# Georgia Basin Ecosystem Initiative

## A 5-Year Perspective


WORKING TOGETHER
FOR THE
GEORGIA BASIN

AU TRAVAIL
POUR LE
BASSIN DE GEORGIA


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# INTRODUCTION



Spectacular and bountiful, the Georgia Basin encompasses an inland sea and the land around it. Made up of Puget Sound, the Straits of Georgia and Juan de Fuca, this sea and its shores provide vital habitat for the millions of birds that migrate each year along the Pacific Flyway. More waterbirds and raptors winter here than anywhere else in Canada, and five species of salmon use the Basin's waters as the gateway to their spawning grounds.

More and more people are choosing to make this ecologically diverse region their home. In the past 25 years, the Georgia Basin's population has more than doubled. If this rate of growth continues, the pressures on wildlife, migratory birds and fish, and the habitats these species require in order to survive, will need to be carefully managed to ensure the overall well-being of the ecosystem.

*"The Coast Salish people recognize the close relationship between land and sea. They have witnessed first hand the impacts of development on marine resources in the Strait of Georgia and Juan de Fuca. These impacts have altered traditional life."*

*— Tom Sampson, Elder of the Tsartlip First Nations*



# OFFICIAL PARTNERS

**The federal and provincial government partners of the GBEI are:**

- **Environment Canada**
- **Fisheries and Oceans Canada**
- **Parks Canada**
- **Ministry of Water, Land and Air Protection**
- **Ministry of Sustainable Resource Management**
- **Ministry of Community, Aboriginal and Women's Services**

The Georgia Basin Ecosystem Initiative is one of six national ecosystem initiatives supported by Environment Canada

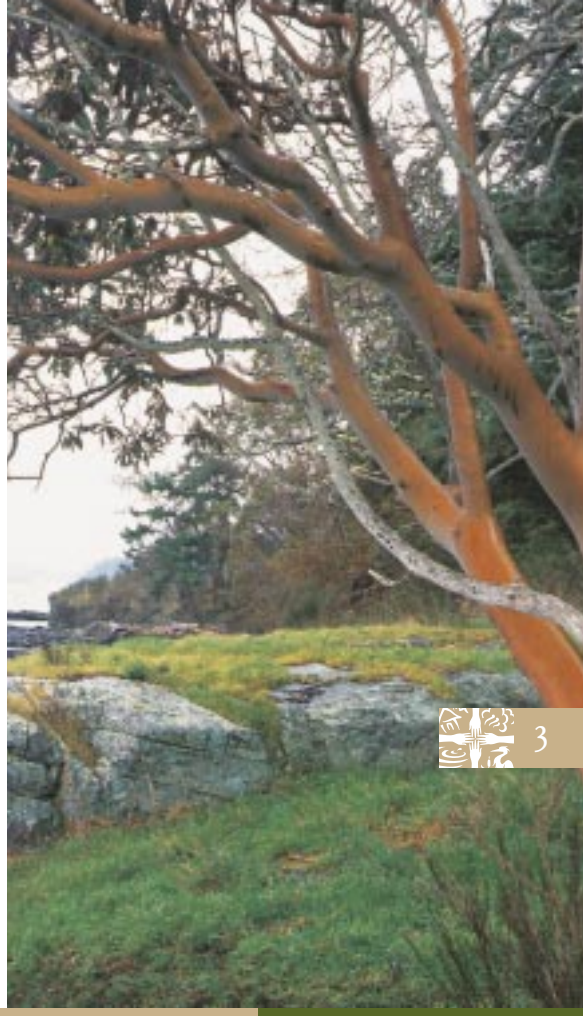
To protect, restore and conserve this unique ecosystem, the federal and provincial governments launched the *Georgia Basin Ecosystem Initiative* (GBEI) in 1998. And, because the Georgia Basin and Puget Sound ecosystems are interconnected, a complementary transboundary plan, the *Joint Statement of Cooperation on the Georgia Basin and Puget Sound Ecosystems*, was signed by Environment Canada and the United States Environmental Protection Agency in 2000. This plan is in addition to the transboundary collaboration of the British Columbia/ Washington Environmental Cooperation Council, established in 1992.

Between 1998 and 2003, the GBEI brought together federal, provincial and state agencies, local government agencies, community groups, Coast Salish First Nations, industry associations, conservation groups and other non-profit organizations. Working collaboratively, these partners used an ecosystem approach to address the Georgia Basin's environmental needs.

Building from a vision of healthy and sustainable ecosystems and

communities, the GBEI focused its support on actions which protect ecological values, and mitigate and reverse the harmful impacts that can result from human activities. Its partnerships have led to actions on growth-management strategies, including the formation of many community round tables throughout the Georgia Basin.

Over its five-year mandate, the GBEI accomplished its key objectives, and communicated these to its partners and audiences through annual public reports and milestone announcements. Public and stakeholder steering committee meetings were also instrumental in relaying progress, as were gatherings like the *Georgia Basin/Puget Sound Research Conference*. This report details the progress made by the partnership over the past five years. While much work still needs to be done to ensure a sustainable future for the region, this progress represents a sound beginning.





## THE "SALISH SEA"

*The Georgia Basin's geographic area corresponds almost exactly with the traditional territory of the Coast Salish People. For thousands of years, the Coast Salish exercised sound environmental stewardship over the land and resources of this unique and sensitive ecosystem, a place referred to as "Sqelatses." This word translates in Coast Salish Halkomelem and Sencoten as "Home."*

*Within "Sqelatses," teachings handed down from elder to child included holistic practices designed to sustain abundance and diversity. These practices recognize the indivisible relationship between land, resources, and people, and to this day, the land, the sea, and all the resources of the Georgia Basin Ecosystem have Coast Salish names.*

*Describing the complex inter-relationships of nature, the lifecycles of flora and fauna, the seasons, the tides, and the winds, this traditional knowledge of the Coast Salish People imparts how humans must live in balance with the ecosystem. This holistic approach to sustainability, demonstrated over countless generations, can provide leadership to the various governments, agencies, and organizations working to restore health and well-being to the Georgia Basin–Puget Sound Ecosystem.*

*Partnership with Coast Salish First Nations, through the Coast Salish Sea Initiative, has helped advance the inclusion of traditional knowledge into GBEI planning activities. It has also increased understanding of Coast Salish environmental priorities, and has facilitated action on issues of specific concern to Coast Salish communities.*

# EXECUTIVE SUMMARY



The GBEI partnership committed itself to taking action on the following goals over five years:

- Supporting Sustainable Communities
- Achieving Clean Air
- Conserving and Protecting Habitats and Species
- Achieving Clean Water

## Supporting Sustainable Communities

Sustainable communities are ones where residents and decision-makers understand and respect the integrity of the ecosystem. The GBEI supported 50 projects initiated by non-profit organizations and local governments to assist environmental decision-making in Georgia Basin communities, as well as annual reports, workshops and a website, which has enhanced communication and dialogue. We also partnered in the development of decision-support tools for sustainable planning, including the *Smart Growth Toolkit, Georgia Basin QUEST*, and the *Stewardship Centre*. As well, we developed and reported on a variety of community-based, regional and transboundary indicators.

## Achieving Clean Air

Communities and ecosystems need clean air in order to remain healthy. To achieve this, we significantly advanced our understanding of the sources and impacts of air pollutants, as well as the management challenges and opportunities associated with improving air quality in the region. Since the Georgia Basin's airshed spreads across international borders, local, provincial, state and federal governments from both Canada and the U.S. are developing common strategies to deal with air pollution. Studies on the nature and causes of air pollution were compared with specific levels across the Georgia Basin. Extensive analysis determined that while traditional pollution-causing sources like motor vehicles and power plants account for SMOG and high levels of airborne particulate matter (PM), emissions from marine vessels are also responsible. The *Pacific 2001 Air Quality Study* detailed the sources and formation of PM and ground-level ozone, establishing in the process an advanced understanding of air quality in the Fraser Valley. In addition, the GBEI examined the effects poor air quality has on human and environmental health and on the economy, as well as the projected impact climate change will have on our airshed. There are lessons to be learned from the proposed Sumas Energy 2 power generation plant in Sumas, Washington. SE2 is in the wrong location within a fragile airshed and the governments of Canada and British Columbia, the Fraser Valley Regional District and City of Abbotsford remain strongly opposed to its construction. Residents will benefit from greater area-based planning within the transboundary Georgia Basin/Puget Sound airshed.



## Conserving and Protecting Habitat and Species

To maintain the biodiversity and well-being of all land and water–based species in the Georgia Basin, we identified sensitive ecosystems and habitats, and the stresses that result from pollution and other human interference. Monitoring the levels of pollutants in waterbirds, and the declining breeding rates among amphibians, served as an indicator of the overall health of the ecosystem. Tracts of land that contain especially sensitive or at-risk plants and animals, such as Garry Oak woodlands, were acquired for protection, and a new National Park Reserve for the southern Gulf Islands was established. The recovery of wild steelhead populations began, as did less-obtrusive marine mammal viewing practices. Conservation and stewardship partnerships were developed, and broader landscape-based approaches to biodiversity conservation were introduced into land-use planning processes. These will better integrate ecological values into growth-management strategies and private land-management practices.

## Achieving Clean Water

To protect and improve aquatic ecosystem health and human well-being in the Georgia Basin, we increased our understanding of the sources, distribution and impacts of key toxic substances through inventories and research. Best management practices to reduce impacts from agricultural and stormwater runoff were developed and implemented, and community-based approaches for watershed management and remediation of closed shellfish harvesting areas were advanced. Educational tools and training to improve the operation and maintenance of on-site sewage disposal systems, reduce waste discharges from vessels, and minimize risks associated with the use of agricultural chemicals all contributed to improved stewardship of the ecosystem.

# Toward Sustainable Communities

## Residents and decision-makers taking action for healthy, productive and sustainable ecosystems and communities.

Sustainable communities are vital to ensuring a healthy ecosystem in the Georgia Basin. In the face of the Basin's increasing population, managing the impacts of growth in ways that protect the environment while meeting the social and economic needs of the region's communities is a complex challenge. In support of our Sustainable Communities goal, we created many partnerships which allowed us to build community awareness and capacity, provide tools to guide and inform local decision-making processes, and report on our collective progress through a broad range of sustainability indicators.

### BUILDING COMMUNITY AWARENESS

Increasing awareness of the benefits of more sustainable practices, and providing access to information, knowledge and tools, translates into informed decision-making. Communities and individuals become better equipped to make decisions concerning land development, habitat conservation and the protection of air and water quality.

### Community Initiatives

In conjunction with community leaders and municipal governments, the GBEI partnered in a number of outreach and awareness-building efforts to promote the protection and restoration of the environment. For example, there are several pledge programs underway in which special recognition is given to residents and businesses that take steps to help protect their environment. The *Business Environmental Pledge Program*, implemented in the City of Abbotsford in 2002, is one such project.

*"In the Georgia Basin, we are leaders in sustainability—encouraging clean air, clean water; promoting biodiversity; ensuring sustainable communities. By involving our communities in sustainable practices, we are raising the awareness needed to preserve our Georgia Basin/Puget Sound ecosystems."*

*—Mike Harcourt,*
*former Premier of British Columbia*

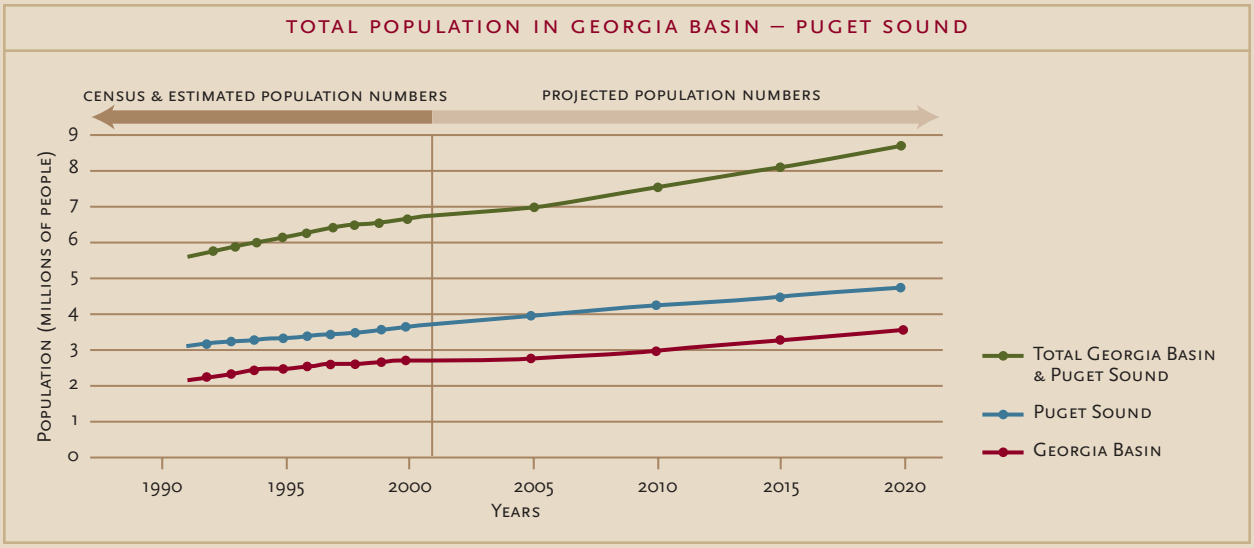
The *Rock Bay Contaminant Reduction Project* in Victoria Harbour is another. This joint endeavour of the Burnside Gorge Community Association and the Veins of Life Watershed Society is a school outreach as well as a business and residential pledge program. Aiming to improve stormwater discharge quality in Rock Bay and significantly reduce chemical contamination of bay sediments, this initiative is operating in conjunction with the City of Victoria's *Stormwater Management Plan*.

The *Community Based Action Program for Shorelines* (CAPS) builds on the success of *Living by Water*, improving awareness of the need for healthy, natural shorelines. Workshops and presentations aimed at realtors, shoreline residents, municipal businesses and other groups interested in shorelines will ultimately lead to improved decision-making and a "natural shoreline consciousness." This program delivers on-the-ground results in protecting, conserving and restoring marine and freshwater shorelines for the benefit of fish, wildlife and residents.



## POPULATION INDICATOR

*Indicators are one of the ways we can measure progress toward reaching goals. Population growth is a major indicator when considering a healthy relationship between communities and the ecosystem. Nearly seven million people currently make their home in the Georgia Basin–Puget Sound region, and predictions indicate that by 2020, this number will reach nine million. Since population growth affects sustainability, monitoring population trends can help us develop strategies to manage the associated issue of land use.*




Source: Georgia Basin–Puget Sound Ecosystem Indicators Report

The *Nature of Cities*, an outreach and education campaign in Victoria and the Lower Mainland, is a project under Evergreen's *Common Grounds* program. Providing environmental policy and program suggestions, and innovative protection and partnership strategies, it also showcases best practices and case studies from across the country, and offers sound economic, environmental and social arguments for better green-space protection and management.

## Education Initiatives



Some innovative educational approaches included sponsorship of the *Regional Sustainable Development and Integrated Assessment* course and lecture series. Taught through the University of British Columbia (UBC), in conjunction with the University of Washington and the University of Western Washington, this course provides an integrative academic program which addresses sustainability challenges in the Georgia Basin–Puget Sound transboundary region in the foreseeable future.


*Building a non-point source pollution model*

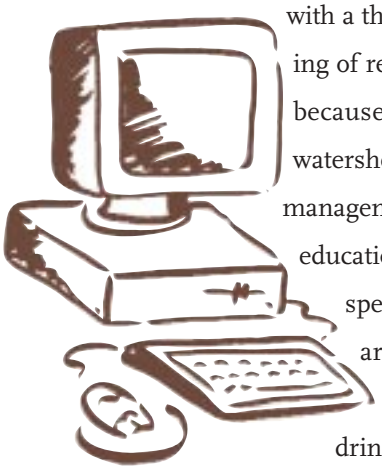
Creative initiatives such as in-class workshops for children and youth have helped to raise awareness of environmental issues in and around the classroom. The *BC EcoEducation Guide to Environmental Action* is a BC Conservation Foundation and Wild BC project designed for teachers and students in Grades 4-8, while the *Salish Sea Handbook* is another innovative educational resource, which uses music to teach students about the importance of marine environments. Also, the *Do-It-Yourself Guide to Building a Non-Point Source Pollution Model* was used to show children how they can build their own community non-point source pollution model within a fun and educational environment.

