Summary: 2011–2013 Water Quality Monitoring Results

for Shuswap and Mara Lakes

CONSOLIDATED UPDATE

SLIPP

Shuswap Lake Integrated Planning Process

Working Together to Sustain the Health and Prosperity of Shuswap and Mara Lakes

Overview

In 2011 the partner agencies in the Shuswap Lake Integrated Planning Process (SLIPP) began a three-year water quality monitoring program. The results of this program show that, in most locations in and around Shuswap and Mara Lakes, water quality is good. Most water samples met government safety guidelines for drinking water, for swimming, and for livestock, fish and wildlife protection.

However, in certain lake locations, rivers, streams and groundwater sites, high concentrations of phosphorus, nitrogen or fecal coliform bacteria were found. This flags a need for a management strategy to prevent deterioration of water quality in and around the lakes. A strategy would encompass steps needed to protect water quality over the long term, as well as short-term measures to address current risks to water quality.

Multiple agencies with responsibilities for water collaborated in the SLIPP water monitoring program, together with small water suppliers, watershed stewardship groups and other community volunteers. Participating agencies included the Province of BC (Ministry of Environment), Fisheries and Oceans Canada, Columbia Shuswap Regional District, City of Salmon Arm, District of Sicamous and Interior Health Authority.

Water sampling was done at over 250 sites at various locations on the lakes and tributaries and at groundwater sites (wells). The monitoring program provided valuable information about the health of the lakes and pollutants of concern. The data was much more comprehensive than what any single agency could achieve independently.

This summary reflects key findings of the three-year SLIPP water quality monitoring program, from 2011 to 2013. This is the second water quality summary report produced by SLIPP, and is an update to the 2011-2012 summary. Both the summaries and the full monitoring reports are available in the resource archive at ***www.slippbc.com***.

left & right photos: jeff summers / christopher porter / alex ristea

REASONS TO TAKE A CLOSER LOOK

In recent years, some areas of Shuswap and Mara Lakes have shown signs of nutrient enrichment – that is, a higher level of nutrients than what is optimal for water quality and lake health. Algae blooms in 2008 (Shuswap Lake) and 2010 (Mara Lake) were of particular concern.

A high level of nutrients and bacteriological contamination in waterways is often connected with activities on land and with inputs such as agricultural run-off or erosion, release of greywater (wastewater from sinks, showers and laundry facilities), septic field and sewage inflows and urban run-off. In contrast, relatively undeveloped regions – such as the Anstey and Seymour Arms of Shuswap Lake – have the most pristine water quality.

Managing nutrients and bacteria in the Shuswap watershed is an important priority for the long-term health of the lakes and tributaries, and for the health of residents and visitors.

HISTORICAL MONITORING AND BENCHMARKING

Water quality monitoring helps ensure that water is clean and that the lake ecosystem is healthy. Collecting and reporting a single year's worth of data has merit, but the greatest value is in continued, long-term monitoring and reporting at several different sites. This approach establishes a benchmark and reveals trends in water quality – improving or declining – over time. It is also possible to determine if water quality is changing in specific areas of a lake or watershed.

Water quality monitoring and studies have been carried out in the Shuswap for over 40 years. As a result, there are water quality benchmarks – that is, a historical set of data to which current data can be compared.

The historical data show that water quality in the Shuswap has generally been good. This data can be used alongside current monitoring results to identify any exceptions or emerging issues of concern.

Water Quality in the Shuswap

2011-2013 SLIPP WATER QUALITY MONITORING PROGRAM

Partner agencies in the Shuswap Lake Integrated Planning Process (SLIPP) saw the need to address questions and concerns about water quality on Shuswap and Mara Lakes. In 2011 they launched a collaborative three-year pilot program to monitor water quality in and around the lakes.

This pilot program complemented and extended the monitoring work undertaken by the agencies individually. Through the program, agencies worked together to meet their own responsibilities and watershed-wide objectives. In this way, the program created efficiencies by coordinating efforts, eliminating duplicate sampling and sharing data.

