing a program to develop Environmental Farm Plans that will assist farmers and ranchers in supporting sustainable practices.
- Organic agriculture, where synthetic fertilizers and pesticides are prohibited, is on the rise in BC: the number of certified organic producers and processors nearly tripled from 154 in 1992 to 430 in 2001.

A one-centimetre-long mayfly nymph – the aquatic stage before turning into an airborne adult.

PHOTO: Jan Benda, University of Ottawa.

Measuring land use pressure with insects

- Aquatic insects such as the larvae of stoneflies, mayflies and caddisflies live on stream beds. They either thrive or suffer depending on the quality of their stream environment, which depends largely on what happens in the surrounding watershed.
- Scientists use these insects as a biological method of rating and assessing watershed impacts. Intensive land use alters the water quality and stream habitat, which changes the number and type of insects living in the water downstream.
- The insect method has been used for several years in the Bulkley and Kispiox watersheds near Smithers and in the Okanagan. Plans are underway to develop and use the method elsewhere in the province.

WATER USE

As the population of British Columbia grows, demands for water become greater, leaving less water for freshwater ecosystems. Water availability in summer is increasingly becoming a problem for many Interior and Coastal BC communities.

Water use

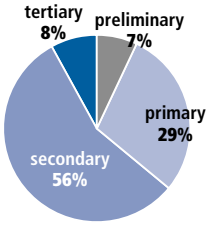
- About eighty percent of British Columbians rely on surface water, while the rest use groundwater. As we remove more water from these sources, less remains for the ecosystems and plants and animals living within them.
- Not all water use entails removing water. Generating hydroelectricity involves harnessing the power of water as it flows over a dam. Over 97% of licensed surface water is used in or stored for power generation, primarily in the Peace and Columbia watersheds. Although this water is not removed from its source, the timing and volume of river flow is altered and can eliminate or restrict access to habitat.
- The remaining 2.5% of licensed water goes to industrial, municipal, agricultural and other uses. For the most part, this water is removed from its source.
- In 1999, the average municipal water use in BC was 678 litres per person per day, down 10% from the 1989 rate. The 1999 rate is still 40 litres higher than the Canadian average of 638 litres per person per day.

Wastewater treatment

- After its extraction and use, water is frequently returned to a lake or stream as wastewater or effluent. Depending on the water use, effluent may contain contaminants that threaten both human and aquatic life. For example, municipal wastewater can include disease-causing pathogens, heavy metals, pesticide residues, pharmaceuticals and solvents.
- The removal of contaminants, nutrients and organic material from municipal wastewater depends on the level of treatment. In 1999, the majority of British Columbians served by municipal wastewater treatment had secondary or tertiary treatment (*see pie chart*). However, 36% still had only basic wastewater treatment.

Percentage of municipal population in BC served by four levels of wastewater treatment, 1999

SOURCE: Environment Canada, MUD database, 2001. NOTES: Approximately 20% of British Columbians are served by on-site sewer systems and were not included in the data for this graph.



Preliminary: screens
Primary: solid material removed in settling chambers
Secondary: suspended and organic material removed
Tertiary: nutrients and target substances removed