## PROVIDING TOOLS FOR DECISION MAKERS

Interactive tools can go a long way toward promoting sustainability. They not only increase our awareness of the current state of the ecosystem, but many can also project possible-case scenarios into the future. This provides communities and decision-makers with advanced forms of information to influence the actions taken to achieve sustainability. Interactive websites and other electronic tools that share current environmental information, land maps that plot the development of the region and informative guides that promote sustainable development practices all empower our decision-makers.

## Computer-Based Tools

The Urban Watershed Management CD-ROM is one of these tools. Developed by UBC's Institute for Resources and Environment Continuing Studies Program, this tool became the "textbook" for an Internet-based course on urban watershed management. It can also provide practicing watershed management professionals and community leaders



with a thorough, up-to-date understanding of related problems and solutions, because it covers topics related to watershed assessment and monitoring, management and planning, action and education. As well, it includes various special topics such as impervious areas, riparian buffer zones, floodplain management and drinking-water supply.

Providing information to users through the Internet was another major platform supported through the GBEI. Tools like the *Stewardship Centre Website* create awareness and provide step-by-step technical guidance on how to conserve land, water, and fish and wildlife habitat. As an interactive site, the *Stewardship Centre* allows people not only to learn, but also to share experiences. Including the *Stewardship Series* guidebooks, interactive case studies, a resource library, and a wide range of environmental and stewardship links, the *Stewardship Centre* covers a range of topics from how to preserve coastal shores to how to set up an estate to benefit the environment, and will help those interested in caring for lands they either own or steward.

Another innovative tool supported by GBEI is QUEST (*Quite Useful Ecosystem Scenario Tool*). This Internet-based computer model was developed under the *Georgia Basin Futures Project* (GBFP), a five-year research project which combines expert knowledge and considered public opinion to explore paths to sustainability. By presenting future scenarios for the next 40 years, QUEST explores how citizens can learn to live within the limits of natural ecosystems, while improving human well-being.



## COMPUTER BASED TOOLS

- Urban Watershed Management CD-ROM
- Stewardship Centre Website
- QUEST *(Quite Useful Ecosystem Scenario Tool)*

*Poorly planned development can lead to urban sprawl and encroachment of critical habitat*

Environment Canada

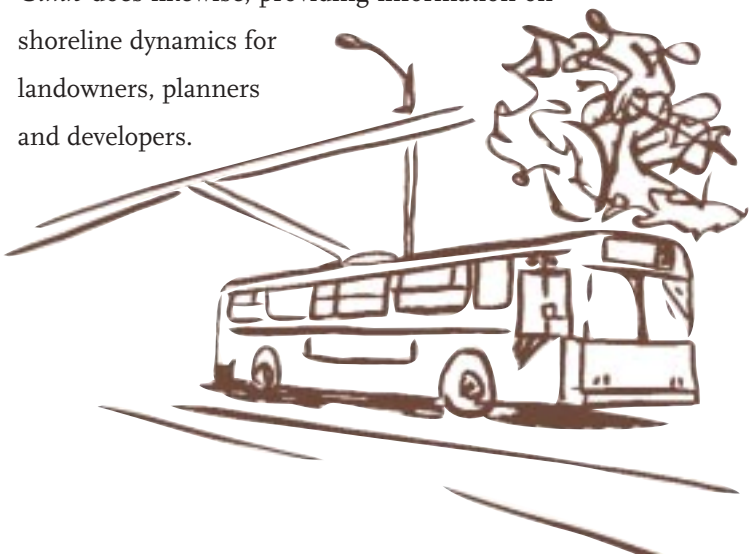

*Vancouver's West End: a mixed use, high density, pedestrian created community*

## Mapping Tools

Land-use mapping is another way in which we can measure urban development and land-use trends. Data management projects have been designed to monitor the state of a watershed and deliver resource information to decision-makers and the public through a number of interactive tools. A good example is the *Integrated Data Management Initiative* in the Cowichan Valley. Including a prototype web-mapping program with live links to data, this innovative tool for local government planners supports environmental protection and provides a broad range of relevant information.

Another example is the *Galiano Island Wildlife Habitat Conservation Project*. Using GIS technology, this initiative provides a web-based exchange of environmental information between local organizations, individuals and government.

The *Natural Areas Atlas for the Capital Region* and the *Coastal Shores Stewardship Guide* are two products designed to help land-use decision-makers. As a web-based mapping tool, the *Natural Areas Atlas* contains geographic information such as the location of salmon-bearing streams, spawning zones, old-growth forests, endangered ecosystems, record-sized trees and shoreline habitats. By providing detailed information about the location and description of natural areas in the Capital Region District (CRD), this tool facilitates well-informed, responsible and sustainable land-use planning. The *Coastal Shorelines Stewardship Guide* does likewise, providing information on shoreline dynamics for landowners, planners and developers.



Many of these tools educate and guide at the same time, articulating the state of the ecosystem and the measures communities can take to maintain its health. Understanding a region's physical processes and native biological communities helps us manage urban and rural development.

## Smart Growth Tools

Since urbanization can affect the environment, reducing the impact of development is key to maintaining ecological health. Through regional and transboundary partnerships, tools and approaches to address this issue are being introduced. Often referred to as "smart growth," these approaches discourage sprawl by developing existing urban areas, protecting the ecological integrity of urban and suburban areas, and minimizing automobile use. A balance between rural and urban spaces, enabled by new and alternative development standards and driven by community involvement, is another major principle in the smart-growth concept.

Reaching out and educating the community about smart growth through conferences and workshops is one way to spread the word. Organized community gatherings, access to written and verbal information on smart growth, and professional advice on ways to develop smart-growth communities are all helping to promote the concepts of ecosystem-based management and community responsibility. A *Smart Growth Toolkit* was created to offer ideas and resources for communities interested in sustainable development. Over 600 of these toolkits have been distributed, in the Georgia Basin, and across Canada.

The *Smart Growth Practitioners Workshop* in Port Townsend, Washington brought together practitioners from both sides of the border to develop common smart-growth strategies that will protect watershed and ecosystem health in the Puget Sound and Georgia Basin. At the forum, speakers presented smart-growth principles, while practitioners identified areas where smart-growth principles need advancing. A summary of the principles and related suggestions for action contributed to the planning of the *Leadership and Innovation in Urban Sustainability Conference* in March 2001, and guided some of the transboundary work on smart growth.

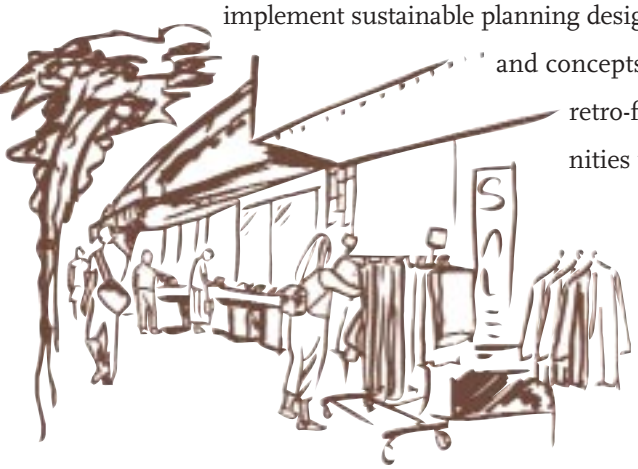


*High density living: an example of sustainable communities*


*Walkable neighbourhoods provide a balance between nature and humans*

Pilot projects allow us to view the benefits of smart growth. In the East Clayton area of Surrey, the *Headwaters Project* has attracted international attention as an example of better-managed growth. Here, walkable neighbourhoods and grassy swales along roads will strike a positive balance between nature and humans. Natural drainage systems and storm-retention ponds, which also provide a home for ducks and frogs, are two other methods by which this project hopes to preserve the state of the ecosystem.

Building on this experience and that of many partnered organizations over the last eight years, the multi-year *Smart Growth On-the-Ground* initiative will attempt to implement sustainable planning design principles and concepts in new or retro-fitted communities within BC.



## DEVELOPING SUSTAINABILITY INDICATORS

To measure progress toward sustainable development, and monitor the environment, we can transform complex data into easy-to-use communication and decision-making tools. These tools, called sustainability indicators, reflect the status of, or trends in, key aspects of the environment and the community. They help draw attention to the challenges our communities face, our progress in addressing them, and the responses necessary for achieving sustainability.

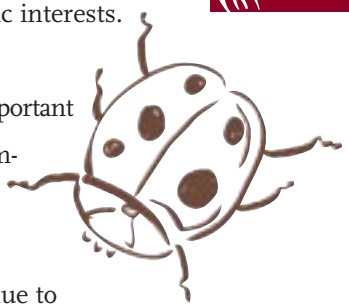
Sustainability indicator initiatives are now in place throughout the Georgia Basin. These programs have grown in response to the needs of decision-makers at the local, regional, provincial, national and international levels, as well as the needs of scientists to communicate their findings more effectively. Environment Canada developed a dynamic set of *Environment Indicators* on toxic contaminants, wildlife sustainability, potential air quality health risk,

biological diversity, ground-water contamination and resource sustainability in the Georgia Basin. Meanwhile, BC Stats produced a socio-economic profile of the Georgia Basin. Available on their website, this profile highlights indicators on the human condition, including demographics, economic hardship, education concerns, labour market and issues, crime, health problems, and children and youth at risk.

As well, a collaborative report titled the *Georgia Basin–Puget Sound Ecosystem Indicators Report* was produced by GBEI partners, the Puget Sound Water Quality Action Team, the Washington State Department of Ecology and the U.S. Environmental Protection Agency. The indicators in this report relate to human population growth, air quality, solid waste and recycling, toxic pollutants in harbour seals, species at risk and protected areas.

Through the support of the GBEI, some communities in the Georgia Basin have developed *Community Indicator and Benchmark Reports*, such as the *New Westminster Healthy and Sustainable Indicators Pilot* and the *Islands Trust –Sustaining the Islands Program*. In the New Westminster initiative, where organizations and residents reported on the community's progress toward social, economic and environmental sustainability, an encouraging finding was a significant increase in parkland over the past 25 years. A report is also underway in Sechelt, building on work which identified the area's priority goals for integrating social, environmental and economic interests.





These initiatives will not only identify important trends, but they will also foster strong community partnerships. With new ways to measure changing conditions, Georgia Basin–Puget Sound communities continue to progress in their efforts to achieve sustainability.

## INCREASE IN NEW WESTMINSTER PARKLAND OVER THE PAST 25 YEARS

*Over the past 25 years, there has been a 50% increase in parkland in New Westminster. Although the city's population has increased by 34%, green space has not been sacrificed to development. Currently, 9.24% (141.71 hectares) of the city's total area is designated parks and green space, which is 7.45 acres per 1000 people.*

| Year | Population | Park Land Added | % of Park Land vs. Total Area of City |
|---|---|---|---|
| 1960 | 35,000 | 72.85 ha (170 acres) | 4.73 |
| 1960-1969 | 40,500 | 7.14 ha (18 acres) | 5.2 |
| 1970-1979 | 38,500 | 3.15 ha (8 acres) | 5.41 |
| 1980-1989 | 41,000 | 12.23 ha (30 acres) | 6.2 |
| 1990-1995 | 45,000 | 5.41 ha (13 acres) | 6.55 |
| 1996 | 47,000 | 6.13 ha (5 acres) | 6.97 |
| Blades/Plazas Total Park | - | 36.06 ha (90 acres) | 7.1 |
| Land Added | - | 50% increase | - |

Source: City of New Westminster. Parks and Recreation Master Plan.

# The Air We Breathe

## Achieving air quality that supports healthy, vibrant communities and healthy ecosystems.

To humans and animals, breathing is essential to life. But unlike the food we eat or the water we drink, there is only one option when it comes to the air we breathe. This is why the GBEI brought together partners from around the Basin in order to provide a better understanding of the state of the airshed, and to meet the challenges it faces in the future.

Air quality is an issue that transcends borders. In the Georgia Basin, local, provincial, state and federal governments are working as neighbours to develop common strategies to deal with air pollution, recognizing that cooperation will allow us a much better chance of success. The *Joint Statement of Cooperation on the Georgia Basin and Puget Sound Ecosystems* is helping to set priorities of action, improve communication through shared information, and establish a common approach to reducing emissions.

As we develop strategies to manage the airshed, we are determining what levels of pollution are acceptable for both human and environmental health, as well as conducting studies to identify the exact nature of air pollution. We are studying the effect air pollution has on humans, on the economy and on plants and animals. We are also studying the effects of climate change and analyzing where air pollutants are coming from. We know air pollution sometimes travels great distances, but we are also learning that it comes from local sources we never suspected. Just as we are working together to increase our knowledge about the nature and effects of air pollution, so too will we work together in our efforts to keep pollution levels down in the face of our growing population.

*"Our watersheds, our airsheds, our ecosystems and our systems of human settlements—they are our life-sustaining systems, our home, and our precious part of this beautiful planet. We owe it to ourselves to realize once again what a unique gift we have been blessed with and resolve to come together, whatever our differences, and safeguard this treasure for always."*

*—Johnny Carline,*
*Chief Administrative Officer, GVRD*

## UNDERSTANDING OUR AIRSHED

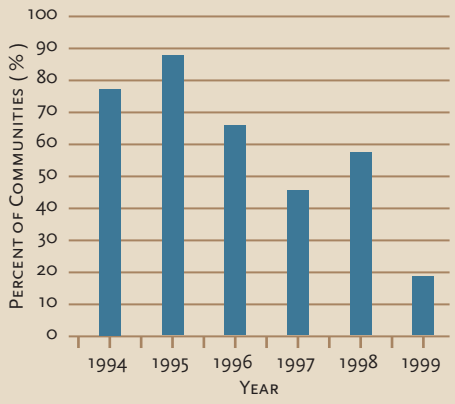
Understanding the sources, composition and transformation of air pollutants is the first step in managing air quality. In the last five years, the GBEI partnership was involved in various initiatives that are helping us understand the nature of air pollution. While much attention is focused on the Lower Mainland and Fraser Valley—an area particularly susceptible to the pressures of growth—other research is taking place around the Basin. For example, a program to measure the chemistry of rainfall over the southern areas of Vancouver Island is underway at Royal Roads University through a partnership with Environment Canada. Also, Environment Canada and the Ministry of Water, Land and Air Protection (WLAP) collaborated with the Cowichan Regional District to complete the first comprehensive air quality study in the Cowichan Valley.

Groundbreaking studies are helping us understand the nature of smog, including why it sometimes appears as a white haze and sometimes brown. Other research has shown us that pollution in the Fraser Valley, previously thought to originate from the Greater Vancouver area, is also being produced in the Valley—from growing cities like Abbotsford and the surrounding farm fields, and from Whatcom County in Washington State.




*The view of Mount Baker is often obscured by white haze*

## $PM_{10}$ INDICATOR




*Population growth is one indicator that pressure is being put on the environment. However, in terms of air quality, we can look to two indicators: smog, the white or brown haze that often blankets densely populated areas, and PM, which refers to airborne particulate matter. Fine particles 10 microns or less in diameter (one-eighth of a human hair), otherwise known as $PM_{10}$, are only one of many pollutants in the air we breathe, but they are known to pose a risk to human health. To monitor $PM_{10}$ concentrations, air quality stations are situated throughout the Georgia Basin–Puget Sound area. This bar graph is based on communities exposed to $PM_{10}$ more than 5% of the time.*

Source: Georgia Basin–Puget Sound Ecosystem Indicators Report

We are further along than ever in taking stock of what is happening in our air. By identifying the sources and studying the effects of air pollution, we can better characterize our airshed. Armed with this knowledge, we can monitor ground-level ozone and the nature of particulate matter (PM) in order to gauge the effectiveness of pollution control measures today, and predict levels years from now.

## Taking a Pollution Inventory

Pollution in the Lower Fraser Valley comes from a variety of sources that can be grouped into categories like point sources, area sources, mobile sources and natural sources. To develop an inventory of these emissions throughout the Georgia Basin, a number of partners came together, integrating Whatcom County into the study for the first time.



The *Year 2000 Emissions Inventory* lists common air contaminants (CACs) as well as ammonia, $PM_{10}$ and $PM_{2.5}$ (2.5 microns or less), and greenhouse gases (GHGs). Local emission sources that lead to the formation of PM include industry, power plants, vehicles, agriculture and natural sources like vegetation and the ocean.