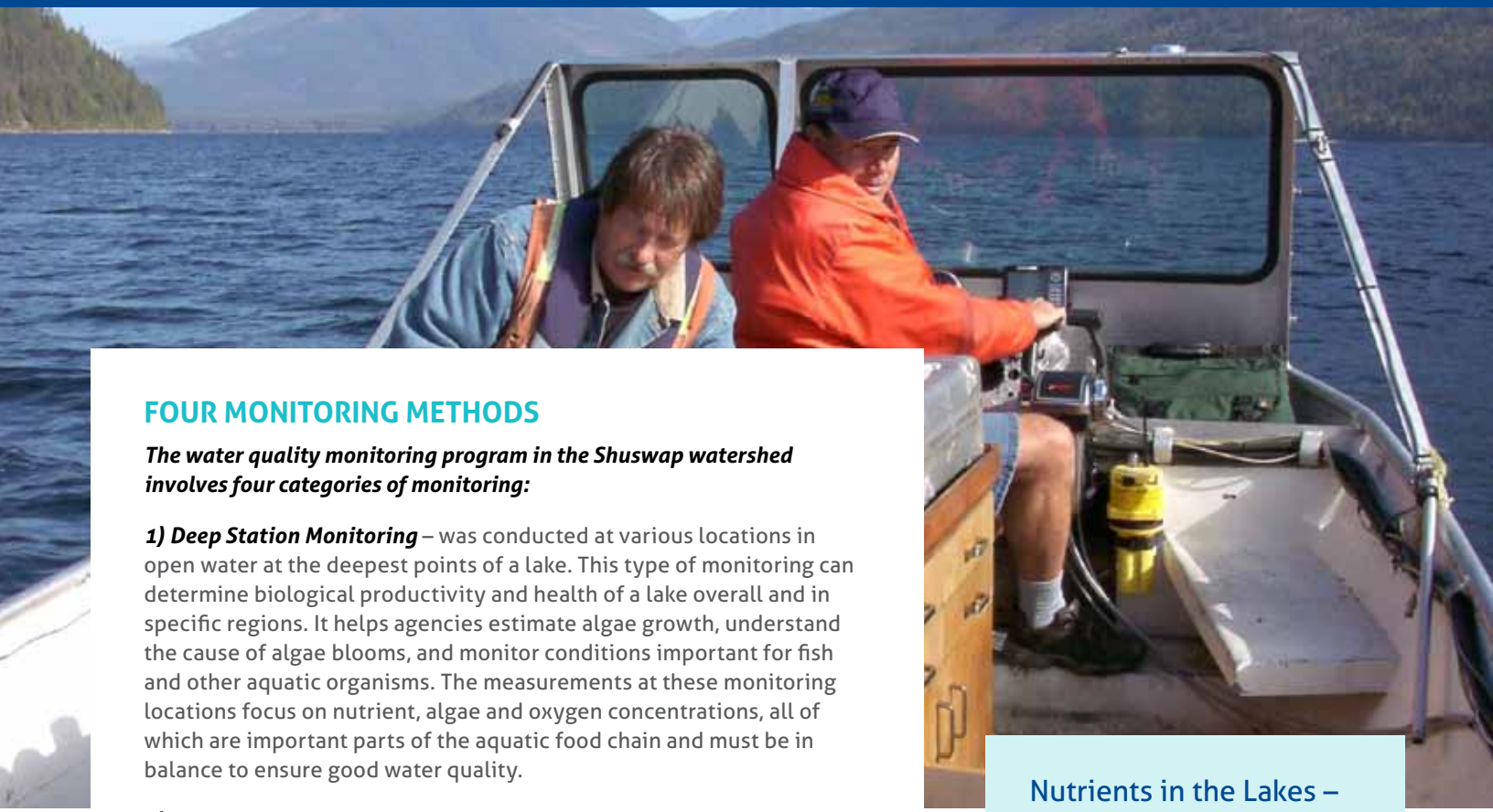
Specific Areas of Focus

The water quality monitoring program was intended to allow responsible agencies to:

- Assess water quality and its safety for drinking, recreation, aquatic life (e.g., algae, plants and fish), livestock watering and wildlife
- Identify water quality trends over time and in different locations
- Better understand the causes of algae blooms that have occurred in Shuswap and Mara Lakes
- Assess the effects of specific activities or discharges (e.g., wastewater treatment plant discharges, boat greywater discharges and seepage from septic systems) into the lakes and tributaries.
- Identify the most significant sources of excess nutrients and contaminants in and around the lakes. The most significant sources can then be managed from a cost-benefit perspective.

"Shuswap Lake, along with Mara and Little Shuswap Lakes, are the centerpiece of economic, social and environmental sustainability in the greater Shuswap basin. They collectively support a thriving tourism industry and an expanding residential and commercial property market. Shuswap Lake is the centre of Canada's houseboat industry, the nursery lake for the world-famous Adams River Sockeye salmon, and the source of drinking water for several local communities and hundreds of lakeshore residents. The best defence for preventing water quality degradation in the Shuswap area lakes is a detailed assessment and analysis of nutrients and contaminants being discharged into these lakes, followed by an action plan to reduce or eliminate nutrients and contaminant loading, as required."

– Shuswap Lake Integrated Water Quality Monitoring Plan, 2010



FOUR MONITORING METHODS

The water quality monitoring program in the Shuswap watershed involves four categories of monitoring:

1) Deep Station Monitoring – was conducted at various locations in open water at the deepest points of a lake. This type of monitoring can determine biological productivity and health of a lake overall and in specific regions. It helps agencies estimate algae growth, understand the cause of algae blooms, and monitor conditions important for fish and other aquatic organisms. The measurements at these monitoring locations focus on nutrient, algae and oxygen concentrations, all of which are important parts of the aquatic food chain and must be in balance to ensure good water quality.