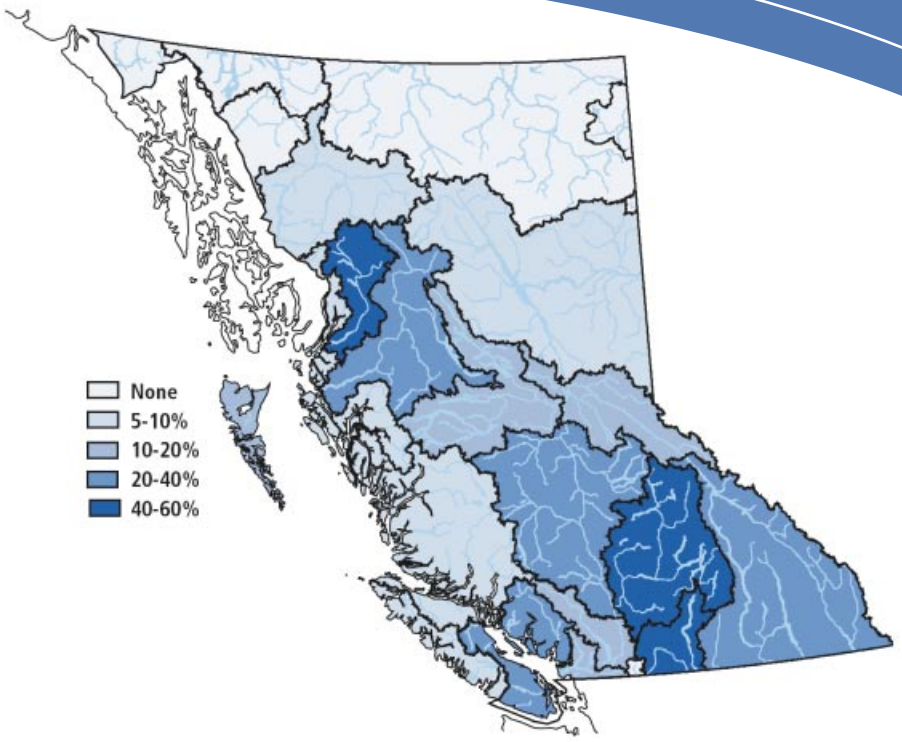
Water availability

- Water availability is a serious problem in many BC communities, particularly in summer when it is hot and dry with low flow in streams and high demands for irrigation. In years with low winter precipitation, rainfall and snowmelt often do not fill reservoirs.
- Water licenses are required to extract or control water from surface sources in BC. The Province places allocation restrictions on streams when the demand for new water licenses threatens human and non-human users of the water supply. The percentage of licensed stream length with allocation restrictions indicates the intensity of water use and limitations on water supply in the province.
- In 2000, approximately 28% of licensed stream length across the province had allocation restrictions (*see map*). This varied from no restrictions in northern

Percentage of licensed stream length in each watershed that has water allocation restrictions, 2000

SOURCE: Ministry of Sustainable Resource Management, 2001.

NOTES: Stream restrictions range from including minimum fish flow clauses in a water license to suspending the issuance of any further licenses on a water body. The Nass watershed in the northwest had licenses on 87 kilometres of the Lower Nass River and 51 kilometres were restricted, accounting for its inclusion in the highest percentage category on the map.



watersheds to 41% of the 4,600 kilometres of streams licensed in the Okanagan and 46% of the 11,675 kilometres licensed in the Thompson.

What is being done?

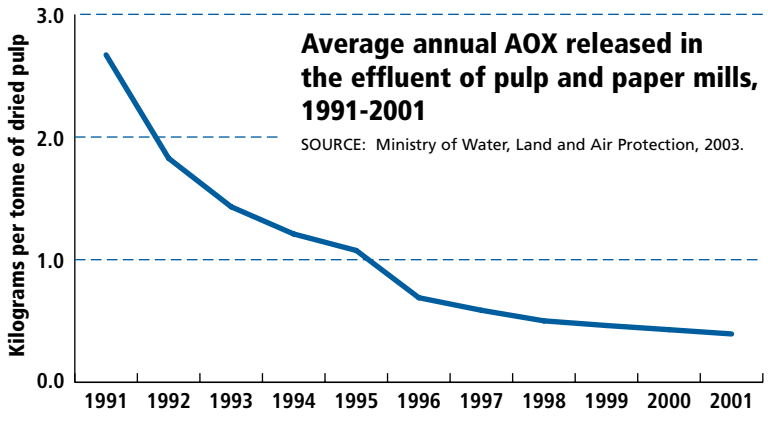
- Water budgets are being developed on some regulated systems to ensure that adequate flow is available throughout the year for ecosystem needs (*for example, see Sooke River, page 43*).
- A 1998 survey in BC had 127 responses and found that 76% of regional districts, municipalities and irrigation districts used water conservation measures, including mandatory restrictions, bylaws and metering programs.
- Federal and provincial agencies are working to improve wastewater management. This includes upgrades to infrastructure such as leaking pipes, which account for an estimated loss of 14% of municipal water across Canada.
- Some water licenses are allocated to protect water from extractive uses for the benefit of fish and wildlife.

Pulp and paper mill effluent

- Most pulp and paper mills release effluent with chlorinated organic compounds such as AOX (adsorbable organic halide), which at high levels is acutely toxic to fish and other species.
- From 1991 to 2001, pulp mill AOX discharges in BC decreased by over 85% (*see graph*). In the early 1990s, pulp and paper mills began using new technology that reduces the level of AOX in effluent.

Average annual AOX released in the effluent of pulp and paper mills, 1991-2001

SOURCE: Ministry of Water, Land and Air Protection, 2003.



PROTECTED AREAS

Approximately 125,000 square kilometres of BC are currently designated as protected areas. By surface area, 13% of lakes and 6.8% of wetlands are within protected areas.

Protected areas and their importance

- BC has a range of protected areas, including national parks, provincial parks and ecological reserves, municipal parks and lands owned by non-government organizations.
- These areas are intended to help protect natural environments in the province, as well as provide opportunities for recreation, scientific research and education.
- Though difficult to do, some researchers try to put dollar values on ecosystem services – the benefits that we get from nature. Examples of these benefits include flood and erosion control, contaminant reduction and water purification. One estimate for the ecosystem services from BC's protected areas puts the figure at $10 billion per year. Half of this comes from the services provided by wetlands and lakes.