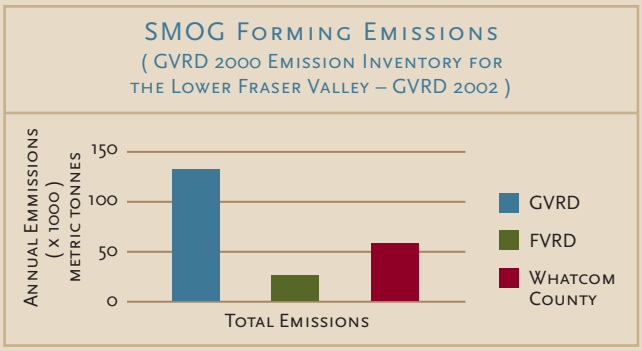
This emissions inventory also provides information on the amount and dispersal of pollutants responsible for smog. Emissions within the Greater Vancouver Regional District (GVRD) accounted for 145,124 metric tonnes, with the Fraser Valley Regional District (FVRD) emitting 38,963 metric tonnes and Whatcom County adding 74,420 metric tonnes.

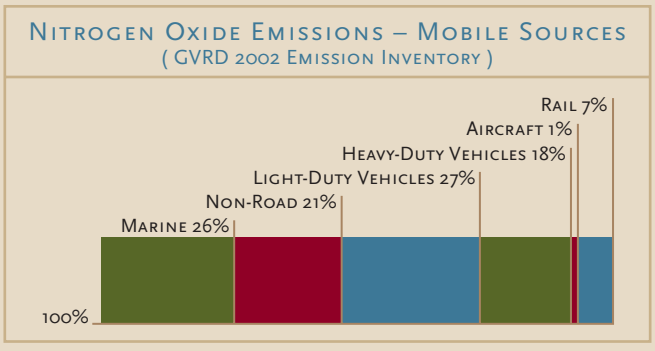
GVRD staff and consultants will use this inventory to backcast and forecast emissions. The forecast will project emissions forward to 2025 and identify the effectiveness of new regulations and emission-control strategies. Among these strategies are vehicle and fuel regulations and AirCare. This information is crucial for decision-makers on both sides of the border in setting future emission-control strategies to better manage air quality.

### Emissions From Marine Vessels

One important finding that emerged from the inventory was that emissions coming from marine vessels—including freighters and cruise ships—are comparable to emission levels from motor vehicles. This prompted Environment Canada, WLAP and the GVRD to begin discussions with industry representatives and other regulatory agencies in an effort to obtain international cooperation in reducing emissions from this sector. This would include improvements to marine vessel fuel quality and stricter controls exercised by our ports.

## TAKING A POLLUTION INVENTORY




Source: Greater Vancouver Regional District Emissions Inventory

*Evaluating a ferry water injection system*

A study undertaken by Environment Canada, in collaboration with Transport Canada and BC Ferries, evaluated an emissions reduction technology: a water injection system on a diesel propulsion engine. As the *Queen of New Westminster* operated under normal service between Vancouver and Vancouver Island, two separate tests were conducted with the water injection system.

When using the continuous water injection system, there was a 10–22% reduction in oxides of nitrogen emission rates (kg/tonne fuel), and a 19.8% (average) reduction of particulate mass without compromising carbon monoxide (CO) and carbon dioxide emissions. The system manufacturer measured differences in other engine parameters and ambient conditions. Engine load increased ~1%, while specific fuel consumption decreased ~1%.

### Ocean Sulphur

To complement the calculation of emissions from various sources, a study assessed the amount of sulphur produced by the ocean. With the help of the Canadian Coast Guard Hovercraft (SIYAI), water and air samples were collected from 51 different locations in the Strait of Georgia. Sample analysis indicated that more than 7% (~1000 tonnes) of the total sulphur emitted to the atmosphere in the Georgia Basin comes from natural oceanic sources (dimethylsulphide).

## Examining Smog-Causing Pollutants: Pacific 2001 Air Quality Study

Having a sound scientific understanding of our current air quality is crucial to ensuring cleaner air for future generations. Led by Environment Canada, an international team of scientists undertook a study in the Fraser Valley to improve awareness of air pollution in the region and in other parts of Canada. This team included the National Research Council, Natural Resources Canada, WLAP, the GVRD and researchers from Canadian and American universities. More than 130 researchers took atmospheric measurements at five sites, on board aircraft and using weather balloons. As they collected data on the complex atmospheric processes that create air pollution in the Valley, researchers based in Washington State conducted a complementary field campaign that extended southward over Puget Sound.



*Smog in Vancouver*

### The Composition and Movement of Pollutants

*Pacific 2001* provided information on the sources, formation and distribution of PM and ground-level ozone—key smog-causing pollutants—in the Fraser Valley. Results from sampling locations confirmed the impact motor vehicles are having throughout the Valley. Measurements of fine PM in Vancouver were compared with similar measurements at Langley and Sumas Mountain, revealing the importance of sea-salt particles in western areas and the dominance of ammonia in eastern areas.

The composition of these particles helps us understand why haze layers appear differently in western and eastern portions of the Valley. The distribution of aerosols measured by the aircraft instruments showed high concentrations filtering up the tributary

valleys during the day and often residing in the valleys overnight. On other occasions, these particles would flow out of the valleys, increasing concentrations within the Fraser Valley.

The movement of pollutants westward out of the Valley into the Strait of Georgia was also documented. Under these wind-flow conditions, pollutants from the Valley mixed with pollutants from other parts of the Basin, stagnating in the Strait until winds increased and moved the pollutants inland once again. The flow of pollutants from the marine sector was observed through highly detailed measurements at the Vancouver sampling location. On two occasions, the air quality data and wind patterns identified plumes from large diesel sources in the English Bay area drifting across Vancouver.



### The Result of Pacific 2001

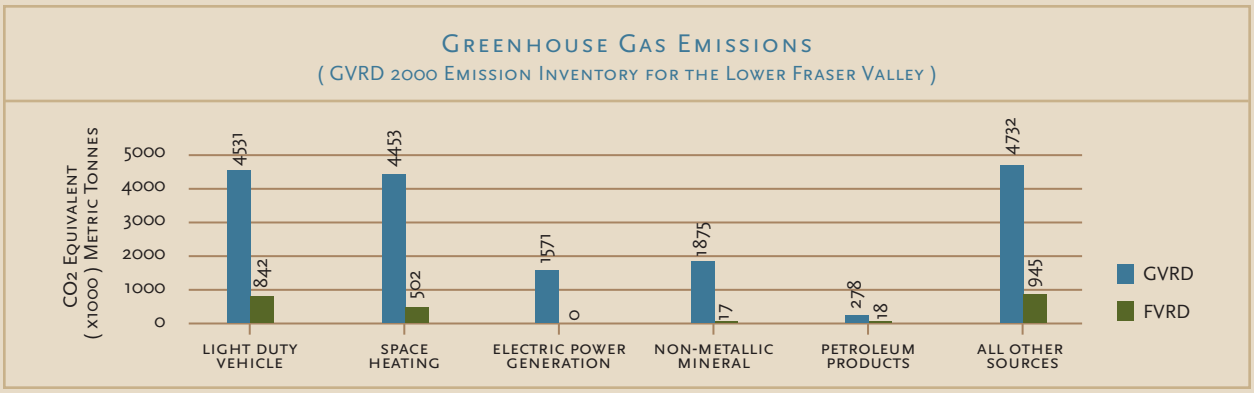
As a result of *Pacific 2001*, the Fraser Valley has become internationally recognized for air quality studies. The many thousands of measurements and subsequent chemical analysis—showing the complex interaction of air pollutants in the Lower Fraser Valley—have been carefully conducted and placed in a data archive, accessible to scientists around the world. This data will also be available to the public by September 2003, providing access to the best available information on pollutant levels in the airshed.

*Pacific 2001* was designed to build scientific understanding of air quality in the Fraser Valley. It also provides important information for the review of the *Canada–US Ozone Annex* in 2004, assists with the implementation of the Canada Wide Standards for PM and ozone, and contributes to policy development for international airshed management.

## Reducing Greenhouse Gas (GHG) Emissions

The GVRD and FVRD are looking ahead 20 years to determine what might be the most promising measures to reduce GHG emissions. In 1999, the first phase of the project helped to identify the largest GHG emitters, including light-duty motor vehicles, cement and power plants. The study also looked for innovative ways to measure the benefits of reducing GHG emissions, such as improvements to human health, employment, income, and water quality.

Joined by Environment Canada and WLAP, the project's second phase developed an integrated options study with the FVRD. This study assessed the amount of emissions attributed to fossil-fuel energy consumption, while also highlighting the viability of reducing




Source: Greater Vancouver Regional District Emissions Inventory

*Mount Rainier, where background levels of sulfate and nitrate measured in air are similar to the Elk Creek Region*



Common Air Contaminants (CACs ) and GHGs. In particular, CO, nitrogen oxides ($NO_x$) and sulphur oxides ($SO_x$) are highly correlated to energy use and GHGs. Almost half of the short-listed emission reduction measures would have a net negative cost per tonne. In other words, they would save society money, rather than imposing costs.

## Characterizing the Airshed

All the accomplished work has helped us better understand our air quality issues. We know that the concentrations of PM and ground-level ozone in the Lower Mainland–Fraser Valley airshed are lower than the Canada Wide Standards. We also know that about 40% of the time, our ground-level ozone exceeds levels that cause measurable health effects. Short-term high concentrations of ozone, while showing some decreases since the 1980s, have been leveling off since 1993, whereas annual average concentrations appear to be on the rise. Measurements of nitrogen compounds in precipitation and in the air have provided information on atmospheric nutrient loading. Investigations into the impacts of atmospheric pollutants in airsheds on Vancouver Island indicate similarities with the types of pollutants measured in the Fraser Valley, even though concentration levels are frequently lower.

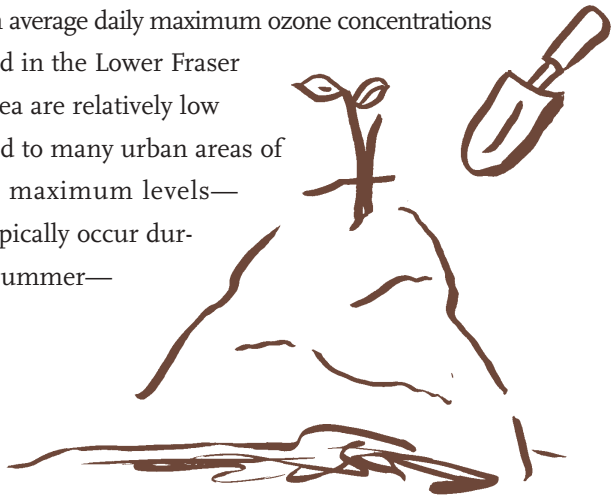
### Georgia Basin Compared to the World

In the Elk Creek region of the Fraser Valley, air samples showed mean sulphate and nitrate concentrations similar to background levels measured at Mount Rainier, but lower than those in Seattle. In contrast, ammonia gas concentrations were double those reported for background areas in North Carolina, similar to those reported in Phoenix, Arizona and in urban Chongju, Korea. Nevertheless, they were 2-5 times lower than those reported for agricultural areas of the Netherlands.

Ammonium levels in the air were similar to those reported for southern Ontario and much of the eastern United States, while concentrations in rainwater were similar to a number of agricultural states in the central U.S. Meanwhile, nitrate concentrations in precipitation in eastern portions of the Lower Fraser Valley were comparable to those reported for the western U.S., but one order of magnitude lower than those measured over the southern Gulf Islands and in some areas of the northeastern U.S.

### Ground-Level Ozone

Environment Canada recently completed an analysis of ground-level ozone data collected by the GVRD. Although average daily maximum ozone concentrations measured in the Lower Fraser Valley area are relatively low compared to many urban areas of Canada, maximum levels—which typically occur during the summer—



are similar to those measured in large urban centres in the Great Lakes–St. Lawrence corridor. Ozone levels occasionally exceeded the National Ambient Air Quality Objective. Trend analysis performed on meteorologically adjusted data found decreasing trends for summer ozone at all stations. Decreasing trends were also found for annual ozone at stations in the eastern portion of the study area, which are more affected by locally produced ozone.

These trends were consistent with local declines in ozone precursors, and are in agreement with reported declines in summer ozone in urban areas of the U.S. and Europe over the same period. In contrast, increasing trends were found for annual ozone at stations in the western portion of the Lower Fraser Valley which, due to their geographical location, are less affected by locally produced ozone but are more likely to be affected by background ozone. There is some indication that increasing trends at these sites may be reflective of a hemispheric increase in background ozone levels.



### Studies on Vancouver Island

Studies on Vancouver Island provided information on the atmospheric pathways that influence air pollution in western areas of the Basin. Air masses reaching the southern tip of Vancouver Island from Puget Sound contained elevated metal concentrations, presumably from industrial emissions, while air masses reaching the site from the Fraser Valley contained elevated ammonia concentrations, predictably from the agricultural industry. Weather patterns bringing air in from the Pacific Ocean contained increased chloride concentrations. Acidity levels in precipitation were slightly lower than in other coastal locations, but this is to be expected from a site primarily influenced by the marine environment.

Bev Raymond, Environment Canada

*Sampling moss for common air contaminants*

A one-year intensive measurement program conducted by Environment Canada, WLAP and the Cowichan Regional District on Vancouver Island's east coast showed a distinctly different chemical loading. In the Cowichan Valley, nitrogen compounds associated with sulphur indicated that the pulp mill to the north was the common, local source of these pollutants. Ammonia concentrations dominated the nitrogen loading, their distribution suggesting the source was primarily agricultural practices. PM measurements indicated a fairly well-ventilated airshed, with concentrations of PM remaining below levels seen in the Lower Fraser Valley.

### A Shared Airshed

A shared border means a shared airshed with the United States. As a unique collaboration between federal, provincial, state and municipal agencies, First Nations and U.S. Tribes, the *Georgia Basin/Puget Sound International Airshed Strategy* sets the stage for cooperation on shared air quality issues. By characterizing the international airshed, this will define the current air quality status, such as where pollution comes from and how it moves back and forth across the border. This will also determine the future of air quality issues, and help us reach an overall air quality management strategy for the international airshed by the fall of 2003.

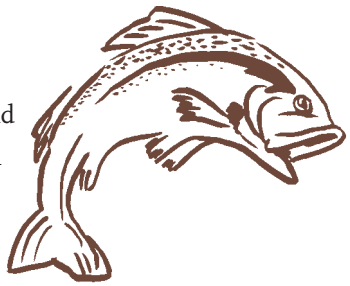
With this in mind, the goal of future efforts is to keep clean areas clean, and continually improve on what we have already achieved. As we continue to gain a

better understanding of fine PM, we can make greater progress in both visibility and health issues.

## AIR POLLUTION AND THE ECOSYSTEM

Air pollution is harmful not only to human health, but also to plants and wildlife. Pollutants absorbed by plants from the air or rain can affect their growth and survival. Some species of moss and lichens are particularly vulnerable because of their high surface area and dependence on the atmosphere for moisture and nutrients like nitrate and ammonia.

Because of these unique properties, Environment Canada scientists have been measuring sulphur, nitrogen and heavy metals in mosses and lichens around the Basin, as well as monitoring rain and air chemistry at a few sites. Once the relationships between concentrations in the lichen and those measured in the air and rain are established, deposition can be calculated over the area surveyed. It is likely that these calculations will show high deposition in urban areas, where sensitive lichen species no longer exist.



Chemical contaminants in the air find their way into the ecosystem through deposition into lakes or associated drainage basins. Fish and other aquatic organisms, including mosquito larvae and zooplankton, may absorb these chemicals. Scientists have found that these depositions are enhanced in arctic and alpine areas because snowflakes efficiently absorb pollutants as they form and travel. As a result, pollutants accumulate in the snow pack over winter, and when the snow melts, they are released to streams, soil and, to some extent, back into the air.