2) Near-Shore Monitoring – looked at water quality along the shoreline (within about 100m) and determined whether near-shore water is safe for drinking, recreation and other uses. Water samples were taken from drinking water intakes, lakeshore sites, park beaches and groundwater sites (wells). Additionally, algae growth was monitored at several near-shore sites. This component of the monitoring program can detect water quality impacts from on-shore activities, seepages or discharges.

3) Water Quality Effects of Specific Activities – helped agencies understand the actual effects of discharges (such as wastewater treatment plant or boat greywater discharges) across the lake and in certain regions of the lake.

4) Watershed and Tributary Monitoring – determined which tributaries carry the largest volume of nutrients and contaminants into the lake. Once these are identified, the upstream sources of the nutrients and contaminants can be investigated and managed.

Members of the water quality monitoring team collect a water sample from a deep station on Shuswap Lake.

Nutrients in the Lakes – A Question Of Balance

In a lake, algae are an important part of the food chain. They are a source of food for small free-swimming invertebrates. Invertebrates are food for small fish, which are food for larger fish. Algae need nutrients such as phosphorus, nitrogen and organic carbon to grow. Naturally occurring nutrients and algae are important to making a lake biologically productive and supporting a healthy fish population.

It is important for nutrients to remain in a balance with plants and animals in the ecosystem. Excessive nutrients and algae can reduce water clarity, create odours and reduce the value of the water for drinking and recreation. When large amounts of algae die and sink to the lake bottom, they decompose and use up the dissolved oxygen in deep water. These low levels of dissolved oxygen can cause reactions that lead to the release of compounds detrimental to drinking water quality, fish and other aquatic life.

left background photo: gordana am

What are the Guidelines for Water Quality?

Drinking Water:

In Canada, there are federal safety guidelines on the quality of drinking water, which include multiple recommended levels of protection, from "source to tap." In BC the *Drinking Water Protection Act* and regulations define the provincial standards for drinking water systems and their operation, which are administered by health authorities and carried out by drinking water suppliers.

The federal Guidelines for Canadian Drinking Water Quality and Guidelines for Canadian Recreational Water Quality set maximum acceptable concentrations of microbiological contaminants (bacteria, viruses and protozoa) and various chemicals. If concentrations exceed specified levels, the water is not considered safe.

For both drinking water and recreation, the guidelines focus on fecal bacteria, *Escherichia coli* (*E. coli*). While these bacteria are not usually harmful, they are good indicators of the presence of disease-causing bacteria, viruses or parasites. The guideline for untreated drinking water states that a safe level is zero *E. coli* bacteria in a 100 mL sample. *E. coli* are found in most lakes and streams because they come naturally from wildlife. For this reason, it is recommended that all surface water be treated before drinking.

Water for Swimming:

Federal guidelines on water quality for swimming state that a safe bacteria level is less than 400 *E. coli* in a 100 mL sample or an average of 200 *E. coli* in a 100 mL sample, based on five weekly samples. Above this, a swimming advisory may be issued.

Synopsis of the

2011–2013 Monitoring Results

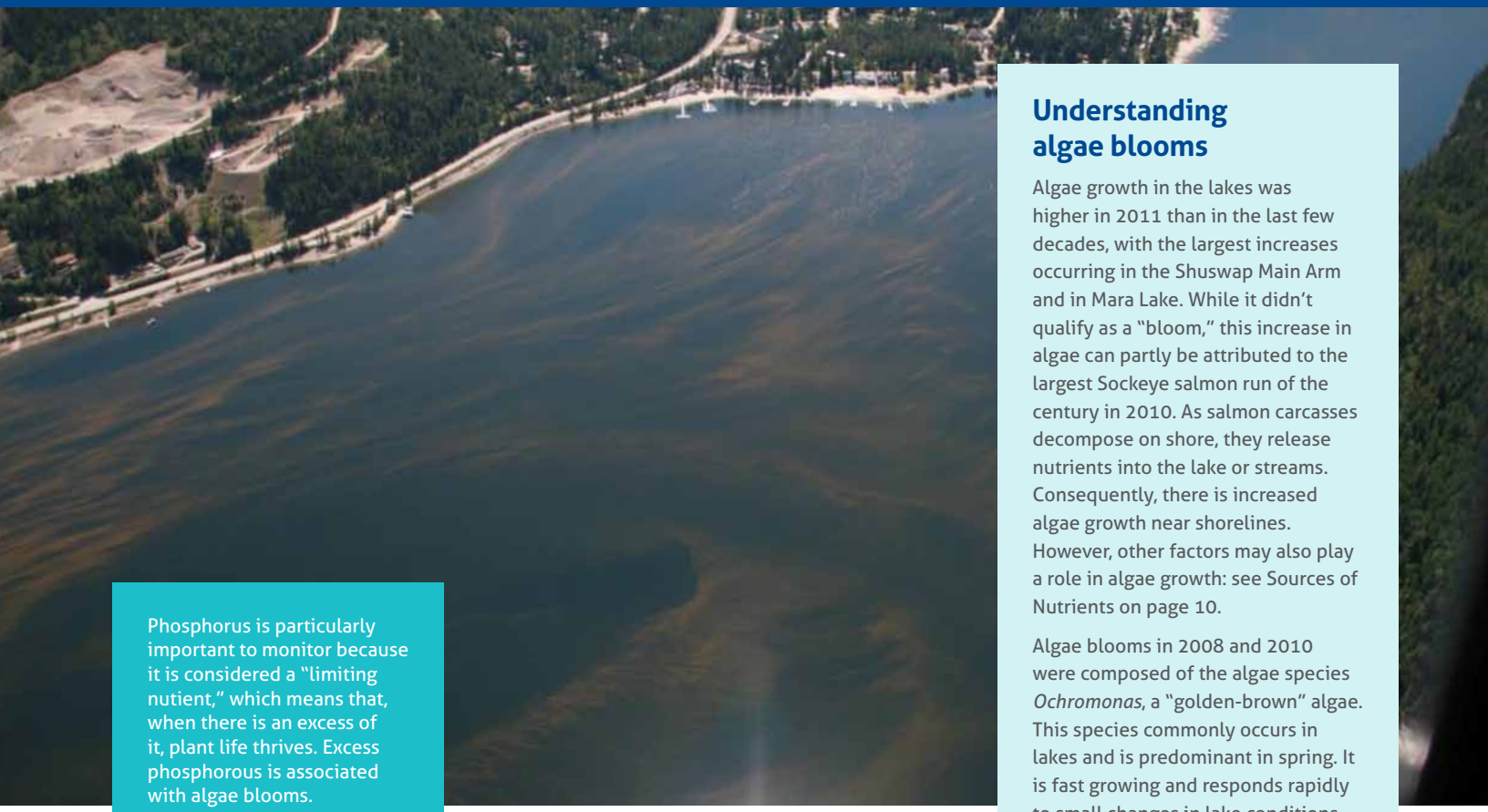
Water quality monitoring was carried out with assistance from stewardship groups and other community volunteers in the Shuswap. Here a biologist prepares an attached algae sample (periphyton) for chlorophyll a analysis.