Status of protected areas

- The Province has made excellent progress in completing the protected areas system which currently covers approximately 125 square kilometres.
- The establishment of protected areas was often originally based on recreational and tourism values. More recently, governments have worked to ensure an adequate representation of the diversity of terrestrial and aquatic ecosystems in BC's protected areas.

Fresh water in protected areas

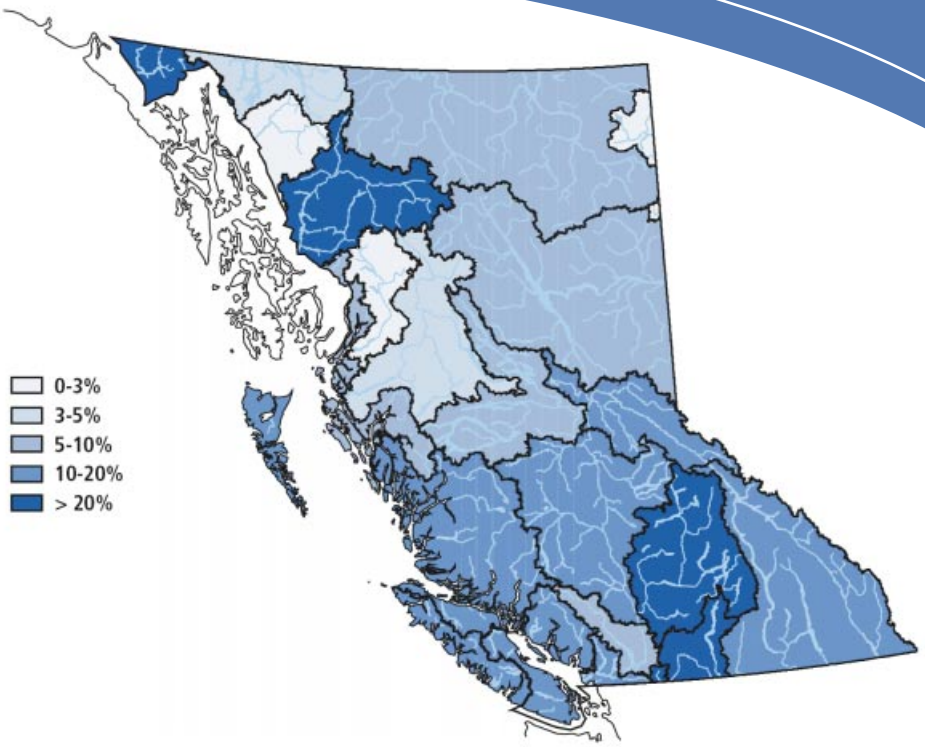
- By surface area, 13% of lakes and 6.8% of wetlands are within protected areas.
- Few large rivers and their watersheds are entirely within protected areas, making them susceptible to disturbance from unprotected upstream and upland areas. However, smaller streams and their watersheds can exist within protected areas.
- The 23 large watershed groups shown on the maps in this report can be divided into several thousand smaller watersheds, each draining into a small stream. Of these small streams and their watersheds, 16% are encompassed within provincial and national protected areas (*see map*).
- Because freshwater ecosystems are heavily affected by what happens elsewhere in their watershed, protection of only one part of a watershed may not protect all of its ecological values. For example, a park downstream of poor land use practices or upstream of over harvested fish populations affords limited protection to habitat, animals and plants.
- Fifty percent of fish species at risk in BC (included on either the Red- or Blue-lists, *see page 18*) have populations living within protected areas. Twenty-seven percent do not occur in protected areas. Three species – Cisco, Giant Black Stickleback and Spottail Shiner – occur only in protected areas.

Rowing at sunset. PHOTO: Ted Zimmerman, Ministry of Water, Land and Air Protection.

Percentage of small streams in each watershed that are within national and provincial protected areas

SOURCE: Ministry of Water, Land and Air Protection, 2003; Ministry of Sustainable Resource Management, 2003.

NOTES: The data are the number of small streams as a percentage of the total for each watershed group on the map. A small stream was considered to be encompassed within a protected area only if 90% or more of its watershed was within a protected area. Here, the definition of a small stream is a third order stream. The tiniest stream is first order, two first order streams join to become a second order stream and two second order streams join to become a third order stream. The data are from the Watershed Atlas of BC, which was compiled from 1:20,000 scale maps. The provincial protected areas coverage includes only parks designated as of December 20, 2001. More recent parks are not yet available in a digital data layer.



Turner Lake and Hunlen Falls, Tweedsmuir Provincial Park.

PHOTO: Gail Ross, Ministry of Water, Land and Air Protection.

What is being done?