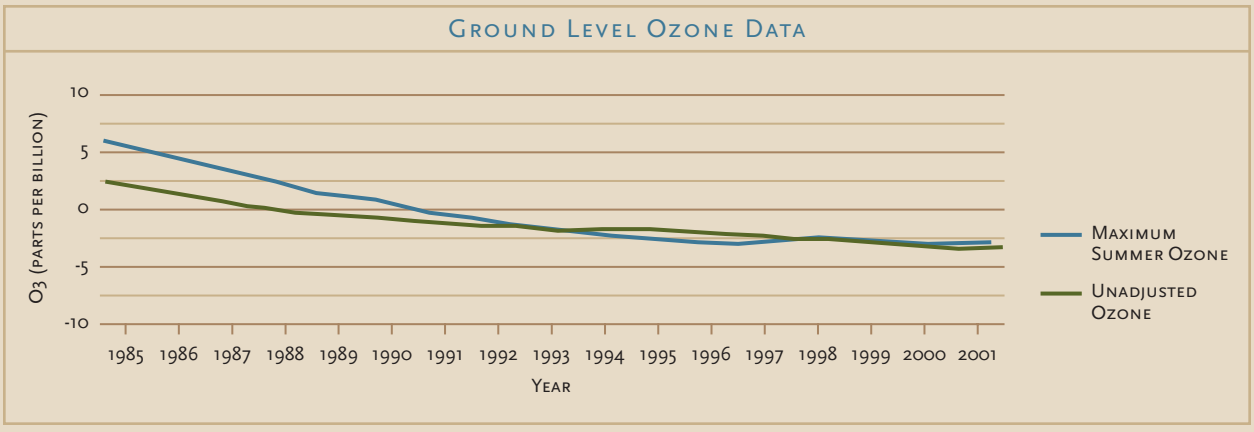


### Persistent Organic Pollutants

Persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs) or trichloro-2, 2-bis-(*p*-chlorophenyl) ethane (DDT) are examples of contaminants. In gaseous form, they can travel by air for very long distances, and are resistant to breaking down in the environment, especially at low temperatures. POPs can also accumulate in the fatty tissues of fish, wildlife and humans. As a result, it is not surprising

## GROUND LEVEL OZONE TRENDS

( SURREY, BRITISH COLUMBIA )




Source: Roxanne Vingarzan, Environment Canada

that low levels of POPs have been detected in mountain snow packs on Vancouver Island and in the Coast Mountains from Chilliwack to Whistler, as well as in fish living in the lakes receiving runoff from these mountains.

Concentrations of POPs in snow were relatively low across the region, but they increased with elevation. In fish, the highest contaminant levels were found in Garibaldi Lake, which is a large glacier-fed lake at 1435 m elevation. While these levels would not be a concern for human consumption of fish, they are potentially of concern for wildlife, such as otter or osprey, which may depend on fish from this lake.



### Air Pollution and Precipitation

At Elk Creek, near Chilliwack, air pollutants in precipitation were measured, providing insights into ecosystem impacts. There the rainwater proved to be less acidic than natural rainwater, reflecting the buffering effect of ammonia. Nitrogen levels in precipitation exceeded those designed to protect acid-sensitive ecosystems in the Rockies. These systems also exist in the Fraser Valley and surrounding hillside and mountains. While none of the nutrients measured in the air exceeded federal or provincial guidelines, three precipitation samples exceeded the WLAP nitrite criterion for the protection of aquatic life in freshwater.

A similar air quality study in the Cowichan Valley identified a full suite of heavy metals and organic and inorganic compounds. Similar air pollutants were present in the Lower Fraser Valley, but concentrations in the Cowichan Valley were lower. The rain in this area was more acidic than areas in the Lower Fraser. Buffering agents like ammonia—which neutralize some of the acidity in the Lower Fraser—are clearly not present in high enough concentrations to decrease the acidity in the Cowichan.

## OUR CHANGING CLIMATE

The effects of a changing global climate have been linked to impacts within the Lower Fraser Valley. Global climate models are a helpful tool in understanding

### SUMMARY OF PROJECTED PRECIPITATION CHANGES IN THE LOWER FRASER VALLEY FOR THE 2080s

*Several global climate models suggest that our winters will be several degrees warmer and much wetter, while summers are likely warmer and drier.*

*Warmer winters would result in a higher fraction of precipitation falling as rain in the Lower Fraser Valley watershed rather than snow. At higher elevations, an increase in winter precipitation could lead to more snow accumulation where temperatures remain below freezing.*

*Some of the impacts of climate change we are likely to witness in the Lower Fraser Valley include: rising sea levels and shoreline erosion, spring flooding and summer drought, more landslides and debris flows, an increase in forest fires and pests and a degradation of coastal ecosystems.*


*Teachers using the Temperature Rising Poster*

the complex interaction between changes in air pollutant concentrations, GHGs and the atmosphere.

Studying the period 1900 to 2100, this model projects that the temperature should rise between 3 and 4 °C in all months by the late 21st century. Also, long-term average temperatures in the Lower Fraser Valley should not change appreciably until late in the 20th century, and then should rise about 3.5 °C by the year 2100.

GBEI partners worked to educate the public about climate change. Targeted to BC high school students and teachers, the *Temperature Rising Poster* shows the impacts of climate change on southern BC. Since this poster was introduced in 1998, 400 workshops for teachers have been conducted.

The poster presents a complete scientific picture, including the role of GHGs and how climate change may impact people, wildlife, fish, forests, lakes, rivers and the ocean. A *Climate Change Indicator* is also tracking trends in temperature and precipitation at 13 climate stations across the region, including one in Victoria.

## AIR POLLUTION, OUR HEALTH AND THE ECONOMY

Air pollution affects the health of people, resulting in higher incidences of lung disease, more hospital admissions and higher death rates. These health effects have a significant economic impact. Environment Canada, WLAP, the GVRD, Health Canada, the BC Ministry of Health Services and the FVRD have been working with an expert local panel of medical researchers and the BC Lung Association to review the effects of air pollution on health. This review is using international and local data to better understand the impacts in the Pacific Northwest, including the area covered by the international airshed.

The relationships found in this study will be used to assess impacts on the health of residents and on the economy. Preliminary economic benefit analysis reveals that human health benefits account for at least 80% of the total economic benefit of improving air quality, while the remaining benefits occur through decreased agricultural crop and building damage, and effects on visibility.



### Impacting Tourism

Poor air quality causes lowered visibility and, as a result, affects tourism. Tourists visiting Vancouver expect stunning views of the mountains surrounding the Georgia Basin. However, when a thick cloud of haze obstructs these views, they may decide against returning or recommending the destination to other potential visitors.

All this adds up to lost tourism dollars. During the summer of 1999, an interactive survey, analyzing how tourists might tolerate reduced visibility, associated the losses of tourism revenues with different levels of visibility. For example, a very poor visibility day could result in the loss of over $8 million in future tourist revenues for the Lower Mainland and Fraser Valley.


*Vehicle emissions contribute to air pollution*

# Protecting Species & Their Habitats

## Conserving land and preserving aquatic and terrestrial species.

The world we live in is home to countless living things. Within a vast array of habitats, a wealth of species play out unique lifecycles in concert with our shared environment. However, pressures on the natural environment from population growth, economic growth and resulting pollution are fraying the ecological fabric of the Georgia Basin. Many species and plant communities in our region are at risk of disappearing due to this growth, and unless we address the issues that have placed them in this vulnerable position, the native habitat and species of the Basin will continue to shrink.

It is not only these specific habitats and species that will suffer from unplanned growth. Their loss puts strain on the entire ecosystem, of which we are all a part. This, in turn, minimizes the vital services healthy ecosystems provide, such as cleaning and storing our water, sequestering carbon and providing refuge. These elements are fundamental in sustaining all life in the Georgia Basin, as well as the quality of life we enjoy.

Through assistance from the GBEI, concerned parties around the Georgia Basin have made progress in the important task of protecting species and their threatened habitats. Partnerships have been established between various levels of government and landowners, non-government organizations and local communities. Decision-makers responsible for land-use management now have access to vital information about air and water pollution and habitat loss, allowing them to develop policies and programs that mitigate the effects of growth.

*"The Georgia Basin is a treasure-trove of biodiversity, and home to a disproportionately high number of species and spaces at risk. At the same time, the Basin's temperate climate and irresistible scenery have given it the second highest population density in Canada. Will there ever be a better time than right now to conserve the natural heritage of the Georgia Basin?"*

*—Jan Garnett, Nature Conservancy of Canada, BC Executive Director*

As a result, there is hope for the plants and animals whose well-being depends on viable habitats. Over ten sites considered particularly sensitive to outside pressures have been set aside and protected. Initiatives such as bird and amphibian studies have promoted awareness of the need to conserve and protect not only the creatures that are an integral part of our economy, but also lesser known indicator species that may be key to maintaining ecosystem health. As in any large-scale venture, education has been, and will continue to be, an indispensable tool.

Our work has taught us that while it may be too late for some habitats, it is not too late to protect or restore many others. Moreover, we have increased our understanding of the pressures human activities exert on the ecosystems of the Georgia Basin, allowing us to make informed decisions on land-use.

## SECURING LAND

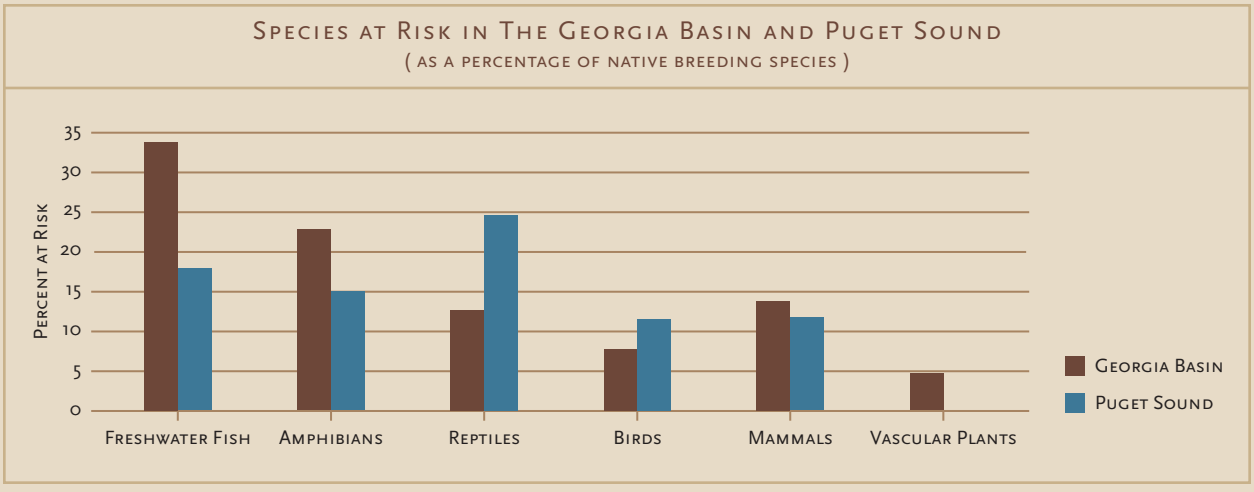
A major initiative of the GBEI has been the acquisition of tracts of land that contain sensitive or at-risk plants and animals. While most properties are purchased outright, some lands that have been identified as having ecological value are protected by a covenant that prohibits development. Depending on the property in question and the nature of the covenant agreement, protection can mean turning the land into a park with nature trails or other recreational components. It may also mean turning the land into a nature reserve.



## SPECIES AT RISK INDICATOR

*To determine the state of the Georgia Basin, we need to look at the number of species at risk. Marine mammals, reptiles and amphibians, birds and fish all have threatened or endangered species. In the Garry Oak ecosystems of the Georgia Basin, the Lewis' Woodpecker no longer exists. Killer whales are under increasing pressure from persistent organic pollutants, reduced food sources and stress from tourism interests. These are only two examples of species at risk. Plants are also under threat from development, pollution and the introduction of invasive and exotic species.*

*Naturally diverse ecosystems play an important part in understanding how all living things are interconnected. Hence, we must persist in our commitment to education and conservation. By establishing protected areas and managing development with healthy ecosystems in mind, we can reduce the threats to other species and guard against their extinction.*




Source: Georgia Basin–Puget Sound Ecosystem Indicators Report

In the latter case, access to the land is usually restricted in the interest of preserving the species that make their homes there.

The GBEI helped to develop a consistent approach to the process of land acquisition in the Basin. A catalogue of sites was created, as well as standards for the mapping of the sites and templates for reporting on the findings at each site. This overall coordinated approach helped to foster a sense of partnership, as well as ownership and accountability within the groups purchasing the sites. We also played a critical role in promoting a long-term conservation vision by developing management systems and strategies for these sites. A number of diverse ecosystems are considered candidates for land securement, including sand-dune-and-forest, which characterizes lands acquired on Savary Island.



## Establishing a New National Park

To protect a representative portion of the Strait of Georgia lowlands, including examples of small island ecosystems, headlands, shorelines and the uplands of larger islands, GBEI Partners, Parks Canada and the BC Ministry of Water, Land and Air Protection (WLAP) established Gulf Islands National Park Reserve. The park consists of 29 properties on 16 islands, plus many islets, reef areas and an intertidal zone. At 33 square km, it is Canada's fifth smallest national park and one of the most at risk.


Tim Ennis, Nature Conservancy of Canada

*Garry Oak Ecosystem*

## Protecting Garry Oak Ecosystems

Perhaps the most prominent ecosystem identified as part of the land-securement initiative is Garry Oak. These woodlands, which also shelter meadows and rocky areas, are incredibly complex, supporting over 100 species at risk, both plant and animal. Fragments of the Garry Oak ecosystem are becoming increasingly rare, as it is among the four most endangered ecosystems in Canada. With less than 5% of British Columbia's original Garry Oak ecosystem remaining in Canada—all within the Georgia Basin—priority was placed on acquiring remnants of these woodlands.

Over the past five years, Environment Canada, Parks Canada, and Fisheries and Oceans Canada acquired several Garry Oak sites for the purposes of conservation. These sites include one at Mill Hill Regional Park, west of Victoria, purchased through funding from the GBEI and the Habitat Stewardship Program and in partnership with the Capital Regional District (CRD) and The Nature Conservancy of Canada (NCC). On Saltspring Island, 640 hectares acquired by the GBEI, the CRD, the Province, The Land Conservancy (TLC) and the local community also protect old-growth Douglas Fir. On Galiano Island, twelve acres of coastal bluff containing a Garry Oak ecosystem were secured through the Islands Trust Fund with support from TLC and the Habitat Acquisition Trust.

GBEI funding also enabled the NCC to establish the Cowichan Garry Oak Preserve. Considered the best example of this ecosystem in BC, research and study at the Cowichan Garry Oak Preserve will focus on protecting existing plants and animals and controlling invasive species. A typical invasive species in Garry Oak ecosystems is Scotch broom, brought from the United Kingdom in the 1700s, and animals like the grey squirrel, introduced from Eastern North America.


*Providing feeding sources for waterfowl*



## PROMOTING STEWARDSHIP

To ensure a future for our ecosystems, we need to take responsibility and manage them carefully. A key to this stewardship process is information networking: tools that can advise landowners and management authorities, including individuals, industry, local governments and non-government organizations, on how best to preserve the natural resources of the Georgia Basin.

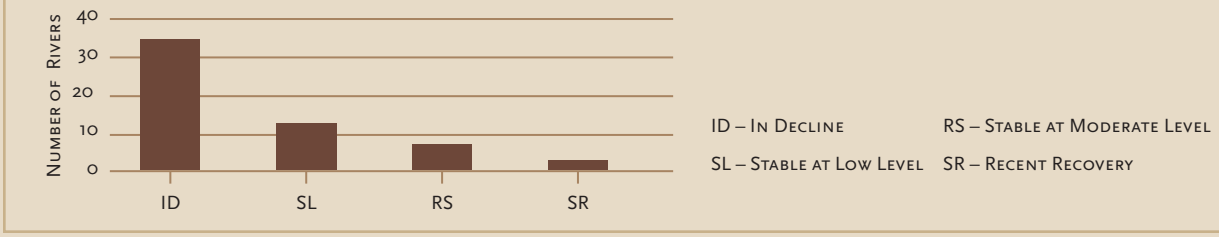
### Donating to Our Future

One of the publications linked to the *Stewardship Centre Website* (see page 9) is *Green Legacies: A Guide to Nature and Conservation Giving in BC*. This initiative focuses on the issue of donating either land or cash in a manner that will help the environment and preserve habitats. With ecological gifts of land now resulting in increased tax benefits for the donors, there is more interest than ever before in setting aside portions of land for permanent protection. Other gifts of cash and assets offer donors the satisfaction of knowing they have made a difference to the environment and preserved nature for future generations. By raising awareness among financial planners and legal advisors—through distribution of the free guide and through its publication on the *Stewardship Centre Website*—*Green Legacies* will increase the number of donors who choose to protect the environment through their generosity. The guide also includes a directory of conservation organizations that are qualified to receive donations of land or money.

### Encouraging Agricultural Stewardship

Responsible agricultural practices are helping to lead the way in terms of low-impact land-use in the Georgia Basin. The *Greenfields Project* is an example of a successful partnership between agriculture and wildlife. Managed by the Delta Farmland and Wildlife Trust,

Trends in Abundance for Steelhead Populations—Greater Georgia Basin




Source: Pam Zevit / WLAP

this program attempts to provide extended feeding sources for migratory and resident waterfowl over a large area by providing incentive for the production of winter cover crops—usually a grain cereal such as winter wheat or rye. Having these essential food sources spread out over larger areas of farmland ensures that individual farms will not suffer from over-intensive feeding use. It also ensures that there is adequate forage for migratory birds, while any left-over cover crop material can be used by the farmer as green manure, which improves soil condition.