These are the key findings of the SLIPP Water Quality Monitoring Program from 2011 to 2013. Full reports are available in the SLIPP resource archive site: ***www.slippbc.com***.

DEEP STATION MONITORING RESULTS

Dissolved oxygen (DO): DO is important to monitor because it is crucial to gill-breathing animals such as fish and insects. It is also important for many of the reactions that take place in a lake. Samples from most sites over the three-year program show the concentration of dissolved oxygen was suitable for aquatic life; but lower levels in Mara Lake and at the Sandy Point Site near Salmon Arm during late summer and early fall helped identify these areas as more productive than other parts of the lake.

Chlorophyll* a *and Algae: Chlorophyll *a* is important to monitor because it is an indication of how much algae is in the lake, which, in turn, is important to water quality for aquatic life, drinking water, recreation, aesthetics and the food chain in a lake ecosystem. Generally, the measurements of Chlorophyll *a* from 2011-2013 do not indicate a problem.



Phosphorus is particularly important to monitor because it is considered a "limiting nutient," which means that, when there is an excess of it, plant life thrives. Excess phosphorous is associated with algae blooms.

Phosphorus (P) and Nitrogen (N): These are important to monitor because they are key nutrients and measures of lake productivity. Nutrients are required in lake food chains, beginning with algae, invertebrates and insects, plants and fish. P is particularly important to monitor because it is considered a "limiting nutrient," which means that, when there is an excess of it, plant life thrives. Excess phosphorus is associated with algae blooms.

Generally, P levels at the deep stations were not a cause for concern from the perspective of lake productivity and aquatic health. However, the Sandy Point sampling site near Salmon Arm consistently showed elevated levels of P. This may have been caused in part by flooding in 2012 and a higher-than-normal spring run-off at that time, which washed nutrient-enriched soil and debris into the lakes.

N concentrations at the Shuswap Lake Main Arm sampling locations have increased. This was especially noticeable in areas where salmon carcasses from the dominant 2010 Sockeye run were deposited on the shoreline. This is to be expected, as salmon are very rich in nitrogen and, as they decompose, nutrients flow into the water. Historically, spikes in Shuswap Lake nitrogen levels occurred after dominant or sub-dominant Sockeye runs. These higher concentrations of N are well below the nitrogen guidelines for the protection of aquatic life, and are not a problem.

N concentrations also appeared higher at the Marble Point site (2012) and Sandy Point site consistently.

Measuring dissolved oxygen

Understanding algae blooms

Algae growth in the lakes was higher in 2011 than in the last few decades, with the largest increases occurring in the Shuswap Main Arm and in Mara Lake. While it didn't qualify as a "bloom," this increase in algae can partly be attributed to the largest Sockeye salmon run of the century in 2010. As salmon carcasses decompose on shore, they release nutrients into the lake or streams. Consequently, there is increased algae growth near shorelines. However, other factors may also play a role in algae growth: see Sources of Nutrients on page 10.