- The Province continues to work at land use planning, which is an essential part of identifying new protected areas. Advances in information technology are helping to provide new ways to collect, manage and analyze environmental information, leading to more informed decisions about protecting key areas.
- A freshwater classification scheme is being developed by the Province in conjunction with The Nature Conservancy of Canada. It will be based on the key characteristics of fresh waters, including water flow, water chemistry, habitat, biological structure and function and physical connections. This will help to ensure that representative freshwater ecosystems are protected.
- Land purchases can help protect ecosystems. For example, a partnership of non-government organizations and government agencies recently purchased a 40-square-kilometre property in the East Kootenays. The property has several different habitat types, including 1.2 square kilometres of wetlands near the Columbia River.
- The BC government has recently acquired properties worth over $17 million on the Cowichan River which will be added to the provincial park protecting large sections of the river's corridor.

RESTORATION AND MANAGEMENT

Numerous initiatives are underway to help restore freshwater ecosystems and better manage water resources in British Columbia. Many of these initiatives focus on fish, but in doing so they often address other components of ecosystems.

Watershed restoration

- Watershed restoration projects take many forms. Some help to create pools and riffles by placing log and boulder structures in streams. Others stabilize and replant streambanks (*see photos below*). Deactivating roads and replacing failing culverts and stream-crossings can also have positive benefits for watersheds. Other projects add nutrients to streams and lakes to boost the food chain from the bottom.
- The BC government operates programs to restore streams that were damaged by past logging practices. Stream restoration projects have been undertaken throughout BC and continue to be funded through the Forest Investment Account.

Watershed-based Fish Sustainability Plans

- Watershed-based Fish Sustainability Plans are stewardship-driven plans to identify and implement protection and restoration activities. They work through the cooperation of federal, provincial and local governments, First Nations, communities, conservation groups, resource companies and other interested groups.
- These plans take a fish-first approach, but recognize that freshwater ecosystems depend on the condition of the entire watershed and that complex connections exist between fish, animals, plants and humans. They also focus on all fish regardless of their economic value or population size.

With its riparian vegetation removed, the bank of Corkscrew Creek in the Nechako watershed was crumbling into the water. A restoration project initiated by the Saik'uz First Nation stabilized the bank by re-contouring it, placing tree trunks that extended partly into the water and securing bundles of willow whips in tiers up the bank. In spring, the willow whips send down roots and begin to establish thickets of riparian vegetation.

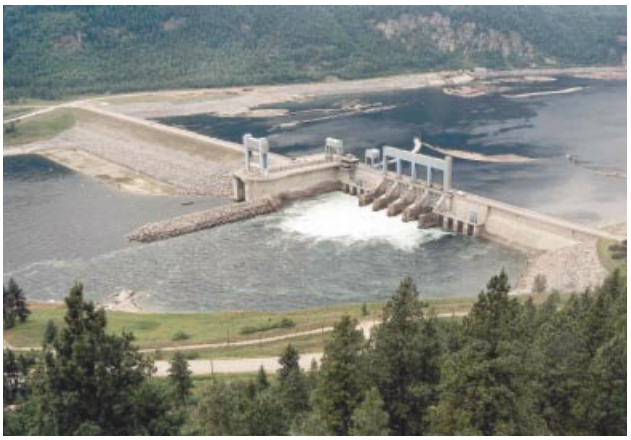
PHOTOS: Andrew Wilson, Ministry of Water, Land and Air Protection.

Georgia Basin Action Plan

- The Georgia Basin Action Plan leads on from the Georgia Basin Ecosystem Initiative that worked on water, land and air issues from 1998 to 2002. The Action Plan is a partnership of three federal and two provincial ministries and aims to protect and restore ecosystems in the Georgia Basin while helping to provide economic opportunities and to enhance human wellbeing.
- The partners work with other governments, First Nations, community groups, industry, businesses and residents. They also collaborate with governments and groups in the Puget Sound area south of the border.
- By 2020, the population is projected to reach four million in the Georgia Basin (Canada) and five million in the Puget Sound (USA). This growth is putting increasing pressure on the land, air and water resources of the area.

BC Hydro water use planning

- In 1998, the Province initiated a Water Use Planning (WUP) program to better meet the environmental, social and industry demands made on water resources at facilities that control water around the province.
- BC Hydro has 30 hydroelectric power generation facilities in 27 watersheds and is on a five-year plan to complete a WUP for each facility. The goal is to find a balance between the human uses of water – domestic supplies, electricity generation, recreation – and the fish and wildlife needs in the freshwater ecosystem. The WUP process includes government agencies, First Nations, the public and other interested groups.
- When implemented, each WUP will specify a flow regime designed to improve freshwater ecosystems and provide other benefits. Each WUP will also include a monitoring and management program to ensure continuous improvement.