## Recovering Steelhead

The presence of a healthy wild steelhead salmon population is a key indicator of watershed health in the Basin. Steelhead are a vital part of the historic and present-day profile of many important river systems found along the Fraser Basin and east coast of Vancouver Island. To many anglers, landing a steelhead is considered the ultimate experience. However, urban development and highway building, coupled with the impacts of forestry practices and other industries, have greatly affected the spawning and rearing areas steelhead are dependent upon for survival. Studies indicate that 51 of 55 winter-run steelhead stocks have been reduced to very low levels, perhaps to the point of becoming regionally extirpated.

Through a GBEI initiative, the *Georgia Basin Steelhead Recovery Team* developed a long-term strategy to address declining steelhead stocks. This involves securing a network of habitats that will enhance spawning success, as well as manage sustainable populations into the future. River habitats are also being rejuvenated through the use of slow-release fertilizers and through protection from future development. Stock trends will be monitored and research fed back into recovery initiative.


M3–Marine Mammal Monitoring Program

*Monitoring marine mammals*

## Protecting Marine Mammals

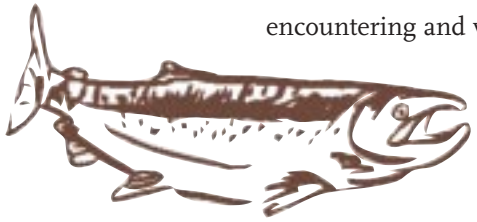
Marine mammals play a vital role in the Georgia Basin Ecosystem. Not only are they central to the marine food web, but they also add considerable value to the wildlife viewing and marine tourism industry. However, this increased demand for interaction by humans also causes problems. Pressures from human activity may affect breeding success and contribute to habitat and food resource impacts on the very creatures humans want to see.

Through the *Habitat Stewardship Program* and GBEI, a project geared toward preserving our marine mammals was implemented. Combining outreach and education with the monitoring of recreational and commercial ecotourists in the Basin, this program promotes less intrusive methods for wildlife viewing. These include respecting specific distances when whale watching and when viewing seals and sea lions on land, as well as restricting viewing time per vessel per watching area.

A valuable outcome of this project has been trans-border partnership building. As a result, marine mammal viewing is approached similarly in both Canadian and U.S. waters.

## UNDERSTANDING STRESSES ON SPECIES AND THEIR HABITATS

By identifying stresses on our ecosystems, we can then promote ways to manage, reduce and, where possible, eliminate these stresses. With so many species in the Georgia Basin now at risk, we need to understand the strains species and plant communities are encountering and why their



Mark Kaarremaa, SEI



*Biodiversity in the Georgia Basin needs to be protected*

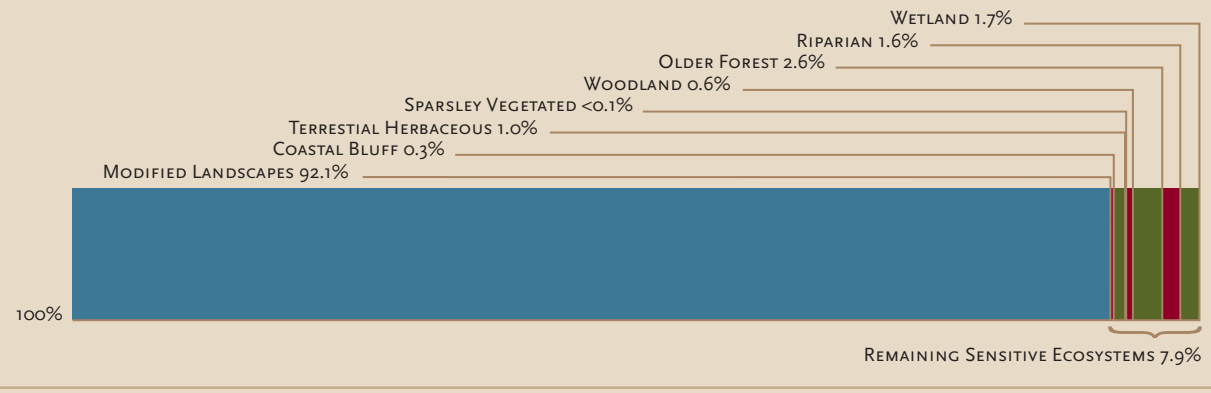
numbers are declining. We must identify the activities and practices that are the cause, and work to mitigate or reverse the damage. We must also identify rare and ecologically significant habitats, as they are often the most vulnerable to the effects of human activities. This information can then be applied towards influencing decisions for land-use in order to reduce these stresses.

## Influencing Land-Use Decisions

In order to conserve and protect the biodiversity of the Georgia Basin, land-use decisions must rest upon a thorough understanding of our native habitats and species. One GBEI-supported initiative addressing the issue of land-use is the *Sensitive Habitat Inventory and Mapping Project* (SHIM). Spearheaded by communities within the Georgia Basin, SHIM focuses on mapping aquatic ecosystems within watersheds, providing detailed information about fish habitats that can be used by decision-makers in the areas of land-use planning and habitat restoration. By listing the attributes of a particular stream or creek, SHIM directs information towards improved land-use decisions that contribute to preserving habitat within watersheds.

Perhaps one of the most significant programs influencing land-use decision-makers is the *Sensitive*

Eastern Vancouver Island—Gulf Islands Loss of Sensitive Ecosystems (1990s–2002)




Source: Environment Canada, Environmental Indicator




*Lakes and ponds provide habitat for waterfowl*

*Ecosystems Inventory* (SEI). This program produced an inventory of rare or relatively undisturbed land-based ecosystems still remaining on both the Sunshine Coast and on East Vancouver Island, which also includes the Gulf Islands. In the East Vancouver Island and Gulf Islands study, seven types of ecosystems were identified and mapped through air photo interpretation and selective field visits. These ecosystems include older forests, wetland and riparian ecosystems, woodlands, coastal bluffs, dunes spits and cliffs, and native grasslands and wildflower meadows.

This SEI study shows how little remains of specific ecosystems. Figures from the mid 1990s reveal that over a 4000 square kilometre study area, only 7.9% of natural ecosystems remain. Moreover, of this small percentage, recent studies have shown that 4% (1300 hectares) of the area mapped in the 1990s was gone by 2002. Urban, rural and resource development have directly impacted these ecosystems, as have fragmentation and the presence of introduced species. Results of the Sunshine Coast inventory will be complete by 2004.

The information contained in the SEIs is designed to be used by land-use planners to take into account the impacts future developments may have on the flora and fauna of a particular region. To facilitate this, a *Conservation Manual* was created. It offers government leaders, planners and other key developers recommendations on how to minimize negative impacts on the ecosystems in question. An evaluation of the use of the SEI by land-use decision-makers, completed in 2003, found that all four regional districts and some municipalities within the Vancouver Island SEI area have adopted the inventory within their Official Community Plans and Development Permit Areas. SEI products were also used to identify priority areas for protection in bylaws, by acquisition or by covenant.

## Increasing Awareness of Biodiversity

Even the most heavily urbanized areas still contain levels of biodiversity. Parks, urban forests and ravines provide refuge and habitat for a variety of animals and plants. Waterfowl use wetlands, agricultural fields, the banks of larger rivers, streams and open water areas such as lakes and ponds. Backyard ponds and seasonal pools are used for breeding by species such as tree frogs. In the Georgia Basin, our landscape is an ecologically rich one—in cities and towns, as well as in rural regions. These diverse and productive ecosystems are essential to the health and livability of the region.

The GBEI supported the development of a *Biodiversity Conservation Strategy* for the Greater Vancouver Regional District (GVRD). Together, the project partners envision a region where the value of biodiversity is recognized and maintained through healthy, functioning ecosystems. The strategy will assess biological diversity in the Lower Mainland and develop coordinated targets and management measures to conserve and enhance regional biodiversity within the context of diverse ecological, economic and social considerations. It will also be expanded for use in other areas in the Georgia Basin.

## Examining Stresses on Wildlife

Few areas of the world can match the Georgia Basin in number and diversity of waterbirds found along its shores. Over 75 species of birds use the region's estuaries and marine habitats, especially during winter. The Basin supports Canada's largest population of wintering waterbirds, but human development and activities along the shorelines have destroyed valuable habitat, while pollution of the waters is of further concern.

To better understand the waterbirds that use sites in the Georgia Basin, a coastal waterbird survey has been initiated to document and examine the populations of various species. Researchers are using information collected by volunteers to track population trends of waterbirds as well as to study the effects of habitat changes on these birds. Other studies undertaken by the Canadian Wildlife Service are focusing on the effects of pollution on birds and amphibians in order to identify, track and address specific threats to wildlife as well as to draw conclusions about the overall health of the Basin.

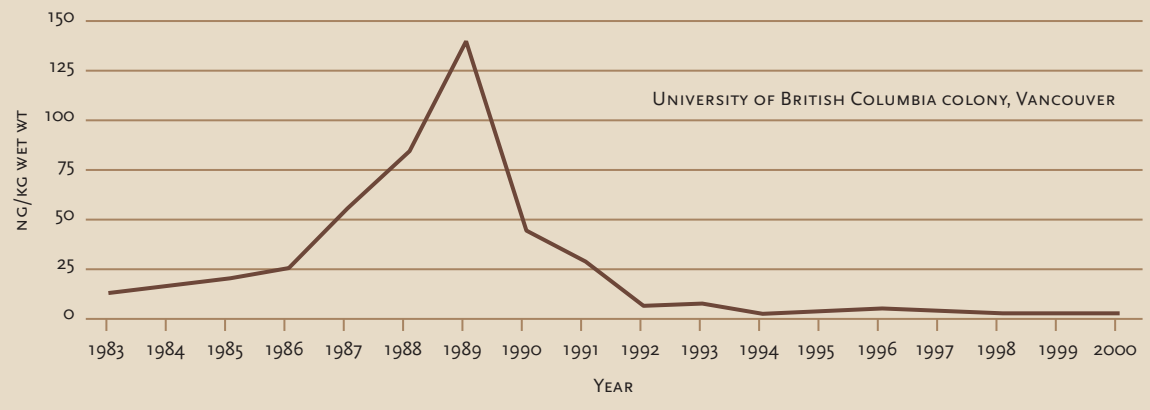
### Monitoring the Effects of Pollution in Birds

Monitoring the levels of pollutants in waterbirds can improve our understanding of how contaminated habitats are affecting these species. A number of species of birds, representing a variety of different food chains and exposure routes, have been examined to determine the exposure and effect of a variety of contaminants. By studying these different species, deductions can then be made regarding the effect of contaminants on the overall health of the Georgia Basin Ecosystem and all the creatures that inhabit the region, including humans.

One species of bird that has been given particular attention is the Great Blue Heron. Most coastal Great Blue Herons in British Columbia live in the Georgia



Dioxin Levels in Georgia Basin Great Blue Herons




Source: Laurie Wilson, Environment Canada

Basin year-round. It is important to maintain their habitats and reduce their exposure to pollution. Studies of polychlorinated biphenyl (PCB) and dichlorodiphenyldichloroethylene (DDE) levels in Great Blue Heron eggs from a colony near the University of British Columbia (UBC) indicate that between 1977 and 2000, levels of these pesticides declined sharply. Similar studies on dioxins and furans in eggs collected between 1983 and 2000 show that dominant pollutants fell markedly in the early 1990s after pulp mills restricted their use of molecular chlorine bleaching and chlorophenolic wood preservatives and anti-sap-stains. However, levels of chemicals linked to flame retardants (added to many commercial products) have increased almost 200-fold between 1982 and 2000.

Government agencies, local growers and interest groups are working to develop alternatives to insecticides that present danger to birds of prey, such as Bald Eagles, Red-tailed Hawks, Great Horned Owls, Rough-legged Hawks and Northern Harriers. Studies showed that the waterfowl which are important in the diet of birds of prey, and the birds of prey themselves, were being poisoned by insecticides used in farming. Of the seven insecticides implicated, two have been withdrawn from the local market, and two are no longer being produced by the manufacturer. Meanwhile, pest-control strategies are being developed, that will aid farmers while reducing the health threat to wildlife.

The American Dipper is a key species for monitoring the health of freshwater streams in sub-alpine forests. Joint government and university research into the basic biology on resident and transient American


*American dipper*


*Bald eagle*

Dipper populations along the Chilliwack River watershed suggests that PCB concentrations were significantly higher in resident Dippers than in migrants. The residents forage on small fish along the main stream, while the migrants move into creeks during breeding season to forage primarily on benthic invertebrates.

**Monitoring the Effects of Pollution in Amphibians**

Studies on the northwestern salamander and on northern red-legged frogs on the Sumas Prairie in the Fraser Valley show that these species have much lower breeding success than expected. In fact, the northern red-legged frog is blue-listed in British Columbia and listed as special concern by the Committee on the Status of Endangered Wildlife in Canada.

There are a number of possibilities that may explain this lack of breeding success. It may be a result of dissolved pesticides in runoff from the surrounding farmland, or ammonia released from fertilizer and animal waste. Some of these compounds may contain environmental chemicals that interact with the endocrine system and are often termed endocrine disrupting compounds (EDCs). Because the endocrine system plays a critical role in the normal growth, development and reproduction of humans and animals alike, even small disturbances caused by EDCs may have profound and lasting effects. Deteriorating water quality has been linked to reduced hatching success in these amphibians. Since these amphibians have an aquatic stage in their lifecycle, they are extremely vulnerable to changes in water conditions.

The lack of breeding success may also be a result of changes to their natural habitat, especially the fact that there are fewer wetlands and associated seasonal wetter areas for breeding and rearing than there used to be in this largely agricultural environment. However, whether the exact cause of low breeding populations is poor water quality or habitat loss or degradation, it is clear that clean water is essential in order to return these species to anywhere near their historic population densities.

### Studying Habitats

A number of related projects are shedding light on the status of various species in the Georgia Basin. Because riparian areas are vital to the seasonal activities of various birds, particularly songbirds, studying the characteristics of these habitats and how songbirds use them can provide us with knowledge of how losing riparian areas may affect the lifecycle of birds dependent upon them.

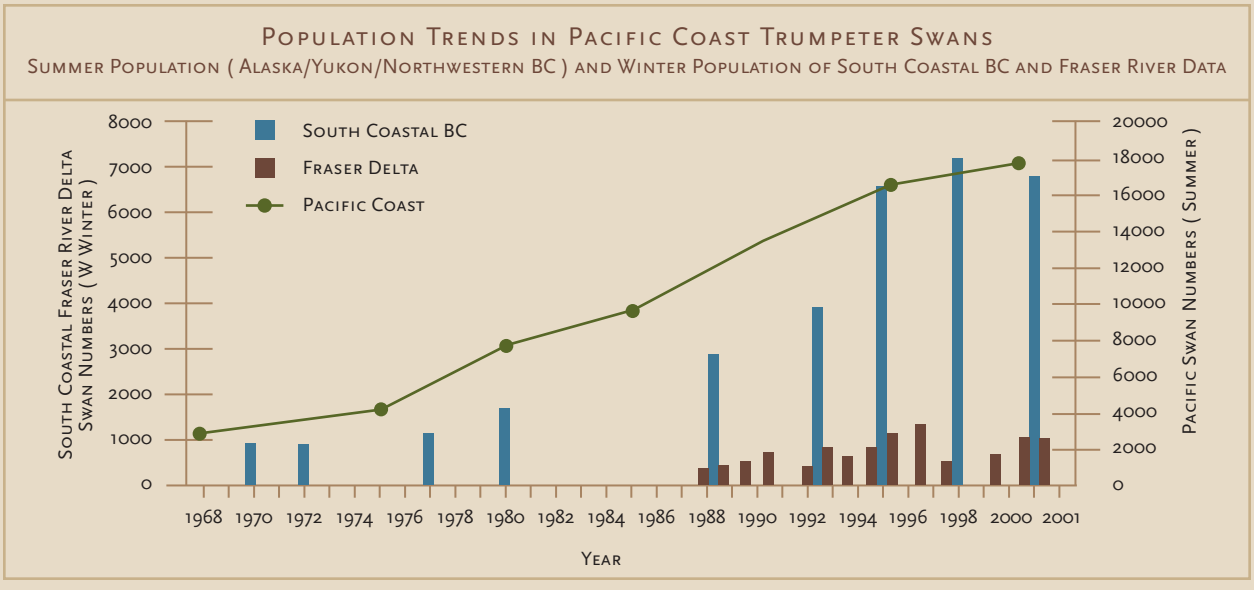
Farmland is critical to the needs of migrant and wintering birds in the Georgia Basin. Hedgerows between farm fields in particular are an important habitat component within the agricultural landscape for some species. Unfortunately, these vital areas are being eliminated due to increasing field sizes and conversion to industrial and/or non-soil-based farming methods.