Algae blooms in 2008 and 2010 were composed of the algae species *Ochromonas*, a "golden-brown" algae. This species commonly occurs in lakes and is predominant in spring. It is fast growing and responds rapidly to small changes in lake conditions. While most other kinds of algae can use only light and dissolved nutrients to grow, golden-brown algae can also grow by consuming other small organisms or by absorbing organic particles from the water. The diverse feeding mechanisms of *Ochromonas*, its ability to rapidly adapt and grow, and its preference for cold water spring conditions at a time when competition from other organisms is negligible give this algae species a better opportunity to form blooms.

Lake and climate conditions in 2008 and 2010 were ideal for the *Ochromonas* algae. Increased nutrient inputs, an early winter thaw (providing increased exposure to sunlight) and extended periods of calm and sunny weather in spring created ideal conditions for its growth. Managing lake water quality to prevent this kind of algae bloom will be challenging since climate change contributes to bloom conditions; however, managing nutrient inputs will help.

NEAR SHORE MONITORING RESULTS

Near shore monitoring on Shuswap and Mara Lakes provides information about drinking water quality and the safety of swimming beaches. It also helps pinpoint any shore-based inputs of nutrients, bacteria or other substances.

Nitrogen (N): N is present in fresh water in several forms, and it transforms from one to another through the nitrogen cycle. The agencies participating in SLIPP monitored several forms of nitrogen (including nitrate - discussed below) at the near shore sites. Sources included seepage from septic fields, storm drains, agricultural and yard run-off and decaying organic matter. Nitrogen is not directly a public health concern, and there is no drinking water guideline for it.

The monitoring results show N levels high enough to suggest that there are shore-based inputs of nutrients at some locations. As noted earlier, decaying salmon carcasses from the large 2010 Sockeye run are thought to be a significant factor in these results, especially in 2011. Elevated levels of N in various forms were detected at the Christmas Island, Eagle Bay, Magna Bay, Cedar Heights, McArthur-Reedman and Crescent Bay sites, either consistently or occasionally.

Total Phosphorus (P): P is important to monitor in near-shore areas because excess P may be related to algae blooms. While some algae can produce toxins, most are not a public health concern in and of themselves. However, the treatment of water is more difficult if it contains particles as large as algae. Since waterborne pathogens may attach to algae, they may escape effective treatment, causing the water to be unsuitable for drinking.

The Christmas Island site emerges as having consistently elevated levels of P. Other sites also had occasionally elevated levels of P. The P levels at the Blind Bay - Sorrento, and White Lake groundwater sites exceeded the Canadian Drinking Water Guidelines on multiple occasions. This is a concern for residents and visitors who draw their drinking water from wells in that region.

Nitrate and Chloride: These are important to monitor as they can be indicators of septic system seepage or other in-flow of treated water. The presence of chloride at near-shore sites may also be due to the use of road salt in winter.

Elevated concentrations of nitrate were detected at several sites throughout the SLIPP water quality monitoring program. These include the Cook Avenue, Cedar Bay, Eagle Bay, McArthur-Reedman and Sorrento Water System sites, as well as at Blind Bay - Sorrento groundwater sites. Elevated levels of chloride were occasionally detected at the Christmas Island, Cedar Heights, Cook Avenue and Sorrento Water System sites. These results may be attributed to septic system seepage or urban run-off.

Fecal Bacteria (E. coli): These bacteria are important to monitor because their presence may indicate contamination with waterborne pathogens such that drinking water is unsuitable for human consumption.

Throughout SLIPP's water quality monitoring program, a few sites emerged as having repeatedly high levels of *E. coli* and bacteriological contamination: the near-shore site at Christmas Island, as well as groundwater sites at Blind Bay - Sorrento, White Lake and Sunnybrae, some of which exceeded the Canadian Drinking Water Guidelines. This is a concern for residents and visitors who draw their drinking water from wells in that region.

Residents and visitors can access drinking water quality reports from their local drinking water suppliers.

"Private septic disposal systems (PSDS) can act as localized sources of chemical and bacteriological contamination to groundwater, which may then contaminate community aquifers and surface water, posing concerns for public health in nearby areas. High concentrations of PSDS in near-shore areas – such as highly developed areas around the Shuswap that don't have community sewers – combined with a shallow water table and relatively impervious underlying bedrock are contaminating water with septic waste. The proximity of drinking water wells to PSDS increase the risk to drinking water."

– 2013 Shuswap and Mara Lakes SLIPP Water Quality Report

left & right photos: courosa / jawcey / keepitsurreal

MONITORING RESULTS RELATING TO SPECIFIC ACTIVITIES

A component of the monitoring program was aimed at assessing the impact of the Salmon Arm wastewater treatment plant on Shuswap Lake. Discharges from the treatment plant enter the lake at an outfall in the lake near the City of Salmon Arm. This is known as a point-source input. The monitoring program looked at how nutrient inputs disperse through the lake, creating zones of highly impacted and less impacted water quality. This was done by collecting samples adjacent to the outfall, and at different distances from it.