A Water Use Plan is in development for the Hugh Keenleyside dam, eight kilometres upstream of Castlegar on the Columbia River. PHOTO: BC Hydro.

Restoring Sooke River water flow

- The Sooke River is important spawning and rearing habitat for salmon and home to many other aquatic animals. In the past, water in the upper portion of the Sooke River has dwindled to zero flow for as long as six months at a time because of water being held back by the Sooke River Reservoir.
- The reservoir at the head of the Sooke River supplies most of Victoria's population with water and has done so for over 100 years.
- In October 2002, a landmark agreement was signed to balance the municipal water use with the water flow needs of aquatic animals. The T'Sou'ke First Nation, the Capital Regional District, Fisheries and Oceans Canada and the Ministry of Water, Land and Air Protection worked together to develop the water use agreement.
- The agreement is restoring more natural flows to the Sooke River with particular emphasis on riffle habitat, which is important for insects, and on fish-rearing habitat.

STEWARDSHIP AND EDUCATION

Since we all rely heavily on British Columbia's freshwater ecosystems, we must all share the responsibility of looking after them. Education of our children and each other is an important part of this shared stewardship.

Watershed stewardship

- Stewardship means caring for something of value that you don't own.
- "Canada's Stewardship Agenda: Naturally Connecting Canadians" is a federal-provincial-territorial initiative that emphasizes the importance of all sectors working together (www.stewardshipcanada.ca). This agenda commits to the goals of investing in stewardship, strengthening the application of knowledge, strengthening policy and legislative support for stewards and connecting stewardship programs.
- The BC Stewardship Centre has a self-register directory that includes over 80 groups and societies. More than half of these are directly involved in stream, lake or wetland protection, restoration and education. Visit them at: www.stewardshipcentre.bc.ca.
- Conservation Connection is an example of a web site dedicated to conservation and stewardship organizations. It enables individuals and groups in the Capital Regional District to connect with others working toward similar goals. Take a look at: www.conservationconnection.bc.ca.

"Keepers" of freshwater ecosystems

- The Streamkeepers Program was initiated in 1993 by Fisheries and Oceans Canada to train volunteers in how to protect and restore aquatic habitat. The Pacific Streamkeepers Federation, a non-profit society, lends support to community groups involved in Streamkeepers activities. They help new groups start up and facilitate training sessions. Visit them at: www.pskf.ca.
- The Wetlandkeepers Program, led by the BC Wildlife Federation, has a handbook and training course in wetland conservation. The training includes how to assess wetlands, survey wetland plants, birds and amphibians, develop public education programs and restore marshes. For more information, go to: www.bcwf.bc.ca.
- The BC Lake Stewardship Society recently launched a three-year BC Lake Stewardship and Monitoring Program. They offer a two-and-a-half day training course focussing on lake ecology and water quality and a Lakekeepers Manual to help lakeshore residents and others protect and restore their local lakes. Find out how to get involved at: www.nalms.org/bclss.
- The Habitat and Enhancement Branch of Fisheries and Oceans Canada has several community involvement initiatives to foster stewardship of aquatic resources. Community advisors and education coordinators are located around the province. For more information and who to contact in your area, visit: www-heb.pac.dfo-mpo.gc.ca/community/hcsp_e.htm.

Heritage Rivers

- The Canadian Heritage Rivers System was established in 1984 by the federal, provincial and territorial governments to conserve and protect the best examples of Canada's river heritage, to give them national recognition, and to encourage the public to enjoy and appreciate them. In British Columbia, the BC Heritage Rivers System, established in 1995, is the first provincial system of its kind in Canada, and helps to promote stewardship of this natural legacy for all British Columbians. To find out the rivers that have been given heritage river designation, visit their websites at: www.chrs.ca and www.bcheritagerivers.ca.

BC Rivers Day

- Since 1980, BC Rivers Day has been held on the last Sunday of every September. Over 100 events attract more than 45,000 people each year. The success of BC Rivers Day led to the recently established Canadian Rivers Day to be held each June.
- BC Rivers Day provides an opportunity for people to celebrate the essential role of streams and rivers in the province. The day is also a chance to raise understanding and awareness of rivers, the many benefits we get from them and the threats they face.
- BC Rivers Day is coordinated by the Outdoor Recreation Council of BC, which also compiles an annual Endangered Rivers List for BC. To find a Rivers Day event near you or to plan an event in your community, go to: www.orcbc.ca.

Great Canadian Shoreline Cleanup

- The Great Canadian Shoreline Cleanup is a national conservation program aimed at reducing garbage in aquatic ecosystems and raising awareness about litter. Every September, volunteers spend time removing objects, including metal, glass, rubber, plastic, cloth, paper and other man-made items, that have been lost or discarded in aquatic environments.
- In September 2002, 239 sites were cleaned up in over 50 communities across Canada. To get involved, go to: www.vanaqua.org/cleanup.