### Tracking Populations

Another study focused on the population trends of birds that use what remains of the Garry Oak ecosystem on southeastern Vancouver Island. Results of this research indicate a decline in breeding populations since the 1970s of 63% of the birds studied, including American Goldfinch, Chestnut-backed Chickadee and Winter Wren. This can be attributed to urban development, which has caused a loss of breeding habitat. However, the wintering numbers of American Goldfinch, Stellar's Jay and Northern Flicker have increased, due to the provisioning of bird feeders in urban areas.

Another monitoring project involved Trumpeter Swans. Since a significant percentage of the world's population winters along the BC coast, this species is being monitored for population trends and the habitats they frequent. Aerial surveys reveal there has been a significant increase in Trumpeter Swans here between 1996 and 1999.






Source: Environment Canada, Environmental Indicator

# Achieving Clean Water

## Cleaning up our water to maintain a vibrant ecosystem.

Water is vital to all living creatures. Numerous human activities depend on it, as does the well-being of animals, birds, fish and plants. But in order for our ecosystem to function effectively, we need to keep our waters clean, and improve overall water quality.

To meet this challenge, the GBEI worked to clean up and prevent pollution in the Georgia Basin. By protecting our waters from non-point source pollution, putting management processes in place for liquid waste, stormwater and agriculture, monitoring watersheds and addressing shellfish recovery, we can prevent or reverse the damage to the aquatic ecosystem. Working in partnerships, educating individuals, and fostering stewardship on issues surrounding clean water, we have been able to move toward this goal.

### UNDERSTANDING AQUATIC ECOSYSTEMS AND POLLUTION

Aquatic ecosystems are a dynamic complex of plants, animals and micro-organisms, which interact with their non-living environments, sustaining a functional system. Rivers and streams, lakes and reservoirs, ponds and estuaries, subsurface aquifers and open coastal waters are all connected through the hydrologic and biological cycle. Point or non-point source pollution can adversely affect an aquatic ecosystem's hydrological and biological processes. Point sources include discernible, confined and discrete sources like end-of-pipe industrial and sewage discharges. Non-point sources are more diffuse. Subtle, gradual and cumulative in nature, these sources include runoff flowing across farm fields and city streets, and improperly operating onsite sewage systems. Excess fertilizers and pesticides from home gardens and pet waste can also contribute to non-point source pollution, as can the deposition of airborne pollutants onto land and into water.

Clean water may be defined by water quality guidelines for specific substances and water uses. Polluted waters can carry diseases, hinder reproduction in some species, and disrupt important recreational and commercial enterprises like shellfish harvesting. To manage and prevent such impacts, we need to identify all potential sources of pollution and continually compare water quality to the appropriate guidelines. By recognizing that land is used for multiple

*"It is encouraging to see that substantial progress is being made toward protecting and improving aquatic ecosystem health and human wellbeing in the Georgia Basin."*

*—Del Haylock, Executive Director, BC Water and Waste Association*

purposes, integrated land management can help us develop and use land in a way that will preserve both water quality and aquatic ecosystem function.

## TAKING STOCK OF THE CHEMICALS AROUND US

### Chemical Profiles, Loadings and Management Options

To better understand the pollutants in Georgia Basin waters, a multi-agency toxics work group listed 44 substances of concern. Projects were undertaken to estimate the sources, releases and loadings of these substances in wastewater for the period 1990 to 1998 (for which adequate information was available). Information was also gathered on potential management options for these toxic substances.

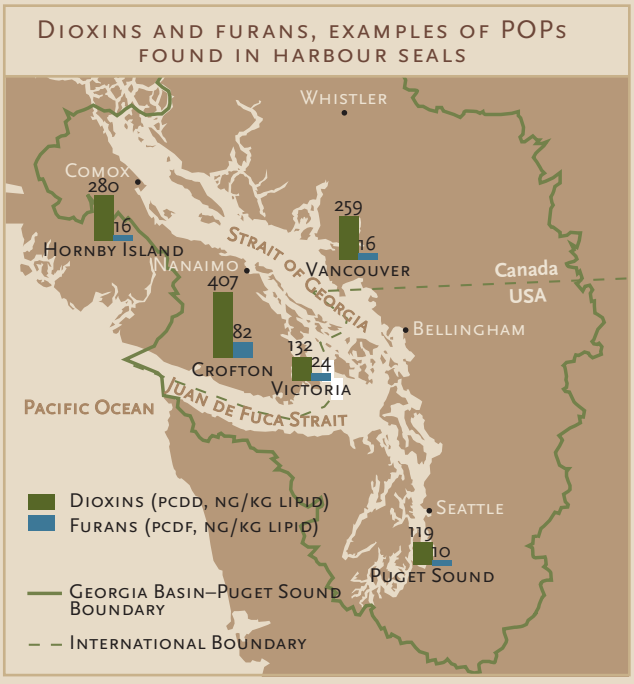
Chemical profiles were developed for 20 of these—or their classes—including phthalate esters, organotins, alkylphenol and ethoxylates, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), didecyl dimethyl ammonium chloride (DDAC), 3-iodo-2-propnyl-butyl carbamate (IPBC), atrazine, endosulphan, chlorinated diphenyl ethers (CDPEs), polybrominated diphenyl ethers, hexachlorobenzene, cadmium, mercury, chromium, zinc, nickel, copper, manganese, silver, sodium, wood extractives, pharmaceutical products and nitrogen-based nutrients. The profiles focused on the sources of these substances, their concentrations in the environment, uses and any regulations governing their use.



Analysis of the loading data showed that most of the PAHs and many of the heavy metals entering our waters potentially came from stormwater, while municipal wastewater treatment plants (WWTPs) apparently contributed most of the ammonia, copper and phenols. The amount of chlorinated organic

## PERSISTENT ORGANIC POLLUTANTS IN HARBOUR SEALS INDICATOR

*Certain indicators tell us that our water is polluted. In the Georgia Basin–Puget Sound region, POPs in harbour seals are one indicator of a damaged ecosystem. POPs resist bio-degradation and accumulate in the foodchain. Since harbour seals feed on a variety of fish and invertebrates, they are near the pinnacle of the marine food web, and therefore exposed to a number of POPs. Analysing POP levels in harbour seals can tell us much about POP levels in the ecosystem as a whole, and can indicate possible risks to humans and other animals consuming large quantities of fish. From these studies, we can determine whether controls on the use of POPs are effective, and develop strategies to prevent further contamination of the marine food web. Dioxins and furans are examples of POPs found in harbour seals, as are PCBs.*




Source: Georgia Basin–Puget Sound Ecosystem Indicators Report

compounds in pulp mill effluents, lead from municipal WWTPs, and residual chlorine from the chemical products industry decreased significantly.

Reducing the loadings of toxic chemicals that have the potential to harm the environment is an important step toward maintaining a healthy ecosystem. Therefore, the profiles, loading information, identified data gaps and potential management options will all guide further actions. Management options could focus on non-point sources such as agricultural runoff and urban stormwater, as well as discharges to sanitary sewers from small and medium enterprises, and could take a pollution prevention or watershed-based approach.



### Pesticide Sales

To determine trends in pesticide sales and use in British Columbia, inventories have been carried out periodically since 1991. In 1999, sales were again quantified.

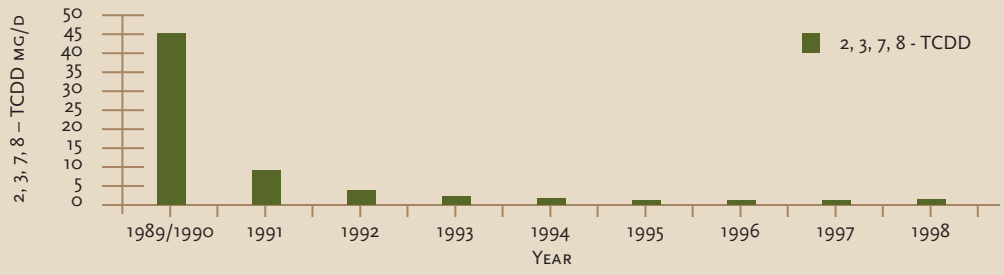
Landscape services in the Lower Mainland reduced their use of pesticides by 40% during the 1990s, suggesting an increased use of Integrated Pest Management (IPM) practices. The quantities of reportable pesticides sold in the Basin will be used in conjunction with toxicity profiles to help develop management strategies.

In another project, the BC Agricultural Council co-ordinated the collection and safe disposal of unwanted and obsolete pesticides, reducing amounts in the Fraser Valley and Vancouver Island by 32,000 kg and 23,000 kg respectively.

## PROTECTING AND MONITORING AQUATIC ECOSYSTEMS

The GBEI identified many facets to protecting and monitoring our waters. Effective measures are needed to manage stormwater in urban areas, while rural areas must use responsible agricultural practices to

Decreasing Levels of Chlorinated Organic Compounds ( Dioxins and Furans ) from Georgia Basin Pulp Mills




Trends in Pesticide Sales: The Top Five Reportable Pesticide Active Ingredients sold in the basin in 1999

| Active Ingredient | Quantity (kg) | Percent of Total |
|---|---|---|
| Glyphosate, Isopropylamine | 70,494 | 14.0 |
| Mineral Oil (Herbicidal or Plant Growth Regulator) | 35,260 | 7.0 |
| Mancozeb | 27,882 | 5.5 |
| Formaldehyde | 25,492 | 5.0 |
| Chlorothalonil | 23,674 | 4.7 |

Source: Environment Canada

prevent harmful chemicals from seeping into the soil or entering water through runoff. Advanced liquid-waste management is also essential to ensuring clean water in the Georgia Basin. Through awareness, partnerships and action, we strove to meet these goals and to implement effective strategies for the future.

## Urban Stormwater Management

One of the greatest threats to our watersheds is urban non-point source pollution. Fuel spills, oil leaks, soap from car washes and herbicides and pesticides all fit into this category. These potentially toxic substances may enter stormwater drains or find their way directly into local streams and creeks, polluting the water and endangering the plants, fish and animals that are all a vital part of our ecosystem.

Watersheds are also impacted by traditional development, as impervious areas such as paved surfaces do not absorb rainfall, and the resultant runoff can adversely change our waters through erosion, flooding and pollution. However, when managed properly, the runoff, or stormwater, is a vital resource for both economic and ecological reasons. Since increased awareness and education are key to addressing the problem of non-point source pollution, a *Stormwater Management Planning Guidebook* was developed to inform local government officials about current challenges for stormwater management and possible solutions. These include best management practices (BMPs) aimed at improving a community's ability to deal with rainwater, with the focus on reducing runoff volume at the source. Available on the Internet, the guidebook has been highlighted at seminars and workshops.

Environment Canada

Laura Maclean

*Capturing stormwater by using a "Green Roof" reduces run-off*

The Capital Regional District (CRD) in Victoria developed specific codes of practice for six commercial and service sectors, aimed at reducing water pollution and improving stormwater quality. These codes of practice for dental, drycleaning, photographic, auto repair, car-wash and food services were developed under the Stormwater Bylaw and the Sewer Use Bylaw to reduce, and eventually prevent, pollution of the local watershed.



Another project carried out in the Byrne Creek watershed in Burnaby aims to reduce stormwater pollutants at their source by inspecting businesses within the area and educating their owners and managers, as well as the local community, about the history and ecology of Byrne Creek and the impacts pollution has had on it. Water quality monitoring was an important part of this program, as linking specific contaminants with particular businesses is a key step in pollution reduction.

In the Baynes Sound region, the threat of non-point source pollution to the water and to local shellfish harvesting prompted the formation of a community-led stewardship program and other related initiatives. With the ultimate goal of rehabilitating shellfish-growing areas, one group monitored marine waters in Comox Harbour, while another carried out GIS mapping of non-point pollution sources in Baynes Sound. A third group monitored discharges from stormwater drains into northern Baynes Sound, comparing fecal coliform bacteria levels with those measured before the removal of sewage cross-connections.

## Agricultural Practices and Management

Responsible agricultural practices are key to reducing water contamination. One aspect of this involves tracking changing patterns in land-use. In the Fraser

Valley, Agriculture and Agri-Food Canada, with support from the GBEI, advanced the development of a GIS inventory of farms by digitizing field boundaries and developing land-use/crop information in key areas like Chilliwack, where monitoring studies were already taking place. This work supports IPM, as well as a hazard-rating system that predicts crop damage by wireworms . It also supports ongoing research into developing new methods of managing these pests to reduce dependence on pesticides.

A number of pollutants in agricultural and urban runoff have been identified as having the potential to adversely affect reproduction and cause growth or birth defects in aquatic organisms. These include contaminants such as PAHs, pesticides, heavy metals and sterols (hormones, for example). We have learned that the concentration of several naturally produced and synthetic sterols increased in tile-drain runoff from manure-treated (dairy and hog) fields when compared to untreated fields. The environmental significance of these substances requires further study.

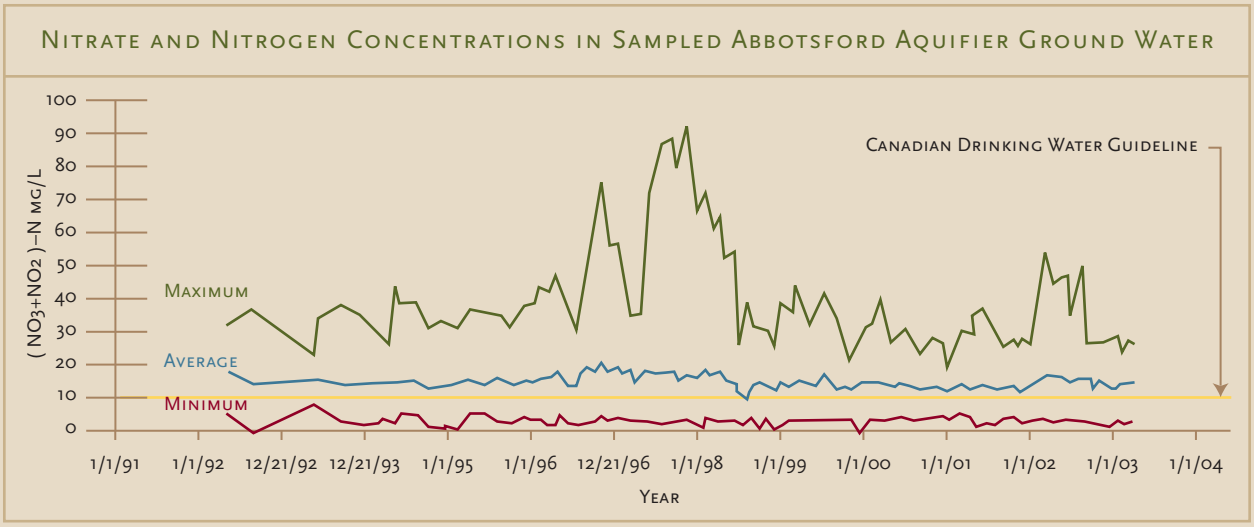


In another study with Agriculture and Agri-Food Canada, soil aeration was evaluated on test plots as a possible BMP to reduce the potential runoff from autumn-manured forage grass fields. Soil aeration reduced overall late-autumn and winter period total suspended solids losses by about 70%, and nutrients by similar amounts.

Some groundwaters in the Basin are contaminated by nitrate, with the Abbotsford aquifer in the Fraser Valley being a prime example. Environment Canada has maintained a long-term groundwater monitoring program of the aquifer. In particular, the Raspberry Industry Development Council has taken up the challenge to address raspberry grower nutrient management issues over the aquifer. With GBEI and other support, fall nitrate soil testing was conducted to identify fields of concern and to assist growers in modifying their practices. The Council also developed and distributed a series of nutrient newsletters in

## NITRATE AND NITROGEN CONCENTRATIONS

*A number of sites in high risk areas of the aquifer have been sampled regularly. Since 1992, the average nitrate concentration observed at these sites have frequently exceeded the Guideline for Canadian Drinking Water Quality (10 mg per litre of nitrate-as oxygen.)*




Source: Environment Canada, Environmental Indicator

English and Punjabi, as well as a nutrient management poster, to increase grower awareness of this issue. Cover cropping, a beneficial BMP to remove nutrients post-harvest, increased from 24% in 2000 to 51% in 2001.