The results of the SLIPP monitoring program indicate that the treatment plant is creating a minor increase in nitrogen and phosphorus levels, localized around the treatment plant outfall; the discharges are within the treatment plant's permitted allowances. A separate and significant source of nitrogen and phosphorus to this area of the lake is the Salmon River, which enters Shuswap Lake near the treatment plant outfall: see Watershed and Tributary Monitoring Results below. There are no detectable increases in *E. coli*, which is to be expected because the effluent from the treatment plant is disinfected before it is discharged.

WATERSHED AND TRIBUTARY MONITORING RESULTS

Watershed and tributary monitoring involved sampling on all large rivers and some creeks that flow into Shuswap and Mara Lakes. This helped identify nutrients and contaminants coming into the lakes from the tributaries.

Fecal bacteria (E. coli): Canoe, Tappen, White and Newsome Creeks all had very high levels of *E. coli*, in some instances above the guidelines for recreation and swimming. Leaking septic systems, agricultural run-off, and wildlife may be contributors to the bacteriological contamination. Concentrations of *E. coli* were lower in the Salmon River than in these creeks, and most samples drawn from the Salmon River were within the guidelines for recreation and swimming. Other creeks and rivers (Adams, Scotch, Seymour and others) had low levels of *E. coli*, below the recreational guidelines and below the partial-treatment drinking water guidelines. This may be attributed to the lower population densities and activity in these watersheds.

Phosphorus (P) and other Nutrients: As previously mentioned, P is important to monitor because of its role in the aquatic food web and because excess phosphorus is associated with algae blooms. The Salmon River and Canoe, Newsome, Tappen and White Creeks had relatively high concentrations of phosphorus compared to other tributaries over the course of the SLIPP water quality monitoring program. However, since Canoe, Newsome, Tappen and White Creeks are small creeks that contribute a very small portion of the lake water, the effect on lake water quality is minimal and localized.

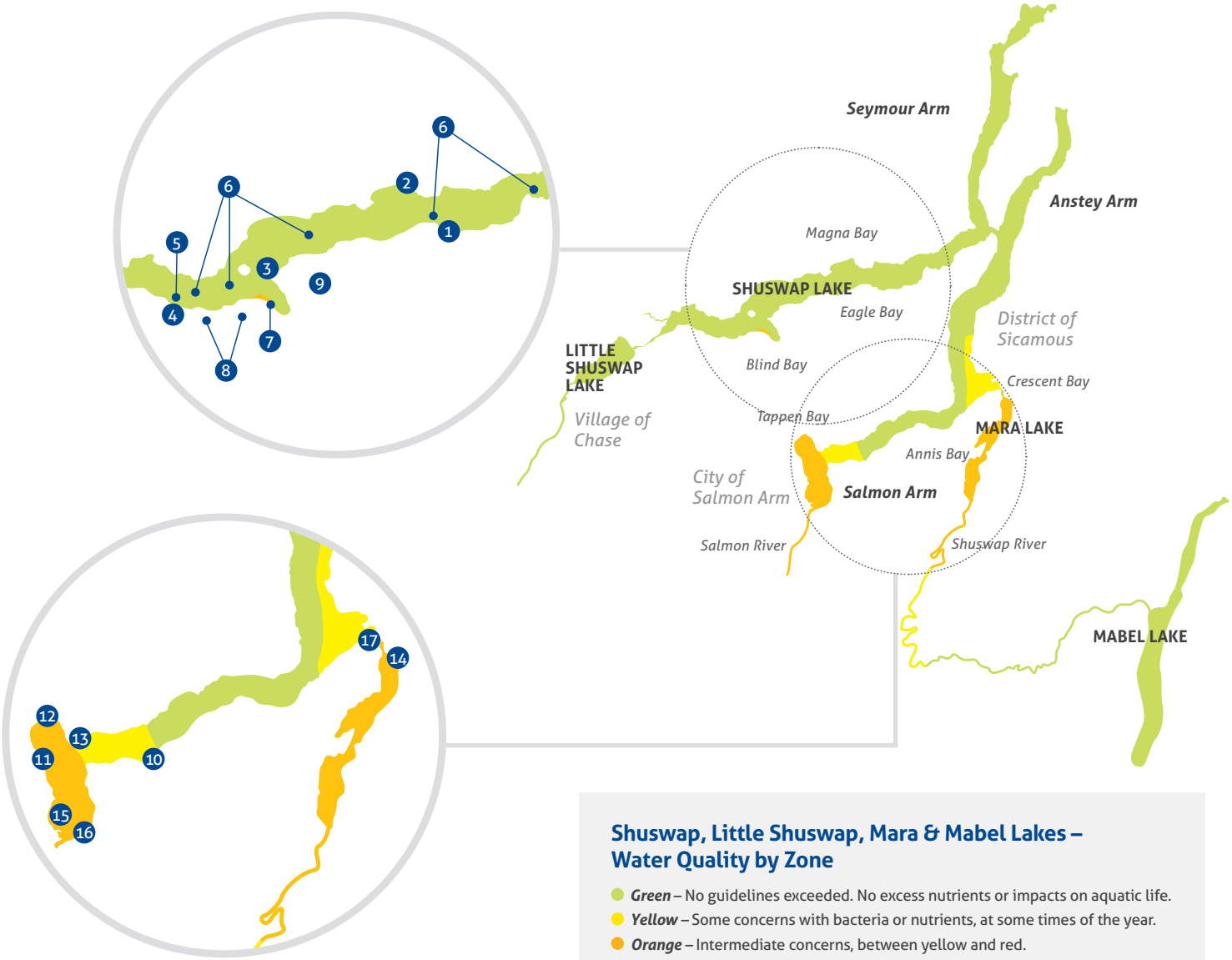
The most significant source of phosphorus and other nutrients to the Shuswap and Mara Lakes is the Shuswap River. The Salmon and Eagle Rivers contribute the second and third largest loadings of phosphorus to the lakes.