Living By Water

- The Living By Water Project was started in 1997 by two BC residents with waterfront property who were trying to find information to protect their shoreline. The project has now expanded to several locations across Canada.
- Living By Water promotes the value of maintaining healthy shorelines alongside all types of water, both fresh and marine. It supports individuals and groups working for this goal by providing publications, workshops and programs to make it easier to develop the tools and find the capacity to operate. Find out more at: www.livingbywater.ca.

Frogwatch

- BC Frogwatch is a monitoring program that collects information on frogs and toads in the province with the help of volunteers. Knowing where different species are found and when they are calling helps biologists better understand the health of BC's frog and toad populations.
- Anyone of any age can help by recording frogs and toads they see or hear. Send the information to BC Frogwatch using the sighting form available at: wlapwww.gov.bc.ca/wld/frogwatch or phone to have a form sent to you.

Wild BC

- Wild BC is a government-sponsored environmental education program funded primarily by its main partner, the Habitat Conservation Trust Fund. Wild BC works cooperatively with other agencies and organizations to provide environmental education programs and resource materials to people in British Columbia.
- Wild BC's mission is to increase the environmental literacy of British Columbians by providing education and stewardship opportunities that foster appreciation, knowledge, understanding and responsible actions for the natural world.
- To inquire about upcoming workshops, hosting a workshop or obtaining resources, visit Wild BC at: www.hctf.ca/wild.htm.

Children learning about Kokanee Salmon at Peachland Creek.
PHOTO: Ministry of Water, Land and Air Protection.

CONCLUSION

The state of rivers and watersheds in British Columbia

British Columbia is a large and ecologically diverse province whose freshwater ecosystems defy generalization. Nonetheless, we need to understand the overall health of these important and fragile systems that sustain both humans and wild species so that we can help them thrive for future generations. Therefore, as a starting point, this *State of Rivers and Watersheds* report provides a broad picture of BC's rivers, lakes and wetlands while identifying what is being done and what can be done to help protect them.

Looking at the big picture for BC, many freshwater ecosystems appear to be functioning well. Some systems, however, have been drastically altered and have severe problems; for example, streams that have been stripped to their banks, wetlands that have been damaged or destroyed and riparian habitat that has been reduced or eliminated. These are only a few examples of freshwater ecosystems that need our attention. In addition, some parts of the province are under considerable pressure from human activity, the severity of which varies from watershed to watershed. Further monitoring and reporting on individual watersheds is clearly needed.

Overall, we can say that:

- **Water quality** is generally good in both surface and ground freshwater ecosystems that have been tested in BC. Several water bodies have water quality problems due primarily to human activities. Many freshwater ecosystems have never been tested and there is a particular lack of information in the north of the province. Testing and long-term monitoring must continue.
- **Water quantity** in BC's rivers, streams and underground aquifers varies substantially as the seasons change. Although this is natural, human pressures coupled with climate trends are creating situations in which sufficient water is not available for many freshwater ecosystems to function properly or to provide for human social and economic requirements. This is of greater concern in some parts of the province than in others, with the situation at times reaching critical levels. Water conservation must become more widespread.
- **Aquatic and riparian species** make up a large component of all the native species in BC.

Above: The town of Osoyoos, like many others in BC, grew alongside water.
PHOTO: Ministry of Water, Land and Air Protection.

Some have thriving populations, others have stable populations and still others are listed by the Province as Threatened, Endangered or of Special Concern. A few no longer exist in BC – or the world. Because healthy plant and wildlife populations are essential for the successful functioning of ecosystems, it is imperative to protect them.

- **Aquatic and riparian habitats** are the cornerstone of healthy species and ecosystems. Habitat loss, fragmentation, degradation and conversion are major causes of lost biodiversity and lost environmental services. Habitats must be protected and, if necessary, restored to ensure the continued prosperity of the province and its inhabitants. In BC, the focus has often been on protecting terrestrial ecosystems. A renewed focus on aquatic ecosystems is needed.
- **Pressures** on freshwater ecosystems vary around the province depending on population and human uses of both land and water. In parts of BC where population growth is highest, the demands made on land and water resources are increasing rapidly. Without careful planning and commitment to minimize human impacts, freshwater ecosystems will be stretched beyond their limits.
- **Responses** by people to help protect and restore freshwater ecosystems include the actions of governments, industries, businesses, organizations, communities and individuals. This joint effort is vital to the successful protection of BC's fresh waters. A lot of positive work takes place in BC, but to ensure that rivers, streams, lakes, wetlands and groundwater ecosystems are conserved, more participation and sustained commitment is needed.

The demand for water increases in summer when many streams have naturally low water flow.