Transporting manure away from the Abbotsford aquifer has been one of the main strategies in tackling the nitrate contamination problem. Early on, the GBEI helped the Sustainable Poultry Farming Group in handling poultry manure. The amount of manure shipped to distant markets from the aquifer area has increased from 16,000 cubic meters in 1998/99 to 27,000 cubic meters in 2001/02. Removing it to areas where it is needed, such as Delta and Merritt, means the risk from non-point source pollution is reduced. However, there remains a long term challenge in the Fraser Valley as attested by an 80% increase in chicken production between 1991-2001.

## Liquid Waste Management

Over the last 10 years, there has been a growing awareness of on-site sewage system failures and malfunctions throughout BC, resulting in environmental and public health concerns. On-site sewage systems are one of the most neglected aspects of liquid-waste management planning, with failures and malfunctions usually resulting from deficient design or inadequate maintenance. To address these inadequacies, on-site wastewater treatment guidelines were developed for site investigation and evaluation, raised adsorption field mound, pressure distribution and cold climate issues. A toolkit to guide management programs for on-site systems was also developed, while training courses have been offered by the Westcoast On-site Wastewater Training Centre at Royal Roads University.

### Managing Biosolids

An important aspect of liquid-waste management is the disposition of biosolids (sewage sludge) generated by Georgia Basin sewage treatment plants. An inventory and characterization study of mercury, and dioxins and furans (PCDD/Fs) in biosolids estimated that 24,200 dry tonnes of biosolids were produced in the Georgia Basin in 1998. Ninety-seven percent was either recycled to land or stockpiled. PCDD/F concentrations analyzed in this study were all below the 100 pg per gram International Toxicity Equivalency Factor limit for biosolids used as a reference comparison in Germany and elsewhere. This study also indicated that while the mercury content varied between WWTPs, the results showed a decline in concentrations at WWTPs with extensive historical records.

In order to improve the management of biosolids, several programs were initiated. Source control guidelines for municipal wastewater inputs were developed, specifically for substances containing mercury and PCDD/Fs. Frameworks for the identification of contaminant sources and recommended strategies for reducing inputs were provided. Additionally, land application guidelines, complementing the provincial *Organic Matter Recycling Regulation*, will ensure biosolids and compost applications do not cause pollution or adversely affect public safety. These guidelines are based on 'beneficial use' of managed organic matter—that they are most appropriately managed as a nutrient source, not as a waste material.

*Applying biosolids with other organic residuals to regulate release of plant nutrients*

An extensive literature review was undertaken to assist British Columbia Medical Health Officers in assessing

Cliff Boldt



*Managing wastewater in Union Bay*

whether the application of biosolids to various types of agricultural lands would result in increased exposure to PCDD/Fs. At PCDD/F concentrations associated with BC biosolids, the expected increase in plant tissue concentrations would be minimal. The review also concluded that there was very little data available to assess the expected effect of dioxins and furans in land-applied biosolids on the contamination levels in animal tissues and cow's milk.

### Managing Wastewater

Disinfecting municipal wastewater is often required to protect public health and shellfish resources. While other forms of disinfection such as ultraviolet radiation are encouraged, chlorination will continue for some time in the future. However, even very low levels of residual chlorine can be toxic to aquatic life. Therefore, a comprehensive review was conducted of the current state-of-the-art methods for chlorine-based disinfection, residual chlorine control, dechlorination chemicals and procedures and the related chlorination and dechlorination equipment. Based on the findings of the review, recommendations have been made to provide guidance to WWTP owners and operators.

An area of the Georgia Basin where the GBEI was instrumental in educating the public about the danger polluted waters pose to the shellfish industry is in Baynes Sound, a large oyster-producing region along the inland waters west of Denman Island to Comox. Union Bay, one community in this area, has been closed to shellfish harvesting since 1969, due to septic seepage into the surrounding watershed, threatening the health of the people of Union Bay and of Baynes Sound itself. Concerned community members hoped to resolve the problem of failing septic systems by developing and subsequently implementing a Liquid Waste Management Plan. This plan intended primary treatment of sewage to take place on-site through a sewage treatment plant. Once this treated liquid waste was filtered through a constructed wetland, it could be clean enough to discharge directly to Baynes Sound. The entrepreneurial initiatives created by this wetland are expected to catalyze cultural, environmental and economic activities.

While the Liquid Waste Management Plan was defeated in a community referendum and an alternate solution is still needed, the project approach proved a partial success as three other communities in the Comox Valley are now looking into addressing the problem of septic seepage in their areas.

## Shellfish Recovery Challenges

Recovered shellfish harvesting areas are an indicator of clean water. Shellfish harvesting has long been a traditional activity in the Georgia Basin for coastal First Nations, commercial enterprises and the general public.

Over the years, many factors have impacted the quality of shellfish growing waters. These include the effects of urbanization (stormwater runoff, on-site septic systems), the inability of existing infrastructure to handle current sewage loadings (overflows, cross-connections) and rural drainage from upland farming activities. As a result, an increasing number of shellfish sanitary closures have been invoked to protect the public from consuming contaminated shellfish.

Education is once again a foundation in the recovery process. A one-day training program is now available at Malaspina University College in Nanaimo. *Water Sampler Preparation Training* teaches students the importance of foreshore pollution source assessments, the dangers of consuming contaminated shellfish, the federal responsibilities as it pertains to the *Canadian Shellfish Sanitation Program*, and laboratory analysis techniques, as well as techniques used in the collection of marine and freshwater samples for shellfish classification purposes.

### Partnering With Local Communities

Over the past five years, the GBEI partnered with several coastal First Nations to raise public awareness of shellfish harvesting concerns. The *Nanaimo River Estuary Project* saw the Snuneymuxw First Nation working with government agencies and various non-government partners to develop an estuary management plan. Under this plan, water sediment and biota samples were analyzed for chemical and bacteriological contaminants, and sources of pollution were identified. Out of this work has come the opportunity for a seasonally controlled depuration fishery of approximately 41.2 hectares along the eastern intertidal foreshore of Nanaimo Harbour.

Other projects throughout the Georgia Basin have emphasized the importance of partnership. In the Halfmoon Bay area, shellfish closures have been a problem for quite some time. A study conducted to determine the sources of pollution to the area contributed to an ongoing *Liquid Waste Management Planning Initiative* on the Sunshine Coast, and raised awareness in the community.

Partnerships with local governments have led to significant environmental improvements within the Georgia Basin. The Saanich Inlet shellfishery has been long recognized as an important food source to the three First Nations and the larger community on the Saanich Peninsula, but the area is currently closed to shellfish harvesting, in part due to bacterial contamination from stormwater discharges. However, Environment Canada and the CRD have been working together since 1999 to open shellfish beds along the Saanich Inlet side of the peninsula. This *Open Saanich Inlet Shellfish Beds Project* has resulted in a significant reduction in the number of stormwater discharges with elevated fecal coliform levels. Also, the number of marine nearshore stations that have exceeded the shellfish criterion of 14 fecal coliforms per 100 millilitres has been reduced by 60%.

Another study involved monitoring fecal coliform bacteria in the waters and stormwaters of Semiahmoo Bay (from the Canada–U.S. border to Kwomais Point in Boundary Bay, including the Little Campbell River),

Andrew McNaughton, Snuneymuxw First Nation

*Shellfish: indicator of a healthy ecosystem*

closed to shellfish harvesting since 1962. Conducted through an exchange with the South Fraser Valley Health Unit, this study assessed the potential for an upgrade in the current classification or a reduction of the prohibited area in Semiahmoo Bay. Since the Bay extends across the U.S. boundary into Drayton Harbour, a multi-stakeholder working group consisting of municipal, provincial and federal levels of Canadian government along with U.S. state representatives, community volunteers and academia was formed to address water quality issues on both sides of the border. Collected data was used to produce a study of contaminant flow, made possible through a cost-sharing agreement. The report generated from this study helped to identify potential pollution sources and prioritize future remediation strategies for Semiahmoo Bay.



Because of this shared-water initiative, people are now more aware of the troubled state of shellfish in waters around the Georgia Basin. Parties on both sides of the Canada–U.S. border plan to address discharges into Semiahmoo Bay and Drayton Harbour over the long term, which will require successful development and implementation of liquid-waste management and restoration plans.

### Encouraging Responsible Boating

The beautiful Georgia Basin is a popular boating area, but boat-discharged sewage also threatens shellfish growing water quality and public health.


*Encouraging responsible boating means less pollutants in the water*

To encourage boaters to dispose of their sewage safely, a project funded by the GBEI led to the construction of numerous sewage pump-out stations including those in Comox, Deep Bay, Madeira Park, Pender Harbour and Gibsons. This successful initiative will help reduce the risk of fecal contamination from boat discharges to shellfish harvesting areas.

To raise awareness of the dangers posed to the ecosystem by harmful substances discharged from boats, the Georgia Strait Alliance distributed a pamphlet titled *Protecting BC's Aquatic Environment – A Boater's Guide* to both commercial and recreational boaters.

## Integrated Approach to Watershed Monitoring

In order to measure the potential effects of multiple land-uses on the aquatic ecosystem, one research study took an innovative monitoring approach. Fish and crayfish were placed in stream-side, flow-through aquariums in two areas of the Lower Fraser Valley: Yorkson Creek, an urban watershed in the Township of Langley, and Elk Creek, an agricultural watershed in Chilliwack. Results from analyzed tissues of the exposed organisms showed that some potential endocrine disrupting compounds (EDCs), such as PAHs and pesticides, are present at low levels. Levels of the insecticide endosulphan (a potential EDC) measured in water and fish tissue samples in Elk Creek were highest at the downstream agricultural site when compared to the upstream reference sites on Elk Creek and Yorkson Creek. Furthermore, levels of the banned pesticide dieldrin were measured at a higher concentration in the urban stream than the agricultural stream. However, none of the pesticides measured in this study exceeded existing water quality guidelines.

As the results continue to be evaluated, this study is allowing us to better define the impact of pollutants on biological systems. For example, the levels of a biochemical stress indicator (Mixed Function Oxidase) were higher in crayfish and cutthroat trout exposed

to water downstream of the agricultural and urban areas. Swimming performance and immune system resilience were reduced in trout, as was reproduction in stickleback.

Benthic invertebrates (insects and other organisms living on stream bottoms) have also been used as indicators of contamination. They are easy to collect and relatively inexpensive to identify compared to water chemistry sample analysis. Representing site-specific conditions, their highly diverse communities provide varied responses to many different environmental stressors.

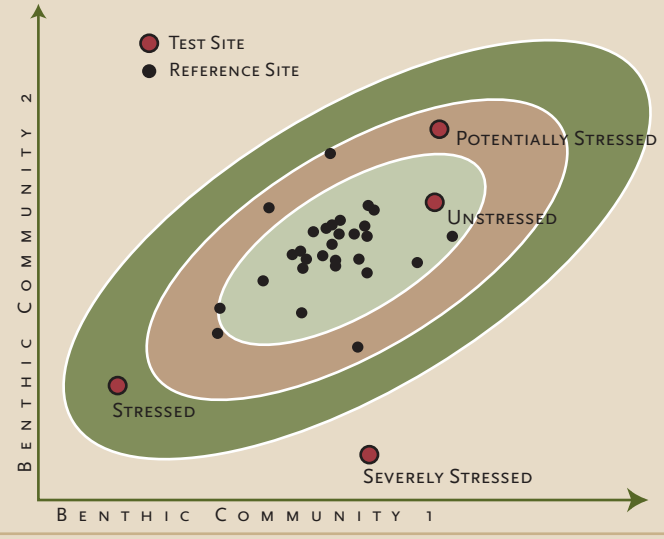
A large database of invertebrate and habitat data was compiled for the Fraser and Georgia Basins, providing reference conditions (minimal human disturbance). From this database, a predictive bioassessment model was developed to link habitat data to invertebrate communities. If the habitat features of a potentially impacted site are known, this model can be used to predict which invertebrate community should be observed. The greater the difference in the community from what is predicted based on the habitat features, the more the community is stressed by the impacts of human activity.

When Georgia Basin sites exposed to agricultural and urban activities were assessed using the predictive bioassessment model, we found that many of the urban streams exhibited differences from what was expected. This included the types of invertebrates, as well as their relative abundance. Some agricultural sites also showed some level of degradation. This data will be made available in an Internet-accessible database along with the reference data, the predictive bioassessment model and the bioassessment software as part of the *Canadian Aquatic Biomonitoring Network* (CABIN).



In 1998 and 1999, the Ministry of Water, Land and Air Protection assessed water quality in Cowichan River, Koksilah River, and Cowichan Bay, in order to identify sources of coliforms and nutrients, particularly from non-point sources. They also sampled additional substances associated with urban or industrial runoff. The results of this assessment can help citizens, agencies, and regulators to protect water resources in these areas.

## Bioassessment Model: Using Benthic Invertebrates as an Indicator of Contaminated Water




Source: Stephanie Sylvestre, Environment Canada

# Our Commitment to the Future:

# The Georgia Basin Action Plan

## Over the next five years, the Georgia Basin Action Plan (GBAP) will build on the progress of the GBEI. Between 2003 and 2008, we are committed to the following goals:

- supporting the sustainability of the Georgia Basin through collaborative stewardship
- using sustainable land, aquatic and resource-use planning and management to support the conservation, protection and restoration of the environment, enhance human and social well-being, and contribute to a strengthened economy
- supporting improved decision-making by using scientific and indigenous knowledge to advance the understanding of key ecosystem stresses
- protecting and restoring targeted ecosystems

These goals will be accomplished through strategies that integrate environmental, social and economic considerations. We aim to generate new knowledge and develop relevant tools for decision-makers and influencers at all levels. By optimizing outreach and stewardship, government programs and collaboration, and by strengthening partnerships and strategic alliances, we will promote best practices throughout the Georgia Basin.

Elena Rivera



Under the GBAP, we will support the development of, and access to, stewardship tools and integrated resource and land-use data and information for the Georgia Basin and Puget Sound. We will aid the development of ecosystem health and community progress indicators, and provide tools to implement ecosystem, airshed and watershed-based approaches in aquatic, land and resource-use plans. We will also promote shared leadership roles in stewardship, sustainable best practices, and eco-efficiency amongst governments, non-government organizations, First Nations, the private sector, communities and individuals.

Our actions will advance understanding of the socio-economic and health impacts of poor air, water or habitat quality, and support the sustainable use of the ecosystem by aquatic and terrestrial resource-based industries. By improving scientific understanding and sharing indigenous knowledge of ecosystem stresses resulting from human activity, we aim to further identify links between human health and environmental conditions, and improve understanding of climate-change impacts and adaptation. We will also reduce loadings and emissions of toxics and contaminants in air and water, protect drinking water sources and conserve, protect and restore important aquatic and terrestrial species and habitats.

Over the past five years, partnership has been key in achieving our goals. As we look to the future, we will continue to strive toward effective partnerships built on cooperation and communication. And we will continue to use science as the fundamental building block of our approach, recognizing that sound knowledge is vital to a sustainable future.