Understanding the Sources of Nutrients in the Lakes

After the first two years of water quality monitoring, SLIPP had good baseline data on water quality in the lakes and tributaries of the Shuswap. As mentioned, the Shuswap and Salmon Rivers were found to carry significant nutrient loads into the lakes. SLIPP subsequently commissioned a study to identify and better understand the sources of these nutrients, so that management options could be canvassed from a cost-benefit perspective.

Through a rigorous modelling exercise, an estimate was made of nutrient inputs from different land uses in the Shuswap watershed. Here are the key findings:

- The largest non-point source of nutrients (over 95%) comes from seepage and run-off from agricultural lands in the Shuswap, Salmon and Eagle River watersheds. This source affects water quality in the lakes much more significantly than other sources do, and should be a management focus.
- If all wastewater treatment plants in the Shuswap increased their capability to tertiary treatment (some are now operating a secondary treatment level), this would likely achieve the largest reduction in nutrients from a permitted point-source.
- Within Shuswap and Mara Lakes, the largest direct nutrient inputs occur naturally from decaying salmon following spawning.



This is a simplified map, for illustration only. For details on data and impacts, see the full monitoring reports.

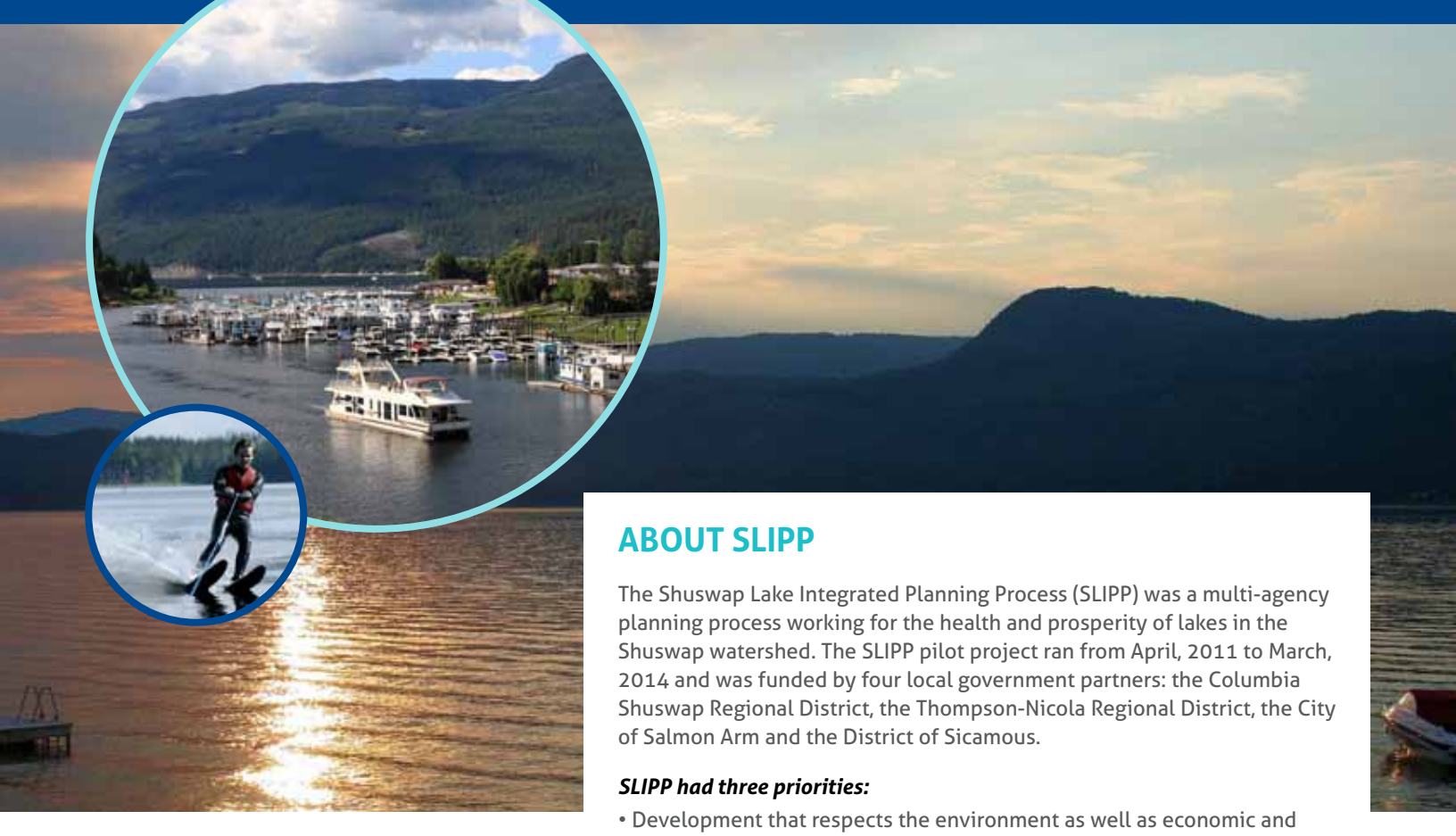
Shuswap, Little Shuswap, Mara & Mabel Lakes – Water Quality by Zone