PHOTO: Rowena Rae, Ministry of Water, Land and Air Protection.

WHAT CAN WE DO?

Shared stewardship of BC's freshwater ecosystems

To ensure that our aquatic resources can continue to support us and the thousands of other species that live in and depend on them, we must all – governments, industries, businesses, organizations, communities and individuals – work together as responsible stewards of freshwater ecosystems. We can do many things as stewards of fresh water, the most worthwhile being ecosystem protection. For ecosystems that have not been adequately protected, ecosystem restoration is a valuable tool. A better and less expensive objective, however, is to protect habitats and species before they become endangered.

What can governments do?

- Continue long-term planning to ensure that the needs of both humans and wildlife, including freshwater species, are met.
- Implement monitoring programs that collect, store, review and report on the condition of freshwater ecosystems.
- Develop best management practices and standards, test and update them and educate industries and the public about how to implement them.
- Provide incentives for industries and individuals to protect and restore aquatic resources.
- Collaborate and form partnerships with other levels of government, industry and organizations.
- Continue to develop relevant policies and legislation to ensure that freshwater ecosystems are conserved.

What can industries and businesses do?

- Recognize and enshrine the inherent value of water for society and for a sustainable economy.
- Follow best management practices to minimize the environmental impact of operations on both land and water.
- Implement practices that conserve water by using less and using it more wisely.
- Protect water quality by reducing the use of toxic chemicals and eliminating toxins from wastewater effluent.
- Support local organizations that have sound stewardship policies.
- Provide sponsorship to events and activities that promote or undertake freshwater ecosystem stewardship.

What can organizations do?

- Promote sustainable land and water use among members of the organization.
- Support local industries and businesses that use sound environmental practices in their operations.
- Participate in activities related to water conservation and freshwater ecosystem protection.

What can communities do?

- Develop long-term plans for land and water use.
- Make bylaws for land development that consider the resources available and potential impacts on freshwater ecosystems.
- Commit to improving wastewater treatment and local septic systems.
- Implement water use restrictions that make sense for the location of the community and the source of water.
- Support and encourage local groups and organizations that work as environmental stewards.

What can individuals do?

- Learn about local watershed issues and motivate your neighbours, friends and co-workers to do the same. Educate your children about the natural world.
- Become a steward of your own property and local area.
- Volunteer your time, energy and passion by joining a local stewardship group.
- Adopt simple lifestyle changes that reduce your impact on freshwater ecosystems.
- Support businesses and organizations that demonstrate environmental stewardship.
- Donate to charitable organizations that advocate healthy ecosystems for healthy communities.

SOME SPECIFIC IDEAS ABOUT HOW TO HELP BC'S FRESHWATER ECOSYSTEMS

Web site addresses for organizations mentioned are listed in the Web Resources section on page 50.

To help conserve water:

- Use water saving appliances such as shower heads, dish washers and washing machines.
- Keep a jug of water in the fridge to avoid running water from the tap for a cold drink.
- Take short showers rather than baths.
- Turn taps off while brushing your teeth.
- Put plastic bottles of water in the toilet tank so each flush uses less water.
- Water gardens only at night to reduce water loss from evaporation.
- Landscape with plants that are native to your area. They will be best adapted to the local water conditions.

To help protect water quality:

- Reduce or eliminate the use of synthetic fertilizers and pesticides.
- Use alternatives to harmful cleaning products.
- Have your septic system checked and maintained regularly.
- Take paints, oils, batteries and other hazardous materials to a recycling or collection facility.
- Never pour anything down storm sewer grates – they flow directly into streams, lakes, wetlands and the ocean.

To help protect wildlife and habitats:

- Learn about the species at risk in your area and what you can do to help them and their habitat.
- Join a local conservation group involved in species recovery or habitat conservation and restoration.
- Donate to organizations that help recover species and protect habitat.
- Leave plants and wildlife alone – don't pick them or transfer them from one place to another.
- Never release aquarium plants or fish, or any other animals, into a water body.
- Wash your boat and trailer between visits to lakes and rivers.
- If a stream runs through your property, plant native vegetation alongside it.
- If you have a wetland on your property, make a stewardship agreement or enact a conservation covenant. Ducks Unlimited Canada can assist you with this.
- If you live along a shoreline, whether lake, stream or ocean, contact the Living By Water Project for information and ideas about protecting your shoreline.

Together we can make a difference and leave a legacy of living rivers, lakes, wetlands and watersheds for our children and grandchildren!