# LIST OF RESOURCES



## Toward Sustainable Communities

**BC Stats Socio-Economic Profile of the Georgia Basin**
www.bcstats.gov.bc.ca/data/sep/georgia/georgia.htm

**Business Environmental Pledge Program**
www.steprecycling.com/bepp.htm

**Capital Regional District Natural Areas Atlas**
www.crd.bc/es/natatlas/overview.htm

**Coastal Shores Stewardship Guide**
www.stewardshipcentre.bc.ca/sc_bc/main/index.asp?sProv=bc#

**Community Indicator and Benchmark Reports**
www.newwestced.bc.ca/sustainable.html

**Cowichan Valley Integrated Data Management**
http://maps.gov.bc.ca/apps/idmi_cowval/

**Eco Education BC**
www.ecoeducation.bc.ca

**Environment Canada's Environmental Indicators**
www.ecoinfo.org/index_e.cfm

**Evergreen's Greening Schools Project**
www.greengrounds.org

**Fraser Basin Council Sustainability Indicators**
http://www.fraserbasin.bc.ca/indicators.html

**GBEI Public Reports**
www.pyr.ec.gc.ca/georgiabasin/reports_E.htm

**Georgia Basin–Puget Sound Ecosystem Indicators Report**
http://www.pyr.ec.gc/georgiabasin/reports/EnvInd_Reports/Summary_e.htm

**Headwaters Project**
www.sustainable-communities.agsci.ubc.ca/projects/Headwaters.html

**Interactive Non-point Source Pollution Model Poster**
www.pyr.ec.gc.ca/EN/IPM/

**Georgia Basin Futures Project (QUEST)**
www.basinfutures.net

**Georgia Basin Environmental Indicators**
http://wlapwww.gov.bc.ca/soerpt/gbindicators/

**Salish Sea: A Handbook for Educators**
www.parkscanada.gc.ca/edu/proj/salish/index_e.asp

**Smart Growth Toolkit**
www.smartgrowth.bc.ca

**Sustainability Tools and Resources (STAR)**
www.sustainabilitytools.ca

**UBC's Regional Sustainable Development and Integrated Assessment Course/Lecture Series**
www.sdri.ubc.ca/lectureseries/

**Urban Watershed Management CD ROM**
www.ire.ubc.ca/y2k/ire/html/cd-rom.htm#cd8

## The Air We Breathe

**AirCare Vehicle Emissions Testing Program in Vancouver**
www.aircare.ca/

**Climate Change and the Lower Fraser Valley Report**
www.pyr.ec.gc.ca/georgiabasin/reports/_E.htm

**Fraser Valley Regional District**
www.fvrd.bc.ca

**Greater Vancouver Regional District Emissions and Air Quality**
www.gvrd.bc.ca/services/air/emissions.html

**Meteorological Summary of the Pacific 2001 Air Quality Field Study**
www.pyr.ec.gc.ca/georgiabasin/reports/pacific_2001_summary/summary_e.htm

**Pacific 2001 Air Quality Study—Lower Fraser Valley**
www.smc-msc.ec.gc.ca/projects/pacific2001/index_e.html

**SMOG-An Indicator of Potential Air Quality Health Risk in the Fraser Valley**
www.ecoinfo.ec.gc.ca/env_ind/region/smog/smog_e.cfm

**Temperature Rising Poster and Teachers Guide**
www.climatechangecanada.org

**The Impact of Visual Air Quality on Tourism Revenues in Greater Vancouver and the Lower Mainland**
www.pyr.ec.gc.ca/georgiabasin/reports/GV_Air_Quality/Summary_e.htm

## Protecting Species and Their Habitats

**BC Shellfish Grower's Association Shellfish Growers Code of Practice**
www.bcsgca.ca/tidelines

**Conservation Covenants**
www.landtrustalliance.bc.ca/public/product.htm

**Ducks Unlimited**
www.ducks.org/

**Ecological Gifts Program**
www.cws-scf.ec.gc.ca/ecogifts/

**Garry Oak Reports**
www.garryoak.bc.ca

**Green Legacies: A Guide to Nature and Conservation Giving in BC**
www.stewardshipcentre.bc.ca/green_legacies_web/index.asp

**Greenfields Project**
www.gvrd.bc.ca/sustainability/casestudies/deltagreenfields.htm

**Living by Water**
www.livingbywater.ca

**Marine Mammal Monitoring Annual Report**
www.salishsea.ca

**Pacific Coast Conservation Program**
www.pyr.ec.gc.ca/EN/Wildlife/habitat/protected.shtml

**Pacific Marine and Coastal Ecosystems**
www.parkscanada.gc.ca/pn-np/bc/gulf/index_E.asp

**Sea Duck Management Plan**
www.seaduckjv.org

**Sensitive Ecosystem Inventory**
www.elp.gov.bc.ca/rib/cbs/sei

**Sensitive Habitat Inventory Mapping Project**
www.shim.bc.ca

**Stewardship Centre Web site**
www.stewardshipcentre.bc.ca

**Steelhead Recovery Plan**
www.SteelheadRecoveryPlan.ca

**Southern Gulf Island Natural Park Reserve**
www.parkscanada.gc.ca/pn-np/bc/gulf/index_e.asp

**Wetlandkeepers Handbook**
www.stewardshipcentre.bc.ca/sc_bc/stew_series/bc_stewseries.asp

## Achieving Clean Water

**A Water Quality Assessment of the Cowichan and Koksilah Rivers and Cowichan Bay**
www.pyr.ec.gc.ca/georgiabasin/reports/Rivers_Water_Quality/summary_e.htm

**BCWWA On-Site Sewage Systems Guidelines**
www.bcwwa.org

**Byrne Creek Watershed Business Inspection and Education Program Progress Report for 2002**
www.pyr.ec.gc.ca/georgiabasin/reports/Byrne_Creek_Watershed/Summary_e.htm

**Capital Regional District Core Area Liquid Waste Management Plan–Stormwater Quality Management**
www.crd.bc.ca/es/lwmp/pdf/chap10.pdf

**Cecilia Creek Best Management Practices**
www.crd.bc.ca/es/education/tour.htm

**Compilation of Environmental Quality Benchmarks CD-ROM**
www.pyr.ec.gc.ca/georgiabasin/reports/Environmental%20Benchmarks/summary_e.htm

**Cooperative Approach to Restoration of Shellfish Growing Waters in Semiahmoo Bay-Drayton Harbour**
www.pyr.ec.gc.ca/georgiabasin/reports/Restoration_Shellfish/summary_e.htm

**Georgia Basin Biosolids Inventory and Mercury and Dioxins and Furans Characterization. November 1999**
www.pyr.ec.gc.ca/georgiabasin/reports/GB_Biosolids_Inv/summary_e.htm

**Georgia Basin Ecosystem Initiative Sewage Treatment Facility Inventory and Optimization**
www.pyr.ec.gc.ca/georgiabasin/reports/GBEI_Sewage_Treatment/summary_e.htm

**Halfmoon Bay Area Water Quality Monitoring Program Report**
www.pyr.ec.gc.ca/georgiabasin/reports/Halfmoon_Water/summary_e.htm

**Harbour Ecological Inventory**
www.veheap.crd.bc.ca

**Heat Pump Applications Using Municipal Effluent-Joint Abbotsford Mission Environmental System (J.A.M.E.S.) Water Pollution Control Centre**
www.pyr.ec.gc.ca/georgiabasin/reports/Heat%20Pump%20Applications%20Using%20Municipal%20Effluent/summary_e.html

**Hydrogeological and Hydrological Evaluations for Development of Remediation Options For Mount Washington, Courtenay, BC**
www.pyr.ec.gc.ca/georgiabasin/reports/Mt_Wash_Report/summary_e.htm

**Loading Estimates of Selected Toxic Substances in Wastewaters discharged to the Georgia Basin Report**
www.pyr.ec.gc.ca/georgiabasin/reports/substances_in_wastewaters/summary_e.htm

**Lower Sooke River Watershed Non-Point Source Assessment: Impact on the Sooke River Estuary**
www.pyr.ec.gc.ca/georgiabasin/reports/Sooke_Watershed/summary_e.htm

**Nanaimo Estuary Management Plans**
srmwww.gov.bc.ca/rmd/coastal/nanaimo/nemp_panels.htm

**Nutrient Levels in the Atmosphere of the Elk Creek Watershed Chilliwack, BC, (1999-2000)**
www.pyr.ec.gc.ca/georgiabasin/reports/NAECWC/summary_e.htm

**Optimization of the Oxidation Ditch Process Through Automated ORP Control of Aerobic/Anoxic Operation**
www.pyr.ec.gc.ca/georgiabasin/reports/Oxidation%20Ditch%20Process/summary_e.htm

**Protecting BC's Aquatic Environment—A Boater's Guide**
www.georgiastrait.org/CleanBoating/guidep1.php

**Sources and Releases of Toxic Substances in Wastewaters within the Georgia Basin Report**
www.pyr.ec.gc.ca/georgiabasin/reports/GBEI_Toxic_Wastewater/summary_e.htm

**State of the Sound GIS Project (Baynes Sound)**
www.pyr.ec.gc.ca/georgiabasin/reports/GIS_Project/summary_e.htm

**Stormwater Management Guidebook**
http://wlapwww.gov.bc.ca/epda/mpp/stormwater/stormwater.html

**Survey of Pesticide Use in British Columbia: 1999**
www.pyr.ec.gc.ca/georgiabasin/reports/Pesticide_Use_BC/summary_e.htm

**Union Bay Liquid Waste to Wealth Report**
www.fraserbasin.bc.ca/documents/Lessons%20Learned%20Mar%202002/37.Union%20Bay.pdf

**Union Bay On-Site Pilot Project**
www.pyr.ec.gc.ca/georgiabasin/reports/Union_Bay_Pilot/summary_e.htm

**Union Bay-Preliminary Evaluation of the GBEI Toolkit "Development of Management Tools and Strategies for On-Site Sewage Systems - 2000"**
www.pyr.ec.gc.ca/georgiabasin/reports/GBEI_Toolkit/summary_e.htm

**Union Bay Liquid Waste Management Committee Final Urban Watershed Management CD-ROM**
www.ire.ubc.ca/y2k/rmes/web_courses/urban/urban.html

**Water Use and Wastewaters in the Georgia Basin —An Indicator of Resource Sustainability**
www.ecoinfo.ec.gc.ca/env_ind/region/wateruse/gbwateruse_e.cfm



# PARTNERS

2010 Bid Corporation
Abbotsford Chamber of Commerce
Abbotsford Land Trust Society
Abbotsford Soil Conservation Association
Abbotsford Streamkeepers
Agriculture and Agri-Food Canada
Alberni Valley Enhancement Association
Alliance Professional Services
Archipelago Marine Research
Artist Response Team Inc.
BC Agriculture Council
BC Building Corporation
BC Conservation Data Centre
BC Conservation Foundation
BC Cranberry Growers Association
BC Energy
BC Environmental Network
BC Ferry Corporation
BC Forage Council
BC Hydro
BC Institute of Technology
BC Knowledge Development Fund
BC Lung Association
BC Onsite Sewage Association
BC Shellfish Growers Association
BC Society of Landscape Architects
BC Statistics
BC Teachers Federation
BC Water and Waste Association
BC Waterfowl Society
BC Wildlife Federation
BC-4H Provincial Council
British Columbia Institute of Technology
Bird Studies Canada
Boundary Health Unit
Burnside Gorge Community Association
Burrard Inlet Environmental Action Program
Canada Mortgage and Housing Corporation
Canadian Cancer Society
Canadian Coast Guard
Canadian Forestry Services
Canadian Foundation for Innovation
Canadian International Development Agency
Canadian Parks and Wilderness Society
Canadian Rural Partnership
Canadian Water Resources Association
Capital Regional District
Carbon Monoxide Information Network
Central Valley Naturalists
Centre for Coast and Ocean Research
Citizens for ActionRecycling and the Environment
Citizens of Salt Spring Island
City of Abbotsford
City of Burnaby
City of Chilliwack
City of Mission
City of Nanaimo
City of New Westminster
City of Parksville
City of Port Alberni
City of Richmond
City of Surrey
City of Vancouver
Clean Print BC
Coastal and Ocean Resources Inc.
Coastal Community Network
Coastal Zone Canada
Council of Forest Industries
Communication Canada
Communities Futures Development Corporation of Howe Sound
Community Futures Development Corporation of Fraser Valley
Comox Strathcona Regional District
Comox Valley Environmental Council
Comox Valley Project Watershed
Comox Valley Watershed Assembly
Corporation of Delta
Correctional Service Canada
Cowichan Tribes
Crop Protection Institute of Canada
David Suzuki Foundation
Deep Bay Harbour Authority
Delta Agricultural Society
Delta Farmers
Delta Farmland and Wildlife Trust
Department of National Defence
District of Campbell River
District of Saanich
District of Squamish
Douglas College Institute of Urban Ecology
Drayton Harbor Shellfish District
Ducks Unlimited
Eco-Education
Ecosystem Restoration Program
Enviroed Consultants
Environment Canada
Evergreen Foundation
Federation of BC Naturalists
Fisheries and Oceans Canada
Fisheries Renewal BC
Fraser Basin Council
Fraser River Estuary Management Program
Fraser Valley Regional District
Fraser Valley Strawberry Growers Association
Friends of Boundary Bay
Friends of False Creek
Galiano Conservancy Association
Galiano Island Forest Association
Garibaldi Health Office
Garland Canada Inc.
Garry Oak Meadow Preservation Society
Geographic Data BC
Geological Survey of Canada
Georgia Strait Alliance
Greater Vancouver Regional District
Greater Vancouver Transportation Authority
Green Roofs for Healthy Cities
Greening School Grounds
Habitat Acquisition Trust
Habitat Conservation Trust Fund
Halfmoon Bay Community School
Harbour Authorities Project Watershed
Health Canada
Hog Sustainable Farming Group
Important Bird Areas
Indiana University (Dr. S. Pryor)
Institute of Health Promotion Research
Investment Agriculture Foundation
International Olympic Committee
Indian Affairs and Northern Development
Island Trust Fund
Kerr Wood Leidal Consulting Engineers
Koers and Associates Engineering Ltd.
Land Conservancy
Land Trust Alliance of BC
Land Use Coordination Office
Langara College
Langley Environmental Partners
Lester B Pearson College of the Pacific
Living by Water Project
Lookout Emergency Aid Society
Malaspina College, Nanaimo
MCC Ecoworks
Millenium Bureau of Canada
Ministry of Aboriginal Affairs
Ministry of Agriculture, Fisheries and Food
Ministry of Community, Aboriginal and Women's Services
Ministry of Forests
Ministry of Health
Ministry of Health Planning
Ministry of Sustainable Resource Management
Ministry of Transportation and Highways
Ministry of Water Land and Air Protection
Mission Chamber of Commerce
Mission Real Estate Board
Mountain Equipment Co-op
Nanaimo Area Land Trust
National Water Research Institute
Native Plants Society of BC
Natural Resources Canada
Nature Conservancy (US)
Nature Conservancy of Canada
Nature Trust of BC
Naturescape BC
Nestucca Fund
New Westminster Community Development Society
New Westminster School District
Northwest Air Pollution Control Authority
Nursery Trades Association of BC
Oregon State University
Pacific Coast Joint Venture Partners
Pacific Streamkeepers Federation
Pacifica Papers
Parks Canada
Partners in Flight / Canada
Partners in Flight / USA
Peace and Global Educators
Port Alberni Port Authority
Powell River Economic Development Society
Powell River Regional District
Prospect Lake Community Association
Provincial Capital Commission
Public Works and Government Services Canada
Puget Sound Clean Air Agency
Puget Sound Restoration Fund
Puget Sound Water Quality Action Team
Puget Sound/Georgia Basin Toxics Work Group
Raspberry Industry Development Council
Real Estate Foundation of BC
Regional Aquatic Management Society
Regional District of Comox - Strathcona
Regional District of Nanaimo
Resort Municipality of Whistler
Robertson Creek Hatchery
Roofing Contractors Association of BC
Royal Bank
Royal British Columbia Museum
Royal Roads University
Saanich Inlet Protection Society
Salt Spring Island Conservancy
Science and Management of Protected Areas Association
Science World
Sechelt Indian Band
Semiahmoo First Nations
Shell Canada
Simon Fraser Health Region
Simon Fraser University
Smarth Growth BC
Snuneymuxw First Nations
Society for Children and Youth of BC
SongBird Project
Southern Rail of British Columbia
Status of Women Canada
Sunshine Coast Conservation Area
Sunshine Coast Community Futures
Sunshine Coast Economic Development Partnership
Sunshine Coast Regional District
Sustainable Poultry Farming Group
Terminal Forest Products Ltd
Tides Association
Transport Canada
Tree Canada Foundation
Trillium Corporation
U.S. Environmental Protection Agency Region 10
Union Bay Improvement District
Union of BC Municipalities
University College of the Fraser Valley
University of British Columbia
University of Calgary
University of Plymouth
University of Victoria
University of Washington
University of Western Washington
Upper Island/Central Coast Community Health Services
Urban Salmon Habitat Program
US Fish and Wildlife Service
US Geological Survey Water Resources
US Tribal Nations
Van City Savings Credit Union
Vancouver Airport Authority
Vancouver Aquarium
Vancouver Foundation
Vancouver Sun
Vancouver-Richmond Health Board
Varian Canada Inc.
Veins of Life Watershed Society
Village of Cumberland
Washington State Department of Ecology
Waterbird Watch Collective
West Coast Environmental Law
West Coast Islands Conservancy
Westcoast Energy Inc.
Weyerhaeuser West Island Timberlands
Wild BC
Wild Bird Trust of BC
Wildlife Habitat Advisory Committee on Compensation
Wildlife Habitat Canada
World Widlife Fund Canada

www.pyr.ec.gc.ca/GeorgiaBasin/

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