- ***Green*** – No guidelines exceeded. No excess nutrients or impacts on aquatic life.
- ***Yellow*** – Some concerns with bacteria or nutrients, at some times of the year.
- ***Orange*** – Intermediate concerns, between yellow and red.
- ***Red*** – Extended periods in which nutrients or bacteria exceed guidelines.
  (Note: No areas of the lakes fall into this category.)

Locally Significant Results

Here are some water monitoring results of concern, by local areas (these results are occasional or frequent exceedances or elevated levels).

1. *Eagle Bay near shore site* – elevated levels of nitrogen
2. *Magna Bay near shore site* – elevated levels of nitrogen
3. *McArthur-Reedman near shore site* – elevated levels of nitrogen
4. *Sorrento Water System site* – elevated levels of chloride
5. *Newsome Creek* – high counts of *E. coli*
6. *Shuswap Lake Main Arm deep stations* – high levels of nitrogen
7. *Cedar Heights near shore site* – elevated levels of nitrogen and nitrate
8. *Blind Bay - Sorrento groundwater sites* – elevated levels of phosphorus (> Canadian Drinking Water Guidelines in some instances); elevated levels of nitrate; high counts of *E. coli* (some > Canadian Drinking Water Guidelines)
9. *White Lake groundwater sites* – elevated levels of phosphorus (> Canadian Drinking Water Guidelines in some instances); high counts of *E. coli* (some > Canadian Drinking Water Guidelines)
10. *Canoe Creek* – high counts of *E. coli*
11. *Tappen Creek* – high counts of *E. coli*
12. *White Creek* – high counts of *E. coli*
13. *Sunnybrae groundwater sites* – high counts of *E. coli*
14. *Cook Avenue site* – elevated levels of nitrate
15. *Sandy Point deep station* – consistently high levels of nutrients, and seasonally depleted oxygen levels
16. *Christmas Island near shore site* – elevated levels of nitrogen, phosphorus, nitrate and chloride; high counts of *E. coli*
17. *Crescent Bay near shore site* – elevated levels of nitrogen and nitrate



ABOUT SLIPP

The Shuswap Lake Integrated Planning Process (SLIPP) was a multi-agency planning process working for the health and prosperity of lakes in the Shuswap watershed. The SLIPP pilot project ran from April, 2011 to March, 2014 and was funded by four local government partners: the Columbia Shuswap Regional District, the Thompson-Nicola Regional District, the City of Salmon Arm and the District of Sicamous.

SLIPP had three priorities:

- Development that respects the environment as well as economic and social interests
- Water quality that supports public and environmental health
- Desirable recreational experiences that are safe and sustainable.

SLIPP supported better coordination among government agencies, public education and engagement, and research and policy recommendations on key issues. SLIPP had an advisory role only; it had no regulatory or enforcement mandate.

Partner government bodies and agencies in SLIPP:

- BC Ministry of Agriculture
- BC Ministry of Environment
- BC Ministry of Forests, Lands and Natural Resource Operations
- Columbia Shuswap Regional District
- City of Salmon Arm
- District of Sicamous
- Fisheries and Oceans Canada
- Fraser Basin Council*
- Interior Health Authority
- North Okanagan Regional District
- Royal Canadian Mounted Police
- Shuswap Nation Tribal Council
- Thompson-Nicola Regional District
- Transport Canada

** Program support and management*

Learn More

SLIPP has now completed its work. Visit the SLIPP archive website to access water quality monitoring reports for 2011, 2012 and 2013, as well as other reports, guides and resources: ***www.slippbc.com***.

For information specific to the quality of your drinking water, contact your water supplier.

Acknowledgements

SLIPP acknowledges those who have offered their expertise in the creation of this summary. In particular, thanks to Dennis Einarson and Lana Miller of the BC Ministry of Environment.

SLIPP
Shuswap Lake Integrated Planning Process

For more information, visit the SLIPP web archive or contact the Fraser Basin Council.

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