Web Resources

Fresh Water – National and International

Canada's Wonder of Water program www.wonderofwater.ca

Canadian Heritage Rivers System www.chrs.ca

Canadian Water Resources Association www.cwra.org

Environment Canada's Freshwater Website
www.ec.gc.ca/water/ e_main.html

United Nations International Year of Fresh Water
www.wateryear2003.org

Fresh Water – British Columbia

BC Heritage Rivers System www.bcheritagerivers.ca

BC Rivers Day www.orcbc.ca

BC Water Portal wlapwww.gov.bc.ca/wat

Networking BC Rivers www.educ.sfu.ca/nbcr

River Recovery: Restoring Rivers through Dam Decommissioning
www.recovery.bcit.ca

Water Conservation

Water Audit
www.ec.gc.ca/water/en/info/pubs/brochure/e_iwdww8.htm

Water Efficiency/Conservation
www.ec.gc.ca/water/en/manage/effic/e_weff.htm

Climate Change

Climate Change www.climatechange.gc.ca

Indicators of Climate Change for BC, 2002 Report
wlapwww.gov.bc.ca/air/climate/indicat

Wildlife and Fish

BC Fish Facts Factsheets
wlapwww.gov.bc.ca/wld/fishhabitats/fishfactsheets.html

BC Fish Wizard pisces.env.gov.bc.ca

BC Frogwatch Program wlapwww.gov.bc.ca/wld/frogwatch

BC Species Explorer (Conservation Data Centre)
srmwww.gov.bc.ca/atrisk/toolintro.html

Committee on the Status of Endangered Wildlife in Canada
www.cosewic.gc.ca

Greater Georgia Basin Steelhead Recovery Plan
www.steelheadrecoveryplan.ca

Natureserve Explorer, an online encyclopedia of life
www.natureserve.org/explorer

Pacific Fisheries Resource Conservation Council www.fish.bc.ca

Pacific Salmon Foundation www.psf.ca

White Sturgeon
www.bcfisheries.gov.bc.ca/fishhabitats/Sturgeon/Sturgeon.htm

Habitats and Ecosystems

Canadian Parks and Wilderness Society www.cpaws.org

Ducks Unlimited Canada www.ducks.ca

Federation of BC Naturalists www.naturalists.bc.ca

Fraser Basin Council www.fraserbasin.bc.ca

Georgia Basin Action Plan www.pyr.ec.gc.ca/georgiabasin

Langley Environmental Partners Society www.leps.bc.ca

Naturescape BC www.hctf.ca/nature.htm

The Land Conservancy of BC www.conservancy.bc.ca

The Nature Conservancy of Canada www.natureconservancy.ca

The Nature Trust of British Columbia www.naturetrust.bc.ca

Household and Gardening

Buy Green: a Guide to Green Products and Services
www.buygreen.com

Environmental Choice Program www.environmentalchoice.com

Native Plant Society of BC www.npsbc.org

Stewardship and Education

BC Lake Stewardship Society www.nalms.org/bclss

BC Stewardship Centre www.stewardshipcentre.bc.ca

BC Watershed Stewardship Alliance www.bcwsa.bc.ca

Community Mapping Network www.shim.bc.ca

Cows and Fish: Alberta Riparian Habitat Management Program
www.cowsandfish.org

Great Canadian Shoreline Cleanup www.vanaqua.org/cleanup

Habitat Conservation and Stewardship Program
www-heb.pac.dfo-mpo.gc.ca/english/programs/hcsp

Osoyoos Lake Water Quality Society www.olwqs.org

South Okanagan Puddle Project
wlapwww.gov.bc.ca/wld/frogwatch/whoswho/puddle.htm

Streamkeepers Program www.pskf.ca

The Living By Water Project www.livingbywater.ca

Wetlandkeepers Program
www.bcwf.bc.ca/programs/wetlands/wetlandkeepers.html

Wild BC www.hctf.ca/wild.htm

Industry and Business

BC Agriculture Council www.bcac.bc.ca

BC Business Council www.bcbc.com

BC Hydro www.bchydro.com

Council of Forest Industries www.cofi.org

Mining Association of BC www.mining.bc.ca

Urban Development

Smart Growth BC www.smartgrowth.bc.ca

Urban Development Institute, Pacific Region www.udi.bc.ca

Government of British Columbia

BC Statistics www.bcstats.gov.bc.ca

Land and Water BC, Inc. lwbc.bc.ca

Ministry of Agriculture, Food and Fisheries www.gov.bc.ca/agf

Ministry of Community, Aboriginal and Women's Services
www.gov.bc.ca/mcaws

Ministry of Forests www.gov.bc.ca/for

Ministry of Sustainable Resource Management
www.gov.bc.ca/srm

Ministry of Water, Land and Air Protection www.gov.bc.ca/wlap

State of Environment Reporting

Environmental Trends in British Columbia
wlapwww.gov.bc.ca/soerpt

Pacific and Yukon Region Environmental Indicators
www.ecoinfo.ec.gc.ca/env_ind/indicators_e.cfm

Index

S

T

U

V

W

Y